

ABSTRACT BOOK

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Table of contents

	Page
Aeropalynology	7
<i>Ambrosia</i> pollen and Amb a 1 allergen emission dynamics in Central Anatolia of Turkey, Aydan Acar Şahin et al.	8
Aerobiology of <i>Quercus</i> and plane tree pollen, allergic sensitization and its putative contribution to pollinosis in Évora, Portugal, Célia M Antunes et al.	9
Atmospheric concentrations and intradiurnal pattern of fungal airborne spores in Tétouan (NW of Morocco), Fadoua Bardei et al.	10
Logistic regression models to predict daily levels of Poaceae and Amaranthaceae airborne pollen, Jordina Belmonte et al.	11
Below cloud scavenging on nine types of pollen by different rain conditions, Carlos Blanco-Alegre et al.	12
Etude de la pluie pollinique dans le massif de l'Edough (Annaba, Algérie), Soumaia Boughediri et al.	13
Pollution du pollen par des particules, Marie Choël et al.	14
Effect of land cover and wind on airborne <i>Olea</i> pollen, Francesco Ciani et al.	15
Impact of ornamental urban trees on the pollen records in the city of Florence (Italy), Francesco Ciani et al.	16
<i>Parietaria major</i> allergens vs Urticaceae pollen in the air we breathe, Concepcion De Linares et al.	17
Detection and quantification of airborne Alt a 1, Concepcion De Linares et al.	18
Allergenic load on the atmosphere of Porto city during 2018, María Fernández-González et al.	19
Cross reaction detection between aeroallergens of <i>Alnus</i> and <i>Betula</i> , María Fernández-González et al.	20
Mobile application of airborne particles and potential sources in Extremadura network of Aerobiology, Santiago Fernández-Rodríguez et al.	21
Light Detection and Ranging on Building Modelling Information as tool for urban planning by green infrastructure of Cupressaceae spp, Santiago Fernández-Rodríguez et al.	22
The effects of climatic change on the airborne pollen presence in the Mediterranean area, Giuseppe Frenguelli	23
Fungal spore calendar at the Middle-West of Spain: a preliminary study., Sergio Fuentes et al.	24
Use of airborne fungal spores as a biological sensor for bioclimatic comparison of two viticultural Galician regions, Estefanía González-Fernández et al.	25
Annual diagram of pollen with allergen potential present in the atmosphere of the city of Ibagué-Tolima (Colombia), Mosquera Mosquera Hilda Rocio et al.	26
Airborne pollen calendar of Tetouan (NW of Morocco): 2008-2014, Asmae Janati et al.	27
The airborne pollen of Es-Senia airport (Oran- Northwest Algeria), Ghania Kiared et al.	28
Aerobiological study of <i>Platanus</i> pollen type and Pla a 1 allergen in Toledo (Spain), Beatriz Lara et al.	29
Airborne pollen records, phenology of <i>Quercus rotundifolia</i> , Alejandro Monroy-Colín et al.	30
Airborne pollen records, phenology and geolocation of plane tree (<i>Platanus</i> sp.), Alejandro Monroy-Colín et al.	31
Results of automatic pollen species identification with the first Swisens Poleno series device, Erny Niederberger et al.	32

Pollen information based on allergy symptoms and real-time pollen measurement - preliminary results from a pilot project, Erny Niederberger et al.	33
Relationship between NDVI using Sentinel and <i>Olea</i> airborne pollen in SW of the Iberian Peninsula, Raul Pecero-Casimiro et al.	34
AIROT applied for the creation of urban risk maps for Cupressaceae family, Raul Pecero-Casimiro et al.	35
Comparative study of <i>Alternaria</i> airborne spore concentrations among urban, rural and natural areas in southern Spain., Antonio Picornell et al.	36
AeRobiology: the computational tool for biological data in the air, Antonio Picornell et al.	37
Bioclimatic indexes and their trends in the North-Spain DO areas, Alba Piña-Rey et al.	38
Identification of airborne pollen using a pollen Raman spectra database, Helena Ribeiro et al.	39
Phenology, aerobiology and thermal requirements in two <i>Olea</i> varieties, F. Javier Rodríguez-Rajo et al.	40
Les maladies allergiques et les paramètres météorologiques dans la commune d'Abomey-Calavi au Bénin, Monique Tossou et al.	41
Comparative study between two aerobiological stations situated in the city of Malaga (southern Spain), María Del Mar Trigo et al.	42
The incidence of Amaranthaceae pollen in Qatar: a two-years research, María Del Mar Trigo Perez et al.	43
Annual diagram of airborne spores of Pteridophytes from Ibaguè Tolima city, Ramírez Cotes Daniel Augusto et al.	44
Pollen forecast in Rome, Alessandro Travaglini et al.	45
A microfluidic approach for the automated analysis of pollen grains, Alessandro Travaglini et al.	46

Melissopalynology 47

Can starch grains inside Cistaceae's pollen supply the deficiency of other components in foraging preferences of the honey bees?, Amelia Virginia González-Porto et al.	48
Etude méliissopalynologique des miels de la région de Médéa (Algérie), Mounia Homrani et al.	49
Botanical origin of several commercial honeys: spring heather and eucalyptus unifloral honeys, David Rodríguez De La Cruz et al.	50
Strengthening of Forest Honey from Salamanca (MW Spain) to improve its commercialization, Silvia Sánchez Durán et al.	51
APICAMPUS, a project on Urban beekeeping developed at the University of Malaga, María Del Mar Trigo Perez et al.	52

Pollen morphology, biology and biochemistry 53

Screening of Amb a 1 allergen localisation in <i>Ambrosia artemisifolia</i> pollen by immunolabeling in TEM, Aydan Acar Şahin et al.	54
Profiles of histone epigenetic marks and histone modifiers enzymes during pollen development and microspore embryogenesis: effects of epigenetic inhibitors, Eduardo Berenguer et al.	55
Lipid composition and associated gene expression patterns during pollen germination and pollen tube growth in <i>Olea europaea</i> L., Antonio J Castro et al.	56
Pollen morphology of genus <i>Cirsium</i> Mill. Sect. <i>Cirsium</i> (Asteraceae: Cardueae) species in Turkey, Sevcan Celenk et al.	57
Morphometric analysis of Ericaceae pollen from southwestern European species, Ludovic Devaux et al.	58
Ultrastructural comparative study of the apertures, wall and tapetum in the Lardizabalaceae family, María Del Carmen Fernandez et al.	59
Air pollutants NO ₂ and O ₃ evoked altered <i>Dactylis glomerata</i> pollen oxidative defenses and allergen expression, Ana Galveias et al.	60
Effect of air pollutants (O ₃ , NO ₂ , SO ₂) on <i>Olea europaea</i> . L pollen performances, Sahar Hadj Hamda et al.	61

Morphology and evolution of the orbicules in the Ranunculales order, Lucía S. Hernández-Moreno et al.	62
Palynological studies on genus <i>Dianthus</i> L. section Fimbriati, Derya Mete et al.	63
New biotechnological strategies with small molecule modulators of autophagy and proteases to improve stress-induced microspore embryogenesis efficiency for crop breeding, Yolanda Pérez et al.	64
Effects of selenium on calcium gradient and on germination in <i>Olea europaea</i> pollen., Emma Tedeschini et al.	65
Morphological characterization of some Gymnospermae non-saccate pollen., Emma Tedeschini et al.	66
Stressful connections during pollen development. A personal account, Oscar Vicente	67
Palynomorphological investigations on <i>Cyanus</i> Mill. Subgenus of <i>Centaurea</i> L. (Asteraceae) in Turkey, Burcu Yilmaz Çitak et al.	68
Identification of novel superoxide dismutase isoenzymes in the olive (<i>Olea europaea</i> L.) pollen, Adoración Zafra et al.	69

Paleopalynology 70

Les environnements végétaux et agricoles de la Crète de 3200 à 2600 cal BP révélés par l'étude du site de Phaistos (alt., 35 m, Grèce), Valérie Andrieu-Ponel et al.	71
Environmental change around a Iron age foreshore settlement at Plougasnou-Saint Jean du Doigt (Finistère, France), David Aoustin et al.	72
Mid- to Late-Holocene Mediterranean climate variability: Contribution of multi-proxy and multi-sequence comparison using wavelet analysis in the north-western Mediterranean basin, Julien Azuara et al.	73
Late-Holocene vegetation changes in the Murcia region in relation with human activities, evidences from a new pollen sequence from the Mar Menor, Julien Azuara et al.	74
Holocene vegetation and fire history in northern Ural region (Komi Republic, Russia), Chéïma Barhoumi et al.	75
Automated recognition by neural networks for paleobotanical applications., Benjamin Bourel et al.	76
Changes in vegetation and Indian summer monsoon during the last deglaciation and early Holocene from sediments of the Bay of Bengal, Charlotte Clément et al.	77
Pollen analysis on spotted hyaena (<i>Crocuta crocuta</i>) coprolites from the fossiliferous site of Buca della Jena, Southern Tuscany (Roselle, Grosseto, Italy), Francesco Ciani et al.	78
Preliminary palynological results from off-site cores at the Terramara Santa Rosa di Poviglio, N Italy (SUCCESO-TERRA Project), Eleonora Clò et al.	79
Transect Méditerranée Occidentale-Orientale : palynologie marine et gradients climatiques (continentaux et hydrologiques) au cours de l'Holocène., Vincent Coussin et al.	80
The role of humans and climate in the process of steppe formation in the high-mountain region of Armenia, Amy Cromartie et al.	82
Fire activity in northeastern India over the last 25,000 years, Anne-Laure Daniau et al.	83
La Tourbière des Narcettes à Montselgues (Ardèche), Palynologie et paléométallurgie, Jacques-Louis De Beaulieu et al.	84
Landscape changes following Greek and Roman contacts and settlement in the coastal hinterland of Emporion-Emporiae (NE Spain), Ana Ejarque et al.	85
Palynological evidence for the use of precious resins (ladanum) to coat Baetican Roman amphorae, Ana Ejarque et al.	86
Quantifying past sea-surface hydrography: palynological approaches are they still competitive? A comparison of dinocyst-derived reconstructions vs planktonic foraminifera-derived ones for some key periods and key areas of the North Atlantic Ocean, Frédérique Eynaud et al.	87
Fluvio-glacial flows and their impacts on paleoceanographic conditions on the Celtic margin during Heinrich Stadial (HS1): Palynological evidence from the Bay of Biscay, Wiem Fersi et al.	88
Environmental changes and cultural adaptations of human populations during the Middle-to-Upper Palaeolithic transition in southwestern France between 44,000 and 35,000 BP, Tiffanie Fourcade et al.	89

Calibrating charcoal preserved in marine sediments to reconstruct paleofire regimes: Iberian Peninsula and Gulf of Lion case studies, Marion Genet <i>et al.</i>	90
Human shaped landscape history around the Minoan town of Malia, Crete: new insights about the Minoan civilization consequences on vegetation cover in the lowlands, Arthur Glais <i>et al.</i>	91
A Holocene record of vegetation change and human land-use: a case study of Northern Vosges Mountains (France), Emilie Gouriveau <i>et al.</i>	92
Transport et sédimentation polliniques sous bioclimat méditerranéen aride, Sahbi Jaouadi <i>et al.</i>	93
Post-landslide forest recolonization: a paleoecological view from a 4000 yrs old case-study, Sébastien Joannin <i>et al.</i>	94
The olive groves landscape of Kournas lake (Crete, Greece) from the Late Neolithic to Present Day, Isabelle Jouffroy-Bapicot <i>et al.</i>	95
Fires and human activities as key factors of the high diversity of Corsican vegetation, Marion Lestienne <i>et al.</i>	96
Deciphering the role of natural and anthropogenic forcings in coastal paleoenvironmental variability: results of a study in progress, Clément Lambert <i>et al.</i>	97
History of semi-arid and arid environments in the Eastern Maghreb during the Middle Holocene: first results of the pollen analysis from Sebkhia Kelbia (Central Tunisia), Vincent Lebreton <i>et al.</i>	98
Neotropical rainforest and climate cycles during the Quaternary, Marie-Pierre Ledru	99
Contributions of palynology and dendrochronology to the understanding of the evolution of the site of Pineuilh, La Mothe (Gironde, France), Chantal Leroyer <i>et al.</i>	100
Raña Maleta mire (Toledo Mountains, central Iberia): the last shelter for a lost forest, Reyes Luelmo Lautenschlaeger <i>et al.</i>	101
Environmental changes and human impact during the Middle to Recent Bronze Age in N Italy (SUCESSO-TERRA Project), Anna Maria Mercuri <i>et al.</i>	102
Patterning Holocene lake dynamics and detecting early Prehistoric human impacts: targets of an improved integration of multivariate ecological indicators thanks to the data mining approach, Yannick Miras <i>et al.</i>	103
Holocene vegetation reconstruction in northern Spain: Potentials of pollen and n-alkane biomarker analyses, Sara Nuñez De La Fuente <i>et al.</i>	105
Climate and vegetation imprint of the cool MIS 13 in the Iberian Peninsula, Dulce Oliveira <i>et al.</i>	106
Holocene paleoenvironments over the last 9 kyr BP in the northeastern Atlantic Ocean: the Grande Vasiere deposit in the Bay of Biscay (NW France), Aurélie Penaud <i>et al.</i>	107
The climate of the last 50 ka in Western Europe reconstructed from the Bergsee pollen record (Black Forest, Germany), Odile Peyron <i>et al.</i>	108
Glacial refugia, postglacial expansion and biogeographic dynamics of "Abies alba" in the Iberian Pyrenees: pollen and genetic data, Albert Pèlachs <i>et al.</i>	109
Vegetation dynamics and human pressure in two Middle Atlas Moroccan lakes during the Holocene, Sebastián Pérez-Díaz <i>et al.</i>	111
Modern pollen rain on an elevational gradient in the Catalan Pyrenees. A tool for quantitative reconstruction of Abies alba forests during the Holocene, Ramon Pérez-Obiol <i>et al.</i>	112
Palaeoenvironmental crises and expansions connect to economic and political changes in medieval Upper Brittany, Aurélie Reinbold <i>et al.</i>	113
Vegetation history and human impact since Neolithic in the eastern coast of Iberia. New pollen record from the Pego-Oliva basin, Jordi Revelles <i>et al.</i>	114
Mid-Holocene palaeoenvironmental evolution along the coast of Corsica. Vegetation history and human impact since Early Neolithic, Jordi Revelles <i>et al.</i>	115
Vegetation dynamics, human impact and climate influences around Lake Sevan in Armenia, Mary Robles <i>et al.</i>	116
Ancient parasites as biomarkers of environmental and land-use changes as recorded in natural archives: application to the analysis of the Asi Gonia peat bog in the White Mountains, Crete, Greece, Kévin Roche <i>et al.</i>	117
Fire regime and land uses shifts in a mountain territory of Cantabria (Spain) from the mid-Holocene to the present. El Cueto de la Espina peatbog, Sara Rodríguez-Coterón <i>et al.</i>	118
First results of the Kerloc'h palynological study (Crozon, Finistère, France), Cédric Rossignol <i>et al.</i>	119
Utilisation des coussinets de mousse dans la caractérisation des relations pluie pollinique/ végétation actuelle dans l'extrême nord est Algérien, Amina Roubal <i>et al.</i>	120

Le temps long de la construction des territoires de l'archipel croate du Kvaner (île de Krk et Cres). Premières contributions, Marine Rousseau <i>et al.</i>	121
800,000 years of western Mediterranean vegetation and climate changes: zooming in on the cold MIS 17 interglacial (700 ka), María Fernanda Sánchez Goñi <i>et al.</i>	122
Vegetation response and landscape dynamics in the Cantabrian region (La Molina peat bog, Northern Iberia): a continuous record for the last 17550 yr cal BP, Marc Sánchez-Morales <i>et al.</i>	123
Changements environnementaux sur l'île de Pâques depuis 1200 ans. Le marais du Rano Aroi, Anne- Marie Sémah <i>et al.</i>	124
Palaeoecological investigation of the Recent Bronze Age site of Este (Padua, N Italy): valuable information from NPPs, Paola Torri <i>et al.</i>	125
Two lakes, two stories: Variations in reconstruction of landscape history from two nearby lakes in the Rieti Basin, central Italy, Irene Tunno <i>et al.</i>	126
Sea-ice dynamics in the Southern Norwegian Sea during the last glacial millennial climate events: insights from combined dinocyst and biomarker analyses, Mélanie Wary <i>et al.</i>	127
Paleoceanographical changes of the Plio-Pleistocene based on marine palynology at ODP Sites 882 and 887, western and eastern North Pacific, Coralie Zorzi <i>et al.</i>	128
Indian vegetation and monsoon response to millennial and orbital climate variability during the last glacial period, Coralie Zorzi <i>et al.</i>	129

List of authors

129

Aeropalynology

***Ambrosia* pollen and Amb a 1 allergen emission dynamics in Central Anatolia of Turkey**

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Common or short ragweed (*Ambrosia artemisiifolia* L.) is a destructive invasive species that is important weed in agriculture and a source of highly allergenic pollen. It is native to North America but has been introduced to many Northern parts of Turkey. There are some modellings that showing pollen of *Ambrosia* could be enter to Turkey especially through West Black Sea region. In this study, it is aimed to investigate *Ambrosia* pollen and Amb a 1 allergens emission dynamics in Ankara province located in Central Anatolia with about 4.5 million population. It has also arid climate. Pollen were collected from Burkard pollen and spore trap and counted daily. Amb a 1 sampling was carried out between July-October during 2015 by using BGI900 Cascade High Volume Air Sampler (900L/min.). Both sampler were placed next to each other on a roof of a building at Ankara University. The ambient air was sampled on two different polyurethane filter (PUF). Two different filter parts (PM₁₀ and PM_{2.5}) were analyzed separately. PUF's were extracted in ammonium carbonate buffer, aliquoted, lyophilized and stored at -20°C until use. Concentrations of Amb a 1 were measured by sandwich ELISA technique. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) modeling system was performed to calculate backward trajectories to analyse the path of air masses on peak days of both pollen and Amb a 1. The sum of seasonal *Ambrosia* pollen indexes were 189 in 2015 and 21 in 2016. Majority of the allergen was found in the PM₁₀ fractions. Total allergen levels were measured for the two years as follows; 5.32x10⁻³ U/m³ and 1.96 x10⁻⁴ U/m³. The highest allergen concentration was measured on 29th August in 2015 (1.62x10⁻³ U/m³) and on 1st September in 2016 (2.01x10⁻⁴ U/m³). The backward air mass trajectory analysis was performed on peak days of pollen and allergen in both years. It showed that the possible sources of *Ambrosia* pollen was seemed to be Ukraine, Crimea and Black sea parts of Russia. The main wind direction in Ankara city was determined as northeast and higher pollen levels were recorded when the wind direction was from northeast and east. (Project No: TUBITAK, 113Z762)

*Speaker

Aerobiology of *Quercus* and plane tree pollen, allergic sensitization and its putative contribution to pollinosis in Évora, Portugal

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Plane (*Platanus hybrida*) and Quercus (*Quercus rotundifolia*) trees pollen are among the most prevalent in Alentejo with pollination peaks in the early spring (March and April). Despite the high level of exposure of the population, these pollen types are considered moderately allergenic and both the sensitization and their allergen profiles are yet poorly characterized in this region. In this work we aimed at characterizing the aerobiology and the sensitization to plane and holm oak pollen among young adults' population.

Pollen was monitored using a seven-day Hirst pollen and spore trap (Lanzoni) following the standard methodology for 2017 and 2018. Fifty volunteers, students in the University of Evora, aged 18-25 years old, were enrolled in this study, after informed consent and Ethical Committee authorization (ref. 15039). A questionnaire was applied to evaluate the prevalence of pollen allergy symptoms. To evaluate sensitization, serum IgE was quantified by specific ELISA and specific IgE to three pollen types (*Dactylis glomerata*; *Platanus hybrida*; *Quercus rotundifolia*) was assessed by EAST (Enzymoallergosorbent Assay). Allergen profiles were analysed by immunoblotting and inhibited immunoblotting was used to assess cross-reactivity. Medication sales in 2017 and 2018 (provided by CEFAR, Portugal) were used as a surrogate of pollinosis symptoms and correlation analysis with predominant pollen types was performed.

Seasonal pollen index (PI) was lower in 2018 compared to 2017 for both Quercus (8745 and 13602 pollen/m³, respectively) and plane (3638 and 5476 pollen/m³, respectively). For both species, duration of the pollen seasons was similar but started ~2 weeks later in 2018. Concomitantly, the peak day was delayed 10 days for both pollen types. Peak day PI was lower in 2018 for Quercus (434 compared to 1282 pollen/m³) and was similar for plane (619 compared to 627 pollen/m³). Quercus and plane pollen types represent respectively 35-45% and 15-18% of the total pollen spectra. During their pollen seasons they represent > 90% of the total daily PI.

The questionnaire analysis combined with the IgE levels, suggested that at least 36% of the individuals enrolled in the study might suffer from allergic symptoms during the pollen season. This population was sensitized to at least one pollen type; sensitization prevalence to grasses was ~45% and to Quercus and plane pollen types was ~30%. Several proteins were identified by EAST positive sera (MW range 10 to 80kDa) including bands with corresponding to Pla a 1 (< 20kDa), Pla a 2 (40kDa) and Pla TLP (21kDa) allergens. Positive EAST sera to Quercus pollen identified several protein bands in the MW range of 15 to 65kDa. Both holm oak and plane tree pollen have shown significant cross-reactivity with grass pollen.

In 2017 and 2018 anti-allergic medication sales increased monthly during the spring time and correlated with the raised PI from predominant pollen types.

These results evidenced a considerable prevalence of sensitization to plane and holm oak tree pollen in Alentejo, Portugal. Despite mildly allergenic, considering the high levels of exposure, these pollen types may contribute to induce pollinosis or aggravate allergic symptoms on the early spring in this region as suggested by the cross-reactivity with grasses and by the medication sales during their pollen seasons. A comprehensive understanding of the cross-reactivity patterns between pollen types, combined with exposure data, might contribute to a better management of seasonal respiratory allergic diseases.

*Speaker

Atmospheric concentrations and intradiurnal pattern of fungal airborne spores in Tétouan (NW of Morocco).

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The prevalence of respiratory allergies is increasing and is a serious global health problem. The objective of this work was to determine the seasonal and intradiurnal variations of the fungal airborne spores in Tétouan (NW Morocco).

Aerobiological sampling was performed during 2009-14 using Burkard volumetric spore traps located on the roof of the Biology department of the Faculty of Sciences. Daily mean concentrations were expressed as the number of spores per cubic meter of air. The study focused on the fungal spores types of *Cladosporium*, *Alternaria*, *Leptosphaeria*, *Pleospora* and *Venturia* according to their allergenic capacity and frequency in the atmosphere.

The above-mentioned spores are present throughout the study period in the Tetouan atmosphere showing a marked seasonal distribution, although they have seasonal fluctuations. *Cladosporium* and *Alternaria* showed highest levels in spring followed by summer and autumn, *Venturia* and *Leptosphaeria* reached their highest concentrations in autumn followed by winter and spring while *Pleospora* peaked in winter and in the spring. The analysis of the intraday concentration of these spores showed that *Leptosphaeria* and *Venturia* had maximum concentration (16.4 % and 13.3 % of the daily total spores on average) between 4-6 h in the morning and midnight-6 h, respectively. While the other types of spores had an almost homogeneous distribution, with a slight increase of 7.6 and 11.5 % of the total daily average between 12-14 h for *Alternaria* and *Pleospora*, respectively, and 3.7 % on average between 14-16 h for *Cladosporium*. The minimum values were obtained between 4-6 h for *Alternaria*, 10-12 h for *Leptosphaeria*, 2-4 h for *Pleospora* and 10–16h for *Venturia*.

With respect to the borderline (3000 spores / m³ for *Cladosporium* and 100 spores / m³ for *Alternaria*), it was exceeded between 13 and 31 days for the former and reached up to 95-days for the latter.

Keywords: Aerobiology, fungal spores, Intradiurnal variation, Allergy, Tétouan, Morocco.

*Speaker

Logistic regression models to predict daily levels of Poaceae and Amaranthaceae airborne pollen

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The Poaceae and Amaranthaceae families (old Chenopodiaceae family being included here recently) comprise herbs present throughout the world and growing in natural, rural and urban environments. The plants of both families are pollinated by the wind and their pollen types are present nearly all the year round, although counts increase between March and June in the case of Poaceae and between May and October in the case of Amaranthaceae. Both pollen types become airborne during the pollination period and are important health offenders due to their allergenic capacity.

Our aim is to establish logistic regression models to predict the presence of airborne Poaceae and Amaranthaceae pollen and the exceedance of concentration thresholds related to degrees of health issues.

Our study is based on data from years 1994-2014 of eight aerobiological monitoring stations in Catalonia (NE Spain). Daily maximum and minimum temperatures, rainfall, relative humidity and pollen concentrations for Poaceae and Amaranthaceae of the period 1994 - 2012 were used to establish four logit regression equations applied to predict the exceedance of thresholds 1, 4, 8 and 12 pollen/m³. Data from 2013-2017 are used to validate the models.

Poaceae pollen levels correlate positively with minimum and maximum temperatures, and negatively with relative humidity, while Amaranthaceae pollen levels showed positive correlations with minimum and maximum temperatures and with rainfall (in the same day, one and two days before); and negatively with relative humidity. The logistic regression models applied show a percentage of correct predictions ranging from 64 % to 93 % for Poaceae and 66-100% for Amaranthaceae.

The prediction of pollen thresholds in the air for the taxa Poaceae and Amaranthaceae by means of logistic regression models is a simple and practical process, with reliable estimation values. The simple proposed equations allow us to easily predict the levels of pollen that will be in the air the next day, becoming a useful tool in aerobiological information systems.

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*Speaker

Below cloud scavenging on nine types of pollen by different rain conditions

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Nowadays, air quality is one of the main concerns of human health, often compromised by several pollutants, as bioaerosols (like pollen, fungal spore, bacteria), related to human diseases such as influenza, lungs diseases or allergies (Oduber et al., 2019). One of the main sinks of aerosols is the washing by rain. Thus, the study of Below Cloud Scavenging (BCS) under different rain intensities or rain accumulated is crucial. Therefore, the main aim of this study is to analyze the evolution of nine types of pollen during rain events with different rain conditions.

Between January 2015 and December 2018 in León (Spain) a campaign for sampling rain and bioaerosols has been carried out. The instruments used were: i) a Laser Precipitation Monitor of Thies Clima to register rain intensity on a 1-minute basis; ii) a volumetric *Hirst* type spore-trap to estimate the hourly pollen concentration between 10 and 100 μm ; iii) a Davis weather station to register the basic meteorological parameters. The Below Cloud Scavenging has been analyzed through the scavenging efficiency ($\Delta C\%$) for nine types of pollen: *Betula*, *Castanea*, Cupressaceae, Oleaceae, *Pinus*, *Plantago*, Poaceae, *Quercus* and Urticaceae. The $\Delta C\%$ was estimated using Eq. 1 to evaluate the change in pollen concentration (so, a positive value is considered effective scavenging) between the times $t1$ and $t2$:

Eq. 1

Only events with:

- i) complete rain and bioaerosol data;
- ii) hourly accumulated precipitation higher than 0.1 mm;
- iii) temperature and wind speed variations below ± 3 °C and ± 2 m s⁻¹, respectively, between 2 h before and after rain;
- iv) the global amount of pollen concentration higher than 1 grain m⁻³ before rain are considered.

The selected events were classified by rain intensity: low (5 mm.h⁻¹).

Along sampling campaign, 122 events were registered and analyzed. The rain events presented a mean duration of 214 minutes, a mean rain accumulated of 3.58 mm and a mean rainfall intensity of 0.87 mm.h⁻¹. Globally, a 71 % of the total events presented effective scavenging, with a mean $\Delta C\%$ value of 24 ± 18 %. By rain intensity groups, the medium and high rain intensities caused the highest scavenging (69.7 and 69.2 %, respectively) on pollen concentration, mainly on *Castanea* and Cupressaceae types. The low rain intensity group presented an effective scavenging of 40.9 %.

In brief, the rain characteristics affect the effective scavenging of pollen and, furthermore, this washing effect depends on the type of pollen. This kind of studies constitutes a valuable tool for the pollen forecast after a shower. Future studies will focus on the study of scavenging effect caused by different raindrop sizes on different types of pollen.

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Oduber et al. (2019) Links between recent trends in airborne pollen concentration, meteorological parameters and air pollutants. *Agric. For. Meteorol.*, 264, 16–26.

*Speaker

Étude de la pluie pollinique dans le massif de l'Edough (Annaba, Algérie)

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Le massif de L'Edough, situé à l'Ouest d'Annaba (Nord-est algérien) est caractérisé par une ambiance bioclimatique humide et une biodiversité unique. Elle réunit dans un espace réduit 9 biotopes: Zénaie, Subéraie, Pinède, Eucalyptaie, Ripisylve, une zone rocailleuse littorale, maquis, pelouse et des Lacs.

Durant une année, nous avons analysé chaque mois la pluie pollinique en utilisant des pièges à pollen.

L'identification microscopique des pollens montre la présence de 82 espèces appartenant à 43 familles. Nous avons compté 36 espèces arborisées et 45 espèces non arborisées.

Nous avons remarqué que 62 % d'espèces de pollen sont, seulement, représentées dans le couvert végétal du site et 38 % ne le sont pas. Ces espèces proviennent soit par le vent, soit il s'agit d'espèces disparues du couvert végétal.

Ce travail est en cours pour l'élargir à la région Nord-est Algérienne.

*Speaker

Pollution du pollen par des particules

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La littérature comporte une vingtaine d'études relatant l'adhésion de particules atmosphériques sur la surface de grains de pollens allergisants. La pollution de pollens par un grand nombre de particules a ainsi été fréquemment observée pour différentes espèces/taxons et dans plusieurs environnements géographiques. Cette adhésion de particules modifie la composition chimique pollinique surfacique. Les effets sur la santé de tels complexes pollen-particules sont encore peu connus, mais de premières études mentionnent qu'il faut s'attendre à une augmentation du potentiel allergisant de ces grains pollués aux particules.

Le capteur de Hirst est la méthode de référence pour la surveillance réglementaire des pollens et il est également utilisé dans certaines études en lien avec l'état de pollution du pollen par les particules. Cependant, en raison de son diamètre de coupure plus faible que $10 \mu\text{m}$, ce capteur peut piéger également des particules micrométriques. Bien que des études antérieures l'aient utilisé pour renseigner la pollution des pollens aux particules, il apparaît inapproprié dans ce cas précis.

Dans un premier temps, des prélèvements de pollens ont été effectués en simultané avec un capteur de Hirst et avec un impacteur en cascade. Nous montrons qu'il existe un important artefact de prélèvement avec un capteur de Hirst, capteur pourtant couramment utilisé dans la littérature pour ce type d'étude, mais qui se révèle donc inadapté pour ces prélèvements. En effet, la vitesse élevée en entrée de buse d'aspiration du capteur de Hirst ne garantit pas une bonne séparation entre les pollens et les particules fines (PM 2.5) et les pollens une fois piégés sur la surface adhésive de prélèvement sont littéralement bombardés de particules.

Dans une seconde phase, l'utilisation d'un impacteur en cascade pendant la saison pollinique du bouleau a permis d'estimer le nombre moyen de particules déposées sur les grains de pollen de betula dans une atmosphère moyennement polluée. En comparant ce nombre avec les données de la littérature, nous mettons en évidence une large surestimation de la pollution du pollen par des particules dans les études publiées. L'analyse des grains pollués par MEB/EDX permet par ailleurs de préciser la nature des particules adhérentes à partir de leur composition élémentaire et, dans une certaine mesure, leur potentiel inflammatoire/dangerosité. Malgré un impact sanitaire élevé, les complexes pollen-particules restent largement méconnus, tant du point de vue de leur fréquence qu'en terme de nature chimique des particules adhérentes. Les études futures ne doivent pas employer de capteur de Hirst à moins de vouloir renseigner non pas l'état de pollution du pollen par les particules mais plutôt la co-exposition des pollens avec les particules atmosphériques.

*Speaker

Effect of land cover and wind on airborne *Olea* pollen

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The study of the potential sources of allergenic pollen is widely used to estimate exposure risk to the high concentrations of airborne particles. From this point of view, the land cover of the area surrounding the sampling station (pollen trap) has a decisive impact on local airborne pollen counts. The study of the vegetation must be combined with the meteorological parameters and, in particular, with the wind, recognized as being one of the most important factors in airborne pollen diffusion. In order to study *Olea* pollen transport, we correlate the pollen records with the area covered by olive groves and the wind directions and intensity. *Olea* pollen type was selected for the great presence of olive trees in this area and for its high allergenic potential. The study was carried out in Florence (Arno Valley, Italy) over a period of five years (2011 – 2015). Pollen data were furnished by Regional agency for environmental protection of Tuscany (ARPAT) whose pollen sampling has been carried out through the use of a volumetric Hirst-type spore trap located at 20 m a.s.l., in the north-western area of the city. Meteorological data concerning wind were supplied by the weather station of the University of Florence, about 2 km from the ARPAT monitoring station, in the north-eastern area of the city. A buffer of 10 km in radius surrounding the volumetric sampler was created using GIS software; olive groves of this area were detected through the use of orthophotos furnished by the Territorial and Environmental Information System of Tuscany. The area surrounding the pollen monitoring station showed a widespread presence of olive groves, in particular in the south-eastern and south-western parts from the sampling point (more than 30% of the southern buffer area) and in the north-eastern area from the sampling point (more than 20% of the eastern buffer area); the lowest presence of olive trees is shown in the north-western area from the sampling station (less than 10%). Regarding the statistical analysis between *Olea* pollen records and wind directions, the greatest correlation is shown when the wind blows from the north-west. *Olea* pollen values also showed a strong negative correlation with wind intensity. The greatest contribution of *Olea* pollen is given by the northwestern winds, despite the low abundance of olive groves in this area. This conclusion hints at a pollen diffusion from a greater distance than that considered for this work and the influence of the topographical features of the study area.

*Speaker

Impact of ornamental urban trees on the pollen records in the city of Florence (Italy)

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Urban green areas can improve people's quality of life: the benefits of ornamental street trees and urban green spaces are widely known. However, airborne pollen spread from urban plants during the reproductive season is one of the main health risks for citizens which suffer more pollen allergies than people living in rural areas. Probably cities are affected by pollen deposition models that are very different from those prevalent in extra urban-area, due to a different climate and increased turbulence caused by the built location. The study done in different sites within a city can be useful to understand these dynamics and the influence of the different plants. A total of 48 moss samples were collected in the historical city center of Florence: the sampling was repeated in the same sixteen sites during three years (1995, 2008, 2017). A buffer of 250 m in radius was drawn around each sampling site: the absolute pollen frequencies (APF, number of grains per gram of sample) of *Tilia*, *Platanus*, *Celtis* and *Ulmus* were statistically correlated with the number of these plants growing inside the buffers. The four genera were chosen as they are widely used only as ornamental street trees or in urban parks of the city and as they are mostly absent in private gardens. The data about the number and the distribution of the trees were furnished by the Municipality of Florence, Territorial Information System. Concentration maps of APF were drawn using Quantum GIS software in order to display the pollen diffusion inside the different sites of the city center. The greatest statistical correlation between APF and the number of trees is shown by *Celtis* and *Tilia*. The former, widely used as ornamental tree on the roadsides in many parts of the city, shows a strictly local influence; the latter, which is the most widespread tree of the urban green area of Florence (about 15% of the total), has a significant local influence, although to a lesser extent than *Celtis*. Low correlation is instead shown by the other two genera (*Platanus* and *Ulmus*). The results of the study highlight the utility of a number of records in different sites for evaluating the contribution of the source on the pollen record, due to the local variability strictly linked to the number of trees in a short-range distance. This study also provides a useful indication to keep in mind in the planning of urban green areas in order to reduce the health risks for the citizens.

*Speaker

Parietaria major allergens vs Urticaceae pollen in the air we breathe

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The Urticaceae family comprises herbs and small shrubs that has two distinctly representative genera, *Parietaria* and *Urtica*. The pollen of both genera, except in the case of *U. membranacea*, is so similar that there is no aerobiological evidence of the proportion of each of them in the airborne pollen concentrations. However, both genera are allergologically different. While *Parietaria* is one of the main causes of pollinosis in the Mediterranean area, *Urtica* lacks this character.

The present study offers a comparative analysis between the airborne Urticaceae pollen and the aeroallergens Par j 1-2 in order to know the seasonality of the Urticaceae pollen and the *Parietaria* allergens.

For airborne allergenic particles detection an Andersen Cascade Impactor was used and for airborne pollen a Hirst trap in two cities of Southern Spain (Córdoba and Granada). The immunological analysis was performed by ELISA immunoassay whereas the pollen counting method followed the recommendations of the Spanish Aerobiology Network (REA) and the minimum requirements of the European Aeroallergen Society (EAS) for pollen. The aeroallergens were studied through a temporal study, from 2006 to 2009, in Córdoba. An spacial analysis was studied during 2006, in two cities (Córdoba and Granada). A Spearman rank correlation test between Par j 1-Par j 2 concentrations and airborne pollen concentrations was performed.

Although the Urticaceae pollen is present all year around, the maximum pollination was registered from February to June. The patterns of airborne Par j 1-Par j 2 and pollen were present in the air during the studied period in both cities. The temporal study realized in Cordoba during the four years showed that the years with maximum allergen concentrations coincided with lower pollen detection and *vice versa*. In the other hand, when comparing pollen and allergens in the two cities during 2006 has been observed an atypical behaviour with an explosive flowering during few days in both cities. *Parietaria* allergens showed significant correlations with pollen in Córdoba during 2007 and 2008 for all period studied while in 2006 significant correlation was obtained only during the period with maximum pollen concentration in both cities.

Urticaceae pollen calendar is as a good tool for prevention because it shows the main periods of risk of *Parietaria* allergy.

*Speaker

Detection and quantification of airborne Alt a 1

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Alternaria is a fungus belonging to the Pleosporaceae family distributed in urban, rural and natural areas. It is considered an important risk factor for human health. Their conidia (or asexual spores) are dispersed by the wind. Airborne spore data are an important reference element for allergologists to interpret the causes of the patients' symptoms and to decide on the preventive therapeutic measures to be taken. However, little is known about the prevalence in the air of the mayor allergen (Alt a 1) and its temporal variations.

The aim of this study is to analyse the airborne concentrations of Alt a 1 using two sampling and analyzing methodologies and to compare them with the concentrations of *Alternaria* conidia obtained through standardized methods.

To obtain the airborne Alt a 1, two different samplers were used: a Burkard Multi-vial Cyclone Sampler and a MCV high volume sampler. These traps were installed beside a Hirst trap for the sampling of the airborne *Alternaria* conidia. All traps were placed in the roof of the C building at the Universitat Autònoma de Barcelona, (Bellaterra, Spain) at 23 m.a.g.l. during the year 2015. The immunological analysis were performed using Dot-Blotting Immunological analysis and ELISA technique whereas the spores counting method followed the recommendations of the Spanish Aerobiology Network (REA).

Results obtained showed that the volume of air sampled plays an important role in the determination and quantification of airborne Alt a 1. The analysis of the samples collected with the cyclone sampler showed that the results were outside the range of detection of the Dot blotting and ELISA techniques. However, the samples of the high volume sampler showed results in good correlation with the conidia concentrations, although in some cases (2/16) Alt a 1 was detected by Dot blotting but could not be quantified.

High Volume Samplers showed to be the best method to obtain the airborne allergen Alt a 1. Dot Blotting showed to be a good method to detect Alt a 1 and ELISA technique a good method for Alt a 1 quantification.

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*Speaker

Allergenic load on the atmosphere of Porto city during 2018

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The knowledge of the aeroallergen content is a useful tool to establish the risk allergy warnings for the sensitive people. The main airborne allergenic pollen come from trees, grasses or weeds (mainly Urticaceae). The present study sought the quantification of the pollen and Bet v 1, Ole e 1, Lol p1 and Par j1-2 aeroallergen concentration as well as how weather variables influence the pollen and allergen concentration in Porto city.

The aerobiological study was performed using a Hirst-type volumetric sampler for pollen collection and a Burkard Cyclone sampler for the aeroallergens during 2018 followed by ELISA technique. We carried out a Spearman correlation analysis between meteorological and aerobiological data. Finally, a backward trajectory was applied in order to analyse the discordances between pollen and allergen maximum concentrations.

The longer main pollen season was of Urticaceae (71 days) and the shortest for *Olea* (17 days). The same tendency was detected in total amount of pollen; it was the highest in Urticaceae (1181 pollen) and lowest in *Olea* (220 pollen). The maximum pollen peak was registered in April 24th for *Betula* (167 pollen/m³).

The highest total aeroallergen concentration was 4.333 ng for *Betula* and the lowest were for *Olea* (0.868 ng), the maximum daily concentration was registered in April 24th for Bet v1 (1.506 ng/m³) and the lowest were observed in May 12th for Urticaceae (0.057 ng/m³).

The correlation test showed a significant and positive correlation between pollen and aeroallergen values and with the temperature whereas the correlation was negative with relative humidity, rainfall and wind speed. The back trajectory analysis results showed that when the pollen and allergen peaks were registered on the same day, air masses always come from the continent. However, when the peaks do not coincide, the air masses come from the continent in the case of the pollen peak and from the sea for the allergen peak.

In our study it was observed that the available traditional information for allergenic Type I patients, corresponding to the amount of pollen in the bioaerosol, does not accurately identify the allergenic load in the air.

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*Speaker

Cross reaction detection between aeroallergens of *Alnus* and *Betula*

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Alnus Mill. (alder) and *Betula* L.(birch) belong to the Betulaceae family. These trees are very common in the Northern Hemisphere. The major allergen in the alder tree pollen is Aln g1 with a molecular mass of 17 kDa (Negrini, 1992; King et al., 1995). The major allergen for *Betula* is Bet v 1 with 17 kDa, a protein recognised in the serum-IgE antibodies in up to 95 % of birch pollen allergic patients. These allergens are very similar structurally and immunochemically, this fact can induce cross reactivity processes between the antibody and the allergen. The repeatability of the amino acid sequences in the species of the genus reaches the 80-90% (Matthiesen et al., 1991). The objective of this study was to ascertain whether pollen *Alnus* and *Betula* pollen concentrations as well as Aln g1, and Bet v1 allergens (detected by means the use of Bet v1 antibodies) were correlated.

The study was conducted in Ourense (NW-Spain). The airborne pollen was quantified by using a volumetric sampler Lanzoni VPPS-2000 during the years 2017 and 2018. The content of the atmospheric allergen was quantified by using a Burkard Cyclone sampler and enzyme-linked immunosorbent assay (ELISA) double sandwich technique. Meteorological data were obtained from the Spanish National Institute of Meteorology. *Alnus* pollination usually occurs in January and February. The total annual pollen was 2603 pollen and 6534 pollen grains in 2017 and 2018 respectively and the maximum pollen daily concentration occurred in January 24th in 2018 with 867 pollen grains/m³. The total aeroallergen concentration was 8.68 ng and 7.32 ng in 2017 and 2018 respectively and the maximum daily concentration was registered in February 1st 2017 with 1.81 ng/m³. *Betula* pollen grains and Bet v1 allergens were detected from the last days of March to May with a total annual pollen integral of 2411 and 8651 pollen grains in 2017 and 2018 respectively. The maximum daily concentration was registered in April 25th 2018 with 1283 pollen/m³. The total aeroallergen concentration was 5.19 ng and 8.66 ng in 2017 and 2018 respectively and the maximum daily concentration was registered in April 11th 2017 with 0.80 ng/m³.

We observed cross reactions between the Aln g1 and the Bet v1 as the *Betula* major allergen can detect the *Alnus* pollen presence in the atmosphere. The aeroallergen daily distribution data follows very closely the variations of the *Alnus* and *Betula* daily mean pollen concentrations. Therefore, the allergenic people sensitized to *Betula* pollen could present allergenic reactions in previous (January or February) periods to the *Betula* flowering.

*Speaker

Mobile application of airborne particles and potential sources in Extremadura network of Aerobiology

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The AeroUEX research group provides aerobiological information to the population through the website, SMS and social networks. Mobile applications are being an important tool for the daily routine of people, in this way a new app has been developed including new criteria and requirements. The idea is the improvement of the health of citizens in temporal and spatial scale at real time aerobiological monitoring. The main goal is to develop a technological application joining all aerobiological information related with potential health impact for citizens in Extremadura from network of Aerobiology (Badajoz, Cáceres, Don Benito, Plasencia and Zafra) in the SW Spain.

The application is developed with the 'framework' Ionic, which allows with a single code to export the result to different mobile platforms such as Android, iOS or Windows Mobile. Home page shows a logo, the name of the network and gives optional access to the different sections of the application that are also accessible from the side menu of the application. For this purpose we considered the data in sections; initiation, location, list, levels, forecasting, stations, information, settings and language.

The page is loaded by default in the component "maptabs" and from it searches for pollen sources could be done based on different variables: pollen type, search radius and location by Global Navigation Satellite System (GNSS). Once the pollen sources have been found it will be possible to access this page and see about the location of the sources in the map. From this page you can search pollen levels in the different locations with samplers of the Extremadura Network of Aerobiology. Values of the different pollen types obtained by the sampler will show with the colour code the total level of the day and the individual level of each pollen type (there are twenty-four different main pollen types). Apart from the value obtained for the date selected, the average of other years will be shown.

The Extremadura Network of Aerobiology has five airborne stations. In this page, some cards with information about them are shown. It also has weather stations with real time from them (since your data is updated in the database every 10 minutes) with pressing the orange button on each tab. For the forecasting, we use the images generated by the SILAM model by the Finnish Meteorological Institute. It shows different maps of air quality, both gases and pollens. SILAM offers a five-day prediction from the current date. Furthermore, standard 10-day synthesis images of NDVI 300m from the PROBA-V satellite of Copernicus (European Space Agency) were added to the application. On the other hand, a wind forecast is presented for the following seven days from the Windy web application, based on the ECMWF model.

We propose a mobile application as a tool to be considered in Aerobiology and in related urban disciplines as a component in air quality analysis, in order to reduce the potential impact. This mobile application is a novelty to show information at real time monitoring to visualize urban environments for the cities of the Extremadura Network of Aerobiology. The novelty of this application is the inclusion of georeferenced pollen sources and the access to updated weather and predictive information. Furthermore, this mobile application is opened to include more functions in 3D and to be scalable to cities of other sampling networks.

*Speaker

Light Detection and Ranging on Building Modelling Information as tool for urban planning by green infrastructure of *Cupressaceae* spp

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Building Information Modeling (BIM) is a methodology that includes the generation and management of built environments based on their physical and functional data. Social benefits can be applied by the public infrastructure owner, utilising BIM productively in urban planning and consultation, to develop new and healthy urban green areas in new public infrastructures. Such as parks or avenues and streets, which consider the environmental effects on the population. For instance, in green urban areas, the allergenic factor has high importance when trees are selected, to improve the quality of life of those affected. This is done by data quantification and reproduction through BIM workflow. The main goal of this study is to model in 3D environmental urban information using point cloud by laser scanner in two information blocks third dimension (3D) and fourth dimension (4D) on BIM, considering the relation of distance between cypress trees in Engineering Agricultural School of Badajoz in Extremadura (SW Iberian Peninsula) from the Hirst volumetric sampler with their pollen concentrations and meteorological parameters.

The allergenic potential impact study was developed in the Engineering Agricultural School (EAS) of the University of Extremadura (Badajoz, Spain). The data used in this study were; daily *Cupressaceae* pollen recorded by a Hirst volumetric sampler at 6 m height on the terrace of a building of EAS during 27 years (1993–2019), cypresses trees geo-localized with the coordinates around 250 m to the sampling pollen on file of Google Maps, point cloud by laser scanner of Light Detection and Ranging (LIDAR) using Mobile mapping system Topcon IPS-3 and finally, meteorological parameters with weather station at 3 m of sampling point.

All this information is integrated in two information blocks, through the programmes of Autodesk software. The first one is the 3D of BIM, in order of work with: representation existing urban condition and landscape, in 3D Models with ReCap, from laser scanning with LIDAR; geo-location with Google Maps (trees coordinates imported to AutoCAD Civil 3D and buildings coordinates imported to InRoads) to get the distance between trees and from the Hirst volumetric sampler (with UTM coordinates); 3D construction of buildings and trees (with width and high) from EAS area with Revit; transmission of 3D Models and constructions in a real-world of InRoads driven prefabrication. Finally, the second information block is the 4D of BIM, with Dynamo directing study data from Excel and 3D Models representation of Revit.

The main novelty of this study is to model urban environment 3D from aerobiological information to urban planning using BIM, which reflects the information to understand the potential allergenic factor risk and its impact on the urban population.

*Speaker

The effects of climatic change on the airborne pollen presence in the Mediterranean area

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Weather conditions are affecting the life cycle of plants and any change in climate influences the phenology and distribution of species across the world.

In the last decades, it has been evidence of an increase of air temperature by about 0.9°C over the past 100 years. The best projections show that average global temperatures are likely to increase 1.8-4.0°C by the end of the century, depending on the amount of carbon emission. In the Mediterranean region, average temperatures have already risen by 1.4°C since the pre-industrial era, while extreme daily rainfall increased in spite of the fact that total rainfall, generally, decreased. These changes involve many aspects of plant phenology and physiology such as the timing in which pollination occurs, the behaviour of pollen release, the length of pollen season, pollen production and viability, nectar secretion, but also photosynthesis, flower induction and development, plant-pollinator interactions and response to stress conditions. Usually, in Mediterranean basin, these changes are stronger in early-flowering plants and less marked in late-flowering species.

It is our duty, using aerobiological monitoring, to update the influence of any climate change on plant phenology which can imply a lot of risk for ecosystems and human health. It is, moreover, fundamental to render our scientific knowledge accessible not only to scientific community but also to policy-makers and key stakeholders to try to find solutions and consider adaptation options for mitigating the consequences of climate change in the Mediterranean environment.

*Speaker

Fungal spore calendar at the Middle-West of Spain: a preliminary study.

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Introduction

Pollen and spore calendars are very useful tools in medicine especially for people who suffer from allergic diseases. Although pollen calendars are well-known, those considering fungal spores are still rare to find. Despite it is possible to find fungal spore calendars worldwide, in countries such as Australia, India or Poland, in Spain, these studies are unusual. On the other hand, the majority of the spore calendars refers only to one or two different spore types, probably due to the difficult that implies the study of the fungal aerosol.

Material and Methods

The methodology used was the one suggested by the Spanish Aerobiology Network (REA) (Galán *et al.*, 2007), being the monitoring conducted from 17 February 2014 to 16 February 2016, both included. Fungal spores were captured by using a Hirst type spore trap sampler, placed on the roof of the Faculty of Pharmacy of the University of Salamanca, at a height of 25 m.a.s.l.. The spore types were identified to the genus level and we considered *Aspergillus* and *Penicillium* together as one single category (*Aspergillus/Penicillium* type). The “others” category included all the unidentified and damaged spores.

The spore calendar was performed according to the Spieksma’s model adapted to fungal spores (Sánchez Reyes *et al.*, 2016). The order indicated in the calendar was based on their appearing in the air spectra, including only the spore types that showed an annual percentage equal or greater than 1%.

Results

A total of 57 spore types were identified but only 12 reached the limit of 1% from the annual percentage. As other studies pointed out before, *Cladosporium* was the most abundant spore type followed by *Aspergillus/Penicillium* type. These two spore types reached the highest categories in the Spieksma’s model (Class 10 and 9, respectively). *Agaricus* registered around 100-199 spores/m³ (class 7). The medium categories (class 6 and 5) contains the majority of the spore types as follows: *Alternaria*, *Coprinus*, *Periconia* and *Pleospora* were included in a class 6 and *Bovista*, *Epicoccum*, *Ganoderma* and the category of others were in the class 5. *Leptosphaeria* and *Myxomycetes* reached the lowest values in a class 4 and the total spore concentration was in the highest class (class 11).

Conclusion

Cladosporium was found along the whole year with its maximum representation being located in the summer. *Aspergillus/Penicillium* type showed its maximum during May and *Agaricus* was captured in great number during the autumn. *Alternaria* spores were more abundant during the summer although this spore type was not identified as one of the most abundant types like other studies pointed out. *Ganoderma* spores had the lowest presence in the atmosphere of Salamanca, probably due to the absence of the substrate for their development.

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*Speaker

Use of airborne fungal spores as a biological sensor for bioclimatic comparison of two viticultural Galician regions

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Introduction

Phytopathogenic fungi are the main cause of harmful crop damages and yield loss on vineyard around the entire viticultural regions, mainly *Plasmopara viticola*, *Uncinula necator* and *Botrytis cinerea* (responsible of downy mildew, powdery mildew and grey mould respectively) (Bois *et al.* 2017). Nevertheless, the study of airborne spores and its distribution suppose an accurate biological sensor of environment conditions. Disease development depends on the interaction of a susceptible host, a virulent pathogen and favourable environment conditions for disease development (Agrios 2005). In the vineyard ecosystem, weather conditions largely influence on pathogen survival and development, and the particular ecoclimatic regime of Northwestern Spain favours the disease processes.

Material and Methods

The study took place during the years 2017 and 2018 in two Galician vineyards of Designation of Origin areas, D.O. Ribeiro (Cenlle) and D.O. Rías Baixas (Areiro), with Albariño cultivars. Airborne pathogenic spores were trapped using a Lanzoni VPPS-2000 (Hirst 1952). Meteorological data were obtained from a HOBO Micro Station and from MeteoGalicia.

Results and Discussion

Aerobiological results showed important differences on total spore amount as well as its distribution along the grapevine vegetative cycle for both areas. In the Ribeiro D.O., *B. cinerea* represented the predominant pathogen among the atmospheric content, whereas in the Rías Baixas D.O. vineyard, *P. viticola* had a marked superiority respect to the other phytopathogenic fungi. The same behaviour was observed for the spore daily concentration peaks. These differences are mainly motivated by the typical bioclimatic characteristics of each region. Following the Continentality Index (Rivas-Martínez 2005) both areas belong to the Oceanic type, but Cenlle has an Attenuated Semicontinental subtype while Areiro has a Marked Semihyperoceanic subtype. Temperature and humidity are considered as the main factors affecting fungal disease processes. The higher humidity levels of Areiro enhance the pathogenic development of *P. viticola*, which needs the continuous presence of free water to germinative stages of disease cycle (Dalla-Marta *et al.* 2005). Our statistical results support these findings. We applied a Principal Component Analysis (PCA) to denote the meteorological influence on each pathogen atmospheric content for both areas. We found a strong positive correlation between *B. cinerea* and *P. viticola* with rain and relative humidity in most of cases, but this trend was not followed by *U. necator* in Areiro. In this case, we observed that rain had a negative effect on spore concentration as colony development of powdery mildews is stopped by rain and water sprays (Chellemi and Marois 1991, Jarvis and Slingsby 1977, Sivapalan 1993). The presence of free water, in this case is detrimental to conidial germination (Fernández-González *et al.* 2016).

Conclusions

The adaptation of the pathogenic fungi to the specific vineyard conditions of both continental and coastal areas can be studied by aerobiological methods, as airborne spores are a valuable biosensor of favourable conditions for disease development. Furthermore, this bioclimatic relation could be used for crop protection against the consequences of climate change, as the expected increase in the variability of climatic conditions may affect the vegetal phenology and pathogen biology (Lamichhane *et al.* 2015).

*Speaker

Annual diagram of pollen with allergen potential present in the atmosphere of the city of Ibagué-Tolima (Colombia)

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Pollen diagrams constitute a fundamental tool for aeropalinological-aerobiological studies because it show the permanence of pollen grains and spores in the atmosphere in a certain period, The information generated is important for health centers, which present cases of pollinosis. Studies in countries such as Spain, Uruguay, Argentina, France, Mexico and Brazil have generated many pollen diagrams in which most of the sporopollinic particles have some degree of allergenicity. In Colombia, the development of this type of research is still incipient, there is only one aerobiological station in operation since 2017 and it is located in the city of Ibagué (Tolima), it was created with the objective of determining and diamaging the pollen types in state aerovagante, present in the atmosphere of the city. In this research, data from one year of sampling are presented.

For the collection of the aerovagant material and its characterization of allergenicity, the recommendations of the Spanish Aerobiology Network - SAN Galán et al. (2007), for which a volumetric collector type Hirts (Hirts, 1952) was used, located at the University of Tolima, the sporopollinic particles collected on the Melinex® tape were assembled with fuchsy glycerogelatine and observed at 40X in an optical microscope ; which allowed the analysis and determination of the pollen types. The Excel® program was used to record the data after reading the plate.

During a sampling year, a total of 1,491,723 grains / m³ were registered, belonging to 21 aerobic pollen types, of which 13 are categorized as H.A. (highly allergenic) with a total of 1,054,928 grains (70.7%), these were: *Chenopodiaceae*, *Cyperaceae*, *Poaceae*, *Alnus acuminata* Kunth., *Amaranthus spinosus* L., *Betula acuminata* Ehrh., *Cannabis sativa* L., *Cupressus lusitanica* Mill., *Mimosa pudica* L., *Pinus patula* Schiede ex Schtdl., *Plantago major* L., *Ricinus communis* L., *Sambucus nigra* L. ; 6 taxa were categorized as MA (mildly allergenic) with a total of 341,618 pollen grains (22.9%) corresponding to *Cecropia peltata* L., *Eucalyptus globulus* Labill., *Fraxinus chinensis* Roxb., *Helianthus annuus* L., *Psidium guajava* L. , and *Spondias purpurea* L. and finally the pollen types *Apiaceae*, and *Syzygium malaccense* (L.) Merr., are categorized as NMA (not very allergenic) with a total of 95,177 grains (6.3%).

It is concluded that the most abundant pollen type during the sampling period was *Poaceae* with a total of 277,979 grains / m³ (18%), this possibly is due to the presence of extensive and abundant monocultures of grasses including *Zea mays* L., in the city of Ibagué and the department of Tolima. These data constitute preliminary information for further studies of pollen calendars and for investigations related to pollinosis.

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Key words: aeropalinology-aerobiology, allergenicity, airborne pollen.

*Speaker

Airborne pollen calendar of Tetouan (NW of Morocco): 2008-2014

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Pollen grains of the anemophilous plants are the most important source of allergens in the atmosphere, triggering allergic diseases such as rhinitis and asthma in atopic individuals.

Pollen grains in the atmosphere of Tetouan (NW of Morocco) were recorded during a 7 year period (2008-14) using a Burkard volumetric pollen trap located on the flat roof of the department of Biology of the Faculty of Sciences. Daily mean pollen concentrations of 10-day periods were summed and averaged over the 7-year study period to construct the pollen calendar following the technique adopted by Spieksma (1991).

The mean annual total pollen grain index recorded during this period was 44597, belonging to 52 higher plant taxa (30 trees and/or shrubs and 22 herbaceous species). The maximum annual pollen index (63187) was recorded in 2009 and the minimum (30899 p/m³) in 2014. During the study period, the main pollen was registered from February to June (89 %), with the highest daily mean pollen counts recorded in March (26.38 %) and February (21.13 %). The timing, intensity and length of the pollen seasons varied according to the taxa. The pollen calendar of the Tetouan atmosphere reflects a great pollen diversity (37 pollen types), Pollen omnipresence throughout the year, long pollination periods and typically Mediterranean taxa: Cupressaceae, *Olea*, *Platanus* and *Quercus*. Some trees and herbaceous plants perform their anthesis in winter: Cupressaceae, *Fraxinus*, *Populus*, *Pinus*, *Mercurialis* and *Parietaria*. Some of them extend their pollen season until spring at the same time as other types of pollen appear typical of spring. *Morus* and *Pistacia* have a short pollen season, while *Cannabis sativa*, Amaranthaceae, *Olea*, *Parietaria*, *Plantago*, Poaceae, *Quercus*, *Rumex* and *U. membranacea* are characterized by prolonged pollen season. The pollen spectrum of Tetouan is differentiated by *Cannabis* pollen, with a longer and more intense pollination period than that detected in other Mediterranean regions. Based on these results, pollen calendar of Tetouan provides interesting and useful information to aerobiologists as well as professionals working in fields such as allergy and public health.

Keywords: Airborne pollen, Pollen calendar, Tétouan, Morocco.

*Speaker

The airborne pollen of Es-Senia airport (Oran-Northwest Algeria)

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A systematic study of the pollen content of the atmosphere in the region of Oran (Northwest of Algeria) was performed using the Cour method for two consecutive years (from 2004 to 2006). The area studied was the meteorological station at Es-Senia airport in Oran. The resultant data were recorded using the maximum weekly average method.

The aim of this study, is to establish the diversity of airborne pollen, the pollination periods of the major taxa with the intensity of pollen emissions. This work shows also seasonal distribution of the taxa and the relationship between autochthonous and allochthonous vegetation in the region.

The mean annual index is 3246 grains, of which 3237 grains are identified (99.7 %) those unknown and unidentifiable represent only 0.3 %.

Pollen harvest of the first year (4230 grains) is significantly higher than that of the second year (2258 grains). Herbaceous plants (69.5 %) are significantly more numerous than those of trees (27.9 %) and shrubs (2.3 %). Pollens identified, listed in descending order, are :Chenopodiaceae - Amaranthaceae (41.4 %), *Plantago*, *Olea*, spontaneous Poaceae, *Lygeum*, Cupressaceae, Urticaeae, Total *Quercus*, *Pinus*, Total Asteraceae, *Eucalyptus*, Brassicaceae, *Casuarina*, *Pistacia*, Arecaceae, Apiaceae and *Rumex*.

Seasonal distribution : Most of taxa pollinate in spring : Chenopodiaceae / Amaranthaceae, *Lygeum*, spontaneous Poaceae, *Pinus*, *Pistacia*, *Plantago*..., total Asteraceae, total *Quercus*, *Olea*. In winter, only two taxa: Cupressaceae and Arecaceae. In summer, pollinate Apiaceae and *Eucalyptus* and *Casuarina* in autumn.

Finally, pollen from Allochthonous vegetation, at Oran, is low: most pollen is from autochthonous vegetation specifically in spring,

Keywords: Airborne pollen; Cour Method; Pollen content analysis of the air; intensity of pollen emissions, Seasonal distribution, autochthonous and allochthonous, Es-Senia Airport (Oran - West Algeria).

*Speaker

Aerobiological study of *Platanus* pollen type and Pla a 1 allergen in Toledo (Spain)

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Platanus pollen is an important cause of allergy in many cities of western Europe where plane trees are commonly planted in urban green spaces. In Spain, *Platanus* pollen mainly come from the species *Platanus orientalis* L. var. *acerifolia* Dyand in Aiton. The major allergen of *Platanus* pollen is Pla a 1; in Spain allergic patients to this pollen type present 60 % of IgE and a prevalence of 83-87 %. In this paper, we studied this pollen type and the allergen Pla a 1 along the year 2018 in the atmosphere of the city of Toledo (central Spain). The aims of this work were to analyze the characteristics of the main period of pollination of the *Platanus* pollen and to study the relationship between the airborne concentration of *Platanus* pollen and the major allergen Pla a 1. Furthermore, we studied closely the influence of meteorological variables on the concentration of this pollen type.

Pollen sampling was carried out using a Hirst volumetric spore trap and for allergen sampling a multi-vial volumetric cyclone was used. In the analysis of the aerobiological samples the procedure established by the International Association for Aerobiology (IAA) was followed and the quantification of the allergen was carried out using the ELISA technique using anti-Pla a 1 antibody. The main pollination period was calculated as 95 % of total annual pollen, obtained after removing 2.5 % of the start and end of total production.

The results obtained in Toledo during 2018 indicate that the main pollen season of the *Platanus* pollen took place from April 5th to May 20th, recording the day of maximum concentration on April 18th. There were 19 days of risk of allergy (> 50 pollen grains/m³) for allergic people, of which three are considered as high-risk level (> 200 pollen grains/m³). Regarding the relationship between the concentration of pollen and allergen, the results indicate that there is a clear relationship between both (R = 0.527, p< 0.01). Temperature and precipitation are the meteorological variables that most influence the *Platanus* airborne pollen in Toledo (year 2018). The allergenic load (Pla a 1) coincides with the presence and magnitude of the concentration of pollen in the atmosphere. Pollen counts are good indicators and useful to alert the allergic population because pollen constitute the main allergen carrier although other factors are involved on the dispersion of allergens.

*Speaker

Airborne pollen records, phenology of *Quercus rotundifolia*

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Introduction

Oaks (*Quercus*) are woody plants with ecological and economic importance. They are found mainly in the Northern Hemisphere: in Europe, Southeast Asia and Northeast Africa. The greatest diversity of species occurs in temperate forests, as those present in Mediterranean environments, where pollination season is predominantly between April and May. This work aims to assess the relationship between the airborne pollen sampled from the oaks with its flowering phenology.

Methods

Aerobiological sampling was carried out in Badajoz (SW Spain) in 2016-2018 using Hirst volumetric spore trap. Meteorological station closes to the spore trap (2 m) was used for obtaining data on temperature, rain, direction and velocity of wind and relative humidity. Trees were geo-localized in the urban area. Pollination phenology was studied in 10 specimens, five in the surroundings of pollen station and five at 4 km apart of pollen station with a frequency of 3-4 days on average. The period studied was March-May. For phenology, BBCH methodology was used.

Results

Annual pollen integrals during the period 2016-2018 ranged from 4202 (2016) to 33755 pollen*day/m³ (2017). The daily peak also was higher during 2017, reaching 3461 pollen grains/m³ (05/04). The phenology of pollination ranged from 23/03 to 02/05, with an average length of 29 days and the maximums being reached within the first week of April (except for 2018, which showed a delay). Finally, the maximum pollen concentrations were reached from 2-6 days after in relation to maximum pollination phenophase.

Conclusions

In all the years, the peaks of phenology of the different species can be matched with peaks of airborne pollen records, considering that rain and predominant wind direction patterns, can prevent a more precise correspondence.

*Speaker

Airborne pollen records, phenology and geolocation of plane tree (*Platanus* sp.)

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Introduction

The plane trees (*Platanus*) are one of the more frequent ornamental trees cultivated in urban environments of Mediterranean region. Airborne pollen records are related with pollination phenology and potential ornamental trees sources distribution with the meteorological parameters, especially the speed and direction of the wind. This work aims to assess the relationship between the airborne pollen sampled from plane trees with its flowering phenology and tree geolocation.

Material and methods

Aerobiological sampling was carried out in Badajoz (SW Spain) in 2016-2018 using Hirst volumetric spore trap. Meteorological station close to the spore trap (2 m) was used. Plane trees were geolocated in the urban area by using GIS and Google Maps. Pollination phenology was studied in 15 specimens, five in the surrounding of pollen station, five at 4 km of pollen station and five 3,6 km apart with a frequency of 3-4 days on average. The period studied was March-June. For phenology, BBCH methodology was used and branches around the tree top up to 2 m height were tested if pollen was shedding.

Results

2685 trees have been located. For the three years analysed, annual pollen integral for *Platanus* were 894, 2381 and 647 pollen*day/m³, respectively. Daily peak maximum pollen concentration reached 142 (31/03/16), 449 (15/03/17), 134 (02/04/18) pollen grains/m³. Phenology of pollination for plane trees ranged in 2016 18/03-25/04, with a maximum 08/04, in 2017 18/03-03/05, with a maximum 10/04, in 2018 20/03-02/05, with a maximum 06/04. Maximum pollen concentrations were reached 8 (2016), 26 (2017) and 4 days (2018) before in relation to maximum pollination phenophase. In all years, most pollen grains fall into the phenological record; 0.3 % in 2018, 1.2 % in 2017 and 5 % in 2016.

Conclusions

Pollination phenology plane trees showed a close relationship with airborne pollen records, only a reduced proportion of those pollen grains were detected outside the pollination period.

*Speaker

Results of automatic pollen species identification with the first Swisens Poleno series device

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The performance of the new measuring device called Swisens Poleno will be presented. The device measures individual aerosol particles, especially pollen, in flight and is able to identify the pollen species automatically. Swisens Poleno is an air-flow cytometer based on the analysis of light scattering, holographic images and UV-induced fluorescence. An integrated aerosol-concentrator enables a high time resolution of seconds to minutes for the local pollen concentrations. The complete system includes identification software, a weather protection housing, telecommunication means and a Sigma 2 based inlet. It makes the local pollen concentration available in real-time for the whole pollen season.

B. Crouzy from MeteoSwiss and Y. Zeder, a student of Lucerne University of Applied Sciences and Arts have developed algorithms for detecting different types of pollen by processing the measurement data of the device. The first preliminary results obtained with the data from the first prototype and their algorithms were presented by B. Crouzy at the 11th international congress on Aerobiology held beginning of September 2018 in Parma. They achieved an average correct identification rate of over 90 % for the seven investigated pollen species. In the mean time the improved Swisens Poleno series device are available. In addition the algorithms were improved. New results will be published in June 2019 in a scientific paper.

As improvements on the algorithms are ongoing, the actual status of the achieved performance will be presented at the conference, as well as the current experiences with the monitoring system in the field.

The presentation includes also a report on the experiences made to increase the number of recognizable pollen as Aerobiologists want to be able to recognize other or additional species of pollen in their local area.

The software used for the pollen identification is based on machine learning algorithms. To train these algorithms, training data sets from each pollen species are needed. A data set from one pollen species should contain only data from pollen grains of this specific species. In other words, for each species a data set as clean as possible is required.

For obtaining a training data set, pollen from a specific species is dispersed in the air near the inlet and then measured by the device. This procedure is performed sequentially for the different types of pollen. In practice, one usually has unwanted foreign particles in the training data sets. In a first step an automatic algorithm sorts out particles that are obviously not pollen. Thanks to the holographic images of each individual pollen grain, a human can then easily further clean the training data sets if needed. This has to be done only once per pollen species and enables Aerobiologists to easily create their own training data sets for expanding the variety of detectable species. Updated recognition algorithms can be created in collaboration with other researchers or the device manufacturer.

*Speaker

Pollen information based on allergy symptoms and real-time pollen measurement - preliminary results from a pilot project

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The pilot project "Digital pollen information" aims at investigating how the quality of life of pollen allergy sufferers can be improved. Allergy symptoms of individuals are gathered via a mobile app and pollen measurements are done in real time at specific sites. The potential of earlier and more accurate information for improved prevention and treatment should be explored.

We assume that a denser measurement network is needed for timely and accurate pollen information. The best cost-benefit ratio can be achieved by dense monitoring networks in cities, where a lot of affected people can benefit from it. The new real-time measuring instruments, in combination with the collection of the symptoms of the allergy sufferers, enable numerous new possibilities.

Benefits of real-time data for pollen allergy sufferers

Thanks to earlier and more accurate information, affected allergic persons can take preventative measures to minimize contact with the pollen and take their medication at the time needed, so the drug can develop its effects more effectively. The daily routine can be adjusted to avoid high pollen concentration zones thus reducing symptoms. Due to the more accurate exposure knowledge and thanks to pollen concentration- and geolocalization tracking via mobile app, allergists can diagnose faster and more accurate and better treatment is made possible. The quality of life of each individual increases and the economic damage due to loss of productivity decreases.

Approach / Consortium

Each and every allergic person is also a pollen sensor. The pollen concentration can also be measured via measuring the symptoms. In 2018, Ally Science launched an app for symptom gathering of pollen allergy sufferers in Switzerland and used the symptom and geolocation data to determine the local pollen concentration within hours. The Ally Science consortium consists of Ally Science of Bern University of Applied Sciences Institute for Medical Informatics I4MI, aha! allergy Foundation, MIDATA Cooperative, University Hospital Zurich and Federal technical college Zurich and since 2019 Swisens AG.

Swisens AG, a Swiss start-up company, has developed a device that enables automated pollen measurement. Thus, in contrast to the existing manual system, airborne particles can be measured in real time automatically (without delay), providing minute values (instead of daily values) for the pollen concentration.

Targets of the pilot project

The 2019 pilot project will be used for a preliminary scientific study to investigate the benefits of real-time data accessible to allergy sufferers. It will create a basis for a larger research project on the subject area and show that relevant and beneficial research can be done with the principal approach from the pilot project.

Pilot cities

The 2019 pilot cities in Switzerland are Biel/Bienne and Lucerne. The operation will start in March 2019.

Continuation

The project will continue in 2020. There are more pilot cities under discussion and a consortium for the preparation of an extensive research project is founded covering a longer time horizon. The research project aims at scientifically substantiate the benefits of real-time data in conjunction with user symptoms and quantify the evidence.

*Speaker

Relationship between NDVI using Sentinel and *Olea* airborne pollen in SW of the Iberian Peninsula

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Cultivation of *Olea* trees has been well extended in the Mediterranean area, due to its traditional use due to benefits obtained from olive groves. Recently, it is being cultivated as ornamental trees. Their pollen grains are allergenic with a potential problem for allergy patients in environmental urban and surroundings. Remote sensing is being used as a prediction tool for the phenological observations and pollen emission. So as for the prediction of biomass or for studying pathologies in trees and for the assessment of the environmental impact of the crops. One of the parameters that can supply this related information is the Normalized Difference Vegetation Index (NDVI) by different satellites as Landsat or Sentinel. The aim of this study is a new approach to test the NDVI with Sentinel as tool to forecast the *Olea* pollen concentration.

The correlation between the NDVI related with olive trees within three training data polygons (15, 25 and 50 km-distance to the volumetric sampler Hirst) was studied to Extremadura. It is an agricultural region (41635 km²) of the South-West Spain. Five cities were studied in the region; in the west, Badajoz (BA), in the north, Plasencia (PL), in the middle, Cáceres (CC), in the east, Don Benito (DB) and in the south, Zafra (Z).

The daily average *Olea* airborne pollen concentrations of 2016, 2017 and 2018 in the SW Iberian Peninsula (Extremadura) were studied. Average daily data of *Olea* airborne pollen concentration (pollen grains m⁻³) were obtained using a Burkard 7-day volumetric spore trap. These were situated on the terraces of School Engineering Agrarian (BA 1993-2019), (38.89, -6.96) at 6 m; Hospital Virgen del Puerto (PL 2011-2019), (40.04, -6.08) at 16 m; School of Technology (CC 2014-2019) (39.47, -6.34) at 6 m; I.E.S Donoso Cortés (DB 2011-2019), (38.96, -5.86) at 6 m; and Hospital Zafra (ZA 2011-2019), (38.43, -6.42) at 6 m about ground level. NDVI images were studied by extracting the values of NDVI in the three training areas. After that, the correlation between *Olea* pollen concentrations, NDVI values and meteorological parameters were correlated and modelled with Artificial Neural Networks (ANNs).

The main challenge is to forecast the occurrence time of *Olea* pollen emission, considering meteorological parameters, with Sentinel. The satellite images obtained by Sentinel have more resolution than other satellites and their NDVI values can be more decisive to be used in routine forecasting tasks.

*Speaker

AIROT applied for the creation of urban risk maps for Cupressaceae family

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Ornamental plants in the cities fulfil a series of beneficial functions, among them, the reduction of the pollution levels. However, a significant percentage of the population is allergic to the pollen that some of these plants produce. This fact would make necessary to implement a legislation that regulates and controls the concentration of certain pollen types in the urban air and, at the same time, to think about new tools that keep the population informed. One of these possible information tools is developing risk maps for airborne pollen. The aim of this study is to create urban risk maps in the city of Zafra (SW Spain) for several species of the *Cupressaceae* family, all of them having a high allergenic potential, selecting this place as first approach.

A aerobiological index AIROT (Aerobiological Index of Risk for Ornamental Trees) will be used, calculated from several parameters that include the number of specimens, maturity degree for each specimen, pollen production and the use of each species for the different species (not all studied species produce the same amount of pollen), incidence and presence of high buildings, narrow streets and squares, height above sea level, total surface of the city and the potential for dispersibility. To calculate the latter, LiDAR (Laser Imaging Detection and Ranging) technology has been used, which allows to know which areas of the city would have direct exposure to ornamental sources that release pollen grains. In addition, it is also necessary to use Kriging techniques to give value to the representative exposure levels in each area of the city.

The urban risk map calculated for the city of Zafra, indicates the areas of the city where there is a greater risk of exposure to *Cupressaceae*. This map represents the risk by colours (green = low, yellow = medium, red = high) that exists both in the place where the pollen sources are located, and in areas close to them due to the different parameters studied. Using this map, which may have different applications, another called healthy map has been created, which shows restaurants in the city and will serve as an informative tool to the population. It also shows itineraries to travel safely within the city avoiding areas of high risk according AIROT index.

In conclusion, due to the problems generated by exposure to urban ornamental sources and its corresponding release of pollen content in allergic population, and due to the current lack of legislation that regulates it, it is created a risk map based in AIROT index, as an informative urban planning tool that could reduce the exposure to aerobiological risk, important for allergy patients, allergists, urban planners and policy-makers.

*Speaker

Comparative study of *Alternaria* airborne spore concentrations among urban, rural and natural areas in southern Spain.

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One of the most cosmopolitan fungal spore types present in the air is that belonging to *Alternaria*. This spore type has been proved to have a negative impact on sensible population, in general, and children with airway hyperresponsiveness, in particular. Furthermore, *Alternaria* species are phytopathogens that cause high economic losses in agriculture. Therefore, studies on the dispersion behaviour and distribution patterns of *Alternaria* spores will be very useful in order to reduce their negative impact on the population health and the agriculture. The aim of this study was to establish relationships between the airborne concentrations of *Alternaria* spores and the meteorological and climatic variables of the studied areas, as well as land use. For that, an aerobiological study has been carried out during 2018 in three sampling sites: a coastal urban city (Malaga, 58 m.a.s.l.), an inland rural city with high influence of crops and natural areas (Ronda, 751 m.a.s.l.), and a third site located inside a Natural Park (Sierra de las Nieves, 1070 m.a.s.l.).

The samplings were carried out by means of three Hirst-type volumetric pollen traps, and the samples obtained were mounted and counted following the methodology proposed by the Spanish Aerobiology Network (REA). Meteorological data were supplied by the National Agency of Meteorology (AEMET) in the case of Malaga and Ronda stations, and by ACAMET meteorological network in the case of Sierra de las Nieves. Statistical analysis was carried out by using R software and "AeRobiology" package.

Negative and significant ($\alpha=0.001$) Spearman correlations were found between daily values of *Alternaria* spore concentration and precipitation as well as relative humidity in all the sampling sites, while positive and significant correlations were found with temperatures (the highest with maximum temperature). *Alternaria* daily concentrations showed significant differences between Sierra de las Nieves and Malaga, but there were not significant differences between the other compared stations. This may be explained on the basis of a certain degree of similarity in land use in the case of Malaga and Ronda and to being situated in the same biogeographical area in the case of Ronda and Sierra de las Nieves. Despite the results obtained by other authors, regarding the climatic parameters, we did not find a direct relationship between the continentality index and the total amount of *Alternaria* spores detected during spring and summer in the different sampling stations. Similar results were obtained with average annual temperature and total annual rainfalls. Regarding land use, the highest concentrations were obtained in the rural locality of Ronda.

*Speaker

AeRobiology: the computational tool for biological data in the air

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Aerobiology databases are constantly growing. Managing these extensive datasets requires large amounts of time and effort. Nevertheless, publication and dissemination of the scientific findings demand quick and elaborated results, which have led to integrate computational techniques in almost all scientific fields. "AeRobiology" is a new computational package implemented for R software which has been designed to automatically manage and visualise aerobiological data. It is an open access package and completely free to use.

"AeRobiology" package has 14 different functions which can be structured according to their utility: (1) checking the quality of the data, (2) data analysis and (3) visualization of results. Some of these functions allows to: interpolate missing gaps within the database with different techniques, calculate the main parameters of the pollen season according to all the existing Main Pollen Season definitions (percentages, logistic method, number of days with a certain amount of pollen grains in a given period of time, clinical methods, and a new one proposed by the authors based on the application of a moving average to the pollen series exceeding a pollen threshold), elaborate pollen calendars, detect and measure trends in the main seasonal indexes, visualise the relative abundance of the different particles detected in the air, compare different years or different types of aerosols, visualise phenological parameters, and elaborate interactive plots for interpreting results on real time. More detailed information about each function can be consulted at:

<https://cran.r-project.org/web/packages/AeRobiology/AeRobiology.pdf>

This new computational tool, which is already available at CRAN repository, could constitute a useful tool to the scientific field of aerobiology. It can reduce the time and effort of the data analysis even for researches who are not very familiar with programming languages. Furthermore, it could be a necessary tool to manage the real-time data from the new automatic sampling devices.

*Speaker

Bioclimatic indexes and their trends in the North-Spain DO areas

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Viticulture represents an important economic activity especially in North-western of Spain. Nowadays, aerobiological works can be influenced by climate variability in a study area, it will impact in fluctuations of pollen and phytopathological spore concentrations. Therefore, it is important to define the viability of this crop as it is expected that climate change will have a significant effect on wine production and quality (Jones et al. 2005a, b).

Aerobiological study was carried out in the Ribeiro DO from 2004 to 2017 (NW-Spain), pollen and spores were captured in a volumetric trap (Lanzoni VPPS-2000). In addition, the interaction between the vine climatic requirements and its vegetative cycle was evaluated in main Designation of Origin areas of Galicia: Ribeiro, Rías Baixas, Valdeorras, Monterrei and Ribeira Sacra by means several bioclimatic indexes: Winkler index (WI, Winkler et al. 1974), Huglin index (HI, Huglin 1978), Cold night index (CI, Tonietto 1999), the growing season suitability (GSS, Malheiro et al. 2010, Santos et al. 2012), the growing season precipitation index (GSP, Blanco-Ward et al. 2007) and the hydrothermal index of Branas, Bernon and Levadoux (BBLI, Branas et al. 1946). To assess the agreement between our measurements and the set of high-resolution dataset "Spain02", the bioclimatic indexes were statistically compared by means of Taylor diagrams (Taylor 2001). In DO Ribeiro, the high pollen were observed in 2013 (359 pollen) and the low pollen were 2010 (22 pollen). We studied the trends of pollen, *P. viticola* spore and meteorological variables during 14 study years, the trends were positive for maximum. Minimum and average temperatures, pollen season and spores, but the trend were negative for relative humidity and rainfall. These data showed the meteorological variables trend could influence in the increase pollen and spores trend. With the aim to extrapolate this data to the main Designation of Origin areas of Galicia we carried out Taylor diagrams, it shows that the best adjustment was observed with the Winkler and GSS Index for all Designation Origin Areas. Huglin Index showed better results for Valdeorras DO with the highest correlation coefficient and the lowest RMS values, contrary to Ribeira Sacra DO. Similar patterns were observed between the BBL and GSP index (correlation coefficients were recorded between 0.3-0.8 and 0.6-0.9, respectively). Regarding the CI, Monterrei DO obtained the lowest correlation coefficient (0.4) while the rest of the DO oscillated between 0.6 and 0.9. The results in general show an acceptable agreement between the measures and the "Spain02" database. Using the set of high-resolution dataset "Spain02" the trends of the bioclimatic indexes was analysed for the period 1950-2015. All DO areas showed a positive trend for WI and HI, for GSS index was a positive trend in Valdeorras, Ribeira Sacra and Monterrei DO, for Ribeiro, Monterrei and Rias Baixas DO the CI index was showed a positive trend. On the contrary the trend was negative with GSP index in the Ribeiro DO, and finally the BBL index don't showed significative differences.

The climatic conditions of the North-western of Spain could become unfavourable for the crop in the future. If the trend to a temperature increase continues, some cultural practices should be conducted in order to preserve the grape cultivation: change of the grape varieties, irrigation applications or the movement of the vineyards to more elevated areas characterized by colder weather conditions.

*Speaker

Identification of airborne pollen using a pollen Raman spectra database

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For airborne pollen identification and quantification light microscopy has been the reference method used however, it is time-consuming and requires an experienced palynologist. Pollen grains present several differences at its wall chemical composition, that can allow identification. Therefore, during the last years, the spectroscopic examination of pollen has become increasingly important.

In this work, we present a library of Raman spectra of reference pollen from 34 pollen species belonging to the most common trees, weeds and grasses. This pollen was collected in the city of Porto, in public gardens, during the flowering period. A Horiba Jobin-Yvon LabRaman spectrometer interfaced to an Olympus optical microscope was used for the pollen characterization at the excitation wavelengths of 632.8 nm and on a fingerprint spectral range of 400–1800 cm^{-1} . Both reference and test spectra were pre-processed in the same way using the Labspec software.

Afterward, this preliminary database was used to test the possibility of identify airborne pollen collected using a Burkard Cyclone sampler. Airborne samples were examined on glass slides and the pollen identification was performed based on the comparison between the questionable Raman spectra and the library of Raman spectra obtained from blank pollen samples using the KnowItAll software. The Hit Quality Index (HQI) was used to rank the results of a spectral search using two different algorithms – Euclidean distance and Correlation.

Our results showed that the spectra have distinct bands in the functionality region between 1000 and 1700 cm^{-1} . At lower wavenumbers, several vibrations appear, these being more frequent in the grasses and weeds pollen group. For example, each one of the six species studied belonging to the Poaceae family presented a distinct Raman spectrum.

Using Raman spectroscopy, it was possible to identify airborne pollen grains at the species level with all first hits corresponding to the same blank pollen species of the query sample from the air whichever algorithm (correlation or Euclidian distance) is used.

This possibility can be an interesting line of investigation for future RAMAN technology development in the area of aerobiology.

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*Speaker

Phenology, aerobiology and thermal requirements in two *Olea* varieties

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Olive (*Olea europaea*) crop is one of the major economic activities in the Mediterranean region (Galán et al. 2005). Specifically, Spain produces 41.9 % of the world's total olive oil production followed by Italy, Greece and Tunisia (Aguilera et al. 2014). In Galicia in particular, an increase in the cultivation of olive trees was produced in the recent years with both ornamental and industrial uses, the latter being the most extended. The meteorological variables play a fundamental role in to duration of the phenological phases. The aim of this study is to know the phenological and aerobiological behaviour of the olive trees to be able to determine its thermal requirements for the develop of predictive agrophenological models.

The study was carried out in 2016 and 2017 in an olive crop at Verín, located in the Ourense Province (North-West Spain). Airborne pollen was determined using a Lanzoni VPPS-2010 volumetric trap. The sampler was placed in the central part of the crop. Phenological study was carried out during the active olive crop season following the BBCH scale (Meier, 2001). A total of 20 selected plants of the Arbequina and Frantoio varieties were monitored. In addition, a phenological model was carried out, to predict the phenology in terms of degree days accumulated (GDD) using as a threshold temperature 10°C.

In 2016 the main pollen season took place from 1st June to 12th July (42 days). The total amount *Olea* pollen was recorded 1978 pollen grains, with a maximum of 264 pollen/m³ on 14th June. In 2017 the duration of the main pollen season was 56 days, from 28th April to 22th June. The total *Olea* pollen registered was 5157 pollen grains, with a maximum of 938 pollen/m³ on 24th May.

The airborne *Olea* pollen concentrations in the crop are strongly influenced by the meteorological conditions. The Spearman correlation test showed positive significative correlation with the average, maximum, minimum and dew point temperatures while negative correlation with the wind speed.

Phenological models proposed in this work offer a high accuracy as the standard deviation of error between estimated and observed values was low. The prediction variability ranges around from 3.5 to 1.5 phenological scales in 2016 and 2017 respectively.

These results indicate that the models developed to predict the phenology, in terms of degree days accumulated (GDD) using as a threshold temperature 10°C, can be a useful tool to forecast the successive phenological events in the Verín area.

*Speaker

Les maladies allergiques et les paramètres météorologiques dans la commune d'Abomey-Calavi au Bénin.

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La présente étude est réalisée à Abomey-Calavi au sud du Bénin d'Avril 2015 à Avril 2017. Les données cliniques ont été obtenues grâce aux registres de consultations et d'hospitalisations du service statistique de l'hôpital de ladite commune et celles des paramètres météorologiques auprès de l'Institut International d'Agriculture Tropicale (IITA) et qui concernent la température, la pluviométrie, la vitesse du vent, l'humidité relative et l'évapotranspiration (annexe 1). Au total, cinq types d'affections allergiques existent au sein de la population. Il s'agit de l'asthme (36,76 % -38,28 %), la rhinite (18,45 % -16,62 %), la conjonctivite (14,52 % -16,35 %), la bronchite (15,88 % -13,30 %) et les dermatoses (14,38 % -15,44 %). Les plus fréquentes sont l'asthme (36,76 %) et la rhinite (18,45 %) qui se manifestent respectivement en saisons pluvieuses et en saisons sèches. Le dépouillement des registres a révélé au cours des deux années un total de 8953 cas de patients dont 5287 femmes et 3666 hommes. Les enfants et les femmes sont reconnus les plus vulnérables à ces maladies allergiques. Les mois à fortes manifestations allergiques sont ceux de décembre, janvier, août et octobre. Le test de Pearson effectué entre les facteurs météorologiques (température, vitesse du vent, pluviométrie, humidité relative et évapotranspiration) et les maladies allergiques montre une corrélation entre ces deux paramètres. Cette dernière est globalement faible avec des valeurs de probabilité supérieures à 0.05 entre la pluviométrie, l'évapotranspiration, la vitesse du vent et les maladies allergiques. Cependant la pluviométrie est beaucoup plus corrélée avec l'asthme. La température et l'humidité relative sont positivement corrélées avec l'asthme, la rhinite et les dermatoses mais négativement avec la conjonctivite et la bronchite. Les facteurs météorologiques influencent fortement la production, la libération et la dispersion des grains de pollen et spores dans l'atmosphère mais ont de faibles relations avec les maladies allergiques.

Mots-clés : Maladies allergiques – pollens - spores - paramètres météorologiques - Bénin

*Speaker

Comparative study between two aerobiological stations situated in the city of Malaga (southern Spain)

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An aerobiological sampler covers the pollen information of a determined area, whose extension mainly depends on the topography of the territory but, in a city, buildings are the elements that obstruct and re-distribute winds as well as the particles suspended in the air. This is the reason for what several pollen traps are often needed for covering the information in a big city.

Malaga is one of the biggest cities in Spain with a population of more than 600,000 inhabitants. In 1991 a Hirst-type pollen trap was installed in the northwest part of the city (Malaga-Teatinos station), which have been kept operational until nowadays. Additionally, in 2017, a second device (Malaga-Centre station) was installed in the very city centre, 4 km apart from the first. The aim of this work is to search whether or not there are significant differences between the results obtained in the two locations. For that, the samples obtained were mounted and counted following the methodology proposed by the Spanish Aerobiology Network (REA) and the pollen concentrations expressed as number of pollen grains/m³ of air (daily mean).

Results indicate that pollen spectra are quite similar in both sampling stations. However, we found important differences in the annual amount of pollen recorded, regarding some of the more abundant pollen types in the city, *Amaranthaceae*, *Olea europaea*, *Plantago* and *Quercus* being much more abundant in Malaga-Teatinos, with annual pollen indexes that sometimes triple the obtained in Malaga-Centre. On the contrary, *Pinus* and *Parietaria* reach higher values in Malaga-Centre, especially the last one, with annual pollen index almost four times highest than the obtained in Malaga-Teatinos. Phenology was quite similar in the case of almost all the pollen types with scarce differences in the case of *Olea* and *Parietaria*.

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*Speaker

The incidence of Amaranthaceae pollen in Qatar: a two-years research

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Aerobiological studies have been carried out in many areas of the world; the information generated being released through different mass-media, internet, social networks, etc. to the population in general. Besides that, many are the studies published in the scientific literature, being this kind of studies more and more frequent in different parts of the world. However, there are still countries in which they hardly have been done. This is the case with the Middle East, where aerobiological studies are scarce or even null.

Qatar is a country that occupies the small peninsula with the same name, on the northeastern coast of the Arabian Peninsula, in which two volumetric Hirst type pollen traps were installed in May 2017. One of them was situated in the city of Doha, the capital, at the terrace of a building in the Hamad Medical City. The other, at the plain roof of the Al Khor Hospital, 48 km further north of Doha, in the municipality of the same name. The pollen traps have been working with several interruptions because of damages caused by the intense dust in suspension due to the proximity to the deserts of the Arabian Peninsula. The methodology used for preparing and counting the samples was the proposed by the Spanish Aerobiology Network, the REA.

In general, pollen concentrations obtained are very low, with maximum annual pollen indexes of 303 for Doha and 932 for Al Khor, Amaranthaceae being the pollen type most abundant, with percentages of 32 to 65 % out of the annual total pollen, depending on the station and the year.

Amaranthaceae are present in the atmosphere of Qatar mainly from August to October, but daily mean pollen concentrations hardly reach values of 30 pollen grains/m³ of air, 36 being the maximum value registered in Al Khor and 5 in Doha. These results probably are a consequence of the sparse vegetation of these areas and the scarce rainfalls with annual cumulative values of 79 and 62,8 mm, as average, for Doha and Al Khor, respectively. Nevertheless, the period in which these scarce precipitations occur is of great importance and determinates the vegetation development and, consequently, the flowering phenology and pollen concentrations registered.

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*Speaker

Annual diagram of airborne spores of Pteridophytes from Ibagué Tolima city

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Colombia is considered the first country in the world in Pteridophytes (41 families, 157 genera and 1650 species). Spores of these plants due to their morphological characteristics such as: size, shape, weight, ornamentation and aerodynamics; It is characterized by its anemophilic-aerophilic dispersion. The little information available is part of research in Argentina, Spain and mainly India; they mention the pollinosis capacities as a medical condition, affecting the vulnerable population, generally children, the elderly and hypersensitive individuals. In Colombia, especially for the city of Ibagué, the climatic conditions, geographic position (center of the country) and biogeographical distribution, could benefit the presence of this type of vegetation. Therefore, the objective of this work was to generate a behavior diagram of Pteridophyte spores found in the atmosphere of the city of Ibagué, during a sampling year.

For the collection of atmospheric spores the recommendations of the Spanish Aerobiology-REA network were followed (Galán *et al.*, 2007), a volumetric collector type Hirts (Hirts, 1952) was used, which was located at the University of Tolima in the center of the city, after which the assembly was done with fuchsin glycerogelatine, the spores were observed at 40X in a light-field optical microscope. a volumetric collector type Hirts (Hirts, 1952) was used, which was located at the University of Tolima in the center of the city, after which the assembly was done with fuchsin glycerogelatine, the spores were observed at 40X in an optical microscope of clear field.

During a sampling year a total of 898,610 grains / m³ were registered, belonging to 24 aerovagant taxa, these were: *Asplenium auritum* Sw., with 33.537 (3,7 %), *Asplenium cuspidatum* Lam., 51.735 (5,7 %), *Asplenium serra* Langsd. & Fisch., 35.413 (3,9 %), *Blechnum fragile* (Liebm.) C.V. Morton., 47.597 (5,2 %), *Culcita conifolia* (Hook.) Maxon., 73.975 (8,2 %), *Cyathea caracasana* (Klotzsch) Domin., 27.514 (3,0 %), *Cyathea multiflora* Sm., 47.021 (5,2 %), *Dicksonia sellowiana* Hook., 34.333 (3,8 %), *Elaphoglossum andicola* (Fée) T. Moore., 28.530 (3,1 %), *Elaphoglossum glossophyllum* Hieron., 26.829 (2,9 %), *Equisetum bogotense* Kunth., 22.923 (2,5 %), *Huperzia reflexa* (Lam.) Trevis., 31.681 (3,5 %), *Hymenophyllum lindenii* Hook., 29.494 (3,2 %), *Hypolepis stuebelii* Hieron., 20.617 (2,2 %), *Hypolepis viscosa* H. Karst., 36.657 (4,0 %), *Lophosoria quadripinnata* (J.F. Gmel.) C. Chr., 25.359 (2,8 %), *Melpomene flabelliformis* (Poir.) A.R. Sm., 18.423 (2,0 %), *Melpomene pilosissima* M. Martens & G., 20.395 (2,2 %), *Pecluma eurybasis* (C. Chr.) M.G. Price., 19.281 (2,1 %), *Polypodium levigatum* Cav., 63.675 (7,0 %), *Polystichum lehmannii* Hieron., 42.045 (4,6 %), *Pteridium aquilinum* (L.) Kuhn., 75.246 (8,3 %), *Pteris longipetiolulata* Lellinger., 36.324 (4,0 %), *Pteris muricata* Hook. 50.006 (5,5 %).

According to the obtained, it is concluded that: the taxon *P. aquilinum*, with 75.246 g/m³ (8.3%) of herbaceous vegetation type, was the most abundant, possibly due to its wide biogeographic distribution in the High Valley of Magdalena river - Colombia, where the winds converge with the surrounding vegetation transporting this type of particulate material. This type of Aeropalinological research is considered fundamental since it helps to know the biological content of the air and constitutes a contribution for future medical studies on pollen allergies (pollinosis).

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Keywords: Aerobiology, Aeropalinology, Pteridophyte, spore, pollinosis.

*Speaker

Pollen forecast in Rome

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Forecast modeling in aerobiology is proposed to achieve forecasts that allow allergic population to intervene with targeted and accurate preventive therapies. This benefit not only the individual, but also the community, considering the social cost of pollinosis in terms of therapies and medical examinations and the indirect costs, linked to absenteeism from work and reduced productivity. The allergy is indicated by the WHO as an important pathology; [1] the trend is increasing [2].

The proposed forecasting model has the advantage of using free software that is easy to use and fast in data processing. The considered variables are: Cupressaceae, *Olea europaea* L., Platanaceae and Poaceae (Monitoring Centre - University Rome Tor Vergata), average daily temperature, daily precipitation, total daily radiation, average daily relative humidity and average daily wind speed [3,4] (Tor Vergata meteorological station - Regional Functional Center of the Regional Protection Agency of the Lazio Region), between January 1, 1997 and December 31, 2017.

The package IBM® SPSS STATISTICS® 25 was used to measure the cross-correlation between the series of pollen concentrations and environmental variables and a statistical self-regressive model ARIMAX in R-3.3.3 type was used for forecasts.

The degree of reliability of the daily is always more than 70 %: Cupressaceae 84 %, *O. europaea* 87 %, Platanaceae 90 %, and Poaceae 72 %, showing a relationship between pollen concentrations and meteorological variables; in pieno accordo con la letteratura che individua in temperatura e radiazione solare le principali variabili temporali [5,6]. Understanding how pollen in air changes - the concentrations and the phenology of the pollen season - and predicting its trend, is of particular interest and closely related to respiratory allergies.

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*Speaker

A microfluidic approach for the automated analysis of pollen grains

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The measurement of the atmospheric concentration of pollen and fungal spores is an approximation of the real value [1]; the approximation is subject to error mostly in the counting operation under the optical microscope. From several years automatic systems are developing for recognition of pollen and fungal spores [2,3].

Automated systems for pollen analysis have the potential to improve the speed, quality and size of pollen studies with reduced costs. They have applications in general palynology as well as in specific fields such as aeropalynology, pollination biology and quaternary palynology [4].

The use of microfluidic approaches to pollen analysis was pioneered by Di Berardino et al. [5] and enables the characterization of single pollen grains with high-throughput. In particular, microfluidic impedance cytometry (MIC), a single-particle technique previously used in the analysis of mammalian cells, bacteria, nematodes and protozoa, was demonstrated to be able to predict pollen viability and germination capabilities [5]. Briefly, in MIC particles flow through a microchannel and their electrical properties are measured using integrated microelectrodes.

Here, we propose a microfluidic approach for single-particle, high-throughput analysis of pollen grains based on electrical characterization and simultaneous optical imaging inside a microfluidic impedance cytometer. The electrical characterization exploits a peculiar measurement setup and a multi-frequency approach which enable an accurate estimation of particle size and position [6]. Image analysis of pollen grains flowing in the channel is based on a convolutional neural network (CNN). Due to the richness of obtained information, this multi-modal approach is uniquely posed for pollen analysis.

Preliminary results show the potential that this technique has for pollen hydration/viability assessment and for classification of a mixture of different taxa. During *Cupressus sempervirens*L. hydration the system is able to classify populations of intact pollen grains, fully hydrated intine and split-off exine shells with high accuracy based on electrical parameters only. In taxa classification experiment the system is able to classify *C. sempervirens*, *Fraxinus ornus* L. and *Ostrya carpinifolia* Scop. pollen grains with high accuracy. Typically, more than 3000 pollen grains were analysed in each experiment with a throughput of 150 grains/seconds.

Future experiments will investigate the ability of the system to reconstruct the temporal evolution of *C. sempervirens* hydration and to analyse mixtures involving a larger number of taxa.

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*Speaker

Melissopalynology

Can starch grains inside Cistaceae's pollen supply the deficiency of other components in foraging preferences of the honey bees?

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Pollen contains all the nutritional requirements that honey bees need for its development, therefore is the bees' main source of protein, and is required for muscle growth in brood and young adult bees (Di Pasquale et al. 2013). Cistaceae pollen is very attractive for bees and is the most frequently collected by beekeepers in Mediterranean region. Cistaceae are a small family distributed in temperate areas of the Northern Hemisphere and have the Mediterranean basin as the main center of diversification (Muñoz Garmendia et al. 1993). Analyzing different specimens of bee pollen we have observed that all samples of Cistaceae bee pollen, and only them, presented an abundance of foreign bodies, never cited in bibliography, both inside and outside the pollen, which led us to analyze them.

Objectives: In relation with Cistaceae's pollen: 1) To determine their colors, 2) To identify their pollen types, 3) To know their total content of proteins and polyphenols, and 4) To identify the foreign bodies founded and to analyze their importance.

Material and methods: We analyzed 45 Cistaceae bee pollen dry samples (Quintana-Edesa et al. 2008), and a wild population of *Cistus ladanifer* L. Color code determination by PANTONE 747XR Universal Guide. Melisopalynological analysis according Louveaux et al. (1978). Total content of protein (Kjeldahl method) and polyphenols (Folin-Cicalteu). TEM, pollen grains were fixed in 1% glutaraldehyde, post fixed in 2 % osmium tetroxide and embedded in epoxy-resin. Sections were cut using an ultramicrotome with a diamond knife and stained with 5 % uranyl acetate.

Results: Cistaceae pollen colors are defined by 115-147 PANTONE codes, corresponding to different shades of yellow and orange. Four pollen types are defined: Cistaceae t. (17), *Cistus* t. (7), *C. ladanifer* t. (7) and *Helianthemum* t. (13). Total content of protein varies between 13.03 % - 17.78 % and polyphenols between 0.41 % - 1.46 %. Foreign bodies have been identified as starch grains.

Discussion: Total content of proteins and polyphenols in Cistaceae pollen are considerably low, especially when compared with other botanical groups (eg Leguminosae 18.65 % - 34.10 % and 2.50 % - 3.79 %, respectively). However, the low protein content can be largely compensated by the presence of starch grains. Enzymes transform starch either into glucose, burned to obtain the energy needed for flight, or into proteins, oils and other carbohydrates (Robyt, 2001).

Conclusions: Cistaceae pollen, despite its low content of proteins and polyphenols, is largely collected by bees due to its great starch contains. The high starch grains content is a great energy reserve and compensates the basic needs of bees.

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*Speaker

Etude méliissopalynologique des miels de la région de Médéa (Algérie)

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Le spectre pollinique des miels algériens est relativement mal connu. Ces dernières années plusieurs recherches fragmentées sur ce sujet ont été réalisées. Cependant, aucun inventaire n'existe à ce jour concernant la répartition de la flore mellifère en Algérie. En raison de l'absence de législation d'une part et le manque de laboratoire de contrôle de la qualité d'autre part, Les renseignements concernant les origines botaniques des miels, correspondent généralement à des observations effectuées par des apiculteurs sur le terrain sans aucune confirmation par des études méliissopalynologiques. La connaissance des spectres polliniques des miels algériens selon les régions de leurs récoltes permettrait de donner plus d'intérêt aux produits locaux mais également de les valoriser sur le marché en leur attribuant des dénomination selon leur typicité et leur permettre ainsi une plus grande visibilité. Ce travail rentre dans la cadre de la valorisation et la connaissance des caractéristiques des miels produits dans différentes localités de la région de Médéa située au centre nord de l'Algérie.

L'analyse pollinique de sept échantillons de miels provenant de différentes localités de la région de Médéa, collecté durant l'été de l'année 2015 ont été étudiés. Les échantillons ont été préparés par la méthode classique (Louveaux et al., 1978). Ainsi 10g de miel sont dissouts dans de l'eau bidistillée puis centrifugés à 4500 rpm (3383g). Les analyses quantitatives et qualitatives ont été réalisés respectivement afin de quantifier leur richesse en grains de pollen et de déterminer leur spectre pollinique.

Les miels étudiés présentent une teneur en pollen allant de 7750 à 81000 grains /10 g. Les résultats ont révélé que parmi les échantillons étudiés, 2 sont mon floraux dont un domine par le pollen de taxon *Zizyphus lotus* et l'autre 5 *coriandrum* et 5 sont multifloraux. Soixante-trois (63) taxons, ont été inventoriés, appartenant à 33 familles botaniques dont les plus représentées sont les *Leguminosae* avec neuf espèces (22.2%) suivi par *Compositae*, *Apiaceae*, *Brassicaceae*, *Lamiaceae* avec respectivement des moyennes de 24%, 18%, 12%. Le nombre de types polliniques présent dans chaque miel varient de 15 à 35. Les espèces *zyziphus lotus*, *Coriandrumsativum t* et *Foeniculumvulgare t* sont présents dans la totalité des échantillons analysés. Les autres espèces présentes dans la majorité des miels sont *Eucalyptus*, *Pimpinellaanisum t*, *tamarix*, *Papaver rhoeas t*, *Cistus*, *Hedysarumcoronarium*, *Genista t*. Les résultats obtenus ont montré que les miels provenant de la région de Médéa sont à dominance polyflorale. Ils sont également caractérisés par la présence de certaines espèces polliniques à savoir *zyziphus lotus*, *Coriandrumsativum t* et *Foeniculumvulgare*, ce qui pourrait leur donner une typicité.

Mot clé : Miel, Méliissopalynologie, Médéa, Algérie,

*Speaker

Botanical origin of several commercial honeys: spring heather and eucalyptus unifloral honeys

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Background: The increase in the consumption of natural products in the last decades requires the development of methods to assess their quality. Microscopical analysis, especially the identification and counting of pollen grains in honey sediment, is widely used to ascertain the botanical and geographical origin of honeys. The purpose of this work was to evaluate the botanical origin of some commercial honeys labelled as heather and eucalyptus honeys.

Methods: Thirteen single-honeys labelled as eucalyptus honey (7), spring heather honey (5) and "spring heather and chestnut honey" (1) were bought in different stores during year 2018. The quantitative and qualitative analyses were carried out according to the procedures described by Gadbin (1979) and Louveaux *et al.* (1978), following the recommendations suggested by González-Porto *et al.* (2018) for Spanish honeys.

Results: The quantitative analysis enabled the honeys to be placed in the class III established by Maurizio (1975), except one honey labelled as "Eucalyptus honey" that was included in class II. The qualitative studies showed that all the identified pollen grains were typical of the flora from the Iberian Peninsula. Taking into account only the pollen types coming from plants that contribute nectar to honey, the results displayed that analysed eucalyptus unifloral honeys contained percentages in relation to pollen content near or upper to 80 % of *Eucalyptus* pollen. In the case of spring heather honeys, two of them did not reach more than 20 % of pollen representation from different species of the genus *Erica* L. Finally, "spring heather and chestnut" honey did not show high values of chestnut and heather pollen both (20 % and 6.6 %, respectively).

Conclusions: The qualitative analysis displayed that pollen content of *Eucalyptus* in studied honeys could be sufficient to be considered eucalyptus monofloral honeys (Rodríguez *et al.*, 2013). However, two of the heather honeys did not reach sufficient pollen content of the *Erica* genus to be considered as heather honeys (Persano Oddo, 1995).

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*Speaker

Strengthening of Forest Honey from Salamanca (MW Spain) to improve its commercialization

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With the project "Potenciación de las mieles de bosque salmantinas para mejorar su comercialización", the following objectives were set: to study the general environment and the business capacity of the most important beekeepers' cooperative in the province (Reina Kilama Cooperative Society), in order to know the commercialization potential of these honey type, as well as to evaluate the intrinsic characteristics, perception and valuation of possible consumers, with the aim of finding a viable differentiation of this honey compared to others, which allows its commercialization in gourmet stores of all the national territory.

Firstly, an internal analysis of the cooperative and an external analysis of the market (PESTEL, DAFO and Porter) were carried out to identify the key points of the company and its competitive environment and, secondly, three different analyses of the different samples of honey under study were undertaken: physico-chemical (humidity and electrical conductivity), pollen (both quantitative and qualitative studies, taking into account the characteristic honeydew elements due to its interest when characterizing forest honeys) and sensorial, for which blind tastings were conducted in order to study consumer preferences.

20 samples of honey were studied for both physicochemical and pollen analysis, fifteen of them provided by the cooperative Reina Kilama (11 forest honeys and 4 with different sensory characteristics: orange blossom, multifloral, eucalyptus and lavender honey) and another 5 ones labelled as "forest honey" or "oak honey" acquired in stores.

From the sensorial point of view, 6 samples were analyzed, to know the consumer's perception (lavender, orange blossom, multifloral, eucalyptus and two forest honeys). There were 4 blind tastings with 24 people per session, with different characteristics of sex, age or educational level.

According to the results about the market analysis of the cooperative situation, it was found that it has important strengths because it promotes innovation, the modernization of its installations and the improvement of the quality of the final product (Calicer and Tierra de Sabor brands), being one of the largest European producers of forest honey. Although it also faces important challenges such as getting into the gourmet market and achieving the consumer's valuation as a quality product.

With respect to physicochemical analysis, the forest honeys showed values of electrical conductivity characteristic of this variety of honeys (with an average of 1.28 mS / cm at 23°C), and they also presented a typical pollen spectrum, standing out the high pollen representation of *Castanea sativa* (an average of 53 %), followed by the *Echium plantagineum* type (an average of 12 %). The most frequent characteristic honeydew elements in all samples were trichomes and fungal spores, mainly *Cladosporium*, followed by *Alternaria* and *Pleospora*. The results of the blind tasting sessions showed that neither the characteristics of the individuals, nor their purchasing habits, nor the frequency of consumption, were determinant in the rating given to each honey, evaluating all of them in a similar way (without significant differences). Multifloral honey was the best valued, with an average of 7.23 out of 10 points, and the lowest valued one was Orange blossom with 5.37.

For those reasons, we can conclude that, the forest honeys of Salamanca have excellent quality and characteristic distinctive elements, but the consumer does not yet distinguish these properties.

*Speaker

APICAMPUS, a project on Urban beekeeping developed at the University of Malaga.

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Urban beekeeping has flourished in the last years, with many institutions interested in creating colonies on their roofs. Bees and other animal pollinators contribute to increase food production, making bees essential for agriculture and plant life, in general. And, as bee populations decline, the need for secondary sources of pollinators for agricultural production grows.

The Vice-rectorate of Smart-Campus of the University of Malaga focuses on two fundamental aspects: understanding the UMA campus as a Smart City in itself and marking new lines of action at the academic level that will make the UMA an international benchmark in Sustainability.

Framed in the program above mentioned, APICAMPUS is a pilot and interdisciplinary project that involves researchers and students belonging to 4 departments of 2 university faculties together with Bee Garden Malaga, a multi-disciplinary environmental company with thematic areas on beekeeping. The project aims to promote the development of beekeeping in urban environments, raising awareness about the importance of the bees as pollinating insects, as well as the use of the beehive products.

For the above mentioned, two beehives, Langstroth type, were installed at the roof of the Faculty of Science, a traditional wooden one, and another made of polystyrene. The main interest of this project lies in the monitoring of the hives by means of temperature and humidity sensors, electronic scales for weight control, video cameras located inside and outside of them, together with the use of bee-marking systems. Additionally, analysis for characterizing and study the origin and the properties of the beehive products will be carried out, as well as field monitoring to highlight the situation of pollinators at the University Campus of Teatinos.

Although the samplings have barely begun, this communication intends to be the official presentation of the project APICAMPUS to the scientific community.

Acknowledgement: this project is supported by a grant provided by the Smart-Campus Vice-rectorate, University of Malaga.

*Speaker

Pollen morphology, biology and biochemistry

Screening of Amb a 1 allergen localisation in *Ambrosia artemisiifolia* pollen by immunolabeling in TEM

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Pectate lyase allergens are classified as polysaccharide lyases, a class of enzymes which cleave galacturonic acid-containing polysaccharide chains. In general, polysaccharide lyases are divided into 23 families, at which allergenic pectate lyases are clustered in family 1 (PL1). Amb a 1 allergen from short ragweed (*Ambrosia artemisiifolia*) belongs to this allergen family. In this study, it was aimed to determine the localisations of allergens in pollen by immunolabelling method in transmission electron microscopy. Mature ragweed pollen was isolated from freshly opened flowers. After anhydrous fixation and embedding, thin sections were taken with an ultra microtome and sections were transferred to nickel grids. Treatment with the primary antibody (anti Amb a 1 MA-3C7) was followed by the gold labeled secondary antibody. After uranyl acetate and lead nitrate staining, allergens were visualized with Jeol JEM 1010 model TEM. As a result, the allergens were especially localized in columella, cavea and intin in pollen wall. In the cytoplasm, they have been found around the ribosomal rich areas like vesicles, the endoplasmic reticulum and mitochondria. No labeling was observed in starch grains. This is the first detailed study of Amb a 1 allergen localisation in ragweed pollen (Project no: BAP, 16L0430006).

*Speaker

Profiles of histone epigenetic marks and histone modifiers enzymes during pollen development and microspore embryogenesis: effects of epigenetic inhibitors

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In vivo, microspores divide and follow the gametophytic program to produce mature pollen grains. However, in response to stress treatments *in vitro*, microspores can be reprogrammed to become totipotent cells that follow an embryogenic pathway producing haploid and double-haploid embryos, important biotechnological tools in plant breeding. Stress-induced microspore reprogramming and totipotency acquisition involves repression and/or activation of numerous genes associated with the new developmental program as well as changes in global genome organization. Epigenetic modifications are key factors contributing to the functional status of chromatin that regulate gene expression during cell proliferation and differentiation. Histone modifications, methylation and acetylation, are major epigenetic marks controlling gene expression during plant development and in response to environment. Methylation of histones can occur on different lysine residues; H3 methylation at positions K9 and K27 is generally related to gene silencing. In contrast, acetylation of histone H3 and H4 tails is mainly associated with actively transcribed genes.

In this work, we have analysed the level and distribution patterns of key histone epigenetic marks, H3K9 methylation (repressive mark) and H3/H4 acetylation (activating marks), as well as the expression patterns of histone methyltransferase *HKMT SUVR4-like*, histone demethylase *LSD1*, histone acetylase *HAT*, and histone deacetylase *HDAC7*, writer and eraser enzymes of H3K9me2 and H3/H4ac, during the two pollen pathways, pollen development and microspore embryogenesis, in *Brassica napus* L. Results have shown that both microspore pathways, gametophytic and embryogenic, were epigenetically regulated and that microspore reprogramming to a different cell fate involved changes in the level and distribution of these histone marks, correlating with the gene expression profiles of their writer and eraser enzymes. Gametophytic development and pollen maturation involved a progressive increase of global H3K9 methylation and low levels of histone acetylation, mainly in generative and sperm nuclei of pollen grain. In contrast, microspore reprogramming, totipotency acquisition and embryogenesis initiation were associated with low levels of histone H3K9 methylation and increasing histone H3 and H4 acetylation, in early proembryo nuclei. Treatments with the histone epigenetic modulators BIX-01294 (inhibitor of H3K9 methyltransferase) and SAHA (inhibitor of histone deacetylase) that reduced H3K9 methylation and increased histone acetylation, respectively, promoted microspore reprogramming and enhanced embryogenesis initiation rate. Similar profiles of histone H3K9 methylation have been also observed in other plant species, from very distant families, like *Hordeum vulgare* and *Quercus suber*, suggesting common epigenetic mechanisms.

Taken together, results indicate that histone H3/H4 acetylation and H3K9 demethylation favors microspore reprogramming, totipotency acquisition and embryogenesis initiation, while pollen maturation involves histone H3K9 hypermethylation and low levels of histone acetylation. Moreover, these findings provide new insights into the epigenetic mechanisms that regulate pollen development and microspore reprogramming, opening up new possibilities to enhance microspore embryogenesis initiation in crop species through pharmacological modulation of histone methylation and acetylation by using small compounds that target histone modifier enzymes.

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*Speaker

Lipid composition and associated gene expression patterns during pollen germination and pollen tube growth in *Olea europaea* L.

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Pollen lipids are essential for plant reproduction but lipidomics studies have been mainly focused on the mature pollen. Therefore, our current knowledge regarding lipid dynamics during pollen germination is very scarce. In this work, we carried out a study of the lipid composition and associated gene expression in the olive (*Olea europaea* L.) pollen during germination. First, we surveyed an olive pollen transcriptome that is publicly accessible (<http://reprolive.eez.csic.es/olivodb/>) and identified almost 300 unique transcripts (~2% of the full transcriptome) involved in the biosynthesis of all lipid classes, except suberin and cutin. The content of total lipids and the fatty acid composition were significantly different from data previously reported in olive leaves, seeds and drupes, indicating that the olive pollen lipidome is unique. Both linoleic acid (18:2) and α -linolenic acid (18:3) significantly increased their levels during olive pollen germination. A survey of the olive pollen transcriptome allowed us to identify three *FAD2* and one *FAD3* genes, called *FAD2-1*, *FAD2-3*, *FAD2-5* and *FAD3B*, respectively. All these genes showed a similar expression pattern, with a peak of transcription after one hour of germination. Neutral acyl-lipids, mainly triacylglycerols (TAGs), were the most abundant lipid class in the olive pollen grain. During the early stages of pollen germination, the TAG pool came down to about a third, suggesting that an intense catabolism of these storage lipids was taking place. Interestingly, we found that an orthologue of Arabidopsis *SDPI* gene was significantly up-regulated after meiosis. The corresponding transcripts accumulated during pollen maturation and in the early stages of germination, suggesting that this lipase may have a major role in TAG degradation. On the other hand, the genes encoding two specific enzymes of the glyoxylate cycle- isocitrate lyase (*ICL*) and malate synthase (*MLS*)- transiently increased their expression after pollen rehydration, reaching a peak after one hour of germination. These data suggest that the glyoxylate cycle might be active in the pollen tube, at least during its emergence and early apical growth, providing the cell with precursors for the synthesis of sugars from released fatty acids. After the initial drop, the TAG content remained steady afterwards, suggesting that there may be a continuous synthesis and recycling of these compounds at this period. Phosphatidylcholine (PC) was the most abundant phospholipid in the mature pollen grain. During pollen germination, an important increase in the content of phosphatidic acid (PA) occurred, while PC levels abruptly decreased. Since an orthologue of the *PDAT1* gene was expressed at high rates at the early stages of germination, it is plausible that the fatty acid present in the sn-2 position of the PC was used for the synthesis *de novo* of TAG.

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*Speaker

Pollen morphology of genus *Cirsium* Mill. Sect. *Cirsium* (Asteraceae: Cardueae) species in Turkey

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Background: The genus *Cirsium* Mill. contains 250 species as one of the largest genera in Asteraceae (Subfamily: Carduoideae Cass. ex Sweet, tribe: Cardueae Cass., subtribe: Carduinae (Cass.) Dumort). According to a study published by Yildiz et al (2016), it is established that *Cirsium* sect. *Cirsium* is represented by 17 species (27 taxa), 3 (7 taxa) of which are endemic, and 2 hybrids in Turkey. Palynological studies about the *Cirsium* have been very limited. In this study, we investigated pollen morphology of 22 taxa from genus *Cirsium* Mill. sect *Cirsium* which disturbed in Turkey in.

Methods: The morphological features of pollen grains were measured using a light microscope (LM) and scanning electron microscope (SEM). Slides were prepared following the Wodehouse (1959) method for LM studies. The SEM micrographs were obtained using an XL–30 ESEM-FEG/PHILIPS microscope.

Results: Pollen grains of investigated *Cirsium* taxa is radially symmetrical, isopolar and trizonocolporate. Pollen shape was varied oblate to prolate (P/E 0.73-1.37), polar axis and equatorial diameter was varied between 30.27 to 58.94 μ and 30.54 to 63.51 μ , respectively. Colpi are measured between 17.32 to 38.32 μ in length and 2.88-12.69 μ in width. Amb shape is circular. Exine and intine thickness were measured as 1.35 to 3.04 μ and 0.67-1.92 μ . Exine thinner in poles. Ornamentation echinate or scabrate, tectum complete structured, surface of tectum psilate/microreticulate/ornate with suprategal spines. Spines are the conical base with the curve, pointed or rounded tip.

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*Speaker

Morphometric analysis of Ericaceae pollen from southwestern European species

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Pollen records from southern Europe show that Ericaceae was a major component of the Iberian vegetation in various periods of the last climatic cycles. The Ericaceae morphotype includes a number of species that have different ecological requirements. Increasing the taxonomic resolution of Ericaceae pollen identification is therefore important for paleoecological and paleoclimatic reconstructions. Previous studies on Ericaceae pollen morphology provided identification keys that are often difficult to use for routine pollen analysis due to complex prioritization and morphological features based on Scanning Electron Microscope (SEM) analysis. If SEM provides detailed information on pollen wall structure, they are not always visible under the optical microscope. This work aims at providing palynologists with identification criteria for optical microscope observations of fossil pollen.

We examined the pollen from 14 Ericaceae species (*Arbutus unedo*, *Calluna vulgaris*, *Daboecia cantabrica*, *Erica arborea*, *Erica carnea*, *Erica ciliaris*, *Erica cinerea*, *Erica lusitanica*, *Erica scoparia*, *Erica tetralix*, *Erica vagans*, *Rhododendron ferrugineum*, *Vaccinium myrtillus*, *Empetrum album*). To take into account the intra- and interspecific variabilities, we selected three separate geographical sample sites located in southwestern France and Spain and a minimum of three individuals per site was sampled. A total of 7255 pollen grains was examined under optical microscope on which fourteen quantitative and qualitative traits related to the shape of the tetrad, the characteristics of the pollen wall and the apertural system were analyzed. We performed a CART (Classification And Regression Tree) analysis, used to develop a multi-trait classification model, combined with various multivariate analyses of the morphological character dataset.

Multivariate analyses show four partially overlapping groups of species for which it is difficult to define four distinct morphotypes. The CART model allow separating the pollen grains of the different species with small error of classification, based on a fewer morphological features than measured. Qualitative characters, mostly ornamentation and detected endoaperture with an optical microscope, appear as major criteria for species separation while quantitative features, essentially the size of the tetrad and the angle and length of the duplicolpus, play a secondary role.

*Speaker

Ultrastructural comparative study of the apertures, wall and tapetum in the Lardizabalaceae family

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This work is part of a larger study about the pollen ontogeny at the ultrastructural level in the Ranunculales order that is located between the basal clades of the Eudicot. As the first objective we focus on comparing the ultrastructure of mature apertures and the different layers of the wall: tectum, infratectum, foot-layer and endexine in the pollen grain of the Lardizabalaceae family.

This family is located in the base of the Ranunculales order. This is a continuation of our previous studies and very little ultrastructural data exists.

We compare the observations obtained from some species of 6 of the 7 genera that make up the family: Akebia, Boquila, Decaisnea, Holboelia, Sinofranchetia and Stautonia. We establish whenever possible a wall and apertural model for the family and establish the differences of each genera. We also consider the importance of establishing the characteristics of the tapetum, mainly the presence/absence of orbicules and, if applicable, describe its ultrastructural types.

The final objective of the study is to compare our results with the known data of the neighbouring and related core families within the order: Menispermaceae, Berberidaceae and Ranunculaceae.

We have studied the 6 genera with transmission electron microscopy (TEM). The floral buds containing mature pollen at some different stages of maturation were collected, placed in 3% glutaraldehyde, buffered with 0.025 M sodium cacodylate and post-fixed in OsO₄ in the same buffer. The samples were always collected from live material from different European Botanical Gardens.

The most relevant results: Regarding the strata of the wall it is possible to establish a single model with discontinuous tectum, infratectum with high columnelles, a thick foot layer and the endexine sometimes continuous and sometimes fragmented. The apertural regions have a complex structure that has three strata: the bacules remain, the endexine is well developed with a large quantity of well organized lamellar structures and the intinuous oncus is full of dense tubulations. The tapetum has orbicules with different morphologies both with and without a dense core.

Conclusion: The lardizabalaceae family is one of the most homogenous families at ultrastructural level that we have so far described in the Ranunculales order.

*Speaker

Air pollutants NO₂ and O₃ evoked altered *Dactylis glomerata* pollen oxidative defenses and allergen expression

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Air pollutants, in particular O₃ and NO₂, impact airborne pollen at several levels: morphology, cell wall, protein content or release, as well as chemical modification of specific biomolecules. Oxidative damage to lipids, proteins and nucleic acids or protein nitration are, respectively, among O₃ and NO₂ described deleterious effects. These may result in pollen physiology damage and enhanced allergenic activity or allergen expression, contributing to an increased incidence of pollen driven respiratory allergic diseases in urban areas.

The goal of this research was to study the effects of O₃, NO₂, alone and combined, to ROS scavenging enzymes SOD, catalase and GSH peroxidase (GPx) from *Dactylis glomerata* pollen and evaluate their contribution to the pollen physiology and allergenicity.

Pollen samples were exposed to O₃, NO₂ and O₃+NO₂ in an environmental chamber during 6hrs (concentrations within ambient levels). Unexposed pollen was used as control. Pollen germination (%) was determined for control and exposed batches (Dafni, 1992). Pollen extracts were prepared in phosphate buffered saline (PBS) and frozen until analysis. SOD, catalase and GPx activities were determined by previously described spectrophotometric methods (Asada, Takahashi, & Nagate, 1974; Bailly et al., 2004; Fecondo & Augusteyn, 1983; Han et al., 2007). SDS-page separated proteins were blotted and used to obtain IgE-reactivity patterns with pooled sera (from four *D. glomerata* EAST-positive sera) and with antibodies against grasses group 5 allergens and profilin.

Pollen germinative capacity was increased by NO₂ exposure and was not significantly affected by O₃ or O₃+NO₂. Pollen exposure to O₃ alone did not significantly affect SOD or GPx activity but induced a 2 fold increase of catalase activity (p< 0.05) while NO₂ evoked a 50% increase of SOD and catalase activities (p< 0.1). Exposure to O₃+NO₂ induced a 2 and 5 fold increase in SOD and catalase activities, respectively (p< 0.05). Pollen GPx was not affected by the exposure to NO₂ or O₃+NO₂. Some protein bands, having correspondence to known allergens, were affected by the pollen exposure to air pollutants: MW 18, 29, 33 and 60 KDa, respectively, SOD, Dac g 5, Dac g 1, Dac g 4. Additionally, immunoblot using anti-Dac g 5 and anti-profilin IgG confirmed overexpressed bands with, respectively, ~30 KDa and ~13 KDa, in O₃ treated pollen.

Taken together, these results show that pollen oxidative defenses are activated by common air pollutants affecting both its germinative capacity and its allergenic activity.

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*Speaker

Effect of air pollutants (O₃, NO₂, SO₂) on *Olea europaea*. L pollen performances

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Olive trees produce and release large quantities of pollen into the atmosphere due to the pollination process. While airborne, the pollen is highly influenced by the environmental conditions, such as climate and pollution. These conditions can alter the plant metabolism inducing the modification of the chemical structure of proteins present in pollen leading to the pollen sterility with impact on the pollination and crop size but also the health of workers and citizens sensitive to *Olea* pollen allergens. The present work aims to study the effect of some gaseous pollutants (O₃, NO₂ and SO₂) on the fertility, the protein profile of olive pollen (*Olea europaea*.) collected separately from two Tunisian cultivars (Chetoui and Chemlali). The experiment tests were carried out using an environmental chamber system for in vitro exposure of pollen to different levels of pollutant gases during continuously 6 hours. The results of fumigated samples comparatively to non- exposed pollen revealed a significant decrease of pollen fertility in term of viability and germination. The polypeptide profiles were determined using sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) showed bands ranging from 15 to 100 kDa with changes of blotting intensities and different behavior of the cultivars. All of these results suggest that increasing levels of air pollutants may have a negative impact on the *Olea europaea* pollen and hence influence on the fruit production. Other analysis were also conducted to study the physiological response of pollen to such abiotic stress by evaluating ROS and RNS production and significant results were found. A real time PCR showed also significant changes in gene expressions.

*Speaker

Morphology and evolution of the orbicules in the Ranunculales order

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Currently morphological data do not play a fundamental role in the reconstruction of the phylogenies of the vegetal groups, since the accelerated generation of sequences of many molecular markers respond to the majority of the phylogenetic questions (Wiens, 2004). However, the evaluation of morphological characters such as potential synapomorphies can provide additional support in phylogenetic reconstructions when molecular studies are insufficient (Endress, 2003). This is especially true for associated micromorphological characters such as pollen morphology and ultrastructure (Blackmore, 2007).

This study focuses on whether the morphology of orbicules is a character of importance for phylogenetic reconstructions. The presence of orbicules is a plesiomorphic character for angiosperms and are present in their basal clades and in ferns and gymnosperms.

The order Ranunculales consists of seven families: Eupteleaceae, Papaveraceae, Circaeasteraceae, Lardizabalaceae, Menispermaceae, Berberidaceae and Ranunculaceae. These last three families, together with the Papaveraceae family, have the highest number of species.

Here we complete the data on the morphology of the orbicules in the different families of the order. We have used scanning and transmission electron microscopy techniques on more than 60 species of 43 genera, plus cytochemical techniques in those cases where there were doubts about the nature of the orbicules.

The orbicules have been grouped according to the morphology observed in 6 morphological types. We have also carried out a reconstruction of the phylogeny of the group and a mapping of the characters of the orbicules. Different characters have been used, with the most important being the presence or absence of orbicules and the form and presence or absence of core.

The most relevant results: the three types of orbits with triangular, lobed and kidney shaped forms are described for the first time in the group, and we have shown how TEM studies have given us more information than those made using SEM.

From the mapping on the phylogenetic tree of the Ranunculales order we have determined that the ancestral characters of the Ranunculales order are the presence of orbicules and the round shape and the absence of pits and perforations in the orbicule wall. Regarding the presence or absence of core, it has not been possible to determine this until the second dichotomy, this character being the presence of the electrodense core. However, it has been possible to delimit morphological groups of orbicules at the level of families Eupteleaceae and Papaveraceae, at sub-family level Berberidoideae, Nandioideae, Menispermoideae and Papaveroideae and at tribe level the Delphinieae and Ranunculeae.

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*Speaker

Palynological studies on genus *Dianthus* L. section **Fimbriati**

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Dianthus L. is represented by 84 species in Turkey. Many species of the genus have been grown as ornamental plants for hundreds of years due to their attractive flowers. In this study, it is aimed to reveal and compare pollen morphological characteristics of *D. tabrisianus* Bien. ex Boiss., *D. sessiliflorus* Boiss., *D. stramineus* Boiss. & Heldr., *D. recognitus* Schischk., *D. libanotis* Lab., *D. vanensis* Behçet & İlçim in section Fimbriati. The pollen morphology of 6 taxa belonging to section Fimbriati. was studied in LM and SEM in detail. In light microscopic studies, pollen preparations were photographed with Leica EC3 and Leica DFC3 imaging systems prepared by Erdtman (1952) method. In the SEM studies the pollen was placed on the stub and covered with gold. Morphological observations were made with JEOL JSM 6490LV model scanning electron microscope and pollen microphotographs were taken. Pollen is radial symmetric, apolar, pantopolyporate and spheroidal. Diameter (D) ranges from 32.1 to 53 μm . Ornamentation is scabrate and scabrate-perforate. In 10 μm^2 has 13-23 spinules, 1-8 punctum. The semicircular conical spinules are 0.5-1 μm in length and 0.6-1.2 μm in base width. The exine is 2.2-3.9 μm and is subtectate. Sekzin is thicker than the nekzin. Pores are 3.4-8.3 μm in diameter, circular in shape and prominent in taxa, the distance between pores (C) ranges from 8 to 20.5 μm . The operculum has conical spinules with a diameter of 1.6-4.1 μm and a length of 1.8-4.4 μm . The number of por varies between 14-24 (± 3). The pollen diameter showed similarity between *D. sessiliflorus* and *D. stramineus* while *D. libanotis* has the maximum pollen diameter within the taxa examined. Also, *D. vanensis* has the minimum pollen diameter. *D. tabrisianus* is scabrate; *D. sessiliflorus* *D. stramineus* *D. recognitus*, *D. libanotis* and *D. vanensis* have scabrate perforate ornamentation. The largest por diameter was observed in *D. stramineus* while the smallest por diameter was calculated in *D. tabrisianus*. *D. recognitus* and *D. vanensis* have a minimum number of pores, while *D. tabrisianus* has a maximum number of pores.

*Speaker

New biotechnological strategies with small molecule modulators of autophagy and proteases to improve stress-induced microspore embryogenesis efficiency for crop breeding

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Stress-induced microspore embryogenesis is an important biotechnological process for production of doubled-haploid (DH) plants which are widely used in plant breeding programs. During this in vitro process haploid microspores, from immature flower buds, are reprogrammed by the application of stress treatments and they abandon the gametophytic developmental program to follow an embryogenic pathway, producing haploid and DH embryos and plants. Microspore embryogenesis is currently exploited by seed and nursery companies to produce DHs, although its efficiency is very low in many cases. The yield of microspore embryogenesis is highly affected by early occurrence of cell death in the cultures, because of the stress treatment applied to induce embryogenesis. Nevertheless, the regulating mechanisms underlying stress-induced cell death in microspore cultures are still elusive. Autophagy is a universal cell degradation pathway that plays critical roles in stress response and cell death. Cathepsins are Papain-like C1A cysteine-proteases involved in many physiological processes, including programmed cell death.

In this work, we have firstly analysed the involvement of autophagy and cathepsins in cell death during stress-induced microspore embryogenesis in two crop species, *Hordeum vulgare* and *Brassica napus*. The results have shown that the stress treatment led to endogenous production of reactive oxygen species (ROS) and activation of autophagy in the microspore cultures, as demonstrated by degradation of the autophagy receptor NBR1, up-regulation of key autophagy genes (*ATG5*, *ATG6*) and increase of autophagosomes and autophagic structures. Concomitantly with autophagy, we have detected induction of protease activities, particularly papain-like Cys-proteases and caspase 3-like proteases.

The potential of small molecules to modulate physiological processes has been reported, although their efficient application in plants is still quite limited. Taking into account the results, we have explored the use of small molecule modulators of autophagy and proteases as new biotechnological strategies to enhance microspore embryogenesis efficiency. Pharmacological treatments with small compounds that inhibit ROS, autophagy and specific cell death-proteases led to reduced cell death and increased embryogenesis initiation rate, revealing the involvement of autophagy and cathepsins in the cell death of microspores, in the two crop species studied, barley and rapeseed. These results also suggest common cell death mechanisms during microspore embryogenesis in different plant families, and the possibility that results could be extended to other crop species. The findings open up new intervention pathways with small bioactive compounds modulating autophagy and proteases, very promising to increase the efficiency of in vitro microspore embryogenesis systems by reducing cell death, for biotechnological applications with DH plants for crop breeding.

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*Speaker

Effects of selenium on calcium gradient and on germination in *Olea europaea* pollen.

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Selenium (Se) as an antioxidant, is an essential trace element for the well-being and maintenance of human health. Recently it has gained importance in plant thanks to its effect on the defence system. Se counteracts the damage of environmental and biological stress. Several researches show the use of Se in agriculture as a fertilizer to protect crops against water stress or to save water, and in some cases it seems to prevent the attack of pathogens. But the Se is also a toxin and an environmental pollutant and when it reaches high levels, even in plants, it plays a detrimental effect. Plants readily absorb Se thanks to its similarity to sulphur (S-2), and its accumulation in the reproductive organs is well documented. In the antioxidant action, Se improves the stress tolerance by regulating the quenching of reactive oxygen species (ROS), mostly the hydrogen peroxide. This action could affect the performance of the pollen since the production of endogenous ROS is essential for the cross-talk between pollen and stigma and to promote the pollen germination. In this paper we have studied the action of the antioxidant on *Olea europaea* (olive) pollen to verify if the quenching of ROS, dependent on Se, can influence its germination. The results showed an antioxidant action of Se, able to neutralizes ROS activity on the release of intracellular calcium modifying, into the pollen grain, the calcium gradient. Calcium ion (Ca²⁺) represents the central regulator of pollen tube growth during germination. The establishment of the Ca²⁺ gradient, that directs the tube growth already at the beginning of the hydration of pollen grain, determines the site where the tube will protrude. The practice of using Se in agriculture could affect the reproductive performance in olive, and therefore lead to major consequences on plant productivity.

*Speaker

Morphological characterization of some Gymnospermae non-saccate pollen.

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The high incidence of respiratory diseases related to airborne particles has stimulated the need for a network for atmospheric monitoring which answers the different needs of the population, considering also the typical vegetation of each geographical area. In central Italy and in a vast area of Mediterranean basin assumed a major importance the pollen monitoring of species belonging to Cupressaceae-Taxaceae, for their abundance and duration of pollen season.

The pollen of Gymnospermae families is caught in the atmosphere by volumetric spore-traps, the samples was analysed and insert in international monitoring network as Cupressaceae-Taxaceae, without distinction between the genus or species belonging to different families, due of their similar pollen morphology.

This research represents a tray to overcome the difficulties providing useful morpho-biometric data to recognize pollen of Gymnospermae. A total of 21 species was analysed by selecting the most common belonging to Cupressaceae-Taxaceae normally found in urban areas as ornamental plants. This study was also extended to other Gymnosperm belonging to *Cephalotaxaceae*, *Araucariaceae* and *Taxodiaceae* less widespread but characterized by anemophylous and non-saccate pollen grains. This study pointed out four pollen typologies on the basis of apertures: aperturoidate, areolate-papillate, areolate-porate and porate.

The results of this study provide further knowledge about morphology features significant to overcome the general definition of inaperturate attributed of the Gymnospermae pollen. These results can be useful for aerobiological research, since they enable, to identify the similar pollens and therefore its assignment to genus or species which released ones. In the same way the pollen morpho-biometric analysis could be insert into the botanical guides, as other distinctive characteristic useful for plant identification.

The morpho-biometric study is one of the most important fields which supports Palynology and it is forming the starting point to many other research concerning the pollen.

*Speaker

Stressful connections during pollen development. A personal account

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Pollen is amazing. It shows many peculiar characteristics, as compared to other plant cells, which makes the study of any aspect of pollen biology a fascinating research topic. Pollen, the male gametophyte of higher plants, has a quite simple structure – only two or three cells – and, generally, a ‘life span’ of only a few days, from the precursor ‘microspore mother cells’ to the fully mature pollen grain. Everything else, metabolism, cellular processes, gene expression mechanisms, are as complex as, if not more complicated than for any other plant tissue or organ. There is an extensive overlapping of gametophytic and sporophytic gene expression; all plant ‘housekeeping’ genes are also expressed in pollen, in addition to a few thousand pollen-specific genes. Pollen can be considered as a kind of ‘endosymbiont’ of the sporophyte, utterly dependent on the mother plant for its development and survival, whereas it produces the male gametes for the plant sexual propagation. The very fact that immature microspores, isolated from the anther, can continue *in vitro* normal gametophytic development under appropriate conditions – as shown, at least, in the model plant tobacco – distinguishes them from any other plant cells, which when isolated from the plant and cultured *in vitro* will de-differentiate and form a callus, never continue their *in vivo* developmental fate.

The formation of the mature pollen grain, both in the anther and *in vitro*, provides a useful experimental system to investigate different plant biological processes, apart from the obvious study of (male) gametophytic development in itself. For example, cell cycle progression and cell division, as pollen development consists in a series of successive, often synchronous cell divisions: meiosis of the microspore mother cells, the asymmetric microspore mitosis that produces bicellular pollen, and the second, symmetric mitotic division of the generative cell to give rise to the two sperm cells. Also, the interactions between the gametophyte and the sporophyte during the development of the microspores and pollen grains *in vivo* (e.g., the role of the tapetum), the formation of the – unusual – pollen wall, or intracellular transport processes during pollen tube growth.

Moreover, pollen represents also a unique system to investigate specific responses of plants to abiotic stress. Within a narrow developmental window, around microspore mitosis (uninucleate microspores or early bicellular pollen), different stress treatments block normal gametophytic development and induce the formation *in vitro* of embryogenic cells, from which haploid embryos and plants can develop. This reprogramming of the immature male gametophyte, apart from its academic interest, has also important biotechnological applications, as the generation of doubled-haploid plants is very useful for crop breeding programmes. Abiotic stresses negatively affect pollen development at all stages, but in the last phase of *in vivo* development, before dispersal, pollen must go through a desiccation process, more or less intense depending on the species, which leads to profound metabolic changes, acquisition of ‘desiccation tolerance’ and developmental arrest. Pollen dehydration is not an externally imposed stress, but a developmentally regulated, natural process necessary for the pollen to survive the period that it will remain in the environment as a ‘free-living’ organism – also a peculiar example for plant cells – before it lands on the stigma. Mature pollen is, however, very sensitive to heat stress. Pollen germination can also be inhibited under different stress conditions, and *in vitro* germination could be used as an alternative system for the identification and characterisation of ‘stress-tolerance’ genes, cloned under control of pollen-specific promoters. Finally, the relative tolerance or sensitivity of pollen of a given species to environmental stresses – perceived through the sporophyte – will obviously affect the reproductive success of the plant. A particular case is represented by halophytes, plants that can complete their life cycle under high salinity conditions. It should be logical to assume that pollen of halophytes should also be highly resistant to salt stress, but there are almost no experimental data supporting this notion, as most research work has focused on the salt tolerance of halophytic seeds and early seedling development.

In this talk, some examples of specific stress responses during pollen development will be presented and discussed, from a personal point of view. I will try to answer some open questions but, mostly, to raise new issues for which I have no answer, but which may provide some food for thought.

*Speaker

Palynomorphological investigations on *Cyanus* Mill. Subgenus of *Centaurea* L. (Asteraceae) in Turkey

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This study includes a detailed pollen morphological analysis of twenty taxa of *Cyanus* subgenus of *Centaurea* genus. The plant materials were collected from several localities for *Cyanus* subgenus. All of the specimens used for this research were stored in KNYA herbarium. Wodehouse Technique (1935) was used for light microscopic investigations. In this technique pollen grains were obtained from mature anthers and then were stained with glycerin-jelly with safranin, and were covered by coverslip. Pollen slides were photographed using Leica light microscope. Measurements were based on 30 or more pollen grains per specimen. For scanning electron microscopy (SEM) studies, dried pollen grains have been transferred to aluminum stubs and coated with gold in a Cressington Auto 108 sputter-coater. They were photographed with Zeiss EVO LS10 SEM at Advanced Technology Research and Application Center, Selcuk University, Konya. The determined qualitative and quantitative characters were scored for numerical analysis with MVSP program. The pollen grains of *Cyanus* subgenus are radially symmetrical and isopolar. Pollen grains are mainly tricolporate. Pollen shape of species is variable from oblate-spheroidal to prolate-spheroidal. Scabrate-perforate ornamentation is observed in taxa. The amb shape is subtriangular. Intine and endexine have similar thickness in taxa. Taxa have distinct costae. The investigated taxa have Dealbata or *Cyanus* pollen type according to Wagentiz's study. Pollen shape and the numbers of spines are observed as essential pollen morphological characters for discriminating species. *Cyanus* subgenus is one of the most important components of *Cyanus* subgenus .

*Speaker

Identification of novel superoxide dismutase isoenzymes in the olive (*Olea europaea* L.) pollen

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Among antioxidant enzymes, the superoxide dismutase (SOD) family is a major actor in catalysing the disproportionation of superoxide. Apart from its role as antioxidant, these enzymes have a role in cell signalling, and Cu,Zn-SOD proteins are also major pollen allergens. In order to deepen our understanding of the SOD isoenzymes present in olive pollen and to analyse the molecular variability of the pollen Cu,Zn-SOD family, we carried out biochemical, transcriptomic and localization studies of pollen grains from different olive cultivars and other allergenic species.

Olive pollen showed a high rate of total SOD activity in all cultivars assayed, which did not correlate with pollen viability. Mass spectrometry analysis together with activity assays and Western blotting experiments enabled us to identify new forms of Cu,Zn-SOD enzyme (including chloroplastidic and peroxisomal forms) as well as differentially expressed Mn-, Fe- and Cu,Zn-SOD isoenzymes among the pollen of different olive cultivars and allergenic species. Ultrastructural localization of Cu,Zn-SOD revealed its plastidial localization in the pollen grain. We also identified the occurrence of a shorter form of one of the cytosolic Cu,Zn-SOD enzymes, likely as the result of alternative splicing. This shorter enzyme showed lower SOD activity as compared to the full length form.

The presence of multiple SOD isoenzymes in the olive pollen could be related to the need of finely tuning the ROS metabolism during the transition from its quiescent condition at maturity to a highly metabolically active state at germination.

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*Speaker

Paleopalynology

Les environnements végétaux et agricoles de la Crète de 3200 à 2600 cal BP révélés par l'étude du site de Phaistos (alt., 35 m, Grèce)

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Une série de carottages a été obtenue dans la plaine de la Messara, au pied du palace minoen de Phaistos, en Crète. Les problématiques étaient les suivantes : quel type d'environnement (marin, lagunaire, lacustre ?) existait au cours de l'époque minoenne et y avait-il à proximité du site de Phaistos une source d'eau douce qui puisse permettre d'alimenter les populations. L'étude palynologique du sondage de Phaistos 2 (alt. : 35 m) a révélé une chronique de 400 ans (3157 cal BP à 2650 cal BP), entre le Minoen récent III et la période archaïque. Un spectre pollinique tous les 22 ans a été étudié. Les assemblages témoignent d'un paysage agricole dépourvu de forêt (taux de pollen arboréen < 10 % de la Somme Pollinique, SP) essentiellement dominé par la culture de l'olivier (les pourcentages peuvent atteindre 35% de la SP), des céréales et des activités pastorales (spores de *Sporormiella*). La comparaison de ces données fossiles avec les assemblages livrés par la pluie pollinique actuelle montre que les paysages, au temps des minoens et après, étaient aussi ouverts et cultivés (oliveraie) que ceux de la plaine de la Messara de nos jours. L'instabilité socio-politique, qui caractérise les "Dark Ages" ne semble pas avoir affecté les activités pastorales qui demeurent stables, dans l'ensemble, au cours des 400 années étudiées. L'identification de pollens de plantes de milieu d'eau douce (*Sparganium-Typha*, *Alisma plantago*, *Isoetes*, *Ranunculus*) permet d'attester l'existence d'un lac à proximité du site au cours des 3e et 2e millénaires avant notre ère. La combinaison des données sédimentologiques, paléontologiques et géochimiques permet d'affirmer que le site de Phaistos n'était pas en situation littorale pendant la période minoenne ; Kommos et Matala devaient faire office de port.

*Speaker

Environmental change around a Iron age foreshore settlement at Plougasnou-Saint Jean du Doigt (Finistère, France)

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A palaeoenvironmental study of Plougasnou/Saint-Jean-du-Doigt (Finistère, France) coastal area was carried out both on the marsh at the back of a gravel barrier and on the foreshore where an iron age settlement was discovered with a wooden fence preserved in peat. Research was based upon a multi-proxy approach integrating archaeology, geomorphology, dendrochronology and palaeoecological study (pollen and non-pollen palynomorphs). On the foreshore, sampling was performed on the peaty and organic clayey levels of three archaeological surveys. A geomorphological survey was carried out on the marsh to reconstruct the depositional history of the infill by drilling and coring in a cross-section on both sides of the Donan River. The rhythmicity of deposits seeming different on each side, two cores were selected for pollen analysis (pollen and NPP's).

The lower half of the two marsh's sequences (6700 to 5500 cal BP) indicates a wooded landscape, with *Corylus* associated with numerous deciduous trees (*Quercus*, *Ulmus*, *Betula*, *Tilia*, *Fraxinus*) and shrubs (*Hedera*, *Lonicera*, *Sambucus*, *Rosaceae*) in the dryland, and with *Alnus* accompanied by *Salix* in the wetland. Herbs are scanty but some peaks of *Apiaceae* indicates hydrological changes. Crops and livestock farming are scarce. A large hiatus is revealed by the modification of pollen assemblages.

The upper half (2916 to 1500 cal BP) indicates that the landscape that was deduced from the lower half, had been replaced by an open landscape with a marshy meadow. Riparian woods and dry land forest had been exploited for crops and farming activities. The foreshore sequences associated with the Iron age settlement (dated of the 4th century BC) fit into the first part of this ensemble. The site was then disconnected from any marine input and was not located on the foreshore anymore: the gravel barrier was much further away.

*Speaker

Mid- to Late-Holocene Mediterranean climate variability: Contribution of multi-proxy and multi-sequence comparison using wavelet analysis in the north-western Mediterranean basin

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Understand the causes of past climate variability is crucial to better understand the influence of past climate changes on the vegetation history of the Mediterranean region during the Holocene period. However, forcings and mechanisms underlying Holocene climate variability still remain poorly understood. The comparison of signals from different paleoclimatic proxies using spectral analysis may emphasize the joint cyclicities and lead us closer to the causes of climate changes. Nevertheless, the non-stationarity of Holocene climate variability has been highlighted by numerous studies based on diverse proxies and is crucial to understanding the physical mechanisms at play and the role of external forcings. Wavelets are tools for spectral analysis of non-stationary time series. We adapted an existing algorithm to propagate the age model errors of paleoclimate timeseries within wavelet analysis. Then we compiled and analyzed 10 paleoclimatic proxy records from 5 sequences from the Gulf of Lions and surrounding areas:

- pollen and clay mineral from the core PB06 recovered in southern France (Languedoc region),
- Sea Surface Temperatures (SST) derived from alkenones, concentration (TERR-alkanes) and average chain length (ACL) of n-alkanes, Ca/Ti and K/Ti ratio from the core KSGC-31_GolHo-1B recovered in the gulf of Lion inner-shelf,
- SST derived from planktonic foraminifera assemblages from the Bay of Biscay
- $\delta^{18}\text{O}$ from speleothems recovered in the Asiul Cave in north-western Spain,
- granulometry in the sediment drift at 2391 m water depth north of Minorca island.

These paleoclimate time-series were supplemented with proxies of the North Atlantic Oscillations (NAO), El Niño–Southern Oscillations (ENSO) and the Intertropical Convergence Zone (ITCZ) variability. A comparison of their frequency content is proposed using wavelet analysis.

Three main groups of shared periodicities specific to the Mid- and Late Holocene (after 7000 yrs cal BP) can be defined on the basis of the results of these analyses: an Atlantic cyclic period, solar cyclic periods and tropical cyclic periods. The Atlantic cyclic period is probably related to periodic fluctuations of the Atlantic thermohaline circulation which would induce changes in the storm track extension and position thereby impacting upon precipitation and storminess over a millennial scale. The centennial scale solar cycles might induce a NAO-like variability of the atmospheric circulation thereby influencing storminess in Western Europe and Mediterranean. Finally, some climate proxies of the Gulf of Lions shared cyclicities with eastern-Pacific and tropical Atlantic proxies, probably highlighting an influence of the ENSO variability over the western Mediterranean.

*Speaker

Late-Holocene vegetation changes in the Murcia region in relation with human activities, evidences from a new pollen sequence from the Mar Menor

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South-Eastern Spain is a particularly suitable area for studying the impact of human societies on their environment. Indeed, this part of the Iberian Peninsula has a long history of human occupation and shelters a great diversity of highly contrasting plant communities. The history of vegetation in south-eastern Spain has already been the subject of numerous publications, but mainly at high altitude sites. Here we present a new high resolution and continuous pollen sequence from the coastal lagoon of Mar Menor in the Murcia region. This new sequence covers the last 6500 years, from the end of the Neolithic to the present period, with a robust chronological framework (19 radiocarbon dates). The history of vegetation obtained from pollen data is compared with a proxy of mining activity in the watershed of the same lagoon and with the regional archaeological records as well as with paleoclimatic data in order to disentangle the influence of human activities and climate change on the vegetation of this part of the Iberian Peninsula. While the influence of past climate variability on the vegetation in the Murcia region remains difficult to perceive, the data show a very clear concomitance between changes in the archaeological record and changes within plant communities.

- During the Argar period (early Bronze Age), which is characterized by a remarkable development of human societies in the south-eastern Iberian Peninsula, pollen data show an important deforestation and also changes in the composition of herbaceous communities.
- A spectacular recovery of the vegetation with a clear ecological succession is recorded during the Roman period and match perfectly with the end of the mining activities.
- Changes in the composition of the thermo-Mediterranean shrub communities are recorded in relation with the very important pastoral practices during the medieval period.
- Between the 18th and the 19th centuries the development and the evolution of the agricultural practices as their impact on the regional vegetation is well recorded.

The pollen record provides valuable indications for assessing the resilience of thermo-Mediterranean coastal plant communities to anthropogenic environmental changes, particularly in the face of intense mining activities during Classical antiquity or medieval pastoral practices.

*Speaker

Holocene vegetation and fire history in northern Ural region (Komi Republic, Russia)

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Climate change is already undergoing changes in the boreal regions in terms of vegetation dynamic and fire activity. In these regions, vegetation dynamic is influenced by fire regime which is the major driver that shaped forests. The study of the past fire activity, linked to the past vegetation in archives such as lake or peatland sediments can improve the comprehension of the past boreal forest dynamic and therefore allow a finer modeling and prediction of forests dynamics under the climate change. We used a paleoecological approach to investigate a sediment archive from two peatlands in Komi Republic (in the Western foothills of the Northern Ural region) which cover the entire Holocene to have a continuous and high temporal resolution record of the local vegetation dynamic of this area. In addition, we used the REVEALS model to get a regional view of the forest composition of the area. Forest taxa dominate all along the cores. At the beginning of the Holocene, from 10,000 cal. yr BP to 6000 cal. yr BP, there is a majority of *Betula* and *Pinus sylvestris*/*Picea*, which fluctuate in opposition. These taxa are typical of a light taiga system. Fire activity is low, with a Fire Return Interval (FRI) evolving from 600 to 300 years. From 6000 cal. yr BP at 3800 cal. yr BP, the FRI is 200 years, while *Pinus sylvestris* and *Betula* decrease contrary to *Picea* increases and *Pinus sibirica* and *Abies* appearance, showing a change of forest toward a dark taiga system. From 3200 to 100 cal. yr BP, *Pinus sylvestris* increases while *Picea* and *Pinus sibirica* decrease, the system gradually evolves towards a light taiga system because the activity of fire has increased, with a FRI equal to 150 years. From 100 to 0 cal. yr BP, *Betula* sharply increases which shows a strong human impact through logging and increasing fire activity, with a FRI less than 100 years. In the first half of the Holocene, it is suggested that geomorphological changes have had an impact on the establishment of peatland systems, which has influenced the local vegetation composition. This, combined with climatic factors allowed the establishment of the light taiga. At the beginning of the second half of the Holocene, humidity increased which allowed the establishment of the dark taiga which, in turn, leads to the limitation of fire activity. But then, the decreasing humidity factor allowed an increase of the fire activity combined with the disappearance of the dark taiga, in favor of light taiga system. Finally, from -100 to 0 cal. In BP, the explosion of *Betula* taxon with the huge increase in fire activity are markers of high human impact.

*Speaker

Automated recognition by neural networks for paleobotanical applications.

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Pollen identification requires extensive knowledge of palynofloras and is highly time consuming. Since the 1960s, palynologists have been interested in developing automatic pollen grain recognition. Many methods and approaches have been developed with success for fresh pollen grains, and are currently used in aeropalynology and to study plant-pollinator interactions. But these approaches only work because they are designed and used for intact pollen grains. They are not often applicable for paleobotanical studies because fossil pollen grains are often damaged, folded, broken and their exine altered. No studies have worked specifically on the recognition of damaged pollen. The last study mentioned on the subject is the study of Han and Xie (2018) based on a textural approach. They highlighted a failure of obtaining good classification for deformed pollen grains. For fossil pollen grains, the last study dates back to Kong *et al.* (2016). This study of 2016 was based on convolution neural networks (CNN) and recurrent neural networks (RNN). It achieved good results, but only on a small number of pollen types (13.9% misclassification of three pollen types with similar morphology) and only for pollens with good conservation. In order to recognize damaged and/or fossilized pollen grains of 8 pollen types, we have developed an automatic system based on multiple convolutional neural networks (CNNs) that uses light microscopy (LM) images. Our study shows that it is possible to obtain meaningful classification of damaged modern and fossil pollens. Misclassification rates are small, less than 5.5% for 8 different pollen types: 6 types of Amaranthaceae with similar morphology and 2 types of Monocotyledoneae that are very common in pollen records (Poaceae and Cyperaceae). This rate of misclassification was obtained by adapting the taxonomic precision according to the preservation of the characters determined by the CNNs for identification of each pollen types. The important advancement of our study is that recognition works well for pollen in various states of preservation: intact grains, folded grains with altered exine, pollen fragments, etc. These preliminary results are very promising, the creation of software adapted to identify a much larger set of pollen types with application to making paleobotanical inferences from various sedimentary contexts.

*Speaker

Changes in vegetation and Indian summer monsoon during the last deglaciation and early Holocene from sediments of the Bay of Bengal

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The Indian Summer Monsoon (ISM), which is part of the Asian monsoon system, brings most of the annual rainfall to the Bay of Bengal and adjacent landmasses, impacting billions of people's daily lives. Although many studies have shown that the ISM is highly variable over time, the factors behind this variability are still poorly understood. This work focuses on the response of the Indian vegetation and monsoon rainfall to the large-scale reorganizations that affected the Earth's climate during the last deglaciation and early Holocene at orbital and millennial timescales.

We will present results derived from the pollen analysis of marine sediments from the IODP Site U1446. This site, which covers the last 1.4 Myr, was collected during the IODP expedition 353 "Indian Monsoon Rainfall" on the eastern Indian margin off the Mahanadi river exit. It mainly recruits pollen from the vegetation of the Mahanadi river basin, which is located in central eastern India within the core monsoon zone, an area where the ISM has its most representative expression.

Preliminary results show that during the last deglaciation the Mahanadi landscape dramatically changed from a grassland and marshland dominated vegetation with very sparse trees to a temperate moist deciduous forest inland with mangrove in the coastal area, suggesting deglacial strengthening of the monsoon rainfall.

*Speaker

Pollen analysis on spotted hyaena (*Crocuta crocuta*) coprolites from the fossiliferous site of Buca della Jena, Southern Tuscany (Roselle, Grosseto, Italy)

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Pollen studies in fossil faecal remains may provide significant palaeoclimatic, palaeovegetational and palaeoethnological information. These data can be decisive where other substrates are not available for pollen analysis. Coprolites, thanks to their hardness, can preserve pollen grains for a long time, isolating them and preventing exine oxidation. It is known that pollen is incorporated into coprolites in different ways: by the ingestion with food or water, by the licking of the fur. Noticeable pollen amount is found when the diet includes flowering plants. Pollen analysis was lead on two coprolites of spotted hyaena *Crocuta crocuta* found in the site of Buca della Jena (Roselle, GR) in order to reconstruct the local vegetation surrounding the hyaenas den. The samples were taken from the center of each coprolite and treated following the standard procedure. The analysis revealed a rather good pollen concentration in both the coprolites, which also displayed similar pollen spectra. Almost all the pollen grains belonged to herbaceous plants. The most represented taxa were *Plantago*, Chenopodiaceae and Poaceae, the two lasts with different morphotypes. Urticaceae and Lamiaceae also showed noticeable percentages. The fossil assemblage at Buca della Jena includes the following species: *Crocuta crocuta*, *Canis Lupus*, *Vulpes vulpes*, *Ursus arctos*, *Equus ferus*, *Cervus elaphus*, *Rupicapra rupicapra*, *Arvicola amphibius*, *Microtus (Microtus) arvalis*, *Lepus sp.* According to the faunal record, the presence of *Rupicapra rupicapra* and *Microtus arvalis* suggest a relatively cold environment in the surrounding of Buca della Jena, whereas the occurrence of *Arvicola amphibious* and *Crocuta crocuta* indicates an age referable to the Late Pleistocene, older than ca. 31 ka, last occurrence of the spotted hyaena in Italy. The pollen results hint the presence of an extensive grassland characterized by taxa which are common in the steppe vegetation. This scenario may describe the environment visited by the hyenas during their feeding activity in one or few days before the deposition of faeces and indicates the occurrence of a cold span of time during the unstable temporal interval of the Last Glacial period, in agreement with the information inferred from the fossil mammal assemblage. This locality represents a rare and important database of information for MIS 4-3 in Southern Tuscany due to the scarcity of other fossiliferous sites in this area.

*Speaker

Preliminary palynological results from off-site cores at the Terramara Santa Rosa di Poviglio, N Italy (SUCCESSO-TERRA Project)

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The archaeological site "Terramara Santa Rosa di Poviglio" (1550–1170 BC) has been investigated for 35 years, under the direction of M. Cremaschi and M.A. Bernabò Brea. It is the key site of the national-funded SUCCESSO-TERRA Project (*Human societies, climate-environment changes and resource exploitation/sustainability in the Po Plain in the mid-Holocene: the Terramare culture*; PRIN-20158KBLNB; <https://www.successoterra.net>; Cremaschi et al. 2018). This interdisciplinary project focuses on the relationship between humans, climate, and environment during the trajectory of the Terramara culture. This society underwent a phase of intense development and demographic increase before it collapsed, after 3000 years, due to negative climate factors and the unsustainable exploitation of natural resources.

Three off-site cores were collected at different distances north of the archaeological site "Terramara Santa Rosa di Poviglio" in the summer 2018 with the main purpose to verify the presence of a Po River palaeo-riverbed near the site, and to collect data on Holocene environmental transformations. A total of 292 pollen samples are under study. First results regard the more recent samples from the three cores, detailing land use and land cover after the Bronze Age. Pollen data suggest the decrease of agricultural land use in the area, with spread of wet meadows (Cyperaceae and aquatics) and environments rich of hygrophilous woods (with *Salix* and *Alnus*).

Palynological data add information to stratigraphical descriptions, radiocarbon dating, petrographic and organic matter analyses, in addition to the archaeological analyses. The strong interdisciplinary perspective facilitates the investigation of the climatic and anthropic contributions to environmental changes in the region, and their relationships with the different adaptive behavior of the Terramare people. The new palynological data obtained from off-site palaeoenvironmental analyses can integrate the on-site analyses already carried out showing evidence of local human activities (Cremaschi et al. 2016). The correlation between off-site and on-site studies is necessary to understand the lasting environmental changes at a regional scale (Mercuri et al. 2012).

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Key-words: pollen, off-site cores, interdisciplinary, climate change, Po Plain

*Speaker

Transect Méditerranée Occidentale-Orientale : palynologie marine et gradients climatiques (continentaux et hydrologiques) au cours de l'Holocène.

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Les eaux de surface de l'Océan Atlantique pénètrent en Mer Méditerranée par le détroit de Gibraltar. Cette masse d'eau de surface qui longe la côte nord-africaine porte le nom de courant algérien. Ce courant peut être décrit comme une série de tourbillons eux même sources de remontées d'eaux profondes sous forme de plumes d'upwellings en mer d'Alboran. Des blooms de productivité primaire sont ainsi régulièrement observés le long de la marge algérienne. Afin de comprendre l'impact de cette dynamique paléo-hydrologique sur les écosystèmes planctoniques et son lien avec les variations climatiques régionales et globales, nous présentons une étude paléocéanographique et paléoclimatique inédite sur la marge algérienne à partir de la carotte MD042801. Celle-ci fait l'objet d'une centaine d'analyses palynologiques couvrant les derniers 14 000 ans avec une résolution d'étude de 100 ans en moyenne. Cette étude permettra de mettre en évidence la particularité des conditions hydrologiques de surface et leur sensibilité aux variabilités climatiques régionales et globales. Nous soulignons ainsi, à l'échelle pluri-séculaire un relais entre (i) des périodes caractérisées par une dominance des conditions d'upwelling, au Younger Dryas ainsi que durant l'Holocène inférieur (11,7 à 8,2 ka BP) et sur les derniers 6 ka BP, et (2) des périodes caractérisées par des décharges fluviales accrues entre 8,2 et 6 ka BP. Cette dernière période, correspondant à l'African Humid Period, est décrite par des précipitations importantes sur le continent africain. La comparaison de ces résultats avec des données palynologiques marines proches met en évidence la singularité de la marge algérienne en termes d'assemblages dinokystes reconstruits, en particulier par la surreprésentation des taxons hétérotrophes comparativement aux autres séquences de Méditerranée occidentale et du Golfe de Cadix. Ces résultats préliminaires issus de premiers travaux (Master 2 – soutenus au printemps 2018) s'inscrivent aujourd'hui dans la thèse " Transect Méditerranée Occidentale-Orientale : palynologie marine et gradients climatiques (continentaux et hydrologiques) au cours de l'Holocène " débutée en octobre 2018 (thèse UBO, Brest). Ce projet est défini par trois axes de recherche principaux : i) le développement méthodologique de la datation radiocarbone sur des grains de pollen mono spécifiques dans les carottes marines, ii) l'établissement de séries temporelles d'âge réservoir océanique à partir de la comparaison entre âges radiocarbone pollen et carbonates sur les mêmes niveaux, iii) l'étude paléoclimatique Holocène à haute résolution temporelle (pluri-décadale) avec une chronologie robuste permettant une meilleure approche des modalités de la variabilité climatique rapide infra-millénaire. Les piquages de grains de pollen ont d'ores et déjà délivré des premiers résultats sur 3 niveaux de la carotte MD04-2801. Bien qu'entachés d'une grande incertitude, ces premiers tests réalisés sur le spectromètre de masse par accélérateur ECHOMICADAS démontrent la faisabilité du projet, et sont encourageants pour la poursuite de ce travail. Les données palynologiques, à ce jour uniquement les assemblages dinokystes, seront comparés avec les assemblages polliniques (à venir), afin de mettre en parallèle les

*Speaker

premières données océaniques acquises au cours d'un stage Master 2 à Brest en 2018 (LGO, IUEM) avec des données climatiques continentales (collaborations LGO, MNHN, ISEM). Cette thèse (Région Bretagne – Université de Brest) comprendra également l'étude d'autres carottes depuis la Mer d'Alboran jusqu'au détroit siculo-tunisien permettant d'évaluer les variations des conditions paléohydrologiques et paléoclimatiques à une échelle régionale suivant un transect Ouest-Est et avec une résolution décennale à pluri-décennale (Projet INSU EC2CO, LEFE " DATAPOL ", Mistrals).

The role of humans and climate in the process of steppe formation in the high-mountain region of Armenia

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In the country of Armenia, nomadic pastoralists are often blamed for the transformation of the landscape from forest to steppe. More recent palynological research from the Southern Caucasus, however, has challenged these assumptions and has revealed that some areas have hosted a steppe landscape throughout the Holocene. Utilizing pollen, non-pollen polymorphs, and charcoal analysis, we will present the results from a 3.5-meter sediment core spanning just over 10,000 years. This core was extracted from a small mire located on the flanks of the tallest mountain in Armenia, Mount Aragats. Today this area is primarily a grassland steppe and archaeological evidence points to agricultural and pastoral activities in the region for almost 6000 years. In this paper, we explore how humans and climate have transformed the plant composition in this steppe landscape. Our results show that steppe installation occurred prior to the onset of agriculture and pastoralism. We suggest that climate was the primary driver of the transition from *Chenopodiaceae* / *Artemisia* steppe in the Early Holocene to a *Poaceae* steppe after 9000 cal BP. We then consider the role of pastoralism, wood acquisition, and climate in changing the composition of the arboreal landscape when a drop in *Betula* occurs accompanied by a reduction in fire frequencies at 4700 cal BP. Finally, we propose that a change to a more arid climate occurs just prior to 2000 cal BP when we see a drop in arboreal pollen and an increase in *Poaceae* and fire frequency during the Iron Age. We will then contextualize these findings with other records from the region to present a regional view of steppe formation in the Southern Caucasus.

*Speaker

Fire activity in northeastern India over the last 25,000 years

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Today, about 55% of the forest area in India is prone to fires every year. Fires are present in all types of forest ecosystems, the most vulnerable being tropical dry deciduous forests. Fire incidences are highest in March and April, a period which is marked by high temperatures and dry spells increasing fuel flammability. The fire season disappears with the onset of the monsoon (June to September). Fires in India are mostly anthropogenic, although set when forests are most susceptible to burn. Here we present a record of fire activity covering the last 25,000 years based on the analysis of microcharcoal particles, produced by vegetation fires, preserved in Site U1446 in the Bay of Bengal. This core integrates environmental information from the Mahanadi hydrographic basin in the northeastern India, located in the core monsoon zone. Results show fire was present although variable during the last 25 kyr. From 25 to 19 ka, fire activity was low. High fire activity is observed between 18 and 10 kyr, followed by a decline from 10 to 6 kyr with the lowest values during the interval 8-6 ka. A last increase in fire is observed from 6 to 3.5 ka before subsided up to the present-day. Preliminary interpretation suggests that fire activity is controlled by monsoon and vegetation type, low fire activity reflecting strengthening of the monsoon. However, the decline in fire activity during the last 3.5 kyr is likely related to the reduction in flammable fuel due to the opening of the landscape.

*Speaker

La Tourbière des Narcettes à Montselgues (Ardèche), Palynologie et paléométallurgie.

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A l'extrémité méridionale des Cévennes ardéchoises, le plateau de Montselgues héberge quelques placages tourbeux dont la tourbière des Narcettes (1035 m). Par d'impressionnants abrupts il domine vers l'ouest les gorges de la Borne et du Chassezac, connues comme un espace minier argentifère (argent, plomb, zinc) depuis l'antiquité (Minvielle Larousse, 2017). Cette proximité a généré, dans le sillage des fouilles archéologiques, un programme d'étude des remplissages tourbeux associant analyse pollinique et géochimie des métaux traces issus des activités minières, dans le prolongement de travaux conduits sur le mont Lozère (Baron et al., 2005). Deux carottes très voisines (MS1 et MS2) ont été étudiées. Cinq datations ¹⁴C étayent une chronologie. En dépit de leur très faible puissance (65 et 85 cm) leurs bases sont antérieures à 7000 cal BP et l'histoire de la végétation présente des similitudes avec celle du proche Velay. Le signal régional est partiellement masqué par des implantations successives de *Betula*, *Calluna* et *Osmunda* sur le site. Après une phase de domination des feuillus mésophiles, une hêtraie –sapinière s'installe. Puis la déforestation est marquée par une succession d'épisodes caractérisés par des pratiques agricoles différenciés. L'écho des cultures d'oliviers et de châtaigniers en contrebas du plateau est bien perceptible.

Les signaux des métaux-trace identifient trois épisodes de perturbation. L'un, vers 6000 cal BP est pour le moment d'origine inconnue ; les deux suivants correspondent à des activités métallurgiques, l'une antique, l'autre contemporaine. Des recherches historiques sont en cours pour évaluer le lien entre ces dernières, les cycles agropastoraux du plateau, et les dynamiques de la production minière cévenole.

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*Speaker

Landscape changes following Greek and Roman contacts and settlement in the coastal hinterland of Emporion-Emporiae (NE Spain)

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The Catalan Empordà plain outstands for its archaeological richness documenting the development of the Iberian culture and subsequent colonial settlement. This includes the founding of Greek and Roman colonies such as *Rhode* and *Emporion/Emporiae*, and also the proliferation of rural sites and field system organization in the immediate coastal hinterland. All this happened within a dynamic littoral ecosystem subjected to sea-level changes and fluvial flooding contributing to the formation of beach-barriers and the in-filling of the plain. In order to better understand both the timing, intensity and influence of colonial settlement in the shaping of the Empordà landscape, we carried out a palaeoenvironmental study in Els Estanys palaeowetland, located in the immediate hinterland of *Emporion*. Spanning from ~1600 cal BC, the record allowed for a high-temporal resolution analysis of the Iberian, Greek and Roman periods. We coupled a range of proxy indicators comprising mineralogy, geochemistry, macrocharcoal, pollen, and non-pollen palynomorphs with available local palaeogeomorphological and archaeological data-sets. From ~1600 to ~650 cal BC, Els Estanys developed as a shallow back beach lagoon with marine water influence. Between the 14th and 10th centuries BC, the development of low-intensity agropastoral activities resulted in short-lived fire-related woodland openings. Enhanced deforestation occurred during the Bronze age-Iron age transition, with the long-lasting clearance of coastal woodlands, the expansion of grasslands and renewed farming. From the early-7th century cal BC, Els Estanys turned into a freshwater marshy lagoon within a mud flat due to increased fluvial flooding and the development of more permanent sand barriers. Coeval to this and to the development of stable Iberian settlement and the founding of the Greek colony of *Emporion*, increased farming exploitation is documented, with the expansion of pasturelands, the grazing exploitation of marshy areas and increased cropping activities. Roman settlement in the floodplain during the mid-2nd century cal BC accentuated the landscape opening, occupation and management of the coastal hinterland with 1) the removal of littoral woodlands, 2) the expansion of wet pastures and cultivation lands in an increasingly drained floodplain, 3) intensified rural settlement, and 4) the development of new economic activities such as mining and smelting.

*Speaker

Palynological evidence for the use of precious resins (ladanum) to coat Baetican Roman amphorae

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The on-going underwater excavation of a Roman shipwreck near the Formigues islands (Baix Empordà, Girona, NE Catalonia) has revealed an important cargo of Dressel 7/11 Baetican amphorae from southern Spain dated to the 1st century BC. Typological criteria and the documentation of fish bones inside the vessels points that these were used to transport fish sauces and salted fish. The latter were highly valued products in the Roman Empire, but little information is available on the varied plant resources used in the processing of fish products and/or the plant resins used to coat the vessels. To fill in this gap, pollen and non-pollen palynomorph analyses have been performed in well-preserved resins coating some of the recovered vessels. Preliminary results obtained suggest that *ladanum*, a sticky resin produced by *Cistus* shrubs to protect themselves from the heat, was used to coat the amphorae. *Ladanum* was a precious product in the Antiquity, used for drug and perfume preparation due to its medicinal and aromatic properties. However, ancient sources do not document the use of this substance to coat vessels. In order to verify our hypothesis, we performed palynological analysis of present-day *Cistus* resin collected in Crete using traditional gathering methods similar to that described in ancient sources. Results obtained further support the use of this precious and hard-to-collect substance for coating the amphorae, and underline the high commercial value of Baetican fish products that were transported and traded across the Mediterranean throughout the Roman Empire. Further multidisciplinary analyses are needed to confirm these results and better understand the use of plants in the manufacturing of fish products. However, these preliminary results provide new insights into the use of wild plants such as *Cistus* that were of importance for ancient societies but that are poorly recorded in archaeobotanical and/or paleoenvironmental contexts.

*Speaker

Quantifying past sea-surface hydrography: palynological approaches are they still competitive? A comparison of dinocyst-derived reconstructions vs planktonic foraminifera-derived ones for some key periods and key areas of the North Atlantic Ocean

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Microfossils constitute key material for paleoceanographers for who they are, since nearly one century, basic tools for stratigraphical and hydrographical reconstructions. In this context, approaches relying on the compilation of modern eco-biogeographical databases, derived from the analysis of recently fossilized populations in the topmost oceanic sediment layers, provide precious comprehensive datasets. These modern sedimentary spectra, analysed for their contents/ relative abundances in some key fossil bioindicators (e.g., diatoms, dinocyst and/or foraminifera), offer the advantage of integrating regional taphonomic processes, and can furthermore be statistically tested and exploited to provide numerical reconstructions of past oceanic conditions, as done for instance with transfer functions *sensu lato*.

Here we test the robustness of the Modern Analog Technique (MAT) to reconstruct past sea-surface hydrography focusing on the comparison of two complementary proxies: dinocyst (DINOs) and planktonic foraminifera (PF). Two independent databases were used for calculations; they respectively represent training sets of n=1189 modern analogs for DINOs and n=1007 modern analogs for PF. The PF database benefited from a new and extended set of oceanic parameters extracted from the NOAA atlas.

For this work, we mainly focus on sea-ice cover and salinity reconstructions in the Northern North Atlantic Ocean. Few selected marine archives covering the last 70 000 years at a high time resolution were tested with the aim to highlight discrepancies or convergences between the two proxies. Over this period, Stadials and Heinrich events especially provide pertinent climatic extremes for such a comparison, as those events of intense ice-sheet calvings, were supposed to have generated stronger stratification of the water column with meltwater products concentrated at the surface. As a consequence, and thanks to their respective ecological preferences, PF and DINOS may have been representative of distinct water-depth habitats, thus offering a way to reconstruct contrasted oceanic responses during such events. Our new reconstructions offer a way to challenge this hypothesis.

*Speaker

Fluvio-glacial flows and their impacts on paleoceanographic conditions on the Celtic margin during Heinrich Stadial (HS1): Palynological evidence from the Bay of Biscay

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The last glacial period was punctuated by rapid climate changes accompanied by prominent sea-level lowstands and the presence of massive continental European Ice Sheets (EIS), implying major paleogeographic reorganizations along the European margin. The last glacial maximum was characterized by the presence of the "Fleuve Manche" paleoriver, one of the largest rivers that ever drained Western Europe and flowed into the Bay of Biscay (North-East Atlantic Ocean). In the present work, a high-resolution marine palynological study was conducted on the 17 500 – 14 000 years BP section of core MD13-3438 (47° 27'N, 8° 27'W, 2180 m water depth) retrieved from the Celtic margin (Bay of Biscay) and combined with micropaleontological, geochemical and sedimentological analyses from the neighboring reference core MD95-2002. Such a multiproxy approach allows (1) to reconstruct the coupled EIS and "Fleuve Manche" dynamics during Heinrich Stadial 1 (HS1) and (2) to discuss their impacts on sea surface conditions in the North Atlantic with a special focus on Pre- and Post-Heinrich Event 1 (HE1) conditions in order to better understand the detailed sequence of climatic events characterizing the last deglaciation.

Our analysis performed on the organic walled dinoflagellate cyst (dinocyst) assemblages, associated with quantification of palynological remains reflecting continental influences (pre-Quaternary dinocysts, pollen grains, spores and freshwater micro-algae such as coenobia of *Pediastrum* spp.), highlights significant climatic and paleoenvironmental changes on the Celtic margin mainly related to melt-product releases from proximal European sources. In addition, quantitative reconstructions of sea-surface conditions derived from dinocysts and planktonic foraminifera assemblages provide a numerical robust evaluation of the hydrographical associated changes.

The Pre-HE1 interval (laminated deposits) corresponds to maximal concentrations of pre-Quaternary dinocysts, pollen grains and spores as well as *Pediastrum* spp. coenobia tracing high terrigenous supply in the Bay of Biscay. This is caused by a huge advection of European Ice Rafted Debris (IRD) and fluvial waters via the "Fleuve Manche" paleoriver in response to the seasonal melting of the EIS. Reconstructed Sea Surface Salinity (SSS) shows low values ($\bar{31}$ ‰) and the maximum occurrence of the estuarine taxa *Lingulodinium machaerophorum* argues for strong stratification of the upper-water column related to the maximum fluvial discharges. Then, the HE1 is associated to Laurentide-sourced IRD and to a substantial decrease of proximal fluvial inputs. Maximum percentages of the polar to sub-polar dinocyst taxa *Islandinium minutum* reflect drastic sea-surface condition with seasonal sea-ice cover occurrence and low Sea Surface Temperatures (SST) ranging between -2°C and 0°C. The end of HS1 is marked by the occurrence of *Bitectatodinium tepikiense* and cysts of *Pentapharsidinium dalei* suggesting high thermal seasonal amplitudes and the retreat of sea-ice. Dinocyst-derived SST and SSS are then increasing and the occurrence of the taxa *Operculodinium centrocarpum* highlights the advection of warm and salty Atlantic Surface Waters conveyed by the North Atlantic Drift current, a major component of the Atlantic Meridional Overturning Circulation at the end of HS1.

*Speaker

Environmental changes and cultural adaptations of human populations during the Middle-to-Upper Palaeolithic transition in southwestern France between 44.000 and 35.000 BP

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One of the joint issues in archaeology and paleoenvironment is the impact of climate changes on human populations and their means of adaptation. Determining the impact of climatic changes on past human populations is difficult and needs to identify possible synchronicities between a climatic event and a cultural transition. However, the identification of a concomitance is undermined by the uncertainties inherent in the chronologies of archaeological sites (dating methods) and by the resolution of environmental data. Our study focuses on improving the temporal resolution of these environmental data for southwestern France, a region that has provided abundant studies on cultural traditions since the Middle Palaeolithic.

Pollen grains and spores preserved in marine sediments are good tracers of environmental changes and our study was carried out using a deep-sea core collected in the Bay of Biscay. This analysis made it possible to study at very high-resolution (100-300 years), the environmental changes in southwestern France between 44,000 and 35,000 years before the present. We then compare our results with the chronology of cultural transitions in the southwestern France, allowing us to better understand whether climate changes may have been concomitants with the development of these cultural transitions.

Our very high-resolution pollen study and other climate tracers preserved in the same samples allowed us to detect several climate phases and associate them with the main climate events in the North Atlantic Ocean and Greenland, i.e. Dansgaard-Oeschger cycles and Heinrich events. In addition, we were able to observe three phases during the Heinrich 4 stadial, which were identified in very high-resolution studies of Greenland ice cores, but also in deep-sea cores from the Iberian margin.

*Speaker

Calibrating charcoal preserved in marine sediments to reconstruct paleofire regimes: Iberian Peninsula and Gulf of Lion case studies

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Long-term temporal marine charcoal records capture regional-scale biomass burning over a large range of natural climate variability, i.e. multiple warm and cold climate states. For example, Daniau et al (2007) showed that values of biomass burning off the southwestern Iberian Peninsula were larger during the Holocene and the last Interglacial, the Eemian, compared to the last glacial period. However, we don't know yet how to link these changes in "biomass burning" to fire regime metrics. Higher values of biomass burning may reflect an increasing frequency of small wildfires or an increase in the size of wildfires. This study aims at developing the calibration of charcoal preserved in marine sediments. Microcharcoal concentration was quantified in interface sediment samples from the Atlantic Ocean margin off the Iberian Peninsula. Microcharcoal concentration was then compared with different parameters linked to the microcharcoal production source area (burnt area, net primary productivity, type of burnt plants, watershed size), and to the transport/deposition (wind, currents, bathymetry, distance to the river's mouth, sedimentary discharge). Our results show a great heterogeneity in the spatial distribution of microcharcoal concentrations. However, the south of the Iberian margin is characterized by higher mean concentration than the northern region. Burnt area and the numbers of fires partially explain this pattern. Our results suggest that the high winter net primary productivity of grassland and dry shrubland and the hot and dry climate observed in the southern region explain high microcharcoal concentration values in the south of the Iberian margin. Additionally, the bathymetry and the distance from the river's mouth influence the distribution of concentration within this area. A similar approach is being applied to surface sediment samples from the Mediterranean Sea off the Gulf of Lions allowing a wider range of environmental conditions to be explored in developing this calibration.

*Speaker

Human shaped landscape history around the Minoan town of Malia, Crete: new insights about the Minoan civilization consequences on vegetation cover in the lowlands.

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The site of Malia, on the northwest coast of Crete, is a good case study for combined palynology and geoarchaeology. A Minoan palatial town developed during the Middle and Late Bronze Ages in an area that was occupied for a long time, and has been the subject of archaeological excavations for a century. A small marsh located near the sea and close to the archaeological site offers rich natural archives and new record in an area still little investigated. These sedimentary archives can now be combined with archaeological data and allow to address some important issues: the questions of chronology and causes of apparent changes are especially important and tricky in the Minoan world where the absolute chronology is still under debate. How can we link the temporal frames of extra and intra-site, for events/breaks but also for more durable situation? The investigations conducted off-site offer the opportunity to assess the long-term changes of the environment due to climatic, tectonic or sea level changes or to land use changes related to the change of the human activities. The chronology for the sedimentary filling of the marsh is based on 40 radiocarbon dates divided onto 11 new core-drillings carried out in 2015. All of them cover the Minoan period. In this paper we present the pollen, non-pollen palynomorphs and fire analyses from one core located into the marshy area. These palaeobotanical proxies give an overview of major changes on the vegetation cover induced by anthropogenic impacts. Combined with the first geomorphological and sedimentological results, we can propose a scenario for the landscape evolution at the bottom of the Minoan site from the Late Neolithic to the historic periods and to discuss the causes of the environmental changes. In particular, the question of the direct and indirect impact of the Santorini eruption on the landscape and the town and the effect of the agropastoral practices on the wetland is raised. This case study highlights the interest to combine geomorphological data to palynological evidence in a rich archaeological context. It points out this necessity to assess the effects of specific farming and herding practices on the dynamics of mosaic landscapes in Mediterranean areas to discuss the question of human society-environment interactions.

*Speaker

A Holocene record of vegetation change and human land-use: a case study of Northern Vosges Mountains (France).

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The past vegetation history is quite well known for the southern and central Vosges Mountains where lots of pollen analyses have been conducted (de Klerk 2014). On the other hand, palynological data are very rare in the northern Vosges Mountains (NVM). In this middle mountain range stretching from the Saverne town (Bas-Rhin department) to the German border, only five pollens analyses, at very low resolution and without radiocarbon dating, have been conducted (Hatt et al. 1937, Dubois et al. 1938). To reconstruct the vegetation evolution in this region, multiproxy studies (pollen, non-pollen palynomorphs, sedimentological and geochemical analyses) have been recently conducted in two peatlands located in the sandstone NVM: Kobert-Haut and La Horn peatlands. Results, from about 9500 cal. BP to recent times, show classical vegetation succession with *Corylus* phase, mixed oak-forest period followed by *Fagus-Quercus* phase and the recent phase of *Pinus-Picea*. On the other hand, unlike in the rest of the Vosges, *Pinus* remains a prevailing taxon all along the Holocene. Another particularity is the early establishment of *Picea*, around 1531 cal. BP, long before the plantings that occurred during the 18th-19th century.

In the NVM, archaeological remains attest to ancient human settlement since the Mesolithic period (Schmit et al. 2017). Nonetheless, in the studied area, protohistoric (particularly Bronze and Iron Age) remains are very occasional, and remains from the Middle Age are even rarer. In the NVM, the beginning of human activities, as agro-pastoralism, metal working and glass-making, as well as their impacts on ecosystems have never been clearly identified and dated. In La Horn peatland, strong human impact is attested since the late Bronze Age with two abrupt openings of woodland (around 3160 and 2950 cal. BP) combined with increase of anthropogenic pollen indicators (API) and coprophilous fungi spores related to pastoralism. A second phase of human occupation begins at the end of La Tène period (around 2260 cal. BP) with a gradual opening of woodland and the development of crops and other API, attesting to agricultural activities close to the site. This phase lasted until the end of the Middle-Age. The geochemical results (XRF) also highlight the presence of metallic elements such as lead, iron, copper and zinc. Combined with strong arboreal pollens fall and significant abundance of carbonized particles, these elements allow to identify potential metal working, with increasing significance since the Bronze Age. In Kobert-Haut peatland, human occupation is younger (1500 cal. BP) but lasted from the Gallo-Roman period to the beginning of the Modern Period. Development of crops, other API and coprophilous fungi spores during this period indicates agropastoral activities. In both sites, strong human activities phases generated erosion of sandstones from the catchments, as shown by increasing detrital inputs underlined by silica, rubidium and titanium variations.

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*Speaker

Transport et sédimentation polliniques sous bioclimat méditerranéen aride

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Les séquences sédimentaires propices à l'analyse pollinique sous bioclimat méditerranéen aride sont rares, mais les analyses récentes de séquences holocènes de sebkhas ont montré le potentiel de ces archives pour la reconstitution de la végétation et des climats en Tunisie (Lebreton et al., 2015; Jaouadi et al., 2016). Toutefois, les processus de transport et de sédimentation des grains de pollen dans ces régions arides sont encore mal connus. L'impact potentiel de ces processus peut venir biaiser les enregistrements polliniques et limiter les reconstructions environnementales

L'objectif principal de cette étude est de fournir, à travers l'analyse d'échantillons polliniques de surface, des données fondamentales pour élaborer un modèle du transport et de la sédimentation pollinique en régions méditerranéennes arides. Le fonctionnement des sebkhas en tant que réceptacles hydriques et sédimentaires saisonniers implique que les écoulements de surface soient le facteur principal de transport pollinique. Les grains de pollen sont principalement acheminés vers les environnements de sédimentation par lessivage de surface lors d'inondations violentes avec d'importants remaniements des sédiments. Des échantillons de sol ont été collectés dans les bassins versants, les cours d'eau et à la surface de sebkhas afin de saisir 1) la dispersion et la sédimentation pollinique et 2) l'image pollinique enregistrée à la surface des sebkhas et sa relation avec les associations végétales des biomes steppiques de la Tunisie centrale et méridionale.

Les données issues de soixante spectres polliniques actuels indiquent une bonne correspondance globale entre l'enregistrement de pollen à la surface des sebkhas et les associations végétales des bassins versants. Cependant, les enregistrements polliniques sont moins précis 1) lors d'inondations extrêmes avec apports sédimentaires clastiques et 2) dans certains environnements subdésertiques et dans des petits bassins versants où les spectres polliniques reflètent la végétation halophile locale.

*Speaker

Post-landslide forest recolonization: a paleoecological view from a 4000 yrs old case-study

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In Armenia, a mountainous country from Caucasus, Eastern Europe, the provinces of Gegharkunik and Tavush suffer from medium to high landslide hazards. The Kalavan Red Lake (1912 m a.s.l.) was formed by a large Holocene landslide of about 0.86 km² which occurred thanks to combining water saturation in the substratum and slope steepness (average 24%). Accumulation zone created folding and depressions today occupied by Kalavan Red Lake and a mire eastward. Nowadays, montane forest only occupies the northern side of Gora Dzhanatapa (2427m), affected by the landslide, while grasslands and upwards steppes occupy other sides of the peak.

We hypothesise that post-landslide vegetation recolonization in the lake catchment is recorded in pollen assemblages in the sediment of Kalavan Red Lake, while lower and not affected vegetation zones are a minor component of the record. Therefore, pollen and XRF analysis were provided on a 5 meters long core to unravel vegetation and erosion changes, respectively. Basal age of Kalavan sediment (i.e. 3800 years cal BP) may approximate landslide age which produces a new, not vegetated slope, including the lake catchment. Erosion and sedimentation processes brought at first coarse and heavy minerogenic elements, declining along time with the catchment colonization by tall-grassland pioneers. This shift in the sedimentation continues, suggesting less erosion in the catchment, when sparse woodland of *Quercus* (oak) and grasslands settled. Starting from 2000 cal. BP, arboreal pollen increases successively thanks to the step recolonization of *Quercus macranthera* (open forest), *Carpinus orientalis* (oriental hornbeam) and *Fagus orientalis* (final forest).

Regional records in forested landscapes from the Lesser Caucasus are missing to compare this post-landslide vegetation dynamic. It therefore hinders to be too conclusive in the actual knowledge. Whereas oak development is known from Aparan valley in Armenia and may possibly relate to regional vegetation shift, beech, which is a known indicator of forest development climax stage, appears first as single stands at 1700 cal. BP. Upward, two forested phases are observed. The last, starting 700 years ago, is similar to today's forest pollen signal (evidenced by 5 moss pollen traps) both in composition and proportion. This work shows a different pattern of vegetation dynamic compare to primary succession. Main characteristics here are tall-grass accounting for the pioneer stage that delay the forest recolonization by about 2000 years.

*Speaker

The olive groves landscape of Kournas lake (Crete, Greece) from the Late Neolithic to Present Day

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The opportunities to follow the Holocene evolution through sedimentary archives are not numerous in south-eastern Mediterranean, and especially in the Aegean. In Crete, the largest Greek island, Kournas lake is the only natural lake and its sedimentary record offers the opportunity to study 10 millennia of environmental changes. On the 14 meters long core we extracted from the lake, multiproxy studies of sediments, pollen and non-pollen palynomorphs, and charcoals, were undertaken in order to document: 1) lake formation and evolution, 2) floods and slumps events, 3) land cover and biodiversity changes, 4) human agro-pastoral activities and 4) fire history.

The results highlight the Holocene environmental trajectory as well as key socio-cultural phases in the eastern Mediterranean basin. For example, early Neolithization, the development of Minoan civilization, Greek and Roman Antiquity and Venetian rule over Crete. The south-eastern Mediterranean is an area sensitive to climate change and/or rapid climate change events. In addition, the region is exposed to natural hazards such as volcanism and earthquakes, the most famous being Santorini eruption. This research allows us to assess and compare socio-cultural and natural process that shaped this typical Mediterranean landscape and the processes linking causes and effect in these changes.

At Kournas, considering changes in the vegetation cover, pollen biodiversity and fire regimes, our perception is that human disturbances are the main cause of changes. So are the different phases of olive cultivation that have succeeded one another since 6000 BP. From the Late Neolithic to the Present Day, the main stages comprise a sharp decrease at the end of Minoan civilization, a significant and sustained cultivation during Hellenistic and Roman periods, a decrease under the Venetian rule that favoured wine, and then, new growth from the Ottoman period onwards. Disturbances as an effect are more obvious on the hydrology of the watershed, including floods and changes in lake productivity. However, the major changes are often linked to multifactor causes. As an example, around 3600 BP, the Santorini eruption is not a disruption in the palaeoecological history in this area. But, at that time, seismic activities that caused several slumps in the lake, together with socio-political perturbations of the Late Minoan, and changes in agro-pastoral activities resulted in a significant environmental change.

Obviously, around the Cretan lake of Kournas, the main feature of the current landscape is a legacy of a 6 millennia-long olive cultivation, and the socio-cultural evolutions drove the rhythm of this major land-use. Nevertheless, only complex interrelations between natural and cultural changes led to ecosystems changes as may also succeed in the future.

*Speaker

Fires and human activities as key factors of the high diversity of Corsican vegetation

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Like most of the Mediterranean area, Corsica is a hotspot of biodiversity and this region is the most affected by forest fires. The current vegetation of the island is in some way adapted to this disturbance but a change in fire frequency or intensity may lead to ecological, economical and human disasters. Here, we present the dynamic of vegetation–human–fire interactions for the past 12000 years as recorded by the lake Bastani (Corsica, France). Well-dated sedimentary records of charcoals, pollen and fungal remains were used to reconstruct past fire regime, land-cover and land-use changes. Our results suggest that the climate and the natural fires were the main factors shaping the landscape before 5500 cal. BP. However, the extraordinary diversity of herbs, shrubs and trees in the current Corsican landscape is mainly due to human activities since at least the Bronze Age (3500 cal. BP). The modern decrease in pastoral activities and the land abandonment associated with, combined to the increase in fire frequency and intensity expected in the next decades due to global warming and human density increase, threat this delicate balance. This study is part of a wider work aiming to simulate past fires from vegetation and climate data obtained by pollen and climate models, and to model recent fire process, in order to build predictive models.

*Speaker

Deciphering the role of natural and anthropogenic forcings in coastal paleoenvironmental variability: results of a study in progress

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Coastal areas are particularly sensitive to environmental dynamics in parallel with substantial human disturbances. Multidisciplinary palaeoclimate regional studies are thus required to better understand the spatio-temporal complex functioning of coastal ecosystems under different forcing mechanisms. Northwestern Europe is particularly interesting because of its connections to main atmospheric and oceanic natural oscillations that govern the North Atlantic climate from decadal (i.e. North Atlantic Oscillation or NAO) to pluri-decadal (Atlantic Multi-decadal Oscillation or AMO) timescales. Moreover, the history of past human civilizations is also dependent on environmental changes. Taking into account these preliminary thoughts, estuary outlets appear to be particularly favourable for detecting ecosystem changes in response to climatic and/or anthropogenic disturbances on their watersheds. Palynological studies combining analyses of dinoflagellate (phytoplanktonic algae) cysts (or dinocysts) and pollen grains provide essential information regarding past sea-surface and continental conditions, respectively, and constitute then a land-sea continuum approach involving a large number of natural and human forcings. Pollinic assemblages enable to discuss vegetation dynamics on watersheds and climatic processes responsible for changing production and/or transport in pollen grains while dinocyst analyses consist in an indirect approach to access the palaeobiodiversity of dinoflagellates and thus of one of the major components of the primary productivity also known to be very sensitive to environmental changes. Beyond the natural post-glacial evolution pattern of the continental vegetation, palynological anthropogenic indicators (in particular *Cerealia* pollen grains) that provide information on the development of cultivated cultural landscapes and agro-pastoral activities can detect dynamics of human occupation. We will attempt to decipher the respective influences of local anthropogenic pressures *versus* regional natural forcings over the Holocene at different timescales (e.g. at the Meso-Neolithic transition; for the last 2,500 years), thanks to a cross-correlated pollen-dinocyst analysis conducted in a giant estuarine environment of northwestern France: the Bay of Brest.

*Speaker

History of semi-arid and arid environments in the Eastern Maghreb during the Middle Holocene: first results of the pollen analysis from Sebkhia Kelbia (Central Tunisia)

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Climate projections show the extreme vulnerability of the semi-arid and arid environments on the southern shore of the Mediterranean. Global warming and the growing impact of human activities on the steppe ecosystems of central Tunisia result in an acceleration of the desertification process. To study these steppe environments, it is necessary to have long-term cross-observations of 1) the environmental changes over the last ten millennia (Holocene) and 2) the impact of human societies on the environments since the emergence of the Neolithic.

The steppes from Central Tunisia are crossed by many wadis flowing into depressions (sebkhias, temporary lakes) whose sedimentary deposits constitute paleoenvironmental archives that are still under-studied. A core recovered in the Sebkhia Kelbia has provided a long continental sequence (15 m) covering the last 8 millennia. A multiproxy study is being conducted to characterize palaeohydrological changes and vegetation history in response to climate changes.

For this presentation, we will focus on the Middle Holocene period, which records the end of the African Humid Period and the establishment of a long arid period affecting the environment since the 6th millennium BP. During this period, the Sebkhia Kelbia gradually evolved from a strictly lacustrine hydrological system to a temporary lake system and then a sebkhia. Local and regional vegetation responded to an increase in aridity with the establishment of Mediterranean xerophyte taxa on the relief of the Tunisian Dorsale. The data acquired in the Sebkhia Kelbia is compared with other sequences available in the arid environments of Central and Southern Tunisia.

*Speaker

Neotropical rainforest and climate cycles during the Quaternary

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Tropical forests cover only *ca* 10% of the Earth's land surface, but are of global importance, as they store and process large quantities of carbon-processing and house between one-half and two-thirds of the world's species. In the last decades our knowledge about responses of the tropical forests to past climate changes greatly improved. In tropical South America rainforest represents 36% of the territory. They are bounded by very specific and contrasted climatic patterns mainly controlled by the monsoon activity. Recently speleothem studies showed that hydrological cycles were paced by the orbital cycles. With almost a continuous land area from Antarctica to equator, South America represents a very interesting laboratory to evaluate the interplay of polar air masses on continental climate and more specifically on mean annual temperature and forest diversity. We will present the most recent palynological results together with other complementary proxies and discuss them in the frame of the climate cycles and global changes. Specific tropical patterns will emerge from this review.

*Speaker

Contributions of palynology and dendrochronology to the understanding of the evolution of the site of Pineuilh, La Mothe (Gironde, France)

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In connection with Pineuilh La Mothe (Gironde, France) excavation, multidisciplinary approaches, integrating palynology and dendrochronology, have been carried out in order to reconstruct the land use history and woodland management of the site, with a high temporal resolution. The specific status of Pineuilh La Mothe manifested by its establishment on an artificial islet in the middle of the riverbed, and by the abundance and quality of archaeological relics, clearly indicates a site of well-established elite headquarters.

Analysing 500 oak samples, complete with their outer ring, it was possible to determine with an extreme precision the felling phases, and enabled to follow the pace of constructions, from the settlement of a surrounding ditch protecting a central main building to creation of a motte and its new building. The palynological study is based on eight sequences: four off-site cores and four extracted in the organic filling of the ditch

The cross-referencing of palynological and dendrochronological data allowed to propose a model with three phases of occupation and landscape management practices, between the 10th and the 12th century AD.

The first phase corresponds to the beginning of the settlement, with the development of a surrounding ditch and a central main building (1a = 976/977 to 994/995 AD), and then an extension involving a wooden footbridge and a landing stage (1b = 994/995 to 1044-1045 AD). Crops and livestock farming were well developed but woodlands persisted: alder woods in the valley and oak groves on the slopes. Old wood oaks were used for the constructions. The ditch was used as a dump (discharge of faeces).

In a second phase (1044/1045 to 1123 AD), access to the site was modified and oriented southwards. Cereal crops increased while riparian forest was being exploited. Younger woods, collected from coppice, and more diversified (as shown by the use of elms and alders alongside oaks), were used for constructions.

The third phase (1123 to 1200 AD) corresponds to a change in the site's status, with the addition of a new building a hundred meters to the north, in a dry area. Farming activities decline while afforestation increased in the valley bottom.

*Speaker

Raña Maleta mire (Toledo Mountains, central Iberia): the last shelter for a lost forest

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The Mediterranean region hosts highly diverse ecosystems resulting from an outstanding-geological and climatic diversity (particularly of mesoclimates) and peculiar geography. However, today's exceptional richness cannot be fully understood without taking into account the significant influence of the dynamic and long-lasting interactions between climate, fire regimes and human activities in this part of the world. Paleoecological studies allow us to reconstruct the trajectories that explain current ecosystem configuration and the way cultural landscapes were shaped. Mountain ecosystems are particularly sensitive to changes in climate, land use and disturbance regimes, therefore representing a unique setting to understand long-term ecological forcing.

The Toledo Mountains is a mid-mountain range located in the heart of the Iberian Peninsula, separating Tagus and Guadiana basins. This mountainous area experiences a typical Mediterranean climate, with some oceanic influence towards its westernmost edge. The vegetation here mainly consists of sclerophyllous evergreen woodlands. Hunting and livestock husbandry have traditionally been the main activities developed by local human settlers in these landscapes. Additionally, the Toledo Mountains have acted as a prominent reservoir of other natural resources for human communities, with wood, charcoal or wax as the most important products obtained directly from the local woodlands.

During the Holocene, the Toledo Mountains have also served as a refugium for many cold-adapted species that persist today as relict populations along the mountain range. The Raña Maleta mire paleoecological record enabled us to reconstruct the landscape of the southern Toledo Mountains from *ca.* AD 1200 to 2011. This study shows how the local vegetation once comprised not only evergreen and deciduous *Quercus* woodland, currently dominating the landscape along with many crops and shrublands, but also more mesophilous communities with *Corylus*, *Betula* and *Myrica gale* that today are locally absent. We show that neither late Holocene climatic oscillations nor changes in socio-economical activities and fire regime affected the persistence of this refugium. Raña Maleta mire site is exceptional compared to other previously studied paleoecological sites in the Iberian Peninsula and thus helps us to understand this understudied territory and its singular history.

*Speaker

Environmental changes and human impact during the Middle to Recent Bronze Age in N Italy (SUCCESSO-TERRA Project)

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This contribution reports on the ongoing interdisciplinary research program SUCCESSO-TERRA (*Human societies, climate-environment changes and resource exploitation/sustainability in the Po Plain in the mid-Holocene: the Terramare culture*; PRIN-20158KBLNB, 2017–2020; <https://www.successoterra.net>) aiming at reconstructing the landscape and landuse transformations that occurred during the development of the Terramare culture (16th-12th century BC) in the Po Plain of Northern Italy. The project joints experts on Geoarchaeology, Palynology and Archaeobotany to study high-resolution archaeological sediments with an interdisciplinary ecological perspective (Cremaschi et al. 2018). The study of sediments and pollen assemblage from both natural archives and selected Bronze Age sites (Terramara of Santa Rosa di Poviglio and Vasca di Noceto, and occupation layers of S. Michele di Valestra) shine a new light on the mutual interconnection between climate change, landuse, and human resilience.

The palynological research focused on Santa Rosa di Poviglio and allowed details of some of the complex processes in the agricultural economy to be filled in, such as were practiced on the basis of wood management and crop fields (Cremaschi et al. 2016). Pollen diagrams showed oscillations of the curves of deciduous oaks and other woody plants (*Carpinus betulus*, *Corylus*, *Fraxinus* and *Carpinus orientalis/Ostrya carpinifolia*). The role of trees and shrubs supplying fruits (*Prunus* and other woody Rosaceae, *Cornus mas*, and especially *Corylus* and *Vitis*) resulted of special interest. The fields included different types of cereals (*Avena/Triticum* and *Hordeum* groups, *Secale cereale* and *Panicum*). Most of the open landscapes around the villages were used for pastures as suggested mainly by Cichorieae and other pasture pollen indicators. The Anthropogenic Pollen Indicators-API group (Mercuri et al. 2013) are significant in the spectra together with other synanthropic plants, and indicate a continuative human pressure in the area.

The last phases of the pollen diagrams show a decrease of woodland together with a reduction in cereal fields suggesting that soil and wood overexploitation might have been among the causes of the Terramare's crisis and their societal collapse (Mercuri et al. 2006; Cremaschi et al. 2016). The interdisciplinary study will disclose the natural (environmental aridification) and anthropic (overexploitation of natural resources) reasons of the collapse of the Terramare culture, by investigating the environmental changes in the region and their relationships with the different land-use adopted by the Terramare people.

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Key-words: landuse, climate change, Terramare, mid-Holocene, interdisciplinarity

*Speaker

Patterning Holocene lake dynamics and detecting early Prehistoric human impacts: targets of an improved integration of multivariate ecological indicators thanks to the data mining approach.

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Recent research has highlighted that the overloading of water bodies with nutrients (principally nitrogen and phosphorus) is a widespread environmental problem which leads to (1) ecological disturbances (e.g. cyanobacterial blooms), (2) public health problems (e.g. water quality degradation due to cyanotoxin production or oxygen depletion) and (3) erosion of ecosystem services (swimming prohibitions, reduced local aesthetic valuation). Feedbacks to society are thus expected and restoration of eutrophic freshwaters is an environmental top-priority.

In the Chaîne des Puys, located in Auvergne (Massif central, France), lake systems such as the hypereutrophic lake Aydat (837 m a.s.l.), suffering from recurrent cyanobacterial blooms, are under increasing stress from anthropogenic impacts (agriculture, tourism etc.), and vulnerable to the Earth's changing climate. The registration of this area at the UNESCO's world heritage list is subject to the formulation of viable mitigation and conservation strategies guaranteeing both the environmental quality of freshwaters systems - for which local authorities have heavily invested (public amenities) - and the socio-economic development, vital for this rural territory.

Current management options of lake Aydat aim at reducing present-day nutrient inputs by promoting the extension of a filtering peatland. But the current ecological status of this lake is also determined by the legacy of long-term cumulative impacts caused by natural and anthropogenic stressors over the seven last millennia. Palaeoecological research was thus undertaken at a high temporal resolution in order to analyse the natural and anthropogenic modifications of its catchment, which favoured an enhanced external input of sediment and nutrients and which induced disturbances on lake Aydat system. A careful selection of proxy bioindicators (pollen, non-pollen palynomorphs, diatoms) were combined in an innovative approach of time-constrained data mining (MOBI-PALEO: <http://mobipaleo.univ-bpclermont.fr/>) in order to characterize sets of specific and multi-variate indicators of the lake Aydat states and trajectory through time. This research aims to address more specifically:

- (1) the baseline conditions of the lake system, prevailing prior to extensive human impact, and from which the further anthropogenic disturbances may be analysed;
- (2) the pace, direction and magnitude of aquatic transitions – distinguished from natural variability- and how reversible they may be or, on the contrary, how they explain the long-term drift of the lake system.
- (3) the apportionment through time between natural (e.g. gravitary event, climate) and anthropogenic drivers on the past lake dynamics;

*Speaker

- (4) the timing and nature of human impacts which are complex and variable through time. Special focus is put on the prehistoric influences, which is challenging due to their subtlety. Nevertheless, analysing the response and/or recovery after these earliest impacts on "natural" system provide significant insights into a better knowledge of the further lake trajectory;
- (5) the model of past lake behaviour and sensitivity assessment, useful for directing feasible management interventions and projecting future responses under global change scenarios.

Holocene vegetation reconstruction in northern Spain: Potentials of pollen and *n*-alkane biomarker analyses

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Knowledge of past changes in vegetation serves for a better understanding of archaeological data, the earth climate system and carbon cycle and genetic diversity, and can help to build up current predictions and conservation strategies. The need for accurate vegetation cover datasets is particularly acute for the mid-Holocene, given the critical role of human and climate dynamics and biochemical cycles. However, the current knowledge about mid-Holocene vegetation in southwestern Europe is limited due to the lack or scarcity of high-resolution palaeobotanical records. The poor spatial coverage and dating control of the available pollen records may lead to contradicting interpretations of the composition of mid-Holocene vegetation cover. All mentioned problems are well pronounced in northern Iberia, where the majority of pollen records were carried out decades ago and they do not have radiocarbon data or these are very scarce, and where the acquisition of socio-economic practices by the first farmers' societies was later than in the rest of the peninsular territory. We report the results of a comparative study of *n*-alkane biomarkers and pollens in a peat deposit at Roñanzas, Asturias province in northern Iberia, and discuss the likely causes for the discrepancy in the interpretations of the *n*-alkane biomarker and pollen records in terms of climate and vegetation changes.

*Speaker

Climate and vegetation imprint of the cool MIS 13 in the Iberian Peninsula

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The study of past interglacials, periods of reduced ice volume like our present interglacial (the Holocene) is crucial for understanding the future climate. Marine Isotope Stage (MIS) 13 (478–533 ka) represents a Quaternary interglacial of primary interest and in recent years it has become the focus of much attention. One of the main reasons of this interest stems from the fact that MIS 13 is among the most glaciated and cooler interglacials of the past 800,000 years, and unexpectedly it is associated with an unusual strong summer monsoon, even though CO₂ and CH₄ levels are not particularly high. Conversely, a growing body of evidence indicates that the conditions during MIS 13 vary geographically, and several continental records document a rather warm interglacial coupled with relatively low global ice volume. In the Mediterranean region, the study of MIS 13 climate is, however, strongly hampered by the paucity of available records, particularly in the terrestrial realm as only two vegetation sequences contain a complete record of MIS 13.

Here we present the first high-resolution (centennial-scale) pollen record from IODP Site U1385 covering MIS 13, that allows the reconstruction of vegetation and atmospheric changes on orbital and suborbital timescales, in a direct comparison to alkenone-based sea surface temperature (SST). This site, also known as the "Shackleton Site", was collected on the SW Iberian margin, a region highly sensitive to global warming that is considered a prime location for tracing past climate changes. Western Mediterranean atmospherically-driven vegetation changes and surface oceanic conditions are discussed in the light of a larger European and North Atlantic context to assess the influence of global and remote controlling factors throughout MIS 13.

*Speaker

Holocene paleoenvironments over the last 9 kyr BP in the northeastern Atlantic Ocean: the Grande Vasiere deposit in the Bay of Biscay (NW France)

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In order to document NW French Holocene paleoenvironments both involving long-term and rapid climate changes as well as growing human impacts in the territory through time, a multi-proxy analysis including new high-resolution (70 years in average, with minimal spacing of 20 years between studied samples) palynological analysis (dinoflagellate cysts -dinocysts- and pollen assemblages for sea surface paleohydrological and vegetation dynamics) on cores CBT-CS11 and VK03-58bis both located on the northern part of the Armorican shelf (Bay of Biscay, South of Brittany, Western France), is discussed together with geochemical (oxygen and carbon stable isotopes) and sedimentological (XRF, granulometry) data previously published in Mojtahid et al. (2018) for CBT-CS11 core. This study also allows revising previous works published in this area with core VK03-58bis (Naughton et al., 2007). In core VK03-58bis, the condensed interval with thanatocenoses of concentrated *Turritella* shells, often attributed to the 8.2 ka event, is well correlated to a main stormy interval centered at 7.6 ka BP and represents a major discontinuity surface implying probably 2 kyr of sediment hiatus. On the other side, CBT-CS11 allows discussing continuously the last 7 kyr BP with a major sediment change noted at around 5.5 ka BP probably related to the reducing marine accommodation space on the platform itself governed by the relative sea-level stabilizing at this period. Our composite results then allows discussing major paleoenvironmental changes over the last 9 kyr BP. Among main features, a specific interval centered at 3.5 ka BP is characterized by quasi monospecific dinocyst assemblages as well as increasing percentages, concentrations and fluxes of the estuarine-neritic species *Lingulodinium machaerophorum*, as well as increasing pollen grain percentages of the riparian tree *Alnus* (maximal values of the whole sequence). Interestingly, these major fluvial discharges appear synchronous with reconstructed negative modes of the North Atlantic Oscillation (especially on the interval 3.5-2.5 ka BP) implying increasing winter precipitations on northern Europe. This interval also corresponds to main cultural changes/practices that remains discussed within the archeological community. We also highlight increasing agro-pastoral practices on land since 4.2 ka BP and stronger increases of pollinic indexes for anthropisation also associated with dinocyst-derived eutrophication signals during the Middle Ages, with a peculiar pollen signature evidencing a tree reconquest at the end of the Roman period (Late Antiquity) that may be attributed to a major rapid climate change (known around 1.5 ka BP with especially higher storms and humidity), involving the withdrawal of men from the coast inland.

*Speaker

The climate of the last 50 ka in Western Europe reconstructed from the Bergsee pollen record (Black Forest, Germany)

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This study aims to reconstruct quantitatively the high-frequency climate changes of the period 45 – 9 ka cal. BP in Western Europe from the Bergsee pollen record (Black Forest, southern Germany). The climate reconstruction is based on multi-method approach including the standard Modern Analogue Technique, the Weighted Average Partial Least-Squares regression. We also tested here the Inverse Modelling method, the only method able to take into account the ecophysiological effects of changes in CO₂ concentration during the reconstruction of climate changes from fossil pollen assemblages. Changes in CO₂ concentration are important during the Greenland Interstadials and Stadials.

Results reveal that temperatures of the Last Glacial (Marine Isotope Stages 3 and 2) were on average 10 °C less than present-day. We detect the imbricated climate variabilities recorded for the North Atlantic, with i) a wet late MIS 3 (45 – 30 ka cal. BP) compared to a very arid MIS 2 (30 – 14.5 ka cal. BP), ii) a series of short-lived warm/wet episodes corresponding to D/O interstadials, more frequent and pronounced during late MIS 3 (mostly GIs 8 to 5.1) than during MIS 2, which was caused by the massive regression (MIS 3) and expansion (MIS 2) of polar ice-sheets, and iii) four particularly dry/cold phases attributed to the Heinrich stadials, with nonetheless a changing pattern from a single-phase HS 4 to multi-phase HSs 3, 2 and 1 linked to the increasing melting of the European ice-sheets through the Last Glacial.

A comparison of climate reconstructions between the Bergsee and other European records (marine and terrestrial) reveals synchronous and similar climate changes, supporting the direct impact of the Atlantic Ocean on the European climate. But some differences in time and amplitude suggest gradients of the climate change signatures through Europe

*Speaker

Glacial refugia, postglacial expansion and biogeographic dynamics of "Abies alba" in the Iberian Pyrenees: pollen and genetic data

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In recent years, different studies involving palynology or genetics have reconstructed the postglacial colonization dynamics of Silver fir (*Abies alba*) in the Pyrenees and the Alps, where glacial refuges have been raising a controversy that remains unsolved: in the past Silver fir had wider distribution areas than today and probably was growing on different altitudinal stages and exposures. Wick and Mohl (2006) affirm that the recent decline of Silver fir in the Alps is partly a consequence of the reduction of the genetic variation that gives a lack of adaptability. The use of molecular markers have highlighted the presence of several *Abies* refugia in the Alps and Liepelt et al. (2009) inferred the existence of a former *Abies* glacial refuge in the Pyrenees. On the other hand, Matías et al. (2016) state that genetic analyses in the Pyrenees separate eastern and western provenances in two different lineages. In the Pyrenees, palynological data indicate a westward colonization but neither the pollen nor the macroremains data have allowed identifying Silver fir refugia.

In this study, we combined palynological and genetic approaches to clarify the past history of the Pyrenean Silver fir forests by providing new hypothesis of their postglacial dynamics, and by describing precisely their ecological range and their geographical distribution. We used molecular analyses of 43 Silver fir populations comprising 1.173 individuals across the Iberian Pyrenees, near the south-west limit of the species distribution in Europe. Populations from the Alps were included as external references. Individuals were genotyped at 65 SNPs (single nucleotide polymorphism) and the distribution of the genetic diversity was analysed among populations and among individuals within populations. Paleocological proxies (palynology, pedoanthracology, plant macroremains) and information from 30 pollen diagrams on the Pyrenees and adjacent areas were also used, with particular focus on Silver fir past dynamics.

Pollen indicates a progressive expansion of Silver fir westwards and the genetic survey, confirms the presence of two genetics groups in the eastern and western Iberian Pyrenees with a hybridization zone in the central part.

The distribution of the genetic diversity among the 43 Pyrenean Silver fir populations is strongly correlated with longitude and the direction of the correlation depends on the genetic marker: 17% of SNP markers show an increase in genetic diversity eastwards, whereas 27% of SNPs show an increase in genetic diversity westwards. The presence of a strong and significant isolation by distance suggests a larger diffusion by colonization westwards, in agreement with palynological inferences. In addition, the modelisation of past demographic scenarios using the coalescent theory and Approximate Bayesian Calculations (ABC methods) highlighted different demographic history between the genetic lineages of *Abies* in the Pyrenees.

The genetic differences between the eastern and western lineages suggest the likely existence of Silver fir

*Speaker

refugia in the Iberian Pyrenees. The study of the genetic diversity across and within populations becomes a key factor to understand the current biogeographical distribution of Silver fir and it is necessary to better forecast its vulnerability to climate change. The history of Silver fir as deduced from paleoecological and genetic data should be reinterpreted under climatic, human and genetic points of view.

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Vegetation dynamics and human pressure in two Middle Atlas Moroccan lakes during the Holocene

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The relationship between landscape evolution and human activities is currently an issue of great interest in the palaeoenvironmental scientific literature. The study of this connection is of particular interest during the Holocene, when the climate variability could have influenced the human's ways of life. Here we present the palynological analysis of two Moroccan lakes located in the Middle Atlas Mountain.

The Moroccan Middle Atlas includes more than forty lakes. The high rainfall (800 to 1100 mm / year) and the karstic processes explain this richness in aquatic ecosystems. The lakes are mainly concentrated in the wettest zone and the 3 highest (> 1200 m altitude), exposed to precipitation coming from the Atlantic. In this work we present the palaeoenvironmental analysis (pollens, spores and non-pollen palynomorphs) from Iffer and Afourgagh lakes.

Main results show two dominant arboreal taxa as evergreen *Quercus* and *Pinus pinaster* along both sequences, with *Cedrus atlantica*, Cupressaceae, *Pinus halepensis* and deciduous *Quercus*. Open areas are more frequent in recent chronologies, with anthropogenic evidences and cereal cultivation.

*Speaker

Modern pollen rain on an elevational gradient in the Catalan Pyrenees. A tool for quantitative reconstruction of *Abies alba* forests during the Holocene

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Based on several pollen sequences obtained in the Catalan Pyrenees, it has become apparent that *Abies alba* had wider distribution areas than today. It should be inferred that in the middle Holocene there was a significant increase of climate suitability for *A. alba*. Subsequently, at about 4000-3000 years cal BP, fir populations seem to decline mainly due to climatic causes. In this region, the regression because of anthropogenic causes becomes very intense during the medieval period although it begins before or during the Roman Period.

Holocene pollen values need a paleoecological interpretation to facilitate a better understanding of *Pinus-Abies* transitional periods in pollen records. To know the quantitative importance of the past populations of *Abies alba* and the magnitude of their regression it is crucial when interpreting the past pollen records. Accordingly, it has been made a modern proxy-calibration study, analysing the relationships among modern pollen rain, vegetation structure parameters and altitude.

Moss polsters were collected between 1500 and 2900 meters altitude, with a vertical equidistance of 50-60 meters. Around each point, an inventory was made (radius = 20 meters). Basal diameters of all the arboreal taxa in each plot were measured and the bushy and herbaceous cover percentage was recorded.

Modern pollen assemblages show that pollen of *Abies alba* is underrepresented if we consider the number of individuals, their density or the area covered around the moss polster. This subrepresentation is more marked at altitudes where the fir forest is in contact with pine populations. The percentage of *Abies alba* pollen decreases dramatically in the upper parts of the study area. Due to the size, shape and density of fir pollens, the decline in pollen deposition with distance from a source is remarkable.

Birch and hazel populations present more unpredictable pollen percentages in the different plots, probably because they act as secondary communities. In broad terms, *Corylus* presents higher pollen values at lower altitudes and *Betula* is better represented at higher altitudes. On the other hand, the pollen of some herbaceous plants such as Poaceae (appearing in the most anthropized places) is recorded in a much smaller proportion than initially could be expected.

The results have been expressed confronting several data. For each plot, the number and density of the individuals, the basal diameters and the sum of the basal areas have been considered. To sum up, it can be argued that more pollen calibration studies for *Abies alba* are required at different altitudes and orientations to know its real past abundance in the Pyrenees. The relationship between the *Abies alba* forests and the pollen percentages is very complex in areas close to mountain pine stands. The high dispersion capacity of *Pinus* pollen, always over-represented, does not ever reflect the existence of pure and dense fir forest stands. Because the cores we have in the Catalan Pyrenees are at this altitudinal range, that brings us to think that the high percentages of fir pollen found during the middle Holocene would indicate the presence of dense and mature fir forests in the areas where nowadays is located the ecotone between the *Abies-Pinus* forest.

*Speaker

Palaeoenvironmental crises and expansions connect to economic and political changes in medieval Upper Brittany

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This presentation focuses on expansions and crises based on vegetation dynamics. This study seeks to summarize the results of eight high or good-temporal and spatial resolution pollen sequences. Climate changes are not recorded on these depositional basins in western France (Lespez 2012). This study only deals with the last millennium. The investigation area is located in the northern part of medieval Upper Brittany. The interest of this area rests on its location, on the northern border of the Duchy of Brittany. This territory is both a zone of armed conflicts and economic prosperity between the 10th and 16th centuries. Vegetation dynamics are similar with those recorded for nearby territories (Maine, Nantais, Normandy border). The dynamics of agrarian expansion and regression may be connected to economic and political events. An agropastoral regression is observed on pollen diagrams of the northern part of the area, nearby the coast, in the 10th century. This regression may be linked with the Norman raids. A general rise of agropastoral activities characterizes the medieval expansion in the 11th-12th centuries. From this date onwards the whole landscape is exploited and managed by societies as everywhere else in medieval Europe. In the Late Middle Ages, an agropastoral decline is observed on the northern sites of the study area. In contrast, a new agrarian development is observed on pollen diagrams of southern sites. These different dynamics between the north and south of the study area are confirmed by the archival data. The crises linked to the Hundred Years' war are located on the northern coast of the duchy, where military conflicts are concentrated, while the rest of the Duchy prospers. These crises (Norman raids and Hundred Years' war) can be detected on pollen diagrams because of their intensity and duration. Insecurity leads to agrarian decline. The abandonment of villages leads to an atrophy of farming production and a conversion of some area (fields to pastures for example).

Lespez Laurent, 2012, *Paysages et gestion de l'eau. Sept millénaires d'histoire de vallées et de plaines littorales en Basse-Normandie*, Caen, Presses Universitaires de Caen / MRSH, Bibliothèque du Pôle Rural, n°3

*Speaker

Vegetation history and human impact since Neolithic in the eastern coast of Iberia. New pollen record from the Pego-Oliva basin.

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The study of the core P17-9, extracted in a coastal lagoon in the Pego-Oliva basin (València, Spain) provided a new pollen record to reconstruct Mid-Holocene vegetation history in the eastern coast of Iberia (project Med-CoRes, H2020-MSCA-IF-2015, No. 704822). The study area has been successively occupied by Mesolithic and Neolithic human communities during the Early to Mid-Holocene and combined pollen analysis and geoarchaeological analyses allowed assessing human-environment interaction during the period 7000-1000 cal BP. First signals of farming practices were attested since Early Neolithic (*ca.* 6950 cal BP and 6400-6000 cal BP), when the landscape was predominated by mixed oak forests. The Holocene Climate Optimum, expressed in maximum values of deciduous oak and other mesic trees, lasted until *ca.* 5000 cal BP, when a regression of broadleaf deciduous vegetation is attested and evergreen oak and maquia dominated in the landscape. At local scale, a succession of phases of humid vegetated shore (*ca.* 6600-6300 cal BP and *ca.* 3200-1500 cal BP) / freshwater conditions (*ca.* 6200-5300 cal BP) / detrital inputs (*ca.* 5900 cal BP, *ca.* 5100-3500 cal BP) was documented, responding to climate fluctuation and sedimentation dynamics.

*Speaker

Mid-Holocene palaeoenvironmental evolution along the coast of Corsica. Vegetation history and human impact since Early Neolithic.

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First human settlement in Corsica is marked by a sharp discontinuity between Mesolithic and Neolithic, being documented a gap of population in the transition from the 9th to the 8th millennia cal BP. First evidence of Neolithic is documented around 7800 cal BP, showing a rapid colonisation of the island by first farming societies. The introduction of domesticated plants and animals would have involved significant landscape transformation, but few palaeocological data were available for this period in Corsica. In this work, two coastal lagoons were sampled for geoarchaeological and palaeoecological analyses, in Saint Florent (North Corsica) and in Piantarella (South Corsica). This sequences enabled the reconstruction of palaeoenvironmental evolution, vegetation history and climate change at opposite sides of the island, and it allowed defining regional differences and characterising environmental dynamics of Corsica since Early Neolithic (6300 cal BP to present in Saint Florent, 7400 cal BP to present in Piantarella). While Mediterranean scrublands dominated in the south since Middle Holocene, sclerophyllous forests were the main component of landscape in the north. First signals of the impact of farming practices were documented in southern Corsica, *ca.* 7350 cal BP in Piantarella, and human impact is more evident since Late Neolithic in the north, *ca.* 5900-5000 cal BP in Saint Florent.

This paper is a contribution to the French national Research Programme CNRS-MISTRALS-PALEOMEX-INEE that aims to evaluate the impacts of Holocene climate changes on both the landscape configuration and the human societies since Early Neolithic times.

*Speaker

Vegetation dynamics, human impact and climate influences around Lake Sevan in Armenia

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Current ecosystems are increasingly affected by climatic changes. In this context, studying past environmental changes is important to understand actual dynamics and to anticipate future changes. Some regions, like the Lesser Caucasus Mountains in Armenia, currently have few paleoecology studies. Moreover, vegetation records from this region are often low resolution and do not cover the entire Holocene.

The aim of this project is to reconstruct vegetation changes, to identify human activities and to quantitatively reconstruct past climate during the Holocene in the Vanevan peat (South-Eastern shore of lake Sevan, in Armenia). A sediment core of 6 meters has been collected and the radiocarbon dates suggest a complete Holocene sequence. Palynology is commonly used to reconstruct vegetation, human activities and climate, but distinguish human impact from the climate forcing is still challenging. Therefore, we adopt here a multi-proxy approach: palynology will be combined with Non-Pollen Palynomorphs (NPP) to obtain valuable information on human activities.

Specifically, this study aims to reconstruct the first steppic vegetations during Early Holocene, to identify the beginning of agriculture and its consequences on vegetation around lake Sevan. Human impacts during this period is not currently evident in paleoenvironmental studies from the region. Other records show a forest phase appearing around 8 ka cal BP in the Lesser Caucasus which is favored by humid and warmer conditions. An earlier paleoenvironmental study in Vanevan peat shows the emergence of forest before 7.7 ka cal BP (Leroyer *et al.*, 2016). However, the exact date remains to be determined and will be challenged in this work. In the Lesser Caucasus, the Late Holocene is generally marked by an opening of the vegetation and the human impact by deforestation appears. This high-resolution study around lake Sevan aims to identify precisely agro-sylvo-pastoral practices and to understand their impact on the environment. First results will be presented during the conference.

Reference

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*Speaker

Ancient parasites as biomarkers of environmental and land-use changes as recorded in natural archives: application to the analysis of the Asi Gonia peat bog in the White Mountains, Crete, Greece.

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Paleoparasitology has traditionally focused its interest on the recovery of microscopic eggs laid in the environment by oviparous gastrointestinal helminths. The chitinous part of the eggshells allows a good preservation despite various taphonomical conditions. They can therefore be extracted from soils, coprolites or various sediment samples in which they can accumulate, and observed under light microscopy.

In archaeological context, those organisms can shed lights on health and hygiene of past populations, food consumption, agronomy, or migration process. If the latter information given by those studies regards our understanding of the distribution and circulation of parasitic infections of humans and other animals in the past, they also can be used in a less usual way as paleoecological biomarkers in natural archives. The present work proposes an example of application in this way.

Located in the White Mountains of Crete, the Asi Gonia peat bog constitutes an exceptional 2000-years-long sedimentary archive. The multi-proxy analysis of the 6-meters peat core including sediment, charcoal, pollen, and fungal remains highlighted the shaping landscape through time and the local evolution of biodiversity (Jouffroy-Bapicot et al., 2016). This site is an especially suitable natural archive for this purpose in order that the small size peat deposit, located in a small size watershed. High amount of dung fungal spores seemed to indicate different periods of frequentation by herbivorous animals. We therefore hypothesized that such an area could concentrate faunal faeces residues carrying parasites that the parasitic diversity could be used as a proxy for local animal frequentation through time. Not only a wide diversity of animal parasites was observed in the whole core, but their distribution seemed to be consistent with other analysis regarding changing environment and land use in the region. Moreover, this parasitic diversity could be consistent with other proxies suggesting grazing activities and give more information about locally bred cattle, if any. This is the first time that animal parasites are analyzed as systematic biomarkers in the paleoecological study of a peat bog core. Observed parasites include several helminths genera, notably *Macranchanthorhynchus* sp., *Trichuris* sp. and *Fasciola* sp., well known to be hosted by pigs and ruminants.

We report here our findings regarding animal parasitic infections detected at Asi Gonia, shedding lights on a variety and succession of animals, including different and distinct periods consistent with other micro-bio-indicators of grazing activities and landscape evolution over the last 2,000 years.

*Speaker

Fire regime and land uses shifts in a mountain territory of Cantabria (Spain) from the mid-Holocene to the present. El Cueto de la Espina peatbog

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Fire plays a major role in the formation of mountain landscapes, especially in the territory where this research is being conducted. In Cantabria (Northern Spain), the use of fire for opening forest spaces and maintaining pastures has been steady since the Prehistory until the present. Nowadays, the landscape is mainly formed by open communities of shrubs with the presence of some livestock. In this sense, the use of fire represents a traditional management practice for pastoralism and clearances in order to facilitate transit for the livestock and farmers that persist at the present.

This communication complements the results previously obtained in the framework of the Project CSO2015-65216-C2-1-P, which is currently being developed. The aim of this study is to assess the patterns that link fire regimes with land uses shifts and its relation to human activity from the mid-Holocene to the present in the Cantabria territory where human presence has been widespread and well known since the Prehistory.

The first data obtained from the sedimentary record of El Cueto de la Espina peatbog (1130 m a.s.l) at the region of Cantabria is presented. The core obtained had a 255 cm depth, which allows to study the period from 5880 cal yr BP to the present. The fire indicators analysed have been macro-charcoal (> 150 µm), which are related to local fires, and microscopic charcoal, counted on pollen slides, indicator of local and regional fires. In addition, other specific taxa have been analysed: Poaceae and Cerealia pollen, indicators of open spaces and agricultural use; *Pteridium* and *Glomus* spores, indicators of an environmental disturbance; and some coprophilous fungi spores, such as *Sporormiella*, *Podospora*, *Sordaria* and *Cercophora*, indicators of livestock presence.

The results indicate a substantial presence of fires since mid-Holocene in Cantabria. Initially, the different charcoal sizes analysed provide information about local and regional fire regimes. Therefore, while macro-charcoal values have remarkable fluctuations along the whole sequence; micro-charcoal ones seemed to be uninterrupted along time until 1500 BP, despite minor shifts are also observed.

Moreover, biological indicators confirm the human presence from the Mid-Holocene. Some indicators, such as *Glomus*, *Pteridium*, Poaceae and coprophilous fungi have a correspondence in its evolution with the micro-charcoal signal, while an alternation among them and the macro-charcoal signal is detected. The manifestation of Cerealia is intermittent along the study, although it is more likely related to the micro-charcoal signal than with the macro-charcoal. It is when the latter is interrupted that cereals are observed.

Due to human activities, in the last 5880 years several different periods have been reported regarding fire regime and land use. Consequently, it can be concluded that local fires had an impact in the vegetation shifts, while the presence of open landscapes is associated with micro-charcoal evolution.

*Speaker

First results of the Kerloc'h palynological study (Crozon, Finistère, France)

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The development of a research program dedicated to Lateglacial societies located along the Atlantic coast resulted to a search for new off-site paleoenvironmental sequences in Western France. If Holocene paleoenvironmental data are rich in this region, Lateglacial sequences are scarce and generally mixed. The Kerloc'h lake at Crozon (Finistère, France) was identified as a potential site where Lateglacial sediments might be preserved. Coring was first organized in 2015. The Kerloc'h lake is located behind dune ridges and corresponds to a residual pond formed within a large area of wetland.

Nine cores were collected from different locations in the lake in order to fully characterize the sedimentary fill. Coring has not yet bottomed the sequence. Our study essentially focused on 2m-deep core KER 15-03 offering a 3000 year sequence according to available radiocarbon dates. A palynological study was performed as well as a geochemical log (XRF core-scanner). XRF results show terrestrial materials in a swamp context at the base of the core. It precedes marine sedimentation with an important sandy layer just below further terrestrial sedimentation, which testifies to a disconnection between the wetland and the littoral zone resulting in the installation of the actual lake.

The palynological investigation records important changes to the vegetation cover through the sequence. These changes are consistent with the available data about regional vegetation history. KER 15-03 also shows more local phenomena with the alternation of hygrophilous and halophilous taxa evidencing the alternating continental/marine/continental nature of the wetland system. The progressive development of a cultural landscape is also recorded in the core.

More coring is scheduled for 2019 in order to complete the available sequence and hopefully to sample Lateglacial deposits at > 2m depth.

*Speaker

Utilisation des coussinets de mousse dans la caractérisation des relations pluie pollinique/végétation actuelle dans l'extrême nord est Algérien

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Dans le cadre de la contribution à l'étude de la relation végétation régionale et pluies polliniques dans l'extrême nord est algérien, nous avons réalisé une analyse pollinique sur des coussinets de mousses provenant de plusieurs sites qui se dispersent le long d'un transect bioclimatique Nord/Sud.

l'échantillonnage a été réalisé dans des formations forestières en partant l'étage bioclimatique humide puis le sub humide, le semi aride supérieur et en fin le semi aride inférieur selon la présence des coussinets de mousses.

le prélèvement des coussinets de mousses est manuelle quant à la purification des pollens nous avons utilisé le protocole standard. La lecture et l'identification ont été réalisées sous microscope grossissement X40 et en comparaison avec les atlas pollinique de M. Reille (1992, 1996, 1998)

les résultats obtenus de l'identification du pollen ont permis de dresser un diagramme pollinique. L'observation de ce diagramme montre une nette zonation de végétation qui met en relation les séries de végétations, la position de la station et l'étage bioclimatique.

Ces résultats ont montré une relation non claire, car nous avons constaté l'existence des espèces présentes dans l'inventaire pollinique et son absence dans l'inventaire floristique est le contraire. Ces contradictions sont dues aux caractéristiques morphologiques du pollen, la durée du cycle végétatif ainsi que l'aptitude de l'espèce à produire le pollen.

Il serait donc souhaitable de multiplier les prélèvements de coussinets de mousses dans la même série de végétation.

Mots clés: pluie pollinique, transect, étage bioclimatique, inventaire de la végétation, Nord est Algérien

*Speaker

Le temps long de la construction des territoires de l'archipel croate du Kvarner (île de Krk et Cres). Premières contributions

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Les îles offrent l'avantage d'être des espaces finis, géographiquement circonscrits, qui possèdent leurs propres écosystèmes soumis à des millénaires de pratiques agricoles souvent originales. Mais ce sont aussi des systèmes fragiles en raison de l'exiguïté du territoire, de la limitation des ressources et de la variabilité de leur peuplement.

Les recherches présentées portent sur une partie de l'archipel croate du Kvarner, au nord de la mer Adriatique, et plus spécifiquement sur les îles de Krk et Cres. Depuis plusieurs années, ces deux îles font l'objet de recherches historiques et archéologiques alliant l'analyse des données textuelles, les prospections et les fouilles archéologiques, actuellement centrées sur des sites occupés surtout à l'Antiquité et au haut Moyen-Âge, et parfois continuellement de la protohistoire à aujourd'hui. Ces fouilles ont, entre autres, mis au jour d'importantes concentrations de sépultures qui permettent une étude anthropologique et paléo-génomique des populations qui ont successivement occupé les lieux. Ces deux îles possèdent en outre des parcellaires anciens exceptionnellement bien conservés qui traduisent l'extension des pratiques agricoles et agropastorales qui se sont succédé durant les derniers millénaires.

A proximité des sites archéologiques et au cœur des espaces agropastoraux, des lacs, des dolines comblées et des lagunes peu profondes offrent l'opportunité d'exploiter les archives sédimentaires pour des analyses paléo-environnementales. La caractérisation sédimentologique des séquences, la détermination et le comptage des pollens, des spores et des micro-charbons, une caractérisation à l'échelle moléculaire des matières organiques permettent la mise en culture et l'extension des zones pâturées et cultivées et de discriminer les flux sédimentaires détritiques générés par l'érosion des sols qu'elles entraînent.

Quel était l'état de la couverture forestière et comment a-t-elle évolué? Quelle agriculture a été développée? Quelle était la part du pastoralisme? L'arrivée de nouvelles populations, aux habitudes alimentaires différentes, a-t-elle entraîné une réorganisation des territoires et l'apparition de pratiques agropastorales différentes? Cette communication permet d'apporter les premiers éléments de réponses à ces questions.

*Speaker

800,000 years of western Mediterranean vegetation and climate changes: zooming in on the cold MIS 17 interglacial (700 ka)

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We will present new vegetation and climate data for the last 800,000 years from the western Mediterranean region based on the analysis of pollen grains preserved in the southwestern Iberian margin IODP Site U1385 (37°34.285'N, 10°7.562'W, 2578 m depth). This site, collected during IODP Expedition 339 - "Mediterranean Outflow", is under the direct influence of the westerlies, which bring precipitation to Europe and control present-day vegetation greenness, an indicator of forest cover. The pollen record reveals that the shape of the terrestrial interglacials in southwestern Iberia is different and, more importantly, the amplitude of the Mediterranean forest expansion differs as well. High and low forest expansion occurred before and after 400 ka, indicating that the mid-Brunhes event did not produce a vegetation shift in the Mediterranean forest, contrasting with what is seen in the global records, i.e. Greenhouse Gas (GHG) concentration, polar temperature and the $\delta^{18}O$ benthic isotopes. The lowest Mediterranean forest expansion occurred during Marine Isotopic Stage (MIS) 19 and 11, coinciding with the lowest values in summer insolation. Surprisingly, MIS 11 coincides with high polar temperatures and GHG concentrations. In contrast, the low insolation values of the Holocene along with high GHG concentrations coincide with strong forest expansion. The period between 550 ka and 250 ka, MIS 13, 11 and 9, was characterized, on average, by low Mediterranean forest pollen percentages indicating relatively low precipitation and cold climate. Mediterranean forest expansion was strongest at the beginning of each interglacial, even during MIS 17, a cooler interglacial according to Antarctica and Greenland (synthetic) records, marked by the lowest GHG concentrations of the last 800,000 years. This interglacial, dated between ~ 715 and 685 ka, marks the end of the Mid-Pleistocene Transition with the emergence of severe, long and asymmetrical 100,000-year ice age cycles, and with the North American ice caps taking over the previous dominance of the Eurasian ice sheets in the total Northern Hemisphere ice volume. This change in the location of the dominant ice caps coincided with a major reorganization of the North Atlantic oceanic currents, when the "Boreal heat pump" was replaced by the "Nordic heat pump" implying a northward migration of the Polar Front. Some authors recently suggested that the well-established 100-kyr cycles would start after a long period of advection of warm water that brought atmospheric moisture to Europe enhancing the growth of Alpine glaciers. Our pollen data support the arrival of sustained high amount of moisture to southern Europe during the first part of MIS 17, and show for the first time a subsequent pronounced northward shift of the westerlies bringing moisture to northern hemisphere high latitudes leading to the strong 100,000-year ice age cycles.

*Speaker

Vegetation response and landscape dynamics in the Cantabrian region (La Molina peat bog, Northern Iberia): a continuous record for the last 17550 yr cal BP

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Cantabria (Northern Iberia) is one of the European regions with more known Palaeolithic sites. A combination of different sedimentary records obtained from La Molina peat bog (Puente Viesgo) enabled the study of the vegetation dynamics from the Late Pleniglacial (17550 cal yr BP) to the present, its relationship with the fire regime and with climate oscillations. Analysis of pollen, non-pollen palynomorphs, microcharcoal (> 150 μm) and loss on ignition (LOI) have been performed.

According to the results, there is a clear dominance of non-arboreal taxa during the Late Pleniglacial and the Late Glacial. It is revealed a community dominated by Poaceae while *Artemisia* doesn't bring important percentages, which is indicative of a cold open landscape with Atlantic influence. The presence of deciduous *Quercus* is continuous and presents some increases coinciding with the Oldest and the Older Dryas. The pollen signal of *Pinus* is also continuous, even though it is only represented by values below 30%. However, other arboreal species such as *Betula*, *Corylus* or evergreen *Quercus* appear interruptedly from 17550 to approximately 13500 cal yr BP, when *Betula* colonizes the landscape and reaches pollen values up to 85%. However, during the Younger Dryas its presence decreases coinciding with a continuous presence of evergreen *Quercus*. On the other hand, the communities of hygrophytes and hydrophytes (e.g., *Ranunculus*, Cyperaceae) suffer changes in composition probably as a consequence of local physicochemical variations in the peat bog (e.g., O₂ content or the depth of the soil water), which are directly related to climate conditions. Finally, there are not charcoal peaks recorded before the Holocene, probably due to the low fuel availability determined by the slight presence of woody plants.

Coinciding with the beginning of the Holocene, deciduous *Quercus* and *Betula* increase and the arboreal pollen are close to 100%. Also, it is during the Early Holocene when *Corylus* expansion is detected. The charcoal particles increase during this epoch and coincides with some peaks of *Pteridium* spores. At the same time *Betula* suffers a strong decrease probably due to the expansion of grasslands and *Corylus* stands as well as to the maintenance of deciduous *Quercus* values. Afterwards, the 8200 event is recorded in the pollen spectra as an increase of *Pinus* reflecting a cold and presumably dry event.

In addition, different fungal and mosses spores' peaks appear along all the sequence although their ecological meaning is still under discussion.

To conclude, this work indicates the presence of an open landscape during the Late Pleniglacial. The colonization by different tree species is also well recorded, as well as the beginning of the fire activity and the influence of climate. All this new data complements the work from Pérez-Obiol (2016), who studied the last 6740 years. During that time fire played an important role and, on the other hand, some tree species such as *Fagus*, *Alnus*, *Fraxinus*, *Olea*, *Platanus* or *Castanea* increased its presence or colonized the landscape.

Reference

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*Speaker

Changements environnementaux sur l'île de Pâques depuis 1200 ans. Le marais du Rano Aroi

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L'île de Pâques, Rapa Nui, a été peuplée il y a environ mille ans par des navigateurs polynésiens. Cette île volcanique chilienne (27°S - 109°W), ne doit ses ressources en eau qu'aux précipitations (actuellement 1300 mm/an), ce qui la rend particulièrement sensible au climat, subtropical océanique. L'importance de la gestion de l'environnement est ainsi capitale si l'on considère la culture des premiers Pascuans, navigateurs et le mode de fabrication et de transport des grands Moais (statues géantes) impliquant l'utilisation de la forêt et la coupe des arbres.

La végétation, notamment endémique (Zizkila, 1991), y est particulièrement fragile comme sur toutes les îles du Pacifique.

Les changements de cette végétation ont été étudiés par des pionniers tels que Flenley (Flenley and King, 1984 ; Orliac et Orliac, 2000). On leur a attribué des causes anthropiques (Flenley and Banh, 2007), une destruction par la faune (Hunt and Lipo, 2007) et par le climat (Orliac, 2000 ; Rull et al, 2016). Elle aurait particulièrement souffert lors du Petit Âge Glaciaire (Sachs et al, 2008 ; Nelson and Sachs, 2016 ; Delcroix et al, 2018).

Pour toutes ces raisons, l'étude du dernier millénaire à haute résolution, dont la période entre 1650 et 1722 AD, pour lequel très peu d'enregistrements ont été recueillis, est riche en informations potentielles.

Un projet pluridisciplinaire (LEFE, Bycephal - 2017) mené sur le site du Rano Aroi Dapporte un nouvel éclairage sur cette période ; études anthracologique, palynologique, isotopes des ostracodes, XRF, isotopes (δD) des lipides et datations, ¹⁴C réalisées sur un sondage de 130 cm et couvrant 1200 ans d'histoire.

Les résultats de l'analyse pollinique mettent en évidence plusieurs changements de végétation: à une forêt ouverte succède un paysage de prairie à Asteraceae correspondant à une période sèche (700 à 1000 AD), puis on observe un retour à des conditions plus humides avec un pourcentage important de l'Arecaceae *Paschalococos disperta* (1000 à 1300 AD). Enfin une prairie à prédominance de Poaceae se développe, entre 1400 et 1700 AD. Cette dernière phase qui voit la diminution drastique des arbres correspond à la fois au Petit Âge Glaciaire et à une persistance de La Niña responsable, dans cette partie du Pacifique, de conditions sèches.

L'ensemble des données déjà obtenues permet d'avancer l'hypothèse que les Pascuans ont poursuivi leur exploitation traditionnelle de la forêt mais qu'ils n'ont pu faire face à la conjugaison de phénomènes climatiques nouveaux entraînant, par une trop grande sécheresse, la disparition de la forêt.

*Speaker

Palaeoecological investigation of the Recent Bronze Age site of Este (Padua, N Italy): valuable information from NPPs

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The study of non-pollen palynomorphs (NPPs), combined with pollen and seed/fruit analyses, is a valuable tool for palaeoecological reconstruction of archaeological sites. These proxies have been applied to the archaeological site of Este – via Comuna, excavated in 2015. The site, located in the Po Plain in the southwestern part of Euganean Hills (Veneto), is archaeologically dated back to the beginning of the Recent Bronze Age (14th-13th century AD) (Bortolami, 2015-2016).

Nine pollen samples were collected from a stratigraphical section of a trench opened within a basin/channel characterised by peat layers and alluvial deposits. Pollen and NPPs were counted in the same samples. NPPs were identified using morphotypes descriptions and photographs from reference literature (e.g van Geel 2001; Gelorini et al. 2011). In general, the pollen sequence shows quite a good presence of pollen (from 28.000 to 140.000 p/g), and outstanding quantities (from 84.000 to 642.000 npp/g) and variety of NPPs. About 130 morphotypes have been identified; among the not identified types, seven NPPs will be proposed as new types to be included in the NPP list.

The integrated study of NPPs, pollen and seeds/fruits highlights the system of sources exploitation attested in the site surroundings, and the presence of a water basin representing a useful source for human settlers. Coprophilous fungi testify the presence of animals (van Geel et al., 2003) probably associated with grazing/breeding activities that increase at the same time as woodlands sharply decrease, and cereals and synanthropic species increase. Algae reflect particular conditions of water depth and temperature (Riera et al., 2006; Limaye et al., 2016), and also inform about nutrient supply in the basin (van Geel et al. 1994; Di Rita et al. 2010). Conductor elements of tracheophytes have been found often associated with saprobic fungi living on decayed or decaying wood. Particular attention has to be paid to the complementary information provided by some peculiar plant remains, such as *Ceratophyllum* leaf spines and astrosclereids of Nymphaeaceae.

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*Speaker

Two lakes, two stories: Variations in reconstruction of landscape history from two nearby lakes in the Rieti Basin, central Italy

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The Mediterranean area is intensively affected by anthropogenic impact from human activities, (i.e. grazing, forest cutting and fire), which started to alter natural systems over 10000 years ago. At the same time, human society has been influenced by natural climatic change. This mutual influence results in a complex interaction between humans and the environment that contribute to the development of vegetation history. During the last millennium, central Italy has been affected by intense human activities and climatic change that led to severe impact on the landscape. We present the reconstruction of the landscape history in the Rieti Basin through multi-proxy records such as pollen, non-pollen palynomorphs (NPP), charcoal, rock magnetism, palaeomagnetism, sedimentology, and geochemistry of cores from Lago Lungo and Lago di Ripasottile. The two lakes are remnants of an ancient bigger lake, *Lacus Velinus*, reclaimed by a system of artificial channels opened by the local population since the Roman period. The lakes are only 2 km apart, periodically connected by the channel system. Despite their close proximity and periodic connection, these lakes preserve different records of landscape change, potentially because Ripasottile has received higher inputs from the major river in the area, the Velino, and potentially because land-use practices were spatially highly variable. The Lungo sediments span 2700 years in 14.37m while Ripasottile has a higher sedimentation rate; 1300 years in 12.40m. The higher sedimentation rate in Ripasottile together with a higher percentage of chestnut pollen compared to Lungo, suggests greater inputs of fluvial sediment and pollen originating at higher elevations through the Velino River. Both lakes show a dramatic decrease in forest taxa percentage during the Medieval period (900-1400CE) and an abrupt increase during the early modern time starting around 1450CE. In contrast, the disturbance taxa, mostly related to agricultural and grazing activities, reveal a different human impact on the lakes. Ripasottile pollen spectrum is characterized by a high percentage of grass and disturbance taxa throughout the entire period of analysis, whereas the Lungo core shows phases dominated by woodland, phases dominated by grass and disturbance taxa, particularly during the Medieval period. The comparison between these two lakes confirms that human impacts on the environment appear to be spatially heterogeneous, and multiple sites in addition to a multi-proxy approach are important to fully understand the dynamics and the response of the vegetation to climatic and human induced change in a highly impacted environment such as the Mediterranean region.

*Speaker

Sea-ice dynamics in the Southern Norwegian Sea during the last glacial millennial climate events: insights from combined dinocyst and biomarker analyses

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Dansgaard–Oeschger and Heinrich events constitute ones of the most enigmatic features of the last glacial period. Many studies have focused on their characteristic millennial climate variability, testing atmosphere-cryosphere-ocean couplings, but major uncertainties and discrepancies still remain. A new scenario, mainly supported by dinocyst-derived paleoreconstructions and freshwater hosing experiments, has recently emerged. Reconciling most of the up to now hypothesized theories, it suggests the occurrence of a regional paradoxical seesaw pattern: cold Greenland and North Atlantic phases coincide with warmer sea-surface conditions and shorter seasonal sea-ice cover durations in the Norwegian Sea, in relation to enhanced subsurface advection of warm Atlantic waters re-emerging in the Norwegian Sea. Here we provide new paleoreconstructions of sea-ice dynamics in the Southern Norwegian Sea (core MD95-2009), over the 35-27 ka BP interval encompassing four interstadials-stadials (including HS3) cycles, based for the first time on the combination of biomarker IP25 concentration and dinocyst-derived sea-ice cover duration. The striking correspondence, over the millennial climate shifts, between these reconstructions derived from two independent proxies, further provides robust evidence for the occurrence of this atypical hydrographical pattern. In contrast, the strong variability between the three PIP25 signals (calculated by combining IP25 concentration with either triene, brassicasterol, or dinosterol concentration), and between them and our two other independent indicators of sea-ice dynamics, highlights the need to better constrain the PIP25, a semi-quantitative proxy of seasonal sea-ice.

*Speaker

Paleoceanographical changes of the Plio-Pleistocene based on marine palynology at ODP Sites 882 and 887, western and eastern North Pacific

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The growth of glaciers in Alaska during the early Pliocene is not consistent with the hypothesis suggesting that development of permanent continental ice in the circum-North Pacific occurred to onset of the modern halocline at 2.7 Ma. However, the paucity of paleoceanography data documenting salinity in the eastern North Pacific prevents full understanding of the relationship between the halocline development and glaciers growth at regional scale. Numerical simulations have led to suggest that a strong contrast over the subarctic gyre during the Pliocene, with high sea surface temperature (SST) in the east and low SST in the west, might explain early ice growth in North America. Here again, the lack of paleoceanographic data is critical. In view to fill this gap and to better constrain the scheme of the Plio-Pleistocene climate-ocean-ice transition in the northern North Pacific region, we investigated the dinocyst assemblages at Ocean Drilling Program (ODP) Sites 882 and 887, located respectively in the west and the east of the basin.

Species associated with subpolar waters such as *Pyxidinopsis braboi*, *Filisphaera filifera* and *Impagidinium pallidum*, occurred in the western Pacific until 4.2 Ma. The presence of these species contrasts with the occurrence of *Ataxiodinium zevenboomii*, *Impagidinium velorum* and *Impagidinium patulum* in the Gulf of Alaska as these taxa are associated with warm and temperate sea surface conditions. Between 4.2 and 2.7 Ma, the dinocyst assemblages at both sites are characterized by the dominance of the cold tolerant taxon *Habibacysta tectata*, which alternates with *Impagidinium detroitense*, and suggests homogenous cooling of the Pacific subarctic gyre. After 2.7 Ma, dinocysts assemblages suggest temperate conditions and seasonal warming at the surface due to enhanced stratification related to the existence of the modern halocline. Concomitant extinction of *Impagidinium detroitense*, which marks a major biostratigraphical limit, is reported simultaneously at both ODP Sites 882 and 887 supporting simultaneous onset of the modern halocline in the North Pacific at 2.7 Ma. Dinocysts assemblages suggest the presence of warmer sea surface conditions in the Gulf of Alaska during the Pliocene and tend to support strong zonal contrast in the subarctic gyre prior to 4.2 Ma leading to early glaciers growth fostered by high evaporation and moisture supply in the east. However, our results also indicate a reduction of east-west gradient at 4.2 Ma, well before the development of the halocline at 2.7 Ma, which is recorded here for the first time in the Gulf of Alaska.

*Speaker

Indian vegetation and monsoon response to millennial and orbital climate variability during the last glacial period

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The Indian Summer Monsoon (ISM), which brings up to 80-90% of the annual rainfall in areas such as Central India in the so-called Core Monsoon Zone (CMZ), is highly variable and sensitive to global climate change. Its impact affects the daily lives of billions of people (IPCC 2014) and extremes monsoon events have had large devastating impacts on populations and economies in the past. However, predictability of the ISM variability by numerical simulations is still uncertain, especially because processes underlying the natural variations of the ISM at the different timescales remain unclear and are still debated.

With the aim to better constrain the ISM variability in response to abrupt climate changes or changing boundary conditions, such as ice sheet melting and insolation changes, we investigated samples from IODP Site U1446 collected during the Expedition 353 Indian Monsoon Rainfall.

Our study is based on an original approach that consists of pollen analysis of marine sediments. Pollen assemblages at IODP Site U1446 represent an integrated image of the regional vegetation, and hence climate, in the Mahanadi hydrological basin, which is ideally located in the eastern part of the CMZ. This approach enables a direct comparison of terrestrial and marine tracers without chronological ambiguities.

Here we present the preliminary results of our palynological investigations. Pollen data are compared with other proxy records from IODP Site U1446, such as sea surface temperature estimates derived from alkenones. The outstanding nature of the record provides insights into the key mechanisms driving ISM variability at orbital and millennial time scales. More specifically, we document the ISM response to insolation changes in a glacial context (MIS 4 to MIS 2) and to the abrupt climate changes of the last glacial period. At centennial to millennial time scales, we attempt to discriminate the respective influence of the northern high-latitude forcing, controlling the pace and magnitude of weak monsoon intervals, from the subtropical forcing, impacting Indian Ocean sea surface temperatures and, thus regional evaporation feeding summer rainfall in India.

*Speaker

List of authors

- Álvarez, Sabela, 20
Şîrîn, Emrah, 68
Čaušević-Bully, Morana, 121
- Abdala, Roberto, 52
Abrantes, Fátima, 106
Abreu, Ilda, 19, 39, 60, 61
Abt, Reto, 32, 33
Acar Şahin, Aydan, 8, 54
Achmakh, Lamiae, 27
Adeli, Mehdi, 43
Aira, M Jesús, 20, 40
Ajouray, Nabila, 10
Al-Nesf, Maryam Ali, 43
Alan, Şenol, 8
Alcàzar, Purificación, 17
Alché, Juan de Dios, 56, 61, 69
Ali, Adam A., 75
Alonso-García, Montserrat, 122
Alonso-Garcia, Montserrat, 106
Andersen, Nils, 77, 129
Andrieu-Ponel, Valérie, 71
Antunes, Célia M., 9, 60
Antunes, Celia A., 29
Aoustin, David, 72, 113, 119
Arabacı, Turan, 57
Archer, Claire, 126
Arriegas, Rute, 9, 60
Arteaga Cardineau, Carlos, 101
Asma, Necib, 13
Azuara, Julien, 73, 74
- Bárány, Ivett, 55, 64
Bégeot, Carole, 108
Babonneau, Nathalie, 80
Barboni, Doris, 76
Bardei, Fadoua, 10
Barhoumi, Chéïma, 75, 82
Barra, Adrien, 111
Bartolini Lucenti, Saverio, 78
Bassetti, Maria-Angela, 73
Beaufort, Luc, 76
Beauger, Aude, 103
Belmonte, Jordina, 11, 18, 28
Belt, Simon, 127
Ben Dhiab, Ali, 61
Ben-Menni Schuler, Samira, 59, 62
- Benslama, Mohamed, 13, 120
Berbel-Cascales, Modesto, 59, 62
Berenguer, Eduardo, 55, 64
Berger, Jean-François, 91, 98, 111
Bernard, Guillaume, 90
Bernard, Vincent, 72, 100
Bessedik, Mostefa, 28
Bichet, Vincent, 121
Bignens, Serge, 33
Bisegna, Paolo, 46
Blanchet, Claire, 82
Blanco-Alegre, Carlos, 12
Blanz, Thomas, 77, 129
Blarquez, Olivier, 101
Bolton, Clara, 77
Borrego, Ángeles, 105
Bosi, Giovanna, 102, 125
Boudad, Larbi, 111
Bouet, Alain, 117
Boughediri, Soumaia, 13, 120
Boujelben, Abdelkarim, 98
Bourel, Benjamin, 76
Bourillet, Jean-François, 107
Bouziane, Hassan, 10, 27
Bouzouina, Mohammed, 49
Brandolini, Filippo, 102
Bricchi, Emma, 66
Brighetti, Maria Antonia, 45, 46
Brisset, Elodie, 114
Brugiapaglia, Elisabetta, 116
Bruneau, Margot, 98
Burch, Philipp, 32
Burgos, Ana, 29
Burjachs, Francesc, 114
Businaro, Luca, 46
- Cabezudo, Baltasar, 36, 42
Cabrera, Juan Antonio, 52
Caley, Thibault, 124
Calhau, Isabel, 9
Calvo, Ana Isabel, 12
Camarero, J. Julio, 109
Canela, Miquel, 11
Cardinali, S. Haoa, 124
Carneros, Elena, 55, 64
Carracedo-Martín, Virginia, 109, 118, 123
Caselli, Federica, 46

Castro López, Antonio Jesús, 69
 Castro, Amaya, 12
 Castro, Antonio J, 56
 Cattaneo, Antonio, 80
 Celenk, Sevcán, 57
 Chataigner, Christine, 94
 Choël, Marie, 14
 Ciani, Francesco, 15, 16, 78
 Cirilli, Omar, 78
 Clément, Charlotte, 77, 83
 Clò, Eleonora, 79, 102
 Clemens, Steven C., 77, 83, 129
 Colombaroli, Daniele, 96
 Combourieu-Nebout, Nathalie, 73, 74, 80
 Cortés-Perez, Juan Pedro, 22
 Corvo Beldarrain, María, 50
 Costa, Ana R., 9, 29
 Costarelli, Alma, 66
 Coste, Pierre-Olivier, 107
 Coussin, Vincent, 80
 Cremaschi, Mauro, 79, 102
 Cromartie, Amy, 82
 Cunill, Raquel, 109
 Cunill-Artigas, Raquel, 118

 d'Errico, Francesco, 89
 Díaz de la Guardia, Consuelo, 17
 Daire, Marie-Yvane, 72
 Dalache, Fatiha, 49
 Daniau, Anne-Laure, 83, 90, 124
 Dason Blessing, Reena, 43
 David, Rémi, 119
 de Beaulieu, Jacques-Louis, 84
 de Garidel-Thoron, Thibault, 76
 De Linares, Concepcion, 11, 17, 18
 De Ninno, Riccardo, 46
 de Vernal, Anne, 128
 Debret, Maxime, 96
 Delcroix, Thierry, 124
 Dell'Olmo, Lorella, 15
 Dendievel, André-Marie, 111
 Desprat, Stéphanie, 58, 77, 83, 106, 122, 129
 Devaux, Ludovic, 58
 Deverchère, Jacques, 80
 Dezileau, Laurent, 73, 74
 Di Mascio, Martina, 125
 Didier, Julien, 96, 121
 Dietre, Benjamin, 121
 Dirmenci, Tuncay, 57
 Dorado-Valiño, Miriam, 105
 Dorador, Javier, 122
 Duchamp, Loïc, 92
 Duprat-Oualid, Fanny, 108
 Durán-Barroso, Pablo, 21
 Dural, Hüseyin, 68
 Durand, Matthieu, 107
 Dutour, Olivier, 117

 Ehrhold, Axel, 97
 Ejarque, Ana, 85, 86
 El Haskouri, Fatima, 10
 Ertuğrul, Kuddisi, 68
 Escuredo, Olga, 49
 Etienne, David, 82
 Etourneau, Johan, 127
 Expósito, Isabel, 114
 Eynaud, Frédérique, 87, 88, 107

 Fady, Bruno, 109
 Fernández-Fernández, María del Carmen, 59, 62
 Fernández-González, Delia, 12
 Fernández-González, María, 19, 20, 25, 38–40
 Fernández-Rodríguez, Santiago, 21, 22, 30, 31, 34, 35
 Fernandes, Manuel A., 9
 Ferretti, Patrizia, 122
 Fersi, Wiem, 88
 Fidalgo-Hijano, Concepción, 101
 Florenzano, Assunta, 102, 125
 Florindo, Fabio, 126
 Foggi, Bruno, 15, 16
 Fourcade, Tiffanie, 89
 Fraile, Roberto, 12
 Frenguelli, Giuseppe, 23, 65, 66
 Frigola, Jaime, 73
 Fuentes, Sergio, 24

 Gal, Jong-Ku, 127
 Galán, Carmen, 17
 Gally, Yves, 76
 Galveias, Ana, 9, 29, 60
 Ganne, Axelle, 107
 García Rogado, M^a Rosa, 50
 García-Amorena, Ignacio, 109
 García-Codrón, Juan Carlos, 109, 118, 123
 García-Giménez, Rosario, 101
 García-Sánchez, José, 42
 García, Arnau, 85
 Garrido, Alejandro, 40
 Gassier, Ghislain, 76
 Gauthier, Emilie, 121
 Genet, Marion, 90
 Gharbi, Dorra, 43
 Ghilardi, Matthieu, 71, 115
 Gil Gómez, Jose, 52
 Glais, Arthur, 91
 Gomez Turpin, Eva María, 52
 González-Fernández, Estefanía, 25, 38
 González-Garijo, Ángela, 30
 González-Martín, Juan Antonio, 101
 González-Porto, Amelia Virginia, 48
 Gonzalo-Garijo, Ángela, 21
 Gonzalo-Garijo, Angela, 31, 34, 35
 Goubert, Evelyne, 97
 Gouriveau, Emilie, 92

Gregoire, Fabrice, 84
 Grimalt, Joan, 106
 Guedes, Alexandra, 39
 Guerrero-Ramírez, Javier, 21, 34
 Guiot, Joel, 108
 Guiter, Frédéric, 84

 Hély-Alleaume, Christelle, 96
 Hadj Hamda, Sahar, 61
 Hamzaoglu, Ergin, 63
 Hanquiez, Vincent, 90
 Hardy, William, 107
 Herlédan, Maiwenn, 107
 Hernández, María Luisa, 56
 Hernández-Moreno, Lucía S., 62
 Hirhish, Ussama, 18
 Homrani, Mounia, 49
 Hunt, Christopher, 93

 Jalali, Bassem, 73
 Janati, Asmae, 27
 Jaouadi, Sahbi, 93, 98
 Jiménez Moreno, Gonzalo, 93
 Joannin, Sébastien, 75, 82, 94, 116
 Jouffroy-Bapicot, Isabelle, 95, 96, 117
 Julià, Ramon, 85

 Kadiri, Mohamed, 27
 Kang, Sujin, 127
 Karakhanian, Arkady, 94
 Karbouch, Mostapha, 98
 Kaynar, Hidayet Nisa, 57
 Kazzaz, Mohamed, 27
 Kiared, Ghania, 28
 Kim, Jung-Hyun, 127
 Krishnamurthy, Anupama, 77, 129

 López-Días, Veneranda, 105
 López-Figueroa, Félix, 52
 López-Sáez, José Antonio, 91, 101, 105, 111
 Lahaye, Christelle, 89
 Lahuerta Otero, Eva, 51
 Lambert, Clément, 97, 107
 Lara, Beatriz, 29
 Larbi, Ajmi, 61
 Latour, Delphine, 103
 Lauterbach, Stefan, 77, 129
 Lavrieux, Marlène, 103
 Le Bailly, Matthieu, 117
 Le Digol, Yannick, 100
 Le Roy, Pascal, 97
 Lebreton, Vincent, 73, 74, 93, 98
 Ledger, Paul, 103
 Ledru, Marie-Pierre, 99
 Legrand, Benjamin, 103
 Leroyer, Chantal, 72, 100, 119
 Lespez, Laurent, 91
 Lestienne, Marion, 96

 Lima-Cabello, Elena, 56
 Lonlac Konlac, Jerry, 103
 Lorenzo, M. Nieves, 38
 Luelmo Lautenschlaeger, Reyes, 101
 Luelmo-Lautenschlaeger, Reyes, 105
 Lurbe-Sánchez, Lara, 112

 Magny, Michel, 108
 Malaizé, Bruno, 124
 Marambat, Laurence, 113
 Marchant, Ross, 76
 Marchi, Maria Giovanna, 15
 Marguerie, Dominique, 72, 113
 Mariani, Guido S., 79, 102
 Mariotti Lippi, Marta, 15, 16, 78
 Marques, Diogo, 9
 Martínez-Rivas, José Manuel, 56
 Martin-Hernández, Raquel, 48
 Martinez, Philippe, 77, 83, 129
 Massa, Charly, 121
 Matías Martínez, Yago, 50
 Matthiessen, Jens, 127
 Maya-Manzano, José María, 21, 22, 30, 31, 34, 35
 Mazel, Florian, 113
 Mazuecos-Aguilera, Ismael, 59, 62
 Mazzanti, Marta, 102, 125
 Meliksetian, Khachatur, 116
 Menadjlia, Nouha, 120
 Mendes, Sara, 60
 Menot, Guillemette, 116
 Mensing, Scott, 126
 Mephu-Nguifo, Engelbert, 103
 Mercuri, Anna Maria, 79, 102
 Messenger, Erwan, 82, 119
 Mete, Derya, 63
 Meunier, Guillaume, 95
 Millet, Laurent, 108
 Minvielle Larousse, Nicolas, 84
 Miola, Antonella, 125
 Miraglia, Annarosa, 45
 Miras, Yannick, 103
 Mobayed, Hassan, 43
 Mohammed Ali, Ramzy, 43
 Mojtahid, Meryem, 107
 Molina-Gallart, David, 109
 Molnár, Tibor, 12
 Monroy-Colín, Alejandro, 21, 22, 30, 31, 34, 35
 Montaldi, Mélanie, 98
 Morales del Molino, César, 101, 122
 Morillo-Barragán, Juan, 21, 22, 34
 Mosquera Mosquera, Hilda Rocio, 26, 44
 Mouillot, Florent, 90
 Msallem, Monji, 61
 Muñoz-Gallego, Antonio Roman, 52

 Nadal, Jordi, 112
 Nadal-Tersa, Jordi, 109, 118

Naudinot, Nicolas, 119
 Naughton, Filipa, 106, 122
 Niederberger, Erny, 32, 33
 Nizou, Jean, 107
 Noble, Paula, 126
 Nuñez de la Fuente, Sara, 105

 Oduber, Fernanda, 12
 Oliveira, Dulce, 77, 106, 122
 Olivero, Jesús, 52
 Olivier, Bellier, 94
 Ollivier, Vincent, 82, 94, 116
 Orliac, Catherine, 124
 Orliac, Michel, 124
 Oteros, Jose, 37

 Pérez Díaz, Sebastián, 101
 Pérez, Yolanda, 64
 Pérez-Badia, Rosa, 29
 Pérez-Díaz, Sebastián, 105, 111
 Pérez-Haase, Aaron, 109
 Pérez-Obiol, Ramon, 109, 112, 118, 123
 Pèlachs-Mañosa, Albert, 109, 112, 118, 123
 Pailler, Yvan, 97
 Palet, Josep María, 85
 Palomo, Javier, 52
 Pandolfi, Luca, 78
 Pardo-Martin, Cristina, 48
 Pecero-Casimiro, Raul, 21, 22, 30, 31, 34, 35
 Pedrotta, Tiziana, 95
 Peiry, Jean-Luc, 103
 Penaud, Aurélie, 80, 87, 88, 97, 107
 Pereira, Joana R.S., 19
 Perello, Bérengère, 94
 Peyron, Odile, 75, 80, 82, 108, 116
 Piña-Rey, Alba, 25, 38
 Picornell, Antonio, 36, 37, 42, 52
 Pinar, Nur Münevver, 8, 54, 63
 Piovesan, Gianluca, 126
 Polanco-Martínez, Josue M., 122
 Pomadere, Maia, 91
 Prasad, Srinivasan, 77, 129
 Prodeo, Frederic, 100

 Quevedo-Martínez, Eva, 22

 Ramírez Cotes, Daniel Augusto, 26, 44
 Real, Raimundo, 52
 Reale, Alessia, 46
 Recio, Marta, 36, 42, 52
 Redolosis, Yasmin, 52
 Reinbold, Aurélie, 113
 Renard, Mélanie, 71
 Revelles, Jordi, 114, 115
 Ribeiro, Helena, 19, 39, 60, 61
 Richard, Hervé, 121
 Riera, Santiago, 85, 86
 Rinaldi, Rossella, 102

 Risueño, María-Carmen, 55, 64
 Rius, Damien, 108
 Robin, Vincent, 92
 Robles, Mary, 116
 Roche, Kévin, 117
 Rodríguez de la Cruz, David, 24, 50, 51
 Rodríguez-Coterón, Sara, 118
 Rodríguez-Flores, M. Shantal, 49
 Rodríguez-Rajo, F. Javier, 19, 20, 25, 38–40
 Rodríguez-Tovar, Francisco-Javier, 122
 Rodrigues Costa, Ana, 60
 Rodrigues, Teresa, 106, 122
 Rojo, Jesus, 29, 37
 Romero-García, Ana Teresa, 59, 62
 Romero-Morte, Jorge, 29
 Rook, Lorenzo, 78
 Rossignol, Cédric, 119
 Rossignol, Linda, 87–89
 Rottoli, Mauro, 125
 Roubal, Amina, 13, 120
 Rousseau, Marine, 121
 Ruffaldi, Pascale, 92
 Ruiz-Mata, Rocío, 36, 42

 Sánchez Durán, Silvia, 51
 Sánchez Goñi, María Fernanda, 89, 106, 122, 127
 Sánchez Reyes, Estefania, 24, 50, 51
 Sánchez Sánchez, José, 24, 50, 51
 Sánchez-Morales, Marc, 109, 112, 118, 123
 Sémah, Anne-Marie, 124
 Sabatier, Pierre, 73, 95, 96
 Sagnotti, Leonardo, 126
 Sahakyan, Lilit, 116
 Santos Requejo, Libia, 51
 Sattar Hisham, Ahmed, 43
 Savorelli, Andrea, 78
 Schmidt, Sabine, 90
 Schneider, Ralph, 77, 129
 Schnitzler, Annik, 92
 Scotti-Saintagne, Caroline, 109
 Seijo, M. Carmen, 49
 Sellés, Bárbara, 52
 Serieyssol, Karen, 103
 Sforzi, Andrea, 78
 Shin, Kyung-Hoon, 127
 Sicre, Marie-Alexandrine, 73
 Silva, Catarina, 9
 Silva, Joaquim C., 9
 Silva-Palacios, Inmaculada, 21, 22, 30, 31, 34, 35
 Skonieczny, Charlotte, 124
 Smik, Lukas, 127
 Solís, Mayte, 55
 Soriano, Joan Manuel, 112, 123
 Soriano-López, Joan Manuel, 109, 118
 Stephan, Pierre, 97
 Suárez-Santiago, Víctor N., 59, 62

Tchabi Lopez, Lopez, 41
Tedeschini, Emma, 65, 66
Testillano, Pilar S., 55, 64
Tetard, Martin, 76
Tinner, Willy, 95
Tisnérat - Laborde, Nadine, 80
Tormo-Molina, Rafael, 21, 22, 30, 31, 34, 35
Torri, Paola, 79, 102, 125
Tossou, Monique, 41
Toucanne, Samuel, 88, 107
Tozalakian, Petros, 94
Tozalakyan, Petros, 116
Travaglini, Alessandro, 45, 46
Trigo Perez, María Del Mar, 36, 42, 43, 52
Tuffaha, Amjad, 43
Tunno, Irene, 126

Véron, Alain, 84
Vacchi, Matteo, 115
Valencia-Barrera, Rosa María, 12, 50
Valle, Ana M., 17
Vannière, Boris, 95, 96, 117

Vega, Julia, 52
Vega-Maray, Ana M^a, 12
Vicente, Oscar, 67
Vidal, Muriel, 97
Visez, Nicolas, 14
Vlez-Pereira, Andrés, 11
von Kaenel, François, 33

Waelbroeck, Claire, 88
Walsh, Kevin, 95
Walter-Simonnet, Anne-Véronique, 92
Wary, Mélanie, 87, 88, 127

Yildiz, Bayram, 57
Yilmaz Çitak, Burcu, 68

Zafra, Adoración, 69
Zaragosi, Sébastien, 87
Zeder, Yanick, 32
Zerboni, Andrea, 79, 102
Zimmerman, Susan, 126
Zorzi, Coralie, 77, 128, 129