

ANTHRACO 2023 8th International Anthracology Meeting

Porto, Faculty of Sciences University of Porto 29th August – 2nd September

- Abstract book -







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INSTITUTIONAL SUPPORT

CIBIO/BIOPOLIS - Research Center in Biodiversity and Genetic Resources, Univ. of Porto MHNC-UP - Museum of Natural History and Science, Univ. of Porto FCT - Foundation for Science and Technology, B-Roman Research Project PTDC/HAR-ARQ/4909/2020 CM Porto - Porto Municipality

SUPPORT TEAM

Catarina Magalhães (PhD Student - Faculty of Arts and Humanities Univ. Porto, CITCEM) Catarina Sousa (Master Student - Faculty of Arts and Humanities Univ. Porto) Cláudia Oliveira (PhD - CIBIO-BIOPOLIS) Luís Seabra (PhD - Faculty of Sciences Univ. Porto, CIBIO-BIOPOLIS) Mariana Rodrigues (PhD Student - Faculty of Social Sciences Univ. Nova Lisbon, CIBIO-BIOPOLIS) Rita Gaspar (MHNC- Univ. Porto: conference logo design)

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Metro Station to Faculty of Sciences, Univ. Porto 20 min walk - 1,6km – <u>Link here!</u>



Directions to Biology Dept. Faculty of Sciences, Univ. Porto and Wine Reception 5 min walk - 500m – <u>Link here!</u>



Building FC4, Biology Dept. Faculty of Sciences, University of Porto



mic a S --Ð P Directions from Anthraco Venue to Conference Dinner 15 min walk – 1,2km – <u>Link here!</u>



8TH ANTHRACO SESSIONS

SESSION 1. Palaeoethnobotanical approaches to wood gathering and use

Studies with strong connection to particular archaeological realities, whether at the site, regional or multiregional levels will be presented in this session. This includes mostly palaeoethnobotanical studies, focusing on the use of wood for different purposes (fuel, construction, woodcraft, etc.), wood gathering strategies and their impact in past landscapes. Approaches to site formation processes and the integration with other archaeological and archaeobotanical data (e.g. phytoliths, isotopes, carpology, etc.) are also welcome.

SESSION 2. Methodological and theoretical developments in charcoal science

The production of wide amount of data and the will to enhance the archaeological and historical interpretative value of charcoal assemblages led to the development of new theoretical but also methodological approaches. A special focus will be given to sampling strategies, integrative multi-proxy studies, new methods in microscopy and image analysis, data analysis, databases, and platforms/strategies for data sharing.

SESSION 3. Charcoal analysis and multi-proxy studies in paleoecology

This session will gather paleoecological studies mostly centred in charcoal data but eventually combining these with other proxies from palaeoenvironmental disciplines focusing on multiple biological remains (isotopes, pollen...) or geoarchaeological data.

SESSION 4. Dendro-anthracology and human-plant interactions

Tree-ring anatomy methods and theories have been largely applied in charcoal analyses providing valuable information regarding wood gathering strategies, tree and woodland management and palaeoecology. This session will focus on these advances through casestudies as well as theoretical and experimental approaches.

SESSION 5. Databases, Dissemination and Regulatory Policies

The aim of this session is display and discuss recent developments in data management and the dissemination of anthracological science to specialists and non-specialist audiences. In a framework where anthracology is increasingly important among archaobotanical research, it is also the purpose of this session to discuss the integration of this field in broad archaeological regulatory policies as well as guidelines for the recovery of these plant evidences.

SESSION 6. Charcoal production, kilns and metallurgy

This session will focus on charcoal production sites, the exploitation of woodlands and the use of wood or charcoal in kilns for several purposes. It will address both palaeoecological and technical aspects related to fuel gathering and use as well as the management of trees and stands.

SESSION 7. Pedoanthracology

In this session, research from sedimentary charcoal, i.e., from non-archaeological sites, will be discussed, including methodological approaches and paleoecological studies in multiple spatial and time scales.

ANTRACO FULL PROGRAM



Anthraco Day 1 – Tuesday, 29TH August

Room 0.40, Faculty of Sciences – University of Porto and Porto Botanical Garden



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

8:00-9:30 Registration

9:30-10:00 CONFERENCE OPENING

	CONFERENCE OPENING	
	SESSION 1 - Palaeoethnobotanical approaches to wood gathering and use	
	10:00-10:45	KEYNOTE 1: Fuel use in the ancient Near East Katleen DECKERS, S. Riehl, D. Karakaya, K. Badreshany, D. Lawrence
		10:45-11:15 COFFEE BREAK
	11:15-11:30	The landscape of Mula river valley (Murcia, Spain) in the Middle and Upper Paleolithic Ernestina BADAL, C.M. Martínez-Varea, J. Zilhão
	11:30-11:45	The Lost Ancient Juniper Stands of the Southern Levant: Further Evidence from an Upper Paleolithic (ca. 37.5–34 ky cal. BP) Hunter-Gatherer Rock Shelter Near The Dead Sea Mark CAVANAGH, D. Langgut
	11:45-12:00	Sustainable fuel gathering at the Mesolithic Ljungaviken site in southern Sweden Santeri VANHANEN
	12:00-12:15	They get what they have: Firewood gathering in two ritual shellmound sites in Southeastern Brazil Rita SCHEEL-YBERT, A.A. Pinto, N.R. Souza-Pinto
	12:15-12:30	Session discussion
12:30-14:00 LUNCH		
	14:00-14:15	Plants and people at Morro do Ouro shellmound (Southern Brazil): Insights from charcoal analysis Taís CAPUCHO, R. Scheel-Ybert
	14:15-14:30	Prehistoric woodland use at lake shores in pre-alpine SW-Germany: charcoal and wood analysis Oliver NELLE
	14:30-14:45	Woodlands, trees and fuel in Bronze Age eastern Crete, Greece Maria NTINOU, L. Picornell-Gelabert, T. Brogan, A. Livarda, C.H. Sophianou, J. Soles
	14:45-15:00	Session discussion
	15:00-15:15	Orchards of the Oasis: fruit cultivation in the Bukhara Oasis in the 1st Millennium CE

Late Neolithic fuel use and paleoecology in Southeastern Arabia. Results from Khs-a in Al-15:15-15:30 Khashbah, Oman Lucas PROCTOR, M.P. Maiorano

Madelynn von BAEYER

15:30-15:45	Firewood exploitation in the Amu Daria region of Uzbekistan from 300 BCE to 1400 CE Raquel PIQUÉ-HUERTA, J.M. Gurt, V. Martínez-Ferreras, E. Ariño, R. Portero, S. Pidaev
15:45-16:00	Session discussion
	16:00-16:30 - COFFEE BREAK
16:30-16:45	Gone with the fire. The role of charred plant remains in burial and cremation rituals in the Iron Age necropolis of Puig des Molins (Ibiza, Balearic Islands) Yolanda CARRIÓN MARCO, G. Pérez-Jordà, M.A. Esquembre
16:45-17:00	Wood in graves: preservation and use. Examples from Bulgaria Ivanka HRISTOVA, E. Marinova
17:00-17:15	Iron Age charred woodcrafts: challenge and opportunity to enlarge our knowledge about wooden material culture María MARTÍN-SEIJO
17:15-17:30	Detecting patterns in fuelwood exploitation and goods deposition in cremation-related deposits from southern France Isabel FIGUEIRAL, C. Cenzon-Salvayre, C. Vaschalde
17:30-17:45	Session discussion

18:30-19:30

<u>Guided visit and wine reception at the Porto Botanical Garden –</u> <u>Biodiversity Hall of the Natural History and Science Museum University of Porto</u>



Anthraco Day 2 – Wednesday, 30TH August

Room 0.40 & Lab. 0.34, Faculty of Sciences, University of Porto



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

8:15-9:00 Registration

9:00-9:15	Funerary practices at the Roman Empire's northern frontier: wood charcoal and associated plant remains from a Romano-British cremation cemetery on Hadrian's Wall, Cumbria, England Zoë HAZELL, G. Campbell, T. Wilmott
9:15-9:30	Fuel exploitation and landscape dynamics before and after the Conquest: charcoal evidence from the Prehispanic village of Cueva Pintada (Canary Islands) Paloma VIDAL-MATUTANO, S. Pardo-Goedó, M.C. González Marrero, I. Díaz Sierra, J.I. Sáenz Sagasti, K. Onrubia, C.G. Rodríguez Santana
9:30-9:45	Woodland exploitation by early modern military camps and their impact on the forest environment. Anthracological analysis from inove-doorn noord (1692-1693, 1745, Belgium) Germain HELLO-LAPRÉRIE, A. Salavert, K. Deforce, A. Verbrugge, C. Callou
9:45-10:00	Landscapes of transhumance. Historical and environmental characterization of agro-sylvo- pastoral practices in Maritime Alps (Piedmont, Italy) between the 12th and 20th century Valentina PESCINI, B.I. Menozzi, I. Rellini, N. Égüez

10:00-10:15 Session discussion

10:15-11.00 POSTER SESSION 1 & COFFEE BREAK

SESSION 2. Methodological and theoretical developments in charcoal science

11:00-11:45	KEYNOTE 2: From fire properties to taphonomy, an experimental approach to temperature Isabelle THÉRY-PARISOT, B. Audiard, A. Carre, J. Chrzavzez, VL. Coli, P. Garberi, A. Lavalette
11:45-12:00	Oleiculture and viticulture in southern France during the iron age and roman period: a reconstruction based on charcoal, seed, fruit and archaeological data compared to agroecosystemic modelling Laurent BOUBY, N. Bernigaud, L. Chabal, A. Bondeau, M. Cabanis, C. Carrato, C. Cenzon-Salvayre, J. Hardonneau, C. Delhon, F. Durand, I. Figueiral, L. Flottes, J. Gomes, C. Hallavant, A. Henry, L. Liottier, P. Marinval, R. Pinaud-Querrac'h, P. Poirier, J. Ros, MP. Ruas, P. Sejalon, JF. Terral, M. Tillier, M. Toriti, C. Vaschalde, J. Guiot, N. Rovira, S. Maune
12:00-12:15	Systematic anomalous radiocarbon dates for Scots pine (Pinus sylvestris) and yew (Taxus baccata) charcoal recovered from archaeological sites in the Low Countries Koen DEFORCE
12:15-12:30	Session discussion

12:30-14:00 LUNCH

14:00-14:15	Spatial analysis of the isotopic signal (δ13c) of palaeolithic charcoals: a new tool in chrono-environmental contextualisation Benjamin AUDIARD, J. Monney, M. Padovin, T. Blasco, G. Battipaglia, I. Théry
14:15-14:30	The first identification key for woody species of the Ethiopian dry Afromontane forest Stéphanie BODIN, K. Neumann, A. Beldados, E. Lulekal, M. Wondafrash
14:30-14:45	Macchia or forest? An exploratory quantitative eco-anatomical approach applied to Arbutus unedo for a better reconstruction of Ericaceae formations in Corsica (NW Mediterranean) during the Holocene Thomas CAMAGNY, S. Ivora, JF. Terral, L. Bouby, C. Delhon
14:45-15:00	Preservation of inter- and intra-annual variation of δ13C in charred tree-rings: application to the wood of Notre-Dame de Paris E. Rocha, Frederic DELARUE, K.T. Rinne-Garmston, E. Sahlstedt, A. Ghavidel, M. Mendez- Millan, T.T. Nguyen Tu, A. Dufraisse
15:00-15:15	Session discussion
15:15-16:00	LAB SESSSION KEYNOTE 3: Distinction between trunks and branches in anthracology: new research perspectives Alexa DUFRAISSE, S. Coubray, L. Picornell-Gelabert, M. Alcolea, S. Bianco, O. Girardclos, F. Langenegger, M. Lemoine
	16:00-16:30 - COFFEE BREAK

16:30-17:45 LABORATORY SESSION (Lab. 0.35) (Bring your charcoal!)



Anthraco Day 3 – Thursday, 31st August

8:15-9:00

Registration

Room 0.40, Faculty of Sciences - University of Porto



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

SESSIC	SESSION 3 – part 1. Charcoal analysis and multi-proxy studies in paleoecology	
9:00-9:15	"Faire feu de tout bois". Insights into vegetation changes during the Pleistocene- Holocene transition and firewood selection strategies of Later Stone Age inhabitants at the Bushman Rock Shelter site, South Africa Elysandre PUECH, I. Théry-Parisot, M. Bamford	
9:15-9:30	Wood charcoal analysis from Los Monegros (NE Iberia): first results of the last 7000 years paleoenvironmental evolution Marta ALCOLEA, J.L. Peña-Monné, M.M. Sampietro-Vattuone, J. Picazo	
9:30-9:45	Neotropical forest dynamics after deglaciation in the central american highlands: first anthracological results from el Gigante Rockshelter (11,000 – 1,000 bp), Honduras Lydie DUSSOL, K. Hirth, T. Scheffler	
9:45-10:00	Fruit tree horticulture: new 7,000-year-old charcoal remains from the central Jordan Valley (Israel) Dafna LANGGUT, M. Cavanagh	
10:10-10:15	Changes in local vegetation in the Carpathian foothills: study based on plant remains from the early Neolithic settlement at Biskupice (southern Poland) Magdalena MOSKAL-DEL HOYO, A. Wacnik, M. Kapcia, M. Korczyńska-Cappenberg, A. Czekaj-Zastawny, N. Marek	
10:15-10:30	Session discussion	
	10:30-11:00 COFFEE BREAK	
	SESSION 4. Dendro-anthracology and human-plant interactions	
11:00-11:15	New insights using anthracology and spatial analysis in level Ra from the Neanderthal site Abric Romani in North-eastern Iberia Tomás FERNÁNDEZ-IRIARTE, B. Mas Velez, M.G. Chacón, P. Saladié, J. Vallverdú, E. Allué	
11:15-11:30	Evidence of woodland management at the eneolithic pile dwellings (3700-2400 BCE) in the Ljubljansko barje, Slovenia? Welmoed OUT, K. Hänninen, M. Merela, A. Velušček, C. Vermeeren, K. Čufar	
11:30-11:45	Wood Use in Predynastic Upper Egypt: Results of Charcoal Analysis from Two Predynastic Settlements in the Nile Valley. Ranran ZHANG, P. Kováčik, J. Marston, K. Bard	
11:45-12:00	Anthraco-chronology of the metallurgical forest in Languedoc during Antiquity (1st c. BC - 4th c. AD) Julien HARDONNEAU-HENNEUSE, B. Brossier, C. Vaschalde, N. Houles, B. Micouleau, JF. Terral, S. Mauné	

Characterization of fuelwood supply in the city of Barcelona (NE-Iberian Peninsula) between the 15th-17th cc. CE: a dendro-anthracological approach to Quercus sp. deciduous and Pinus halepensis.

12:00-12:15 deciduous and Pinus halepensis. Sabrina BIANCO, I. Picornell-Gelabert, A. Dufraisse, M. Lemoine, E. Allué, S. Riera Mora, C. Miró Alaix

12:15-12:30 Session discussion

	12:30-14:00 LUNCH
	SESSION 5. Databases, Dissemination and Regulatory Policies
14:00-14:45	KEYNOTE 3: The application and use of Guidelines for the retrieval, analysis and reporting of charcoal remains in Ireland Ellen O'CARROLL
14:45-15:00	Portuguese Archaeobotany at a crossroads: where do we go from here? Filipe VAZ, J. Tereso, P. Monteiro, A. Matias
15:00-15:15	The Brazilian path: from anthracology and archaeobotany to science dissemination and formal education Leonardo WAISMAN DE AZEVEDO, T.P. Capucho, R. Scheel-Ybert
15:15-15:30	SILVA and BIAD: SILVA and BIAD: how can a small project contribute to a big purpose? Claudia SPECIALE, N. Riabogina, A. Timpson, E. Allué
15:30-15:45	Towards an archaeological charcoal database for the Low Countries: insights from a meeting of charcoal specialists in Flanders and the Netherlands Radek GRABOWSKI, S. Lange, J. Van Der Laan
15:45-16:00	From excel files to open repositories: challenges of 30 years of anthracological studies at IPHES-CERCA Ethel ALLUÉ, B. Mas, I. Euba, S. Bianco, J. Sopenses, A. Robledo
16:00-16:15	Joining the conversation: sharing anthracological databases from the central part of Argentina Andrés ROBLEDO, I. Prado, R. Cattaneo, C. Romanutti, A. Izeta
16:15-16:30	Session discussion
16:30-17:15 POSTER SESSION 2 & COFFEE BREAK	
	SESSION 6. Charcoal production, kilns and metallurgy
17:15-17:30	From kilns to legacies in the environment: an interdisciplinary study of historical charcoal production in NW European lowlands Cláudia OLIVEIRA, S. Devin, V. Robin

- 17:30-17:45 Transversal regards on charcoal production history on the Mont Salève (Haute Savoie - France). Anthracology, palynology, historical studies, archaeological operations and botanical inventories approaches Sandrine PARADIS-GRENOUILLET, A. Mélo, I. Pozzi, S. Perret, P. Ruffaldi, P. Prunier
- 17:45-18:00 To reconstruct the historical forest in the Ore mountains Grit NEUBAUER

Charcoal-making in pits: an ethno-anthraco-archaeological approach 18:00-18:15 in the Moroccan Rif Aline DURAND, V. Bernollin, H. Arioua, H. Daïde

18:15-18:30 Session discussion

19:30 – (...) Conference Dinner at Vilar Oporto Hotel





Anthraco Day 4 – Friday, 1st September

Room 0.40, Faculty of Sciences - University of Porto



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

8:15-9:00 Registration

SESSI	ON 3 – part 2. Charcoal analysis and multi-proxy studies in paleoecology
9:00-9:15	The beech-fir forest, the baseline forest ecosystem in the mountain belt of temperate Europe: questioning a myth Vanessa PY-SARAGAGLIA, Saulnier MÉLANIE, L. Larrieu, B. Sylvain
9:15-9:30	The ecological impact of Longshan Neolithic urbanisation: insights from charcoal analysis in Shanxi Province, China Marvin DEMICOLI
9:30-9:45	Environmental and agrarian dynamics in the valley of al-Ula (Saudi Arabia) during the last three millennia: charcoal analysis completed by seed/fruit and phytolith studies Vladimir DABROWSKI, C. Bouchaud, E. Chambraud, A. Decaix, L. Purdue, A. Garnier, M. Lemoine, X. Desormeau
9:45-10:00	Timbers of the coffered ceiling of the Gallo-Roman cultural complex of Saint-Martin-au- Val, Autricum-Chartres (Eure-et-Loir, France): interdisciplinary approaches for the characterization of woodlands, provenance, choice and woodworking Magali TORITI, Y. Le Digol, B. Bazin, C. Azzi, E. Bouilly, S. Papaïan, C. Hano, JP. Blondeau, W. Kloppmann, N. Pollet
10:10-10:15	Environmental Archaeology between the Thar Desert (Pakistan) and Gujarat (India) during the IV-II millennium BC: preliminary anthracological results in a multi-proxy approach. Ignazio MINERVINI, M. Madella, M. Primavera
10:15-10:30	Session discussion
	10:30-11:00 COFFEE BREAK

SESSION 7. Pedoanthracology

The use of subfossil insects as a complementary tool for pedo-anthracology studies in old-growth forest soils

- 11:15-11:30
 Sarah PARRILLA, P. Moret, S. Stagno, M. Saulnier, V. Pescini, L. Larrieu, Valladares, H. Brustel, V. Py-Saragaglia
 Holocene dynamics of beech versus oak forest stands inferred by soil charcoal
 11:30-11:45
 analysis: insights at regional scale
 Vincent ROBIN, T. Feiss, D. Aran, J. Levillain, J.-L. Dupouey
- Charcoal across the slopes: 20 years of anthracology on both sides of the Petit-Saint-11:45-12:00 Bernard pass (Northern French and Italian Alps) Claire DELHON, V. Robin, T.M. Schroedter, S. Thiebault, P.-J. Rey
- The regional and spatial diversity of vegetation history based on the antracological data 12:00-12:15 from Bohemian sandstone areas Jan NOVÁK, P. Bobek, V. Abraham, M. Man, P. Pokorný

12:15-12:30 Session discussion

12:30-14:00 LUNCH

SESSION 3 – part 3. Charcoal analysis and multi-proxy studies in paleoecology	
14:00-14:45	KEYNOTE 3 Woody vegetation of Portugal, a brief synthesis Carlos AGUIAR
14:45-15:00	The Chernovskoe hillfort and its immediate surroundings in the Iron Age and the Early Middle Ages: Economic activity of the inhabitants and its impact on the environment Julia SALOVA, N. Ryabogina, L. Vyazov, E. Ponomarenko, V. Mingalev, R. Utyagulova
15:00-15:15	Landscape changes, deforestation and plant exploitation in western Iberia during Roman times: new data from the B-Roman project João TERESO, F. Costa Vaz, C. Oliveira, L. Seabra, A.C. Sousa, C. Detry
15:15-15:30	Anthracology in a relict forest in the south pacific, an archaeobotanical approach on wood charcoal assemblages from Mocha island Ayelen DELGADO ORELLANA
15:45-16:00	Evaluation of the roof structure condition of Notre-Dame de Paris (France) Magali TORITI, F. Fohrer, O. Girardclos, JY. Hunot, C. Penagos
16:00-16:15	Session discussion

16:15-16:45 COFFEE BREAK

16:45-17:45 PLENARY SESSION & MEETING CLOSURE



Anthraco Day 5 – Saturday, 2nd September Post-Congress Excursion



- 8:30-8:45 Meeting point at **Porto Planetarium** (near Faculty of Sciences University of Porto).
- 9:00-12:00 Transport and **guided visit to the Iron Age site of Citânia de Sanfins** (Paços de Ferreira).



12:00-14:45 Transport, **lunch** (lunchbox) and **guided visit to the Oak Forest of Reixela** (Ovil, Baião).



15:00-17:30 Transport and guided tour to the vineyards and caves of Quinta da Aveleda (Penafiel). Wine tasting experience.



17:30-19:00 Transport and arrival to Porto Planetarium



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

- SESSION 1 -

Palaeoethnobotanical approaches to wood gathering and use

Oral Abstracts

Keynote Session 1

FUEL USE IN THE ANCIENT NEAR EAST

Katleen DECKERS* (University of Tübingen); S. RIEHL (University of Tübingen); D. KARAKAYA (University of Tübingen); K. BADRESHANY (University of Durham); D. LAWRENCE (University of Durham)

*katleen.deckers@uni-tuebingen.de

In this presentation we will investigate the contents of ovens, hearths, and fire pits from many sites, periods, and regions in the Near East to gain understanding of former fuel use and selection. As part of the ERC-funded "Climate, Landscape, Settlement and Society" (CLaSS)-project we evaluate published archaeobotanical data that was entered into an updated version of the ADEMNES database, including the contents of more than 20 newly investigated fire installations. The project also possesses a large database of more than 50,000 ancient Near Eastern settlements dating to the last 8000 years, that allows gaining insight into settlement patterns and the degree of pressure on the vegetation for fuel acquisition. With this data we will focus on the following questions in this presentation: Can we observe changes in fuel use related with population increase and decrease? Can we detect former selection criteria in fuel acquisition, such as e.g., species selection towards higher caloric values or wood size selection related with woodland management? What is the impact of environmental and land use change on fuel acquisition?

Keywords: Charcoal datasets; Seed datasets; Ovens; Hearths; Near East.

THE LANDSCAPE OF THE MULA BASIN (MURCIA, SPAIN) IN THE MIDDLE AND UPPER PALEOLITHIC

Ernestina BADAL* (University of Valencia); **C.M. MARTÍNEZ-VAREA** (University of Salamanca); **J. ZILHÃO** (University of Lisbon)

*ernestina.badal@uv.es

Three Paleolithic sites in the Mula Basin of Murcia (Cueva Antón, Abrigo de la Boja and Finca de Doña Martina) have offered, in the last years, significant insights on Middle and Upper Palaeolithic cultural dynamics and human behaviour.

Archaeological research at these sites revealed stratified sedimentary accumulations with a high chronological resolution, which have become reference sequences for the culture-stratigraphy of the Upper Pleistocene of eastern Iberia. Neanderthals and modern humans occupied these sites recurrently, leaving behind perfectly stratified combustion structures and associated archaeological remains. From the beginning of the excavations (2006), sediments were systematically sampled to recover plant remains (wood charcoal and seeds) to reconstruct the region's Palaeolithic landscape and plant management strategies, from MIS5 to the end of MIS2, in one of the driest areas of Europe.

In this communication, we present a synthesis of the archaeobotanical results. Nowadays, due to its geographical situation, the Mula Basin has an arid Mediterranean climate, with mean annual precipitation around 300 mm. This aridity seems structural and typical for the Upper Pleistocene of the area, as xeric taxa (*Pinus halepensis, Juniperus, Artemisia, Echium vulgare*) predominate throughout. The changes detected in the taxonomic composition of the archaeobotanical assemblages respond to variations in temperature rather than precipitation: for firewood, thermophilous plants were used during MIS 5, and cryophilous plants were used from MIS4 to MIS2. In both cases, humans used whatever dry firewood was locally available regardless of taxonomy.

Keywords: Charcoal; Seeds; Middle and Upper Palaeolithic; Upper Pleistocene; Murcia.

THE LOST ANCIENT JUNIPER STANDS OF THE SOUTHERN LEVANT: FURTHER EVIDENCE FROM AN UPPER PALEOLITHIC (CA. 37.5–34 KY CAL BP) HUNTER-GATHERER ROCK SHELTER NEAR THE DEAD SEA

Mark CAVANAGH* (Tel Aviv University); D. LANGGUT (Tel Aviv University)

*markgordonc@mail.tau.ac.il

Though today totally absent from the arid regions of modern Israel, previous anthracological studies have demonstrated that Juniperus sp. (suggested as J. phoenicea, the Phoenician juniper), a Mediterranean element, was present in the Negev Desert until the Chalcolithic period, with the assumption that it was a relict population with a low distribution that went extinct in the region about 7,000 years ago. Today, small-scale distributions of relict populations of J. phoenicea exist in the nearby arid regions of the northern Sinai Peninsula and the Edomite Plateau in Jordan. Our new results from the Judean Desert may be "the missing link" in the former distribution of the species, and point to the possibility that its spread was not "patchy". Charcoals collected from Nahal Rahaf 2 rockshelter, a habitation site in the Judean Desert near the Dead Sea dated to the early Upper Palaeolithic (ca. 37.5–34 ky cal BP) contained high ratios of Juniperus (56%), and is the only evidence so far for the presence of this tree in this location. Once again the high exploitation of juniper trees in yet another district where the taxon is now extinct is presented, forwarding the growing discussion on the former distribution of the tree and the implications vis-à-vis the role of humans in its complete disappearance in much of the southern Levant. In addition to juniper, the charcoal assemblage is also characterized by high frequencies of the toothbrush tree (Salvadora persica, 17%) and white broom (Retama raetam, 12%), aiding in our reconstruction of the ancient landscape while raising the possibility that these taxa were specifically collected for their physical-chemical properties. Our paleoenvironmental reconstruction suggests that the woody vegetation of the Judean Desert was much denser during the Late Pleistocene, providing higher quality timber resources, specifically for fuel, for the inhabitants.

Keywords: Juniper; Palaeolithic; Deforestation; Southern Levant; Desert.

SUSTAINABLE FUEL GATHERING AT THE MESOLITHIC LJUNGAVIKEN SITE IN SOUTHERN SWEDEN

Santeri VANHANEN* (Archaeologists State Historical Museums)

*santeri.vanhanen@arkeologerna.com

More than fifty Mesolithic (ca. 7000–6000 cal BC) huts were found well preserved below a thin gyttja layer and two meters of alluvial sand in Ljungaviken in southern Sweden. This enabled good conditions for preservation of charcoal inside the huts and in fireplaces. Charcoal was studied in more than hundred radiocarbon dated samples and more than two thousand charcoal pieces were identified. In addition to taxonomic identification, ring curvature, insect degradation and average growth ring width were studied. Also plant macrofossils and pollen were studied at the site. The results show only minor changes in forest composition, which was dominated by pine (Pinus cf. sylvestris), together with some aspen (Populus cf. tremula). Oak (Quercus sp.) and other broad-leaved species became more common around 6000 BC, probably related to warming climate. Interestingly, the amount of hazel (Corylus avellana) and Pomoideae charcoal was minor, though hazelnuts were common and crab apples (*Malus sylvestris*) quite common in the plant macrofossil assemblage. This could indicate that fruits and nuts were procured from a distance from the site. Ring curvature and average ring width shows negligible changes, which seem to indicate sustainable fuel gathering from the surroundings.

Keywords: Mesolithic; Sweden; Huts; Wood Charcoal Analysis; Macrofossil Analysis.

PLANTS AND PEOPLE AT *MORRO DO OURO* SHELLMOUND (SOUTHERN BRAZIL): INSIGHTS FROM CHARCOAL ANALYSIS

Taís CAPUCHO* (Museu Nacional, Universidade Federal do Rio de Janeiro); R. SCHEEL-YBERT (Museu Nacional, Universidade Federal do Rio de Janeiro)

*taiscapucho@mn.ufrj.br

Sambaguis are shellmounds built to hold funerary ceremonies of past societies who inhabited Brazilian coast from 10,000 to 1000 years BP. In those events, sambaqui people practiced funerary feasts and covered their dead with mound-like layers of mixed materials (shells, sand, earth, fish bones, ashes, charcoal). Sambaguis can reach up to 30 meters high and hundreds of meters long, and sometimes represent thousands of years of continuous ritual activities. Until now, habitation areas of the sambaqui builders remain unknown, therefore all information about their lives derives from studies of the funerary mounds. Sambagui Morro do Ouro (5207-4527 to 4500-3896 cal BP), located at Santa Catarina (Southern Brazil), holds several records of intense plant consumption. The high prevalence of caries, presence of cultivated plants micro-remains, and plant protein identified in isotopic analysis are the main evidence in debate. For this reason, the site was excavated in 2019 by the project "Exploring the origin of food production in the Atlantic Forest coast of Brazil". Anthracological samples sent to the Laboratory of Archaeobotany and Landscape in Museu Nacional are under analysis. So far, the assemblage identified is consistent with a restinga environment (e.g. Anacardiaceae, Annonaceae cf. Xylopia sp., Eupatorium sp., Cordia sp., Euphorbiaceae cf. Alchornea sp., Lauraceae, Malvaceae Bombacoideae, Fabaceae, Malvaceae Tilioideae, Melastomataceae, Meliaceae, Myrtaceae, Sapotaceae, Sideroxylum sp. etc.), with presence of mangrove (Rhizophora mangle) and of the Atlantic Forest nearby - the latter indicated by gymnosperms remains (Araucaria angustifolia, Podocarpus sp.). The charred samples also contain remains of palm stems, palm nuts, and seeds. A. angustifolia seeds are an important food staple for more recent populations; their starch grains had been previously identified in nearby sambaguis, but were interpreted as exogenous. The charcoal record suggests it might be local and regularly exploited.

Keywords: Sambaqui; Landscape; Anthracology; Coastal Archaeology; Brazil.

THEY GET WHAT THEY HAVE: FIREWOOD GATHERING IN TWO RITUAL SHELLMOUND SITES IN SOUTHEASTERN BRAZIL

Rita SCHEEL-YBERT* (Museu Nacional, Universidade Federal do Rio de Janeiro);
 A. ÁVILA PINTO (Museu Nacional, Universidade Federal do Rio de Janeiro);
 N.R. SOUZA-PINTO (Museu Nacional, Universidade Federal do Rio de Janeiro)

*scheelybert@mn.ufrj.br

The Brazilian coast was occupied through several millennia by shellmound builders who constructed impressive mounds locally named "sambaquis". Two decades ago, when anthracological research began in these sites, these people were thought to be fishergatherers and the mounds were interpreted as residential units. Now, they are recognized to have had a system of mixed economy, where fishing and gathering were associated with horticulture, and the mounds are demonstrated to have been funerary. Anthracological and archaeobotanical research largely contributed to these changes. The several sites already studied in the Southern-Southeastern coast indicated that sambaqui people had an intrinsic association with the restinga ecosystem, but their catchment area extended to other vegetation types present in the environment, such as the Atlantic Forest and mangroves. Two sites recently studied in the rear of the Guanabara Bay, near Rio de Janeiro city (Sambaquis Sernambetiba, dated from c. 2000 to 1800 cal BP, and Amourins, dated from c. 4200 to 3900 cal BP) confirm that sambaguis were established in the restinga, but present an unusual predominance of mangrove wood as firewood. In this context, we will discuss the implications of these findings to environmental reconstruction and landscape, as well as regarding the plants used to fuel ceremonial hearths and those probably used in funerary offerings and feasting.

Keywords: Sambaqui; Landscape; Funerary rites; Coastal Archaeology; Brazil.

WOOD TECHNOLOGY AND DIVERSITY OF ARTIFACTS IN THE EARLY NEOLITHIC SITE OF LA MARMOTTA (LAGO DI BRACCIANO, ITALY)

Laura CARUSO-FERMÉ* (Instituto Patagónico de Ciencias Humanas y Sociales -CONICET); P. MONTEIRO (DGPC-LARC; ICArEHB); M. MINEO (Museo delle Civiltà di Roma); G. REMOLINS (Regirarocs, S.L.); N. MAZZUCCO (Università di Pisa); J.F. GIBAJA (Escuela Española de Historia y Arqueología en Roma; CSIC)

<u>*lcarusoferme@gmail.com</u>

The lakeshore site of La Marmotta is one of the most important Early Neolithic sites of Mediterranean Europe. The site is famous for the exceptional preservation of organic materials, including numerous wooden artefacts related to agricultural and hunting activities, navigation, textile production and instruments for processing a broad array of raw materials. The wide range of wooden artefacts found in the same archaeological site and the occupation time of La Marmotta between 5700 and 5300 cal BC, was an exceptional opportunity for reconstructing the wood technology of the first Neolithic communities that spread throughout the Mediterranean and understanding their level of craft specialization.

The main aim of this work is to make visible the extreme richness of the La Marmotta archaeological record and provide insights into Neolithic woodworking, by identifying the wood taxa utilized as raw material. To this goal, we have studied various types of wooden artifacts such as spoons, sickles, bows, dugout canoes and objects related to navigation. The assemblage of wooden artifacts found at the La Marmotta site reflects the significance of this raw material for the Neolithic societies. The results of the taxonomic analysis provide an excellent image of the selection of wood raw material used to manufacture these artifacts. These results enable a discussion about the criteria of selection and use of the ligneous raw materials depending on the type and function of the wooden artifacts, is of great importance to understand the degree of specialization of the first Neolithic communities that spread in this area.

Keywords: Woodworking; Taxonomic analysis; Waterlogged site; Early Neolithic, Mediterranean.

PREHISTORIC WOODLAND USE AT LAKE SHORES IN PRE-ALPINE SW-GERMANY: CHARCOAL AND WOOD ANALYSIS

Oliver NELLE* (Dendrochronology lab, Baden-Wuerttemberg State Office for Cultural Heritage - Regierungspraesidium Stuttgart, Gaienhofen-Hemmenhofen, Germany)

*oliver.nelle@rps.bwl.de

Pre-alpine Neolithic and Bronze Age lake settlements are an exceptional archive for organic material due to waterlogged conditions at lake shores or in peatlands. Large numbers of wooden piles and wood remains from cultural layers and pile fields have been gained since the 1980ies from sites in Baden-Württemberg (SW-Germany), and analysed taxonomically and dated dendrochronologically by the dendrolab in Hemmenhofen. Thus knowledge about construction timber is very detailed, concerning taxa, dimension, dating and dendroecology. As for the use of fuel wood, there are still gaps to be filled by further anthracological works. The talk will present the current state of analysis of charcoals either gathered in recent excavations, with a new awareness of collecting charcoals from bulk samples being sieved and flotated, or being "rediscovered" in storage archives as samples from older excavations. These are now under analysis and put in context. The corpus of the new data serves as a base for the discussion on common trends and differences in the preference of certain woody taxa for construction, energy, and tool making, and complements the rich palynological corpus of the region.

Keywords: Prehistoric Lake Settlements; Dendrochronology; Neolithic Woodland Composition.

WOODLANDS, TREES AND FUEL IN BRONZE AGE EASTERN CRETE, GREECE

Maria NTINOU* (Dept. of Archaeology, Aristotle University of Thessaloniki, Greece); L.
 PICORNELL-GELABERT (ArqueoUIB Research Group; University of the Balearic Islands);
 T. BROGAN (INSTAP Study Center for East Crete); A. LIVARDA (Catalan Institute of Classical Archaeology); C.H. SOPHIANOU (Ephorate of Antiquities of Lasithi); J. SOLES (Dept. of Classical Studies, University of North Carolina)

*mgntinou@hist.auth.gr

Bioarchaeology has gained increasing attention in Cretan archaeology in the last decades and systematic recovery and analyses of different categories of bioarchaeological remains is commonly carried out in many sites. Therefore, analyses of plant macro-remains have become relevant in assessing past landscapes, economy and societies in Crete. The present study focuses on the anthracological datasets from Bronze Age sites in eastern Crete. The studied sites are all coastal settlements, namely Mochlos, Papadiokambos, Palaikastro and Chryssi island, located in different natural settings along the northern coast and off the southern coastline. They preserve Middle and Late Minoan phases of variable spatial organization and different socio-economic characteristics. Most of the studied wood charcoal assemblages originate from buildings without evidence of destruction by fire, thus representing firewood debris. In this sense, the study focuses on firewood procurement and consumption patterns in the different settlements and buildings. Accordingly, we assess the role of fuel and firewood in the economy, the nature of woodlands and their management by Bronze Age communities in Eastern Crete. Other bioarchaeological, landscape and paleoenvironmental records that account for the economy and the use of natural resources in the area are also considered. We discuss woodland composition, its time-space dynamics and management, as well as the development of tree-crops and their role in the settlements' economy for fruit, fodder and firewood.

Keywords: Fuel; Woodland; Tree-crops; East Crete; Bronze Age.

ORCHARDS OF THE OASIS: FRUIT CULTIVATION IN THE BUKHARA OASIS, UZBEKISTAN DURING THE 1ST MILLENNIUM CE

M. VON BAEYER* (Max Planck Institute for Geoanthropology)

*vonbaeyer@shh.mpg.de

Fruit has long been associated with Central Asia, not without reason. The native ranges of many of the world's economically important fruits are assumed to be in Central Asia. For example, apples originate in Tian Shan Mountains, at the northeastern edge of modern Kazakhstan and northwest China. Samarkand, one of the largest cities in Medieval Central Asia, is known for sending "golden peaches" to the Chinese court. Even now popular tourist photos from Central Asia often feature the many dried fruits and nuts available at local markets. Despite the association of fruits and Central Asia, the exact nature of this relationship in the past is not well known.

This paper will examine the wood charcoal assemblages from two sites, Paykend and Bukhara, on the Lower Zarafshan River in Uzbekistan, for evidence of changing fruit cultivation patterns in the first millennium CE. Paykend was a Zoroastrian ritual center from the third century BCE through the fifth century CE and then transitioned into a merchant city beginning in the sixth century CE. Bukhara was settled sometime in the first century CE and then emerged as the dominant city in the Bukhara Oasis at the end of the seventh century CE, right before the Arab Conquest. After the Arab Conquest in the beginning of the eight century CE, Bukhara became a major hub of international trade.

By examining the wood charcoal assemblages of Paykend (9 samples) and Bukhara (10 samples) during the first millennium CE, this paper will trace the changes in fruit cultivation before and after these sites choose to invest in international trade. This analysis will examine the evidence for local cultivation or trade of fruits within the Bukhara Oasis. It will also critically examine the cultural assumptions we have about the relationship between fruits, trade, and people in Central Asia.

Keywords: Charcoal; Fruit cultivation; Uzbekistan; Medieval; Late Antiquity.

LATE NEOLITHIC FUEL USE AND PALEOECOLOGY IN SOUTHEASTERN ARABIA. RESULTS FROM KHS-A IN AL-KHASHBAH, OMAN

Lucas PROCTOR* (Institute for Archaeological Sciences, J.W. Goethe University Frankfurt am Main); M.P. MAIORANO (Institute for Archaeological Sciences, J.W. Goethe University Frankfurt am Main)

*proctor@em.uni-frankfurt.de

This study combines the results of anthracological analysis and archaeological excavation from the Late Neolithic (fifth–fourth millennium BCE) site of KHS-A in al-Khashbah, Oman with regional climate proxy information to examine the availability of wood fuels and the paleoecology of the southern piedmont of the Hajar Mountains during the Middle Holocene. During the Holocene Humid Period (8000–3000 BCE), south-eastern Arabia, including Central Oman, experienced increased humidity as a result of a stronger and more northward annual monsoon. This climatic event begins to retreat by the end of the Neolithic. However due to a lack of well-dated Neolithic sites and reliable paleovegetation reconstructions in the interior of Oman, there remains little information about local vegetation development and human occupation during this time.

In this study, we present an anthracological analysis of samples collected from two years of excavation at the site of KHS-A. The site, first identified in 2022, has resulted in the only substantial charcoal dataset thus far collected from a Neolithic site in the interior of Oman. Excavations at two loci within the site have explored stone alignments resembling structures and ten fireplaces built over at least two different phases. We discuss the implications of this dataset for understanding of Neolithic fuel preferences and mobility in central Oman. In particular, the identification of *Avicennia marina* and shell beads at this inland site highlights connections with the coastal regions of Oman. Through a comparison with anthracological datasets from the Hafit Period (3200–2700 BCE) settlement at al-Khashbah and nearby Late Islamic (1500–1800 CE) sites, we further examine evidence for and against changes in land cover related to the end of the Holocene Humid Period. Finally, we consider the methodological challenges arising from the study of charcoal from ephemeral hunter-herder sites in desert environments.

Keywords: Oman; Neolithic; Mobility; Holocene Humid Period; Avicennia.

FIREWOOD EXPLOITATION IN THE AMU DARIA REGION OF UZBEKISTAN FROM C. 300 BCE TO C. 1400 CE

Raquel PIQUÉ-HUERTA* (Department of Prehistory, Autonomous University of Barcelona); J.M. GURT (ERAAUB, Department of Ancient History and Archaeology, University of Barcelona); V. MARTÍNEZ-FERRERAS (ERAAUB, Department of Ancient History and Archaeology, University of Barcelona); E. ARIÑO (Department of Prehistory, Ancient History and Archaeology, University of Salamanca); R. PORTERO (Department of Prehistory, Ancient History Ancient History and Archaeology, University of Salamanca); S. PIDAEV (Institut of Fine Arts, Academy of Sciences of Uzbekistan)

*raquel.pique@uab.cat

This work presents the results of the analysis of charcoal recovered during the recent excavations in the ancient city of Termez and other sites of the silk road in the Amu Daria region of Uzbekistan, dated between 300 BCE and 1400 CE. The charcoal analysis has focused on the identification of taxa with the aim to approach the firewood acquisition and use. The taxa identified indicates the exploitation of the species growing at the riverside forests near the course of the Amu Darya along the sequence. *Tamarix* sp., *Fraxinus* sp., and Salicaceae are the most recurrent taxa. Moreover, other taxa like *Eleagnus* sp., *Vitis vinifera*, *Prunus* sp., Maloideae are also present, which suggest the use of branches from pruning of fruit trees. Differences in firewood use are documented along the sequence but also in relation with the activities identified in the sectors of the site.

Keywords: Charcoal; Uzbekistan; landscape evolution.

CULTIVATED LANDSCAPES OF WESTERN AFRICA – THE TREE-SIDE STORY

Alexa HÖHN* (Goethe Universität, Frankfurt)

*a.hoehn@em.uni-frankfurt.de

Intentional fires, pastoralism and plant food-production have decisively shaped the composition and appearance of western African savannahs today and in the past. With the hoe as the main tool, shifting cultivation and the protection of useful trees within fields, human impact has changed composition and physiognomy of the vegetation. For their reminiscence of English parks, these cultivated landscapes are often termed parklands in western Africa, and different varieties exist. Depending on type and intensity of land-use, environmental conditions and cultural preferences, the composition of the tree layer varies and is characterized by one or few woody taxa, among them the shea tree (*Vitellaria paradoxa*) or the apple-ring tree (*Faidherba albida*). The existence of various parklands in different regions of West Africa today is but the result of a process that supposedly has started with the beginning of farming about 4500 years ago, but whose dynamics are largely unknown.

The project "Cultivated Landscapes" precisely aims to understand more about the history, dynamics and sustainability of these systems in the past. To this end, we are examining wood charcoals from sites in key regions of archaeological research throughout West Africa and complement the results with carpological, archaeozoological and palynological evidence wherever present. From the data available so far, the aforementioned shea tree and apple-ring tree, as well as the pioneer *Guiera senegalensis*, a Combretaceae, and the Nile acacia (*Vachellia nilotica*) have emerged as characteristic for different Iron Age farmscapes. Along these taxa and their traditional uses, we will give an overview of possible trajectories that emerge for the development of cultivated landscapes in western Africa.

Keywords: Charcoal; Land use; Savannah; Iron Age; Western Africa,

GONE WITH THE FIRE. THE ROLE OF CHARRED PLANT REMAINS IN BURIAL AND CREMATION RITUALS IN THE IRON AGE NECROPOLIS OF PUIG DES MOLINS (IBIZA, BALEARIC ISLANDS)

Yolanda CARRIÓN MARCO* (Universitat de València); G. PÉREZ-JORDÀ, (Universitat de València); M.A. ESQUEMBRE (ARPA Patrimonio, S.L.)

*yolanda.carrion@uv.es

The necropolis of Puig des Molins was the cemetery of the city of Ibiza throughout antiquity. During the fieldwork in 2006 and 2007, a set of charred plant remains (wood, seeds and fruits) were recovered by sediment flotation, both from cremations and burials from the 1st millennium BCE. Plant remains are essential part of the funerary practices, but sometimes their origin may be uncertain or not contemporary with the tomb in which they are found. The study of plant remains in funerary contexts is suitable for investigating issues such as funeral gestures, the presence of offerings or the taphonomic processes that occurred in the burial structures.

At Puig des Molins, the presence of these materials in the cremations is linked to their use as fuel or as offerings during the ritual, while their presence in the burial pits might be accidental. In the first case, along with the charred wood (presumably the fuel used in the pyres), different remains of cultivated (cereals, legumes and fruits) and wild (pine nuts) plants were documented. Their presence could be explained by the fact that they would be offerings introduced into the fire at some point in the ritual. On the contrary, the burial pits are filled with sediment that may contain heterogeneous remains from the entire area of the necropolis and from the activities that took place in it. The characteristics of the plant remains and the radiocarbon dating carried out confirm this dynamic.

Remains of bread have also been documented, which indicates the consumption and/or offering of this product.

Keywords: Necropolis; Plant Remains; Offerings; Pyres; Bread

WOOD IN GRAVES: PRESERVATION AND USE. EXAMPLES FROM BULGARIA

Ivanka HRISTOVA*, (Department of Historical, Philosophical and Religious studies, Umeå University); E. MARINOVA (Laboratory for Archaeobotany, State Office for Cultural Heritage Baden Wuertenberg, Geienhofen-Hemmenhofen

*ivanka.hristova@umu.se

Plant remains are frequently found in ritual contexts, often associated with certain symbolic or utilitarian meaning. Among those remains, the wood and wood charcoals play a significant role and therefore here we focus on those finds and discuss the importance of wood remains for the archaeological and environmental interpretation of burial contexts.

Case studies from graves situated on the modern territory of Bulgaria, corresponding to the time frame 5 c. BC - 3 c. AD, are considered here. The temperate climatic conditions of the study area, allow mostly preservation in charred state. If special conditions arise, other types of preservation, like mineralization, waterlogging, desiccation can also occasionally occur. Starting with the way of preservation, we will also discuss the role of wood in the studied contexts: fuel, construction, woodcraft, as well as possible ritual significance. In addition, a reconstruction of the woodland vegetation around the sites will be attempted.

The results show wide diversity of the used wood. Species like oak (*Quercus* sp.), cornel (*Cornus* sp.), elm (*Ulmus* sp.), hazel (*Corylus* sp.), and hornbeam (*Carpinus* sp.) were often used as fuel in cremations. The timber in constructions was dominated by oak (*Quercus* sp.), pine (*Pinus* sp.), and ash (*Fraxinus* sp.). Various species were used for furniture and other objects: ash (*Fraxinus* sp.), Macedonian/Bosnian pine (*Pinus* peuce/heldreichii), oak (*Quercus* sp.), guelder rose (*Viburnum* sp), etc.

Detailed analysis of wood and other organic remains from burials show the important role of those findings for the further archaeological interpretation of the artefacts. Moreover, they can significantly contribute to our understanding of the funeral ritual and give information on the surrounding environment.

Keywords: Charcoal; Wood analyses; Graves; Hellenistic and Roman period; Bulgaria
IRON AGE CHARRED WOODCRAFTS: CHALLENGE AND OPPORTUNITY TO ENLARGE OUR KNOWLEDGE ABOUT WOODEN MATERIAL CULTURE

María MARTÍN-SEIJO* (Universidad de Cantabria)

*maria.martin@unican.es

The existence of intentional or accidental fire events, and actions involving the destruction of objects by burning for example in relation to feasting contexts has provided an exceptional opportunity to obtain information about Iron Age woodcrafts. Our current and previous research projects (MATERIAL, B-WILD, WILD) in northwest and northern Iberia have involved the study of a growing number of wooden objects including artefactual and non-artefactual wood. Those studied up to now have provided information about the selection of specific taxa for specific uses (e.g. alder for all kind of containers), complementing the information about wood management in relation to firewood consumption. Their study has also produced information in relation to the incorporation of technological innovations -such as lathe-turning- and has enlarged our knowledge about Iron Age perishable material culture which mostly remain unknown until recent years. Despite this, charred woodcrafts still being challenging objects of study. Their fragmentary state of preservation, besides their fragile nature, requires the design of a methodology which privileges the application of non-invasive methods such as SEM and micro-CT besides the obtention of 3D models, and the incorporation of experimental programs in tandem with the morpho-technological analysis of the archaeological remains.

Keywords: Wooden crafts; Charcoal; Material Culture; Morpho-technological analysis; Non-invasive methods

DETECTING PATTERNS IN FUELWOOD EXPLOITATION AND GOODS DEPOSITION IN CREMATION-RELATED DEPOSITS FROM SOUTHERN FRANCE

Isabel FIGUEIRAL* (INRAP, DST Paris and Centre de Villeneuve-les-Béziers, ISEM, UMR5554, Université Montpellier, CNRS, IRD, EPHE); C. CENZON-SALVAYRE, (Independent researcher); C. VASCHALDE (Mosaïques Archéologie)

*isabel.figueiral-rowe@inrap.fr

Excavations in southern France uncovered the vestiges of Gallo-Roman burials, including cremations, yielding charred plant remains, especially charcoal. Our work examines data obtained by charcoal analysis in 33 sites and reflects on their likely significance in terms of practice, firewood economy and location (urban / rural).

The 'general' results obtained from both primary and secondary deposits, point to a great variety of taxa similar to that from domestic contexts suggesting the absence of any particular selection or restrictive rules regarding wood supplies for cremations. Taxa diversity fluctuates, but no discernible differences appear between urban / rural contexts. Local availability and easy access were apparently the main regulating criteria. In some sites, results suggest the opportunistic recycling of pruning remains from orchard and vineyards, which raises questions concerning the minimal diameter required. Apparently, small calibre woods were much employed, probably because of technical requirements (facility of ignition, speed and effectiveness of the cremation). In certain cases, we can but ask whether the presence of very small well-preserved twigs may in fact reflect a last minute charge of wood.

Systematic sampling applied whenever possible, suggests that the diversified spectrum identified may be linked not only to firewood but also to personal wooden objects placed in the pyre to accompany the deceased, (furniture, samples of preferred fragrant woods, etc.). It is also possible that particular species were included for symbolic reasons (ex: branches with flowers and fruits?).

Combined with the osteological and carpological findings, charcoal should allow us to reconstruct the burial ground (position of body, firewood distribution, placement of grave goods) and to discuss certain social and technical aspects of burial practices.

Keywords: Cremation; Roman Period; Southern-France; Firewood; Grave goods.

FUNERARY PRACTICES AT THE ROMAN EMPIRE'S NORTHERN FRONTIER: WOOD CHARCOAL AND ASSOCIATED PLANT REMAINS FROM A ROMANO-BRITISH CREMATION CEMETERY ON HADRIAN'S WALL, CUMBRIA, ENGLAND

Zöe HAZELL (Historic England, UK); **G. CAMPBELL** (Historic England, UK); **T. WILMOTT** (Historic England, UK)

*zoe.hazell@historicengland.org.uk

In 2009 excavations were undertaken at the Romano-British cremation cemetery associated with Birdoswald Roman Fort, on Hadrian's Wall, Cumbria, north-west England, situated above the River Irthling. Initial excavations were carried out by North Pennine Archaeology Ltd and were followed later that year by more extensive investigations led by Historic England (then as English Heritage). These excavations were threat-led, driven by the risk of erosion (cliff collapse).

In total, 49 cremation-related deposits were excavated and recorded, including 3 *bustum* burials. Excavation, sampling and recovery aimed to recover as much detail as possible about the diversity funerary and burial practices at the cemetery using a wide range of scientific techniques. Some burials with partial/complete urn vessels were block-lifted for micro-excavation, with some of the conserved remains now on display at the Fort's visitor centre. A programme of radiocarbon dating helped formulate the chronology for the site, indicating that the cemetery was in use from the late 2nd to the early 3rd centuries AD.

Analysis of the wood charcoal, alongside that of the other charred plant remains, has provided information on the cremation practices from the region; both in terms of the fuel/pyre material and offerings. The wood taxa identified so far are hardwoods, with species native to mainland Britain e.g. *Quercus* sp. (oak), *Fraxinus* sp. (ash), *Ulmus* (elm). Yet evidence of imports comes from the remains of exotic fruit and nuts, likely used as offerings. Much of the wood charcoal is in poor condition, with evidence of non-typical growth patterns, especially knotwood.

Comparison will be made with other sites close to the Wall (although few), with the Cumbrian Roman fort and civil settlement at Brougham (*Brocavum*) and the cemetery and fort at Beckfoot (*Bibra/Bribra*), yielding useful assemblages.

Keywords: Roman; Hadrian's Wall; Cremation; Charcoal; Archaeobotany.

FUEL EXPLOITATION AND LANDSCAPE DYNAMICS BEFORE AND AFTER THE CONQUEST: CHARCOAL EVIDENCE FROM THE PREHISPANIC VILLAGE OF CUEVA PINTADA (CANARY ISLANDS)

Paloma VIDAL-MATUTANO* (Departamento de Geografía e Historia, Universidad de La Laguna);
S. PARDO-GORDÓ (Departamento de Geografía e Historia, Universidad de La Laguna);
M.C. GONZÁLEZ MARRERO (Departamento de Ciencias Históricas, Universidad de Las Palmas de Gran Canaria);
I. DÍAZ SIERRA (Departamento de Ciencias Históricas, Universidad de Las Palmas de Gran Canaria);
J. SÁENZ SAGASTI (Museo y Parque Arqueológico Cueva Pintada);
J. ONRUBIA (Universidad de Castilla La Mancha);
C.G. RODRÍGUEZ SANTANA (Museo y Parque Arqueológico Cueva Pintada)

*pvidalma@ull.edu.es

Insular systems represent true natural laboratories where we can understand the evolution of the biotic components of the environment. In this regard, the Canary Islands constitute a relevant case of study to analyse insular landscape dynamics developed since the colonisation carried out by the Northern Africa Berber groups during the first millennium AD. Human impact on Canarian forests before and after the Conquest has resulted in the modification of landscapes and the regression of some plant formations such as thermophilic forest, *fayal-brezal* and laurel forest. However, most of the known anthracological sequences don't cover the period of contact between the aboriginal and European populations and the colonial period.

The village of Cueva Pintada (110 m a.s.l.) consist of a group of structures and caves excavated in the volcanic tuff. It's one of the most important sites in the Canary Islands as it presents an archaeological sequence that includes the Prehispanic and the Colonial periods (from the 6th to the 16th century AD). In this oral communication, we present charcoal data from several structures of the site, including both scattered contexts and charcoal collected from combustion structures, pits and post holes. Twigs documented during charcoal analysis have been selected to obtain new radiocarbon dates on short-lived material.

The anthracological results obtained indicate the preferential use of the Canary Island pine (*Pinus canariensis*) as fuel before and after the Conquest, even though the pine forest is nowadays far away from the site. After the Conquest, low values of the *fayal-brezal* and the laurel forest are observed. Finally, the combination of anthracological data with simulation methods allows the analysis of possible scenarios regarding the potential distribution area of plant formations currently sheltered in specific areas of the island.

Keywords: Charcoal; Prehispanic; Canary Islands; Colonial; Landscape dynamics.

WOODLAND EXPLOITATION BY EARLY MODERN MILITARY CAMPS AND THEIR IMPACT ON THE FOREST ENVIRONMENT. ANTHRACOLOGICAL ANALYSIS FROM NINOVE-DOORN NOORD (16921693, 1745, BELGIUM)

Germaine HELLO-LAPRÉRIE* (AASPE - National Museum of Natural History, France); A. SALAVERT (AASPE - National Museum of Natural History, France); K. DEFORCE (Ghent University); A. VERBRUGGE (SOLVA); C. CALLOU (AASPE - National Museum of Natural History, France)

*germain.hello-laprerie@mnhn.fr

Few anthracological studies exist for the modern period (1400-1900 AD) in Europe, in particular for military camps. Nevertheless, woodland resources were important for armies to ensure their needs during conflicts. This paper presents the preliminary results of the charcoal analysis of Ninove-Doorn Noord, a set of militaries camps located in northern Belgium (1692-1693: Nine Year's War; 1745: war of the Austrian Succession). The goals are to observe the dynamic of the landscape between the two periods and to improve our understanding of the firewood supplies of modern armies at local scale.

Currently, this study focuses on the taxonomic identification of more than 4,000 charcoal fragments. In total, 100 samples from 74 structures are being analysed. The first results reveal that the troops mainly gathered firewood in riparian formations dominated by *Alnus*, Salicaceae and *Fraxinus*. The charcoal assemblages of the earliest camp (1692-93) present a higher taxonomic diversity than the ones of the following camp (1745), respectively 15 and 10 taxa. Furthermore, the strong presence of Salicaceae charcoals in 1745's assemblage suggests a degradation of the environment probably due to anthropogenic pressure. These preliminary results highlight the potential of anthracology to improve our knowledge of the impact of warfare on woodland history.

This analysis takes place in the frame of a doctoral dissertation (2022-2025) untitled: "The impact of conflicts on European forests. First application of charcoal analysis to modern military camps from the XVIIth to the beginning of the XIXth century". To our knowledge, this dissertation constitutes the first application of charcoal analysis on modern military camps in Belgium, the Netherlands and Luxembourg. This project aims to understand the management of wood resources during wars and the impact of conflicts on the diversity of forests, which played a major role in military strategies.

Keywords: Conflict Archaeology; Militaries Camps; Modern Wars; Riparian Forest; Pioneer Species; Ecological Succession

LANDSCAPE CHANGES, DEFORESTATION AND PLANT EXPLOITATION IN WESTERN IBERIA DURING ROMAN TIMES: NEW DATA FROM THE B-ROMAN PROJECT

João TERESO* (CIBIO-BIOPOLIS - Univ. Porto; UNIARQ – Univ. Lisboa; CEIS20 – Univ. Coimbra; MHNC – Univ. Porto); F. COSTA VAZ (CIBIO-BIOPOLIS - Univ. Porto);
 C. OLIVEIRA (Faculty of Sciences Univ. Porto; CIBIO-BIOPOLIS - Univ. Porto); L. SEABRA (Faculty of Sciences Univ. Porto; CIBIO-BIOPOLIS - Univ. Porto); A.C. SOUSA (Faculty of Arts and Humanities Univ. of Porto); C. DETRY (Faculty of Arts Univ. of Lisbon; UNIARQ – Univ. of Lisbon)

*jptereso@gmail.com

The expansion of the Roman Empire led to the implementation of new socioeconomic models and the creation of a new territorial order. In Iberia, together with a more intense exploitation of mining resources, new forms of settlement helped expand agricultural and grazing areas as new crops and animal breeds were introduced. Overall, pressure over natural resources, including woodlands, increased significantly, leading to greater deforestation and soil erosion.

However, archaeobotanical investigation in western Iberia has been centred mostly in its northernmost areas, making it difficult to fully characterize these dynamics. Only recently, through the ongoing B-ROMAN project, was possible to study several archaeological sites in more meridional areas, in what in Roman times was the Lusitanian province. These included Alcáçova de Santarém, Mesas do Castelinho, Miróbriga, Calçada do Lavra, Idanha-a-Velha and Conimbriga, among others, in which both wood charcoal and fruits/seeds were analysed.

In this presentation, the palaeoecological and paleoethnobotanical records of western Iberia will be addressed in detail, combining data recently obtained with different palaeoenvironmental records from previous studies. The main goal is to better understand the exploitation and use of plant resources during Roman times and their role in the implementation of new socioeconomic and cultural models under the Roman rule in western Iberia, within the economic, social and environmental history of the Empire.

Keywords: Roman Empire; SW Iberia; Landscape Evolution.

LANDSCAPES OF TRANSHUMANCE. HISTORICAL AND ENVIRONMENTAL CHARACTERIZATION OF AGRO-SYLVO-PASTORAL PRACTICES IN MARITIME ALPS (PIEDMONT, ITALY) BETWEEN THE 12TH AND 20TH CENTURY

Valentina PESCINI* (Catalan Institute of Classical Archaeology - ICAC); B.I. MENOZZI (University of Genoa - DISTAV); I. RELLINI (University of Genoa - DISTAV); N. ÉGÜEZ (Archaeological Micromorphology and Biomarkers - AMBI Lab)

*vpescini@icac.cat

Transhumant pastoralism has had a central role in the formation and management of Mediterranean mountain landscapes. Involving specialized agro-sylvo practices it has played a pivotal role in transforming the ecology of environmental systems: from plant to animal populations, up to the physicochemical properties and structural characteristics of the soils. Yet, only fragmented traces of this millenary practice remain in sedimentary and pedological archives, and they are often difficult to identify and interpret. This contribution presents the results of an interdisciplinary investigation carried out in Mount Mongioie (Piedmont – Italy, 1.530 m a.s.l.), summer pastureland historically affected by transhumant livestock from the Tyrrhenian coast and the Po valley. High-resolution multi-proxy research is proposed, combining pedoanthracology, palynology, biomolecular analysis, soil micromorphology, and chemistry together with radiocarbon dating. These evidences have been cross-checked with documentary and iconographic sources (i.e. historical texts, maps, and photos) to untangle the complexity inherent in the historical ways of accessing grazing resources. Such an approach provides new insight into environmental changes that occurred between the 12th and 20th century in this mountain sector due to a multiple land use system involving pastoral activity, temporary sowing, and use of fire and expression of collective use of resources (commons) which gradually disappeared long the 19th century.

Keywords: Fire Regimes; Historical Variation; Environmental Resource Archaeology; Medieval and Post-Medieval Age; Pedoanthracology; Palynology.



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

- SESSION 1 -

Palaeoethnobotanical approaches to wood gathering and use

Poster Abstracts

WOOD EXPLOITATION AT THE EARLY FUNNEL BEAKER SITE OF FRYDENLYND, FYN, DENMARK: SELECTIVE USE OF WOOD FOR DOMESTIC ACTIVITIES AND GRAVE MONUMENTS?

Welmoed OUT* (Moesgaard Museum); J. OLSEN (Aarhus Univeristy); N.H. ANDERSEN (Moesgaard Museum)

*wo@moesgaardmuseum.dk

Despite the large number of sites, knowledge about wood exploitation at sites of the Funnel Beaker Culture is remarkably scarce (though see e.g. Jansen and Nelle 2014) and studies from settlement sites are even more rare. This contribution aims to partially fill this gap by focussing on woodland exploitation at the early Funnel Beaker site of Frydenlund (Early Neolithic, c. 3600 BCE), located on the island of Fyn in Denmark. The analyses are part of a project that is supported by the Danish Ministry of Culture.

The site of Frydenlund revealed two two-aisled houses that were in use during a first activity phase at the site, covered by two burial monuments that date to a second phase. ¹⁴C-dates and Bayesian modelling based on field observations indicate that the site was in use for a remarkably short period only. The grave monuments, representing Denmark's oldest monuments, consisted of stone platforms on top of the houses, a palisade around one of the houses, and tall facades build of wooden planks west to both monuments (Andersen 2015). Systematic sampling of c. 1300 samples allowed for the analysis of carbonized macroremains and charcoal from domestic and monumental contexts to investigate plant exploitation, including the use of wood. Did people simply use those woody taxa that were available, or did they use specific taxa for particular purposes? Is it possible to say which taxa were used for the monumental structures?

Keywords: Funnel Beaker Culture; Neolithic; Wood exploitation; Domestic contexts, Burial monuments.

PINE FUEL SELECTION BY NEANDERTHAL GROUPS FROM CRVENA STIJENA (MONTENEGRO)

 Paloma VIDAL-MATUTANO* (Departamento de Geografía e Historia, Universidad de La Laguna); G. MONNIER (Department of Anthropology, University of Minnesota); G.
 PAJOVIC (National Museum of Montenegro); G. TOSTEVIN (Department of Anthropology, University of Minnesota)

*pvidalma@ull.edu.es

Almost 3000 charcoal fragments have been analyzed from the Middle Palaeolithic site of Crvena Stijena (Montenegro). Charcoal analysis shows the preferential use of *Pinus nigra-sylvestris* (black-scots pine) throughout the sequence. Besides this, other taxa have been identified such as *Juniperus* sp. (juniper), *Acer* sp. (maple), *Cornus* sp. (dogwood), *Fraxinus* sp. (ash), *Prunus* sp. (the rose family) or Fabaceae (woody legumes). Palaeoecological results point out to the important role of cryophilous pine forests in the local landscape, which would be the most extended plant formation throughout the sequence.

Microscopic observation of fungal decay patterns on each fragment of charcoal suggested fuel collecting strategies oriented to deadwood. Other degradation features produced by xylophagous insects have been also observed being similar to those detected in other Middle Palaeolithic sites. Wood-boring holes, frequently observed, could be related with the hyperfragmentation or even the disappearance of the most degraded charcoals. These taphonomic observations suggest the preferential collection of pine due to its high production of dead wood.

Spatial charcoal analyses from Crvena Stijena contributed to the discussion about concentrated/scattered charcoal assemblages in sites where the location of combustion structures remains unclear. The use of Geographic Information Systems for spatial charcoal analyses is a very useful tool to observe the spatial relationships between concentrated charcoal and those charcoal fragments located in surrounding areas.

We present here new palaeoenvironmental, palaeoeconomic, taphonomic and spatial data providing new insights into the local landscape and fuel collection strategies among Neanderthals groups from Crvena Stijena.

Keywords: Charcoal; Neanderthal; Degradation Features; Deadwood; Montenegro.

BURNING IN *OLISIPO*: THE ARCHAEOBOTANY OF THE ROMAN NORTHWEST NECROPOLIS OF MODERN-DAY LISBON

Catarina SOUSA* (Faculty of Arts and Humanities Univ. Porto); **F. COSTA VAZ** (CIBIO-BIOPOLIS Univ. Porto); **D. FERREIRA** (Faculty of Arts and Humanities Univ. Porto, CITCEM, Univ. Porto); **P. REBELO** (Neoépica Lda.); **P. PEÇA** (Neoépica Lda.); **C. BOLILA** (Neoépica Lda.); **J. TERESO** (CIBIO-BIOPOLIS - Univ. Porto; UNIARQ – Univ. Lisboa; CEIS20 – Univ. Coimbra; MHNC – Univ. Porto)

*anacatasosa@gmail.com

A section of the Roman Northwest Necropolis of *Olisipo* (modern day Lisbon) was identified within the framework of an emergency excavation in Calçada do Lavra (Arroios, Lisbon) made by Neoépica Lda. The necropolis was used between the 2nd and 4th centuries AD and comprised both cremation and inhumation burials. Several sediment samples were collected in cremation pyres and secondary contexts and were analysed as part of the first author's Master's degree in Archaeology hosted at University of Porto and CIBIO-BIOPOLIS.

Samples were processed by bucket and machine-assisted flotation. The charcoal analysis followed standard methodology with species identification and the recording of anatomical characteristics capable of providing paleoenvironmental and paleoethnobotanical data. The identification of fruits and seeds also followed standard methods and was based on their morphology.

Results obtained from c. 30 cremation contexts provided a diverse set of trees and shrubs. The presence of wood from *Quercus* sp. type evergreen, *Quercus* sp. type deciduous and *Pinus pinaster* were the most frequent and already expected due to analogue studies as well as their existence in the region. Other relevant taxa, such as *Fagus* sp., *Ficus* sp., *Vitis vinifera*, *Laurus nobilis* and *Olea europea* was also identified. Additionally, several samples contained carbonized seeds, namely cereals and pips.

This presentation will discuss these results in order to 1) understand how and where the roman population of *Olisipo* selected wood and other plant resources for the cremation pyres and 2) reveal the role plants and foodstuffs performed in Roman religious and cremation rituals. The presence and possible meaning of specific taxa, such as the ones mentioned above, will be discussed.

Keywords: Charcoal; Fruits and seeds; Olisipo; Roman period; Cremations.

THE PRESENCE OF *PINUS* SP. IN PILANDUK CAVE, PALAWAN, PHILIPPINES: IMPLICATIONS FOR THE TROPICAL PALAEOENVIRONMENT

Jane CARLOS* (School of Archaeology, University of the Philippines, Quezon City, Philippines); M. RAMOS (Forest Products Research and Development Institute, Los Banos, Philippines); A. GARONG (National Museum of the Philippines, Manila, Philippines); J. OCHOA (Department of Anthropology, University of the Philippines, Quezon City, Philippines)

*abcarlos1@up.edu.ph

This paper deals with the identification of wood charcoal from Pilanduk Cave in Palawan Philippines. Several wood species were determined from 93 samples collected from hand picking, dry sieving and flotation. The wood charcoal assemblage is dominated by the softwood *Pinus* sp. which is mosty present in the layer dated from 22,000 – 20,000 cal BP, with a few fragments in the younger layers. Only two species of *Pinus* exist in the Philippines and part of this study aims to determine if the charred fragments are of the high altitude *P. kesiya* or the lower altitude *P. merkusi*. The results could potentially complement or challenge earlier studies with regards to palaeoenvironmental signals around the site.

Keywords: Pilanduk Cave; Palawan; Philippines; Palaeolithic; Pinus sp.

WOOD COLLECTION ECONOMY AND FIRE USE DURING THE FINAL LATER STONE AGE IN JUBILEE SHELTER, MAGALIESBERG, GAUTENG, SOUTH AFRICA

Roxane MATIAS* (ICArEHB, Univ. Algarve); M. BAMFORD (Evolutionary Studies Institute – ESI); N. BICHO (ICArEHB, Univ. Algarve); L. WADLEY (Evolutionary Studies Institute – ESI)

*roxanematias7@gmail.com

Charcoal remains scattered in well-stratified Later Stone Age (LSA) layers from archaeological sites have contributed to reconstructing past environments and climates from several regions in South Africa, mainly located in the country's coastal regions. The potential wood use, collection strategies, and fire use have been taken into consideration when interpreting the vegetation, and climate signature. Nevertheless, the paleoethnobotanical perspective needs to be further explored in the interior of the country.

This poster presents the initial results of a research project focused on the human acquisition strategies for woody resources and firewood in Jubilee Shelter, an LSA archaeological site located in the Magaliesberg mountain range, South Africa. In order to understand firewood gathering practices throughout the Holocene period in Jubilee shelter, scattered charcoal collected in nine sequenced layers (c. 8500 BP., to Late Iron Age – c. 1350 BP.) were analysed, and are associated with a suite of Lithic industries, respectively Oakhurst, Wilton, and Post-Wilton techno-complexes. A sub-sample of charcoal from Hearth 3 in layer 6 (Post-Wilton industry) was analysed for the gender aggregation theory associated with that Hearth. Standard anthracology procedures were applied in this qualitative and quantitative study. The following topics will be presented: 1) the woody species present in the layers, 2) similarities/differences between the layers; 3) the species diversity in Hearth 3 compared with the ones in the surrounding sediments, and 3) their association with other artifacts in the same area. Archaeological studies based on anthracological remains are scarce in the province under study. The charcoal record from the site is a precious additional proxy to be used as a tool to understand possible cultural transformations across time, as well as human adaptations to their local environment and societal structure during the Holocene period.

Keywords: Charcoal; Firewood; Wood Gathering Practices; South Africa; Holocene.

ANTHRACOLOGICAL DATA AS EVIDENCE FOR CULTURAL DIFFERENCES IN THE USE OF WOOD RESOURCES IN THE 1ST MILLENNIUM CE BY COMMUNITIES IN THE WESTERN BALTIC CULTURAL CIRCLE IN POLAND

Katarzyna CYWA* (W. Szafer Institute of Botany Polish Academy of Sciences); M.
 KARCZEWSKI (Faculty of History and International Relations, University of Białystok);
 A. WACNIK (W. Szafer Institute of Botany Polish Academy of Sciences)

<u>*k.cywa@botany.pl</u>

The effect of archaeological research and accompanying palaeobotanical analyses carried out in north-eastern Poland since the 1950s is the availability of a rich anthracological data. These include taxonomic determinations of several thousand charcoal fragments from several dozen archaeological sites, which showed, among others, the taxonomic profile of wood associated with the functioning of the Bogaczewo and the Sudovian culture and Yotvingian settlement belonging to the Western Baltic cultural circle. The area that the above-mentioned settlements and cemeteries cover in Poland is of particular interest because of its transitional character, on the one hand expressed by the specific features of its postglacial vegetation history, linked to the range boundaries of many central European plant species, including some trees and shrubs, which run here, and on the other hand because of the ethnic Polish-Ruthenian-Balt borderland.

The analysis was aimed at characterising and capturing the distinctiveness of the use of wood by Western Baltic communities with a broad chronological perspective, from the Roman Iron Age to the early Middle Ages.

Large differences were found when comparing the anthracological record obtained from sites of the Bogaczewo culture in relation to those of the Sudovian culture. The former relied on hardwoods such as birch, oak and alder for both housing and burial rituals. In contrast, pine, spruce and yew played a primary role in the Sudovian culture. Interestingly, the palynological results indicate that both cultures may have used a similar resource base.

An important observation was that in both cultures one type of wood was used selectively for the construction of funeral pyres, with birch being the preferred material for the Bogaczewo culture and pine for the Sudovian culture. The synthesis of anthracological and palynological data suggests a cultural basis for differences in the management of local forest resources, related to specific practices and customs.

Keywords: Macrocharcoals; Woodland use; Funeral Pyres; Environmental Archaeology.

CHARCOAL FROM PREHISTORIC COOKING PITS: TYPOLOGICAL AND REGIONAL VARIATION

J. K. LARSEN (Archaeological Science and Conservation, Moesgaard Museum); Karen VANDKROG SALVIG* (Archaeological Science and Conservation, Moesgaard Museum)

*kvs@moesgaardmuseum.dk

In recent years renewed interest in Danish finds of systematically aligned rows and clusters of 'cooking pits' has led to a dramatic increase in charcoal analysis and AMS-dating of material from these features. Charcoal analysis represents one of the few ways to elucidate 'cooking pit' activities. As charcoal in these pits represents fuel residue, research questions have particularly focused on species identification to examine selection of tree resources based on the quality of fuel, availability, and also the possibility that choices reflect ritual practices.

In 2020 Rønninge Søgård, the well-known Bronze Age 'cooking pit' site on Funen, was revisited. These recent excavations allowed dating and examination of charcoal from multiple pits and rows. The results revealed short-term activities and a varied use of local tree species. But it also became clear that the scope of questions is challenged by the lack of comparative data, also from other fuel-related contexts, e.g., structures in habitation areas.

Comparative studies of material from different 'cooking pit' sites and different systems in Denmark, e.g., clusters and alignments – single rows as well as series of rows, has revealed local and regional variations in tree species exploited. Most likely this primarily reflects species availability in local landscapes. However, some species seem to be present only in certain systems, which may be tied to typological or functional differences. These issues need further exploration.

Insufficient data (in part due to lack of sampling, analyses and/or dating) remains a significant barrier to fully realizing the potential for studying carbonized traces of this prehistoric practice. Therefore, future work remains supporting national 'cooking pit' strategies and initiatives through additional charcoal analyses from archaeological investigations in Denmark, as well as researching parallels both archaeological in other regions and from the realm of ethnography.

Keywords: Charcoal; Cooking Pits; AMS dating; Nordic Bronze Age; Denmark

CHARCOAL ANALYSIS FROM A COLLECTIVE SECONDARY HUMAN CREMATION: THE PIT 40 FROM PERDIGOES ARCHAEOLOGICAL SITE (ALENTEJO REGION, PORTUGAL)

 S. GEBRESELASSIE (University of Évora); A. VALERA (ERA Arqueologia S.A, ICArEHB – Univ. Algarve); C. Botanni (Hercules Laboratory, Univ. of Évora); Ginevra CORADESCHI* (Hercules Laboratory, University of Évora)

*ginevrac@uevora.pt

This study aims to present the preliminary results of a Master dissertation in a framework of the Archmat Erasmus Mundus Joint Master in Archaeological Materials. The large, ditched enclosure of Perdigões is situated in the Reguengos de Monsaraz municipality, Évora district, in southern Portugal. Several funerary features have been discovered and radiocarbon dated to the second half of the 4th millennium BC and the 3rd millennium BC. A wide variety of burial features and body manipulation practices have been documented.

Along with other recent discoveries the chalcolithic Pit 40 was retrieved at Perdigões. It is a massive circular hole, 2.5 m across and 0.80 m deep, containing different secondary deposition moments of both cremated and unburned human remains, retrieved together with some animal bones, charcoal fragments (object of this study) and diverse types of votive materials. The grave goods were retrieved largely burned. A minimum number of 240 individuals belong to the pit was identified.

In this study anthracological analysis of Pit 40 is undertaken. The main objective of this study is to analyse the exploitation of wood by the chalcolithic community of Perdigões, investigating if rational or less rational human choices were related to the wood selection for rituals purpose. In addition, with the study of charcoal assemblage from Pit 40 we want to shed light to the interpretation of this uncommon burial context.

Keywords: Anthracology; Iberian Chalcolithic; Wood exploitation; Funerary archaeology; Alentejo region; Portugal.

FUEL ECONOMY IN NORSE SOCIETY IN SOUTHERN GREENLAND

Claudia BAITTINGER* (National Museum of Denmark); A.M. STEVNSVIG (National Museum of Denmark)

*claudia.baittinger@natmus.dk

Settlers from Scandinavia lived in Southern Greenland from the end of the 10th century CE until the 15th century.

Two kitchen middens where charred cereals have been found in earlier excavations are being analysed to gain further knowledge of Norse plant use. High temporal resolution analysis of macrofossils and pollen will inform on the Norse settlers plant use but can also give information about their fuel economy. Fuel was an important factor and hearth remains are preserved in the middens associated with Norse houses.

Charcoal from a kitchen midden from Igaliku (Ø49, 12 layers) excavated in 2021 and a midden from Qorlortup Itinnera (Ø35, 18 layers) excavated in 2022 are being analysed. Both are located in the so-called Eastern Settlement (Østerbygd). The basal layers of these middens are already known to be from the early Norse period and they will additionally be dated with AMS radiocarbon dating. The question of whether local resources, imported wood or driftwood or a combination of these were used will be addressed as well as the question of whether this balance changed during the Norse settlement period.

The charcoal, macrofossil and pollen results from the kitchen middens will be further compared to data on the local climate and environment with the aim of examining whether climatic and/or environmental changes influenced the Norse use of plant resources.

Keywords: Charcoal; Norse Society in Greenland; Kitchen Middens; Fuel Economy; Driftwood/Local Resources.

A LONG HISTORY OF PLANTS AND PEOPLE: HUMAN OCCUPATION AND LANDSCAPE IN THE SERRA DA CAPIVARA NATIONAL PARK, PIAUÍ, BRAZIL

Leidiana ALVES DA MOTA* (Museu Nacional, Universidade Federal do Rio de Janeiro); R. SCHEEL-YBERT (Museu Nacional, Universidade Federal do Rio de Janeiro)

<u>*leidiana.mota@gmail.com</u>

The Serra Capivara National Park, in Northeastern Brazil, is an area of high ecological, archaeological, and social relevance. In addition to its importance for the preservation of the caatinga biome, specific to this region, the park has a large concentration of archaeological sites and rock art. It was declared a Cultural Heritage of Humanity by UNESCO in 1991. It contains several sites dated to Late Pleistocene, which is probably due to the strong investment in archaeological research and radiochronological dating. This corroborates data from other regions of Brazil, Chile, and Mexico, pointing to a colonization of the continent prior to the milestone of the conservative model established for the entry of human groups into America via Bering Strait. The anthracological analysis of two sites (Toca do Boqueirão da Pedra Furada and Vale da Pedra Furada) and punctual data on a third one (Toca do Sítio do Meio) provided information on palaeoenvironment and cultural aspects from c. 30,000 to after 6,000 cal yrs BP. The identification of 3721 dispersed and concentrated charcoal pieces point to environmental changes through time, with a more humid vegetation recorded during the Pleistocene, and the establishment of caatinga, typical to semi-arid climate, at c. 6,000 cal yrs BP. Semi-deciduous forests and cerrado formations coexisted in the area throughout this time. It was demonstrated that firewood was collected opportunistically, probably essentially based on dead wood gathering. Diameter estimations suggest a preference for branches with smaller to medium diameters (2-10 cm). Charcoal diversity in different levels suggest that the sites occupations were possibly temporary and of short duration, especially during the Pleistocene, and that there were several episodes of reoccupation over the millennia. In Toca do Bogueirão da Pedra Furada, a probable period of more stable occupations occurred around 8,000-7,000 cal yrs BP.

Keywords: Palaeoenvironment; Palaeoethnology; Peoples of the Americas; Serra da Capivara; Brazil.

FIRE AND FUELWOOD IN MARTINIQUE DURING THE EARLY CERAMIC AGE: CONSTRUCTING AN ANTHRACOLOGICAL REFERENCE COLLECTION FOR HUMAN-LANDSCAPE INTERACTIONS

Michelle ELLIOTT* (Université Paris 1, ArScAn); L. DUSSOL (Université Côte d'Azur, CEPAM); E. GOKPON (Université Côte d'Azur) ; B. FERLAY (Conservatoire Botanique National de Martinique); C. TRABON (Université Paris 1); A. CARRE (CNRS, CEPAM); E. DUTTO (Université Côte d'Azur); B. BERARD (Université des Antilles & ArchAm)

*michelle.elliott@univ-paris1.fr

This project represents an axis of the "Microregional approach to the early ceramic occupation of Martinique" collaborative research program, directed by Benoît Bérard (Université des Antilles). The overarching goal is to understand the social and migratory processes that led to the arrival of the first human settlers on Martinique, and how these farming populations proceeded to populate the island and transform their environments over the course of the Early Ceramic period (300 BC to AD 400). To address aspects of this latter question, we are undertaking the first systematic anthracological analyses of Early Ceramic sites on Martinique to reconstruct the forested spaces and the strategies of plant resource management associated with the settlements studied. Furthermore, we are able to investigate how Early Ceramic populations faced and adapted to environmental hazards, namely through study of the Mont Pelée volcanic eruptions that are documented for 98 BC-103 AD (P3) and 293-513 AD (P2). These eruptions no doubt impacted forest growth and regeneration and posed important adaptive challenges to the human populations. As a first step in this research, we are constructing an anthracological reference collection that represents the major vegetation communities around our study area, as well as the economic species that are most likely linked to Prehispanic populations. This work involves the collection of 89 wood specimens to date, and their taxonomic identification at the Conservatoire Botanique National de Martinique. The specimens are carbonized under controlled conditions and then photographed and described to form an anthracological atlas. This ongoing work has allowed for the preliminary study of archaeological charcoal assemblages at the sites of Terre Patate and Gradis.

Keywords: Fuelwood; Volcanism; Martinique; Paleoenvironment; Reference collection.

VEGETATION DYNAMICS IN THE BONNEVILLE BASIN (NEVADA - USA) AT THE PLEISTOCENE-HOLOCENE TRANSITION (CA. 13,000 – 5,000 CAL BP)

Aurélie LIARD* (Université Côte d'Azur, CEPAM UMR 7264); D. RHODE (Nevada Desert Research Institute); A. HENRY (Université Côte d'Azur, CEPAM UMR 7264)

*aurelie.liard@cepam.cnrs.fr

The Bonneville Basin is a cold desert in the east-central United States (Nevada - Utah - Idaho). A major aridification process, alternating between phases of extreme aridity and less dry phases, took place from the end of the Pleistocene, finally leading to major changes in the landscape. It was also during this period that the first prehistoric settlers reached the area and settled there. Despite the gradual drying up of the environment, human occupation seems to have been almost continuous until today.

We present the results of the anthracological study of archaeological charcoal remains from the Bonneville Estates Rockshelter site (Nevada, USA), in the Bonneville Basin. For nearly 8,000 years since the end of Pleistocene, the results show a landscape composed of shrubs, mainly of the genera *Artemisia* (sagebrush) and *Ephedra* (shadescale). Even though the frequencies of these two taxa fluctuate between archaeological levels, two major phases can be distinguished. An initial one between 13,000 and 8,300 cal BP is clearly dominated by *Artemisia*. The second one lasts at least until 5,000 cal. BP and seems to document the expansion of *Ephedra*, probably marking the development of the Big Sagebrush - Mixed Desert Shrubland Alliance, characterized today by the codominance of *Artemisia* and *Ephedra* in association to other shrubby desert taxa sharing similar ecological requirements.

Palynological studies provide a different view of the vegetation history of the Bonneville Basin. *Artemisia* is clearly identified as predominant but shows repeated retreats throughout the sequence interpreted as linked to drought peaks, while *Ephedra* is almost absent from the palynological record.

Palynology and anthracology are often complementary as they represent different proxies which most often are not applied the same type of deposits (natural *vs.* anthropogenic). Between human selection and ecological reality, how can we explain the complementarity and alternation of *Artemisia* and *Ephedra* shown by anthracology in the Bonneville Estates Rockshelter landscape?

Keywords: Charcoal analysis; Artemisia; Ephedra; Aridification; Nevada.

WOODLAND EXPLOITATION AT THE MESOLITHIC SHELLMIDDEN OF ARAPOUCO (ALCÁCER DO SAL, SETÚBAL): PELIMINARY RESULTS OF THE CHARCOAL ANALYSIS

André MARQUES* (Faculty of Arts Univ. Lisbon); P. MONTEIRO (DGPC-LARC; ICArEHB); M. DINIZ (Faculty of Arts Univ. Lisbon, UNIARQ – Univ. Lisbon)

*andre.s.margues@campus.ul.pt

Wood Charcoal analysis was carried out for the first time at the Mesolithic site of Arapouco (Alcácer do Sal, Setúbal), a shellmidden which belongs to the river Sado's valley cluster of shellmiddens in south Portugal. The shellmidden is located very near to the river, in a small hill at 47 m above the river bed and it's the one that is located most downstream in the river valley, distancing about 40 km from the river mouth. It is interpreted as an important habitat specialized in fishing activities, it has the largest quantity of icthiofaunal remains and the biggest diversity of shellfish recovered from all the shellmiddens. The anthracological analysis was carried out on 1222 wood charcoal fragments sifted from sediment samples taken from the units dated from the Mesolithic period in the excavation site 1, during the project SADO-MESO II (2016). Being scattered remains and thus representing some aspects of repeated actions over time, like the cleaning of hearths, the analysis of these remains give us the possibility to infer on aspects of wood fuel use on the site during the span of time that it was inhabited, as well as paleoenvironmental data. The preliminary results of the taxonomic analysis show a predominance of the Pinus genus (35%), of which the taxa Pinus pinea/pinaster is the most abundant with 229 fragments identified. The second most represented genus was the Olea (8%), notably Olea cf. europaea with 82 fragments. Also worth mentioning is the identification of Arbutus unedo (18 fragments). Because most of the charcoal fragments were very small and highly vitrified, there's also a high number of unidentified Gymnosperms (26%), Angiosperms (16%), Monocotyledons (12%) and general unidentified (1%). This analysis shows the presence of these species locally during the Mesolithic and that pine wood was the most used.

Keywords: Anthracology; Mesolithic; Shellmidden; River Sado; Portugal.

REGIONAL VEGETATION RECONSTRUCTION OF TWO EARLY MEDIEVAL HILLFORTS IN SOUTHWESTERN BOHEMIA (CZECHIA), EVALUATION OF ANTHRACOLOGICAL EVIDENCE

Veronika PETRLÍKOVÁP* (LAPE, Faculty of Science, University of South Bohemia); **M. PTÁK** (Institute of Archeology, Faculty of Philosophy, University of South Bohemia)

*petrlv01@prf.jcu.cz

This study focuses on the possibility of regional vegetation reconstruction based on anthracological evidence originating from two hillforts Prácheň and Netolice. These two sites were political centers of the Early Czech state in the 10th to 12th centuries in southwestern Bohemia. They are set in the altitude 450 -550 m and their natural surroundings are very similar.

All together 2170 charcoals were analyzed from both hillforts and from the areas under the hillfort. Specific anthracomass, the relative proportion of mass fractions and the part of the tree used according to the curvature of the tree rings were monitored for the sets. Relative frequencies of taxa were compared with the results of the pollen analysis from the palycz database and with the reconstruction map of the vegetation.

Pinus and *Quercus* predominated in both localities, which corresponds to the assumed acidophilic oak forests in the vicinity of the housing estate. Comparison of anthracological and pollen data reveals only small differences in tree species composition in the case of Netolice. In Prácheň, very low presence of *Abies* and presence of *Carpinus* in charcoal assemblages are unexpected in this region. According to the results of the RDA analysis, the composition of the assemblages from the fort is different from the assemblages from the area under the hillfort, mainly due to the higher content of *Quercus*. This is likely related to the use of oak for the construction of extensive fortifications.

This analysis reveals information about wood selection on the early medieval hillforts Prácheň and Netolice and about vegetation state before High Middle Ages transformation. Further research should focus on the state after High Middle Age transformation in this region.

Keywords: Archeo-anthracology; Regional Vegetation; Early Middle Ages; SW Bohemia.

STORIES OF DAILY LIFE FROM THE MIDDLE BRONZE AGE WATERLOGGED SITE OF OPPEANO "4D" (VERONA, NE ITALY): COMPARISON OF ANTHRACOLOGICAL, CARPOLOGICAL AND PALYNOLOGICAL DATA

Silvia D'AQUINO* (Dipartimento di Beni Culturali Università di Padova; Laboratorio di Archeobotanica e Paleoecologia, Università del Salento); M. DAL CORSO (Dipartimento di Geoscienze, Università di Padova); G. FIORENTINO (Laboratorio di Archeobotanica e Paleoecologia, Università del Salento); C. NICOSIA (Dipartimento di Geoscienze, Università di Padova)

*silvia.daquino@studenti.unipd.it

Archaeological domestic contexts, with their hearths, ovens, pits, and waste heaps inside and outside dwellings represent an important source of information on the use of plants and of space by ancient communities. The potential of this information increases especially in the presence of well-preserved archaeological levels, which have undergone fire events, rapid burial or are located in waterlogged sites.

These exceptional conservation conditions were met at the site of Oppeano Via Isolo "4D" (Verona, N-E Italy), an important multi-phase settlement dated to the Middle Bronze Age (1650-1350 BCE; chronology based on Cardarelli 2010). The site, excavated in 2015, preserved traces and wooden structures of eight huts (BM 1), large waste heaps, multi-layered hearths, floors and associated dwelling layers (Gonzato et al., 2021; Nicosia et al. 2022).

As part of the ERC-funded GEODAP project, it was possible to study many organic finds sampled inside some huts (occupation layers, hearths, ground-levelling layers, etc.). The analysis of plant macroremains including high amounts of charcoal, seeds and fruits, and of microremains, as pollen, made it possible to outline a first picture of the environment and plant resources in use and the probable function of the domestic areas.

The taxonomic analysis of wood shows anthropogenic selection activity in some cases, especially for use as carpentry wood or as fuel. The huts in Oppeano were built using vertical posts and horizontal wooden elements interwaved to form a fence of wattle (s.c. "viminata" technique).

The presence in the same contexts of wood with different degrees of carbonization or waterlogging suggests a differential use of the woody resource within the structures and indicates different processes of formation and conservation of the anthracological record.

Keywords: Charcoal; Pollen; Carpology; Bronze Age; Domestic Contexts.

A HARBOUR TO THE WORLD: CHANGES IN PLANT EXPLOITATION BETWEEN EARLY IMPERIAL TIMES AND THE LATE ANTIQUITY AT CASTRO DE GUIFÕES (PORTUGAL)

Catarina MAGALHÃES* (CITCEM; CIBIO-BIOPOLIS - Univ. Porto); **A. AREZES** (Faculty of Arts and Humanities Univ. Porto; CITCEM); **L. SEABRA** (CIBIO-BIOPOLIS - Univ. Porto); **J. VARELA** (CM Matosinhos, Museu da Memória de Matosinhos); **J. TERESO** (CIBIO-BIOPOLIS - Univ. Porto; UNIARQ – Univ. Lisboa; CEIS20 – Univ. Coimbra; MHNC – Univ. Porto)

*omcatarina@gmail.com

Castro de Guifões (Matosinhos, North-Western Portugal) is a settlement at the bank of the river Leça, near the river mouth and the Atlantic Ocean, with occupations between the Iron Age and Late Antiquity. In 2016, new archaeological excavations, carried out in the framework of a research project, implemented the sediment sampling for archaeobotanical studies for the first time in the site.

The anthracological study was mainly focused on the Augustan Period and Late Antiquity contexts with primary (fireplaces) and secondary depositions. Results revealed the predominance of deciduous *Quercus* sp. and Fabaceae in the earliest phase, suggesting firewood gathering was distributed between deciduous forests and riparian vegetation, where large logs could be found, and subserial formations, which provided wood of smaller calibre to start the fire. In the Late Antiquity levels, *Castanea sativa*, already present in the previous phase, became the most common taxon, followed by the previously mentioned ones. Moreover, the register of dendrological characteristics has allowed the identification of growth changes in the tree-rings in the wood of *Castanea sativa*, likely related to pruning.

Overall, both phases revealed a highly Romanised setting and the probable development of silviculture, suggested by the combined presence of species such as *Castanea sativa*, *Vitis vinifera*, *Ficus carica*, and *Laurus nobilis*, the identification of pruned wood fragments, and seeds of *Prunus persica*. The expansion of *Castanea sativa* in late imperial times is testified in other sites in the region, but its presence in Augustan levels suggests its early presence in the area. Despite its native character, this taxon is rare in such chronologies in the region.

The results contributed to the understanding of this site's economic, cultural and even social framework, which, by combining the unearthed artefactual and ecofactual data, support the hypothesis of constant and diachronic assimilation of exogenous products with relationships that extend, directly or indirectly, to the Mediterranean.

Keywords: wood charcoal; Augustan Period, Late Antiquity, Northern Portugal.

WOOD FOR LIFE, WOOD FOR DEATH. USE OF WOOD IN DOMESTIC AND FUNERAL CONTEXTS FROM TWO BRONZE AGE SITES IN SOUTHERN ITALY

Marianna PORTA* (Department of Cultural Heritage, University of Salento); F. BREGLIA (Department of Geosciences, University of Padova); G. FIORENTINO (Department of Cultural Heritage, University of Salento); T. SCARANO (Department of Cultural Heritage, University of Salento)

*marianna.porta@studenti.unisalento.it

We present the preliminary results of anthracological analysis carried out in two nearby protohistoric coastal sites: the cremation necropolis of Torre Guaceto (MBA3- RBA2) and the fortified settlement of Scogli di Apani (MBA2-3) near Brindisi (Apulia, Southern Italy). This work aims to recognize the dynamics of exploitation of vegetal resources in specific functional contexts. Charcoal remains indeed represent, in one case, the material outcome of the preparation of the funeral pyres and the deposition of the cremations; in the other case, they testify to the choices made for the construction of huts and the management of the domestic hearths. The comparison between the two contexts allows us to highlight the different choices of timber procurement made in relation to the different functions that this had to perform and, perhaps, of its symbolic and ritual value. The selection of woods in the two contexts opens spaces for interpretation on the availability of wood resources and on the dynamics of supply, transport and possible storage of wood; all functional operations both for the management of the daily activities of the settlement and for use in funeral practices.

Keywords: Charcoal; Bronze Age; Settlement; Cremation Necropolis; Wood Resource.

SELECTION AND USE OF FOREST RESOURCES AT THE PILE-DWELLING CAVE SETTLEMENT OF GROTTE DI PERTOSA (SOUTHERN ITALY)

Francesco BREGLIA* (Department of Geosciences, University of Padua)

*francesco.breglia@unipd.it

The cave of Grotte di Pertosa (Campania, southern Italy) housed a pile-dwelling settlement during the Middle and Late Bronze Age, known since the end of the 19th century. A peculiar aspect of this archaeological site is the conservation of protohistoric wooden structures thanks to the water of a stream flowing through the cave. The result of the xylological and anthracological analyses carried out on different plant macro remains are presented here. The study of the waterlogged pile-dwelling structural elements and artefacts gave us the opportunity to understand both the choices made in raw-material selection and the woodworking techniques adopted according to specific carpentry or craft objectives. A soil sample containing charcoals was also analysed returning a greater floral diversity, corroborating the hypothesis of a strong selection of a specific timber in spite of a variety of available forest resources. The reuse of carpentry waste as fuel has also been taken into account, completing the frame of forest resource exploitation in this site.

Keywords: Pile-dwelling; Wood Supply; Woodworking; Human-environment Interaction; Bronze Age.



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

- SESSION 2 -

Methodological and theoretical developments in charcoal science

Oral Abstracts

Keynote Session 2

FROM FIRE PROPERTIES TO TAPHONOMY, AN EXPERIMENTAL APPROACH TO TEMPERATURE

Isabelle THÉRY-PARISOT* (CNRS, CEPAM); B. AUDIARD (Universidad de Valencia); A. CARRE (CNRS, CEPAM); J. CHRZAVZEZ (CEPAM); V.-L. COLI (Université Côte d'Azur); P. GARBERI (CNRS, CEPAM); A. LAVALETTE (ALTR&D)

*isabelle.thery@cepam.cnrs.fr

Whether one is interested in paleoeconomic or technical aspects related to the use of fire, or in taphonomy, the concept of temperature is central in charcoal analysis. Based on experimental results, we will provide an overview of the concept of temperature in anthracology, covering both its theoretical and epistemological aspects.

What does the temperature tell us about the function of the hearths? Can prehistoric hearth temperatures be accurately a posteriori measured, and what information could be gleaned from these measurements?

Changing scale, what are the effects of fire temperatures on the residues themselves in terms of taphonomy? Can temperatures impact the preservation of charcoal after combustion and during post-depositional processes? Furthermore, how can we assess the effects of temperature on the anthracological record?

To address these questions, we conducted over two hundred experimental standardized combustions in both laboratory and natural conditions (combustions in open structure and muffle furnace; weathering in natural and laboratory conditions; physical and chemical measurements). Our findings, supported by mathematical data processing, provide insight into the properties of wood combustion, including fragmentation processes during and after charcoal deposition. Additionally, we explored the challenges of measuring temperature in both the combustion structures and the charcoal itself.

Our results show that temperatures in the open-air fireplaces are highly labile, with average temperatures always within the same range whatever the specie is. We also provide informations on the effect of high temperatures on the fragmentation processes during combustion and after deposit but also on the isotopic signal.

Keywords: Temperature; Hearths; Taphonomy; Experimentation; Palaeolithic.

OLEICULTURE AND VITICULTURE IN SOUTHERN FRANCE DURING THE IRON AGE AND ROMAN PERIOD: A RECONSTRUCTION BASED ON CHARCOAL, SEED, FRUIT AND ARCHAEOLOGICAL DATA COMPARED TO AGROECOSYSTEMIC MODELING

Laurent BOUBY* (ISEM); N. BERNIGAUD (ASM); L. CHABAL (ISEM); A. BONDEAU (IMBE), M. CABANIS (INRAP); C. CARRATO (Mosaïques Archéologie); C. CENZON-SALVAYRE (ANTHRACOMED, LA3M); J. CHARDONNEAU (ASM, ISEM); C. DELHON (CEPAM); F. DURAND (INRAP); I. FIGUEIRAL (INRAP); L. FLOTTES (Archeodunum); J, GOMES (ASM); C. HALLAVANT (HADES); A. HENRY (CEPAM); L. LIOTTIER (ARBOCA); P. MARINVAL (ASM); R. PINAUD-QUERRAC'H (ASM); P. POIRIER (INRAP); J. ROS (ISEM); M.-P. RUAS (AASPE); P. SEJALON (INRAP); J.-F. TERRAL (ISEM); M. TILLIER (IPSO FACTO); M. TORITI (CREAAH); C. VASCHALDE (ASM); J. GUIOT (ASM); N. ROVIRA (ASM); S. MAUNE (ASM)

*laurent.bouby@umontpellier.fr

Olive and vine growing have dramatically shaped the landscapes as well as the culture and economy of human societies in the Mediterranean region. It is generally considered that the cultivation of these plants appeared and expanded in Mediterranean France during the Iron Age and the Roman period (ca 750 BCE - 500 CE).

The objective of this paper is to propose an updated overview of the history of olive and vine growing based on a multidisciplinary survey combining on the one hand, archaeobotanical and archaeological data and, on the other hand, agroecosystemic modeling.

We collected all published and unpublished results of charcoal and seed/fruit analyses in Mediterranean France (traditional regions Languedoc-Roussillon and Provence) and entered them into a database. Seed and fruit remains provide evidence of fruit consumption and processing (table vs. pressing), while charcoal and wood remains are stronger indicators of local cultivation. We also included published archaeological information about olive and wine growing e.g., storage units, planting traces, presses and amphora workshops. The reconstructions based on the multi-proxy information contained in the database are compared to the LPJmL model estimates of the potential yields of vines and olive trees and their variations in our study area over time.

On the whole, this work aims to reconstruct the spatial and temporal dynamics of viticulture and olive growing in Mediterranean France and to better understand the extent of the influence of climate and/or socio-economic factors.

Keywords: Archaeobotany; Archaeology; Agroecosystemic modeling; *Olea europaea*; *Vitis vinifera*

SYSTEMATIC ANOMALOUS RADIOCARBON DATES FOR SCOTS PINE (*PINUS SYLVESTRIS*) AND YEW (*TAXUS BACCATA*) CHARCOAL RECOVERED FROM ARCHAEOLOGICAL SITES IN THE LOW COUNTRIES

Koen DEFORCE (Archaeology Department, Ghent University; Royal Belgian Institute of Natural Sciences)

*koen.deforce@ugent.be

Charcoal is probably the most widely used material for radiocarbon dating of archaeological features. However, the use of charcoal for age determination of archaeological features implies several potential risks, such as the old wood effect and the presence of residual older charcoal in the soil. To limit the risk for a potential old wood effect, charcoal fragments are now frequently identified prior to their use for radiocarbon dating in archaeological projects in The Low Countries (i.e. Belgium and The Netherlands). In this process, several charcoal fragments of Scots pine (*Pinus sylvestris*) and yew (*Taxus baccata*) have been recovered from archaeological features dating from the late Holocene period (Bronze Age till Roman period). Radiocarbon dates on these pine charcoal fragments consequently produced an early Holocene age however and those obtained from yew charcoal fragments a middle Holocene age. The obtained age differences are too large to be explained by an old wood effect.

In this paper, we discuss the taphonomy of these pine and yew charcoal fragments and argue that the age differences between the archaeological features and the charcoal fragments and are likely to result from residual soil charcoal (for pine) and the use of subfossil wood (for yew). Also, consequences for the Holocene history of both species and for sample selection of charcoal for radiocarbon dating of archaeological features are discussed.

Keywords: Radiocarbon Dating; *Pinus sylvestris; Taxus baccata;* Residual Charcoal; Subfossil Wood.

SPATIAL ANALYSIS OF THE ISOTOPIC SIGNAL (δ^{13} C) OF PALAEOLITHIC CHARCOALS: A NEW TOOL IN CHRONO-ENVIRONMENTAL CONTEXTUALISATION

Benjamin AUDIARD (Universitat de València, UCA-CEPAM-UMR 7264); **J. MONNEY** (EDYTEM-UMR 5204); **M. PADOVIN** (Università degli Studi di Trento); **T. BLASCO** (LOV-UMR 7093); **G. BATTIPAGLIA** (University of Campania); **I. THÉRY** (CEPAM-UMR 7264)

*benjamin.audiard@outlook.fr

In the last three years, the development of wood taxonomic analyses has largely shown their interest in reconstructions of local woody environment. Generally, the palaeoecological representativeness of the anthracological remains is based on the study of numerous wood charcoals scattered in the sediments and reflecting a relatively long occupation. Sampling is done by sieving or flotation of the sediment to avoid collect bias, followed by an interpretation according to the frequency spectrum of the taxa. Nevertheless, applied to palaeolithic sequences, the low taxonomic diversity combined with occasionally poor preservation of charcoal may limit the interpretations conventional anthracologic approaches. Moreover, certain chrono-stratigraphic contexts and the loss of material during sampling may complicate the studies.

In this presentation we propose to return to an alternative and complementary approach to the study of charcoal applied at the Grotte aux Points site (Upper Palaeolithic, Ardèche, France). Manual collection of charcoal, with recording of spatial coordinates, was carried out, completed by systematic sieving of the sediment. A crossed approach, taxonomic and isotopic analysis (δ^{13} C) was then applied to the whole corpus. A spatial restitution of the data was then carried out.

This original approach allowed us to observe several "isotopic sets" and thus to define several successive occupation phases with contrasting climates and environments. These chrono-environmental data allowed the targeting of additional radiocarbon dates, which validated this division. Where the taxonomic study alone would have provided an overview of the forest composition over a large chronological interval, the combination of an adapted protocol and a multiproxy analysis of the charcoal allowed to expand the discussion to a complementary chronological scale.

Keywords: Anthracology; Isotopes; Paleoenvironment; Sampling methods.

THE FIRST IDENTIFICATION KEY FOR WOODY SPECIES OF THE ETHIOPIAN DRY AFROMONTANE FOREST

Stephanie BODIN* (Senckenberg Gesellschaft für Naturforschung); K. NEUMANN (Senckenberg Gesellschaft für Naturforschung); A. BELDADOS (Addis Ababa University); E. LULEKAL (Addis Ababa University); M. WONDAFRASH (Addis Ababa University)

*stephanie.bodin@senckenberg.de

Identifying wood and wood charcoal from tropical regions is challenging. This is due to the high number of woody species growing in such areas and even more to the lack of tools – atlases, reference collections and identification keys – needed to identify them. In Africa in particular, wood and wood charcoal identification have still a long way to go: the studies are mostly concentrated in the Western and Southern part of the continent and very rare – or even inexistent – in the other regions. This is especially true for the Horn of Africa.

The Ethiopian highlands were crucial for the development and the evolution of early Homo sapiens, and archaeological rock shelters provide rich charcoal assemblages. Their study is of utmost interest to decipher past human-vegetation relationships. The dry Afromontane forest comprises 460 woody species and is part of the Afromontane biodiversity hotspot.

Here, we present the first wood identification key for the species of the Dry Afromontane Forest of Ethiopia. The key is set up on the online platform Xper 3 and will be available in open access. The anatomical features follow the IAWA nomenclature and include additional ones, in order to improve the identification process. Descriptions are based on (1) species available in InsideWood and (2) species from the reference collection in Frankfurt, Germany. The key also includes original images made on samples from this reference collection. These new descriptions and images will be contributed to InsideWood in return. The key will eventually include anatomical descriptions of the 89 genera currently present in the reference collection, already representing 46% of the genera growing in the dry Afromontane forest. In the future, users will be able to add further descriptions and images from newly available reference material.

Keywords: Identification; Wood Anatomy; Anthracology; Dry Afromontane Forest; Ethiopia.

MACCHIA OR FOREST? AN EXPLORATORY QUANTITATIVE ECO-ANATOMICAL APPROACH APPLIED TO *ARBUTUS UNEDO* FOR A BETTER RECONSTRUCTION OF ERICACEAE FORMATIONS IN CORSICA (NW MEDITERRANEAN) DURING THE HOLOCENE

Thomas CAMAGNY* (Université Côte d'Azur, CNRS, CEPAM, ISEM, Université de Montpellier, CNRS, IRD, EPHE); **S. IVORA** (ISEM, Université de Montpellier, CNRS, IRD, EPHE); **J.-F. TERRAL** (ISEM, Université de Montpellier, CNRS, IRD, EPHE); **L. BOUBY** (ISEM, Université de Montpellier, CNRS, IRD, EPHE); **C. DELHON** (Université Côte d'Azur, CNRS, CEPAM)

*thomas.camagny@cepam.cnrs.fr

Erica arborea and *Arbutus unedo* are very abundant in pre- and protohistoric anthracological assemblages of Corsica (NW Mediterranean). Nowadays, these Ericaceae species compose the macchia, a shrubland habitat ecosystem, covering a major part of the island. This plant formation is currently mostly maintained at a low and open shrubby stage by frequent perturbations such as wood cutting and fire, but rare preserved plots show that it can evolve to a high, nearly forested stage, with *Erica arborea* and *Arbutus unedo* forming trees up to 10 m high and more.

Traditional anthracological approach documents the floristic composition of past woodland but it does not allow us to specify the growth habitat of the trees. Thus, the physiognomy and structure of the Holocene Ericaceae formations remain unknown, while they constitute crucial information for the reconstruction of the landscapes, and of their potential for pre- and protohistoric human activities.

To address this issue, we have developed a quantitative eco-anatomical approach for the characterisation of *Arbutus unedo* habitat and size pattern (tree/shrub; high/low). This method is based on measurement and quantification of wood structural and vascular elements whose abundance and size are influenced by natural or anthropogenic ecological parameters, using modern wood samples.

Our protocol includes measurements in cross-section, and for the first time in tangential-section, as rays width and height seem to play an important role in the structural diversity of *Arbutus unedo*. Results from statistical analyses show that branch size and at a lesser degree growth habitat, seem to be recorded by eco-anatomical features. As a result, it seems possible to assess the morphology of the trees and the physiognomy of the woodlands. This approach is now being applied to a larger modern charcoal collection to provide a solid foundation for the examination of archaeological charcoals from Bronze and Iron Age Corsican sites.

Keywords: quantitative eco-anatomy; palaeoenvironment; palaeoecology; Arbutus unedo; Corsica.

PRESERVATION OF INTER-AND INTRA-ANNUAL VARIATION OF Δ^{13} C IN CHARRED TREE-RINGS: APPLICATION TO THE WOOD OF NOTRE-DAME DE PARIS

E. ROCHA (UMR 7619 METIS and UMR 7209 ASSPE); FREDERIC DELARUE* (UMR 7619 METIS); K.T. RINNE-GARMSTON (Natural Resources Institute Finland); E. SAHLSTEDT (Natural Resources Institute Finland); A. GHAVIDEL (UMR 7619 METIS, UMR 7209 ASSPE); M. MENDEZ-MILLAN (UMR 7159 LOCEAN); T.T. NGUYEN TU (UMR 7619 METIS); A. DUFRAISSE (UMR 7209 ASSPE)

*frederic.delarue@upmc.fr

The stable carbon isotope composition of charcoals ($\delta^{13}C_{char}$) in tree-rings is often used as a proxy of environmental conditions, notably hydric stress. Although $\delta^{13}C_{char}$ depends on the initial $\delta^{13}C$ of wood, carbonisation can also lead to substantial modifications altering its value. Hence, using $\delta^{13}C_{char}$ as a paleoenvironmental proxy can rely on the close relationship between carbonisation-induced ¹³C-fractionation and heating temperatures, often estimated by the carbon content (%C) of charcoals. To date, the strict preservation of $\delta^{13}C$ after carbonisation has never been fully addressed. To overcome this knowledge gap, experimental studies were conducted on non-charred and charred wood from Fontainebleau to assess the potential preservation of $\delta^{13}C$ in tree rings of the Notre-Dame charred oak. To this end, $\delta^{13}C$ was determined at interannual resolution using an elemental analyser coupled with an isotope ratio mass spectrometer (EA-IRMS) and, for the first time, at intra-annual resolution with laser ablation coupled with an IRMS (LA-IRMS).

Formed using a cone calorimeter, experimental charred woods exhibited a similar heating temperature to those from Notre-Dame. Our results show that inter- and intraannual variability was preserved after carbonisation at temperatures above 500°C, independent of the duration of charring, with a strong correlation (p < 0.01) between initial and charred δ^{13} C values. The charred samples were consistently ¹³C-depleted by $1 \pm 0.3 \%$ relative to initial values. In addition, we checked the time-series for its reaction to extreme climatic conditions. This study paves the way to use the charcoal remains from the Notre-Dame de Paris as a unique environmental archive to assess the paleoenvironmental conditions prevailing in the Paris Basin during the High Middle Ages period.

Keywords: Charcoal; Carbon isotopes; Inter and intra-annual variability; Notre-Dame de Paris.

Lab Keynote Session 2

DISTINCTION BETWEEN TRUNKS AND BRANCHES IN ANTHRACOLOGY: NEW RESEARCH PERSPECTIVES

 Alexa DUFRAISSE* (CNRS, UMR 7209 AASPE); S. COUBRAY (INRAP, UMR 7209 AASPE);
 LL. PICORNELL-GELABERT (ArqueoUIB, Universitat de les Illes Balears) ; M. ALCOLEA (Universidad de Zaragoza); S. BIANCO (IPHES-CERCA Tarragona; Universitat de Barcelona); O. GIRARDCLOS (UMR 6249 LCE) ; F. LANGENEGGER (Laboratoire de dendrochronologie de Neuchâtel); M. LEMOINE (CNRS, UMR 7209 AASPE)

*alexa.dufraisse@mnhn.fr

The DENDRAC project has developed dendro-anthracological parameters based on the wood anatomy and applicable to archaeological charcoal fragments that allow to distinguish the parts of the tree exploited in the past, in particular trunk and branches. This distinction is not trivial: in fact, the collection of branches does not have the same technical, social, and ecological significance as felling young trees of the same diameter. Moreover, paleoenvironmental studies based on ring widths should exclude branches which are poor recorders and may induce false signals. This is valid also for the stable carbon isotopes analysis, whose values are impacted not only by different compartments of sapwood-heartwood andpruning, but also by the juvenile state of the wood.

In this framework, new referential studies have been established, considering separately branches, trunk and whole tree, of different conifer species (*Pinus halepensis, Pinus cembra, Pinus sylvestris, Larix picea*) and one deciduous tree (*Quercus petraea, Q. pubescens*). By combining charcoal-pith distance and ring widths, the results obtained show that it is possible to separate trunks from branches, a distinction that is not feasibleby using the charcoal-pith distance alone. Results show that the distinction is defined/determined by a ring-width treshold which do not overlap in conifers, due to natural branch pruning. In oaks, conversely, the overlap area between branches and trunks can be significant depending on the age of the stands. Although this approach is constrained by the establishment of current reference for taxa and regions, the application of dendro-anthracological parameters to anthracological assemblages allows us to characterize collection practices and to hypothesize about technical systems, livehood or woodland management in the past opening new perspectives in terms of paleoenvironmental analyses on archaeological charcoal material.

Keywords: Dendro-anthracology; Tree Organ Discrimination; Woodland Management; Quantitative Methods.



8th International Anthracology Meeting Porto, 29th Aug. - 2nd Sep. 2023

- SESSION 2 -

Methodological and theoretical developments in charcoal science

Poster Abstracts
WHEN SMOKE IS IN THE AIR: AN EXPERIMENTAL APPROACH TO CHARACTERIZE FUEL EMISSIONS ON PAST HUMANS DWELLINGS

Andrés ROBLEDO* (IPHES-CERCA, Universitat Rovira i Virgili, Instituto de Antropología de Córdoba (CONICET), Universidad Nacional de Córdoba); **J. PALLARES** (Departament d'Enginyeria Mecànica, Universitat Rovira i Virgili); **S. CITO** (Departament d'Enginyeria Mecànica, Universitat Rovira i Virgili); **E. ALLUE** (IPHES-CERCA, Universitat Rovira i Virgili)

*arobledo@iphes.cat

Fire, since it became a feature of daily life, had a great significance for humans in the past. When reconstructing fire use and maintenance it is important to know what kinds of fuels were being used as energetic resources and how these were managed. We present the first results of a project that aims to investigate how important was the use of fire and how was the awareness or knowledge about the health effects on people. The objective is to study wellbeing (health and habitability) in prehistoric communities from different periods and dwelling conditions in the inhabited places (open air, semi-open as rockshelters and enclose places such as huts & houses) when fire was used.

Our research focusses in the identification of patterns that could refer to the decision making regarding the type of dwelling, as well as the size, ventilation, location of hearths and type of fuel used. For this we have designed an experimental protocol of experimental fires. The experiments are based in well-known paleolithic study cases with a large trajectory in the research on fuel management practices and different types of dwellings from the Western Mediterranean (e.g. Abric Romani and Molí del Salt).

Fire experiments were made in open air locations and in an enclosed scenario (hut) in the winter and spring. The main fuel used was *Pinus sylvestris* in order to evaluate fuel management and combustion practices. In the experiments we have registered meteorological conditions, hearth temperatures, as well as light, radiative heat and fine particles emissions using different tools. This has allowed to monitor several data in order to analyse air quality as well as habitability conditions in the different dwelling scenarios regarding health and wellbeing of the prehistoric communities.

Keywords: Fuel Emissions; Fire; Air Quality; Health; Heat.

THE PANOPLI PROJECT. A MORPHO-ARCHITECTURAL AND ISOTOPIC APPROACH ON *SALIX* SPP. TO INVESTIGATE THE PHYSIOGNOMY OF LATE GLACIAL SHRUB-TUNDRA LANDSCAPES

B. AUDIARD (Universitat de València); Auréade HENRY* (UMR 7264 CEPAM); J.-F. TERRAL (UMR 5554 ISEM); A. CARRÉ (UMR 7264 CEPAM); B. LIMIER (UMR 5554 ISEM, INRAE Montpellier 0378 SDAR); A. TOMASSO (UMR 7264 CEPAM)

*aureade.henry@cnrs.fr

The low taxonomic resolution inherent to paleovegetation records of arctic plant communities (Willerslev et al. 2014) makes it extremely difficult to assess if the identified woody taxa correspond to one or several species of the same genus as well as to small (creeping or dwarf, prostrate shrubs) or taller individuals (e.g., Riehl et al. 2014). This clearly limits our understanding of past environmental conditions and landscape physiognomy, the latter being a highly debated subject especially with regard to the effects of the Last Glacial Maximum (LGM) on the human peopling of northern Eurasia (e.g., Binney et al. 2017; Chytrý et al. 2018). In this context, canopy height is key to understanding local landscape habitability as this parameter is indicative of biomass and environmental conditions including ground thermal conditions and wildlife habitats (Bartsch et al. 2020).

In this poster, we present a project based on a morpho-architectural and isotopic approach aimed at increasing the resolution provided by *Salix*, a major taxon of the Late Pleistocene shrub-tundra. Wood from a selection of *Salix* species growing under different conditions from the mountain to the alpine vegetation belts will be collected. Control samples will be subjected to δ^{13} C measurements, while the rest of the samples will be charred in controlled conditions and be the object of microanatomical and isotopic investigations. Microanatomical measurements will include pore size and distribution, ray height and tree-ring curvature patterns. Comparisons between the δ^{13} C values of charred and uncharred material will be used to calibrate the isotopic signal on *Salix* charcoal. Finally, the combination of morpho-anatomical and isotopic markers will allow us to explore the relationships between taxonomy, shrub height and climatic conditions and to assess whether differences can be identified between creeping, dwarf or low and higher shrubs.

Keywords: *Salix*; Microanatomy; Shrub height; Stable isotopes; Anthracological Reference Dataset

CHARCOAL IDENTIFICATION OF THE *PRUNUS* SPECIES FROM SOUTHERN ITALY: A METRIC APPROACH

Anna Maria GRASSO (Laboratorio di Archeobotanica e Paleoecologia, Univ. Salento); G. FIORENTINO (Laboratorio di Archeobotanica e Paleoecologia, Univ. Salento)

*annamaria.grasso@unisalento.it

Most *Prunus* species are deciduous trees with fruits as drupes, usually with a juicy fruit flesh and, sometimes, edible seed. The *Prunus* genus comprises more than 400 species (Rosaceae family) economically and ecologically important, with many cultivated species; according to Pignatti (1982), up to 12 species are present in Southern Italy.

Prunus species have had numerous applications in ancient times especially in human diet and, being widespread, their wood has been used as firewood often. Their remains are thus frequently found in the archaeological contexts. The most widely distributed part of the *Prunus* plant discovered here is the wood (most frequently charred), but according to traditional anatomical pattern, it is generally difficult to discern the specie. So, it is complex to understand human economic and cultural development over time and the ecological setting in which this took place.

To address this lack, the present study examines the anatomical patterns of some modern Prunus species which grows in Southern Italy (*P. persica, P. dulcis, P. webbii, P. armeniaca, P. cerasifera, P. spinosa, P. domestica, P. avium, P. cerasus* and *P. mahaleb*). The reference specimens are heated in the muffle furnace under limited oxygen conditions at 400°C for 2 hours, after that the diagnostic sectional surfaces were exposed by manual fracture and were digitised; the quantitative characteristics of the wood's anatomy were determined and relieved according to the IAWA list of microscopic features for hardwood identification. In order to metrically characterise the considered *Prunus* species, descriptive and multivariate statistics were obtained.

The preliminary results indicate that the *Prunus* species could be distinguished, so the study of the archaeological remains could shed new light on the history and spread of this genus in Southern Italy.

Keywords: Prunus; Quantitative Wood Anatomy; Southern Italy.

CHARCOAL ANALYSIS AS A TOOL TO RECONSTRUCT INDIVIDUAL EPISODES IN THE LIFE CYCLE OF PREHISTORIC PITS: THE EXAMPLE OF TONGÓBRIGA (FREIXO, MARCO DE CANAVESES, PORTUGAL)

María MARTÍN-SEIJO* (Universidad de Cantabria); I. LÓPEZ-DÓRIGA (Wessex Archaeology); J. TERESO (CIBIO-BIOPOLIS - Univ. Porto; UNIARQ – Univ. Lisboa; CEIS20 – Univ. Coimbra; MHNC – Univ. Porto)

*maria.martin@unican.es

Pits excavated in the ground are the most frequent archaeological features in prehistoric sites. Their processes of backfilling are extremely complex, and therefore the interpretation of the archaeobotanical data obtained from them has been difficult. Our previous research focused on Bronze Age sites of northwest Iberia such as Monte das Cabanas (Spain), Terraço das Laranjeiras, Foz do Medal and Quinta de Crestelos (Portugal) has stressed the relevance of the paleoethnobotanical and taphonomic information stored in the charcoal remains recovered from pits. This poster presents the charcoal analysis results obtained at Tongóbriga (Freixo, Marco de Canaveses, Porto, Portugal), where a highly detailed sequence of the pit-filling single episodes was obtained. It was designed a strategy of sample recovery which involves the gathering of soil samples from thin artificial layers in each stratigraphic unit. The combination of this strategy of sampling with the analysis of all the charcoal fragments of each sample, besides the integration of data obtained from other archaeobotanical and archaeological evidence, has offered a unique opportunity to retrieve taphonomic information. This exhaustive analysis has allowed us: 1) to better define the management of plant resources by Bronze Age communities, 2) to stress the relevance of registering dendrological and taphonomic attributes besides taxonomic identification, 3) to highlight differences between stratigraphic units, but also between artificial layers, and finally 4) to propose new hypotheses of single episodes during the pit-filling process in the last use of these features.

Keywords: Charcoal analysis; Dendrological attributes; Taphonomy; Pit biographies; Bronze Age.

FLOTATION DEVICES - A NEW EASILY ACCESSIBLE AND ENVIRONMENTAL-FRIENDLY SYSTEM BUILT IN RIO DE JANEIRO

Marcos Davi Duarte CUNHA^{*1} (National Museum of the Rio de Janeiro/UFRJ); **Rita SCHEEL-YBERT**^{*2} (National Museum of the Rio de Janeiro/UFRJ).

<u>*1mdaviduarte@ufrj.br;</u> *2scheelybert@mn.ufrj.br

Flotation is an essential procedure for adequate collection of anthracological and archaeobotanical remains. A considerable part of flotation systems in existence, especially under humid climates, requires a substantial volume of water to be moved. Nowadays, concern about the whole chain of production, use, and cost of drinking water on a global level is ever greater. Water waste in open flotation systems can have severe environmental impacts. As such, its use as a field and laboratorial tool also motivates caution about the search and use of renewable resources. In this context, a new flotation system with water reuse was elaborated and constructed at the Laboratory of Archaeobotany and Landscape, National Museum of Rio de Janeiro, aiming to replace the open system previously used. The water's reuse is made possible through a submerged pump in a reservoir. Through the application of mechanical impulses, pressure is generated in the water, which considerably increases the system capacity. A more agile flotation is thus possible, with optimisation of the collection process for charred remains. This also allows for a safer handling of the samples, since it reduces or eliminates the necessity for manually revolving the sediment. The project developed here has basic construction requirements which are sufficiently simple and use parts of low to moderate cost. This achieves the goal of producing an equipment which is of easy access, reproducible, easy to operate, and easy to maintain. With this, we aim to diminish the environmental costs of use, bringing a positive proposal in what refers to preserving the environment and fighting against shortage of essential resources. Projects like this seek to raise the scientific community's awareness of its responsibility to constantly improve the use of natural resources.

Keywords: Charcoal; Flotation systems; Environment preservation.

IMPACT OF CARBONIZATION ON δ^{18} O IN WOOD: PRELIMINARY STUDY

Frederic DELARUE (Sorbonne Université, CNRS, EPHE, PSL, UMR 7619 METIS); D. DU
 BOISGUEHENEUC* (Laboratoire des Sciences du Climat et de l'Environnement/IPSL, UMR CEA/CNRS 1572, AASPE- CNRS/MNHN, UMR 7209); V. DAUX (Laboratoire des Sciences du Climat et de l'Environnement/IPSL, UMR CEA/CNRS 1572); T.T. NGUYEN
 TU (Sorbonne Université, CNRS, EPHE, PSL, UMR 7619 METIS); A. DUFRAISSE (AASPE-CNRS/MNHN, UMR 7209)

*diane.duboisgueheneuc@lsce.ipsl.fr

The destruction of the framework of the cathedral "Notre-Dame de Paris", in 2019, left the charred woods of "the forest" available to the scientific community. The oak trees of the framework constitute a unique opportunity to document the Medieval Climate Anomaly (MCA, ~ 900-1350 AD). The δ^{13} C and δ^{18} O isotopic compositions of wood are typically used to study the evolution of past climates. However, these climatic proxies cannot be directly used in the carbonized wood without considering the impact of carbonization, poorly documented for δ^{18} O values.

The present study aims at: (i) studying the impact of carbonization on the δ^{18} O values of oak wood and (ii) identifying processes driven these modifications. *Quercus petraea* was experimentally heated under pyrolysis and combustion conditions. δ^{18} O values were determined before and after carbonization by TC/EA-IRMS. The elemental composition and chemical structure were determined using elemental analysis, infrared spectroscopy, and Rock-Eval thermal analysis.

During the pyrolysis experiment, the change of the wood δ^{18} O occurs in two phases: (1) a slight increase in δ^{18} O until 300°C (up to +1.6 ‰) associated with the volatilization and preferential degradation of thermolabile components, and (2) a significant decrease in δ^{18} O (up to \approx -30 ‰) induced by the degradation of lignocellulosic complexes. Samples heated in combustion present different δ^{18} O evolution with temperatures probably due to different carbonization kinetics. The original δ^{18} O values of wood charred under combustion and pyrolysis can be approximated from H/C atomic ratio and isotope composition of charred wood. A confidence interval of approximately 2 ‰ for the estimated values, that is of the order of magnitude of the typical interannual variations of δ^{18} O in wood, precludes, at the moment, the use of δ^{18} O of carbonized woods too reconstruct subtle paleoclimate and palaeoenvironment variations but may be effective in tracing medium- or long-term trends.

Keywords: Charcoal; Pyrolysis; Stable Oxygen Isotopes; Carbonization Intensity; Wood Degradation

3D DIGITIZATION TECHNIQUES AND ARCHAEOBOTANICAL ANALYSIS OF WOODEN ARTIFACTS RECOVERED IN DRY AND WATERLOGGED CONTEXTS

Laura CARUSO FERMÉ* (Instituto Patagónico de Ciencias Humanas y Sociales -CONICET-); P. MONTEIRO (DGPC-LARC; ICArEHB); I. GONZÁLEZ BAGUR (CONICET); G. REMOLINS (Regirarocs, S.L.); M. MOZOTA (Unidad de Biotecnología. Laboratorio Agroalimentario de Santander. Ministerio de Agricultura, Pesca y Alimentación, Spain)

<u>*lcarusoferme@gmail.com</u>

The 3D scanning of wooden artifacts allows to obtain high resolution geometrical and radiometric information which is used to make quantitative and qualitative comparative analysis. The processed digital models can store geometrical information about texture and register the artifacts' state of conservation. These data allow to create virtual collections which can then result in further studies of the artifacts at archaeometric level in a remote way.

The objective of this work is to present the combination of 3D scanning techniques with the archaeobotanical analysis of wooden artifacts recovered in dry and waterlogged contexts. With this purpose, we studied wooden artifacts recovered in different archeological sites of Argentinean Patagonia, preserved in completely dry contexts without significant changes in temperature and humidity. These artifacts are associated to groups of hunter gatherers corresponding to different settlements during the Early and Late Holocene. We also worked with wooden artifacts recovered under the waters of Bracciano lake (Anguillara Sabazia, Italia). These artifacts belong to La Marmotta Neolithic site -5700 and 5300 cal BC-.

We worked with two 3D scanning techniques: digital photometry and 3D laser scanning with the objective of presenting the scope and limitations of both techniques and their usefulness in the analysis of woody raw material. The analysis of 3D triangular meshes, with different software bring a new perspective to discuss methods and techniques applied to the study of wooden archaeological artifacts. The methodology of analysis developed in this work makes it possible to apply it to the study of different woody materials regardless of their chronology and recovery site.

Keywords: Woodworking; 3D scanning; Photogrammetry; Early and Late Holocene South America; Early Neolithic Mediterranean



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- SESSION 3 -

Charcoal analysis and multi-proxy studies in paleoecology

Oral Abstracts

Keynote Session 3

WOODY VEGETATION OF PORTUGAL, A BRIEF SYNTHESIS

Carlos AGUIAR* (CIMO – Mountain Research Center, Instituto Politécnico de Bragança)

*cfaguiar@ipb.pt

Portugal is a small country with 92,090 km² located in the extreme southwest of Europe. Three Atlantic archipelagos are added to the Portuguese mainland: Azores, Madeira and Selvagens, which were not populated at the time of their discovery. The great European phytogeographic border between the Eurosiberian and Mediterranean regions crosses the NW quadrant of the country, separating two territories with very different bioclimates, flora and vegetation. The biogeographical position, the bioclimatic diversity and the presence of limestone, basic and ultrabasic islands immersed in a matrix of acidic rocks are central to explain the phytocenotic diversity and the complexity of the vegetation of mainland Portugal and its dynamics. In order to understandably summarize this diversity and its spatial distribution, the presentation will begin with a brief methodological introduction to the symphytosociological method and the dominant bioclimatic and lithological types. Then, based on vegetation series and geoseries concepts, a description will be made of the main types of indigenous forest vegetation in Portugal and their most relevant replacement stages, with particular focus on woody shrub vegetation. There is a correlation between the distribution of the vegetation series and the agriculture systems: an example from the northeast of Portugal will be given. The presentation will end with a brief reference to the woody vegetation cover of the Madeira and Azores archipelagos, emphasizing its originality in a European context. The presentation is based on the book Vegetação de Portugal, edited by J Capelo & C. Aguiar in 2021, available in pdf at the address https://imprensanacional.pt/wp-content/uploads/2022/03/A-Vegetacao-em-Portugal.pdf.

Keywords: Woody flora; Vegetation series; Vegetation of Portugal; Portugal

"FAIRE FEU DE TOUT BOIS". INSIGHTS INTO VEGETATION CHANGES DURING THE PLEISTOCENE-HOLOCENE TRANSITION AND FIREWOOD SELECTION STRATEGIES OF LATER STONE AGE INHABITANTS AT THE BUSHMAN ROCK SHELTER SITE, SOUTH AFRICA

Elysandre PUECH* (Université Nice Côte d'Azur, CNRS, CEPAM, France and Evolutionary Studies Institute, University of the Witwatersrand, South Africa); I. THERY-PARISOT (Université Nice Côte d'Azur, CNRS, CEPAM, France) ; M. BAMFORD (Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg 2050, South Africa)

*elysandre.puech@cepam.cnrs.fr

The Middle and Later Stone Age archaeological site of Bushman Rock Shelter is located in the southeastern part of Limpopo Province, on the Highveld near the northern edge of the Great Escarpment. The site benefits from an exceptional preservation of plant remains, including charcoal, on which excavations have exposed a large assemblage along the stratigraphy, derived from fire-related activities carried out by huntergatherer occupants. Charcoal assemblages from six stratigraphic units, as well as six concentrated charcoal deposits inferred to in situ combustion features, were analysed along the Later Stone Age sequence comprised between ca. 10.7 and 15.7 ka cal BP. Anthracological analysis allowed to document changes in local woody vegetation from the late Pleistocene to the early Holocene, for which only few past environmental and climatic records are available in the area. Results show strong variations in frequencies and/or replacement of some taxa at the Last Glacial-Interglacial transition. For instance, the appearance of Acacia-type (lato sensu) or the drop of Olea-type at the early Holocene reveals a dry and cool environment at the end of the Last Glacial period and then a moister and warmer condition after ca.11.7 cal BP. The study provides also information about temperatures and precipitation trends as well as landscape cover at this critical time period. Moreover, observation of charcoal alteration such as fungi hyphae and cell wall deformation were recorded to provide information on the state of collected wood. Alteration levels reveal that both green and decayed woods have been probably gathered according to particular taxa. Finally, attention is given to the methodological approaches employed in terms of sampling representativeness, identification process, and climatic affinities of charcoal-types as part of a case study applied to the Bushman Rock Shelter site.

Keywords: Pleistocene-Holocene transition; Later Stone Age; Southern Africa; e Environmental changes; Fuelwood management

WOOD CHARCOAL ANALYSIS FROM LOS MONEGROS (NE IBERIA): FIRST RESULTS OF THE LAST 7000 YEARS PALEOENVIRONMENTAL EVOLUTION

Marta ALCOLEA* (Dept. of Ancient Studies. University of Zaragoza, Spain); J.L. PEÑA-MONNÉ (Dept. of Geography. University of Zaragoza); M.M. SAMPIETRO-VATTUONE (Laboratory of Geoarchaeology, National University of Tucumán, CONICET, Argentina); J. PICAZO (Dept. of Ancient Studies. University of Zaragoza)

*malcolea@unizar.es

Open-air archaeological sites in semiarid Mediterranean lands are overly infrequent causing a severe bias for the understanding of settlement patterns and paleoenvironmental evolution in certain regions. This is the case of central Ebro basin lowlands (NE Iberia). This work is focused on the semiarid region of Jubierre (Los Monegros, NE Iberia). Our objective is to present the first results of wood charcoal analyses covering from the 7th millennium cal BP to the Little Ice Age. The fieldwork recently carried out within the framework of a multidisciplinary project including archaeology, geomorphology and palaeobotany suggests this region has been recurrently populated from the 7th millennium cal BP, especially during the Bronze Age. An intense local-scale deforestation of woodlands would take place, inducing soil erosion episodes and ending in a degraded landscape with scarcely fertile and often bare soils. Our fieldwork allowed the discovery or revision of 26 open-air sites including the archaeological remains in their geomorphological contexts. Main archaeological records were recovered from the slope deposits of isolated buttes and residual reliefs (tozales). The presence of charred plant macro-remains in some of these accumulations allowed the radiocarbon dating of the sequence. Indeed, large wood charcoal samples have been recovered from five of these accumulations. These records have a high paleoenvironmental significance and opens the door to future paleoclimatic studies. This work is a first contribution to the reconstruction of human-forest interactions with a diachronic perspective during the Holocene in one of the most arid areas in Europe today.

Keywords: Semiarid Mediterranean landscape; Middle-Late Holocene; Central Ebro basin; Human impact; Anthracology

NEOTROPICAL FOREST DYNAMICS AFTER DEGLACIATION IN THE CENTRAL AMERICAN HIGHLANDS: FIRST ANTHRACOLOGICAL RESULTS FROM EL GIGANTE ROCKSHELTER (11,000 – 1,000 BP), HONDURAS

Lydie DUSSOL* (University Côte d'Azur, CEPAM); K. HIRTH (Pennsylvania State University); T. SCHEFFLER (tesARCH SERVICES)

*lydie.dussol@cepam.cnrs.fr

The mechanisms for the establishment of present-day vegetation during the early Holocene remain poorly understood in the Neotropics (American tropics), where paleoecological data are scarce and high biodiversity complicates forest dynamics. In Central America, understanding post-glacial forest expansion is further complicated by regional heterogeneity in temperature and humidity during and after the Younger Dryas, as recorded in speleothems and lake sediments. The few available pollen records covering the late glacial-Holocene transition reflect this variability, and the vegetation changes they reveal in the lowlands are therefore difficult to generalize on a regional scale. However, it is in the Highlands, today mainly covered by pine-oak forests, that Paleoindian hunter-gatherers first spread, followed by Mesoamerican horticulturalists in the Archaic and Formative periods (9,000-2,000 BP). Located at 1,300 masl in the mountainous interior of Honduras, El Gigante rockshelter gives a unique opportunity to examine postglacial dynamics of montane forests at a local scale using archaeological wood charcoal. The earliest occupation of the rockshelter by Paleoindian groups was dated to the final late glacial (11,000 BP). It was followed by intermittent phases of occupation until the Classic period (1,000 BP). The results of the anthracological study reveal an unprecedented forest dynamic, from post-glacial plant communities without modern analog to the establishment of present-day mixed montane forests. These changes in the woody cover contributes to better understand the paleoenvironmental context of human expansion in Central America from the Paleoindian period. They can be directly compared to the beginnings of horticulture, changes in hunting strategies, the rise and diversification of maize, and the development of the first farming villages in the region in the Late Formative (2,500-2,000 BP). This study is part of important issues in American prehistory, where the characterization of Neotropical primary forests and the understanding of human impact on the forests are highly controversial.

Keywords: Central America; Post-glacial reforestation; Neotropical montane forest; Paleoecology; El Gigante Rockshelter

FRUIT TREE HORTICULTURE: NEW 7,000-YEAR-OLD CHARCOAL REMAINS FROM THE CENTRAL JORDAN VALLEY (ISRAEL)

Dafna LANGGUT* (Laboratory of Archaeobotany and Ancient Environments, Institute of Archaeology and The Steinhardt Museum of Natural History, Tel Aviv University); M. CAVANAGH (Laboratory of Archaeobotany and Ancient Environments, Institute of Archaeology, and The Steinhardt Museum of Natural History, Tel Aviv University)

*langgut@tauex.tau.ac.il

Compared to the evidence for the origin of cultivated cereals and pulses in the Old World, information on the beginning of fruit tree horticulture is fragmentary. Olive (Olea europaea) and fig (Ficus carica) charcoal remains were recovered from Tel Tsaf, a Chalcolithic site in the central Jordan Valley near the Sea of Galilee (Israel). Young olive and fig branches were ¹⁴C dated to ca. 7,000 cal. years BP, making this the earliest robust evidence for olive domestication based on the occurrence of charcoal remains outside Olea's natural habitat. Fig horticulture is suggested mainly in relation to charcoal remains of young fig branches, likely the result of pruning. Though other funders of fruit tree horticulture – grapevine (Vitis vinifera), pomegranate (Punica granatum) and date palm (Phoenix dactylifera) – were not present in the Tel Tsaf charcoal assemblage, they will also be examined according to their natural distribution and current archaeological and archaeobotanical evidence. We argue that all five founders were first domesticated in one geographically limited region - the central Jordan Valley. From this core area, knowledge and/or seedlings were transferred to nearby regions; yet, we cannot rule out that other parallel independent domestications may have occurred in other regions. In the central Jordan Valley, the onset of this development is dated to the 8th millennium BP. We claim that political-economical considerations were the prime motivator behind this process (rather than climatological-environmental concerns or other factors). Understanding the early stages of fruit tree domestication sheds light on the history of our civilizations, and according to this study, preceded urbanization or state formation by more than a millennium and a half. A better understanding of the origin and early stages of this development is also of great importance, given the immediate need to adapt horticultural practices to environmental degradation and global climate changes.

Keywords: Anthracology; Levant; Fruit tree cultivation and domestication; ¹⁴C dating

CHANGES IN LOCAL VEGETATION IN THE CARPATHIAN FOOTHILLS: STUDY BASED ON PLANT REMAINS FROM THE EARLY NEOLITHIC SETTLEMENT AT BISKUPICE (SOUTHERN POLAND)

Magdalena MOSKAL-DEL HOYO* (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland);
 A. WACNIK (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland);
 M. KAPCIA (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland);
 M. KORCZYŃSKA-CAPPENBERG (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland);
 M. KORCZYŃSKA-CAPPENBERG (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland),
 A. CZEKAJ-ZASTAWNY (Institute of Archaeology and Ethnology, Polish Academy of Sciences, Poland),
 N. MAREK (Institute of Archaeology, Jagiellonian University, Poland)

*m.moskal@botany.pl

The archaeological excavations conducted at Biskupice site no. 18 (within the framework of the project no. NCN 2018/30/E/HS3/00867) revealed remains of at least four Early Neolithic houses belonging to the Linear Pottery culture. The site represents the first appearance of a stable settlement in the Wiśnicz Foothills. Taking into account the character of the landscape, the site has a unique location as in a regional scale, the closest settlement clusters of the Linear Pottery culture are situated in the Upper Vistula River Basin. The settlement is located on a loess-mantled hummock (ca. 312 m.a.s.l.), delimited by two streams. Thanks to the evidence of the first entrance of agrarian societies in the foothills zone it is possible to study local vegetation and characterize its changes due to human occupation (ca. 5200-5000 BC).

Anthracological and carpological assemblages came from more than 1700 samples (5129 liters of sediment) taken from all archaeological features. Such a large number of samples is due to a general low plant density per liter from the Early Neolithic sites located in the loess areas. The results of plant macro-remains (wood charcoals, fruits and seeds) are compared between houses, as differences of the occupational phases might be suggested by a study of pottery style. These data are also supplemented with results of palynological analysis as pollen samples were taken from archaeological features and from the off-site profile of mineral-organic sediments cored outside the settlement place at Biskupice. The pollen spectrum for the Atlantic phase is characterised by a predominance of tree pollen of *Pinus, Betula, Salix, Quercus* and *Ulmus,* while the anthracological one is dominated by *Quercus, Fraxinus* and *Corylus.* Finally, the taxonomic list, relative frequency of identified taxa and the status of plants (native *versus* foreign species) from Biskupice will be compared with palaeobotanical data from southern Poland.

Keywords: Early Neolithic; Linear Pottery culture; vegetation changes; micro- and macroscopic plant remains; Carpathian Foothills

THE EUROPEAN FIR-BEECH FORESTS, THE BASELINE FOR MONTANE BELT FORESTS IN EUROPE: THE REVISITING OF A PARADIGM IN ECOLOGY

Vanessa PY-SARAGAGLIA^{*1} (GEODE, UMR 5602, CNRS-UT2J); Mélanie SAULNIER^{*2} (GEODE, UMR 5602, CNRS-UT2J); L. LARRIEU (INRAE, UMR Dynafor, CNPF-CRPF Occitanie), B. SYLVAIN (TRACES, UMR 5608)

*¹melanie.saulnier@univ-tlse2.fr; <u>*²vanessa.py@univ-tlse2.fr</u>

The conservation of old-growth forests has regained international attention because of their crucial role in mitigating climate change and in providing refuge areas for biodiversity. The problem, however, is which forests should be prioritized for preservation and what should be done to ensure that other forests evolve to resemble high-value forests. Many agree here that the reference state should serve as a benchmark and guide management so that the forests furthest from that state come closer to it. For the European montane belt, it is commonly admitted that the reference forest is a mature fir-beech forest (*Abies alba* Mill., *Fagus sylvatica* L.) with yew (*Taxus baccata* L.).

Palaeoecological and archaeological records provide a longer temporal perspective to address issues of naturalness, maturity, and ancientness, and thus shed light on the gap between these forests and a near-natural (reference) state. Through the analysis of charcoals from soils and charcoal kiln platforms we have attempted to better characterize the Holocene trajectory and sub-recent dynamics of these forest formations in two mountain areas: the Romanian Carpathian and the French Pyrenees. Our results from 6 stands, 3 in each massif are consistent with post-glacial forest recolonization processes known on a regional scale and species successions that followed the last glacier retreat.

The temporal depth provided by our study in two disjointed massifs reveals a common trajectory during the late Holocene where the establishment of the fir-beech mixed forest resulted from a close co-construction between the life history of tree species and the development of pre-industrial societies. Considering the high heritage value of these forests inherited from human-nature interaction, it deserves to be considered in its own right and as a reference to be reached and preserved in the European montane level.

Keywords: European old-growth forests; Reference state, Charcoals, Carpathian and Pyrenean Mountains.

THE ECOLOGICAL IMPACT OF LONGSHAN NEOLITHIC URBANISATION: INSIGHTS FROM CHARCOAL ANALYSIS IN SHANXI PROVINCE, CHINA

Marvin DEMICOLI* (University of Liverpool, Museum of London Archaeology)

*marvindemicoli@gmail.com

This research presents anthracological analysis from sites in the eastern Loess Plateau within Shanxi Province of central-northern China. The sites date to the Longshan Neolithic (ca.3000-1900 BCE), a period characterised by increasing site and population densities and the emergence of the first large urban centres in China. Anthracological analyses were conducted on charcoal from sites within two regions: Bicun and smaller sites in the Jinxi-Yufenhe region in the north, and Zhoujiazhuang in the Yuncheng basin in the south of the province.

The Late Longshan charcoal assemblages varied across the regions, with the northern region having *Pinus* as the dominant taxon and the south having a prevalence of deciduous *Quercus*. The results suggest that the arboreal vegetation in both regions represented a wetter and warmer climate than the present. Dendro-eco-anthracological analyses did not provide concrete evidence of woodland management for fuelwood and timber production, but the presence of several economic tree taxa might suggest possible arboriculture.

Nevertheless, some patterns in the inferred arboreal vegetation cannot be attributed to past climatic changes, hinting towards an ecological impact of early urbanisation. The taxonomic composition in the Jinxi-Yufenhe region changes from one with *Quercus* and *Pinus* as dominant taxa in the Early Longshan period to a *Pinus*-dominated one during the Late Longshan period. Regional pollen records do not show significant climatic changes or vegetation shifts between these periods. It is suggested that the change in vegetation diversity within the anthracological assemblages was possibly the result of localised deforestation and secondary forest regeneration, leading to taxa with high successional potential taking over.

This research highlights the possible ecological footprint of early urbanisation in the Longshan Neolithic period. It is particularly relevant considering present anthropic pressures on the natural environment and the need to understand how humans have affected landscapes in the past.

Keywords: Charcoal; China; Late Longshan Neolithic; Ecological impact.

ENVIRONMENTAL AND AGRARIAN DYNAMICS IN THE VALLEY OF AL-ULA (SAUDI ARABIA) DURING THE LAST THREE MILLENNIA: CHARCOAL ANALYSIS COMPLETED BY SEED/FRUIT AND PHYTOLITH STUDIES

Vladimir DABROWSKI* (UMR 7209, MNHN/CNRS); C. BOUCHAUD (UMR 7209, MNHN/CNRS); E. CHAMBRAUD (UMR 7209, MNHN/CNRS), A. DECAIX (UMR 7264, Univ. Nice Côte d'Azur/CNRS), L. PURDUE (UMR 7264, Univ. Nice Côte d'Azur/CNRS), A. GARNIER (UMR 8591, UPEC/Paris1/CNRS), M. LEMOINE (UMR 7209, MNHH/CNRS), X. DESORMEAU (UMR 7209, MNHN/CNRS)

*vladimir.dabrowski@mnhn.fr

The Al-'Ulā valley (Saudi Arabia) in Northwest Arabia has a long history of human development that deeply contributed to shape the regional landscapes. Recent excavations on two ancient major towns of the valley, namely the archaeological sites of Dadan and Madâ'in Salih, in addition of satellite sites, give opportunities to document the environmental and agrarian dynamics linked to settlement patterns over the three last millennia through charcoal study completed by seed & fruit analysis. In addition, phytoliths sampled in ancient agrarian soils identified in geoarchaeological soundings situated in the core modern oasis provide supplementary data to discuss the beginning and long-lasting development of the oasis.

Charcoal analysis combined with the seed & fruit results, supported by direct radiocarbon dating alongside with phytoliths, document the emergence of the oasis at the end of the 2nd millennium BCE, followed by a development phase during the 1st mill. BCE in the core oasis of Al-'Ulā. From the mid. 1st mill. BCE to the mid. 1st mill. CE, the charcoal results from the residential area of Madâ'in Sâlih show a correlation between the evolution of plant communities and settlement dynamics. Indeed, the predominance of the wild Amaranthaceae shrubby family during the 2nd half of the 1st millennium BCE is possibly related to the clearance of local spots for the installation of new populations and agricultural plots; the great taxonomic diversity of wild taxa seems to indicate the degradation of the neighbouring vegetation cover at the turn of the Common Era. From the 1st c. CE onward, the increasing presence of date palm and other fruit trees likely show the development and extension of the oasis. Finally, new data unearthed from the Medieval Dadan indicate the presence of numerous fruit trees (date palm, pomegranate tree, fig tree, jujube tree, Prunoidae, Maloidae) underlying the investment for diversifying the local agrobiodiversity.

Keywords: Archaeobotanical multiproxy analyses; Arabian Peninsula; Oasis agricultural system; Evolution of natural vegetation cover

TIMBERS OF THE COFFERED CEILING OF THE GALLO-ROMAN CULTURAL COMPLEX OF SAINT-MARTIN-AU-VAL, AUTRICUM-CHARTRES (EURE-ET-LOIR, FRANCE): INTERDISCIPLINARY APPROACHES FOR THE CHARACTERIZATION OF WOODLANDS, PROVENANCE, CHOICE AND WOODWORKING

Magali TORITI* (UMR6566 CReAAH, Le Mans Université); Y. LE DIGOL (Dendrotech); B.
 BAZIN (UMR 8546 AOROC, Ville de Chartres et Chartres); C. AZZI (Université Paris-Est Créteil Val-de-Marne - Paris 12); E. BOUILLY (Ville de Chartres et Chartres Métropole);
 S. PAPAÏAN (Ville de Chartres et Chartres Métropole); C. HANO (LBLGC, Université d'Orléans EA1207, INRAE USC1328); J.-P. BLONDEAU (CEMHTI, Université d'Orléans, UPR3079); W. KLOPPMANN (Bureau de Recherches Géologiques et Minières, BRGM);
 N. POLLET (EGCE, Université Paris-Saclay, CNRS, IRD)

*mag.toriti@gmail.com

For the past fifteen years, a research programme directed by the Archaeology Department of the city of Chartres has been focusing on the excavation and study of an Ancient cultural complex in Chartres (Eure-et-Loir, France). Built between the end of the 1st century and the beginning of the 2nd century AD, this complex includes a podium and an altar dedicated to Apollo. Below, a monumental fountain has been discovered. In addition to the veneers of coloured marble imported from Italy, Greece and Turkey that are still visible, three basins were uncovered, two of which were ceremonial. The latters contained nearly 2000 pieces of charred and waterlogged wood. They correspond to a decorated hexagonal and rhombic coffered ceiling in an exceptional state of preservation. This corpus, which is unprecedented in the Western Roman world, is made up of oak for the framework elements, fir for some of the framework parts and the beams, joists and planks making up the coffers, and limewood for the sculpted decorations. The study presented here combines human and social sciences, plant and animal sciences, and geosciences: anthraco-entomology, dendrochronology and dendroprovenance, rereading of ancient texts, traceology, isotopic geochemistry, DNA, infrared, phytochemistry. One of the objectives of this research is to characterize the provenance and morphology of the woodland chosen for the ceiling, and thus to raise the question of the economy of timber for a city such as Autricum. It is also from the analysis of the work of the craftsmen that it is possible to learn about the management and transformation of a tree into a coffer element. The case of the 560 fir trees in the corpus, a species exogenous to the territory of Autricum, and more broadly to the region, will be discussed.

Keywords: Interdisciplinary; timber; gallo-roman period; charcoal and watterlogged wood

ENVIRONMENTAL ARCHAEOLOGY BETWEEN THE THAR DESERT (PAKISTAN) AND GUJARAT (INDIA) DURING THE IV-II MILLENNIUM BC: PRELIMINARY ANTHRACOLOGICAL RESULTS IN A MULTI-PROXY APPROACH

 Ignazio MINERVINI* (Laboratory of Archaeobotany and Palaeoecology, Department of Cultural Heritage. University of Salento); M. MADELLA (ICREA and CASEs Research Group, Department of Humanities, Universitat Pompeu Fabra, Barcelona); M.
 PRIMAVERA (Laboratory of Archaeobotany and Palaeoecology. Department of Cultural Heritage. University of Salento)

*ignazio.minervini@unisalento.it

This contribution presents the preliminary results of anthracological analyses carried out on three Harappan sites located between central Pakistan (Thar Desert western boundary) and northwestern India (Gujarat), as part of the Ph.D. project entitled "Archaeology of climate change between Sistan (SE Iran) and Gujarat (NW India): what lessons from protohistoric civilisations for a sustainable future?" (PON "Research and Innovation" 2014-2020 FSE REACT-EU).

The results of the charcoal analysis from Loteshwar (Gujarat, 3600-3300 BC), Bhando Qubo (Sindh - Larkana district, 2800-1900 BC) and Taloor Je Bhitt (Sindh - Khairpur district 2600-1900 BC) are compared with paleoenvironmental studies and other biological remains analysis available for the area (*off-site*) as well as for each of the investigated sites (*on-site*), in a multi-proxy approach. Specifically, correlation between charcoal results, phytoliths analysis, pollen sequences and isotope analysis (O, N, C) on lacustrine sediments allow to understand the relationship between climate fluctuation at regional scale and human local adaptation during IV and II millennium BC.

The aim of this paper is in line with the main goal of the Ph.D. project, focused on understanding whether cultural choices, made by past societies in the face of climate changes, can provide knowledge for today's society.

Keywords: Wood-charcoal; Phytoliths; Pollen; Isotopes; Lacustrine and estuarine sediments; Gujarat; Sindh.

THE CHERNOVSKOE HILLFORT AND ITS IMMEDIATE SURROUNDINGS IN THE IRON AGE AND THE EARLY MIDDLE AGES: ECONOMIC ACTIVITY OF THE INHABITANTS AND ITS IMPACT ON THE ENVIRONMENT

Julia SALOVA* (University of South Bohemia, Czech Republic); N. RYABOGINA (University of Gothenburg, Sweden); L. VYAZOV (University of Ostrava, Czech Republic); E. PONOMARENKO (University of Ottawa, Canada); V. MINGALEV (Perm Higher School of Economics, Russia); R. UTYAGULOVA (Tyumen Scientific Centre SB RAS, Russia)

*yadviga13ya@gmail.com

Both archaeobotanical and paleoenvironmental research on expansion of agriculturalism into remote and isolated areas are very limited. This data gap is particularly notable in Eastern Europe, distanced from the original farming areas. To address this issue, we conducted an archaeobotanical investigation in the southern taiga zone of the Urals. Our study aimed to correlate the changes in charcoal spectra with the agricultural development and wood utilization. To achieve that, we examined both onsite and off-site stratigraphic sections of the site Chernovskoye-1 that experienced multiple phases of habitation and abandonment beginning 1900 yBP. Our study employed charcoal analysis complemented by the soil palynology. A correlation has been established between charcoalified bark, cereals, Betulaceae, and agricultural utilization in the slash-and-burn cultivation system, as well as between charcoalified conifers, fungal sclerotia, and synanthropic species and other types of forest utilization. Our reconstruction model indicates a shift from the activities confined to the hillfort towards the expansion of forest clearings around 500 CE, followed by the long-term abandonment of the area from 750 to 1650 CE and subsequent repopulation.

Keywords: Archaeobotany; Charcoal; Macroremains; Landscape archaeology; Environment reconstruction.

ANTHRACOLOGY IN A RELICT FOREST IN THE SOUTH PACIFIC, AN ARCHAEOBOTANICAL APPROACH ON WOOD CHARCOAL ASSEMBLAGES FROM MOCHA ISLAND

Ayelen DELGADO ORELLANA* (Institute of Archaeology, University College London)

*ayelen.orellana.17@ucl.ac.uk

Mocha Island is located in the South Pacific Ocean (38°22' S) only 30 km off the coast of Southern Chile. Since its emergence the island has never been accessible by land, so its vegetal and faunal native composition differs from the mainland. Also, all human presence before the 20th century implies the use of navigation technologies. The island was "discovered" on 1544 CE, and the reports left by European navigators between the 16th and 17th centuries inform of a well populated Island, where the natives grew maize, beans and kept "sheep" with long necks (Ilamas). The Spaniard conquerors never settled on the island, and they force its depopulation between 1685-1687 CE. The island was uninhabited until 1850 CE, when the Chilean state started a colonization program in Southern Chile.

The last decades of archaeological research on the Island show that Pre-Hispanic groups visited it sporadically during the Archaic Period (1500 BCE), and more regularly from the Early Ceramic Period (100 CE). But around the year 1000 CE (Late Ceramic Period), the archaeological sites show continuous and reiterative use of the space around domestic units, and mound-and -platform complex has also been dated to this Period.

This paper presents from an archaeobotanical perspective the wood charcoal analysis results of three archaeological Sites from Mocha Island, dated between the 1000 and 1685 CE. As well as previous visitors or occupants of the Island, groups from the Late Ceramic Period introduced animal and plant species to this insular territory of 52 km². The aim is to discuss the changes in the forest environment over 500 years of Pre-Hispanic and early Historic inhabitation that involved crop cultivation, camelid's husbandry and population growth.

Keywords: Paleoethnobotany; Southern Chile; Temperate Forests; Old Growth Forests; Mapuche.

EVALUATION OF THE ROOF STRUCTURE CONDITION OF NOTRE-DAME DE PARIS (FRANCE)

Magali TORITI* (UMR6566 CREAAH, Le Mans Université); F. FOHRER (Centre Interdisciplinaire de Conservation et de Restauration du Patrimoine - CICRP); O. GIRARDCLOS (UMR6249 Chrono-environnement, UFC-CNRS); J.-Y. HUNOT (UMR6566 CREAAH, CNRS-Pôle archéologique département Maine-et-Loire); C. PENAGOS (UMR6249 Chrono-environnement, UFC-CNRS)

*mag.toriti@gmail.com

The fire of 15 April 2019 in the roof structure of Notre-Dame de Paris cathedral (France) destroyed its medieval and modern frameworks. These remains are the subject of a research project called ANR CASIMODO (coord. A. Dufraisse, MNHN, AASPE UMR7209, France), within which an anthraco-entomological study is being carried out. The main objective of this study is to characterize the biological organisms (xylophagous insects) present in the charred wood of the medieval framework to assess its condition before the fire, at different periods if possible.

There exist more than 600 species of wood-boring insects, each with its own biology. They generally prefer decaying trees, stored wood or timber. Attacks can target the cambium, sapwood and/or heartwood, in different parts of the tree, and can affect both coniferous and deciduous trees. In a structural context, our analysis can identify the origin of the infestation by assessing the moisture conditions, the duration of the infestation, providing information on the nutritional value of the wood, and assessing the structural impact of the infestation on the mechanical properties of the structure.

Based on current breeding programs and repositories of insect traces, this study aims to highlight practices in the choice and management of raw materials, maintenance, refitting and construction of frameworks in medieval and modern societies. If the wood does not show any trace of infestation, the question of a healthy structure and wood protection arises.

At the interface of human/social sciences and biological sciences, this cross-disciplinary approach remains unprecedented for the medieval period. In link with building archaeologists specialized in frameworks and dendrochronologists, the pieces of wood will be recontextualized both spatially and chronologically, anthraco-entomological interpretations will be refined, and methodological tools will be developed for each field.

Keywords: Timber; Anthraco-Entomology; Wood condition; Medieval period



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- SESSION 3 -

Charcoal analysis and multi-proxy studies in paleoecology

Poster Abstracts

TIMBER IN LOWER PROVENCE MEDIEVAL RURAL ARCHITECTURE: NEW CROSS-DISCIPLINARY APPROACHES

C. VENOT-TISSERAND (LA3M UMR 7299-IMBE UMR 7263 Laboratories); Aline DURAND* (Le Mans University, CReAAH UMR 6566 Laboratory); F. GUIBAL (CNRS, IMBE UMR 7263 Laboratory)

*aline.durand@univ-lemans.fr

The absence of woody artifacts in non-subhumid archaeological sites of Lower Medieval Provence hinders the study of architectural timber. New approaches need to be developed to remedy this situation.

Rocky medieval sites are not rare in calcareous or sandstone Provence. Although their archaeological potential is known, they have never been the subject of in-depth synoptic work. These sites present numerous notches and negative wood imprints carved in the rock. These notches can provide the minimal morphology of the woods and at least part of the carpentry or joinery treatments they underwent. A specific protocol was developed to systematically record these embedding traces in medieval castellated sites in the Alpilles and Lower Provence. They testify to the use of wood in rural vernacular architecture. They open onto the technical operational sequence of woodworking (carpentry, joinery) and also onto forest and environmental management by villagers.

Dendroecology completes and supports the data from the study of the embedding traces. The growth curves of key tree species, selected according to anthracological data of castellated villages, were acquired from present-day fertility stations located close to medieval archaeological sites. They offer new tools to address these questions in archaeology, and were partially completed by pedoanthracological analyses.

The interweaving of the three approaches – anthracological, dendroecological and archaeological – makes it possible to propose models of growth or even forest management of the architectural woods used in rural twelfth-fourteenth century construction, especially at castellated villages.

Keywords: Timber, Rural construction, Middle Age, Anthracology, Dendroecology

THE MEDIEVAL LANDSCAPES OF CORSICA: PRACTICES AND SOCIO-ENVIRONMENTAL DYNAMICS

Aline DURAND* (Le Mans University CReAAH UMR 6566 Laboratory); M. TORITI (Le Mans University CReAAH UMR 6566 Laboratory); C. VASCHALDE (Mosaïques Archéologie, Aix-Marseille University LA3M 7298 Laboratory)

*aline.durand@univ-lemans.fr

The medieval landscapes of Corsica are still poorly known because written sources are scarce and few anthracological analyses have been carried out. Preventive medieval archaeology is little developed in the island. The programmed excavations mainly focus on castra - castellated sites grouped and fortified from the year one thousand and designed to shelter the *inermes* in the protective shade of the manorial tower. However, Corsica is of major paleoecological interest because it is a mountain seated in the middle of the sea where the altitudinal change in vegetation is very rapid, and its granitic and volcanic origin has led to the development of a silicicolous vegetation. The anthracological analyses carried out on the castra of Contudine, Rostino and L'Ortolo offer the possibility of reconstructing their woody environment and sometimes their evolution between the 13th and 15th centuries. They also lead to a better understanding of the practices linked to firewood or timber wood collection. In this perspective, new tools such as anthraco-entomology or quantitative eco-anatomy bring a decisive contribution: the way in which wood was collected for the domestic hearth is better understood, and the results highlight that fruit growing – which was enriched by new species - clearly intensified at the end of the Middle Ages.

Keywords: Middle Age, Corsica, castra, landscape, practices

A MULTIDISCIPLINARY ANALYSIS OF LANDSCAPE DYNAMICS IN BAD WALDSEE (SW GERMANY) DURING THE MEDIEVAL AND EARLY MODERN TIMES

 Sara SAEIDI* (Baden-Wuerttemberg State Office for Cultural Heritage-Regierungspraesidium Stuttgart); O. NELLE (Baden-Wuerttemberg State Office for Cultural Heritage- Regierungspraesidium Stuttgart); E. MARINOVA (Baden-Wuerttemberg State Office for Cultural Heritage- Regierungspraesidium Stuttgart); R.
 HESSE (Baden-Wuerttemberg State Office for Cultural Heritage- Regierungspraesidium Stuttgart); C. LEMMES (Institute of Historical Regional Studies and Auxiliary Sciences of History, Eberhard Karls University of Tübingen, Tübingen, Germany); K. HAAS (Institute of Geosciences, - Technical University of Darmstadt); T. SCHIEDEK (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt); M. HINDERER (Institute of Geosciences - Technical University of Darmstadt)

*<u>sara.saeedi@gmail.com; sara. Saeidighaviandam@rps.bwl.de</u>

The spatial proximity of a town with a rich legacy of historical documents (Bad Waldsee) and a sediment archive deposited in its lake right outside the medieval town wall (Stadtsee) offers great potential to research landscape changes and socioenvironmental developments during the preindustrial phase of 1200-1800 AD. We combined sedimentary charcoal influx records (macro- and micro-charcoal) and palynological and geochemical records (PAHs) to investigate past fire events in terms of man-made or climate-driven fire signals. Additionally, using anthracological and geochemical analyses on charcoal production sites close to the town, we explored past woodland exploitation for charcoal supply in a landscape where Fagus-dominated woodland is the main potential natural vegetation type on mineral sites. The pollen evidence shows that these forests suffered from severe human impact, starting with intensive Iron Age land use and both, increasing crop cultivation and regional fire activities. During the High Medieval period, the catchment was largely deforested. Macro charcoal analysis revealed two main phases of biomass burning. The first phase (1297-1497) was followed by a distinct fire-free interval (~220 years), and the second burning phase was from 1637 until today. During Late Medieval times and after 1750, low-magnitude local fires coincided with intense land use pressure. During the first burning phase, macro charcoal wood morphotypes were dominant until the end of the Late Medievals. Preliminary geochemical analysis indicates that the macro-charcoal particles mainly originated from conifers, which contrasts with the woodland composition of the surroundings. Most probably, this links to the burning of buildings' construction wood during fire accidents, which has a high coniferous proportion. In the subsequent periods, both charcoal morphotypes and geochemical evidence suggest changes in the type of burned material. To explore the relationship between these fluctuations and forest exploitation, the ongoing analyses of charcoal kilns based on mega-charcoal identifications, PAH measurements and LIDAR data will be considered.

Keywords: Multiproxy analysis; Fire history; Woodland composition; LIDAR; Charcoal production site

ECOLOGICAL NICHE MODELS OF SUB-MEDITERRANEAN OAK SPECIES AND THEIR RELATIONSHIP TO NEOLITHIC HUMAN SETTLEMENTS IN THE NORTH-EASTERN IBERIAN PENSINSULA

Bàrbara MAS* (Seminari d'Estudis i Recerques Prehistòriques, Departament d'Història i Arqueologia, Universitat de Barcelona; Institut d'Arqueologia de la Universitat de Barcelona, Facultat de Geografia i Història, Universitat de Barcelona); N. SILLERO (Centro de Investigação em Ciências Geo-Espaciais (CICGE), Faculty of Sciences, University of Porto); S. RIERA (Seminari d'Estudis i Recerques Prehistòriques (SERP), Departament d'Història i Arqueologia, Universitat de Barcelona); E. ALLUÉ (Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Departament d'Història i Història de l'Art, Universitat Rovira i Virgili (URV)

*barbara.mas86@gmail.com

The anthracological data from Neolithic sites in north-eastern Iberian Peninsula indicate the presence of two main woody taxa: deciduous Quercus sp. (oak) and evergreen Quercus sp. (Holm oak), as well as other woody taxa that coexist with these sub-Mediterranean oak communities. To better understand the distribution of suitable habitats of these oak formations and their relationship to the anthracological assemblages, we projected to the Middle Holocene (8.2-4.2 kyr BP, north-eastern Iberian Peninsula) current ecological niche models calculated with the maximum entropy algorithm (MaxEnt) for Quercus pubescens (pubescent oak) and Quercus ilex subsp. ilex (Holm oak) in the Iberian Peninsula. Furthermore, we explored the relationship between wood gathering activities and both oak suitable habitats by examining the locations of Neolithic archaeological sites recording anthracological data. Our results suggest that the two oak species responded differently to climatic conditions, using therefore different suitability habitats. Temperature and precipitation factors, particularly seasonal temperature conditions, significantly impacted the response of both species. The habitat suitability maps showed denser vegetation cover in the lowlands and a more open landscape in the highlands, with pubescent oak being dominant in the northern areas, while Holm oak was restricted to certain coastal areas. The ENMs of the two oaks indicated a high degree of spatial overlap with the locations of the analysed Neolithic sites: Neolithic human groups were knowledgeable about the potential of forests and likely engaged in gathering woody resources in proximity to their settlements. In conclusion, our study highlights the importance of considering the relationship between suitable habitats of vegetative landscapes and human behaviours related to the acquisition of wooden resources to better understand the palaeoecological and anthracological contexts.

Keywords: anthracology; Neolithic settlements; oak woodlands; habitat suitability; wood gathering activities)

FIRST RESULTS FROM BADANJ (BOSNIA AND HERZEGOVINA)

Marta ALCOLEA* (Dept. of Ancient Studies. University of Zaragoza); A. RUIZ-REDONDO (Dept. of Ancient Studies. University of Zaragoza, Spain); N. VUKOSAVLJEVIC (Dept. of Archaeology, University of Zagreb)

*malcolea@unizar.es

Badanj rockshelter (Bosnia and Herzegovina) is one of the richest Upper Palaeolithic sites in South-eastern Europe (i.e. the Balkans). After the first investigations in the 1970s and 1980s, fieldwork at this site has recently been resumed within the framework of an international project. These excavations have allowed to recover some charcoal fragments to radiocarbon date the archaeological sequence and to obtain first results in the human management of forest resources and paleoenvironmental conditions during human occupation of the site. In this work a total of 41 samples recovered during 2019 and 2022 archaeological fieldwork seasons have been analysed. The charcoal assemblage belongs to the human occupation recorded in levels 4-7 (c. 19-16 kyr cal BP) coinciding with the Early-Late Epigravettian transition. The sequence is coniferdominated, with the predominance of cryophilous pines (Pinus tp. sylvestris) accompanied by steppic plants such as junipers (Juniperus sp.), and a low proportion of angiosperms (Betulaceae), revealing an open woodland pointing out to a cooler and more arid climate during MIS 2. Documented vegetation is undoubtedly influenced by the environmental conditions of the LGM but also by the distance from the coastline modified by the sea level fluctuations in the Adriatic Basin during this period.

Keywords: wood charcoal analyses; Epigravettian; LGM; MIS2; Adriatic Basin.

ISOTOPIC ANALYSIS (δ^{13} C) OF PALAEOLITHIC CHARCOAL FROM COVA DE LES CENDRES: CONTRIBUTION TO CHRONO-ENVIRONMENTAL AND STRATIGRAPHIC READING

Benjamin AUDIARD* (Univarsitat de València); V. VILLAVERDE (Univarsitat de València); C. REAL (Univarsitat de València); D. ROMAN (Univarsitat de València); C.M
 MARTÍNEZ-VAREA (Univarsitat de València, Universidad de Salamanca);
 E. BADAL (Univarsitat de València)

*benjamin.audiard@outlook.fr

In recent years, the combined use of taxonomic and isotopic analysis of ancient charcoal has justified its interest in high-resolution palaeoenvironmental studies. Although this approach offers a certain methodological adaptability according to the anthracological corpus and stratigraphic contexts, the good conservation of the latter and the risks of reworking paradoxically remain the main limitation.

In this work, we present the first isotopic (δ^{13} C) results obtained on charcoal from Cova de les Cendres (Teuladad-Moraira, Alicante, Spain). A key site in the study of the Upper Palaeolithic of the Spanish Levante since we have documented regular human occupations from the Aurignacian to Magdalenian. While most studies on the Pleistocene isotopic signal have focused on *Pinus* sp., we propose here a study focused on *Juniperus* sp., complemented in the more temperate phases by *Pinus* type *nigra/sylvestris*.

Overall, our results from Cova de les Cendres has helped to characterize with precision the major climatic fluctuations that occurred both during the second half of the MIS3 until the Tardiglacial, faced by prehistoric inland groups (from the Aurignacian to the Magdalenian). However, if the mean isotopic signal in the upper part of the sequence allows a chrono-environmental dictation at high resolution (Solutrean-Magdalenian), the probable impact of gutters in the test-pit complicates the reading of the isotopic record in ancient layers (Aurignacian-Gravettian).

Finally, the isotopic signal on *Pinus* sp. seems to present a depletion in ¹³C compared to that of *Juniperus* sp. This contract in the inter-generational response opens new perspectives in multi-taxon isotope analysis.

Keywords: Anthracology; Isotope; Paleoenvironment; Paleoclimate; chronostratigraphy

FUEL WOOD PROCUREMENT AT THE PAVLOVIAN SITE OF DOLNÍ VĚSTONICE I (CZECH REPUBLIC)

Magdalena MOSKAL-DEL HOYO* (W. Szafer Institute of Botany, Polish Academy of Sciences);
 G. JUŹWIŃSKA (W. Szafer Institute of Botany, Polish Academy of Sciences);
 J. WILCZYŃSKI (Institute of Systematics and Evolution of Animals, Polish Academy of Sciences);
 M. NOVÁK (Institute of Archaeology, Czech Academy of Sciences, Brno);
 S. BORIOVÁ (Institute of Archaeology, Czech Academy of Sciences, Brno),
 M. HÄNDEL (Austrian Archaeological Institute, Austrian Academy of Sciences)

*m.moskal@botany.pl

The limestone ridge of the Pálava Hills in Moravia (Czech Republic) is a very well-known place with Upper Palaeolithic archaeological sites related with anatomically modern humans and their rich cultural expressions. Archaeological excavations and decades of research showed that near the Pálava Hills around 30 thousands years ago, several camp sites of hunter-gatherers developed thanks to the relatively mild climatic conditions. One of the most renowned sites is Dolní Věstonice I, where a well-known figure of Venus was found. The site has been recently excavated within the framework of the ERC project "MAMBA - Exploring Mammoth Bone Accumulations In Central Europe" (no. 101045245), which focuses on the formation of mammoth bone deposits in Upper Palaeolithic sites of Central Europe. Apart of mammoth and other animal bones, multiple archaeobotanical samples were taken from the site of Dolní Věstonice I. They mostly contain remains of wood charcoal, which represent fuel wood used for fireplaces. However, new data are not directly related with any of the combustion structures, and represent mostly dump areas. Previous anthracological data from several sites located near the Pálava Hills showed that wood was available locally and was used as fuel.

New anthracological analysis will expand our knowledge on fuel procurement by focusing on taxonomic identification of trees and shrubs, the characterization of a quality of the fuel used (e.g., deadwood, branchwood) and on the description of annual rings to infer not only selection criteria among the Palaeolithic groups, but also climatic conditions around the sites. The environmental conditions will also be characterized by a study of faunal remains. Among them, numerous species commonly linked with steppe-tundra environment have been described, including woolly mammoth and rhinoceros, horse, reindeer, wolf, and fox, as well as different taxa of rodents.

Keywords: Upper Palaeolithic; Gravettian; Central Europe; mammoth bone deposits; fuel wood procurement

USAGE OF CULTIVATED AND WILD PLANTS FROM THE NEOLITHIC SITE AT BRONOCICE (SOUTHERN POLAND)

Maria LITYŃSKA-ZAJĄC* (Institute of Archaeology and Ethnology, Polish Academy of Sciences);
 M. MOSKAL-DEL HOYO (W. Szafer Institute of Botany, Polish Academy of Sciences, Poland);
 G. JUŹWIŃSKA (W. Szafer Institute of Botany, Polish Academy of Sciences);
 T. OBERC (Institute of Archaeology and Ethnology, Polish Academy of Sciences);
 P. WŁODARCZAK (Institute of Archaeology and Ethnology, Polish Academy of Sciences);

*marialitynska@gazeta.pl

The Neolithic settlement at Bronocice is the reference site for a long-term occupation of the Funnel Beaker culture (IVth millennium BC) in southern Poland. The site provided multiple archaeobotanical samples assigned to various chronological phases, which formed the basis for tracking preferences in plant use by prehistoric societies and changes in local vegetation caused by their activities. New archaeological excavation works (2021-2022), conducted within the current project (National Science Centre no. 2019/35/B/HS3/03860) offered a great opportunity to expand a database and add new information on plant utilisation, especially when new protocol for sampling and flotation was applied.

Fruit and seed analyses showed that the crops contained emmer wheat *Triticum dicocon* and einkorn *T. monococcum* as well as barley *Hordeum vulgare*, which were the basis of food. Peas *Pisum sativum* and lentils *Lens culinaris* were also sown, albeit in small amounts. The people living in the settlement in Bronocice also used wild plants, collecting, for example, the fruits of the apple tree *Malus sylvestris*, seeds of *Chenopodium album* or green parts of *Rumex*.

One of the hypotheses that can be tested based on new wood charcoal analyses is a change in proportion of the main taxa due to human pressure and long-term woodland management. Previously, in various occupational phases of Bronocice, a fluctuation from *Quercus-P. sylvestris*-dominated assemblages to *P. sylvestris-Quercus*-dominated and back to *Quercus-P. sylvestris*-dominated was observed. The changes were interpreted as forests regeneration processes and a faster growth of pines replacing oak trees.

Keywords: Funnel Beaker culture; Woodland Management; Cultivated and Wild Plant use; Bronocice; southern Poland



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- SESSION 4 -

Dendro-anthracology and human-plant interactions

Oral Abstracts

NEW INSIGHTS USING ANTHRACOLOGY AND SPATIAL ANALYSIS IN LEVEL Ra FROM THE NEANDERTHAL SITE ABRIC ROMANI (NORTH-EASTERN IBERIA)

Tomáz FERNÁNDEZ-IRIARTE* (Univ. Rovira i Virgili, Institut Català de Paleoecologia Humana i Evolució Social; B. MÀS (Seminari d'Estudis i Recerques Prehistòriques, Univ. de Barcelona, Institut d'Arqueologia de la Univ. de Barcelona); M.G. CHACÓN (Institut Català de Paleoecologia Humana i Evolució Social, Univ. Rovira i Virgili, UMR 7194 -Histoire Naturelle de l'Homme Préhistorique (CNRS/MNHN/UPVD), Musée de l'Homme); P. SALADIÉ (Univ. Rovira i Virgili, Institut Català de Paleoecologia Humana i Evolució Social, Museo Nacional de Ciencias Naturale, CSIC; J. VALLVERDÚ (Univ. Rovira i Virgili, Institut Català de Paleoecologia Humana i Evolució Social, Museo Nacional de Ciencias Naturales, CSIC; E. ALLUÉ (Univ. t Rovira i Virgili, Institut Català de Paleoecologia Humana i Evolució Social, Museo Nacional de Ciencias Naturales, CSIC; E. ALLUÉ (Univ. t Rovira i Virgili, Institut Català de Paleoecologia Humana i Evolució Social

<u>*iriarte.tom@gmail.com</u>

Abric Romaní is a site located in Capellades (Catalunya, Spain) with a well-known sequence of 25 archaeological layers, dated by U-series between 40 and 110 ka years old. This site has provided detailed information about Neanderthal hunting and animal processing strategies, lithic technology, raw material management, and fire technology through several occupations. This study focuses on level Ra, which is dated around 60 ka years BP. The analysed material is composed by charcoal remains that were recovered during 2020, 2021 and 2022 field seasons.

For this study we have used two methodological approaches: firstly, the traditional anthracological taxonomic and taphonomic observation methods, with an optical microscope (Olympus BX41), as well as image analyses with an Electron Scanning Microscope (ESEM). The second approach is the analysis of the data using GIS software ArcMap 10.2 to better understand the distribution of the charcoals and the assemblage formation processes. There were used both visual plotting for establishing relations between variables and Kernel distribution to assets the presence of clusters.

The results show that *Pinus sylvestris* type was the main fuel used, being around 70% of the anthracological record. Exceptionally, another species, such as *Prunus* sp., was documented. The study of alterations revealed a high presence of compression wood, which is related to environmental conditions and mechanical stresses that affected the growth of the trees. Taphonomical analysis allowed to classify biological (spores and mycelium), post-depositional (concretion and sediment inclusion) and fire-related alterations (vitrification, combustion scars and cracks). The spatial analysis showed interesting distribution patterns in relation to charcoal size and its clustering. This information can contribute, on the one hand, to the knowledge of assemblage formation, and on the other hand, to a better understanding of Neanderthal fire technology, their interactions with the environment as well as the use of space.

Keywords: Fuel management; Spatial distribution; Fire technology; Charcoal taphonomy; Middle Paleolithic

EVIDENCE OF WOODLAND MANAGEMENT AT THE ENEOLITHIC PILE DWELLINSG (3700-2400 BCE) IN THE LJUBLJANSKO BARJE, SLOVENIA?

Welmoed OUT* (Moesgaard Museum); **K. HÄNNINEN** (BIAX *Consult*); **M. MERELA** (University of Ljubljana); **A. VELUŠČEK** (Research Centre of the Slovenian Academy of Sciences and Art); **C. VERMEEREN** (BIAX *Consult*); K. ČUFAR (University of Ljubljana)

*wo@moesgaardmuseum.dk

It is assumed that people practiced woodland management, i.e., coppicing and pollarding, in prehistory, but details are poorly known. This study aims for a better understanding of woodland exploitation through time in the wetland basin of the Ljubljansko barje, Slovenia, from 3700–2400 BCE. To do so, uncarbonized, waterlogged wood from 16 Eneolithic pile dwellings situated in two geographical clusters that cover a time span of c. 1300 years were subjected to age/diameter analysis. It is the first time that age/diameter analysis has been applied to multiple sites from the same region. The investigated posts represent a wide range of taxa, but oak (*Quercus* sp.) and ash (*Fraxinus* sp.) represent 75% of the total, indicating selective use of wood for this purpose. Diameter selection of ash may have taken place as well. At both site clusters, the age/diameter data do not reveal any unequivocal evidence for woodland management. Only at the youngest sites, settled at around 2400 BCE, the data possibly show some gradually changing practices.

Keywords: dendroarchaeology; woodland management; age/diameter analysis; waterlogged wood; eneolithic

WOOD USE IN PREDYNASTIC UPPER EGYPT: RESULTS OF CHARCOAL ANALYSIS FROM TWO PREDYNASTIC SETTLEMENTS IN THE NILE VALLEY

Ranran ZHANG* (Boston University); P. KOVÁČIK (Boston University); J. MARSTON (Boston University); K. BARD (Boston University)

<u>*zhangela@bu.edu</u>

This paper aims to explore fuel acquisition strategies and wood use patterns in two Predynastic settlements in Upper Egypt—Halfiah Gibli and Semaineh. A total of 24 wood charcoal samples were recovered during the 1989 and 1991 excavation seasons. While both sites remained in use into the Old Kingdom, the 20 samples collected from Halfiah Gibli came exclusively from the Predynastic Nagada period (4000-3100 BCE), whereas the 4 samples from Semaineh date to both Nagada Ia-IIb (c. 3900-3600 BCE) and Old Kingdom (c. 2686-2125 BCE). Out of 371 analyzed fragments, Tamarix (85.4%) was the most abundant taxon, followed by Acacia (7.3%), Faidherbia albida (3.2%), Acacia nilotica type (2.4%), and indeterminate hardwood (1.6%). All 4 identified taxa are typical woody plants that grew in Egypt around the banks of the Nile River, where Halfiah Gibli and Semaineh were located in antiquity. Additionally, dendroanthracological characteristics were recorded, including: curvature degree, pith, bark, vitrification, and fungal hyphae. The majority of the wood charcoal assemblage from both sites is inner wood (60%) and has marks of fungal hyphae (55%). This is indicative that people were primarily collecting naturally fallen, deadwood for fuel. The predominating Tamarix presence among the samples emphasizes tamarisks as the preferred fuelwood type and an abundant resource along Nile River banks. The minimal variations between these two sites are also suggestive that this wood acquisition strategy for fuel is utilized in this broader region, as resources and environment are similar along the Nile Valley in Upper Egypt.

Keywords: Egypt; Predynastic; Tamarix; Fuelwood collection; Dendroanthracology

ANTHRACO-CHRONOLOGY OF THE METALLURGICAL FOREST IN LANGUEDOC DURING ANTIQUITY (1ST C. BC - 4TH C. AD)

J. CHARDONNEAU-HENNEUSE* (ASM UMR5140, ISEM UMR5554); B. BROSSIER (ISEM UMR5554), C. VASCHALDE (LA3M UMR7298); N. HOULES (ISEM UMR5554); B. MICOULEAU (ISEM UMR5554); J.-F. TERRAL (ISEM UMR5554); S. MAUNÉ (ASM UMR5140)

*julien.chardonneauhenneuse@gmail.com

Wood, in all its forms, is one of the pillars of ancient economy. The important consumption of fuel described under the Roman Empire, and the current state of the Mediterranean vegetation, has long raised the question of the negative impact of the latter on afforestation. Today, research describes a much more nuanced reality, where methods of managing forest areas may have been put in place in order to perpetuate the wood resource.

As part of a thesis dealing with the economy of wood in artisanal contexts in western *Gallia Narbonensis* during Antiquity, anthracological samples were taken from the drains of metallurgical and mining hearths (firesetting). The good preservation of these remains made it possible to characterize the wooded environment exploited for the functioning of these crafts, but also to apply the anthraco-chronological approach, made possible by the presence of large-caliber charcoals. This type of analysis consists of the application of dendrochronology methods on charcoal. It thus makes it possible to trace the growth patterns of each charcoal, in order to cross-date and highlight dendrological characteristics, linked to afforestation exploitation models.

The anthracological studies were mainly carried out on the Pioch Farrus mining site (Cabrières, Hérault; dir. N. Houles) and the metallurgical site of LaPrade Basse (Cuxac-Cabardès, Aude; dir. B. Micouleau). The anthraco-chronological method was applicable on ash and beech coals and made it possible to highlight cuts alternated by regeneration phases of around twenty to forty years, similar to the cutting rhythms observed on the potter's workshop of Contours (Saint-Pargoire, Hérault), active between the 1st and the 3rd century AD. These results shed a new light on the question of the management of wooded areas, indicating that the resource was managed in a similar and reasoned way throughout a vast region, with the aim of preserving woodlands and supply chains.

Keywords: Charcoal; Woodland; Antiquity; Metallurgy; Languedoc
CHARACTERIZATION OF FUELWOOD SUPPLY IN THE CITY OF BARCELONA (NE-IBERIAN PENINSULA) BETWEEN THE 15TH-17TH CC. CE: A DENDRO-ANTHRACOLOGICAL APPROACH TO *QUERCUS* SP. DECIDUOUS AND *PINUS HALEPENSIS*

Sabrina BIANCO* (Institut Català de Paleoecologia Humana i Evolució Social, Univ. de Barcelona); LL. PICORNELL-GELABERT (Dept. Ciències Històriques i Teoria de les Arts Univ. de les Illes Balears.); A. DUFRAISSE (UMR AASPE 7209, Muséum National d'Histoire Naturelle); M. LEMOINE (UMR AASPE 7209, Muséum National d'Histoire Naturelle); E. ALLUÉ (Institut Català de Paleoecologia Humana i Evolució Social, Univ. Rovira i Virgili); S. RIERA MORA, (Univ. de Barcelona SERP); C. MIRÓ ALAIX (Servei d'Arqueologia de Barcelona)

*sabrina.bianco.1993@gmail.com

Archaeological charcoal fragments constitute a specially valuable proxy to shed light on woodland management and wood exploitation by societies in the past. These archaeobotanical remains, in fact, preserve wood-anatomical traits which allow taxonomical determination, but also keep other dendrological features that allow a further reconstruction of wood procurement practices and thus, raising hypotheses on woodland structure.

Particularly, growth-rings width, minimum diameter reconstruction (charcoal-pith distance) and presence/absence of tyloses are dendro-anthracological parameters that can be recorded and combined, allowing to group charcoal fragments based on whether they originated from a branch or a trunk, or from an old or younger tree. This approach, called anthraco-typology and recently developed by DENDRAC project, provides a better characterization of the wood charcoal assemblage and consequently, more tools to interpret how woodland was managed and shaped by humans according to their energetic needs and technological choices.

In this framework, the aim of this study is to evaluate the characteristics of charcoal assemblages sampled in 4 urban archaeological sites from Barcelona's city (NE-Iberian Peninsula) dated to the 15th-17th cc. CE, by applying the anthraco-typology method. Charcoal analysis in several sites of Barcelona revealed that *Quercus* sp. evergreen, and shrubs as *Arbutus unedo* and *Erica arborea* were the most used woods for fueling the city. However, for these Mediterranean taxa dendro-anthracological methods have not been tested nor calibrated yet. Accordingly, at this first stage of the research, anthraco-typology has been applied on *Quercus* sp. deciduous and *Pinus halepensis* charcoal fragments. These taxa are less frequent in the assemblage considered, but dendro-anthracological methods have been previously tested. Around 530 charcoal fragments have been successfully measured for the dendro-anthracological study. Furthermore, in order to interpret the dendro-anthracological parameters measured on archaeological materials, a local modern referential has been established, by sampling and studying *Pinus* and *Quercus* woodlands nearby Barcelona.

Keywords: Dendro-anthracology, Antraco-typology, Woodland management, Barcelona, Early Modern Period.



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- SESSION 4 -

Dendro-anthracology and human-plant interactions

Poster Abstracts

ESTABLISHING A LIVING-TREES REFERENTIAL OF *PINUS HALEPENSIS* AND *QUERCUS PUBESCENS* FOR DENDRO-ANTHRACOLOGICAL-TOOLS APPLICATIONS IN THE CENTRAL CATALAN COAST (NE-IBERIAN PENINSULA)

 Sabrina BIANCO* (Institut Català de Paleoecologia Humana i Evolució Social, Univ. de Barcelona); LL. PICORNELL-GELABERT (Dept. Ciències Històriques i Teoria de les Arts Univ. de les Illes Balears.); A. DUFRAISSE (UMR AASPE 7209, Muséum National d'Histoire Naturelle); M. DE LUIS (Univ. de Zaragoza); M. LEMOINE (UMR AASPE 7209, Muséum National d'Histoire Naturelle); E. ALLUÉ (Institut Català de Paleoecologia Humana i Evolució Social, Univ. Rovira i Virgili)

*sabrina.bianco.1993@gmail.com

One of the recent challenges in anthracology is characterizing firewood exploitation strategies in the past and propose assumptions on woodland structure, starting from wood charcoal fragments sampled in archaeological contexts. Charred material is often very fragmented and resulted by the exploitation of several indistinguishable trees, which generally does not preserve more than 10 wood growth-rings, and neither pithbark distance. This makes impossible the application of traditional dendrochronological or dendroecological methods to detangle management or climatic signals.

In this sense, DENDRAC project has established specific parameters to be measured in the charcoal fragments section (dendrometrical tools), in order to evaluate their initial proceeding i.e. the organ of the tree (trunk/branch) and tree's maturity. These parameters include the measure of growth-ring size (i.e. growth-rate) and the charcoalpith distance estimation (i.e. minimum wood-diameter), which combination, helps to distinguish trunks from branches. Furthermore, it is a tool to discriminate the heartwood-sapwood on oak, which provides information about the tree-minimal age.

However, dendrological data, as the growth-rate and diameters of trunk/branches, and the developing age of heartwood (i.e. tyloses formation in vessels) need to be measured also on fresh wood from living stands with specific environmental constrains. This allows defining locally-based anthraco-typological models and provides a valuable interpretation of the information obtained with these tools on archaeological charcoal. Hence, this work presents the referential dataset obtained sampling five *Pinus halepensis* and three *Quercus pubescens* woodland stations, located along the central Catalan coast of the Iberian Peninsula. Five stems for each station were sampled, obtaining for each tree two trunk-cores and four discs of different diameters from a branch, for a total of 80 cores and 160 discs. Tree-rings measures have been carried out on this material in order to establish a threshold value to separate branch from trunkgrowth-rate.

Keywords: Referential, Living stems growth-rings, Dendro-anthracology, Anthracotypology, Woodland management

ARCHAEOANTRACOLOGICAL EVIDENCE OF YEW (*TAXUS BACCATA*) FROM THE CZECH REPUBLIC, THOUSANDS OF YEARS OF EXPLOITATION (FROM THE NEOLITHIC TO THE MIDDLE AGES)

Petr KOCAR* (Institute of Archaeology of the CAS); **R. KOCAROVA** (Laboratory of Archaeobotany and Anthracology, Nepomuk); **J. NOVAK** (Faculty of Science, Charles University, Prague)

*kocar@arup.cas.cz

Yew (*Taxus baccata*) is one of the rarest taxa documented in archaeo-anthropological research in Central Europe. This situation is not the result of overlooking yew charcoals in anthracological analyses. Yew charcoals are easily identified. They can thus serve as a suitable model for the study of species distribution in archaeo-anthropological material. Its rareness is probably due to the fact that this species was not commonly used as fuel. The charcoal finds are therefore considered as evidence of the burning of waste from the processing of yew wood as a specific raw material destined to produce a limited number of artefacts (weapons, wood vessels) or from the artefacts themselves.

The study focuses on the findings of yew charcoal in archaeological contexts investigated in the Czech Republic over the last 100 years. It attempts to reveal the relationship of these finds to the type of sites (e.g. overhang, cave, upland site, flat site), chronological period (from the Neolithic to the Middle Ages), altitude of the sites, etc. We work with a database of 601 sites with 289 497 charcoal pieces of evidence.

In 2022, two sites (one from the Early Bronze Age and the other from the Early Medieval or Medieval Period) with a significantly higher representation of yew charcoal fragments in archaeological contexts have been documented. The characteristics of these sites are also of interest. In both cases, these are sites with specific natural conditions suitable for yew growth (located near river canyons). We assume that these are unique examples of settlements specialised in processing yew wood.

Keywords: *Taxus baccata*; Agricultural Prehistory; Middle Ages; Yew exploitation; Czech Republic.

ANTHROPIC AND CLIMATIC FACTORS IN THE DYNAMICS OF FOREST SOCIO-ECOSYSTEMS DURING THE MEDIEVAL OPTIMUM: A DENDRO-ECOLOGICAL APPROACH AND AN INTERDISCIPLINARY READING OF WOOD AND CHARCOAL FROM THE VALLAURIA MINE (TENDE, ALPES-MARITIMES)

Léane LEVILLAIN* (GEODE, UMR 5602, CNRS-UT2J); M. SAULNIER(GEODE, UMR 5602, CNRS-UT2J); A. DUFRAISSE (AASPE, UMR 7209, CNRS-MNHN); B. ANCEL (Service Culturel Municipal de L'Argentière-La Bessée, TRACES, UMR 5608, CNRS-UT2J); V. PY-SARAGAGLIA (GEODE, UMR 5602, CNRS-UT2J)

*leane23081999@gmail.com

Current global changes raise issues about the capacity of complex socio-ecosystems such as forest to cope and to adapt. The in-depth study of past socio-ecological transitions may offer privileged time windows to investigate the modalities of such resilience. The woody remains (wood and charcoal) are veritable black boxes of forest/society/climate interactions and their evolution in a context of global change.

The multi-secular exploitation of the great silver-lead mine of Vallauria (Southern Alps) in the Middle Ages overlaps a major socioecological transition. This transition is characterized by a global warming and the strong increase of anthropogenic pressure on environment and mountain resources (woodlands, pastures, ores) resulting from the development of economic activities managed by powerful communities of inhabitants. Abundant wood and charcoal remains coming from firesetting have been rigorously sampled during several excavations (2011 to 2019) and studied using of a global methodology. Dendrochronology was used to refine the temporalities of the different phases of the exploitation comprised between the 10th and 14th c. and to date them with precision. Anthracological and xylological analysis were used to identify the area(s) of wood supply and the species that were exploited. Finally, dendro-anthracology and dendroecology were used to characterize the management system implemented to ensure the sustainability of the resource during the mining phases. The holistic approach of these remains should provide new insights into the climatic and/or anthropogenic drivers that have strongly modified the forest landscape (disappearance of certain heritage species as Abies alba Mill) and, more generally, into the management of forest resources in the past, from which we could draw inspiration.

Keywords: Mining; firesetting; Alps; Woodland management; Middle-Age.



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- SESSION 5 -

Databases, Dissemination and Regulatory Policies

Oral Abstracts

Keynote Session 5

THE APPLICATION AND USE OF GUIDELINES FOR THE RETRIEVAL, ANALYSIS AND REPORTING OF CHARCOAL REMAINS IN IRELAND

Ellen OCARROLL* (Irish Archaeological Consultancy Ltd)

*eocarro@tcd.ie

The use and exploitation of trees, woods and forests has played a very important role in the history of humankind and the environment. Charcoal data from archaeological excavations provides excellent information on woodland resource usage both spatially and temporally. However, it is important that this data is sampled, assessed, and analysed in a consistent manner by all practitioners to achieve high-quality and scientifically meaningful results. Transport Infrastructure Ireland (TII) Palaeoenvironmental sampling Guidelines (PESG) have been in operation for just over 10 years (DN-ARC-03076-01) on Irelands transport development schemes. The guidelines deal with the stages of retrieval, analysis and reporting of plant macro-remains, charcoal, wood and insects from archaeological deposits, as well as sampling procedures and information retrieval associated with pollen analysis (palynology). The implementation and use of these guidelines has provided consistency in charcoal sampling procedures across a range of different sites as well as standardised analysis and reporting from anthracological remains on all TII schemes. These guidelines are currently being reviewed and updated resulting in engagement with a large number of stakeholders to gain extensive and varied feedback on the implementation and use of these guidelines in order to complete a rigorous and high-quality review and update. This paper will present an overview of the guidelines as well as the key steps used at each stage of the process in the context of the Standard Conditions of Engagement. The addition of new methodological and theoretical approaches will also be discussed and reviewed for inclusion in these updated guidelines.

Keywords: Ireland; Charcoal; Guidelines; Best practice; Sampling and Analysis

PORTUGUESE ARCHAEOBOTANY AT A CROSSROADS: WHERE DO WE GO FROM HERE?

Filipe COSTA VAZ* (CIBIO-BIOPOLIS, University of Porto); J. TERESO, (CIBIO-BIOPOLIS, University of Porto; UNIARQ University of Lisbon; CEIS20 University of Coimbra; MHNCUP Univ. do Porto); P. MONTEIRO, (ICArEHB, DGPC - Directorate-General for Cultural Heritage, Ministry of Culture Portuguese Government); A. MATIAS, (DGPC -Directorate-General for Cultural Heritage, Ministry of Culture Portuguese Government)

*filipe.mcvaz@gmail.com

Portuguese Archaeobotany has grown considerably from its early steps in 1950's and 1960's. The steady increase of the number of national and international researchers working in the country resulted in a dramatic rise in the number of sites and chronologies studied, but also in scientific projects and outputs, particularly from the late 2000's onwards.

There are, however, still several major constraints inhibiting the sustained growth and further expansion of this research area in Portugal and preventing the realization of its full scientific potential. On top of the limited funding opportunities for research, common to other European countries but even more prevailing in poorer economies, the main obstacle facing Portuguese Archaeobotany is the absence of any type of criteria, guidance or regulation regarding environmental archaeology practices in the country. This allowed the systematic and persistent disregard of archaeobotanical sampling and studies in both preventive archaeology and research projects executed in the country in the last decades as well as a pervasive lack of awareness of these themes and methods by the Portuguese archaeologist community. The absence of mandatory sampling and studies of archaeobotanical macro-remains also prevents the feasibility of any commercial (freelance or corporate) sector in the field, as has been happening for decades in the UK or France.

However, last year, in response to a proposal lead by the authors, the Directorate-General for Cultural Heritage, Ministry of Culture Portuguese Government, has started a process, which will hopefully change this scenario for the better, leading to a muchneeded regulation of this sector.

In the scope of this presentation, we intend to discuss not only how this could take shape but also take full advantage of the diverse experience from our international colleagues participating in Anthraco2023 in order to provide feedback, comment on and improve upon the presented proposal.

Keywords: Archaeobotany; Portugal; Regulation; Governance; Field Methods.

THE BRAZILIAN PATH: FROM ANTHRACOLOGY AND ARCHAEOBOTANY TO SCIENCE DISSEMINATION AND FORMAL EDUCATION

Leonardo WAISMAN DE AZEVEDO* (Museu Nacional, Universidade Federal do Rio de Janeiro); T.C.J.P. CAPUCHO (Museu Nacional, Universidade Federal do Rio de Janeiro); R. SCHEEL-YBERT (Museu Nacional, Universidade Federal do Rio de Janeiro)

*leonardowa@mn.ufrj.br

Anthracology in Brazil dates back to the 1990s, starting with Rita Scheel-Ybert's PhD thesis on the Sambaquis' (Brazilian Shellmounds) archaeological context. This marked the beginning of Archaeobotany's presence in Brazilian Archaeology, leading to the development of different methodologies, techniques, research problems and a diversity of vestiges. Since then, in addition to Anthracology, microarchaeobotanical and carpological research have been conducted at multiple sites, including Sambaquis, Amazonian, Proto-Tupi, Proto-Jê, and Paleoindigenous contexts. These efforts have resulted in several works and professional training opportunities, making Archaeobotany one of the most promising research approaches in Brazilian Archaeology. Since 2019, our team has been involved in science dissemination activities with the aim of introducing Archaeology to school-aged students and the general public through workshops, courses, and social media. Starting in 2020, we have also been conducting research on the inclusion of Archaeology in the Brazilian formal education syllabuses, in conjunction with professional training courses and dialogic activities with teachers. Additionally, we are producing science dissemination publications for children's magazines and educational materials. Archaeobotany plays an essential role in all these actions, given its importance in almost all Brazilian archaeological contexts and its appeal to the public. Themes such as landscape management, environmental changes, food production, and consumption are always subjects of debate, arouse curiosity, and have proven to be of great value for teaching. Archaeobotany supports the development of key abilities in the educational process: it encourages interest and identification among the public by associating ancient and contemporary realities known to them, such as food and places; it facilitates discussions on cultural diversity through the exploration of various relationships between humans and plant settings; it addresses transdisciplinary themes and integrates knowledge in the production of educational content; it covers specific and cross-curricular subjects; and it allows for playful, practical, and fascinating educational activities.

Keywords: Archaeology; Archaeobotany; Archaeological Education; Science dissemination; Formal Education.

SILVA AND BIAD: HOW CAN A SMALL PROJECT CONTRIBUTE TO A BIG PURPOSE?

Claudia SPECIALE* (IPHES-CERCA, Spain); N. RIABOGINA (University of Gothenburg, Sweden); A. TIMPSON (UCL, UK); E. ALLUÉ (IPHES-CERCA, Spain)

*cspeciale@iphes.cat

SILVA (Sicilian small Islands Vegetation After human arrival) is a MSCA-COFUND-R2STAIRS project (IPHES-CERCA) that aims to collect new data on the archaeobotanical record of the small volcanic islands around Sicily (Italy) from the Neolithic onwards; the main objective is to reconstruct the vegetation of the island and how it changed through time with the human occupation.

BIAD is the Big Interdisciplinary Archaeological Database (SYNERGY-ERC COREX project, University of Gothenburg). BIAD's originality stays in the interdisciplinarity of the structure, that goes beyond the thematic databases and puts together the chronological, cultural, bioarchaeological, biomolecular, environmental data for the sites. This repository opens the possibility for the users to put every archaeological context in relation to thousands of sites with all the available archaeological data. Its contents are growing with the participation of new projects beyond COREX, whose focus is mostly Central and Eastern Europe.

By integrating anthracological datasets with climate-driven landscape changes and European settlement prehistory utilizing BIAD framework, researchers can account for uncertainties in the data and make more accurate inferences about the dynamics: 1) human influence on changes in the composition and extent of forests, and 2) the spatio-temporal specifics of wood use for economic purposes. SILVA will be the first project to add also the anthracological data, that will then be put in relation to the wider European and Mediterranean prehistoric framework. For this presentation, we will show the first results of SILVA, the multiple potential of BIAD wishing to discuss its structure with the community of anthracologists.

Keywords: Databases; Correlation; Prehistory; Interdisciplinarity

TOWARDS AN ARCHAEOLOGICAL CHARCOAL DATABASE FOR THE LOW COUNTRIES: INSIGHTS FROM A MEETING OF CHARCOAL SPECIALISTS IN FLANDERS AND THE NETHRELANDS

Radek GRABOWSKI* (BIAX Consult); S.H. NICOLAIJ (WOODAN Foundation); S. LANGE (BIAX/WOODAN Foundation); J. VAN DER LAAN (Cambium Botany/WOODAN Foundation)

*grabowski@biax.nl

Analysis of charcoal from archaeological sites has been ongoing in the Low Countries (Flanders and The Netherlands) since the middle of the last century. In the past decades the number of projects has increased significantly, mainly within development-led archaeology. The current anthracological dataset consist of hundreds of reports on a broad range of archaeological phenomena. While positive, this development makes it increasingly difficult to keep track of previously generated data.

As a reaction to this situation, charcoal- and database specialists from BIAX Consult, Cambium Botany and the WOODAN Foundation have begun work on a anthracological expansion to the existing WOODAN Database (<u>https://woodan.org/</u>). The current WOODAN website is an open, international resource, developed for documentation of archaeological wooden objects (waterlogged, dry, etc.) and has to date been used for several large scale synthesis-projects and catalogue-type publications.

To assure that the functionality of the WOODAN charcoal module corresponds with the needs and wishes of the charcoal community, the authors, with support of the Dutch Cultural Heritage Agency, have organised a gathering for all colleagues who are generating or utilising anthracological data.

The core of the gathering focused on pragmatic issues of how to document charcoal in the WOODAN Database. A positive side-effect of the meeting was also that all specialists of the Low Countries were gathered around one table to review the state of anthracological research in this region, which enabled us to discuss possibilities and problems, and initiate steps for improving our output.

In this presentation we will report to the ANTHRACO-community on the outcome of the above described gathering and present an 'early draft' of how the insights of the meeting will be implemented in the charcoal module of WOODAN. Since development of the WOODAN Database will be ongoing at the time of the conference, we expect to be able to integrate feedback and ideas from international colleagues in the development process.

Keywords: charcoal database; WOODAN; current state of research; The Netherlands; Flanders

FROM EXCEL FILES TO OPEN REPOSITORIES: CHALLENGES OF 30 YEARS OF ANTHRACOLOGICAL STUDIES AT IPHES-CERCA

Ethel ALLUÉ* (Institut Català de Paleoecologia Humana i Evolució Social, Uni. Rovira i Virgili);
B. MAS (Seminari d'Estudis i Recerques Prehistòriques, Univ. de Barcelona, Institut d'Arqueologia de la Univ. de Barcelona);
I. EUBA (Independent Researcher);
S. BIANCO (Institut Català de Paleoecologia Humana i Evolució Social, Seminari d'Estudis i Recerques Prehistòriques Univ. de Barcelona);
J. SOPENSES (Institut Català de Paleoecologia Humana i Evolució Social, Seminari d'Estudis i Recerques Prehistòriques Univ. de Barcelona);
J. SOPENSES (Institut Català de Paleoecologia Humana i Evolució Social, Univ. Rovira i Virgili);
A. ROBLEDO (Institut Català de Paleoecologia Humana i Evolució Social, Univ. Rovira i Virgili))

*eallue@iphes.cat

Anthracological data produced by the anthracologists co-authors of this study cover a period between 1994 and 2022. The studies are part of Ms thesis, Doctoral thesis and some 150 publications, unpublished data, or unpublished reports. Over time, these data have been preserved in handwritten documents and in other type of private repositories that have been available along technological improvements (floppy disks, compact disks, external and internal hard disks, or the cloud). These data have been maintained in not been shared files as an open data resource. Databases (e.g. Filemaker) have been rarely used only for specific archaeological sites for which these were available. There are also printed copies of the excel files for most of the sites. The chronological framework of the archaeological sites covers a period from the earliest Paleolithic phases to historical modern age. Most of the studies are from archaeological sites in the NE of Iberia, but also from sites from a wide regional setting. Data included correspond to taxonomic identification (lists, diagrams), taphonomy characters and microscope images. The promotion of an IPHES-CERCA institutional repository is part of the actions included in our Open Data implementation plan, that through the creation of an Open Science Working Group is being providing specific processes and tools. With the emergence of the Open Science paradigm in recent years, IPHES-CERCA is promoting a specific Open Data policy that includes an institutional repository, the creation of a disciplinary Thesaurus, and assistance in writing DMPs among other actions. As part of this initiative, this presentation aims to explore how the anthracological data produced can be adapted to the new standards of Open Science research. This involves organizing and sharing the data in a user-friendly format, making accessible to the wider research community, and contributing to the advancement of Open Science research.

Keywords: Charcoal; Unpublished data; FAIR data; Open science; Institutional repository

JOINING THE CONVERSATION: SHARING ANTHRACOLOGICAL DATABASES FROM THE CENTRAL PART OF ARGENTINA

 Andrés ROBLEDO* (Institut Català de Paleoecologia Humana i Evolució Social; Univ. Rovira i Virgili; Instituto de Antropología de Córdoba, Univ. Nacional de Córdoba);
I. PRADO (Instituto de Antropología de Córdoba, Univ. Nacional de Córdoba);
R. CATTANEO (Instituto de Antropología de Córdoba, Univ. Nacional de Córdoba);
C. ROMANUTTI (Instituto de Antropología de Córdoba, Univ. Nacional de Córdoba);
A. IZETA (Instituto de Antropología de Córdoba, Univ. Nacional de Córdoba)

*arobledo@iphes.cat

This presentation aims to discuss how anthracological research can benefit from actions related to Open Science research. And how, by the publication of these research databases and complementary material on an open access digital repository we are making a contribution to a more ethical and democratic access to the information. In the last years, anthracological data have found new ways of being shared in order to promote further studies on different scales (local, regional and global). These actions have not been yet established as a common procedure, although some particular improvements have been made. We present here the latest updates in the publication of the anthracological databases on a digital repository that holds the archaeological research for the central area of Argentina named Suquia (https://suquia.ffyh.unc.edu.ar/). This repository is dedicated to the protection, preservation and communication of open access archaeological data and publications from Argentina archaeological research.

Over the past 10 years, we have conducted anthracological research from Middle and Late Holocene hunter gatherers occupations in the Ongamira valley (Córdoba, Argentina). This research leads to the production of handwritten documents and digital information (grey literature, databases with taxonomic and taphonomic data, microscope pictures, etc.). In addition, due to the lack of knowledge on taxonomic information on charcoal used in the past as fuel in the area, we have also set up an anthracological reference collection of charcoal and wood slide. It beholds microscopic photographs and taxonomic descriptions of the anatomy of 30 woody species belonging to the Great Chaco phytogeographic community (Córdoba, Argentina). This is part of a collective work, involving students and researchers that collaborate with other types of remains (macro and micro archaeobotanical remains, as well as botanical and ethnobotanical information).

Keywords: Open Data Base; Archaeobotany; Anthracology; FAIR data, Córdoba Argentina



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- SESSION 5 -

Databases, Dissemination and Regulatory Policies

Poster Abstracts

THE NEW ANTHRAKOS: AN OLD DATABASE WITH A NEW IDENTIFICATION SYSTEM FOR ANTHRACOLOGICAL RESEARCH

Rita SCHEEL-YBERT* (Museu Nacional, Universidade Federal do Rio de Janeiro)

*scheelybert@mn.ufrj.br

Charcoal identification in tropical regions is a great challenge. Besides the enormous biodiversity, there is as yet a substantial lack of studies in wood anatomy (exception made to commercial timber). Consequently, the development of comparative collections and of databases is a critical issue that have been concerning me since I began studying tropical anthracology. The first software we developed, in the late 1990s, named "Atlas Brasil", was written in Access 2.0. After more than a decade of valuable service it became outdated and had to be abandoned. It was followed by the "Anthrakos" system, which was an improved, internet-accessible version of the former, using the same database. This program β -version was used for several years at the National Museum of Rio de Janeiro, but unfortunate events led to its loss in 2018. Its database, now increased, was preserved, and it became the basis for a new "Anthrakos". The new system, as its predecessors, was designed to the management of anatomical data from both reference collections of charred wood and ancient specimens (archaeological, paleoecological, or fossil), but can also be used for conventional wood anatomy and literature data. Anatomical features were standardized from the International Association of Wood Anatomists criteria and include some specific adaptations for anthracology. Images may be associated to specimen or taxon descriptions, as well as other information such as ecological and ethnobotanical data. The system allows recording anatomical data and performing searches in the database. It is currently available in Portuguese, English, and French. It has already proved to be an important tool for taxonomic identification, data management, and data sharing. These systems have been key to the development of anthracological research in Brazil. We believe the new Anthrakos can also contribute for anthracological research in other contexts – especially, but not only, in the tropics.

Keywords: Anthracology; Charcoal identification; Database; Internet; Wood anatomy

THE "SAMBAQUI LANDSCAPES" PROJECT: ARCHAEOBOTANICAL REFERENCE COLLECTIONS BASED ON PREVIOUS STUDIES

Leonardo WAISMAN DE AZEVEDO* (Museu Nacional, Univ. Federal do Rio de Janeiro);
T.C.J.P. CAPUCHO (Museu Nacional, Univ. Federal do Rio de Janeiro);
L.A. MOTA (Museu Nacional, Univ. Federal do Rio de Janeiro);
R.G. PATZLAFF (Museu Nacional, Univ. Federal do Rio de Janeiro);
M.R.M. LIMA (Museu Nacional, Univ. Federal do Rio de Janeiro);
M.R.M. LIMA (Museu Nacional, Univ. Federal do Rio de Janeiro);
YBERT (Museu Nacional, Univ. Federal do Rio de Janeiro);
R. SCHEEL-YBERT (Museu Nacional, Univ. Federal do Rio de Janeiro);

*leonardowa@mn.ufrj.br

Sambaguis are Brazilian monumental shellmounds, constructed as burial grounds by indigenous societies in the coastal plains from 10.000 to 1.000 years AP. The most intense debate about these societies concerns how they managed their landscape, with major contributions of archaeobotanical science in topics such as plant gathering and management, horticultural practices, and landscape domestication. Anthracological data from the last three decades showed how Sambaqui people's actions are related to contemporary plant formations, mostly at Restinga biome, where it was possible to identify correlations between taxa frequency and distribution in anthracological and extant environmental records. After the loss of the archaeobotanical collections of Museu Nacional in Rio de Janeiro, we are rebuilding reference collections through sampling in traditional Sambaqui's landscapes. We are performing periodic botanical collections in two environmental preservation areas, located in Rio de Janeiro municipality (Brazil). Wood, fruits, flowers, and leaves are sampled in fertile specimens. The botanical materials are prepared for taxonomical identification and deposited in the institutional herbarium; collection data is fed to the national botanical information system (JABOT). Archaeobotanical reference materials are separated in the laboratory. Wood, fruits, and seeds are preserved both dried and carbonized in a mufla oven; leaves and flowers are preserved dried and will be used to compose phytolith and pollen collections; a starch collection will be produced from fruits, seeds, and eventually underground organs. Charcoal anatomy will be described; data fed to the Anthrakos system will help anthracological identification. This contribution to anthracological, carpological, and microarchaeobotanical reference collections of Museu Nacional will enable the continuity of archaeological research and human resources formation at undergraduate, postgraduate, and local communities levels. The choice of research areas has already proven effective and led to the discovery of unregistered Sambaqui sites, attesting its relevance to archaeological knowledge.

Keywords: Anthracology; Reference Collections; Shellmounds; Brazil; Archaeology

INTEGRATING CHARCOAL DATA IN WOODAN: THE INNS AND OUTS OF A NEW DATABASE FOR ANTHRACOLOGICAL DATA

S.H. NICOLAIJ (WOODAN Foundation); Radek GRABOWSKI* (BIAX Consult); S. LANGE (BIAX Consult/WOODAN Foundation); J. VAN DER LAAN (Cambium Botany/WOODAN Foundation)

*grabowski@biax.nl

The amount of anthracological data being generated in the Low Countries (Flanders and The Netherlands) has increased significantly over the last decades, mainly in development-led archaeology. While positive, this development makes it increasingly difficult for researchers to keep track of previously analysed data. Due to this situation, the authors of this poster, in coordination with colleagues active in the Low Countries, have begun the process of developing an anthracological module for the existing WOODAN Database (https://woodan.org/). With this poster we aim to, in detail, describe the structure and demonstrate the functionality of WOODAN, with preview examples the new anthracological module.

The current WOODAN website is an open, international resource, developed for documentation of archaeological wooden objects (waterlogged, dry, etc.) and has to date been used for several large scale synthesis-projects and catalogue-type publications. The choice to build upon an existing wood database was taken on basis of five main considerations:

Firstly, the structure for documenting meta- and context-data, and the possibilities of connecting site-data to national excavation registries has already been constructed for WOODAN and is fully functional. Secondly, WOODAN has been intentionally constructed to be adaptable for data from different countries and can be adjusted for various languages. This is important as most specialists in The Low Countries regularly perform cross-border research. Thirdly, anthracological work is often performed by individuals who also analyse non-carbonised wood. These specialists will be able to work with a single resource. Fourthly, while WOODAN aims to provide open access to data, functionality has been built in for keeping input data closed for select periods of time. WOODAN can thus be utilised during research as a closed resource, allowing for the data to be made available for other researchers at a later time. Lastly, import of data can be both manual (via input windows) or via standardised import tables. The latter option allows for the development of efficient digital-input workflows.

Keywords: Anthracology; Charcoal database; WOODAN; Database-structure; Database-functionality



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- SESSION 6 -

Charcoal production, kilns and metallurgy

Oral Abstracts

FROM KILNS TO LEGACIES IN THE ENVIRONMENT: AN INTERDISCIPLINARY STUDY OF HISTORICAL CHARCOAL PRODUCTION IN NW EUROPEAN LOWLANDS

Cláudia OLIVEIRA* (Faculty of Sciences Univ. Porto; BIOPOLIS); S. DEVIN (LIEC, CNRS, Univ. de Lorraine); V. ROBIN (LIEC, CNRS, Univ. de Lorraine)

*claudia.oliveira1991@gmail.com

Exploitation of forest resources to produce charcoal, essential for high-temperature demands for ore smelting, was widespread in forest areas all over Europe, leaving traces behind that can be studied today. These traces – charcoal kilns – contain the remnants of the use of wood for charcoal production and they can be analysed to understand in which way the resources were used in the past.

An interdisciplinary study was conducted in Northeastern France lowlands to assess the extent of former charcoal production and the legacies left in the environment. The main goals of this study were: (1) quantification of kilns and their distribution, (2) taxonomic identification and dendrological characterization of the charcoal assemblage, (3) set a chronology of charcoal production, and (4) assess the legacies in the soil and woodlands resulting from historical resources' exploitation.

A forest area covering 57km² was investigated and more than 2600 kilns were detected through LiDAR (Light Detection and Ranging) images. Along with the detection, more than 400 kilns were field-validated, aiming to prove their prior correct detection. A set of 48 kilns was analysed to check for diversity of taxa used for charcoal production. Small diameter *Carpinus betulus* was the most frequent taxon observed, along with *Fagus sylvatica* and *Corylus avellana*. Radiocarbon dating points to charcoal production to post-medieval times and OSL dates the final combustion to late-19th century. Legacies in soils and forest structure and composition connected to the presence of kilns revealed some impacts in both present-day soil and vegetation.

Combined study from quantification of kilns to legacies in the environment allowed a better understanding of the dynamics and evolution of woodland exploitation and the legacies of charcoal production in order to assess in which extent these historical activities have influenced the contemporaneous ecological state of the forests in the area.

Keywords: Charcoal; Kilns; Northeastern France; LiDAR; Carpinus betulus

TRANSVERSAL REGARDS ON CHARCOAL PRODUCTION HISTORY ON THE MONT SALÈVE (HAUTE SAVOIE - FRANCE). ANTHRACOLOGY, PALYNOLOGY, HISTORICAL STUDIES, ARCHAEOLOGICAL OPERATIONS AND BOTANICAL INVENTORIES APPROACHES

Sandrine PARADIS-GRENOUILLET* (Eveha Archaeological Researches and Investigations, Limoges, GEOLAB, UMR 6042 Univ. Limoges); A. MÉLO (Axalp, Historical and Archaeological Researches France); I. POZZI (Auvergne Conservatory of Natural Areas France); S. Perret (Univ. Fribourg Switzerland); P. RUFFALDI (Chronoenvironnement UMR 6249 Univ. Franche-Comté, Besançon; P. PRUNIER (Hepia, Landscapes and Architecture School, Genève)

*sandrine.paradis@eveha.fr

The Salève mountain, situated in the French natural region Avant-pays savoyard, has been the subject of multidisciplinary research for twenty years in order to understand landscape dynamics. In these research programmes, the history of the forest occupies a central place. Although the work carried out initially focused on antique and medieval iron activities (Serneels 1993, Mélo 2001, 2008 and Perret et al. 2018), the question of fuel supply strategies very quickly became the focus of our research (Perret et al. 2018, Mélo et al. in press). Thus, in addition to the mapping of reduction sites and the archaeological excavation of a furnace, several prospecting campaigns in search of charcoal-burning platforms were carried out. Combined with Lidar imagery, they have highlighted the strong presence of charcoal platforms remains over the whole range: more than 200 platforms have been attested among more than 400 anomalies identified. About forty of these platforms were sampled to collect charcoal and carry out an anthracological study. Botanical inventories concerned the environment of twelve of them, and initial archival research documented the historical context from the late Middle Ages to the 19th century. Finally, in order to obtain a more global view of the evolution of the Salève vegetation, palynological studies were carried out in the only (Ruffaldi peat bog in the massif and Prunier, in press). This paper aims to cross-reference all the data acquired in this area in order to retrace the forest trajectories over the last two millennia and thus understand the role played by charcoal production and metallurgy activities on landscape transformations. The multi-proxy approach proposed here thus offers a new reading of the forest history of this area.

Keywords: Wood Charcoal Production; Forest Dynamics; Multi-proxy; Alpes

TO RECONSTRUCT THE HISTORICAL FOREST IN THE ORE MOUNTAINS

Grit NEUBAUER* (Technische Universität Dresden)

*grit.neubauer@tu-dresden.de

Studying archaeological remains of charcoal kilns has a long tradition, but this is the first study in the Western Ore Mountains (Germany). It was conducted in a currently spruce forest area at an altitude of 900–950 m. Until today, countless remains of charcoal production sites witness the tremendous charcoal production for the surrounding mining districts, where tin, silver and other ores were mined and smelted until the 19th century. Using a LiDAR-derived digital elevation model, potential relict charcoal kilns were identified and verified during a field survey. From five sites, historical charcoal was sampled. From the charcoal remnants, the tree species and the number of available annual rings was determined, and with radiocarbon dating an age estimate for each kiln was set.

At all sites, it was found that Norway spruce has been dominant also in the past, sometimes accompanied by larger proportions of European beech or silver fir. On the drier, warmer south-exposed slope, the proportion of beech is higher and it proofs that this tree species grew at higher altitudes of the Ore Mountains during the 16th–18th century. The higher proportion of fir in the 17th–19th century on the more humid west-exposed slope in the eastern area, is an indication that it disappeared very recently from this region, almost certainly due to regulated forestry and acid rain during the last century.

The first records of forest composition in Saxony date back to the 16th century, but they are very imprecise. Only at the beginning of the 18th century, the first forest inventories at individual stand level were initiated. Pollen analyses go back further in time, but do not offer insights in species composition at site level. Here, anthracological investigations of relict charcoal kilns may fill a major gap in our understanding of forest development.

Keywords: Charcoal kilns; Anthracology; Forest species composition; Land use history

CHARCOAL - MAKING IN PITS: AN ETHNO-ANTHRACO-ARCHAEOLOGICAL APPROACH IN THE MOROCCAN RIF

Aline DURAND* (Le Mans University CReAAH UMR 6566 Laboratory); V. BERNOLLIN (AOROC UMR 8546 Laboratory); H. ARIOUA (Sidi M. Ben Abdellah Fès University, Territoires, Patrimoine et Histoire Laboratory); H. DAÏDE (Sidi M. Ben Abdellah Fès University, Territoires, Patrimoine et Histoire Laboratory)

*aline.durand@univ-lemans.fr

In the medieval society, charcoal represented an essential source of energy for processing raw materials. Although charcoal production from stacks is well-known and studied, production in pits has long remained in the shadows. Pits identified as buried ovens for charcoal production and dated back to the 7th - 12th centuries have been discovered in the Provence region (France) in the past decades. Ethno-anthracoarchaeological research was conducted to better understand and interpret them. The Moroccan Rif was chosen because this practice is still in use there and because the biogeographical environments are identical on both sides of the Mediterranean Sea (mesomediterranean bioclimatic level). Field observations consisted in following the production of 17 charcoal batches by seven craftsmen from the same region. The entire technical process was monitored, from raw material acquisition to the end product. In addition to a technical timing of each step, recordings of pits were made by photogrammetry before and after the cooking process. The ligneous material was weighed before it was placed in the pit, and produced charcoal was also weighed to calculate the yield of each firing. The spatial impact of tree cutting on the environment can be evaluated by systematically surveying all the trees from which the pyrolysed plant material was collected. Calorimetric and EDXRF analyses were performed on the samples collected from the walls and bottom of these pits to better interpret archaeological traces. These observations explain why archaeological heather charcoals have so many knots.

Keywords: Charcoal-making; Pits; Ethno-anthraco-archaeology; Rif; Environmental impacts



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- SESSION 6 -

Charcoal production, kilns and metallurgy

Poster Abstracts

FORGING WOODLAND RESOURCES: AN ANTHRACOLOGICAL INVESTIGATION OF WOODLAND MANAGEMENT AND FUEL SELECTION FOR IRON AGE METALWORKING AT CULDUTHEL, INVERNESSHIRE, UK

Sara MARINONI* (Archaeology Institute, Univ. of the Highlands and Islands); S. TIMPANY (Archaeology Institute Univ. of the Highlands and Islands); M. CARRUTHERS (Archaeology Institute Univ. of the Highlands and Islands); G. CRUICKSHANKS (National Museum of Scotland)

*18003764@uhi.ac.uk

In 2005, an exceptional Iron Age craftworking centre was identified in the southern outskirts of Inverness (Scotland) and excavated prior to the development of the land for housing. The site, known as Culduthel, housed a community of skilled metal, glass and enamel workers from approximately 810-550 cal BC to cal AD 130-340. The scale and importance of metal production at the site is evidenced by the presence of ten specialised workshops, alongside nine furnaces, a number of smithing hearths and the recovery of over 250 kg of iron slag.

The aim of this study is to investigate fuelwood use and procurement in relation to these metalworking activities, by means of anthracological analysis from three of the workshops. The analysis employs a combination of standard botanical identification of charcoal macrofossils and dendro-anthracological methods, as well as the recording of morphological features indicative of stress, rot or decay. The qualitative evaluation of growth ring curvature (Marguerie and Hunot 2007) was supplemented by quantitative estimations of minimum wood diameter (Dufraisse et al., 2020), and sequential ring width measurements. Multivariate statistical techniques and the classification of fragments into anthraco-groups were employed to gain a more comprehensive understanding of the importance of wood size, condition, and species in fuel selection, as well as to explore the potential use of management practices.

The findings suggest probable woodland management of hazel and alder to supply wood fuel for furnace activity. Ring curvature and diameter data indicated that mainly small and medium-sized timbers such as branch wood or coppiced rods were used as fuel. The anthracological information also provides the first evidence for Iron Age woodland for this area of Invernesshire due to a lack of palynological information and suggests that wood fuel was collected from more than one source area.

Keywords: Charcoal; Woodland Management; Iron Age; Scotland; Metalworking

PRELIMINARY RESULTS ABOUT THE MANAGEMENT OF WOODLAND FOR METALLURGIC AND CHARCOAL PRODUCTION ACTIVITIES DURING THE EARLY MIDDLE AGES IN MORÉAC (BRITANNY, FRANCE)

Lisa BELLEMÈRE* (Eveha, Archaeological Researches and Investigations, Limoges); S. PARADIS-GRENOUILLET (Eveha Archaeological Researches and Investigations, Limoges; GEOLAB, UMR 6042 Univ. Limoges); Y. DUFAY-GAREL (Eveha Archaeological Researches and Investigations, Limoges; CREAAH, Rennes University)

*lisa.bellemere@gmail.com

During the excavation of a protohistoric settlement in Moréac (Britanny, France), a metallurgic workshop dating back to the Early Middle Ages was uncovered, along with fifteen yet undated charcoal kiln pits. Since the 2000's, a research dynamic has been initiated regarding the relationship between metallurgical activities and forest ecosystems. Metallurgy is often made responsible for the degradation of woodland. However, recent multidisciplinary studies seem to highlight the implementation of specific sylvicultural management to meet the needs of metal industry (Paradis-Grenouillet 2015, Py et al. 2018, Fouedjeu Foumou et al. 2022).

Such investigations have been carried out over the last decades in the Armorican massif, with integrative approaches questionning the role of forging activities in the history of woodland in Britanny, and the role of metal industry in human settlements (Vivet 2002, Oillic 2012).

Anthracological studies are inherently part of such interrogations, and the data acquired in Moréac will contribute to the ongoing research on metallurgical and charcoal production in the Armorican massif. Indeed, the anthracological study will be relevant both for studying wood supply strategies for metallurgical industry – through the observation of the choice of taxa and wood diameters – and for documenting forest landscapes in Brittany during the Early Middle Ages.

The analysis of the charcoal assemblage from the structures uncovered at Moréac aims at clarifying the links between metal production and charcoal-making activities. Combined with radiocarbone dating, dendroanthracological approaches will give additional answers to the taxonomic identification, through the measurement of radius of curvature. Moreover, this research will provide an opportunity to compare two methods of restoring the diameter of wood, in order to assess their compatibility with the constraints of preventive archaeology.

Keywords: Metallurgy workshop; Charcoal production; Wood diameter restitution; Early Middle Age; Preventive archaeology in Britanny

FOREST HISTORY AND INDUSTRIAL DEVELOPMENT INTERLINKS AT A TERRITORIAL SCALE INFERRED FROM AN INNOVATIVE COMBINATION OF WOOD AND CHARCOAL PAST USE EVIDENCE

Vincent ROBIN* (LIEC, CNRS, Lorraine University, France); H. KNAPP (CEZA, Germany); X. ROCHEL (LOTERR, Lorraine University, France)

*vincent.robin@univ-lorraine.fr

Previous studies have shown the importance of wood as a key resource for long-term socio-economic development, as well as the environmental consequences of the use of this resource. However, only a few studies have examined in detail the historical exploitation of forest biomass in relation to local industrial needs. Therefore, we present one of the first attempts to study historical wood consumption related to industrial development at the territory scale. This study is based on a combination of data from charcoal kilns and written historical archives from the "Pays de Bitche" (northern Vosges, France). Analysis of 234 charcoal kilns and 415 written historical records provided information on woodland exploitation, industrial consumption, and forest dynamics.

The datasets are chronologically coherent over the 17th and 18th centuries. *Quercus* and *Fagus* were the most abundant taxa, with *Fagus* dominating the west and *Quercus* the east of the investigated territory. This spatial pattern fits the identified preferential consumption of *Fagus* by glassworks in the west and the preferential consumption of *Quercus*, as well as *Pinus* and *Betula*, for on-site charcoal production for forges in the east. However, it is not clear whether previous changes in forest composition determined the type of wood available locally and thus the location of different types of industries, or whether this forest spatial pattern was related to the type of substrate, which significantly varied from west to east within the territory studied. Moreover, we have identified that the past distribution of forest, inferred from written sources and charcoal data, reflected significant similarities with the current distribution of the tree genera in the area. Finally, the combination of methods we used proved to be highly complementary for the assessment of the historical use of forests and provided relevant and valuable insights for the reconstruction of forest history.

Keywords: Charcoal production; Biomass harvesting; Interdisciplinarity; Vosges.

'FUELLING THE FURNESS': AN EXAMINATION OF THE IMPACT OF CHARCOAL PRODUCTION ON THE LANDSCAPE OF NORTH-WEST ENGLAND DURING THE 18TH CENTURY, USING ARCHIVAL MATERIAL COMBINED WITH REMOTE MAPPING

Alastair PEARSON* (University of Portsmouth); Z. HAZELL (Historic England)

*alastair.pearson@port.ac.uk

The history of the charcoal iron trade in the Southern Lake District in Cumbria, NW England is well recognised, with activity intensifying during the 18th century, controlled by a very small number of iron production companies. This activity has left its mark on the landscape – from the initial extraction of the ore, through the development of a transport infrastructure and the construction of furnaces, to the management of woodlands for charcoal production. There is a wealth of untapped information held in the region's documentary archives, which provides data on the iron production companies themselves, primarily via the account books and associated documents. These records include detail on the charcoal bought in – not only the dates and precise quantities, but the names of the source woodlands and even the names of the individual producers themselves. Using GIS, these sources have been examined in combination with remotely sensed data to provide new evidence of the impact of the iron trade on the woodlands of the Lake District. The results demonstrate that charcoal production was so vital to the iron industry that the woodlands were carefully and sustainably managed, the legacy of which we enjoy today.

This work, commissioned by Historic England, follows on from questions raised about the use of charcoal produced at charcoal burning platforms in Barbon, Cumbria (Hazell *et al* 2017; <u>https://doi.org/10.1016/j.quaint.2017.05.025</u>) presented at the 6th International Anthracology Meeting in 2015, Freiburg, Germany.

Keywords: Post-medieval; Iron trade; Charcoal; Woodland management; Cumbria.

ANTHRACOLOGICAL ANALYSIS OF TWO LIMEKILNS OF THE MEDIEVAL SITE OF MONTECORVINO (APULIA, SOUTHERN ITALY)

Valeria DELLA PENNA* (Univ. di Foggia - Laboratorio di archeobotanica e paleoecologia Univ. del Salento); M. STELLA (Laboratorio di archeobotanica e paleoecologia – Univ. del Salento); P. FAVIA (Dipartimento di Studi Umanistici – Univ. di Foggia); R. GIULIANI (Dipartimento di Ricerca e Innovazione Umanistica – Univ. di Bari); G. FIORENTINO (Laboratorio di archeobotanica e paleoecologia – Univ. del Salento)

*valeria.dellapenna@unifg.it

Archaeological investigations at the medieval site of Montecorvino (Apulia, Southern Italy) provide opportunity studying anthracological samples of two different limekilns in terms of stratigraphy, morphology of structures and chronology.

Founded by the Byzantines (11th century A.D.), the little fortified town of Montecorvino was marked by urban growth during the 12th -13th century. In the mid-14th century, the phase of decline and contraction of the site began, until its abandonment in the mid-16th century. The first limekiln belongs to the last phase of occupation of the site in late 15th century. Located in the *castrum* area, the small circular structure (1m diameter) used the ruined buildings for the production of lime for small renovation works in the area. It was filled with rubble, clay, lime, and charcoal.

During the latest excavation, a second large limekiln (3m diameter) was found, that was built on the slope below the *castrum*. Unlike the first system, this one was probably linked to intensive building works in the urban growth phase of the town. The latter was found with its last load of stone and full fuel.

An anthracological and taphonomic analysis of the charcoals remains allows us to determine the composition of the fuel, the formation way of the anthracological assemblage and the choices adopted for the functioning of the limekilns in two different phases of life of the town.

Keywords: Limekiln; Anthracological analyses; Medieval age; Southern Italy

SIGNIFICANT RELATIONSHIP BETWEEN THE SHAPE OF KILNS AND THE RESULTS OF THEIR ANALYSIS IN A STUDY AREA OF NORTH-EASTERN FRANCE

Vincent ROBIN* (LIEC, CNRS, Lorraine University, France); S. RITZ (INRAP); JC. SZTUKA ("Les amis de Senon et du Pays de Spincourt", France); J. BOUQUEREL (LIEC, CNRS, Lorraine Université, France); L. DELLINGER (LIEC, CNRS, Lorraine Université, France)

*vincent.robin@univ-lorraine.fr

Throughout many investigations conducted during the past decades, significant insights have been obtained about historical charcoal production, such as the method of and use for charcoal production, and its consequences for forest ecosystems. For most of these investigations, the key factor with which to analyze historical charcoal production is the charcoal kilns (or charcoal hearths). Indeed, based on the kiln site itself and the charcoal pieces it contains, it can be investigated, the type and dimensions of the biomass used and the chronology of charcoal production.

Aiming to reconstruct the history of charcoal production in the Spincourt forest in northeastern France, an inventory of the relic charcoal kilns was carried out, according to lidar ("light detection and ranging") data and field prospecting on the 132 km² site. The inventory indicated two different morphologies of relic charcoal kilns. The first type was a simple circular flat body, whereas the second type was a circular "ring shape" made of a small mound clearly visible on the border of the structure, surrounding a flat or concave shape in the center.

Both kiln morphologies have already been identified in the related literature as charcoal or lime kilns, but it appears surprising to find such different kiln shapes on the same study site, close to one another. Even more surprising is the finding that the dendro-anthracological analyses of the samples from several flat and mounded relic charcoal kilns in the study area indicate significantly different results. The charcoal assemblages in the mounded kilns show a low number of taxa, largely dominated by *Quercus*, made up mostly of relatively large wood pieces, whereas the charcoal assemblages in the flat kilns include more taxa, dominated by *Carpinus*, and made of smaller wood pieces. Therefore, it is clear that the two types of kiln are associated with the burning of different sources of wood, the reasons for which remain unclear.

Keywords: Kiln shapes, morphology, taxonomical identification, radiocarbon dates



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- SESSION 7 -

Pedoanthracology

Oral Abstracts

THE USE OF SUBFOSSIL INSECTS AS A COMPLEMENTARY TOOL FOR PEDO-ANTHRACOLOGY STUDIES IN OLD-GROWTH FOREST SOILS

Sarah PARRILLA* (TRACES, GEODE; LASA); P. MORET (TRACES); A. STAGNO (LASA); M. SAULNIER (GEODE); V. PESCINI (LASA); L. LARRIEU (INRAE - Dynafor); VALLADARES (EIP - Dynafor); H. BRUSTEL (EIP - Dynafor); V. PY-SARAGAGLIA (GEODE)

*sarahparrilla.ut2j@gmail.com

The development of soil charcoal analysis has made it possible to reconstruct forest trajectories at the local scale, thus overcoming the main shortcoming of palynology. However, the presence of charcoal implies the occurrence of a forest fire in the past, which provides only a partial picture, at a given time, of past trajectories. It is therefore essential to look at other indicators. Insects, composing a large part of forest biodiversity, can be valuable proxies for (1) canopy density, (2) forest composition, (3) the presence of old trees or bark debris, and (4) the occurrence of disturbances. However, while the study of subfossil insects is common in peatlands or glacial deposits, it has almost never been conducted in soil archives. This study therefore aims to test the combination of insect and charcoal analysis in soils to reconstruct the trajectories of ancient forest ecosystems and assess their ancientness and naturalness.

We sampled soils from three old-growth forest sites located on the northern slopes of the Pyrenees. We dug two pits in each stand to collect soils and extract and analyse both insect (n=1134) and charcoal (n=1203) remains. The distribution of both types of remains in the soil layers is similar, limited primarily to the upper levels, suggesting progressive burial over time as well as taphonomic processes. Twenty wood charcoals were radiocarbon dated, and the probability intervals cover a long period from the Mesolithic to the present, whereas radiocarbon dating of eleven insect remains provides only modern to contemporary dates, but their low carbon content may have induced a rejuvenation of their dating by several centuries.

The insects thus provided additional data on forest trajectories in historical periods and confirmed the multi-century ancientness of the three studied old-growth forests.

Keywords: Old-growth forests, insects, charcoals, soil archives, forest trajectories

HOLOCENE DYNAMICS OF BEECH VERSUS OAK FOREST STANDS INFERRED FROM SOIL CHARCOAL ANALYSIS: INSIGHTS AT A REGIONAL SCALE

Vincent ROBIN* (LIEC, CNRS, Lorraine University); T. FEISS (CNPF-IDF); D. ARAN, (LIEC, CNRS, Lorraine University); J. LEVILLAIN (SILVA, INRAE, AgroParisTech, Lorraine University); J-L. DUPOUEY (SILVA, INRAE, AgroParisTech, Lorraine University)

*vincent.robin@univ-lorraine.fr

Long-term vegetation history in Europe is well documented as a result of much research. Nevertheless, local-scale mechanisms remain unclear, and greater insight is necessary to better understand the ecosystem trajectories. In the European temperate deciduous forests, *Fagus* is among the most competitive trees on well-drained and water-retentive soils and is a key species in the final stages of natural succession. However, even under favorable conditions in these forests, beech distribution is often sporadic in or even absent from present-day stands, whereas *Quercus* is dominant. Based on written sources, the predominance of *Quercus* has been identified as a potential heritage of historical forest management.

To test the hypothesis that past human practices had caused the replacement of *Fagus* by *Quercus* on well-drained soils, we carried out a soil charcoal analysis on current mature Quercus stands in 19 forest sites of the Lorraine Plateau (north-eastern France). Mega-charcoal assemblages were extracted from soil trenches and taxonomically identified. Our results, based on more than 5600 charcoal pieces, identified 18 taxa and showed the presence of *Quercus* and *Fagus* in all trenches. *Quercus* was dominant, followed by *Carpinus* and *Fagus*, reflecting the corresponding distributions today in the surrounding forests, except for *Fagus*, which is not observed in any current forest stands. Other taxa, such as *Prunus*, *Populus*, and *Betula*, were present in charcoal pieces at lower abundances, occurring in only a few sampling sites. The 71 radiocarbon-dated pieces indicated that i) a *Fagus* forest had been in place during the Bronze Age, without any dated oak pieces being found; ii) *Quercus* became common from the end of the Bronze Age; and iii) *Quercus* was mixed with *Fagus* from the middle of the Iron Age.

These results provide new evidence for the hypothesis that historical forest management in western Europe caused the replacement of *Fagus* by *Quercus*, and therefore the manipulation of forest stand species composition started during the Bronze Age.

Keywords: Fire disturbance; Vegetation dynamics; Holocene; Soil charcoal; Europe; Upscaling

CHARCOAL ACROSS THE SLOPES: 20 YEARS OF ANTHRACOLOGY ON BOTH SIDES OF THE PETIT SAINT BERNARD PASS (NOTHERN FRENCH AND ITALIAN ALPS)

Claire DELHON* (Université Côte d'Azur, CNRS, CEPAM); V. ROBIN (Université de Lorraine, CNRS, LIEC); T.M. SCHROEDTER (freelance wood and charcoal analyst); S. THIEBAULT (Université Paris I, CNRS, Trajectoires); P.-J. REY (Université de Savoie, CNRS, Edytem)

*claire.delhon@cepam.cnrs.fr

Between 2004 and 2007, P.-J. Rey and his team carried out a series of manual surveys in areas favourable to sediment deposition on the slopes of the Petit-Saint-Bernard Pass, which straddles the French and Italian Alps. The aim was to document the first occupation of the mountain and the dynamics of the transalpine circulation and to provide data on the history of the landscape and of the pedosedimentary dynamics during the Holocene, at an altitude of 750 to 2300 metres.

Nearly 700 pits were excavated and described. The charcoals were recovered by sieving all the sedimentary layers where their presence was obvious on the field, but also every layer that was of particular interest for archaeological or pedological reasons. It resulted in more than 550 charcoal assemblages, of which 430 have been studied so far, representing more than 9800 fragments. Depending on whether they come from archaeological or non-anthropic strata, they may be due either to human activities (mostly firewood) or to the incorporation of charcoal from vegetation fires in the sediment.

This large dataset, supported by 270 ¹⁴C dates and chronocultural information, documents the establishment and evolution of montane vegetation since the beginning of the Holocene. Oak forests established early at low elevations. Above 1700 m the first steps of forest dynamics are only recorded in the second half of the 5th millennium BCE (pioneer maple formations), and well-established forests are only detected up to the pass from the 4th/3rd millennium onwards. The progressive anthropisation of the landscape can be linked to the progressive extension of human activities (pastoralism) to all vegetation belts. The populations of the middle/final Neolithic could be responsible for a first destabilisation of the plant communities at low/medium altitude. An increase in human activities during the Final Bronze Age, associated with the dynamics of spruce, could explain the generalisation of spruce forests from the beginning of the Iron Age onwards over a large altitude gradient.

Keywords: Archaeological survey; Dedimentary charcoal; Mountain; Vegetation dynamics; Anthropisation

THE REGIONAL AND SPATIAL DIVERSITY OF VEGETATION HISTORY BASED ON THE ANTRACOLOGICAL DATA FROM BOHEMIAN SANDSTONE AREAS

Jan NOVÁK* (Faculty of Science, Charles University); P. BOBEK (Institute of Botany of the Czech Academy of Sciences); V. ABRAHAM (Faculty of Science, Charles University); M. MAN (Institute of Botany of the Czech Academy of Sciences); P. POKORNÝ (Center for Theoretical Study, Charles University and the Czech Academy of Sciences; Nuclear Physics Institute, Czech Academy of Sciences)

*prourou@gmail.com

Sandstone regions represent unique landscapes within Central Europe, which are characterized by steep geomorphological gradient with deep valleys, rocks and flat plateaus. Sandstones set up fine-grained mosaic with high diversity of habitats. Patches with contrasting disturbance regime, microclimatic and light conditions enable the coexistence of species with opposite ecological demands and at the same time they provide conditions for deposition of various palaeoecological archives, through which we can study this co-existence at large time scales.

Our study compares anthracological results from four main sandstone areas in the Central Europe. These anthracological results clearly recorded regional differences, which mainly connected with regional climatic conditions. However, soil in sandstone regions is poor and not suitable for agriculture, the presence of human activities was continually documented from the Mesolithic period. The presence of fireplaces and coprolites in the sediments under rock shelters suggests, the presence of pastoral activities as important human activity.

Our study is focus on the interpretation of spatially different anthracological records from archaeological and soil context. The charcoals from pedoanthracological profiles recorded very local environment, whereas charcoals from rockshelters connected with human activities (e.g. collection of firewood) in the wider area. We assume that the vicinity of rockshalters was affected higher human pressure, than forest in the longer distance.

The other aim of study is the comparison charcoal and pollen records. A comparison based on the Extended Downscaling Approach revealed significance in the taxa composition of four classes for the study landscape. We identified fir forest in valleys and lower altitude; fir-beech forest in northern slopes and higher altitude; acidophilous pine forest on rocks and edges; and acidophilous oak woodland and boreo-continental pine forest on plateaus. Our study shows that spatial explicit modelling of vegetation pattern using charcoal record is possible.

Keywords: Pedoanthracology; Archaeoanthracology; Extended Downscaling Approach; pollen; Bohemian sandstone areas



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- SESSION 7 -

Pedoanthracology

Poster Abstracts

SCALE-DEPENDENT INTERPRETATION OF ANTHRACOLOGICAL RECORDS FROM AN ARCHAEOLOGICAL SITE AND ITS SURROUNDINGS IN SOUTH BOHEMIA (CZECH REPUBLIC)

Jan NOVÁK* (Department of Botany, Faculty of Science, Charles University, Praha, Czech Republic); T. ŠÁLKOVÁ (Institute of Archaeology, Faculty of Arts, University of South Bohemia, České Budějovice)

*prourou@gmail.com

Our study compares different groups of anthracological records (archaeo– anthracological; pedoanthracological) for a more complex reconstruction of woodland history in the surroundings of the Late Bronze Age archaeological sites Březnice and Hvožďany (South Bohemia, Czech Republic).

The studied region has been characterised as an inner periphery in the context of European prehistory. The region consists predominantly of highlands covered by peat bogs and wetland basins with poor soils. One of the settlements is a monocultural site near Březnice; an extraordinary Late Bronze Age site with a unique accumulation of peculiar long features, interpreted as ritual remains of the communal activity.

Pedoanthracological results clearly documented woodland diversity and different habitat conditions in the vicinity of the archaeological site. The charcoal record from soil profiles indicates fire activity in time periods that were not at all recorded at the archaeological site.

Based on our anthracological results, we were able to reconstruct several types of forest: acidophilous oak forests, alluvial forests, and shrubs. According to the archaeological knowledge of the region, we assume relatively low population density during the Late Bronze Age, and thus only a small part of the more or less forested landscape was significantly affected by human activities.

Keywords: Archaeo–anthracology; Pedoanthracology; Spatial differences of charcoals, Late Bronze Age; South Bohemia
HUMAN ACTIVITIES AS CAUSE OF SIGNIFICANT ENVIRONMENTAL CHANGES IN THE KHAN KHENTII MTS. (N. MONGOLIA)

Jan NOVÁK (Department of Botany, Faculty of Science, Charles University, Praha, Czech Republic); A. KUSBACH (Department of Forest Botany, Dendrology and Geobiocoenology, Mendel University, Brno, Czech Republic)

*prourou@gmail.com

Fire is a powerful ecological and evolutionary force that regulates population sizes, community composition, carbon and nutrient cycling and ecosystem function. One of the evidence fire events and vegetation changes are assemblages of macrocharcoal fragments that are able to persist in the soil.

Our pedoanthracological research was performed along an environmental gradient in the Khan Khentii Mountains (N Mongolia). The current vegetation in the study area was forest-steppe or meadow-steppe. The vegetation history on the lower parts of the mountain range has been greatly influenced by human activities. The human impact seems to be the triggering factor in the environmental change and the fire regime, especially during the Late Holocene. Although pedoanthracological results have documented history of very local vegetation, our transect have allowed the assessment of differences among vegetation types at a wider geographical level.

Our study revealed the presence of charcoals in currently forestless vegetation. The diversity of trees in the forest-steppe and light taiga was relatively poor. The meadow-steppe was characterized by the presence of chernozem soil and a very low abundance of charcoals.

Our research clearly demonstrated the connection between environmental conditions, human influence, and the history of Holocene vegetation.

Keywords: Pedoanthracology; Human impact; N Mongolia; Forest-steppe.

FIELD LYNCHETS IN HILLY LANDSCAPES

Pille TOMSON (Estonian University of Life Sciences)

*pille.tomson@emu.ee

The aim of the study was to identify traces of ancient fields on sandy soils in hilly landscapes. The study was carried out in Southern Estonia. The soils contain few rocks, and there are no manmade field-bordering structures in this region. Soil cultivation in such a landscape led to formation of small terraces, or lynchets, at toe slopes. These structures were not built purposefully, but formed naturally due to cultivation and soil detachment. The height of the lynchets depends on the relief, time and intensity of cultivation and used techniques. In the open fields that are still in agricultural use the lynchets are composed mainly of contemporary deposits. In the 19th-century forests that grew in abandoned fields, the lynchets were not affected by modern technology and allowed to examine the history of cultivation. Four trenches were excavated across the lynchets in the forests within former slash and burn cultivation patches, identified on 19th century maps. Results of archaeological surveys were used to select test sites in the proximity to the old settlements of Pre-Roman, Roman and Medieval times. Further, the cultivated sites were compared with the sites mapped as large forest areas on historical maps. The lynchets had a complex layered structure. The upper humus-rich layers of the lynchets contained scattered charcoal fragments that formed due to recurring slash and burn cultivation in the 16th -18th century as demonstrated by the radiocarbon dating. The charcoal from lower layers was dated back to -2471 cal BC. In the forest site, the upper layer of soil contained charcoal dated by 12th and 17th centuries, and the lower layer by -3361 cal BC. All trenches contained specific dark layers containing soft and matt charred material resulting from the natural burning that was distinctly different from the charred organics in the forest soils cleared for cultivation.

Keywords: Ancient fields; Layered structure; Charcoal; Estonia.

HOLOCENE BIODIVERSITY VERSUS NATURALNESS: A FALSE DEBATE? THE CONTRIBUTION OF SOIL CHARCOAL ANALYSIS TO THE ASSESSMENT OF LONG-TERM ECOSYSTEM DYNAMICS

Vincent ROBIN* (LIEC, CNRS, Lorraine University, France); B. TALON (IMBE, AMU, CNRS, IRD, Avignon University, France); J-L. DUPOUEY (SILVA, INRAE, AgroParisTech, Lorraine University, France); O. NELLE (Landesamt für Denkmalpflege Baden-Württemberg, Germany); J.-C. SVENNING (Aarhus University, Denmark)

*vincent.robin@univ-lorraine.fr

In Europe, it has been shown that, for the Holocene, agriculture is the key driver of ecosystem changes, substituting for the megafauna of the Pleistocene but inducing much greater biodiversity and more diverse ecosystem states. However, the analogy between Pleistocene mega-herbivores and Holocene agriculture remains interesting to discuss. Although the impact of anthropogenic forest openings by fire in the Holocene is well documented, there remain important issues about the interlinks between past fire regimes and long-term vegetation dynamics. This is the case concerning the role of fire disturbance on a local scale. The Mesolithic fire history has been used to explain the early Holocene ecosystem openings, but, from the Neolithic onward, it is plausible that large-scale agriculture hides the impacts of local fire signals, which are mostly, but not exclusively, man-made. Such local fires might be a key disturbance of the long-term ecosystem dynamics, possibly comparable to the disturbance regime of the Pleistocene megafauna. Therefore, to assess past vegetation dynamics and to define current ecosystem conservation/restoration strategies, it is important to tackle "the scales of fire".

To achieve this, we used soil charcoal analysis to study the association between fire events and past forest composition, at the local scale, in beech and oak forests in northern Germany, north-eastern France, and southern France. In these study areas, we have identified the local fire signals and compared them with the supra-local fire signals to assess scale-related synchronicities/asynchronicities. Moreover, other components of the past fire regime (magnitude, frequency, fuel, etc.) were identified. In the end, high spatial-resolution analysis of fire signals allowed better characterization of past fire regimes, to enable the comparison of fire-related effects with the mega-herbivore-related disturbance effects identified in the scientific literature.

Keywords: Fire disturbance; Vegetation dynamics; Holocene; Soil charcoal, Europe

