Journée des Doctorant·es

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Ph.D. Day

ABSTRACTS

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Laboratoire Chrono-environnement
UMR CNRS 6249
University Marie & Louis Pasteur
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Environment

POSTER

Assessment of transfer and ecotoxicity of legacy contamination from munition dumping in Vosges lakes - MUSLI project

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This study aims to map and quantify the contamination of lakes in the Vosges mountains (Gérardmer, Longemer and Retournemer) by munitions deposits left over from the two world wars, and to assess their chemical, ecotoxicological and ecological impacts. In France and Europe, following the two world wars, large quantities of shells, bombs and chemical agents were dumped in marine and continental aquatic environments. The gradual corrosion of the metal casings of this ammunition leads to the release of toxic compounds, in particular explosive components (TNT, RDX, tetryl) and metals (arsenic, mercury, lead), which can accumulate in water and sediments and then be transferred to aquatic organisms and along food chains. While much research has focused on marine environments, particularly the Baltic Sea, lake ecosystems remain largely unexplored. However, recent explorations have confirmed the presence of munitions in the Vosges lakes, with significant concentrations of TNT in sediments exceeding certain environmental quality thresholds. Existing studies show that TNT and its derivatives can cause toxic effects even at low doses.

The doctoral work focuses on three areas: (1) mapping contamination: geophysical surveys, sampling and analysis of water and sediment; (2) ecotoxicological effects: laboratory and field tests on aquatic invertebrates; (3) study of contaminant transfers within food webs.

An initial field campaign yielded preliminary geophysical results, with the location of magnetic anomalies in the north-western area of Lake Gérardmer. Associated sediment samples were used to conduct a bioassay, which has already revealed abnormally high metal concentrations (Hg, As, Mo, Sb) and effects on the survival, growth and emergence of benthic macroinvertebrates (*Chironomus riparius* larvae) have been impacted.

Keywords: Dumped munitions, Vosges lakes, Explosives (TNT, RDX), Heavy metals, Bioaccumulation, Trophic transfer.

POSTER

Vulture decline in Africa: local perceptions and conservation engagement in northern Cameroon

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Vultures provide essential ecosystem services by rapidly removing carcasses and limiting disease spread, yet their populations are declining worldwide. Overall, the causes of this decline are well known but vary across regions. In Asia, unintentional poisoning from the veterinary drug diclofenac has been the main driver, whereas in Africa the situation is more complex. In addition to intentional and accidental poisoning, vultures face threats such as commercial and cultural exploitation, and use of body parts in traditional medicine. While these threats are well documented in East, West, and Southern Africa, they remain poorly studied in Central Africa, where local perceptions vary between human communities and are influenced by cultural and regional factors. Understanding these perceptions is critical for developing effective conservation strategies.

In Cameroon, local knowledge and perceptions of vultures are still poorly documented. This study assessed perceptions of vulture population trends, perceived causes of decline, and people engagement in conservation in the Adamawa and North regions. A total of 858 respondents from 28 localities, including herders, veterinarians, farmers, traders, and butchers, were surveyed using structured questionnaires and field observations. Results show that recognition and knowledge of vultures vary with profession, education level, and region. Herders, veterinarians, and farmers demonstrated the greatest understanding of decline causes, whereas younger respondents and butchers had more limited knowledge.

The direct and indirect threats identified align with global patterns, including poisoning, habitat loss, increasing human population and limited food availability. Importantly, most respondents expressed support for vulture conservation, highlighting the potential of human-based, participatory approaches. Targeted awareness-raising for less informed groups could further enhance conservation outcomes. Integrating local knowledge and perceptions into conservation strategies is therefore essential for the sustainable and socially accepted protection of vultures in Cameroon.

Keywords: Vultures, Local perceptions, Conservation, sociological surveys, Cameroon.

POSTER

Integrated synthesis of dispersion factors for conifer bark beetles in Franche-Comté: towards a vulnerability map

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Forests cover about one-third of France's territory and play a major ecological and economic role. Climate change is increasing their vulnerability, particularly in conifer stands affected by bark beetle infestations, which are responsible for large-scale dieback. In Franche-Comté, repeated droughts since 2018 have led to increased infestations and mortality in spruce forests.

Although the climatic, biological, and structural factors influencing these outbreaks are well documented, their spatial integration is rarely taken into account. This study provides a cartographic overview of the landscape contexts conducive to the spread of conifer bark beetles, combining several approaches.

The analyses are based on (i) a synthesis of vulnerability factors from the literature, (ii) the identification of microclimatic conditions conducive to colonization using Landsklim data, and (iii) historical infestation hotspots detected by remote sensing. This information is integrated into a GIS to produce a composite landscape vulnerability index and identify convergence zones considered to be potential hotspots.

This approach provides an integrated view of the ecological and climatic factors that modulate bark beetle dispersal and allows recent dieback dynamics to be contextualized. It is a useful synthesis tool for guiding forest management and supporting future research on the vulnerability of conifer stands to bark beetle outbreaks.

Keywords: microclimate, Landsklim, GIS, remote sensing, vulnerability, outbreaks.

POSTER

Comparative genomics and phylogenomics of epidemic high-risk clones of the bacterial pathogen Pseudomonas aeruginosa for the genetic characterization of their success

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Pseudomonas aeruginosa is an opportunistic pathogen responsible for severe infections, particularly in immunocompromised individuals. This species, naturally present in the environment, particularly in aquatic habitats, possesses a large genome (6-7 Mb), enabling adaptation to diverse biotic and abiotic environments.

Its population displays a non-clonal epidemic structure characterized by high genetic diversity with a limited number of high-risk epidemic (HRE) clones, frequently associated with hospital outbreaks, multidrug resistance, and increased virulence. Through hospital studies, the distribution and prevalence of these clones are relatively well known. However, the genetic factors explaining their epidemiological success remain poorly understood.

In this study, it is necessary to construct a genome database representing the diversity of the *P. aeruginosa* population, including HRE clones. To do this, a selection from public databases, completed by a dedicated sequencing project of laboratory collections, will be performed using quality control and dereplication steps. Based on these genomes, phylogenomic analyses will be performed to reconstruct the population structure and evolutionary history of HRE clones. At the same time, a comparative genomic analysis between HRE and the rest of the population of this pathogen will enable the characterization of specific or enriched genes, clusters, or functions in HRE clones.

To validate the hypotheses linking genomic signatures and biological functions observed in the data, transcriptomic analyses under specific conditions or phenotypic validations will be performed in a second part of this thesis.

All of these approaches, both bioinformatic and experimental, will enable the identification of factors contributing to the adaptability and epidemic success of the main HRE clones of *P. aeruginosa*.

Keywords: *Pseudomonas aeruginosa*, clones à haut risque épidémique, bio, informatique, génomique microbienne, phylogénomique.

POSTER

The PREDHYCKT Jura XXI project: Projecting hydrological and carbon dynamics in the karst and peatlands of the Jura Mountains through the XXIst century

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Beyond their patrimonial importance, the carbon and freshwater stocks hosted by karst and peatland hydrosystems play a pivotal role in the functioning of the Critical Zone (CZ), particularly in the context of increasing climate change impacts on socio-ecosystems.

Although being distinct hydrosystems, they share strong similarities in their hydrogeochemical dynamics. Both can be conceptualized as hydrosystems comprising a transmissive compartment, conduits (karst) or acrotelm (peatlands), and a capacitive one: rock matrix (karst) or catotelm (peatlands). They also contribute to carbon transfer and storage, in karst systems primarily through inorganic pathways driven by limestone precipitation and dissolution. In peatlands, through organic pathways involving production and export of carbon sensitive to aerobic and anaerobic metabolism processes.

In the Jura Mountains, climate change is expected to induce a seasonal redistribution of precipitation with decreasing amounts in summer and increasing amounts in winter. The PREDHYCKT Jura XXI project aims to elucidate past and future trajectories of water-carbon cycle interactions, which still remain insufficiently documented and understood. To achieve this objective, the SNO Karst and SNO Tourbières observatories are monitoring four sites distributed along an altitudinal gradient for more than 10 years. These sites continuously record meteorological (P, T, net radiation, wind...), hydrological (water level, discharge), physicochemical (T, electrical conductivity, turbidity, fluorescence), and geochemical parameters (stable isotopes of water, inorganic and organic carbon, both dissolved and particulate, and major dissolved elements).

Three main specific objectives will be addressed: i) Quantify water and carbon fluxes, char-

acterize feedback dynamics and cyclic variability across multiple timescales and develop rainfall–discharge models for all sites; ii) Determine the origins and relative contributions of these fluxes in order to elucidate the mechanisms controlling water and carbon mobilization; iii) Project water and carbon fluxes throughout the XXIst century using climate projections and machine-learning simulations.

Keywords: Karst, Carbon, Peatland, Hydrogeology, Climate change.

POSTER

Assessment of peatlands degradation status to prioritise restoration under France's low-carbon strategy

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Peatlands are wetlands that accumulate organic matter under anaerobic conditions. Globally, they store 450-650 Gt of carbon, which is nearly one-third of the carbon in soils. However, these ecosystems are seriously threatened by human activities, particularly by agricultural and forestry drainage, which promotes peat oxidation and carbon loss to the atmosphere. These alterations transform peatlands from sinks into sources of greenhouse gases (GHGs), with emissions that can exceed 40 t CO_2eq ha^{-1} $year^{-1}$, depending on land use.

To reverse this trend, restoration programmes have been introduced since the 1990s. Rewetting, particularly by filling in drainage ditches, restores conditions favourable to carbon accumulation and is generally accompanied by a significant reduction in GHG emissions. Although these actions are part of carbon neutrality policies and can contribute to mitigating global emissions ($\sim 1\%$), their implementation faces financial, technical and ecological constraints that require strategic prioritisation.

In France, peatlands still poorly represented in national inventories due to a lack of data on their distribution and degree of degradation. This project aims to characterise their functioning in three ways: 1) modelling the links between peat quality, water table depth and GHG fluxes based on field data; 2) identifying and validating satellite proxies for assessing their functional status; and 3) quantifying the impact of restoration on GHG fluxes and producing a national map to guide restoration priorities. The objective is to develop operational tools to support the restoration of peatlands and their integration into climate and biodiversity strategies.

Keywords: Peatlands, soils, degradation status, climate change, restoration, carbon.

POSTER

Health and Productivity Indicators of Jura Fir Forests under Climate Change: Combined Effects of Plant and Fungal Parasites and Climatic Variability on Stand Growth and Resistance

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Silver fir (*Abies alba*) is a cornerstone of the Jura forests it has historically shaped the local economy and culture, accounting for up to 80% of the budgets of some municipalities at its peak. However, climate change scenarios from the Intergovernmental Panel on Climate Change (IPCC) predict a northward and upward shift in its distribution range, which is expected to weaken local populations.

These changes may also facilitate the expansion of European mistletoe (*Viscum album subsp. abietis*), a parasite of silver fir, throughout the host's distribution range. This parasitic plant reduces tree resilience to climatic stress and deteriorates wood quality.

The objective of this study is to develop forest management recommendations to ensure the long-term persistence of *Abies alba* in the Jura Mountains under climate change.

Three research axes are investigated: (1) Describing the dynamics of European mistletoe in Jura fir forests; (2) Assessing the diversity of pathogenic and mutualistic soil fungi in fir stands and exploring their potential links with fir decline and mistletoe infection levels; (3) Identifying the combined effects of parasitic attacks and climatic variability on fir growth.

To address these objectives, landscape ecology approaches (graph theory) and molecular tools (environmental DNA) will be used to model mistletoe dispersal and connectivity and to produce vulnerability maps of Jura fir forests.

Keywords: Silver fir, Parasitic fungi, Parasitic plants, Climate change.

ORAL

Fungal consortiums inoculation enhance growth and remediation potential of poplar cuttings in contaminated soils

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Phytomanagement strategies using fast-growing and trace elements (TE) accumulating tree species such as poplars (Populus spp.) offer a sustainable solution for the rehabilitation of TE-contaminated and by extension multi-contaminated soils. However, the efficiency of such approaches is often limited by plant stress and the low bioavailability of contaminants. Optimizing plant-microbe interactions, especially through the use of beneficial fungal inoculants, represents a promising approach to naturally enhance plant performance and remediation potential.

In this study, poplars were cultivated in pots containing TE-contaminated soils from Vieux-Charmont and Carrières-sous-Poissy (France) and were inoculated with two different fungal consortia, prepared from strains isolated from rhizosphere and roots of poplars who grew in similar environments. Before planting, the cuttings were immersed in spore suspensions, and additional inoculum was applied to the soil in each pot.

Results showed that inoculated poplars exhibited significantly improved growth compared to non-inoculated controls. This enhanced performance likely resulted from improved nutrient acquisition, stimulated root development, and increased stress tolerance in the contaminated soil environment. Furthermore, fungal inoculation was expected to influence the geochemical cycling of key nutrients. Enzymatic activities in the rhizosphere were analyzed to assess potential changes in microbial functionality and nutrient dynamics.

In addition to promoting plant growth, fungal metabolites increased the bioavailability of TEs, thereby facilitating phytoextraction. TE concentrations in plant tissues were assessed as well as changes in soil chemical properties. These findings contributed to assessing the potential of fungal inoculation as a tool to improve phytoremediation efficiency and the ecological functioning of TE-contaminated soils.

Keywords: TE, phytomanagement, consortium, fungi, plant, soil.

Geology

POSTER

Multi-scale structural analysis, petrochronology and geochemistry on the Nouveau Bourneix exploration permit in the St-Yrieix gold district. A new metallogenic model for new exploration guides.

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This CIFRE PhD project is carried out within the framework of the "Nouveau Bourneix" exclusive exploration permit, located in the Saint-Yrieix gold district (French Massif Central). The objective is to develop an integrated metallogenic model in order to improve exploration guides for gold and polymetallic deposits in the region. The study relies on a multi-scale approach combining structural mapping, petrography, geochemistry and petrochronology. The work will begin with the compilation and integration of existing geological and exploration data into a Geographic Information System (GIS). Detailed structural surveys will then allow the production of revised geological and tectonic maps of the area. These observations will be complemented by the interpretation of local and regional geophysical data. Petrographic, geochronological and geochemical analyses will be carried out on host rocks and mineralized veins in order to characterize the processes responsible for mineralization. The geochemical study of sulfides and isotopic analyses of micas will help constrain the origin and evolution of the mineralizing fluids. This study aims to propose a new integrated metallogenic model and to better understand the role of tectonics, partial melting, and fluid circulation in the formation of gold mineralization and polymetallic zonation.

Keywords: orogenic gold, metallogeny, tectonics, hydrothermal fluids, Saint, Yrieix district, Massif Central.

POSTER

New insights into current deformation in the Jura and implications for groundwater reservoirs: seismological and geodetic measurements

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The Jura represents a region of active, low-amplitude deformation, which has produced some of the strongest recent earthquakes in France. To this day, the controlling processes remain under debate. This study acts as a comprehensive and multidisciplinary approach to study the linkage between surface deformation, seismicity, tectonics and hydrogeological variations - thereby contributing to a better characterization of seismic hazard and water resources in the Jura region.

Here, I present the first results from a seismological analysis of the northern Jura. Data from a local network of 33 stations (8 Juraquake stations) is analyzed using a machine-learning based approach. The workflow of automated phase detection (PhaseNet), phase association (PyOcto) and event relocation (NonLinLoc) allows for the detection of previously unrecognized seismic events and a detailed mapping of earthquake hypocenters. Up to now, data from 2018 - 2020 has been analyzed and more than 1100 events were detected within the area of interest, out of which 780 events had previously not been listed in catalogs. These previously unrecognized events may be classified as earthquake events upon further investigation.

In addition to the seismological analysis, this project will base on data from a dense semi-permanent GNSS network (recording since 2000) and investigate the relationship between crustal deformation and groundwater dynamics in the Jura. The integration of geodetic and seismological observations is expected to provide new insights into the style, amplitude and spatial distribution of active deformation.

Keywords: Active deformation, Jura, Seismology, Geodesy, Tectonics, Hydrogeology, Seismic hazard, Water resources.

ORAL

Nature and age of Ediacaran to Devonian protoliths in the External Crystalline Massifs of the Alps (ECM) and the Maures Massif

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A large part of the European basement, including that of France, is composed of ancient rocks formed or reworked between 300 and 400 Ma during the Variscan Orogeny, a mountain belt comparable to the present-day Himalaya–Tibet orogenic system. The geodynamic context and the paleogeographic framework of the continental blocks involved are currently being reassessed, following advances in in situ analytical techniques and a critical reappraisal of geological maps produced between the 1950s and the 1990s. This effort is part of the national program of the Référentiel Géologique de la France (RGF), which aims to renew geological knowledge of the French territory through an event-based approach linking lithostratigraphic units with analytical data. Within this framework, this thesis aims to better constrain the nature and age of Ediacaran to Devonian protoliths in the External Crystalline Massifs of the Alps (Belledonne–Pelvoux) and in the Maures Massif. The External Crystalline Massifs record a complex polyphase tectono-metamorphic history, whereas the Maures Massif, only weakly affected by Alpine deformation, constitutes a particularly valuable reference area. Lithological and structural results obtained from two east–west transects across the external and internal domains of the Maures Massif reveal, in the external domain, the presence of a continuous sedimentary series from the Cambrian to the Silurian. The internal domain is characterized by protoliths that differ from classical interpretations. Structural analysis highlights the major role of Carboniferous deformation in the lithological interpretation and in the attribution of certain protoliths to either the Ordovician or the Ediacaran. Finally, in situ U–Pb dating of magmatic and detrital zircons reveals a Cambro-Ordovician magmatic episode at the scale of the massif, allowing an integrated view of the geological evolution of these massifs to be proposed.

Keywords: Variscan orogeny, Protolith, Alps, Zircons, Geochronology.

ORAL

Studying the fate of fluids from lithosphere dehydration: from lab experiments to numerical modelling.

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A wide range of fluids flow through the Earth's shallowest (1 - 10^2 m) to deepest (1 - 10^3 km) layers. Among the deep sources of fluids, some rocks undergo a mineralogical reaction induced by increasing pressure and temperature called dehydration, releasing amounts of water comparable – over the scale of a million years – to the volumes of oceans. Changes in rocks nature and high fluid pressures induced by this release of water are known to be responsible for an important part of the worldwide seismicity. Understanding reactions development and characterizing the resulting fluid flow are thus key points to identify associated earthquakes mechanisms.

Using lab facilities to reproduce these systems, inaccessible with direct observation methods in the natural medium, allowed highlighting complexities resulting from numerous couplings between reaction kinetics, fluid drainage, and permeability changes. Based on these experiments, a numerical model has been setted up to study the couplings, and to identify the main properties leading the initialization and the development of dehydrating systems, and their roles in the generation and maintenance of fluid pressure excess in the lithosphere.

Keywords: dehydration reactions, fluid flow, rock mechanics, diffusion equation, earthquakes.

Archaeology

POSTER

Paleoenvironmental dynamics at Pfyn/Finges (Valais, Switzerland): reconstruction through pollen analysis, charcoal and NPP

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The project to build a section of the A9 motorway in Switzerland, linking Leuk to Sierre, led to the discovery in the 2000s of the archaeological site of Pfyngut, located in the heart of the Finges/Pfyn Nature Park (central Valais, Switzerland). This site has revealed continuous human occupation linked with agropastoral activities from the early Iron Age (around 800 BC) to the present day (section of Roman road, buildings from a medieval hamlet, etc.). These discoveries illustrate the close relationship between societies and their environment in a region previously regarded as no man's land.

Knowledges about the evolution of vegetation in Valais since the retreat of the glaciers is based mainly on the work of Welten (1960-1970). Studies on the history of fires in central Valais remain insufficient. The presence of the Rhône river and human drainage have reduced the number of peat bogs and lakes, limiting the available natural archives. Thus, one of the few complete and dated pollen diagrams is that of lake Montorge (Sion).

Although archaeological excavations at Pfyngut have documented human occupation, environmental dynamics remain poorly understood. This site therefore offers an opportunity to study the interactions between societies and their environment in a context where sedimentary archives are scarce.

To fill these gaps, a multidisciplinary approach will be applied to sediment cores taken from four locations near the archaeological site: lakes Rosensee, Pfafforetsee, Pappelsee and the peat bog Pfyn-Seeli. Pollen grains, non-pollen palynomorphs and charcoal will be analysed alongside geophysical and geochemical approaches to sediments. By cross-referencing the results of these analyses with archaeological data, this thesis aims to reconstruct (1) the evolution of landscape since the Iron Age under the influence of climatic, fluvial and anthropogenic dynamics, (2) the history of natural and anthropogenic fires.

Keywords: Pfyngut, land use, palynology, Switzerland, central Valais, archaeology, fire, multiproxy analysis.

POSTER

Evaluating Space-Based Methods for Archaeological Prospection in Greenland A spatial approach using satellite image remote sensing for archaeological site prospecting.

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Originating in Alaska, the Thule people migrated eastward as early as the 13th century, reaching Greenland where they coexisted with the Dorset culture and the Norse. Their presence left lasting traces, both in the landscape and in local legends. This research project focuses on the study and detection of archaeological sites now threatened by accelerating climate change, particularly coastal erosion and permafrost thaw.

The main objective is to develop a remote analysis method suited to the constraints of Arctic environments, using tools such as satellite imagery and spectral analysis. This technique involves identifying specific indicators (moisture, chlorophyll, lichens) that reveal sites through their reflectance detected by satellite sensors. Applying methods like Object-Based Image Analysis (OBIA) allows us to confirm or refute the presence of sites through segmentation and classification. These non-invasive approaches aim to complete the existing archaeological map and document the vulnerability of sites to environmental changes.

From an archaeological perspective, the project seeks to understand the settlement dynamics of Thule dwellings by analyzing the topographic and geomorphological features of their locations. An ethnoarchaeological dimension is also integrated, drawing on local testimonies to bridge scientific knowledge and traditional wisdom, while strengthening ties with Arctic communities.

Keywords: Remote Sensing, Greenland, Thule settlement, Arctic archaeology.

ORAL

Late-medieval and modern timber roof in the jura high chain and the spread of resinous trees : historical, archaeological and dendrochronological analyses.

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The French Jura, a medium-altitude mountain range in eastern France, boasts architectural and forestry heritage that is inextricably linked to its natural environment. The high Jura range, characterised by vast coniferous forests (spruce (Picea abies) and fir (Abies alba)), has been intensively exploited since the Middle Ages and modern times. Among the activities linked to this mountain range, the production of construction timber has not yet been specifically studied.

The vernacular architecture of the Jura, shaped by a harsh climate and tradition, is characterised by massive, functional buildings, often organised as 'block houses' (dwelling, stable and barn under one roof). These buildings are based on softwood frames, designed to support heavy snow loads. Their structure, mainly made of fir or spruce, reflects an adaptation to local resources, but also construction practices that question the existence of regional specificities.

This thesis aims to analyse the architectural characteristics of the buildings in the massif, softwood framing techniques, and the mechanisms of timber export between the late Middle Ages and the early modern period. Dendrochronological and archaeological studies of a varied corpus seek to date and identify the woods used, while comparing these practices with those of other geographical areas.

An examination of the archives will also make it possible to trace the methods used to transport and supply wood, thereby shedding light on the economic and technical dynamics that shaped this forestry and architectural heritage.

Keywords: Dendrochronology, Archaeology, Jura high chain, Framework, Forest history, Resinous trees, Late Medieval, Modern Period.

ORAL

First results from a PhD project - FOOD AND FUEL RELATED ECONOMY OF THE BIBRACTE OPPIDUM (FRANCE)

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The study of economic aspects associated with procurement and management of food and fuel, the two essential commodities for human survival, is fundamental for understanding the functioning of any society, including those of the late Iron Age ones that built the oppida - complex fortified settlements featuring elements of urbanism.

The site on Mont Beuvray in Burgundy, identified as oppidum Bibracte since the 19th century and excavated almost continuously, became the case study for this thesis. One of a key questions of the scientific discourse pertains to the organization of food supply for the oppidum. J. Wiethold (2011), along with many others, sees the immediate environs of Mont Beuvray unsuitable for arable farming, suggests that staple cereals and pulses were imported from surrounding lowland areas and further distant calcareous regions. The studies of fuelwood are rare and limited. Thus, the aim of the dissertation is to use both old and new archaeobotanical data originating from various areas of Bibracte for verification of existing hypotheses regarding food and formulating new ones concerning fuel sources. The majority of new materials were collected between 2000 and 2024. The presentation will introduce the initial results obtained from the study of a new seed assemblage and preliminary insights into charcoal assemblage.

Preliminary carpological results indicate that cultivated plants form the core of the assemblage, with cereals as the dominant category. Hulled barley, broomcorn millet, spelt, and emmer prevail, while pulses are rare and fruits and nuts mainly reflect local gathering. Wild grasses and ruderal taxa were present in small but consistent quantities, likely representing field weeds or processing by-products associated with crop cleaning. The detrended correspondence analysis (DCA) shows high similarity across studied sectors. Observed differences primarily relate to crop-processing stages rather than distinct agricultural traditions.

Future analyses will quantify chaff-to-grain ratios, evaluate weed ecological profiles, and and continued systematic analysis of charcoal assemblages in order to reconstruct fuel selection and woodland exploitation strategies.

Keywords: Archaeobotany, Carpology, Anthracology, Oppidum.

ORAL

Proto-industries and forestry trajectories in the haut Jura: a dendro-anthracological approach

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Wood has long been the main source of energy for proto-industrial activities such as charcoal kilns, lime kilns, pottery kilns, forges, and glassworks. Dependent on the forest resources they consumed in large quantities, these structures provide valuable insight into the interactions between societies and forest environments. Studying them allows us to examine how past communities exploited and transformed forest landscapes in order to produce the resources best suited to their needs.

Archaeological surveys in the upper Jura mountains have revealed a particularly high density of these remains. Charcoal kilns are by far the most common, accompanied by numerous lime kilns, testifying to the intensive exploitation of wood resources from medieval times to the present day.

The dendro-anthracological study conducted on several charcoal kiln and lime kiln sites in the Jura Mountains aims to identify the species used and estimate the size of the wood exploited, thus providing clues about how forest stands were managed. The objective is to discuss both the choice of species according to sector and period, and the silvicultural practices that may have been implemented to meet the needs of these proto-industrial activities.

Keywords: Dendroanthracology, Protoindustries, History of forests, Forest structure.

ORAL

Étude des communautés de parasites digestifs dans les nécropoles tardo-antiques en France : vers une approche des pathocénoses.

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Les parasites, organismes vivant aux dépens de leurs hôtes, peuvent provoquer chez ces derniers l'apparition de symptômes variés. Les communautés qu'ils forment au sein des écosystèmes sont donc une des composantes de la pathocénose, telle que décrite par Grmek en 1969. De même que pour les autres maladies humaines, la transmission de parasites intestinaux au sein d'une même population répond aussi à une contingence de facteurs à la fois écologiques et culturels, spécifiques à la population étudiée. Dans ce réseau d'interactions écologiques, les parasites intestinaux peuvent eux aussi être des facteurs de facilitation ou d'aggravation d'états pathologiques plus sévères, notamment d'origine micro-parasitaire ou métabolique.

Ces pathogènes, en partie déjà connus sous l'empire romain et évoqués dans les textes Celse, Pline ou encore Columelle, étaient présentés sous le terme généraliste lumbrici. Ceux-ci ont accompagné la population romaine au travers d'une période marquée par des changements sociétaux majeurs (urbanisation, migrations, innovations hygiénistes...).

Les études paléoparasitologiques menées sur cette époque portent majoritairement sur les structures collectives telles que des latrines. Riches en matériel organique, elles présentent généralement une plus grande quantité de traces parasitaires ainsi qu'une surreprésentation des parasites associés au péril fécal. Néanmoins, elles ne permettent pas d'entreprendre des approches paléoépidémiologiques. Cette communication portera sur l'étude paléoparasitologique de trois sites funéraires tardo-antiques : Bordeaux (Castéjà, nécropole Saint-Seurin), Pontoise (ZAC Bossut) et Bourget-du-Lac (Route du Tunnel).

Les échantillons sédimentaires provenant de ces sites archéologiques sont analysés au laboratoire Chrono-environnement de Besançon selon une combinaison de techniques alliant à la fois l'identification traditionnelle sous microscope optique et l'identification ADN. Là où la microscopie permet une identification morphologique des œufs, la paléogénétique, elle, permet de détecter la signature moléculaire de ces micro-organismes. Combinées et appliquées sur un

large corpus tardo-antique inédit uniquement composé de structures funéraires, ces deux techniques favorisent une identification plus exhaustive des parasites intestinaux présents. Elles contribuent aussi à mieux apprécier la diversité et l'intensité de la charge parasitaire ainsi que les conséquences de ce parasitisme sur la santé de ces individus.

L'étude paléoparasitologique de ces trois nécropoles à l'aide de cette combinaison de méthodes encore peu pratiquées, permettra la mise en place d'une approche paléoépidémiologique des taxa parasitaires présents dans ces groupes d'individus, et leur rapprochement avec les données paléopathologiques. Ce travail pourrait mener à une potentielle mise en exergue de liens entre parasitisme et indices osseux pathologiques et alimenter le concept de pathocénose.

Keywords: Paléoparasitologie, Pathocénose, Funéraire, Tardo-Antique, Microscopie, ADN.

ORAL

Land use dynamics and territorial management during the Holocene at Chalain and Clairveaux (Jura, France): the contribution of paleo environmental analyses of lake sediment cores.

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Chalain and Clairvaux lakes are an emblematic case study in wetland archaeology in France. However, research conducted over more than thirty years under the direction of P. and A.-M. Pétrequin has primarily focused on Neolithic settlement sites located along the shores. Most environmental analyses have been carried out on ecofacts and artefacts recovered from these sites; they therefore mainly reflect the resource procurement practices of past populations rather than the environment itself. In this context, where "grasping natural data within the infinite complexity of archaeological deposits is often a challenge" (Pétrequin 1989, p. 9), understanding the environment, its long-term evolution, and the processes of anthropogenic impact remains incomplete.

This research aims to investigate these processes at the scale of the Holocene through the analysis of pollen grains, non-pollen palynomorphs (NPPs), and microcharcoal (fire signal) from two sedimentary sequences collected in the deep zones of Lake Chalain and the Grand Lake of Clairvaux. The first results show that:

This palaeoenvironmental approach will (1) reconstruct vegetation changes and assess the impact of human societies on their environment; (2) provide continuous data, unconstrained by excavation bias, to refine our understanding of long-term settlement dynamics; (3) identify the role of fire in land use and ecosystem functioning during the Holocene.

Pétrequin, Pierre. "Foreword." In Neolithic lakeshore sites of Clairvaux-les-Lacs (Jura) – Volume II: The Middle Neolithic. Éditions de la MSH, 1989.

Keywords: Fire, Landscape, Environment, Human impact.

Health

POSTER

Multifunctional theranostic nanostructures for controlled and targeted therapeutic activity

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Theranostic nanoparticles are receiving a lot of attention because they are designed for image-guided therapy, allowing for personalized treatment.

As part of the i-NanoT project aimed at producing efficient theranostic nanoparticles on a large scale, our research group is developing ultra-small gold nanoparticles coated with chelators that are chosen for their ability to form stable complexes with metal ions of interest for imaging (Gd_3^+ for magnetic resonance imaging (MRI), $^{111}In_3^+$, $^{64}Cu_2^+$, $^{68}Ga_3^+$ for nuclear imaging). These gold nanoparticles coated with metal ion chelates and the nanostructures constructed from these gold nanoparticles have a strong potential for image-guided therapy that has been validated by several experiments performed on tumor-bearing animals.

In order to make them more therapeutically effective, we plan in my thesis to functionalize these gold-based nanostructures for active targeting, which is based on a preferential (or even selective) interaction between the theranostic nanostructures and the tissues to be treated.

Two paths will be explored and compared during my thesis: (i) direct targeting and (ii) pre-targeting. Direct targeting consists of functionalizing nanostructures by targeting groups (peptide, antibodies, etc.) that have a strong affinity with the targeted sites, while pre-targeting is based on an *in vivo* bioorthogonal reaction between theranostic nanoparticles and a targeting agent previously immobilized on its target.

My thesis work will focus on the synthesis of gold nanoparticle-based nanostructures coated with chelators and on their functionalization, on the physico-chemical study of their interaction with their target, on the *in vivo* validation of the different strategies implemented for targeting and on the therapeutic exploitation of active targeting.

Keywords: Multifunctional nanoparticles, functionalization, active targeting, medical imaging, therapy.

POSTER

Role of RND efflux systems in siderophore secretion in fluorescent *Pseudomonads*

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Fluorescent *Pseudomonads* are environmental bacteria which secrete a fluorescent siderophore named pyoverdine (PVD). It is a small molecule able to chelate ferric iron, which is essential for bacteria but poorly bioavailable. In *P. aeruginosa*, a human opportunistic pathogen, siderophores' production and secretion are also involved in their virulence.

Up to day, only one efflux system of the ABC transporter called PvdRT-OpmQ is involved in pyoverdine secretion has been identified in *P. aeruginosa*. However, preliminary work in the laboratory and recent data suggest the involvement of efflux systems of the *Resistance-Nodulation-cell Division* (RND) family. Among them, the RND efflux system MexXY/OprM, which is homologous to ParXY that secretes pyoverdine in *P. putida* KT2440, is a candidate. The aim of the project is to investigate the involvement of MexXY/OprM and other RND efflux systems in pyoverdine secretion in *P. aeruginosa* and other rhizospheric fluorescent Pseudomonas species. To this end, fluorescence measurements associated with pyoverdine secretion will be performed in reference strains, in deletion mutants as well as in complemented mutants. Secretomes from mutants and wild-type strains will be compared using chromatography coupled with tandem mass spectrometry in order to identify variations in the nature and quantity of secreted metallophores, including siderophores. Finally, the impact of the mutants will be evaluated in a urinary catheter infection model for *P. aeruginosa* strains, and on plant growth and health for *Pseudomonas* strains isolated from the rhizosphere. Thus, this project will contribute to the development of new antimicrobial strategies and improve understanding of the ecological role of fluorescent *Pseudomonads*.

Keywords: Fluorescent *Pseudomonads*, *P. aeruginosa*, siderophore, pyoverdine, RND efflux systems.

POSTER

Is phage resistance the key of bacterial epidemic clones?

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Pseudomonas aeruginosa is a major opportunistic pathogen responsible for severe infections, particularly in immunocompromised patients. It is ubiquitous in humid environments and soils as well as in hospital, and is characterized by high genetic plasticity and adaptability, which promote its persistence and dissemination. The ST235 clone of P. aeruginosa is classified as a high-risk epidemic clone with global distribution. It is generally associated with low chances of therapeutic success due to its high level of antibiotic resistance. Preliminary work conducted at the Chrono-environment laboratory suggests that this clone may owe its epidemic success to its ability to evade bacteriophage predation. Bacteriophages are viruses that naturally occur in bacteria by injecting their genetic material and causing cell lysis. They therefore play a significant role regulating clinical and environmental bacterial populations. In response to bacteriophage pressure, bacteria have developed extensive defense mechanisms, in a process of co-evolution that has ultimately led to the selection of clones that are more resistant to bacteriophage predation than others. Supporting this hypothesis, a cluster of ten ST235-specific genes has been identified whose predicted function is to encode anti-phage defense systems. Inactivating these genes increases the clone's susceptibility to bacteriophage infection, confirming its direct functional role in phage resistance. Furthermore, preliminary results suggest that high-risk epidemic P. aeruginosa clones possess a greater number of defense systems than low-risk clones, indicating a more extensive defensive strategy. This ability would confer a selective advantage by promoting persistence, survival and transmission in hospital and environmental settings. The aim is therefore to study the ten genes of the cluster and understand, both individually and in combination, their role in defense against bacteriophages.

Keywords: Pseudomonas aeruginosa, epidemic clone ST235, antibiotic resistance, bacteriophage resistance.