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UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

Dipartimento di Scienze della Vita

LPP - Laboratorio di Palinologia
e Paleobotanica



06/08 2021 September · MODENA · Italy

Mediterranean Palynology Societies Symposium 2021

Online Meeting

Modena, 6-8 September 2021

Gruppo di Palinologia e Paleobotanica della Società Botanica Italiana (GPP-SBI)
Association des Palynologues de Langue Française (L'APLF)
Asociación de Palinólogos de Lengua Española (APLE)

ABSTRACTS BOOK

Mediterranean Palynology Societies Symposium 2021. Abstracts Book

Editors: Assunta Florenzano & Eleonora Clò

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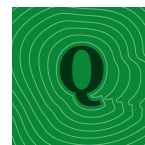


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Welcome to MedPalynoS 2021

Dear Colleagues,

the *Gruppo di Palinologia e Paleobotanica della Società Botanica Italiana* (GPP-SBI), the *Association des Palynologues de Langue Française* (L'APLF) and the *Asociación de Palinólogos de Lengua Española* (APLE) organized and invited to participate all palynologists to the fourth congress of the Mediterranean Palynological Societies Symposium that was held in 2021 according to an online meeting formula taking into account the current sanitary situation due to Covid-19. The 2021 MedPalynoS mainly gathered Italian-, French- and Spanish- speaking palynologists working on paleopalynology, archaeopalynology, aerobiology, melissopalynology, pollen biology and pollen morphology.

This joint online meeting was especially devoted to early-career researchers who, despite the difficult period, had the opportunity to present their projects and last results in the different fields of Palynology. However, contributions by senior researchers were largely welcomed and useful to improve the update sessions. Four invited speakers on transdisciplinary topics and relevant experts on different palynological subjects.

We hope that this symposium has provided an opportunity for sharing experiences, exchanging ideas, discussing research results in a friendly environment or pave the way for future interdisciplinary collaborations.

The Organizing Committee
medpalynos2021@unimore.it

Summary

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MEDPALYNOS 2021 - SCIENTIFIC PROGRAMME

6 September 2021

| Morning | |
|----------------------|--|
| 9.00 - 9.20 | Opening ceremony A. Florenzano , MedPalynos 2021 President A.M. Mercuri , President of GPP-SBI V. Lebreton , President of L'APLF P.S. Testillano , President of APLE |
| 9.20 - 11.15 | S1 - Pollen biology and structure Chairs: P.S.Testillano, G.Aronne Invited speaker: J.Lora , IHSM-UMA-CSIC, Spain |
| 11.15 - 11.30 | <i>Break</i> |
| 11.30 - 12.15 | S2 - Melissopalynology Chairs: A.M.Mercuri , A.-V.González-Porto |
| 12.15 - 13.00 | Poster session 1 <i>Chairs: G.Servera-Vives, E.Clò</i> |
| Afternoon | |
| 14.00 - 15.30 | S3 - Paleopalynology (forests and mountains) Chairs: G.Servera-Vives, D.Attolini Invited speaker: G. Piovesan , University of Tuscia, Italy |
| 15.30 - 15.45 | <i>Break</i> |
| 15.45 - 17.00 | S4 - Paleopalynology (vegetation, landscape and land use) Chairs: C.Zorzi, J.Revelles |
| <i>from 17.00</i> | <i>Virtual tour of Modena and Terramara di Montale</i> |

7 September 2021

| Morning | |
|----------------|---|
| 9.00 - 10.45 | S5 - Paleopalynology ('modern analogues') Chairs: V.Lebreton, A.Picornell Invited speaker: L.Marquer , University of Innsbruck, Austria |
| 10.45 - 11.00 | <i>Break</i> |

| | |
|----------------------|--|
| 11.00 - 12.00 | S6 - Aeropalynology (methods in Aerobiology) Chairs: M.P.Plaza, A.Travaglini |
| 12.00 - 13.00 | Poster session 2 Chairs: G.Servera-Vives, E.Clò |
| Afternoon | |
| 14.00 - 15.30 | S7 - Paleopalynology (Quaternary climate and vegetation changes) Chairs: A.Penaud, K.Kouli |
| 15.30 - 15.45 | <i>Break</i> |
| 15.45 - 17.15 | S8 - Paleopalynology (Holocene environmental changes) Chairs: A.Masi, S.Joannin |
| 17.15 - 18.00 | <i>Voting for the best poster</i> |

8 September 2021

| | |
|---------------------|--|
| Morning | |
| 9.00 - 10.00 | S9 - Bridging session between MedPalynoS and the Italian Botanical Society Chairs: A.M.Mercuri, A.Chiarucci Invited speaker: S.A. Mensing , University of Nevada, US |
| 10.00 - 10.30 | Ceremony award A. Chiarucci , President of SBI A.M. Mercuri , President of GPP-SBI |
| 10.30 - 10.45 | <i>Break</i> |
| 10.45 - 12.30 | S10 - Archaeopalynology Chairs: A.Florenzano, S.Pérez-Díaz |
| 12.30 - 12.45 | Closing remarks |

Monday, 6 September 2021

9:00am - 9:20am

MEDPALYNOS 2021 OPENING CEREMONY

Assunta Florenzano, Anna Maria Mercuri, Vincent Lebreton, Pilar S. Testillano

S1: POLLEN BIOLOGY AND STRUCTURE

Time: 9:20am - 11:15am

Session Chairs: Pilar S. Testillano, Giovanna Aronne

9:20am - 10:00am

POLLEN DEVELOPMENT AND POLLEN-PISTIL INTERACTION. IMPLICATIONS FOR FRUIT TREE CROP BREEDING (Invited talk)

Jorge Lora, Iñaki Hormaza

Pollen development is a highly conserved process with intense crosstalk between the male germline and the sporophytic tissues. Interaction continues between pollen and pistil, in which the female sporophyte both supports and constrains pollen tube growth. Pollen development and pollen-pistil interaction are, therefore, essential processes for the subsequent fruit set that is of central importance in fruit tree crops.

10:00am - 10:15am

INVOLVEMENT OF ENDOGENOUS CYTOKININS IN MICROSPORE EMBRYOGENESIS OF *BRASSICA NAPUS*

Yolanda Pérez-Pérez, Alfonso Albacete, Pilar S. Testillano

Stress-induced microspore embryogenesis is used in breeding to rapidly obtain doubled-haploid plants. The hormonal regulation of the process is not well understood. In the present work we analyzed the dynamics and role of endogenous cytokinins (CKS) during microspore embryogenesis in *Brassica napus*. The results indicate that CKS increase and play a key role in microspore-derived embryo differentiation. Funding: AGL2017-82447-R, PDI2020-113018RB-I00

10:15am - 10:30am

HEAT TREATMENT DURING MICROSPOROGENESIS AFFECTS THERMO-TOLERANCE AND ONTOGENESIS OF TOMATO POLLEN

Maurizio Iovane, Giovanna Aronne

Experimental data on *Solanum lycopersicum* 'Micro-Tom' confirmed our hypothesis that high temperatures on flower buds during microsporangogenesis slightly lower pollen viability at anthesis but become drastically manifest later on the male gametophyte. Further, microscope analysis revealed that heat reduces the life span of the gametophytic generation.

10:30am - 10:45am

IDENTIFICATION OF CANDIDATE GENES DETERMINING THE MORPHOLOGY OF POLLEN GRAIN APERTURES BY TRANSCRIPTOMIC ANALYSIS IN PAPAVERACEAE

Ismael Mazuecos Aguilera, Ana Teresa Romero García, Víctor N. Suárez Santiago

Pollen grain aperture pattern is very diverse between species. However, little is known about its genetic determinism. We carried out a comparative study of the transcriptome of two species of Papaveraceae with colpo-type apertures and two others with pore-type apertures. Thus we identify genes that could potentially be involved in determining the type of aperture.

10:45am - 11:00am

SCANNING ELECTRON MICROSCOPY REVEALS STRUCTURE OF POLLEN GRAINS OF MALE AND FEMALE WILD GRAPEVINE (*VITIS VINIFERA* SUBSP. *SYLVESTRIS* GMEL HEGI) IN CROATIA

Katarina Lukšić, Goran Zdunić, Ana Mucalo, Luka Marinov, Zorica Ranković-Vasić, Jelena Ivanović, Dragan Nikolić

The Eurasian grapevine (*Vitis vinifera* L.) includes two subspecies: wild (*V. subsp. sylvestris*) and cultivated (*V. subsp. vinifera*), both are diploid and sexually compatible.

Scanning Electron Microscopy revealed clear separation between male and female *V. sylvestris* morphotypes based on pollen microstructure of accessions from two Croatian natural populations providing information for future studies on the pollen and flower of grapevine.

11:00am - 11:15am

DOES POLLEN RELEASE EXOSOMES?

Chiara Suanno, Elisa Tonoli, Enzo Fornari, Maria Pia Savoca, Iris Aloisi, Luigi Parrotta, Elisabetta Verderio-Edwards, Stefano Del Duca

We tested the hypothesis that nanoparticles released by pollen could be plant exosomes. To do so, we isolated nanoparticles with a diameter smaller than 200 nm from hydrated and germinated kiwi pollen. We then visualised the vesicles in atomic force microscopy and fluorescence microscopy, and assayed the presence of the homologs of ALIX, a mammalian exosome marker, in western blot.

S2: MELISSOPALYNOLOGY

Time: 11:30am - 12:15pm

Session Chairs: Anna Maria Mercuri, Amelia-Virginia González-Porto

11:30am - 11:45am

NOTES ON THE POLLEN CONTENT OF HONEYS FROM THE MIDDLE-WEST OF THE IBERIAN PENINSULA (SALAMANCA, SPAIN) LABELLED AS SPANISH LAVENDER HONEYS

David Rodríguez de la Cruz, Estefanía Sánchez-Reyes, Alfredo García-Sánchez, Silvia Sabariego-Ruiz, Silvia Sánchez-Durán, José Sánchez-Sánchez

Pollen studies in honeys are fundamental tools to determine their botanical and geographical origin. 20 samples of honey collected in the MW Spain during the year 2018 and catalogued as "Spanish lavender" by beekeepers were

analysed. of which only one was characterised as such according to palynological criteria. This underlines the importance of melissopalynology in the determination of monofloral honeys.

11:45am - 12:00pm

MELISSOPALYNOLOGICAL AND PHYSICO-CHEMICAL ANALYSIS OF HEATHER HONEY (*ERICA ARBOREA* L.) FROM THE REGION OF BABORS KABYLIA (ALGERIA)

Asma Ghorab, Farid Bekdouche, Maria Shantal Rodríguez Flores, Olga Escuredo, Maria Carmen Seijo

The characterization of heather honey from Babors Kabylia provides information on the diversity of beekeeping resources and the main physicochemical characteristics, which are important for honey marketing and quality control. The honey had a mean value of 54.25 % of *E. arborea* pollen and a good quality. The obtained parameters could be characteristics for heather honey from this region.

12:00pm - 12:15pm

BOTANICAL ORIGIN OF HONEYS FROM THE "SIERRA DE MANANTLÁN" BIOSPHERE RESERVE, JALISCO, MEXICO

Xochilt María Morales Najarro, Iris Grisel Galván-Escobedo, Monserrat Vázquez-Sánchez, Ma. de Montserrath Medina-Acosta

As of the application of melissopalynology techniques and the calculation of alpha index of diversity and similarity of the pollen sets between apiaries was possible to define the botanical origin of the honeys produce in "Sierra de Manantlán" Biosphere Reserve. Results indicated a clear differentiation between the pollen composition of the honey samples.

P1: POSTER SESSION 1

Time: 12:15pm - 1:00pm

Session Chairs: Gabriel Servera-Vives, Eleonora Clò

STATUS AND TREND OF THE MAIN ALLERGENIC POLLEN GRAINS IN THE CITY OF ROME ITALY (2003-2019)

Alessandro Di Menno di Bucchianico, Raffaella Gaddi, Maria Antonia Brighetti, Denise De Franco, Annarosa Miraglia, Alessandro Travaglini

This work describes the 2019 status of the presence of the main allergenic pollen families (Betulaceae, Asteraceae, Corylaceae, Cupressaceae/Taxaceae, Poaceae, Oleaceae, Urticaceae) and the *Alternaria* spore in the city of Rome, Italy and their air concentration trends, measured, from 2003 to 2019, by the Aerobiological Monitoring Center of Tor Vergata (Rome).

ASSESSING THE ALLERGENIC POTENTIAL OF THE URBAN PARKS OF FLORENCE (ITALY)

Francesco Ciani, Bruno Foggi, Marta Mariotti Lippi

The study aims to quantify the allergenic potential of several public parks of Florence (Italy) using the Urban Green Zone Allergenicity Index. The results highlighted that the index is a useful tool that provides useful information for the current state of urban green management and future planning.

PHENOLOGICAL MONITORING OF *CUPRESSUS SEMPERVIRENS* L. COMPARISON BETWEEN URBAN AND EXTRAURBAN AREA

Annarosa Miraglia, Maria Antonia Brighetti, Denise De Franco, Francesca Quagliero, Alessandro Travaglini

Cupressaceae pollen is the main cause of "winter pollinosis". The purpose of the study is to compare the trend of phenophases in urban and extra-urban areas in order to predict beginning, end and severity of the cypress pollen season at a local level, based on weather conditions.

THE DIMORPHISM OF *VITIS* POLLEN: A DIFFERENT PALYNOLOGICAL IMPRINT OF WILD AND DOMESTICATED *V. VINIFERA* L.

Anna Maria Mercuri, Paola Torri, Assunta Florenzano, Eleonora Clò, Marta Mariotti Lippi, Elisabetta Sgarbi, Cristina Bignami

The dimorphism of *Vitis* pollen is a well-known feature in agrarian studies and a practically ignored characteristic in the archaeobotanical/palaeoenvironmental field of research.

Trizonocolporate and inaperturate pollen grains are common in the wild subspecies of *Vitis* but can occur in some ancient cultivars of the subspecies *vinifera*.

PALYNOLOGICAL FLORA OF THE COASTAL HABITATS IN DHOFAR (SULTANATE OF OMAN)

Lia Pignotti, Cristina Bellini, Francesco Ciani, Carlotta Bambi, Asia Bonciani, Laura Tagliapietra, Irene Viviani, Tiziana Gonnelli, Marta Mariotti Lippi

We present the results of field surveys in the coastal habitats of Dhofar (Sultanate of Oman) and a contribution to the palynological flora of the region.

EVOLUTION OF THE DIVERSITY OF THE TYPE OF POLLEN FORAGED BY BEES IN RELATION TO THE VEGETAL COMPOSITION OF THE ENVIRONMENT AND THE STAGE OF COLLECTION

Amelia-Virginia González-Porto, José-Antonio Molina-Abril, Cristina Pardo-Martin

The study has the aim of showing the importance of recognizing the vegetation around the hives to deduce the main sources of protein feeding of the bee colonies throughout a year of activity.

AEROBIOLOGY AND POTATO CULTIVARS AS AN EFFECTIVE TOOL TO REDUCE THE INCIDENCE OF LATE BLIGHT AND AVOID YIELD LOSSES

Laura Meno, Olga Escuredo, Maria Shantal Rodríguez-Flores, Maria Carmen Seijo Coello

Sporangia of *P. infestans* are detected in the air of potato crops all seasons but only under favorable climatic conditions produce late blight. This work study in the field the conditions to favor disease development and the susceptibility of different potato cultivars.

S3: PALEOPALYNOLOGY (FORESTS AND MOUNTAINS)

Time: 2:00pm - 3:30pm

Session Chairs: Gabriel Servera-Vives, Davide Attolini

2:00pm - 2:40pm

THE ROLE OF HISTORICAL ECOLOGY IN THE CONSERVATION AND RESTORATION OF MEDITERRANEAN FORESTS (Invited talk)

Jordan Palli, Gianluca Piovesan

Ecological landscape planning should be based on a clear understanding of forest dynamics. Palynology, archaeobotany and dendroecology combined provide detailed information on compositional and structural changes of forests, thus providing insights into the capacity of the ecosystem to face changing environmental conditions. The integration of such disciplines can be pivotal to reconstruct the vegetation history and discriminate drivers of change.

2:40pm - 2:55pm

GLOBAL CHANGES, FIRE AND SPRUCE-FOREST DYNAMICS IN QUEBEC-LABRADOR DURING THE HOLOCENE

Jonathan Lesven, Milva Druguet Dayras, Laurent Millet, Adam Ali, Yves Bergeron, André Arsenault, François Gillet, Damien Rius

Boreal forests are necessary for human activities and climate regulation. Based on pollen grains, macrocharcoal and chironomids assemblages of a Canadian transect, this multi-proxy study provides new insights on fire-climate-vegetation linkages to characterize the mechanisms by which climate change impacts disturbance regimes. It shows that repeated fires across time can alter vegetation composition and trajectory, and thus carbon sink function.

2:55pm - 3:10pm

A MILLENNIUM-LONG HISTORY OF AN ICONIC OLD-GROWTH FOREST IN SOUTH-EAST EUROPEAN MOUNTAINS

Eleonora Cagliero, Donato Morresi, Laure Paradis, Niccolò Marchi, Fabio Meloni, Milić Čurović, Velibor Spalevic, Ilham Bentaleb, Renzo Motta, Matteo Garbarino, Walter Finsinger, Emanuele Lingua

Major human imprints on many forest ecosystems are viewed as causes for today low abundance of European old-growth forests. However, their long-term history is weakly constrained. Our study contributes to evaluate the history and legacies of past human impacts on an iconic European old-growth forest in the Dinaric mountains (Montenegro). The methodology combines field plots, remote sensing and palaeoecological analyses.

3:10pm - 3:25pm

HIGH-ELEVATION VEGETATION DYNAMICS ON THE CANTABRIAN RANGE (NORTHERN SPAIN) DURING THE PAST TWO MILLENNIA: THE LAGO DEL AUSENTE PALAEOECOLOGICAL RECORD

César Morales-Molino, Maria Leunda, Mario Morellón, Jon Gardoki, Javier Ezquerro, Castor Muñoz Sobrino, Manel Leira, Willy Tinner

The number of available palaeoecological records from the Cantabrian Range has significantly increased during the past few decades, contributing to fill many gaps in the knowledge about the Lateglacial and Holocene vegetation dynamics of this region. However, detailed and well dated records focusing on the late Holocene are very rare.

S4: PALEOPALYNOLOGY (VEGETATION, LANDSCAPE AND LAND USE)

Time: 3:45pm - 5:00pm

Session Chairs: Coralie Zorzi, Jordi Revelles

3:45pm - 4:00pm

LANDSCAPE DYNAMICS DURING THE LAST GLACIAL TRANSITION TO THE HOLOCENE IN THE NORTHERN IBERIAN PENINSULA. LA MOLINA PEAT BOG, CANTABRIA

Marc Sánchez-Morales, Ramon Pérez-Obiol, Juan Carlos García-Codrón, Virginia Carracedo-Martín, Sara Rodríguez-Coterón, Joan Manuel Soriano, Jordi Nadal-Tersa, Aaron Pérez-Haase, Albert Pèlach

A multiproxy approach performed in La Molina peat bog (Cantabria, 484 m a. s. l.), which combined analyses on pollen, charcoals (>125 µm) and organic matter, revealed the landscape dynamics for the last 17,552 cal. yr BP. This exceptional sequence provides climatic, vegetation and fire data according to the long-term environmental history of the North Atlantic climate variability.

4:00pm - 4:15pm

VEGETATION, HUMAN PRACTICES AND CLIMATE CHANGES DURING THE LAST 15000 YEARS RECORDED AT LAKE MATESE, IN ITALY

Mary Robles, Elisabetta Brugiapaglia, Odile Peyron, Guillemette Ménot, Bruno Paura, Sabine Wulf, Oona Appelt, Jacques-Louis De Beaulieu, Sébastien Joannin

The aims of this study are (1) to understand modern pollen-vegetation relationships in Matese massif and (2) to reconstruct vegetation, human practices and climate changes recorded in the Lake Matese sediment archive during the last 15000 years using geochemistry (XRF), pollen and Non-Pollen Palynomorphs (NPPs).

4:15pm - 4:30pm

PALEOENVIRONMENTAL RECONSTRUCTIONS SINCE MESOLITHIC ALONG THE SOUTH BRITTANY COAST (BAY OF QUIBERON AND SOUTH-GLENAN SECTOR, FRANCE)

Ophélie David, Aurélie Penaud, Muriel Vidal, Evelyne Goubert, Maiwenn Herlédan, Axelle Ganne, Jean-françois Bourillet, Agnès Baltzer

New results acquired on the southern Brittany shelf allow depicting Holocene coastal paleoenvironmental changes from the Mesolithic to the Middle Ages through a multi-proxy dataset (sedimentological and palynological analyses). Thanks to a well-understood sedimentological framework, palynological data and anthropogenic signal are discussed in light of the millennial to multi-millennial scale mechanisms imprint (i.e., SPG and NAO) on coastal sedimentary records.

4:30pm - 4:45pm

PALYNOLOGY FROM LAKE FAIDEH: ENVIRONMENTAL CHANGES AND HUMAN INFLUENCE IN UPPER MESOPOTAMIA (CA. 32,000 - 8,000 BC)

Jessica Zappa, Luca Forti, Assunta Florenzano, Anna Maria Mercuri, Eleonora Regattieri, Andrea Zerboni

In this contribution we want to present the preliminary results of the palynological analysis of the Faideh fluvio-lacustrine sequence, located in the northwestern Kurdistan Iraqi Region (KRI). The study is part of a multidisciplinary project aimed at reconstructing the evolution of the Late Quaternary landscape of Upper Mesopotamia.

4:45pm - 5:00pm

HOLOCENE LAND USE AND SUSTAINABILITY: INSIGHT FROM THE GRASSLANDS OF ARMENIA

Amy Cromartie, Odile Peyron, Guillemette Menot, Erwan Messenger, David Etienne, Lucas Dugerdil, Mary Robles, Kristina Sahakyan, Lilit Sahakyan, Sebastien Joannin

This paper investigates Holocene land use and sustainability in the steppes of Armenia. We utilize a variety of different methods (pollen, nonpollen palynomorphs [NPP], the molecular biomarker glycerol dialkyl glycerol tetraethers [GDGTs], macro-charcoal) to untangle the impacts of climate, agro-pastoralist, and fire on this steppe landscape.

From 5:00 pm

VIRTUAL TOUR OF MODENA

5:30pm

VIRTUAL GUIDED TOUR OF THE TERRAMARA DI MONTALE ARCHAEOLOGICAL PARK AND OPEN-AIR MUSEUM (live event)

.

Tuesday, 7 September 2021

S5: PALEOPALYNOLOGY ('MODERN ANALOGUES')

Time: 9:00am - 10:45am

Session Chairs: Vincent Lebreton, Antonio Picornell

9:00am - 9:40am

***POLLEN-BASED QUANTITATIVE RECONSTRUCTION OF PAST PLANT COVER: A STATE-OF-THE-ART REVIEW* (Invited talk)**

Laurent Marquer

Pollen-based land cover modelling has been developed over the last decades to correct biases related to pollen production, dispersion and deposition in order to finally assess quantitatively the past land cover changes. This talk will discuss the pros and cons of the different modelling approaches and highlight the main directions in this field of research.

9:40am - 9:55am

MARINE AND CONTINENTAL PALYNOLOGICAL EVIDENCES FOR THE UNDERSTANDING OF MODERN ENVIRONMENTS IN THE WESTERN MEDITERRANEAN SEA (ALGERIAN MARGIN AND GULF OF LION)

Vincent Coussin, Aurélie Penaud, Nathalie Combourieu-Nebout, Odile Peyron, Sabine Schmidt, Sébastien Zaragosi, Nathalie Babonneau

The Mediterranean Sea is generally described as an oligotrophic area. Samples from the Gulf of Lion and the Algerian Margin have been analysed in order to discuss the productive patterns of these areas using marine and continental microfossil bio-indicators. This marinecontinental approach aims to highlight the hydrological and climatic processes leading to the zones productivity.

9:55am - 10:10am

NON-POLLEN PALYNOMORPHS ANALYSES FROM LIGURIAN SOILS PROFILES. PROBLEMS AND PERSPECTIVES

Bruna Ilde Menozzi, Carlo Alessandro Montanari

Soil profiles of different locations on the Punta Mesco promontory were sampled and analysed for their pollen, NPP and microcharcoal content. To better interpret the presence of NPPs it is necessary to clarify their taphonomy in these soils. Their distribution will be discussed focusing on "functional groups" attributed according to their taxonomy or their nutritional and dispersal strategies.

10:10am - 10:25am

MODERN POLLEN RAIN ON AN ELEVATIONAL GRADIENT IN THE CATALAN PYRENEES

Ramon Pérez-Obiol, Marc Sánchez-Morales, Albert Pèlachs, Jordi Nadal, Raquel Cunill, Anna Badia

A transect representing diverse communities and environments was carried out in the western Catalan Pyrenees (between 2027 m a.s.l. and 797 m a.s.l.). Sampling was performed on mosses, commonly used as pollen collectors in Pyrenees reference studies of current pollen rain. Geoprocessing tools have been used to compare pollen values from collected samples with the current vegetation layer.

10:25am - 10:40am

THE ASSESSMENT OF POLLEN REPRESENTATION ON MEDITERRANEAN MOUNTAINS

Davide Attolini, Francesco Ciani, Maria Angela Guido, Carlo Montanari

In recent decades, an increasing number of researches have been carried out to clarify the relationship between recent pollen deposition and vegetation. Here we test some of these methods, together with statistical analysis, to find the most suitable for the particular environmental conditions of the Mediterranean mountains.

S6: AEROPALYNOLOGY (METHODS IN AEROBIOLOGY)

Time: 11:00am - 12:00pm

Session Chairs: Maria P. Plaza, Alessandro Travaglini

11:00am - 11:15am

COMPARATIVE BETWEEN FORECAST METHODS IN AEROBIOLOGY

Antonio Picornell, María del Mar Trigo, Rocío Ruiz-Mata, Baltasar Cabezudo, Marta Recio

Stepwise multiple linear regressions have been traditionally used on aerobiological studies, but in the last decades new forecast methods, such as random forest and neural nets, have been implemented in aerobiological research. The aim of this study is to compare the performance of these three methods to determine which one produces less errors in the pollen and spore predictions.

11:15am - 11:30am

TOMCAST MODEL AND AEROBIOLOGY AS AN EFFECTIVE GREEN TOOL TO PREDICT INITIAL RISK OF EARLY BLIGHT IN POTATO CROPS. A CASE OF STUDY IN A LIMIA REGION (NW SPAIN)

Laura Meno Fariñas, Olga Escuredo Pérez, María Carmen Seijo Coello

Early blight caused by *Alternaria* species is one of the most common diseases in potato crop. Risk models are useful to predict the risk of infection. This study uses aerobiology to adapt TOMCAST model for control early blight in potato crops in A Limia.

11:30am - 11:45am

METABARCODING AS A TOOL FOR POLLEN IDENTIFICATION: POTENTIALS AND PITFALLS

Stephanie Joyce Swenson, Andreas Kolter, Birgit Gemeinholzer

Metabarcoding, a technique of using a short variable DNA region to identify the mixed species composition of an environmental sample, has shown great potential as an identification tool for a wide range of taxa. Our work has aimed to evaluate pollen metabarcoding from a wide of array of sources to further elucidated strengths and weaknesses of this technique.

11:45am - 12:00pm

SAMPLING IS NOT SIMPLE: A COMPARATIVE STUDY OF METHODS FOR POLLEN, POLLEN PROTEINS AND AIRBORNE ALLERGENS COLLECTION

Iris Aloisi, Chiara Suanno, Silvia Sandrini, Paola De Nuntiis, Stefano Del Duca, Delia Fernández-González

Standardised studies comparing airborne pollen, aeroallergen, and meteorological conditions are needed for a comprehensive knowledge of air allergenicity. Airborne proteins, selected allergens, aerosol chemical composition were measured. The sampling was performed with three different collectors running in parallel. Correlation analysis of proteins, allergens, aerosol chemical composition and meteorological parameters highlighted how pollen allergen exposure can be influenced by external factors.

P2: POSTER SESSION 2

Time: 12:00pm - 1:00pm

Session Chairs: Gabriel Servera-Vives, Eleonora Clò

AEROBIOLOGICAL DATA TO INTERPRET THE TERRITORY

Alberto Rodríguez-Fernández, Jose Oteros, Ana María Vega-Maray, Rosa Valencia-Barrera, Carmen Galán, Delia Fernández-González

The aerobiological network of Castilla Y Leon consists of 13 pollen traps. The aim of this study is to know the representativeness of each trap into the network. The clustering was made with the most abundant pollen types in the region. The results showed that the network can be divided into two groups that represent the two geographic areas in the region.

THREE SAMPLERS IN ROME: A YEAR COMPARED

Denise De Franco, Maria Antonia Brighetti, Alessandro Di Menno Di Bucchianico, Francesca Froio, Annarosa Miraglia, Alessandro Travaglini

The Rome city is characterized by significant environmental heterogeneity. The analysis of pollen presence is a useful instrument: the pollen data are those recorded at the aerobiological stations of Tor Vergata Monitoring Center Rome. One year of data (2020) of three monitoring samplers in Rome was considered: Villa S.Pietro Hospital – Rome North, University Tor Vergata – Rome South, Cipro – Rome Center.

AEROBIOLOGICAL STUDY OF THE ATMOSPHERE OF BRAGANÇA (NE PORTUGAL): PRELIMINARY RESULTS

Alfredo García Sánchez, Manuel Feliciano, Leonardo Furst, José Sánchez Sánchez, Estefanía Sánchez Reyes

Preliminary results of the first year of study of the pollen and fungal spores present in the atmosphere of Bragança, Portugal, and the influence of weather variables on their airborne concentrations.

PRELIMINARY PALYNOLOGICAL ANALYSIS OF THE LATE NEOLITHIC AND COPPER AGE SITE OF COLOMBARE DI VILLA (NEGRAR DI VALPOLICELLA, VERONA, ITALY)

Eleonora Rattighieri, Assunta Florenzano, Cristiano Putzolu, Chiara Reggio, Anna Maria Mercuri, Paola Salzani, Umberto Tecchiati

The interdisciplinary research project of Colombare di Villa started in 2019 from the excavation made by Francesco Zorzi in the 50s, and included palynology to contribute to the palaeoenvironmental and economic reconstruction of people that settled in the N Italy site from late Neolithic to the beginning of early Bronze Age.

RIVULARIA HETEROCYSTIS AS INDICATOR OF LONG-TERM CHANGES OF MOISTURE AND NUTRIENTS IN SOILS: A QUALI-QUANTITATIVE STUDY AT THE TERRAMARA S. ROSA DI POVIGLIO (REGGIO EMILIA, ITALY)

Valentina Zini, Francesco Taglini, Paola Torri, Assunta Florenzano, Anna Maria Mercuri, Eleonora Clò

This work is part of the constantly updated research on non-pollen palynomorphs (NPP). The study was focused on the identification of *Rivularia*, a cyanobacterium that is an excellent bioindicator as it requires certain trophic, climatic and environmental conditions at different stages of the life cycle (Whitton and Mateo 2012).

ENVIRONMENTAL AND LAND USE CHANGES IN A MEDITERRANEAN LANDSCAPE: THE CASE STUDY OF THE ANCIENT METAPONTUM (PANTANELLO, S ITALY)

Assunta Florenzano, Andrea Zerboni, Joseph Coleman Carter, Eleonora Clò, Anna Maria Mercuri

The paper presents the results of palynological and geoarchaeological investigation carried out on the Greek-Roman site of Pantanello (Metapontum, S Italy). The combined bio-geoarchaeological approach provides information for palaeoenvironmental and economical reconstructions of the ancient Metapontum area, suggesting that human impact have locally prevailed over climate influence on environmental changes.

A PALYNOLOGICAL APPROACH TO THE RECONSTRUCTION OF MEDIEVAL LANDSCAPE IN TUSCANY, CENTRAL ITALY (NEU-MED PROJECT)

Elisa Furiq, Eleonora Clò, Anna Maria Mercuri, Mauro Paolo Buonincontri, Giovanna Bianchi, Richard Hodges

Part of the nEU-Med project, these palynological analyses on cores taken from Tuscany aim to help the reconstruction of the landscape and land use to better understand the processes of economic growth that took place between the 7th and 12th centuries AD.

THE TOLEDO MOUNTAINS (CENTRAL SPAIN) EXCITING SECONDARY CHARACTER

Reyes Luelmo-Lautenschlaeger, Sebastián Pérez-Díaz, José Antonio López-Sáez

The Toledo Mountains is a mid-elevation range complex placed between the Tagus and Guadiana basins, in the centre of the Iberian Peninsula. Eight mires along the mountain complex have been studied through pollen analysis, fire history reconstruction, loss on ignition, geochemistry and magnetic susceptibility, in order to disentangle the Toledo Mountains vegetation history from Late Neolithic until today.

VEGETAL ANTHROPOGENIC DYNAMICS FROM THE HOLOCENE TO THE ANTHROPOCENE ON THE CANTABRIAN COAST (NORTHERN IBERIA)

Aitor Fernández Martín-Consuegra, Sebastián Pérez-Díaz, Alejandro Cearreta

This study presents the results of two cores from the Saja-Besaya estuary (Cantabria) dated between the Holocene and the Anthropocene.

The human impact is initially reduced to livestock activities. Natural changes in the vegetation are observed during the Holocene, although soon followed by agricultural activity. Eventually, the impact of timber harvesting and replanting is present in the pollen record of the area.

LATE HOLOCENE PALEOECOLOGICAL CHANGES IN THE ECUADORIAN PARAMOS

Olga Aquino Alfonso, Marie-Pierre Ledru, Walter Finsinger

Páramo is a neotropical grassland ecosystem that is widespread in the northern Andes. We analysed the pollen and charcoal record of Papallacta since 5000 years. We found one major ecological change at 2500 cal yr BP in the vegetation and fire records, more specifically frequent fires and high Poaceae frequencies are related to low monsoon activity and low ENSO variability.

S7: PALEOPALYNOLOGY (QUATERNARY CLIMATE AND VEGETATION CHANGES)

Time: 2:00pm - 3:30pm

Session Chairs: Aurélie Penaud, Katerina Kouli

2:00pm - 2:15pm

INDIAN VEGETATION AND MONSOON RESPONSE TO MILLENNIAL AND ORBITAL CLIMATE VARIABILITY DURING THE LAST GLACIAL PERIOD

Coralie Zorzi, Stéphanie Desprat, Charlotte Clément, Dulce Oliviera, Philippe Martinez

The Indian Summer Monsoon (ISM), bringing up to 80-90% of the annual rainfall in Central India, is highly variable and sensitive to global climate change. We investigated marine sediment samples from the last glacial period (~73-20 ka) with the aim to better constrain the ISM variability in response to abrupt climate changes or changing boundary conditions.

2:15pm - 2:30pm

IMPRINT OF SEASONALITY CHANGES ON FLUVIO-GLACIAL DYNAMICS ACROSS HEINRICH STADIAL 1 (NE ATLANTIC OCEAN)

Wiem Fersj, Aurélie Penaud, Mélanie Wary, Samuel Toucanne, Claire Waelbroeck, Linda Rossignol, Frédérique Eynaud

A new dinoflagellate cyst analyses from the northern Bay of Biscay have been carried out at sub-centennial resolution to reconstruct the fluvio-glacial history of 'Fleuve Manche' paleoriver within HS1 interval. We argue that multidecadal change in seasonality played a key role in the hydrological regime of western Europe with episodes of substantial fluvio-glacial delivery concomitant with warm summers.

2:30pm - 2:45pm

NEW IBERIAN MARGIN POLLEN RECORD TO CONSTRAIN THE TERRESTRIAL BIOSPHERE EVOLUTION ACROSS TERMINATION V

Gabriel Hes, María F. Sánchez Goñi, Nathaëlle Bouttes, Déborah d'Olier

This study proposes a three-step integrated approach, combining observation and modelling results, to unveil the evolution of terrestrial biosphere and its contribution to the carbon cycle during Termination V (TV, ~420 kyr).

2:45pm - 3:00pm

VEGETATION PATTERNS IN THE CORINTH RIFT AREA THROUGH SUCCESSIVE CLIMATIC CYCLES OF QUATERNARY: EVIDENCE FROM THE IODP 381 POLLEN ASSEMBLAGES

Aikaterini Kafetzidou, Eugenia Fatourou, Konstantinos Panagiotopoulos, Fabienne Marret, Katerina Kouli

The results of the palynological analysis of the top 250m of the IODP Exp. 381 record from the Gulf of Corinth (Greece) are presented. The analyses aim to investigate the glacial-interglacial vegetation history in the southernmost Balkan tree refugium, constrain the timing of Quaternary extinctions of relict tree taxa, and distinguish global from local drivers of environmental change.

3:00pm - 3:15pm

KEY CHANGES IN THE BRAZILIAN ATLANTIC FOREST BETWEEN 1.5 AND 1.3 MA - COLÔNIA CRATER, BRAZIL

Paula A. Rodríguez-Zorro, Marie-Pierre Ledru, Charly Favier, Edouard Bard, Denise Bicudo, Marta Garcia, Gisele Marquardt, Frauke Rostek, André Oliveira Sawakuchi, Quentin Simon, Kazuyo Tachikawa

A major challenge of testing the responses of tropical diversity richness through climate changes is the scarcity of continuous long sediment records associated to the succession of glacial-interglacial cycles. In addition, understanding the adaptation of tropical ecosystems to such drastic climatic transitions are crucial, since the future of those depends on the ability that they have to adapt to the different stressors over time.

3:15pm - 3:30pm

HOW THE AFRICAN HUMID PERIOD SHAPED ENVIRONMENTAL CHANGES IN NORTHERN MADAGASCAR

Vincent Montade, Helena Teixeira, Jordi Salmons, Julia Metzger, Laurent Bremond, Thomas Kasper, Gerhardt Daut, Sylvie Rouland, Sandratrinirainy Ranarilalaitiana, Romule Rakotondravony, Lounès Chikhi, Hermann Behling, Ute Radespiel

Based on a multi-proxy approach applied to a lacustrine sediment record from a crater lake in the Montagne d'Ambre National Park, our study revealed five major climatic periods with distinct environmental dynamics during the past 25,000 years.

S8: PALEOPALYNOLOGY (HOLOCENE ENVIRONMENTAL CHANGES)

Time: 3:45pm - 5:15pm

Session Chairs: Alessia Masi, Sébastien Joannin

3:45pm - 4:00pm

CONTRASTED CLIMATE PATTERNS DURING THE LATE GLACIAL AND HOLOCENE IN ITALY RECONSTRUCTED FROM POLLEN DATA

Marion Blache, Mary Robles, Sébastien Joannin, Elisabetta Brugiapaglia, Guillemette Ménot, Lucas Dugerdil, Anna Maria Mercuri, Assunta Florenzano, Angèle Jeanty, Odile Peyron

This study proposes here to use pollen data to reconstruct quantitatively the climate trends at the Italian scale during the last 15000 years. In order to reconstruct the climate, the Modern Analogue Technique was used to reconstruct the mean annual temperature and the annual precipitations.

4:00pm - 4:15pm

LATE – HOLOCENE ENVIRONMENTAL CHANGES AND HUMAN IMPACT AT LAKE VOLVI (GREECE)

Lucrezia Masci, Alessia Masi

Macedonia region stands out for its incredible biodiversity both for geological, climatic and human factors. The region is in one of the most ecologically sensitive areas in the Mediterranean and includes river and wetland habitats near the lakes. The region has represented a connection between Asia and Europe for numerous populations since ancient times.

4:15pm - 4:30pm

A STUDY OF INTERACTIONS BETWEEN NORSE FARMERS AND THEIR ENVIRONMENT IN GREENLAND: THE CASE OF THE WESTERN SETTLEMENT

Elia Roulé, Camille Picard, Damien Rius, Emilie Gauthier

At the end of 10th century Norse took advantage of a global warming climate to settle in Greenland, until the middle 15th century. At higher latitude (64°N), the Western Settlement, human activities were constrained by a harsher climate (Arneborg et al., 2012; Schofield et al., 2019). An analysis provides a first glimpse of human-environment interactions (Barlow et al., 1997).

4:30pm - 4:45pm

HOLOCENE VEGETATION AND GRAZING ACTIVITY IN THE ORKHON VALLEY (MONGOLIA)

Chéïma Barhoumi, Marcel Bliedtner, Paul Strobel, Hermann Behling

We present the first pollen results from a sediment core from the upper Orkhon Valley, which show a transition from a more forested landscape at the start of the Holocene, to a steppic environment (between 5500 and 4500 cal. yr BP). These results could be linked both to climate change and to the intensification of grazing.

4:45pm - 5:00pm

MULTI-PROXY AND MULTI-METHOD MONGOLIAN LATE HOLOCENE CLIMATE AND ENVIRONMENT RECONSTRUCTIONS FROM LAKE AYRAG.

Lucas Dugerdil, Guillemette Ménot, Odile Peyron, Isabelle Jouffroy-Bapicot, Salomé Ansanay-Alex, Ingrid Antheaume, Hermann Behling, Bazartseren Boldgiv, Anne-Lise Develle, Grossi Vincent, Jérôme Magail, Matthew Makou, Mary Robles, Julia Unkelbach, Boris Vannièrè, Sébastien Joannin

A coupled pollen-branched Glycerol Diakyl Glycerol Tetraethers (brGDGT) paleoclimate reconstruction approach has been tested to provide independent and robust estimates of Holocene climate and environment changes in the extremely arid environment of the mountainous areas ranging from northern Arid Central Asia (ACA) to the Mongolian Plateau.

5:00pm - 5:15pm

VEGETATION, CLIMATE AND FIRE HISTORY DURING THE LAST 5000 YR BP IN THE CENTRAL CERRADO, BRAZIL (LAKE FEIA)

Katerine Escobar-Torrez, Marie-Pierre Ledru, Raquel Franco Cassino

In an attempt to understand differences between natural fire from anthropic fire, and the effect of fire in the central Cerrado vegetation, we are analyzing a sediment core from Lake Feia (LFB1) to reconstruct fire activity and vegetation of the last 5000 years.

5:15pm - 6:00pm

VOTING THE BEST POSTER

Wednesday, 8 September 2021

S9: BRIDGING SESSION BETWEEN MEDPALYNOS AND THE ITALIAN SOCIETY OF BOTANY

Time: 9:00am - 10:30am

Session Chairs: Alessandro Chiarucci, Anna Maria Mercuri

9:00am - 9:20am

OPENING OF THE 116TH SBI CONGRESS – ANNOUNCEMENT OF THE MEDPALYNOS CLOSING CEREMONY

9:20am - 10:00am

THE CHALLENGE OF COMBINING HISTORICAL ARCHIVES WITH PALEOENVIRONMENTAL DATA TO CREATE ROBUST EXPLANATIONS OF ENVIRONMENTAL TRANSFORMATION THROUGH TIME
(Invited talk)

Scott A. Mensing, Edward Schoolman, Adam Csank, Gianluca Piovesan

This plenary will review the challenges inherent in implementing interdisciplinary research that combines historical, paleoecologic and paleoclimate data to interpret the impact of society on the environment. We will present a conceptual model for project design and data collection that scales appropriately from local case studies to the regional context. This approach is intended to produce more robust causal explanations.

10:00am - 10:30am

CEREMONY AWARD

S10: ARCHAEOPALYNOLOGY

Time: 10:45am - 12:30pm

Session Chairs: Assunta Florenzano, Sebastián Pérez-Díaz

10:45am - 11:00am

THE LAKE DOJRAN POLLEN SEQUENCE: A BRIDGE BETWEEN SCIENTIFIC AND HUMANISTIC APPROACH TO THE ENVIRONMENTAL HISTORY IN THE BALKANS

Alessia Masj, Lucrezia Masci, Cristiano Vignola, Adam Izdebski

The paper reports on the ways in which environmental sciences converges with history as a humanistic discipline that focus on the past. The focus is on the southern Balkans with a comparison between the high-resolution pollen data from Lake Dojran (between Greece and Republic of North Macedonia) and Lake Volvi (continental Greece) records.

11:00am - 11:15am

LANDSCAPE EVOLUTION AND SOCIAL RESILIENCE IN THE BALEARIC ISLANDS SINCE PREHISTORY. THE STUDYCASE OF SANTA PONÇA (MALLORCA, WESTERN MEDITERRANEAN)

Gabriel Servera-Vives, Grant Snitker, Lluís Gómez-Pujol, Llorenç Picornell-Gelabert, Joan J. Fornós, Assunta Florenzano, Manuel Calvo, Anna Maria Mercuri

The EU-funded OLEA-project (G.A.-895735) aims to focus on the drivers and timing of the spread of *Olea macchia* as a central feature of the current Balearic mosaic landscape. This work will advance research on mosaic landscape formation in the Mediterranean in relation to human, climate, and environmental drivers.

11:15am - 11:30am

PALYNOLOGICAL RECONSTRUCTION OF LATE HOLOCENE PALAEOENVIRONMENTAL EVOLUTION IN CORSICAN COASTAL WETLANDS

Jordi Revelles, Matthieu Ghilardi

This study is focused on the potential of palynology for the reconstruction of palaeoenvironmental evolution of coastal wetlands of Corsica during the Late Holocene. The identification of aquatic organisms such as macrophytes, freshwater algae and cyanobacteria informs about limnological conditions, salinity and trophism of waters; and other microremains inform about soil erosion episodes and animal frequentation of coastal wetlands.

11:30am - 11:45am

LONG-TERM ENVIRONMENTAL CHANGES IN THE CENTRAL PO PLAIN: INFERENCES FROM PALYNOLOGICAL ANALYSIS ON THREE TERRESTRIAL CORES

Eleonora Clò

This contribution presents a pollen-based reconstruction of flora and vegetation characterizing the central Po Plain for at least the last 15,000 years. Pollen samples were collected from three terrestrial cores drilled at different distances N from the Terramara S. Rosa di Poviglio, as part of the SUCCESSO-TERRA Project (PRIN-20158KBLNB).

11:45am - 12:00pm

LANDSCAPES AND LAND USE OF THE SARNO RIVER PLAIN (CAMPANIA ITALY) OVER THE LAST 5000 YEARS

Chiara Comegna, Halinka Di Lorenzo, Paola Petrosino, Nicoletta Santangelo, Antonio Santo, Elda Russo Ermolli

Pollen analysis was carried on the infilling succession of the Fossa San Vito sinkhole. In the bottom part of the core, the high forest cover suggests the presence of a closed environment where a few signs of human activities are recorded. From the Greek-Roman age, anthropogenic indicators increase indicating the exploitation of the area for grazing and crops activities.

12:00pm - 12:15pm

THE VEGETATION RECONSTRUCTION OF THE POMPEII AREA BETWEEN THE 1ST MILLENNIUM BC AND AD 79

Cristiano Vignola, Jacopo Bonetto, Guido Furlan, Michele Mazza, Cristiano Nicosia, Elda Russo Ermolli, Laura Sadori

The AD 79 eruption of the Vesuvius severely affected the Sarno River floodplain in the surrounding of Pompeii. The landscape was covered with volcanic materials that destroyed the ecosystem but, at the same time, preserved the traces of former environmental conditions (Vogel and Märker 2010). The palaeoenvironmental reconstruction of the floodplain and its evolution in relation to the past urbanization

12:15pm - 12:30pm

A PALAEOECOLOGICAL RECORD OF LAND-USE CHANGES IN SE SICILY DURING THE LAST 400 YEARS

Fabrizio Michelangeli, Federico Di Rita, Fabrizio Lirer, Donatella Magri

A new marine pollen record from SE Sicily provides a detailed reconstruction of vegetational changes in relation to past socio-economic dynamics, land use changes, and historical land management policies over the last 400 years in Sicily. The high time resolution of our analysis allowed us to interpret nature and extent of human impact from the holistic perspective of historical ecology.

12:30am - 12:45am

CLOSING REMARKS

Session 1

POLLEN BIOLOGY AND STRUCTURE

Chairs: P.S. Testillano, G. Aronne

Invited talk

POLLEN DEVELOPMENT AND POLLEN-PISTIL INTERACTION. IMPLICATIONS FOR FRUIT TREE CROP BREEDING

Jorge LORA ¹, Iñaki HORMAZA ¹

¹ *Department of Subtropical Fruit Crops, Instituto de Hortofruticultura Subtropical y Mediterránea "La Mayora" (IHSM-UMA-CSIC), Málaga, Spain, jlora@eelm.csic.es, ihormaza@eelm.csic.es.*

Pollen development is a highly conserved process in angiosperms with intense crosstalk between the male germline and the sporophytic tissues. Initially, somatic cells and those that become the male germline are morphologically very similar but, later on, remarkable differences arise during male germline development. Meiosis is the key process during microsporogenesis with the formation of the haploid microspores and the beginning of their cell wall formation where small changes can result in clear morphological changes. An example is the subtropical fruit tree crop known as cherimoya (*Annona cherimola*), in which minor ontogenetic changes during meiosis result in the production of aggregated pollen. Meiosis is also very vulnerable to environmental changes, as it has been observed in mango (*Mangifera indica*), a tropical fruit tree crop, in which low temperatures disrupts the normal pollen development process. After pollen development, pollen grains are ready for the next step, pollination, in which pollen is transferred from the anther to the first meeting point between the male gametophyte and the female sporophyte, the stigma. While pollen development is very sensitive to environmental changes, pollen grains are even more influenced by environmental conditions during pollination, including their first pollen-female sporophyte interaction on the stigma. For example, changes of temperature and humidity can influence the percentage of selfing, as shown in cherimoya, by modulating final pollen development and stigmatic receptivity. After pollen germination on the stigma the pollen tubes grow into the style where they will find a more protected environment and where an intense male gametophyte-pistil sporophyte takes place. During this interaction, the female sporophyte both supports (by providing an adequate environment, nutrition and directional cues) and constrains (limiting the number of growing pollen tubes) pollen tube growth. This dual strategy provides opportunities for pollen competition and selection. Pollen development and pollen-pistil interaction are, therefore, essential processes for the subsequent fertilization, embryogenesis, and finally, fruit set that is of central importance in fruit tree crops.

INVOLVEMENT OF ENDOGENOUS CYTOKININS IN MICROSPORE EMBRYOGENESIS OF *BRASSICA NAPUS*

Yolanda PÉREZ-PÉREZ ¹, Alfonso ALBACETE ², Pilar S. TESTILLANO ¹

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Introduction

In vitro, isolated microspores, at the responsive stage of vacuolated microspore, can be reprogrammed by stress treatments, becoming totipotent cells and producing haploid and doubled-haploid (DH) embryos and plants. This process, known as stress-induced microspore embryogenesis, is widely used in plant breeding to rapidly obtain DH plants, which represent a source of new genetic variability, fixed in complete homozygous plants in only one generation step. Production of DH lines is currently a standard method of the creation of new material in many modern breeding programs, although its application is limited in many crop species due to low efficiency. Despite knowledge gained in recent years, the complex regulatory network of cell reprogramming leading to embryogenesis is still far to be fully elucidated. Several studies have revealed the relevance of auxins and cytokinins (CKs) as regulating factors for cell fate, proliferation and differentiation. Our previous studies have shown the key role of endogenous auxin in rapeseed and barley microspore embryogenesis (Testillano 2019; Pérez-Pérez et al. 2019). However, much less is known on the involvement of endogenous CKs in the process of microspore embryogenesis.

Materials and Methods

In the present work we have analyzed the dynamics and possible role of endogenous CKs during stress-induced microspore embryogenesis in *Brassica napus*, a model system to study this process in which no exogenous phytohormones are present in the culture media. The study was performed by a multidisciplinary approach. We use the technique of qRT-PCR to analyze the expression profile of cytokinin biosynthesis, signaling and degradation genes at different developmental stages of rapeseed microspore embryogenesis, and immunofluorescence assays to study cytokinin localization by using a monoclonal antibody against the cytokinin *trans*-zeatin (the most abundant cytokinin in plants). Furthermore, samples were analyzed by high performance liquid chromatography linked to tandem mass spectrometry (HPLC) in order to know the dynamic of cytokinin levels during microspore embryogenesis progression. We also performed *in vitro* functional analyses testing different concentrations of PI-55, a compound that inhibits cytokinin signaling, to analyze the possible involvement of cytokinin during microspore embryogenesis initiation and progression and its effects on development.

Results and Discussion

The results showed that endogenous CK concentration was low in microspores and at early stages after embryogenesis initiation, in proembryos, while it increased at advanced stages, with embryo development and differentiation. These changes in CK levels correlated with immunolocalization results and the expression patterns of the CK biosynthesis genes *BnIPT9* and *BnIPT1-2*, and CK signaling element type B, *BnARR21* which were up-regulated at advanced stages of embryogenesis. In contrast, *BnARR5* signaling element of type A and *BnCKX2*, enzyme of CK degradation pathway, showed decreased expression during embryogenesis progression. Pharmacological treatments with PI-55 did not affect embryogenesis initiation but severely impaired further embryo development. The results indicate that endogenous CKs would play a key role at advanced stages, during embryo differentiation, while embryogenesis initiation occurs with low CK concentration.

References

- Pérez-Pérez, Y., El-Tantawy, A.A., Solís, M.T., Risueño, M.C., Testillano, P.S. 2019. Stress-Induced Microspore Embryogenesis Requires Endogenous Auxin Synthesis and Polar Transport in Barley. *Front Plant Sci* 10: 1200.
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HEAT TREATMENT DURING MICROSPOROGENESIS AFFECTS THERMO-TOLERANCE AND ONTOGENESIS OF TOMATO POLLEN

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Introduction

Pollen functionality is essential for the successful reproduction of all plant species and therefore plays a key role in the crop species cultivated to produce seeds and /or fruits. Within the Mediterranean region, the alternation of the seasons has characterized the traditional cultivation calendar and determined whether a crop must be cultivated in protected environment or in open field. Within the current scenario of climate changes, in addition to the gradual global warming, also extreme weather events such as heat waves, are becoming more intense and frequent rising the risk of catastrophic losses of crop productions. According to the World Meteorological Organization, a heat wave is a period of five or more consecutive days during which the daily maximum temperature surpasses the average maximum temperature by 5 °C or more. In this framework, more studies on the effects of heat waves on plant reproductive processes are claimed. Previous experiments showed that heat treatments on mature pollen negatively affect pollen viability and germinability of several crop species (e.g., Hedhly et al. 2009; Mesihovic et al. 2016). Differently, we aimed to study pollen thermo-tolerance comparing the effect of a heat treatment exerted during microsporogenesis with that applied during microgametogenesis. We hypothesised that all the heat-induced defects during microsporogenesis may strongly affect the progression of male gametogenesis and therefore, the correct formation of mature pollen. In this work we used *Solanum lycopersicum* 'Micro-Tom', a dwarf variety of tomato selected for experiments in space and quite convenient for cultivation in small and highly controlled growth chambers. Specifically, we tested if high temperature occurring during microsporogenesis can affect pollen formation and subsequent functionality of the male gametophyte.

Materials and Methods

The experiment was performed in two VELP® growth chambers and we ensured that the plants were exposed both at optimal ($22 \pm 1^\circ\text{C}$) and at high temperatures ($30 \pm 1^\circ\text{C}$) only during microsporogenesis. To compare the effect of the two microsporogenesis temperatures on the subsequent pollen functionality, we evaluated pollen viability and germinability after further 72 hours of in vitro pollen incubation at 22°C and 30°C .

Results and Discussion

Data showed that pollen whose microsporogenesis occurred at optimal temperature, resulted more thermotolerant to the following exposure to both higher and optimal incubation temperatures. Conversely, 30°C temperature at microsporogenesis drastically reduced percentage of microspores developing into viable pollen grains. Effects of high temperatures were even more severe on pollen germinability and in fact, heat-treated microspores developed into not germinable pollen. Germinability of pollen developed at optimal temperature increased along flowering and reached the maximum percentage at anthesis. These results were deepened by additional cytological analysis in which we assessed that the highest germination percentage corresponded to the bi-cellular stage that in the control treatment occurred at anthesis. Indeed, tomato pollen is dispersed as bi-cellular gametophytes and the second mitotic division only occurs after germination on the stigma. In the high temperature treatment, all the developmental stages resulted shifted forward compared to the control. In particular, the transition into the bicellular stage representing the condition of mature pollen had already occurred before anthesis. We thus hypothesize that high temperature during microsporogenesis also cause a premature transition of microspores into bi-cellular pollen to ensure mature pollen formation ready for dispersal but reducing pollen lifespan throughout flowering. Therefore, both direct effects of high temperatures during microsporogenesis and pollen lifespan reduction throughout flowering can be responsible for a drastic loss in pollen viability and germinability.

Conclusions

Overall, results revealed that temperatures slightly higher than the optimum during the earliest stage of pollen development, can be crucial for pollen viability and consequently reproductive success. Results also highlighted that short period of high temperature can accelerate pollen senescence processes by shortening gametophyte lifespan so that pollen is already unviable before pollination.

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IDENTIFICATION OF CANDIDATE GENES DETERMINING THE MORPHOLOGY OF POLLEN GRAIN APERTURES BY TRANSCRIPTOMIC ANALYSIS IN PAPAVERACEAE

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Introduction

Pollen grain of Spermatophytes is protected by a resistant outer cell wall called exine, composed of a material called sporopollenin. Pollen wall is enormously diverse in its morphology, largely due to the shape, number and arrangement of apertures, areas where the exine is thinner or non-existent, which are involved in the exit of pollen tubes and pollen-stigma interactions (Ariizumi and Toriyama 2011). According to their shape, the equatorial or subequatorial circular apertures are known as pores and meridional elongate apertures with one of their axes (almost always the longest) that crosses the equator at right angles are called colpi (Erdtman 1986). Despite the immense diversity of aperture patterns, eudicots possess well-defined and fixed apertural systems, while the basal groups of angiosperms present a higher variability due to the lack of characters fixation (Blackmore et al. 1995), so the basal groups are interesting to carry out comparative studies. However, little is known about the genetic determinism of the pollen apertural system. In recent years some genes involved in the formation of apertures have been discovered, such as *INAPERTURATE POLLEN 1*, *D6 PROTEIN KINASE-LIKE3* or *DEFECTIVE IN OPENING FORMATION1* (Lee et al. 2018; Zhang et al. 2020). However, genes involved in the determinism of the different apertural type have not yet been described. Here, we performed a comparative analysis among the transcriptome of 4 species of Papaveraceae, a basal group of angiosperms, with different aperture types to identified potential genes involved in the differentiation of pollen apertural system. We compared *colpate pollen species*, *Dactylicapnos torulosa* and *Eschscholzia californica*, with *porate pollen species*, *Roemeria refracta* and *Fumaria bracteosa*. Moreover, *Dactylicapnos* and *Fumaria* belong to the subfamily Fumarioideae and *Eschscholzia* and *Roemeria* belong to the subfamily Papaveroideae, so we avoid that the differences in expression are due to their phylogenetic relationship.

Materials and Methods

Buds of three plants of *Dactylicapnos torulosa*, *Roemeria refracta*, *Fumaria bracteosa* and *Eschscholzia californica* were collected in tetrad phase to extract the RNA, and total RNA was sequenced. Then raw reads were filtered using trim-galore. Using Trinity, we performed a de novo transcriptome assembly for *Dactylicapnos*, *Roemeria* and *Fumaria*. Then, TransDecoder

and cd-hit was used to select the best open reading frame per transcript and non-redundant transcripts, these were annotated against the Swissprot database.

HISAT2 and StringTie were used for transcript quantification. After that, we compared gene expression of the colpate pollen species (*Eschscholzia* and *Dactylicapnos*) with the porate pollen species (*Roemeria* and *Fumaria*) using the DESeq2 R package. Differentially expressed genes (DEGs) were classified functionally using GhostKoala mapping tool. Finally, the differential expression of RNA-Seq was validated by qPCR.

Results and Discussion

Through differential gene expression analysis of colpate and porate pollen species, 531 DEGs, were obtained. Through GhostKoala DEGs were classified into “Genetic Information Processing” category mainly. Some of the DEG found were annotated as genes that could potentially be involved in the determinism of the apertural type. Three of them, *DYSFUNCTIONAL TAPETUM1*, *BIFUNCTIONAL NUCLEASE 1* and a β -1,3-glucanase are related to the formation or degradation of callose, which is involved in the deposition of sporopollenin. Two other DEGs, *α -L-ARABINOFURANOSIDASE* and *WALLS ARE THIN 1*, appear to be directly involved in cell wall remodeling. On the other hand, two other DEG, *NETWORKED 4B* and *VILLIN5*, encode proteins that intervene with the cytoskeleton and could create cellular domains, which are very important to indicate the places where other proteins should act. Other DEGs were annotated as transcription factors, which could regulate other genes or as genes that intervene in metabolism and cellular processes, which could be acting in the synthesis, degradation or transport of some component of the wall that could define the apertural areas. Finally, RNA-Seq analysis was validated by qPCR, which results showed that the differential expression pattern of the selected genes was consistent with that of RNA-Seq analysis.

Conclusions

De novo transcriptome assembly in buds of *Dactylicapnos torulosa*, *Fumaria bracteosa* and *Roemeria refracta*, generated many new sequences, which are an important new scientific resource. We found different genes that could potentially be involved in the genetic determinism of the apertural type, which should be confirmed by functional analysis.

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SCANNING ELECTRON MICROSCOPY REVEALS STRUCTURE OF POLLEN GRAINS OF MALE AND FEMALE WILD GRAPEVINE (*VITIS VINIFERA* SUBSP. *SYLVESTRIS* GMEL HEGI) IN CROATIA

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Introduction

The Eurasian grapevine (*Vitis vinifera* L.) includes two subspecies: wild (*Vitis vinifera* L. subsp. *sylvestris* Hegi Gmelin) and cultivated grapevine (*Vitis vinifera* L. subsp. *vinifera*). Both subspecies are diploid ($2n = 38$), sexually compatible, and prefer cross-pollination. The wild grapevine is dioecious, and considered to be an ancestor of cultivated grapevines (De Andres et al. 2012). The main difference between these two subspecies is in flower morphology. Pollen microstructure of male and female wild grapevine accessions is very rarely described (Inceoğlu et al. 2000; Gallardo et al. 2009; Mercuri et al. 2021).

Materials and Methods

In this paper, Scanning Electron Microscopy (SEM) was used to describe in detail pollen microstructure of eight male and two female *V. sylvestris* accessions from two Croatian (Eastern Adriatic region) natural populations. Nine morphological characters of the pollen grain were studied according to Nikolić and Milatović (2016) and Radović et al. (2016).

Results and Discussion

All the pollen grains regardless of flower type of the individuals were isopolar, radially symmetrical with foveolate-perforate exine ornamentation. Male pollen was 3-colporate, prolate in shape and had significantly larger pollen grains than inaperturate, spheroidal and subprolate pollen of two female individuals (Figure 1). Principal component analysis (PCA) clearly separated female from male accessions, while cluster analysis revealed hierarchical grouping among accessions based on measured micro dimensions of pollen grains. Two female individuals from the same population significantly differed in the number of exine perforations according to Tukey's *post hoc* test and subtle differentiation was observed when classifying their pollen shape according to Erdtman (1971).

Conclusions

The results indicate clear separation of male and female morphotypes and provide micromorphological information for future functional studies on the pollen and flower of grapevine.

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Figures



Figure 1. Equatorial view and detail exine surface in four *V. sylvestris* genotypes (two female: Pak10 and Pak12; two male: Pak32, Im19) under magnification of 3000x (whole grain) and 15 000x (exine pattern).

DOES POLLEN RELEASE EXOSOMES?

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Introduction

While mammalian and fungal cells capability to secrete exosomes has been known for decades, the ability of plants to form and secrete such vesicles was only demonstrated in 2009 (Regente et al. 2009). Exosome-like nanoparticles of respirable size, named “pollensomes”, were also isolated from germinated pollen in 2014, and they were described as possible allergen carriers (Prado et al. 2015, 2014). However, to date, no molecular markers have been identified on pollensomes to prove they are plant exosomes. In this study, we investigated the nature of pollensomes, proposing plant homologs of ALIX, a molecule characteristic of mammalian exosomes (Furini et al. 2018), as molecular markers for plant exosomes.

Materials and Methods

Nanoparticles with diameter smaller than 200 nm were isolated from kiwi (*Actinidia chinensis* Planch.) pollen grains previously hydrated or germinated. Isolated nanoparticles were analysed by nanoparticle tracking, using ZetaView® to measure their diameter and concentration, and micrographed in atomic force microscopy (AFM). Proteins from pollen-derived nanoparticles were tested for the presence of ALIX homologs by SDS-PAGE and Western blot analysis. Germinated pollen and isolated nanoparticles were also visualised using a fluorescent dye for vesicles.

Results and Discussion

Nanoparticles from germinated pollen were more concentrated than those from hydrated pollen. Their average peak diameter was between 160 and 140 nm for germinated samples, and between 140 and 130 nm for hydrated ones. Western blot analysis revealed a higher concentration of ALIX homologs in the putative exosomes than in the total cell lysate for germinated pollen of both species, whilst we were not able to detect these proteins in nanoparticles from hydrated pollen (Figure 1). The fluorescent dye suggests the presence of vesicles released by the germinated pollen in the medium (Figure 2).

Conclusions

ZetaView and AFM analysis suggests that the isolated nanoparticles are compatible with pollensomes and plant exosomes for size and shape. The high concentration of ALIX plant

homologs shown by nanoparticles from germinated pollen samples is consistent with this idea, and it confirms ALIX homologs as potential pollen exosome markers.

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Acknowledgements (Funds)

SUANNO_CHIARA - Dottorato XXXIV Ciclo

Figures

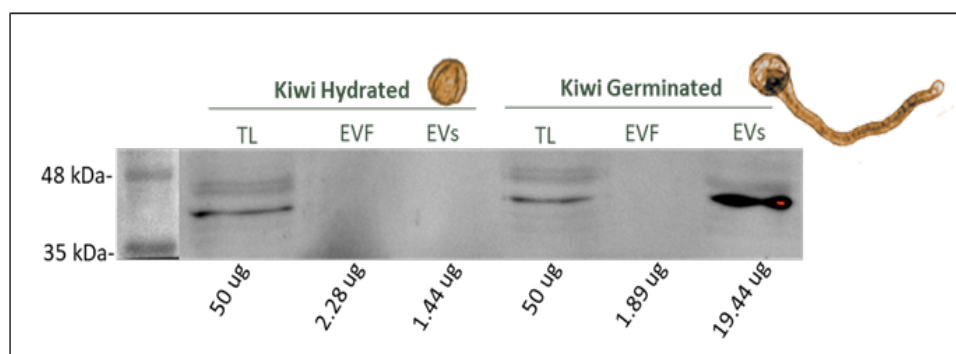


Figure 1. Western blot with anti-ALIX polyclonal antibodies. TL= Total Lysate of pollen grains; EVF= Extracellular Vesicles-Free medium; EVs= Extracellular Vesicles (pollensomes).

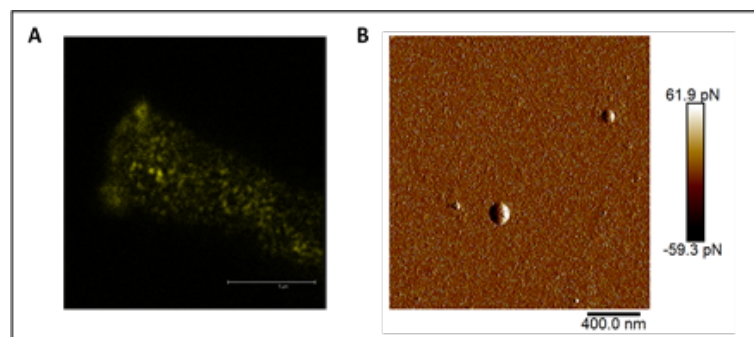


Figure 2. Micrographies of germinated kiwi pollen pollensomes (A) on the pollen tube tip, stained with SynptoRedTMC2 and visualised in fluorescence microscopy, and (B) isolated and visualised in AFM.

Session 2

MELISSOPALYNOLOGY

Chairs: A.-V. Gonzáles-Porto, A.M. Mercuri

NOTES ON THE POLLEN CONTENT OF HONEYS FROM THE MIDDLE-WEST OF THE IBERIAN PENINSULA (SALAMANCA, SPAIN) LABELLED AS SPANISH LAVENDER HONEYS

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Introduction

Pollen studies in honeys are fundamental tools to determine their botanical and geographical origin. Studies aimed at improving the marketing of honeys produced in a given area should include this type of analysis. In fact, the purpose of this study is to help characterise the “Spanish lavender” honeys in the MW of the Iberian Peninsula.

Materials and Methods

20 samples of honey collected in the province of Salamanca during the year 2018 and catalogued as “Spanish lavender” (or “French lavender”) by beekeepers were analysed. For the palynological study, the protocol tested by the honey working group (integrated in APLE, Spanish Society of Palynology) for Spanish honeys was followed (González-Porto et al. 2018).

Results and Discussion

The most common nectar pollen types present in the samples studied were *Echium plantagineum*, *Lavandula stoechas*, *Salix* sp. and *Raphanus raphanistrum*, all of them in more than 15 samples. In 5 of the analysed samples, the percentage values to be considered as monofloral Viper’s bugloss honeys were reached (Martín et al. 2017), as well as for one sample as monofloral willow honey (Persano et al. 2000) and one as monofloral Spanish lavender honey (Persano and Piro 2004).

Conclusions

The characterization of monofloral honeys from Spanish lavender is very complex without the use of melissopalynological analysis. For this reason, and from a botanical point of view, only one of the studied samples corresponds to the name given by the beekeepers, highlighting the importance of pollen analysis in honeys.

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Acknowledgements (Funds)

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MELISSOPALYNOLOGICAL AND PHYSICOCHEMICAL ANALYSIS OF HEATHER HONEY (*ERICA ARBOREA* L.) FROM THE REGION OF BABORS KABYLIA (ALGERIA)

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Introduction

The Babors Kabylia is one of the richest regions in Algeria in terms of floristic biodiversity. Beekeeping is a very common practice in this region and therefore has a big productivity in honey varieties every year. Some interesting unifloral honeys could be produced in this region such as sulla, honeydew and heather honeys (Ghorab et al. 2021). One of the most important plants for honey production is *Erica*. These plants form part of the maquis at altitude lower than 600 m forming the thermophilic facies. The most representative species of this genus is *Erica arborea* L. in association with other important taxa that make the maquis of great interest for beekeeping. In this study, we investigated the characteristics of heather honey produced in the area using melissopalynological and physicochemical analysis.

Material and Methods

Six honey samples were collected during spring from apiaries distributed over different sites in the Kabylia region of Babors. Melissopalynology analysis was carried out to establish the pollen spectra of the honey samples (qualitative) and to determine the number of pollen grains per gram of honey (quantitative). The physicochemical analyses (water content, Ph, free acidity, electrical conductivity, hydroxymethylfurfural (HMF) and diastase content) were performed according to the methodologies suggested by the International Honey Commission (Bogdanov et al. 1997), color (Pfund), mineral content, total phenolic content (TPC) and total flavonoid content (TFC) were also performed.

Results and Discussion

The honey samples had an average pollen content in quantitative terms, being classified as II and III in Maurizio classes with average values of 7248 ± 4192 grains/g. This may indicate that the honeys were extracted by centrifugation from the combs. The samples showed a significant diversity regarding pollen types with an average value of 19 ± 4 .

E. arborea pollen type had a maximum value of 70.1% and the lowest was 29.1% with a mean value of 54.25 %, being a dominant pollen in four samples and a secondary pollen in two. *E. arborea* pollen could be slightly underrepresented type in heather honey. Pollen spectra from the samples indicated a variety of other plant species visited by bees and reflecting the vegetation type of the region. The important and secondary species that were present in the honey samples were both nectar-producing species such as *Myrtus communis* L., *Hedysarum coronarium* L., *Eucalyptus* and non-nectar-producing species such as *Calicotome spinosa* L., and *Pistacia lentiscus* L. Furthermore, the presence of these types of pollen could be useful to discriminate this type of honey from other heather honeys of other geographical origins.

Overall, the results of the physico-chemical analyses were in accordance with the international legislation on honey quality and showed good quality parameters; nevertheless, the content of diastase was relatively low compared to the established limit. The samples had a dark amber color with an average value 122.2 ± 7.5 mm Pfund, high phenol and flavonoid content (109.8 ± 16.4 and 7.9 ± 1.3 mg/100 g), also a high electrical conductivity (0.8 ± 0.2 mS/cm) and therefore a relatively high mineral content compared to other nectar unifloral honeys. The statistical analysis showed an important relationship between these parameters indicating that these could be characteristics for heather honey.

Conclusions

The characterization of heather honey produced in Babors Kabylia provides information on the diversity of beekeeping resources of the area and the main physicochemical parameters, which are important for honey marketing and quality control.

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BOTANICAL ORIGIN OF HONEYS FROM RESERVA DE LA BIÓSFERA SIERRA DE MANANTLÁN, JALISCO, MEXICO

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Introduction

The identification and counting of the pollen grains of honey are needed to knowing the botanical and geographical origin of these (Castañón Chavarría 2009; Ramírez-Arriaga et al. 2011; Sánchez and Lupo 2011). The Sierra de Manantlán Biosphere Reserve (RBSM) is located within the Pacific apicultural region, Jalisco, Mexico, which does not have enough melisopalynological studies. The aim of this work was to determine the botanical origin of *Apis mellifera* L. honeys from nine apiaries located in two communities within the RBSM.

Materials and methods

From quantification and determination of the pollen found in seventeen honey samples collected from the fall bloom, was estimated the alpha diversity with Shannon Weaver index (H') associated with Pielou (J') uniformity index, as well as the similarity of the palynological sets among the apiaries was calculated with Jaccard index (I_j) (Seaby and Henderson 2007; NOM-004-SAG / GRAN-2018).

Results and Discussion

From 32 botanical families found in honeys, Fabaceae (10 taxa), Anacardiaceae, Asteraceae and Malvaceae with four taxa everyone, were the most richness on taxa. Seventy-five pollen types were registered, nine of these types were used to the classification of the honeys, among the pollen types with higher percent were found *Fraxinus* sp., *Quercus* sp. and *Styrax* sp., which have been reported like anemophilous plants (Recio et al. 1999; González Minero and Cebrino 2016), however, other authors report them as important pollen resources in beekeeping (Ortiz 1990; Giovanetti and Aronne 2011). Therefore, due to the presence of pollen types of nectar-poliniferous plants in blend with anemophilous types, the honeys of this work were classified as a natural blend of nectar with honeydew honey (Table 1). On the other hand, there is a high α diversity of taxa ($H' = 2.95$) with a tendency to a uniform distribution per sample ($J' = 0.68$). The Jaccard coefficient (I_j) indicated a clear differentiation among the pollen composition of the honey samples from both locations.

Conclusions

We found it is possibly to apply a new terminology and classification criteria for some blends of floral honeys and honeydew honeys by his botanical origin and not only by physicochemical parameters.

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Tables

Table 1. Botanical origin of honeys from the Sierra de Manantlán Biosphere Reserve, Jalisco, Mexico.

| | | SAN MIGUEL | | | | | | | TELCRUZ | |
|----------------|---|--|--|---|---|--|--|--|---|-----------|
| | | Carretera Arriba | Nuevo | La Lomita | Los Tablones | La Higuera | Piedra Picuda 1 | Piedra Picuda 2 | Llano del Medio | La Parota |
| CLASSIFICATION | Harvest 2019 | | | | | | | | | |
| | Blend of oak honeyde w with flower nectar honey (<i>Bidens</i> sp. & aff. <i>Rubus</i>) | Blend of multiflora l honey (<i>Bidens</i> sp., <i>Dalea</i> sp. & aff. <i>Rubus</i>) with oak honeyde w | Blend of oak honeyde w with multiflora l honey (aff. <i>Rubus</i> , <i>Bidens</i> sp. & <i>Dalea</i> sp.) | Blend of floral nectar honey (aff. <i>Rubus</i>) with oak honeyde w | Blend of oak honeyde w with floral nectar honey (<i>Bidens</i> sp. & aff. <i>Rubus</i>) | Blend of oak honeyde w with floral nectar honey (<i>Bidens</i> sp. & aff. <i>Rubus</i>) | Blend of multiflora l honey (aff. <i>Rubus</i> , <i>Dalea</i> sp. & <i>Bidens</i> sp.) with oak honeyde w | Blend of multiflora l honey (<i>Bidens</i> sp., <i>Dalea</i> sp. & aff. <i>Rubus</i>) with oak honeyde w | Blend of floral nectar honey from <i>Styrax</i> sp. and ash honeyde w | |
| | Harvest 2018 | | | | | | | | | |
| | Blend of floral nectar honey (<i>Lopezia</i> sp. & <i>Mimosa</i> sp. type 3) and oak honeyde w | Blend of ash honeyde w with floral nectar honey from <i>Bidens</i> sp. | Blend of floral nectar honey (<i>Mimosa</i> sp. type 1, <i>Mimosa</i> sp. type 3 & <i>Lopezia</i> sp.) with ash honeyde w | Blend of ash and oak honeyde w with floral nectar (aff. <i>Rubus</i> sp. & <i>Bidens</i> sp.) | Blend of biflora honey (<i>Dalea</i> sp. & <i>Bidens</i> sp.) and ash and oak honeyde w | Blend of ash and oak honeyde w with floral nectar honey (<i>Dalea</i> sp. & aff. <i>Rubus</i>) | Blend of oak and ash honeyde w with multiflora l honey (<i>Mimosa</i> sp. type 1, <i>Dalea</i> sp. & <i>Bidens</i> sp.) | Blend of flower nectar (aff. <i>Rubus</i> & <i>Bidens</i> sp.) with ash honeyde w | | |

Session 3

PALEOPALYNOLOGY (FORESTS AND MOUNTAINS)

Chairs: G. Servera-Vives, D. Attolini

Invited talk

THE ROLE OF HISTORICAL ECOLOGY IN THE CONSERVATION AND RESTORATION OF MEDITERRANEAN FORESTS

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Preserving old-growth forests and restoring functional ecosystems represent urgent goals for sustainable development, especially for those territories characterized by a long history of land-use and resources exploitation. In this context, ecological landscape planning should be based on a clear understanding of forest dynamics in terms of past composition, structure and function, including a detailed description of the land-use history. Historical ecology combines the scientific and humanistic approach to reconstructing past ecosystem dynamics, thus disentangling the role of past natural and anthropogenic disturbances and setting out an appropriate reference model of vegetation. These pieces of evidence combined provide insights into the capacity of the ecosystem, in terms of resistance and resilience, to face changing environmental conditions.

Mediterranean forests represent a unique case study to test new integrated scientific approaches. These biodiversity-rich lands have experienced a long history of resource exploitation succeeded by phases of abandonment and natural ecosystem restoration that has generated a complex mosaic of natural and cultural landscapes. Large patches of old-growth forests and ancient trees have survived over time not far from structurally and compositionally simplified and degraded forests.

Palynology, archaeobotany (e.g., anthracology) and dendroecology provide detailed information on medium to long-term compositional and structural changes of forest environments. In particular, dendrochronology enables us to reconstruct forest growth history revealing the crono-structural features that paleo-studies cannot catch properly. At the same time palynology and anthracology provide complementary information to define the past level of naturalness of a forest (e.g., primary old-growth vs secondary old-growth). The integration of such disciplines can be pivotal to reconstruct medium to long-term phases of vegetation change and to discriminate between natural or anthropogenic drivers for implementing management strategies to conserve biodiversity and mitigate climate change. Future studies should contribute to the understanding of pollen productivity of tree species in old-growth forests to improve the reliability of pollen-based vegetation models.

An emerging research topic is the reconstruction of the trajectory of forest ecological successions for different biogeographical regions and changing climate and soil conditions. Studies should focus on the response of vegetation to historical phases of land abandonment (e.g., post-pandemic rewilding) in each climate and environmental condition. To achieve such a result, cross-disciplinary studies and the cooperation between different specialized scholars are essential.

GLOBAL CHANGES, FIRE AND SPRUCE-FOREST DYNAMICS IN QUEBEC-LABRADOR DURING THE HOLOCENE

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Introduction

Covering ~30% of the global forest area, boreal forests provide numerous goods and services essential to human activities (wood and paper supply, cultural activities, natural resource extraction...) (Gauthier et al. 2015). They also provide a key role in climate regulation, representing ~20% of the global forest carbon sink (Pan et al. 2011). The dynamics of boreal ecosystems are also intricately linked to natural disturbance regimes, the main ones being fire, mainly controlled by climate - vegetation interactions (Ali et al. 2012). However, under the effect of global warming, recent work highlights the increase in fire frequency and severity in boreal forests and a potential shift of the carbon sink function (Walker et al. 2019). In this context, this multi-proxy study aims at providing new insights on fire-climate-vegetation linkages to better characterize the mechanisms by which climate change impacts disturbance regimes, and therefore forest structure and functioning.

Materials and Methods

To cover a latitudinal gradient of temperature and vegetation, and thus potentially a wide range of feedback processes, our study focused on a north-south transect of 5 lacustrine sedimentary cores extending across the Quebec-Labrador ecoregions, and covering the last 10,000 years. On each core, a study of microcharcoal (>150µm), chironomid assemblages and pollen grains were carried out, in order to reconstruct and compare respectively local fire regimes, climate fluctuations, and vegetation dynamics from the spruce-moss forest in the south of the transect to the tundra in the north. The different chronologies were established from radiocarbon and ²¹⁰Pb/¹³⁷Cs dating.

Results and Discussion

A strong link between climate, fire and vegetation is notable across sites. The warmest and driest periods were characterized by high fire frequencies and low fire sizes, related to a small amount of available biomass. By contrast, periods dominated by a colder and wetter climate are marked by

less frequent but larger fire sizes, probably due to a larger fuel accumulation (Carcaillet et al. 2001). During the last 150 years, fire size and frequency increase together, which may indicate a shift away from this “classic” fire pattern since the beginning of the industrial revolution. Black spruce (*Picea mariana*) is the dominant species on the transect during the Holocene. Up to 2500 cal BP, fire events are marked by an opening of the environment characterized by the development of pioneer taxa, before a strong development of black spruce and balsam fir. After the very large fire event around 2500 years ago, our study reveals a continued increase in pioneer taxa and a decrease in black spruce and balsam fir, marking a change in the vegetation trajectory towards a more open landscape.

Conclusions

During the Holocene, climate change induced variations in fire regimes, which appear to show a trend of an increasing size and frequency of fires in recent decades (Foster 1983). This study also shows that repeated large fires can alter the composition and trajectory of vegetation, which could ultimately alter the carbon sink function of boreal forests (Bastianelli et al. 2017).

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A MILLENNIUM-LONG HISTORY OF AN ICONIC OLD-GROWTH FOREST IN SOUTH-EAST EUROPEAN MOUNTAINS

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Introduction

Less than 3% of the total European forest extent is currently occupied by old-growth forests (OGFs). These forests are characterized by a natural vegetation dynamic that is reflected in peculiar forest structures: a fine mosaic of stands in different growth stages, which formed a multi-layered vertical structure and a complex horizontal structure, high values of coarse woody debris in different decay stages, and old trees approaching their maximum longevity (Wirth et al. 2009). While these features indirectly attest that a forest has been continuously wooded without human influence for sufficiently long periods of time, the legacies of past land-use, climate changes, and disturbance by fire remain largely unknown.

Presumably due to different level of historical deforestation among European regions, OGFs are not uniformly distributed in Europe. The Dinaric mountains are considered a hotspot for remaining OGFs seemingly due to low forest exploitation and moderate land-use changes in the past millennium. However, the extent of human imprints is still poorly understood because palaeoecological records are limited to lowland sites.

Here we present new well-dated stand-scale palaeoecological records (pollen, spores, stomata, macrofossils, macroscopic charcoal, and magnetic susceptibility), an extensive dataset of current forest structures and a detailed land-cover map of Biogradska Gora forest, an iconic European OGF in the Balkans (Montenegro), to provide new insights into the long-term vegetation dynamics of old-growth forests in the montane zone of the Dinaric Alps.

Materials and Methods

The Biogradska Gora forest is under protection since 1878 AD and hosts OG stands dominated by mixed *Abies alba* Mill. and *Fagus sylvatica* L. with lesser amount of *Picea abies* (L.) Karst. surrounded by pure beech stands in the outer part (Motta et al. 2015). The study combines analyses of 81 field

survey plots on forest structures, and high-resolution remote sensing and palaeoecological data (pollen, spores, macrofossils, macroscopic charcoal, and magnetic susceptibility) from a sediment core extracted from a small pond located in the outer part of the forest that spans the past 1000 years.

Results and Discussion

The forest includes 3 forest structural types, which denote different degrees of *old-growthness*. High levels of *old-growthness* characterize the inner part of the conifer-dominated mixed OGF. By contrast, the currently beech-dominated stands have substantially lower *old-growthness* with structures that are similar to those found in managed stands.

Palaeoecological records from a small pond are suitable to reflect the local-scale vegetation dynamics. During the Middle Ages the tree cover was low due to a land-use phase which involved agriculture, grazing, and use of fire. In contrast to records from nearby regions and to models, the tree cover increased after 1350 AD. Findings of stomata and macro-fossils during the Middle Ages support the hypothesis that the conifer-dominated area was more widespread in the past and has been reduced by human activities (including use of fire). The shift from disturbance-sensitive *Abies alba* to *Fagus sylvatica* might have happened at Biogradska Gora several millennia later than elsewhere (Morales-Molino et al. 2020) due to the remoteness of the site.

Conclusions

The study shows the potential of combining the assessment of current spatial patterns of forest structure and composition together with long-term ecological records to disentangle the legacies of past human activities from those caused by natural disturbances.

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HIGH-ELEVATION VEGETATION DYNAMICS ON THE CANTABRIAN RANGE (NORTHERN SPAIN) DURING THE PAST TWO MILLENNIA: THE LAGO DEL AUSENTE PALAEOECOLOGICAL RECORD

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Introduction

The number of available palaeoecological records from the Cantabrian Range has significantly increased during the past few decades (e.g., Muñoz Sobrino et al. 2003; Rubiales et al. 2008; Jalut et al. 2010; Moreno et al. 2011; Carracedo et al. 2018), contributing to fill many gaps in the knowledge about the Lateglacial and Holocene vegetation dynamics of this region. However, detailed and well dated records focusing on the late Holocene are very rare. Likewise, not much attention has been paid to the different drivers of vegetation change, particularly fire and transhumant pastoralism. In this communication, we present a new multiproxy palaeoecological record from Lago del Ausente aimed at refining the current understanding on the long-term ecology of the subalpine vegetation of this region of northern Iberia, with a particular focus on the legacy of historical land use.

Materials and Methods

We retrieved a 60-cm long core from the deepest part of Lago del Ausente (43°02'N, 5°21'W, 1740 m a.s.l.) using a UWITEC gravity corer. We dated the sedimentary sequence by means of six ²¹⁰Pb and four ¹⁴C dates and produced a Bayesian age-depth model. Sixty contiguous sediment samples 1-cm thick were treated for pollen, spore and microscopic charcoal analysis, alongside thirty 2-cm thick contiguous samples for plant macrofossil analysis. We conducted zonation, ordination and cross-correlation analyses to track vegetation change quantitatively.

Results and Discussion

The sedimentary sequence studied went back to approximately AD 250, thus spanning from the late Roman Times to today. We have delimited three statistically significant pollen zones, which coincide with subtle but relevant changes in the macrofossil assemblages. From ca. AD 250 to AD 950, the local vegetation mostly consisted of subalpine heathlands (*Erica*, *Calluna*, *Vaccinium*, *Juniperus*, *Cytisus*) with scattered pines (*Pinus* type *sylvestris*) but the timber line composed of pine forests must have been quite close to the elevation of the study site. Later on, pines decline due to increased fire activity probably related to pastoral farming while birches (*Betula*), meadows (Poaceae) and heathlands (*Erica*, *Calluna*, *Juniperus* type) started to expand. A notable rise in agricultural activities occurred, as indicated from the increases in *Cerealia* type and *Secale cereale*. Finally, from ca. AD 1570 to present, birches declined and the vegetation around Lago del Ausente included meadows and heathlands with a significant abundance of plants adapted to disturbance (*Plantago*, *Rumex acetosa/acetosella* type).

Conclusions

The palaeoecological record of Lago del Ausente has shown that the treeline ecotone with pines and birches was at this elevation during Roman Times and Middle Ages and was replaced with treeless subalpine shrublands due to human activities. In particular, it seems that pines decline because of enhanced fire activity related to pastoral farming. Heathlands benefitted from periods of high regional fire activity to expand and establish as the dominant vegetation.

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Session 4

PALEOPALYNOLOGY (VEGETATION, LANDSCAPE AND LAND USE)

Chairs: C. Zorzi, J. Revelles

LANDSCAPE DYNAMICS DURING THE LAST GLACIAL TRANSITION TO THE HOLOCENE IN THE NORTHERN IBERIAN PENINSULA. LA MOLINA PEAT BOG, CANTABRIA

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Introduction

The ecological transition from the Late glacial to the Holocene has been well studied in some sites of the northwestern Iberian Peninsula, but there is a geographical gap in the northern slope of the Cantabrian range. In this work, we present a multiproxy approach for a record from La Molina peat bog, which is dated at c. 17,500 cal. yr BP and fills this lack of information. Due that the most recent epoch has already been studied by Pérez-Obiol et al. (2016), we focused on the oldest part of the record (c. 6,700 – 17,500 cal. yr BP).

Materials and Methods

La Molina is an acidic peat bog located in the village of Puente Viesgo (Cantabria), approximately 25 km south of Santander (Latitude: 43.26; Longitude: -3.97; Altitude: 484 m a. s. l.). The site is found in the northern foothills of the Cantabrian range, between the Pas-Besaya water-divide. Analyses were performed in a sedimentary record between 250 and 499 cm depth, following standard procedures on the organic matter content (e.g., Dean 1974; Heiri et al. 2001), sedimentary charcoals >125 µm (e.g., Carcaillet et al. 2001) and pollen and non-pollen palynomorphs (e.g., Bennett and Willis 2001). A total of 383, 193 and 251 samples were analysed for the organic matter, sedimentary charcoals and palynology, respectively.

Results and Discussion

The pollen spectra revealed a clear dominance of non-arboreal taxa during the Pleniglacial, with Poaceae as the principal herbaceous plant accompanied by low values of *Artemisia*. The Bølling-Allerød chronozone, which is well-delimited by the organic matter content, brought higher water availability and the first significant pulsation of arboreal species, in the form of a *Betula* increase at

around 13,700 cal. yr BP. During the Younger Dryas, however, the tree presence decreased again for the benefit of Poaceae. Pines, which exhibit a minimal signal along all the record, registered a slight increase at that climatic phase. The Holocene started with a consistent recovery of arboreal pollen, now due to the increase of deciduous *Quercus* and *Betula*. The 9.3 kyr event brought the first significant fire episode of the sequence, coinciding with a sharp *Betula* decrease. Between the 9.3 and 8.2 kyr events *Corylus* started its colonization, and the 8.2 kyr event brought another *Pinus* pulsation and the recovery of non-arboreal taxa. Shifts on the landscape dynamics correlated well with climatic pulses until the Neolithic period, when the fire intensity increased coinciding with the onset of agricultural practices and the need to create forest openings.

Conclusions

La Molina record revealed steppe-like vegetation until the spread of *Betula* at 13,700 cal yr BP, followed by the progressive colonization of other mesophytes. A lack of fire episodes is detected until the 9.3 and 8.2 kyr events, which triggered significant landscape changes.

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VEGETATION, HUMAN PRACTICES AND CLIMATE CHANGES DURING THE LAST 15000 YEARS RECORDED AT LAKE MATESE, IN ITALY

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Introduction

Italy is a country where human practices are widespread since the Neolithic. In this context, it can be difficult to disentangle the climatic and human impacts on vegetation in paleoecological records. In addition, southern Italy is a region with few palynological records for the Holocene and the Late Glacial, a period still poorly documented (Joannin et al. 2012; De Beaulieu et al. 2017). Southern Italy is also interesting from climatic point of view because it is located in a transitional zone between several climatic systems including the North Atlantic Oscillation (NAO) and the North African anticyclone (Magny et al. 2013; Peyron et al. 2013; Di Rita et al. 2018). The aim of this study is to better understand vegetation, human practices and climate history in southern Italy during the Holocene and the Late Glacial.

Materials and Methods

The first step of this study is to understand the modern pollen-vegetation relationships in Matese massif. Several modern samples (mosses and botanical relevés) were taken along an altitudinal transect extending from 500 m to 1500 m a.s.l. The next step is to reconstruct vegetation, human practices and climate changes recorded in the Lake Matese sediment archive. The time period targeted covers the Holocene and the Late Glacial and is documented by sediment geochemistry (XRF), pollen and Non-Pollen Palynomorphs (NPPs). Finally, the relationships between vegetation, human practices and climate are established and the climate processes investigated.

Results and Discussion

Modern pollen rain is characterized by evergreen forests dominated by *Quercus ilex* at low altitude and an openness of landscape at higher altitude. Past vegetation shows a dominance of *Artemisia*, Poaceae and deciduous *Quercus* during the Late Glacial whereas deciduous *Quercus* and *Fagus* are mainly recorded during the Mid-Late Holocene. The pollen-based climate reconstructions show a cold Late Glacial marked by a colder Younger Dryas although this event is not pronounced and warmer conditions during the Holocene. The respective role of climatic systems is determined to fully understand long and short-term climatic changes.

Conclusions

This study brings a better understanding of vegetation, human practices and climate changes during the last 15000 years in southern Italy. For the first time in this region, the Younger Dryas has been recorded as a colder event and several abrupt climate changes seem present during the Holocene.

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PALEOENVIRONMENTAL RECONSTRUCTIONS SINCE MESOLITHIC ALONG THE SOUTH BRITTANY COAST (BAY OF QUIBERON AND SOUTH-GLENAN SECTOR, FRANCE)

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Introduction

New results acquired in the southern Brittany shelf (core MD08-3204 CQ: Bay of Quiberon, Baltzer et al. 2014, and core VK03-58bis: south-Glenan sector, Naughton et al. 2007) allow depicting Holocene coastal paleoenvironmental changes from the Mesolithic to the Middle Ages through a multi-proxy dataset including i) sedimentological (grain-size analyses, description of sediment facies, new AMS-¹⁴C dates) and ii) palynological data (vegetation dynamics through pollen assemblages as well as sea surface hydrological changes through dinocyst assemblages).

Results and Discussion

In core VK03-58bis, high sedimentation rates (ca. 1 m of sediments in 1.6 kyr) and progressive increase of *Turritella communis* occurrences, from ca. 10 to 8.4 ka BP, are likely related to the rapid post-glacial sea-level rise. From 8.5 to 5.8 ka BP, the decrease in sedimentation rates, probably associated with the reduction of accommodation space on the platform, led to the establishment of a condensed interval (35 cm corresponding to ca. 2.7 kyr) comprising the “*Turritella layer*” and testifying to the setting up of the maximum flooding surface in the south Brittany platform. Later, from 5.8 ka BP, the major slowing-down of the relative sea-level (RSL) rise at ca. 6 ka BP led to the stabilization of estuarine environments and to the subsequent progradation of deposits on the platform (with quite constant sediment rates until the top of the study sequence, ca. 22 cm/kyr). The same model of sedimentation is observed in the Bay of Quiberon study core. From ca. 5.8 ka BP, on both cores, estuarine-sensitive taxa (i.e., riparian pollen grains and *Lingulodinium machaerophorum* dinocyst taxon) then evidence the amplification of fluvial discharges in south Brittany coastal waters. The decrease of arboreal taxa together with the progressive increase of pollinic indexes of anthropization (IPA: adventive, ruderal and cultivated taxa) testifying of the

human-induced landscape change, is clearly recorded at ca. 4.2 ka BP (start of the Bronze Age in NW France, and of the Late Holocene from a stratigraphical point of view). However, we also suspect a hydro-climatic effect on the IPA signature, already attested in previous Brittany studies (Penaud et al. 2020; Lambert et al. 2020). In sites constrained by inputs from Brittany catchments, major peaks of IPA occur during periods characterized by strengthened subpolar gyre (SPG, likely corresponding to stronger recurrences of NAO-like configurations, i.e., North Atlantic Oscillation), known to favour increased precipitation then fostering winter fluvial discharges in northern Europe. Inversely, in sites constrained by Loire watersheds, the IPA signature seems to be amplified during periods characterized by weakened SPG (likely corresponding to stronger recurrences of negative NAO-like modes), known to favour stronger Loire discharges (Penaud et al. 2020). In the Bay of Quiberon, under Loire and Vilaine rivers influence, results in progress support this effect of millennial to multi-millennial scale mechanisms (i.e., NAO and SPG) on IPA records in coastal sedimentary archives.

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PALYNOLOGY FROM LAKE FAIDEH: ENVIRONMENTAL CHANGES AND HUMAN INFLUENCE IN UPPER MESOPOTAMIA (CA. 32,000 - 8,000 BC)

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Introduction

The Northern Mesopotamia is a key region to study how, during the Holocene, the first human societies took advantage of the natural resources and changed the land use of the territory where they developed. In fact, this area was the scenario of the first attempts of cereal cultivation and then of the beginning of urbanization. The palynological analysis here reported are part of a multidisciplinary project aimed at reconstructing the evolution of the landscape in this region during Late Quaternary.

Materials and Methods

We analysed 30 samples from a fluvio-lacustrine sequence from Faideh, located in the north-western Kurdistan Iraqi Region (KRI) near the Mosul Lake, along the Tigris River. The sequence is composed of 5m of sediments of which we considered the first 2.5m, which was radiocarbon dated between 32,000 and 8,000 BC.

Results and Discussion

The first results show an open landscape dominated by grasses and other plants typical of dry or wet environments. In detail, some species (hygrophilous trees such as *Populus*, together with Cyperaceae and *Typha*) found at the bottom of the sequence (from 250 cm to ca. 150 cm) are characteristic of humid environments. They decline toward the top (from 150 cm to 0.5 cm), where species of arid environments such as Asteraceae, Poaceae and Chenopodiaceae are dominant. Pollen of *Hordeum* group and *Avena/Triticum* group were recognised from 215 cm and 155 cm, respectively. The discrimination between the two groups is based upon the measurement of the longer axis of the pollen and its pore and annulus diameter (ca. 40 µm the axis and 8-10 µm the pore + annulus diameter was defined as *Hordeum* group, while more than 50 µm the axis and 10-12 µm the pore + annulus diameter was defined as *Avena/Triticum* group; Figure 1) (Moore et al. 1991).

These pollen grains are important because they represent species that became the cultivated cereals after the human selection began. In fact, it is important to underline that in arid lands the so-called proto cereals (Andrieu-Ponel et al. 2021) were part of the vegetation even before they were harvested. Then, human societies were able to select some species as particularly suitable for cultivation.

Conclusions

In conclusion, the palynological analysis allowed to reconstruct, together with other proxies, the evolution of the landscape in the study area and helped understanding how the vegetation changed in response both to the climatic changes and the human exploitation of natural resources between ca. 32,000 and 8,000 BC.

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Figures

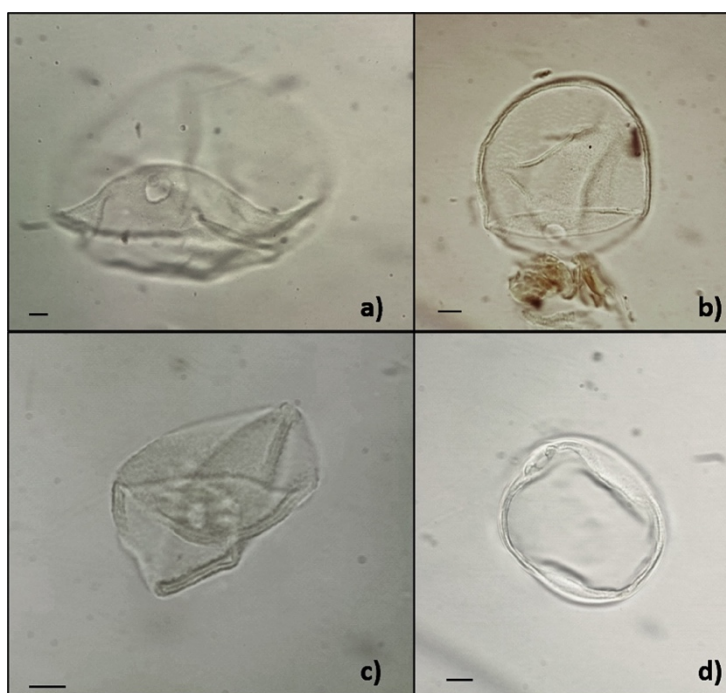


Figure 1. a) 82.16 μm longer axis, 15.6 μm pore + annulus diameter: *Avena/Triticum* group;
b) 53.04 μm longer axis, 11.44 μm pore + annulus diameter: *Avena/Triticum* group;
c) 44.72 μm longer axis, 9.36 μm pore + annulus diameter: *Hordeum* group;
d) 45.76 μm longer axis, 10.4 μm pore + annulus diameter: *Hordeum* group.

HOLOCENE LAND USE AND SUSTAINABILITY: INSIGHT FROM THE GRASSLANDS OF ARMENIA

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Introduction

In the country of Armenia, humans have been practicing agro-pastoralism in the steppe grasslands for at least 8000 years. These dry grasslands are incredibly diverse and contain a high richness of vascular plant species (Aleksanyan et al. 2020). However, relatively little is known regarding the influence of agro-pastoralism in shaping these ecosystems. In the Kasakh Valley, recent results have revealed a grassland landscape for most of the Holocene with limited evidence of human impact (Cromartie et al. 2020). These results, however, stand in contrast to archaeological data suggesting cereal agriculture and pastoralism (Badalyan et al. 2008, 2014). This raises subsequent questions including: are these isolated results? was agriculture practiced in the valley? what was the extent of human impact?

Materials and Methods

To address these questions, we expanded on these first results to include three additional sediment cores taken across a 10-kilometer transect across the valley. We apply an interdisciplinary approach that includes multiple proxies (pollen, non-pollen palynomorphs [NPP], the molecular biomarker glycerol dialkyl glycerol tetraethers [GDGTs], macro-charcoal) and combine these data with published archaeobotanical and zooarchaeological datasets (Badalyan et al. 2008, 2014). We also apply a REVEALS model (Sugita 2007) to understand vegetation transitions across the valley.

Results and Discussion

Following our first results (Cromartie et al. 2020), initial results from subsequent cores and REVEALS models confirms the presences of a Poaceae semi-alpine steppe with limited local tree cover. Across all cores our Cerealia-type pollen percentages, other human pollen indicators (i.e., *Plantago*

lanceolata, *Rumex* spp.), and non-pollen palynomorphs of coprophilous fungi (i.e., *Sporormiella*, *Podospora*) remain low despite archaeological evidence of cereal agriculture and sheep and goat pastoralism (Badalyan et al. 2008, 2014). In addition, these Cerealia-type pollen have a constant low signal throughout our record and appear prior to regional cereal domestication. This signal has previously been attributed to wild species and appears to be similarly represented in all cores with small increases during archaeological periods. Decreases in Poaceae and increases in Cichorioideae and Chenopodiaceae across the valley during the mid- and late-Bronze age appear to be partially driven by shifts in pastoralism with contributions from decreased fire and climate as previously hypothesized.

Conclusions

Overall, these records suggest a continuity of low impact agro-pastoral practices throughout the Holocene preserving this steppe landscape. These practices most likely resembled similar practices to today. This includes vertically utilizing the mountains' open steppe resources for pastoralism, hay making, wild foods, and small plots for cereal agriculture within the valley. More extensive agriculture, however, most likely occurred in the lowlands and adjacent plains of the South Caucasus.

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Session 5

PALEOPALYNOLOGY (‘MODERN ANALOGUES’)

Chairs: V. Lebreton, A. Picornell

Invited talk

POLLEN-BASED QUANTITATIVE RECONSTRUCTION OF PAST PLANT COVER: A STATE-OF-THE-ART REVIEW

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The non-linear nature of the pollen-vegetation relationship has made it difficult to quantify past land cover changes using fossil pollen records. Pollen-based land cover modelling has been developed over the last decades to correct biases related to pollen production, dispersion and deposition in order to finally assess quantitatively the past land cover changes. Different approaches now exist, and each one has its own advantages and disadvantages.

Over the last 10 years, these modelling schemes have been largely applied to reconstruct the Holocene land cover at subcontinental, regional and local scales in many regions of the world; great advances have been made in Asia and China, in particular. Today, some of the important challenges are the developments of the pollen-based land cover models to create past land cover maps at subcontinental, regional and local scales, and perform reconstructions in tropical, arid and mountain areas around the globe. Pollen-based quantitative reconstructions of past plant cover open up the possibility of achieving a considerably more robust assessment of the respective influence of climate and human land-use on land cover changes throughout the Holocene. This is of a particular interest for combining data from different disciplines such as archaeology/history, dendrochronology and paleoclimatology which aims at increasing our understanding about the degree of the impact of past and ongoing climate changes on societies.

This talk will discuss the pros and cons of the different modelling approaches, update the pollen community about the current developments in pollen-based land cover modelling, and highlight the main directions in this field of research.

MARINE AND CONTINENTAL PALYNOLOGICAL EVIDENCES FOR THE UNDERSTANDING OF MODERN ENVIRONMENTS IN THE WESTERN MEDITERRANEAN SEA (ALGERIAN MARGIN AND GULF OF LION)

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Introduction

The Mediterranean Sea is generally described as an oligotrophic area where primary productivity is limited to few coastal environments characterized by nutrient-enriched fluvial inputs. However, several studies have shown that the Western Mediterranean hydrology presents major seasonal productive patterns linked to either large fluvial inputs (e.g. Adriatic Sea under Pô river plumes; (Zonneveld et al. 2009) or seasonal upwelling cells (e.g. Alboran sea; (Penaud et al. 2011). This study aims at: i) discussing the organic microfossil assemblages (pollen grains, dinoflagellate cysts and other non-pollen palynomorphs) from two different productive zones of the Western Mediterranean Sea as well as ii) underlining the interconnections between marine and continental influence responsible for marine and terrestrial palynomorph present-day spatial distributions.

Materials and Methods

Samples from 25 sites collected from the Gulf of Lion and the Algerian Margin have been analysed in order to compare these two present-day noteworthy productive areas.

Results and Discussion

Results highlight: i) the Gulf of Lion's marine productivity driven by a conjunction of Rhône River inputs and seasonal upwelling mechanisms, ii) the strong productive pattern of the frontal meeting zone between Modified Atlantic Waters and Surface Mediterranean Waters (i.e., water density front mixings and related upwellings). Moreover, these two productive patterns are discussed at the light

of major links allowing to understand continental (vegetation witnesses) and marine (sea-surface hydrological conditions) bio-indicators.

Conclusions

This study will therefore allow to better interpret paleoenvironmental signatures derived from palynomorphs in Holocene studies from the Algerian Margin (MD04-2801; Babonneau et al. 2012) and the Gulf of Lion (KCGC-31; Bassetti et al. 2016) where palynological investigations have never been performed.

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NON-POLLEN PALYNOMORPHS ANALYSES FROM LIGURIAN SOILS PROFILES. PROBLEMS AND PERSPECTIVES

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Introduction

In recent years, NPP analyses increased in number, but only few studies have been carried out on soils, especially in the Mediterranean region. The present study brings new data from palynological analyses of soils of a Ligurian promontory. The variety of the NPPs recorded stimulated new questions about the interpretation of their presence. Some preliminary considerations about NPPs' taphonomy in soils will be presented.

Materials and Methods

The soil profiles have been obtained on the promontory of Punta Mesco, located in the eastern Ligurian Riviera on the north end of "Cinque Terre". The climate of Punta Mesco is usually considered as Mediterranean or sub-Mediterranean, characterized by hot and dry summers and mild winters, with a mean annual precipitation value around 1000 mm.

The vegetation cover is a mosaic of Mediterranean scrubs, broadleaved woodlands and abandoned terraces. Olive groves are the most frequent culture, followed by vineyards and horticulture. Chestnut groves are found typically on the northern slopes, while single chestnut trees are scattered on the southern ones.

Four soil profiles from different locations have been sampled and analyzed for their pollen, NPP and microcharcoal content. In addition, some samples from the previously studied sequence "Tr 2" (Guido et al. 2015; Pescini et al. 2018) have been analyzed for their NPP content. Three additional sub-sequences were retrieved from archaeological transects centered on the charcoal burning platform "C4", one of the charcoal kilns previously analyzed for their anthracological content (Guido et al. 2015; Pescini et al. 2018).

Results and Discussion

As the pollen content, also NPP concentration usually decreases with the depth of the samples. However, a large assortment of palynomorphs, both new and already described in the palynological literature, have been recorded. This diversity, and the noticeable difference between sites stimulated new questions about the interpretation of NPP presence in the diagrams. Among the questions we wish to answer regarding the NPP, the most obvious are "What is it?", "Where is it coming from?", "Why is it there?", "Can it be considered an ecological indicator?", and "How old is

it?”. In order to try to answer some of these questions, further considerations about the depositional processes are necessary. To clarify NPP taphonomy in these soils, the palynomorphs have been ideally divided – when feasible – in “functional groups” according to taxonomical or nutritional and dispersal strategies. For fungal spores or conidia – which represent the majority of the NPPs – categories such “coprophilous fungi” (saprotrophs on dung); “lignicolous fungi” (saprotrophs on wood); “carbonicolous fungi” (saprotrophs on charred material); “plant pathogens”; “hypogeous fungi”; “VAM” (Arbuscular Mycorrhizal Fungi); etc. have been used. For the application of similar categories, see also Shumilovskikh and van Geel (2020) and Mulder et al. (2003).

Conclusions

Despite the difficulties in interpreting NPPs presence, they still are a valuable source of information, especially at the local scale. They can help to comprehend the ecology underlying the soil formation and its variations through time. Sometimes they suggest hypotheses about land use or agricultural/husbandry practices. However, further investigations are needed to better comprehend their value as ecological indicators especially in relation with farmers' practices.

Among the additional problems to further investigate there are the possible overlap of different time frames for different palynomorphs in the same sample and the possible selection of palynomorph types through time (different resistance against degradation).

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MODERN POLLEN RAIN ON AN ELEVATIONAL GRADIENT IN THE CATALAN PYRENEES

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Introduction

The main goal of this study has been to provide qualitative and quantitative information concerning the Pyrenees' communities and their pollen representation linked to different environmental variables currently present.

Materials and Methods

A transect representing diverse communities and environments was carried out in the western Catalan Pyrenees (between 2027 m a.s.l. and 797 m a.s.l.). Moss samples were used because of their known suitability in Pyrenees reference studies of current pollen rain (Cañellas-Boltà et al. 2009; Ejarque 2009; Pérez-Obiol et al. 2018). Geoprocessing tools have been used to compare pollen values from collected samples with the current vegetation layers.

Results and Discussion

As it is shown in Figure 1, in subalpine open areas, Poaceae values are less than expected, probably because of pastoral pressure. On the other hand, ruderal grasses of the montane belt are better represented. This family has been shown as an intermediate pollen producer (Ge et al. 2017). Mountain pines show an overrepresentation in percentage values but, in some areas, the local presence of secondary taxa such as *Betula* and *Corylus* distort the interpretation of this plant landscape. On the contrary, *Abies alba* is often under-represented since its values drop dramatically at few metres from the fir forest. In montane environments, *Quercus ilex* shows a relatively high dispersal efficiency. This long-range transport is also exhibited by *Olea*.

Conclusions

The present pollen rain reflects the set of environmental and anthropic variables currently present in the valley. Results will be used with caution when interpreting fossil sequences due to the high percentage values of some ruderal or secondary local taxa. Pine values mask the representation of other taxa. Therefore, it may be useful to represent the *Pinus* percentage out of pollen sum. One

more factor to consider is the underrepresentation of some herbaceous taxa, especially those with entomophilous pollination or reduced pollen production.

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Figures

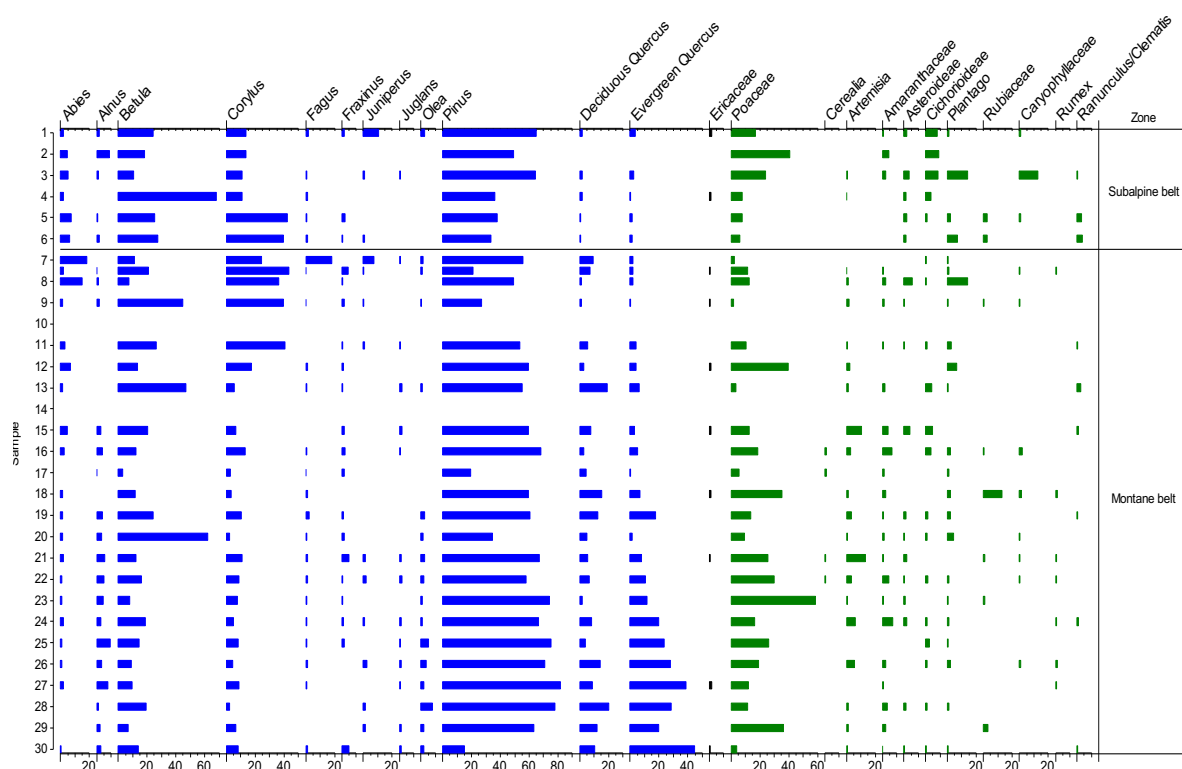


Figure 3. Summarized pollen diagram of the collected samples. *Pinus* percentage was calculated with the pollen sum plus *Pinus* pollen.

THE ASSESSMENT OF POLLEN REPRESENTATION ON MEDITERRANEAN MOUNTAINS (LIGURIAN APENNINES, N-ITALY)

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Introduction

In the northern Apennines, in recent decades a number of researches have been carried out, both in rural and urban areas, in an attempt to clarify the relationship between recent pollen deposition and vegetation (e.g., Guido et al. 2004). The method consisted in comparing local pollen spectra, obtained with the analysis of natural traps (moss polsters) and local vegetation cover, quantified with phytosociological surveys. In the second part of the 20th century, many authors used the R/P ratio (or its reciprocal) to compare the percentage presence of a taxon in the vegetation to that of the same taxon in the corresponding pollen spectrum (e.g., Heim 1970). This strategy had been used by Heim (1970) for extensive documentation in France and Corsica. Later, O.K. Davis (1984), to overcome the possible lack of pollen in the pollen spectra or its source in vegetation, proposed five indices, also useful to clarify other aspects of pollen representation. In the upper valley of the Vara River (La Spezia, Eastern Liguria), we aim to expand the only partially published systematic research based on several pollen samples and phytosociological surveys, by adding new data. While these methodologies may seem less modern and sophisticated, they may be more suitable to the particular environmental conditions of the Mediterranean mountains. Applying methods such as "walking in circles" or evaluating the "relevant source area" (e.g., Bromström et al. 2005; Bunting et al. 2013) is in fact problematic in areas with large altitudinal variations over short distances and characterized by high fragmentation of the vegetation cover.

Materials and Methods

The study was conducted on 65 sites, mainly woodlands, plantations, shrubland and meadows. To analyse the recent pollen rain, we used moss polsters since they represent an average of the accumulated pollen rain in the previous years, obtaining reliable data also comparable to fossil pollen spectra. In each site, at least 10 moss pollsters were taken and mixed into a single sample, then chemically processed for analysis. Vegetation was recorded by means of phytosociological relevés (Braun-Blanquet 1932). The average for each covering value was compared to the corresponding taxon percentage in the pollen spectra. Some taxa were selected on the basis of the most frequent species found in both the pollen spectra and the phytosociological surveys. Covering

values (R) and pollen frequency percentage (P) were calculated for each taxon and then used to obtain the R/P ratio and O.K. Davis (1984) indices. Ultimately, we statistically tested the correlation between APF percentages and covering values of each taxon.

Results and Discussion

From preliminary results, the R/P ratio, if read while accounting for pollen productivity and dispersion and the presence of dominating species, provides useful and reliable information on the local vegetation. If R or P are zero, R/P ratio cannot be calculated, while O.K. Davis indices still provide useful information about that taxon. The local pollen contribution is easily observable in woods, except for beech woods, characterized by a prevalence of pollen coming from the surrounding area: this could be due to *Fagus* low pollen production in the valley and the presence of more productive species in the nearby areas. In non-wooded sites, arboreal pollen contribution is considered extra-local/regional. Herbaceous and shrub taxa are generally under-represented, except for Ericaceae pollen (mainly *Calluna*) in heathlands and Poaceae in meadows. The statistical analysis revealed an overall strong correlation between pollen frequencies and the corresponding covering class. Regarding the arboreal plants, the lower correlation showed by *Fraxinus* and *Quercus* could suggest a non-negligible extra local contribution of this taxa. The same scenario was not depicted by the scarcely correlated herbaceous plants, except for the Poaceae, frequent in both pollen spectra and vegetation.

Conclusions

This repurposed methodology seems to be suitable for mountainous settings such as those of the Ligurian Apennines, where geomorphological features and the patchiness of vegetation complicate the application of different methodologies. The comparison between nearby sampling sites and with the plant cover obtained from present vegetation cartography make possible considerations on pollen dispersal and representation.

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Session 6

AEROPALYNOLOGY (METHODS IN AEROBIOLOGY)

Chairs: M.P. Plaza, A. Travaglini

COMPARATIVE BETWEEN FORECAST METHODS IN AEROBIOLOGY

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Introduction

Stepwise multiple linear regressions have been traditionally used on aerobiological studies because their results are directly interpretable (Beggs et al. 2017). Nevertheless, this methodology relies in the homoscedasticity and normal distribution of the data, and it is easily affected by covariance between forecast variables. In the last decades, new forecast methods, such as neural nets and random forests, have been implemented on aerobiology, but they are not easily applicable (Navares and Aznarte 2017). The main aim of this study is to compare the performance of these three methods in order to determine which one produces less errors in the pollen and spore predictions.

Materials and Methods

For this study, airborne pollen and spore concentrations from Ronda and Sierra de las Nieves were used (Malaga, southern Spain). Pollen samples were obtained by two Hirst-type volumetric pollen traps, and samples were mounted and counted following the Spanish Aerobiology Network (REA) procedures (Galán et al. 2007). Daily pollen and spore concentrations for the period 2017-2019 were used. Models were trained with 80% of the data available and validated with the remaining 20%. Observed and predicted pollen/spore concentrations were converted into classes, then, rates of success were calculated for each pollen/spore type. Meteorological variables, the pollen/spore concentrations of the previous day, and the average concentrations of the previous 5 days were used as predictor variables.

Results and Discussion

Random forest forecasts obtained a higher average accuracy than the other methods (Figure 1). The accuracy of neural nets was highly conditioned by the pollen/spore type considered. The most relevant variables were the pollen/spore concentrations of the previous days.

Conclusions

Forecast methods based on multiple and non-linear simulations generally obtain the highest accuracy but, in some exceptional cases, less complex methods can reach similar values.

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Figures

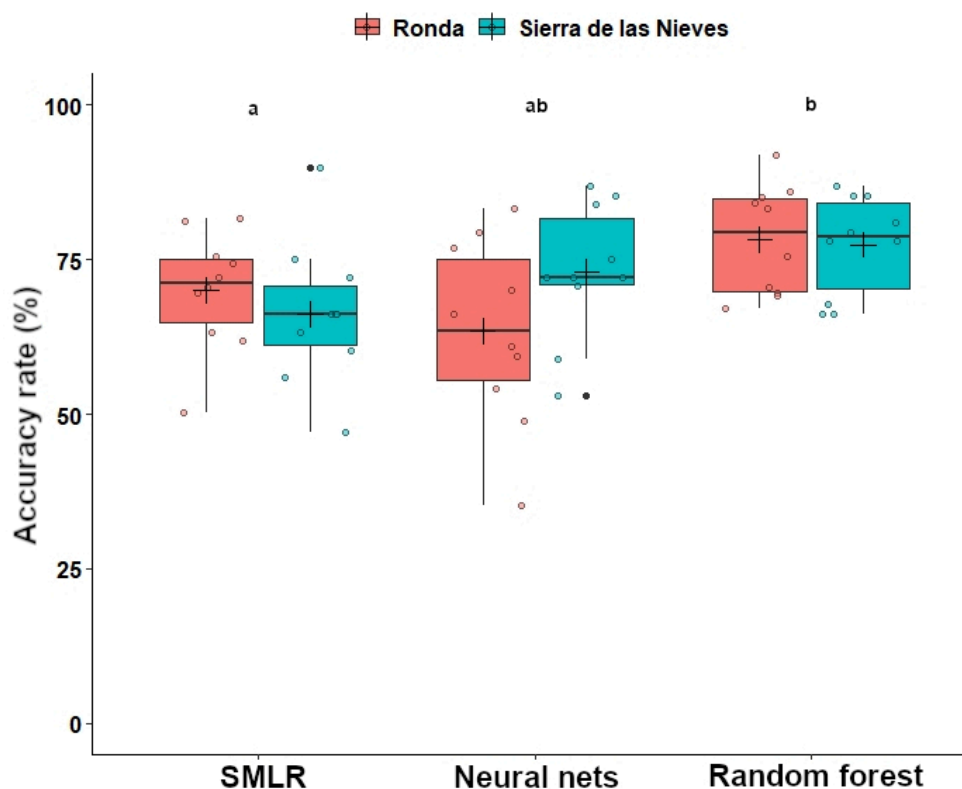


Figure 1. Accuracy rates of the forecast models in Ronda (red) and Sierra de las Nieves (turquoise). SMLR, Stepwise Multiple Linear Regression.

TOMCAST MODEL AND AEROBIOLOGY AS AN EFFECTIVE GREEN TOOL TO PREDICT INITIAL RISK OF EARLY BLIGHT IN POTATO CROPS. A CASE STUDY IN A LIMIA REGION (NW SPAIN)

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Introduction

Potato plants are susceptible to a wide variety of diseases that severely can reduce yield, quality and storability of tubers. Early blight caused by *Alternaria* species, mainly *A. solani* Soraeur and *A. alternata* (Fr.) Keissl, is one of the most common diseases that causes major economic losses in potato crop (Van der Waals et al. 2001; Escuredo et al. 2019). Risk models based on meteorological variables and aerobiological monitoring are an opportunity to control first aerial dispersion of fungi and avoid secondary infections. In this sense, TOMCAST, a Decision Support System (DSS) used for *Alternaria* control (Madden et al. 1978; Abuley 2015) combined with aerobiology can be a powerful green tool to predict risk infection for potato plants in A Limia region and minimize unnecessary fungicide treatments.

Materials and Methods

The study was conducted in a potato field situated in A Limia (Ourense, northwestern Spain) during seven growing seasons from 2014 to 2020. Meteorological data were recorded using a weather station in the potato crop. *Alternaria* conidia in the environment of the crop were sampled using a volumetric sampler Lanzoni VPSS 2000. TOMCAST model, a modified version of the FAST model (Madden et al. 1978) was used with some modifications, to predict the risk of early blight. Finally, for statistical treatments, the SPSS 21.0 software package for Windows was used.

Results and Discussion

Alternaria conidia levels were variable over the years being the 2020 the year with the lowest accumulated value (3651 conidia/m³) and 2017, the year with the highest values (12508 conidia/m³). These conidia were found during entire potato life cycle of studied years but they were more frequent at the end of leaf development period and the last stages of potato crop cycle.

Different risk classes were established considering the spore level in the environment. The classes were: Zero (0 spores/m³); Low (0–50 spores/m³); Intermediate (51–90 spores/m³) and High (>90 spores/m³). Each year, a first peak with values between 50-80 spores/m³ were detected when the plants are emerged. Hence, values correspond to Intermediate class. Intermediate and higher

classes occurred with a minimum temperature higher than 10 °C and mean temperature during the leaf wetness period higher than 13 °C. Lower classes had lower temperatures range. Therefore, temperature of the air influences the presence of *Alternaria* conidia in the environment of the potato crop. These relationships were tested by a Spearman's linear correlation analysis. The minimum temperature of the day and 7 days prior ($p < 0.01$) was positively correlated with *Alternaria* conidia. In the case of mean temperature, a positive correlation ($p < 0.01$) with temperature of the day and four days before was found. Another interesting relationship was found during the leaf wetness period. The mean temperature during this period ($p < 0.01$) was positive correlated with conidia levels.

Considering aerobiological results and the relationships with meteorological data, the TOMCAST model was adjusted for potato crops in A Limia region. Once 10 DSV is reached, the first intermediate peak of spores is observed in the field environment, this means a concentration of conidia oscillating between 51 and 90 spores/m³ per day. The monitoring of potato crops showed symptomatology of early blight a few days after the presence of this intermediate risk level.

Conclusions

Aerobiological monitoring and TOMCAST model applied to the environment of potato crops can predict early blight episodes. Therefore, this strategy constitutes an effective green tool to control the disease trying to minimize unnecessary sprays.

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METABARCODING AS A TOOL FOR POLLEN IDENTIFICATION: POTENTIALS AND PITFALLS

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Introduction

Metabarcoding, a technique of using a short variable DNA region to identify the mixed species composition of an environmental sample, has shown great potential as an identification tool for a wide range of taxa. Pollen metabarcoding has been the subject of much exploration in the last 10 years and areas of investigation have included honey, airborne pollen and pollen attached to insects. The promising results from these studies coupled with the decreasing cost and improvements in the robustness of sequencing technology, could enable its application in large scale biomonitoring and ecology. This technique is not without limitations however, and careless implementation without standardization of methods will most certainly lead to erroneous results. Environmental samples of pollen are highly variable in quantity, contaminants and PCR inhibitors that may require a variety of modifications to laboratory protocols. In addition, geographical considerations must be a factor when choosing a DNA barcode and primer pairs thereof, both for the sake of universal amplification success and completeness of the identification reference database. Our work has aimed to evaluate pollen metabarcoding from a wide of array of sources including airborne, honey, Malaise trap debris, insect body pollen from fresh collections and museum specimens, and via creation of artificial mock communities. We have implemented and evaluated several different laboratory protocols for DNA extraction and amplification using several common plant DNA barcodes and a range of data pipelines. From these evaluations we have further elucidated various strengths and weaknesses of this identification tool for pollen and provide recommendations of when and how this technique could be a valuable component in pollen studies and when it should be avoided.

Materials and Methods

Pollen samples were collected by collaborating partners or by ourselves. Pollens used in mock community experiments were purchased (Bonapol a. s. Czech Republic) or collected by hand. All commonly used plant barcodes were considered for implementation with Illumina MiSeq sequencing, and ITS1, ITS2, *rbcL*, and *trnL* P6-loop were chosen for experimentation. Experiments for pre-DNA extraction processing, DNA extraction method, PCR primer combination and PCR optimization were performed (Swenson and Gemeinholzer 2021; Kolter and Gemeinholzer in review). Several experiments with artificial mock communities were performed to evaluate species retrieval when sample includes a wide range of plant taxa, exine morphology, and GC content of DNA, as well as to test different primer pairings.

Results and Discussion

For the majority of sample types standard plant DNA extraction kits produce sufficient quantity and quality of DNA for sequencing with minimal modifications to the standard protocol. Airborne pollen DNA extraction must include additional steps similar to those for soil DNA extraction to overcome PCR inhibiting components, and adhesives used in airborne pollen traps can interfere with magnetic beads lowering the performance of magnetic bead DNA extraction. Insect body pollen samples with very low quantities of pollen grains, and museum specimens older than 45 years, were especially prone to false positives from contamination. Museum specimens of bumblebees older than 45 showed a high level of DNA degradation rendering them unsuitable for standard PCR methods with an amplicon size larger than 100 bp. Primer validation and general PCR protocol optimization via mock communities has shown that most recent studies missed a considerable proportion (~20%) of taxa by not optimizing the PCR protocols or by using outdated primer combinations.

Conclusions

Prior to implementation of a pollen DNA metabarcoding program:

- Sample type, barcode and primer pair choice, and completeness of DNA identification database for the geographical region must be evaluated.
- PCR optimization of the sample type must be performed prior to processing of “real world” samples.
- Several quality controls must be included, negative controls for evaluation of contaminants and positive controls using mock community mixes to confirm the validity of the methods employed.

We do not recommend using DNA metabarcoding when:

- Samples have a low quantity of pollen grains (<500 grains).
- Voucher specimens are necessary.
- Data concerning the abundance of different taxa is critical.

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SAMPLING IS NOT SIMPLE: A COMPARATIVE STUDY OF METHODS FOR POLLEN, POLLEN PROTEINS AND AIRBORNE ALLERGENS COLLECTION

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Introduction

Pollen allergenicity monitoring is an old problem that requires standardisation and new solutions. Nowadays there is a wide range of different methods available for pollen and allergens monitoring, but their relative efficiency is sometimes unclear, as conventional pollen monitoring does not thoroughly describe pollen allergenicity (Suanno et al. 2021).

Seen the need of integrating pollen and allergen quantification into a comprehensive air allergenicity monitoring system, this study aims comparing airborne pollen spectra, aeroallergen levels, and meteorological parameters.

Materials and Methods

The sampling was performed in Bologna (Italy) during the grass flowering period with three different collectors running in parallel, *i.e.* a Cyclone (total particles), a medium volume Dicothomous PM10 sampler (fine (< 1 µm) and coarse (1 – 10 µm) particles) and a Berner impactor (five particles size classes from 0.05 to 10 µm) (Figure 1). Grass pollen counts were performed by a Hirst-type trap. Total proteins were extracted and Profilin, Lol p 1, and allergens belonging to grass group 1 and group 5 were quantified using a double antibody sandwich ELISA (Aloisi et al. 2018).

Results and Discussion

Proteins and allergens in the cyclone samples were about ten times higher than in the other two sample sets due to their different cut-offs. Taking into account the slight difference in the cut-off diameter (1 µm vs 1.2 µm) the dicothomous and the Berner sampler appeared comparable for what concerns the total proteins collected in the fine fraction (1.3 vs 1.6 mg m⁻³). No allergens could be detected in any of the stages of the Berner impactor, while group 1 and profilins were detected only in the Cyclone. Only group 5 was found in the PM1-10 aerosol fraction of the Dicothomous, which resulted as the most selective sampler for airborne allergen, thus was further investigated.

Positive correlation was observed between total Gramineae pollen and group 5 allergen, both in the fine and in the coarse fractions. A persistent allergenicity following pollination was highlighted

(Figure 2), possibly attributed to the re-suspension of the protein load of pollen after its deposition on the soil and its following fragmentation (Zhang et al. 2014). The release of allergenic proteins outside the pollen grain favored by high atmospheric humidity, suggested by other authors (Grote et al. 2001), seemed not to be corroborated by our results, seen the negative correlation observed between group 5 and atmospheric humidity, particularly in the fine fraction. Only wind speed showed a positive correlation with group 5 concentration.

Conclusions

Correlation analysis of proteins, allergens, aerosol chemical composition and meteorological parameters evidenced correlations between protein concentration and the main aerosol components highlighting how pollen allergen exposure can be influenced not only by biological factors, but also by meteorological parameters and air pollution. Finally, this work evidences the need standardization in air sampling.

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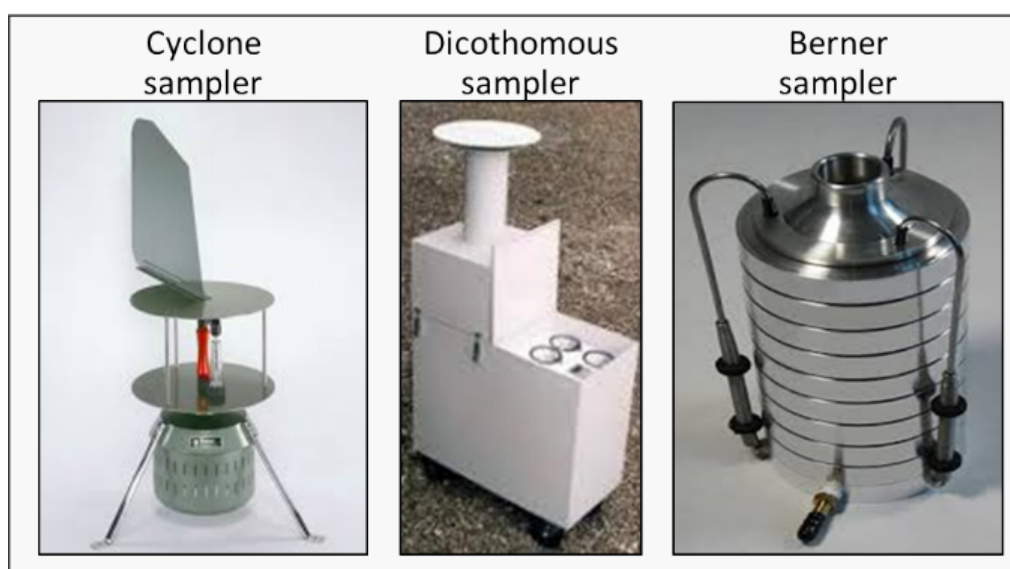


Figure 1. Samples used for the parallel sampling.

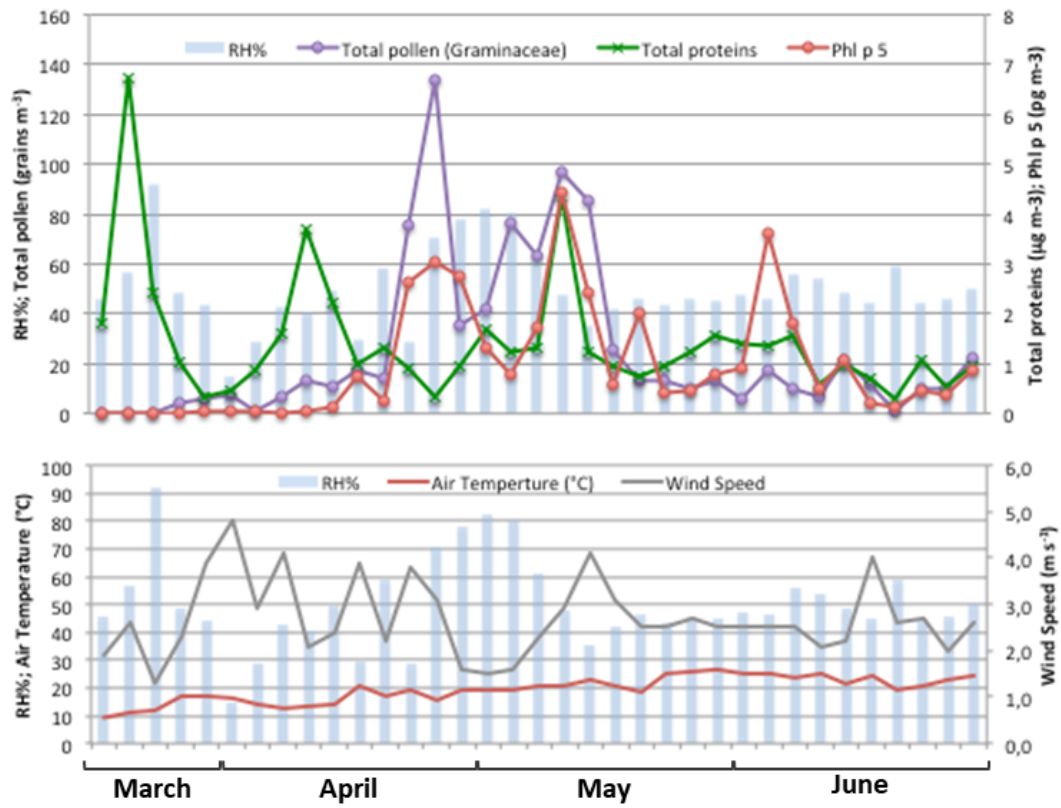


Figure 2. PM1-10 aerosol fraction of the Dicotomous. Plot of grass pollen counts, total proteins and group 5 allergens trend together with meteorological parameters (relative humidity, RH; Air Temperature and Wind Speed).

Session 7

PALEOPALYNOLOGY (QUATERNARY CLIMATE AND VEGETATION CHANGES)

Chairs: A. Penaud, K. Kouli

INDIAN VEGETATION AND MONSOON RESPONSE TO MILLENNIAL AND ORBITAL CLIMATE VARIABILITY DURING THE LAST GLACIAL PERIOD

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Introduction

The Indian Summer Monsoon (ISM), bringing up to 80-90% of the annual rainfall in Central India, is highly variable and sensitive to global climate change. However, predictability of the ISM variability by numerical simulations is still uncertain, especially because processes underlying the natural variations of the ISM remain unclear and are still debated (Ha et al. 2020; Clemens et al. 2021). Historically, reductions of the ISM led to severe famines that had devastating effects on Indian populations, destabilizing past economies and encouraging population migrations (Giosan et al. 2012). Therefore, understanding of the mechanisms causing the reduction in precipitation is undoubtedly part of present-day issues. With the aim to better constrain the ISM variability in response to abrupt climate changes or changing boundary conditions, such as CO₂, ice sheet and insolation changes, we investigated samples from the last glacial period (~73-20 ka).

Materials and Methods

Our study is based on pollen analysis of marine sediments from the IODP Site U1446, collected during the Expedition 353 "Indian Monsoon Rainfall". Pollen assemblages at Site U1446 represent an integrated image of the regional vegetation, and therefore climate, in the Mahanadi hydrological basin, which is ideally located in the strategic area called the core monsoon zone.

Results and Discussion

During the last glacial period, the pollen record is dominated by herb taxa such as Amaranthaceae, Poaceae, *Artemisia* and Cyperaceae, reflecting a predominant semi-arid steppe due to reduced ISM in central NE India. At orbital-scale, the monsoon minimum is recorded during the MIS 2, from 28 to 20 ka, as suggested by the collapse of the forest taxa and relative high herb percentages. In contrast, the ISM maximum occurred from 58 to 41 ka, during the early MIS 3, as shown by strong forest taxa percentages. The strong ISM reduction recorded during the MIS 2 seems to result from

the combined effect of ice sheet albedo and sea level changes, which may have affected the Hadley and Walker circulations, respectively. This atmospheric reorganization likely generated a reduction in the regional evaporation over the Indian Ocean affecting moisture supply to India. The ISM maximum recorded during the early MIS 3 may result from an enhanced interhemispheric gradient led by an obliquity maximum, which maintained northward the ITCZ boundary and increased the heat and moisture transport from the Southern Hemisphere during boreal summer. Our record also shows millennial-scale vegetation and ISM changes superimposed to the orbital variations. Several events characterized by particularly high percentages of the drought-tolerant Amaranthaceae, likely indicate the largest monsoon rainfall decreases of the last glacial period. These events are identified as the response to the Heinrich events in the North Atlantic leading to reduced ISM related to a southward shift of the ITCZ in India, and probably a cooling in the Arabian Sea.

Conclusions

Our study acknowledges the role of the southern Hemisphere, which strongly affects the interhemispheric gradient in the Indian Ocean, and thus, the amount of moisture transported into India, as well the influence of northern ice-sheet growth affecting the tropical region by atmospheric and oceanic feedback mechanisms.

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IMPRINT OF SEASONALITY CHANGES ON FLUVIO-GLACIAL DYNAMICS ACROSS HEINRICH STADIAL 1 (NE ATLANTIC OCEAN)

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Introduction

The northern Bay of Biscay has previously proven its great potential for recording the ‘*Fleuve Manche*’ paleoriver (i.e., the largest Pleistocene river in Europe) fluvio-glacial activity. Multiproxy studies identified recurrent phases of meltwater inputs at the onset of the Heinrich Stadial (HS) 1 between 18.3 and 17 ka BP (e.g., Zaragosi et al. 2001; Mojtahid et al. 2005; Eynaud et al. 2007; Penaud et al. 2009; Toucanne et al. 2010). Materialized in sediments as millimeter- to centimeter-scale laminations, they were attributed to the seasonal melting of the European Ice Sheet (EIS) and seasonal subsequent freshwater discharge from the ‘*Fleuve Manche*’ paleoriver.

Materials and Methods

In this study, new dinoflagellate cyst (dinocyst) analyses have been carried out at sub-centennial resolution in core MD13-3438 (northern Bay of Biscay) to reconstruct the deglacial history of the ‘*Fleuve Manche*’ paleoriver runoff coupled with European Ice Sheets (EIS) fluctuations across HS1 (HS1: 18.2–14.6 ka BP), a key extreme climatic event of the last glacial period. The Modern Analogue Techniques (MAT), was applied on dinocyst assemblages to estimate past quantitative sea-surface environmental parameters over the northern Bay of Biscay (keeping in mind their potentialities and limits in the study area).

Results and Discussion

Dinocyst assemblages are dominated by heterotrophic taxa including especially *Brigantedinium* spp. and miscellaneous peridinioid cysts within the laminated interval (18.2–16.7 ka BP). This period is

also characterized by maximal values of Fluvial-derived Palynological Tracers (FPT) (including percentages of *Lingulodinium machaerophorum* and concentrations of *Pediastrum* spp. micro-algae and pre-Quaternary dinocysts) pointing the enhanced 'Fleuve Manche' paleoriver runoff. Our work suggests a novel sub-centennial scale subdivision of the laminated interval into 5 sub-phases when episodes of substantial fluvio-glacial delivery concomitant with warm summers alternate with episodes of moderate runoff associated with extended cold winters (Figure 1). Cooling sea-surface conditions are recorded with seasonal winter sea-ice cover occurrences and low reconstructed SSTs within the Heinrich Event (HE) 1 (16.7–14.6 ka BP). The end of HS1 is characterized by warmer sea-surface conditions, suggesting the advection of Atlantic surface waters conveyed by the North Atlantic Current and leading to the transition to the warm B/A.

Conclusions

We argue that multidecadal seasonal changes played a key role in the hydrological regime of western Europe during the HS1 interval, with the retreat of the southern limb of the EIS, and associated influx of meltwater and fluvio-glacial delivery, which were strongly influenced by those multidecadal changes in seasonality. Interestingly, our paleoclimatic record not only evidences the crucial role of seasonality in controlling climate and hydrological variations during HS1 but also shows a remarkable echo with reconstructions from the western Mediterranean Basin (Camuera et al. 2021), highlighting common climate forcings at regional scale during the last deglaciation.

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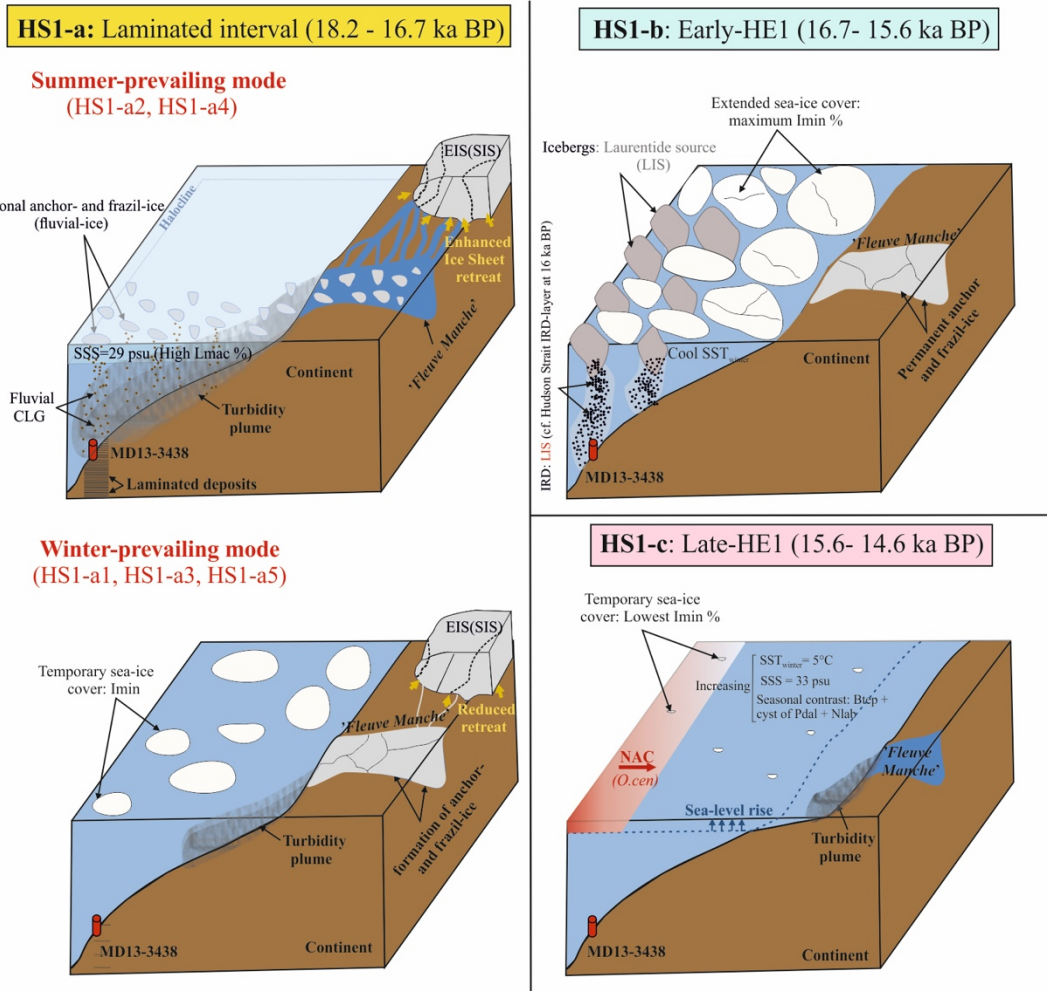


Figure 1. Conceptual model illustrating hydrological conditions and processes involved for fluvio-glacial dynamics across the HS1 interval in the northern Bay of Biscay.

NEW IBERIAN MARGIN POLLEN RECORD TO CONSTRAIN THE TERRESTRIAL BIOSPHERE EVOLUTION ACROSS TERMINATION V

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Introduction

Among the 100kyr climatic cycles of the late Pleistocene, Termination V (TV, ~420 kyr BP) stands out for several reasons. First, it occurs when astronomical forcing is minimum (Berger and Wefer 2003). Second, interglacial periods after TV are characterized by higher atmospheric CO₂ concentrations (Lüthi et al. 2008), revealing a substantial change in the climate system. However, the driving mechanisms explaining TV climate change remain only partially understood. For instance, climate models cannot fully represent the atmospheric CO₂ variation observed in paleoclimate data (Bouttes et al. 2018). Aside from essential oceanic circulation processes, there is increasing evidence that biosphere may have played a key role in the global carbon cycle (Landais et al. 2010; Bouttes et al. 2018, 2020; Barth et al. 2018). In particular, Brandon et al. (2020) suggest that terrestrial biosphere productivity could have delayed the atmospheric CO₂ increase during TV.

Materials and Methods

This study proposes a three-step integrated approach, combining observation and modelling results, to unveil the evolution of terrestrial biosphere and its contribution to the carbon cycle during TV. First, we analyze a new high resolution (~700 years) pollen record in the Gulf of Cadiz (Site U1386, 36°49.680 N; 7°45.320 W) for TV in order to complete the regional climate description and to increase global data coverage. We then construct a global forest pollen compilation for this period. Finally, we provide a direct comparison of the paleoclimate database to iLOVECLIM global simulations.

Results and Discussion

Our results feature a long (~20 kyrs) and moderate expansion of the Mediterranean forest over TV compared to other interglacials (MIS1 and MIS5e). At global scale, the arboreal pollen compilation highlights a strong development of temperate and boreal forest which may have hindered the

atmospheric CO₂ across TV. Besides, first model-data comparisons reveal consistent forest evolution despite model biases.

Conclusions

The present global pollen compilation constitutes a unique testbed for vegetation-resolving climate models and may therefore become a promising tool to sharpen our understanding of TV climate dynamics.

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VEGETATION PATTERNS IN THE CORINTH RIFT AREA THROUGH SUCCESSIVE CLIMATIC CYCLES OF QUATERNARY: EVIDENCE FROM THE IODP 381 POLLEN ASSEMBLAGES

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Introduction

The new sedimentary record from the Gulf of Corinth (southern Greece), retrieved within the IODP Exp. 381: Corinth Active Rift Development is a new archive registering environmental and climatic variability continuously over the last one million years. The Gulf of Corinth is a semi-enclosed basin, sensitive to climate forcing and sea level fluctuations (McNeil et al. 2019a). The palynological analyses of the deposits are preformed within the QECCoRA project and aim to: a) study the glacial-interglacial vegetation history in the southernmost Balkan tree refugium at a millennial scale b) constrain the timing of Quaternary extinctions of relict tree taxa, and c) distinguish global from local drivers of environmental change by studying the alternation between marine and isolated intervals and its impact on local ecosystems.

Materials and Methods

The M0078 sequence, recovered during the IODP Exp. 381 drilling campaign in late 2017, has been sampled at ~2m intervals aiming to obtain a millennial temporal resolution. The chemical processing of the samples followed the protocol used during the Exp.381 (McNeill et al. 2019b). Pollen, dinoflagellate cysts and all other palynomorphs were counted in the same sample to achieve a direct land-sea correlation.

Results and Discussion

The results of the palynological analysis of the top 250 m of the sequence show significant shifts in both terrestrial and marine palynomorphs. Dinoflagellate cyst assemblages show distinct alternations between marine conditions occurring during interglacials and brackish conditions in glacials, revealing changes in surface water salinity, productivity, and temperature. Arboreal pollen and total pollen concentration maxima within interglacial intervals suggest an increase in plant biomass and vegetation cover; however the typical cycle of forested interglacials and open vegetation during glacials is not that apparent. Mesophilous trees increase during warm intervals,

and remain abundant even within cold periods, while Mediterranean species form a substantial part of the vegetation throughout the study interval. Finally, several Neogene relict taxa are encountered until the last climate cycle, while they disappear earlier in other regional records, most likely related to the location of the site in the southernmost tip of the Balkan Peninsula.

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KEY CHANGES IN THE BRAZILIAN ATLANTIC FOREST BETWEEN 1.5 AND 1.3 Ma (COLÔNIA CRATER, BRAZIL)

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Introduction

A major challenge when testing the responses of tropical diversity richness through climate changes is the scarcity of continuous long sediment records associated to the succession of glacial-interglacial cycles. In addition, understanding the adaptability of tropical ecosystems to such drastic climatic transitions is crucial, since the future of those depends on the ability that they have to adapt to the different biotic and abiotic stressors over time. Our stud site, which is located in the Atlantic forest domain in Brazil, offers a unique opportunity for studying quaternary glaciations. Firstly, due to its geological origin, being possibly formed by a meteorite impact, has allowed having a continuous sedimentary infill that until now is known to be originated between the last 5.3 and 11.5 Ma (Simon et al. 2020). Second, the location between the southernmost influence of the South American Summer Monsoon (SASM) and the northernmost limits of polar air advections makes it a crucial place to understand past climatic and vegetation dynamics in the region (Rodríguez-Zorro et al. 2020).

Materials and Methods

The COL17c record was taken from the Colônia basin (23°52'03"S and 46°42'27"W, ca. 700 m a.s.l.), São Paulo, Brazil. A total of 115 m of overlapping sediment cores were recovered, which span the first 50 m depth from the basin. Colônia is a crater-like structure with an annular ring of hills reaching up 125 m and an inner depression characterized by a wetland and alluvial plain that is mainly filled by alluvial sediments. Here we analyze the pollen, charcoal, geochemistry (XRF), and biomarkers from the deepest 6 m from the Colônia drill core COL 17c. We aimed to reconstruct the climatic and vegetation changes of the southern Tropics during the 40-kyr glacial-interglacial cycles dated between 1.3 and 1.5 Ma, a key period to understand the southern paleoclimatology.

Results and Discussion

Our results cover 4 glacial and 3 interglacial intervals and show that the glacial epochs are characterized by the expansion of the semi-deciduous forest and the interglacial by the expansion of the evergreen forest. The floristic composition of the ancient Atlantic forest is characterized by a mixture of today's tropical seasonal-forest and Antarctic elements which currently do not grow in the area of Colônia. Fire activity is low but generally increased during the transition from interglacial to glacial. Changes in the amplitude of the glacial intervals are observed with weak and relatively warm glacials before 1.43 Ma and stronger and cooler glacials after 1.43 Ma suggesting a strong influence of the Antarctic ice volume on the tropical temperature and precipitation (Rodríguez-Zorro et al. in preparation).

Conclusions

Early Pleistocene was a key epoch for the distribution and diversity of the Brazilian Atlantic forest when high latitudes became progressively cooler. The Atlantic forest growing during this period was sensitive to changes in moisture and temperature, which determined the variation on vegetation composition between each of the analyzed glacial and interglacial periods.

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HOW THE AFRICAN HUMID PERIOD SHAPED ENVIRONMENTAL CHANGES IN NORTHERN MADAGASCAR

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Introduction

Quaternary climatic changes have been invoked as important drivers of species diversification worldwide (Hewitt 2000). However, the impact of such changes on vegetation and animal population dynamics in tropical regions remains a matter of debate. Madagascar constitutes a highly suitable region to study these relationships due to its high habitat diversity (Vences et al. 2009). However, studies on paleoecological dynamics in Madagascar are rather scarce.

Materials and Methods

A multi-proxy approach including pollen, charcoal, grain size and XRF analyses have been applied to a lacustrine sediment record from a crater lake in the Montagne d'Ambre National Park. To test ecosystem dynamics as response to climate fluctuations we further compared paleoecological and paleoenvironmental data to demographic inferences made for a forest-dwelling primate (*Microcebus arnholdi*) based on genomic data.

Results and Discussion

Our results revealed five major climatic periods with distinct environmental dynamics during the past 25,000 years. In particular, our study demonstrates the impact of the African Humid Period in northern Madagascar (15.2 – 5.5 kyr) and confirms that precipitation decrease after this period affected ecosystems even before humans significantly impacted the island. Our data-model comparison demonstrates that lemur population fluctuations in Malagasy wildlife are substantial predating any significant human impact, and are likely related to climatic impacts. The recent population dynamic (past millennium) was likely shaped by both climatic changes and human activities.

Conclusions

This provides a critical knowledge of natural, climatically driven, environmental and ecological changes in the past, which is essential to better understand the dynamics and resilience of current and future biodiversity.

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Session 8

PALEOPALYNOLOGY (HOLOCENE ENVIRONMENTAL CHANGES)

Chairs: A. Masi, S. Joannin

CONTRASTED CLIMATE PATTERNS DURING THE LATE GLACIAL AND HOLOCENE IN ITALY RECONSTRUCTED FROM POLLEN DATA

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Introduction

In Europe, the Late Glacial is characterized by important climate changes associated with the successive steps of the deglaciation (Younger Dryas...). Some studies based on chironomids show that the Younger Dryas event is well marked in north Europe but not clearly evidenced in South Mediterranean (Heiri et al. 2014). Discrepancies between chironomids and pollen-inferred climate reconstructions have also been shown for the Holocene period in Italy where settles a complex climatic pattern on either side of latitude 40°N (Magny et al. 2013; Peyron et al. 2013) and also exhibits a millennial-scale climate variability (Di Rita et al. 2018; Ôn et al. 2021). For the last 6000 yrs BP, Di Rita et al. (2018) found in south-central Mediterranean a spatio-temporal hydrological pattern opposite to the south-western one, suggesting that different expressions of climate modes occurred in the south Mediterranean at the same time. In this frame, it appears important to better quantify the climate changes in central Mediterranean during the last 15000 yrs BP.

Materials and Methods

We propose here to use pollen data to reconstruct quantitatively the climate trends at the Italian scale. We selected 16 pollen sequences through a collaboration with authors or from international pollen databases (NEOTOMA or European Pollen Database) according to their age models and temporal resolution. In order to reconstruct the climate of the last 15000 years, the Modern Analogue Technique ("MAT") was used to reconstruct the mean annual temperature and the annual precipitations.

Results and Discussion

Our first results based on pollen records shown a climate pattern similar to the one present in Europe during Late Glacial. Younger Dryas was dry and cold and was more pronounced in northern and central Italy than in the south. This trend is similar to the temperature reconstruction based on chironomids in Europe (Heiri et al. 2014). During the Early and mid-Holocene, Italy was warm and humid but with some local exception. A pronounced climatic optimum is evidenced in northern and central regions while it's a less marked in the south. The Late Holocene was dry and hot in North and South Italy but was colder in the central Italian region.

Conclusions

Our study has allowed us to reveal a latitudinal climatic gradient during the last 15000 years which differs from the conclusion by Magny et al. (2013) (i.e., an opposite pattern on each side of latitude 40°N), but the reconstruction of seasonal parameters is needed to corroborate or not this assumption. This pattern can be explained by the interactions between different climatic parameters like the North Atlantic Oscillation or the Intertropical Convergence Zone (Di Rita et al. 2018; Peyron et al. 2013). We could also show that the different proxies, chironomids and pollen, are in agreement.

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LATE – HOLOCENE ENVIRONMENTAL CHANGES AND HUMAN IMPACT AT LAKE VOLVI (GREECE)

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Introduction

Macedonia region stands out for its incredible biodiversity both for geological, climatic and human factors. The region is in one of the most ecologically sensitive areas in the Mediterranean and includes river and wetland habitats near the lakes (Griffiths et al. 2002). The region has represented a connection between Asia and Europe for numerous populations since ancient times (Welbank 2002). Despite its richness in endemic species and the long-lasting human history, it has been poorly investigated. Lake Volvi, the second largest lake of Greece situated in Central Macedonia, 30 km northeast of Thessaloniki, shows a rare wetland ecosystem: the nearby Macedonian Tempi valley is characterized by dense riparian vegetation and the whole area is protected by the Ramsar convention and has been included in the Natura 2000 network (Efthimiou et al. 2014). The lake has been classified as meso-to-eutrophic and its status is mainly influenced by agricultural runoff and farming activities. The climate in the basin is typical Mediterranean with hot summers and mild winters. The surface of the lake never freezes over the winter (Stefanidis et al. 2011). The lake area has been inhabited since the Late Neolithic as documented by the archaeological findings (Hennig et al. 1981). The aim of this study is to highlight human responses and resilience to climate changes through pollen analysis.

Materials and Methods

A 707 cm long core was extracted from the west bank of the lake to perform geochemical and palynological analyses. A total of 58 pollen samples have been processed and analyzed with an average resolution of 42 years BP covering the entire sequence. An average of 482 pollen grain for each sample and around 54 different taxa have been identified.

Results and Discussion

The preliminary pollen results give an overview of major changes on the vegetation cover and investigate the human impacts on the landscape. The landscape is characterized by arboreal vegetation with the dominance of mediterranean and mesophilous taxa: *Quercus ilex* type, *Quercus robur* type, *Pinus* and *Ostrya/Carpinus orientalis*. A significant reduction of *Q. ilex* and *Ostrya/Carpinus orientalis* is observed around 700-600 yr BP while herbaceous taxa increased. The

slight reduction of *Alnus*, the main element of the riparian vegetation around the lake, seems not related to a decrease in the lake level due to the stability of Poaceae, most likely related to the water belt vegetation. An increasing human impact is observed since 700-600 yr BP with the contemporary presence of cereals, in particular *Hordeum* group, and *Olea* and *Castanea*. Moreover, the anthropization process is indicated by the increase of other plants related to agriculture and pastoralism such as Cichorieae, *Plantago* cf. *lanceolata* and *Rumex*. Human impact is also highlighted by the peaks of *Sporormiella*, a coprophilous fungus, and of *Pediastrum*, an alga indicator of eutrophication, probably related to the soil fertilization due to cattle.

Conclusions

The pollen data evidences the vegetational changes of the last 3000 years, recording an increasing human influence on the natural landscape that couple with a climatic change. Understanding the causes of vegetal landscape changes is always complex and for this reason a multi-proxy approach is essential. The palynological data will be integrated with geochemical proxies and historian documents to provide a complete insight into the vegetation and human dynamics and their relationship with climatic changes in the area.

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A STUDY OF INTERACTIONS BETWEEN NORSE FARMERS AND THEIR ENVIRONMENT IN GREENLAND: THE CASE OF THE WESTERN SETTLEMENT

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Introduction

At the end of 10th century Norse took advantage of a global warming climate to settle in Greenland, until the middle 15th century. The Eastern settlement (60°N) was the larger settlement and probably the best studied by archaeologists and palaeoenvironmentalists (Massa 2012). At higher latitude (64°N), the Western Settlement, in the actual Nuuk's fjord is a smaller settlement. Human activities were constrained by a harsher climate, forcing an adaptation towards hunting and fishing (Arneborg et al. 2012; Schofield et al. 2019). A multi-proxy analysis of a lacustrine sequence performed in the Lake Itinera in the Western Settlement, provides a first glimpse of climate change and human-environment interactions (Barlow et al. 1997).

Materials and Methods

The chronology was established with an age model (¹⁴C, ²¹⁰Pb and ¹³⁷Cs) spanning the last four millennia (Picard 2019). The high resolution study of pollen grains, NPPs (non-pollen palynomorphs) and charcoals is compared with sedimentological results (XRF analysis and granulometry) in order to detect Norse farming activities.

Results and Discussion

Vegetation change in response to Norse footprint are subtle but visible. During the Medieval Warm Period, Norse footprint is characterized by a decrease in shrubs (*Betula nana*, *Salix glauca*) while the environment seems more open (1100-1250 A.D.). A clearing can thus be interpreted, however the anthropic origin of few fires can be questioned (1050-1220 A.D.). After 1250 A.D., at the start of the Little Ice Age, human activities are less perceptible; according to historical sources, Norse left definitely this settlement. Previous studies at low-resolution (Fredskild 1973; Picard 2019) did not specifically detect any Norse footprint in this area.

Conclusions

Farmers may arrive later than in the Eastern Settlement (Bichet et al. 2014). Multi-proxy analyses evidence, discrete pastoral pressure through clearing of the heath (1100-1250 AD). Shrubs clearing

and the use of fire could have been used for maintenance of grass (Bishop et al. 2013). The activities were therefore not only centered on farming activities contrary to the Eastern Settlement (Massa 2012). The Western Settlement economy probably rely on a very mixt economy where hunting took progressively a more important place (McGovern 1991). Our results finally showed that the medieval human activities had little impact on the environment (Gauthier et al. 2015). However these first results need to be completed by other analyses.

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HOLOCENE VEGETATION AND GRAZING ACTIVITY IN THE ORKHON VALLEY (MONGOLIA)

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Introduction

Mongolia presents a great variety of landscapes and climate, depending on the altitude which differs between the mountainous regions of the Altai in the Northwest and the steppe regions of Central Mongolia. The vegetation has also been impacted by human activities, which have been present there since the Upper Palaeolithic (46000 - 12000 cal. yr BP) mainly as small groups of hunter-gatherers (Tumen 2006). Since the Early Middle Bronze Age (4450 cal. yr BP) pastoralism has strongly developed (de Barros Damgaard et al. 2018; Jeong et al. 2018; Tumen 2006). The vegetation dynamics of Mongolian Altai region has been well documented for the Holocene period and is characterized by the development of an open forest (*Larix* sp., *Betula* sp., *Picea* sp., *Pinus* sp., and *Juniperus* sp.) in the Early Holocene until Mid-Holocene, mostly established because of warm and wet climate (Huang et al. 2020; Rudaya et al. 2020; Unkelbach et al. 2018, 2019, 2020). Then in the Late Holocene (2610 cal. yr BP), a steppe environment became dominant, with an increase of herbaceous species, because of a drier climate but also an intensified human impact (deforestation and animal grazing). From 550 cal. yr BP, a more diverse and forested landscape developed again, because of a decrease in the use of fires, and an increase in temperature and precipitation (Unkelbach et al. 2018, 2019, 2020). However, the other regions of Mongolia, notably Tosontsengel in the Northcentral part and the Orkhon Valley in the Central part of Mongolia are not yet so well documented. Here, we present first pollen results from our research project which aims to compare these different regions of Mongolia in terms of vegetation dynamics, fire activity, climate and human impact at the Holocene scale.

Materials and Methods

A total of 49 sub-sample from the sediment core (180 cm) were studied. A 1-cm³ subsample of sediment from the centre of each slice underwent chemical treatment (HCl, KOH, HF, acetolysis) and 500 µm sieving. A minimum of 300 pollen grains was counted per sample. The pollen analysis was carried out with a light microscope at a standard magnification of 400x.

Results and Discussion

The first pollen results from a sediment core from the upper Orkhon Valley show a very smooth transition from a more forested landscape at the start of the Holocene, to an increasingly steppe environment (between 5500 and 4500 cal. yr BP) with the increase in herbaceous species such as *Artemisia* and Poaceae until the end of the Holocene. These results could be linked both to climate change and to the intensification of grazing.

Conclusions

We further planned to study br-GDGTs, diatoms and macro-charcoals from this sediment core and also planned to study other sites at Tosontsengel to learn more about differences in vegetation dynamics between these regions, as well as a fieldwork in August 2021 for the analysis of pollen rain samples and pollen in faeces of animals (horses, sheep, goats, cows and camels).

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MULTI-PROXY AND MULTI-METHOD MONGOLIAN LATE HOLOCENE CLIMATE AND ENVIRONMENT RECONSTRUCTIONS FROM LAKE AYRAG

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Introduction

A coupled pollen-branched Glycerol Dialkyl Glycerol Tetraethers (brGDGT) paleoclimate reconstruction approach has been tested to provide independent and robust estimates of Holocene climate and environment changes in the extremely arid environment of the mountainous areas ranging from northern Arid Central Asia (ACA) to the Mongolian Plateau. The two proxies were calibrated for both global and local modern data sets (NMSDB; Dugerdil et al. 2021).

Materials and Methods

This multi-proxy approach was then applied to a sediment core collected from Lake Ayrag, Arkhangai (Mongolia), covering the Late Holocene. In addition to brGDGTs and pollen, we also performed magnetic susceptibility, micro-XRF, elemental and isotopic bulk chemistry, and Non-Pollen Palynomorph (NPP) analyses on the Lake Ayrag sediments in order to better understand the lake system and human impact dynamics.

Results and Discussion

While the globally calibrated record (both for pollen and brGDGTs) displayed a slight millennial-scale cooling, the locally calibrated results exhibit centennial-scale climate oscillations such as the 4.2 and

3.5 kyr events, the Roman Warm Period (RWP), Dark Ages Cold Period (DACP), Medieval Warm Period (MWP) and Little Ice Age (LIA). These climate oscillations and vegetation changes are discussed with regard to the main Mongolian human historical occupation events documented by pastoralism proxies, especially the Xiongnu, Mongol Empire, Mandchou and Soviet periods. The climate systems currently dominating the Mongolian Plateau are difficult to resolve because inter-annual climate variability is pronounced. However, precipitation mainly occurs in summer (easterly monsoon driven) when the winter Westerlies lead the air mass movement. In the past, both pollen and biomarkers exhibited anti-correlated trends with annual precipitation and temperature: over the last 4,000 kcal yr BP, the warm periods (MWP, RWP) were dry and the cold periods (LIA, DACP, 3.5 kyrs) were humid. Thus, the East Asian Summer Monsoon (i.e., warm and wet conditions dominant during summer) seems not to have influenced central Mongolian climate during the Late Holocene, which could have remained dominated by the Westerlies / Siberian High cells conflict.

Conclusions

A comparison between the Ayrag record and other paleoclimate records from the Baikal area (Dulikha), Mongolian Plateau (D3L6, D1L1, NRX, ATM), and continental China (Kesang, Baluk and Tonnel caves, XRD section) to the Loess Plateau (Huangye and Xianglong caves) suggests that the monsoon front has oscillated since the Early Holocene. A climate synthesis following strictly the same approach (locally calibrated brGDGTs vs. pollen-inferred climate) for all the ACA records available for the Late Holocene helps us to resolve the climate systems paced by centennial to millennial-scale oscillations and their consequences for human societies.

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VEGETATION, CLIMATE AND FIRE HISTORY DURING THE LAST 5000 YR BP IN THE CENTRAL CERRADO, BRAZIL (LAKE FEIA)

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Introduction

The Cerrado is a savanna occupying 23% of the Brazilian territory characterized by several physiognomies from open grassland to forest (Olivera-Filho and Ratter 2002). The distribution of the vegetation relates to three main components: soil fertility, water-availability (precipitation) and fire (Ratter and Dargie 1992; Hoffmann and Moreira 2002). Rainfall seasonality plays an important role, with two main climate features controlling the precipitation regime: the South American Monsoon System and the spatial shifts of the Inter-Tropical Convergence Zone (Marengo et al. 2012). Palynological studies, in the Cerrado, showed that fire was already active in the Pleistocene and during the Holocene (Salgado-Labouriau 1997), it has been suggested that fire presence during the Holocene, in particular since the late Holocene, could be related to human activity (Salgado-Labouriau 1997). In an attempt to separate natural fire from anthropic fire it has been demonstrated that fire increases mostly in periods of transition from humid to dry climate conditions (Salgado-Labouriau et al. 1997; Cassino et al. 2020). The analysis of the core LF15 that covers the time interval between 5000 and 13 000 cal yr BP at Lake Feia showed that the vegetation and fire responded to global climatic changes. Here we analyzed another core of Lake Feia (LFB1) to reconstruct fire activity and vegetation of the last 5000 years in order to assess the differences between wild and anthropic fires and their effects on the biodiversity.

Materials and Methods

The sediment core of Lake Feia (LFB1) is located in the Central Cerrado near Brasília. Chronological frame is based on 10 radiocarbon dates (Table 1). The top 310 cm of the core have been sampled for pollen and macrocharcoal analyses of the last 5000 years.

Results and preliminary conclusions

Core LFB1 presents a continuous sedimentation rate with a resolution of 6 to 25 yr /cm per sample (Figure 1). The charcoal accumulation rate (CHAR) shows a continuous fire activity during the last ~ 5000 years. Particles of macro-charcoal deposited in the sediment range from 1 to 340 particles/cm/year (Figure 1). Two periods with the highest peaks of charcoal influx (60 to 340

particles/cm/year) of the record are observed at 3420 cal yr BP and at 1380 cal yr BP, lasting 200 and 100 years respectively. The in-progress pollen analyses will allow to define the vegetation changes associated to these periods of fire increase and compare with the early Holocene record of Cassino et al. (2020).

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Session 9

BRIDGING SESSION BETWEEN MEDPALYNOS AND THE ITALIAN SOCIETY OF BOTANY

Chairs: A.M. Mercuri, A. Chiarucci

Invited talk

THE CHALLENGE OF COMBINING HISTORICAL ARCHIVES WITH PALEOENVIRONMENTAL DATA TO CREATE ROBUST EXPLANATIONS OF ENVIRONMENTAL TRANSFORMATION THROUGH TIME

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It is widely acknowledged that people have had a major impact on changing the environment through time, and yet demonstrating human influence as a primary causal factor in landscape transformation, as opposed to climate, is challenging. Among environmental scientists, climate is often given primacy in explanations of both landscape change, and societal collapse. One reason for this is the general absence of interdisciplinary teams of social scientists and historians working with environmental scientists to examine more holistic and nuanced explanations of environmental change. Another reason is that combining social science and historical data with paleoclimate and paleoecologic data is not trivial, and designing studies from the outset with both data sets in mind is still fairly uncommon. However, modern forest patterns and structure are a legacy of both human land use practices and climatic change, and if we are to plan for the future, we would be advised to have a clear understanding of how both societal and climatic change interacted in the past to create our existing landscapes. These landscapes have been shaped over periods of decades to centuries, so our examination must take into account change at multiple temporal and geographic scales.

This plenary presentation seeks to present a model for interdisciplinary research that addresses the interaction between society and climate in causing environmental change, at three different scales (local regional and hemispheric or global), that we think are most appropriate for answering specific types of questions. Our goal is to clarify the strengths and weaknesses of differing types of datasets for answering questions of causality in landscape change. For example, physical scientists now have access to Europe-wide datasets of tree rings, pollen, charcoal and other paleoecologic proxies. These analyses identify broad regional patterns of environmental change through time. However, once local data are amalgamated into hemispheric datasets, they become essentially aspatial, and the broad physical patterns seen in the data can no longer be used to explain landscape change at any local site. Thus, using such analyses to explain change in any given place is specious. The opposite problem exists with very local data. When linked with local social dynamics, they may provide clear causal relationships between climate, human activity and land use change; however,

the explanation may not be appropriately scaled up to a regional level. Our challenge is in defining the strengths and limitations of these different scales of analysis, both geographically and temporally, so that interdisciplinary teams can design their data collection and analysis appropriately for the scale of analysis they are using, and not extend their interpretations beyond what their data are suitable for. A further challenge is how to nest these different types of studies so that we can eventually scale up local studies to make more robust regional and hemispheric interpretations.

Session 10

ARCHAEOPALYNOLOGY

Chairs: A. Florenzano, S. Pérez-Díaz

THE LAKE DOJRAN POLLEN SEQUENCE: A BRIDGE BETWEEN SCIENTIFIC AND HUMANISTIC APPROACH TO THE ENVIRONMENTAL HISTORY IN THE BALKANS

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Introduction

How have the societies of the past afforded climatic changes? How prolonged dryness, exceptionally cold winters, or dramatic increases in annual rainfall had been overcome by past societies? Why some societies were resilient while others were vulnerable? Palaeoenvironmental studies have been trying to answer these questions but it is only applying both scientific and historical methodologies in the same project that we can fully understand the past (Izdebski et al. 2016). The Palaeo-Science and History group of the Max Planck Institute of Jena (<https://www.shh.mpg.de/1056512/psh>) explores the ways in which environmental sciences converge with history as a humanistic discipline that focuses on the past. The project focuses on Macedonia and the Peloponnese in Greece, Sicily in Italy, and Western Turkey where evidences suggest the presence of complex societies adapted to a variety of environmental conditions. In this frame, palynology has a primary role reconstructing the past population behaviour, giving essential information on cultivation and land management. Climatic oscillation can be also inferred and contributes in the reconstruction of past events.

Materials and Methods

Here we present a focus on the southern Balkans with a comparison between Lake Dojran (at the border between Greece and Republic of North Macedonia) and Lake Volvi (continental Greece) records. A pollen sequence, covering the last 12000 years with a lower resolution, is already available for Lake Dojran (Masi et al. 2018). The new data consists in the pollen, NPP and charcoal analysis at high resolution for the two lakes.

Results and Discussion

The results give an interesting example of societal and environmental processes that, influencing one each other, left traces in the pollen assemblages. The period taken in consideration spans from the Roman Empire to its collapse and the establishment of Byzantium new equilibrium. Political power and socio-economic structures completely changed, but the Byzantine society was not only able to adjust successfully to dramatic changes, but also became resilient for many centuries. The pollen assemblage of the two lakes shows some similarities related to human exploitation such as

the extensive use of land for cultivation and, to a lesser extent, for grazing activity. The reduction of the forest cover can be ascribed not only to human impact, but also to an aridification trend. Land use is evidenced by the curves of cereal and olive pollen, and also by other anthropogenic indicators. At Dojran grapevine cultivation is also assessed.

Conclusions

The high-resolution pollen data together with the deep knowledge of the historical sources available for the region reveal all the complexity of the historical vs. environmental reconstruction of the Macedonian region, which has always been the connection point between Europe and Asia.

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LANDSCAPE EVOLUTION AND SOCIAL RESILIENCE IN THE BALEARIC ISLANDS SINCE PREHISTORY. THE STUDY-CASE OF SANTA PONÇA (MALLORCA, WESTERN MEDITERRANEAN)

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Introduction

Islands are fragile environments that may shed light on long-term cultural and environmental dynamics by amplifying geographical and cultural factors. The Balearic Islands are crucial for the study of these interactions during the Holocene due to their presumably late human colonisation at ca. 2500-2300 BC, compared to other Mediterranean islands. The EU-funded OLEA-project (G.A.-895735) aims to focus on the drivers and timing of the spread of *Olea* macchia as a central feature of the current Balearic mosaic landscape. This work will advance research on mosaic landscape formation in the Mediterranean in relation to human, climate, and environmental drivers.

Materials and Methods

We will present the results of the paleoenvironmental study of the coastal lagoon sequence of Santa Ponça. This area is rich in archaeological sites ranging from the Bronze Age to Modern Times and provides a record of landscape transformation associated with cultural changes. We will combine off-site paleoenvironmental data (pollen, non-pollen palynomorphs, sedimentology, sedimentary charcoal) and on-site archaeobotanical and archaeological data, to understand socioenvironmental interactions, how newcomers produced new types of landscapes and how humans faced societal and climate challenges throughout history. Three mechanical drillings were performed in different locations from Santa Ponça and SP3 core was selected for the palynological study. Archaeobotanical data from the nearby Puig de Sa Morisca Archaeological Park will be also correlated to paleoenvironmental data to better understand land uses and mosaic landscape formation.

Results and Discussion

Palynological studies carried out in the Gymnesic islands (Mallorca and Menorca) highlight an abrupt vegetation change at ca. 3200-3000 BC in Mallorca and between ca. 3650-2500 BC in Menorca (Burjachs et al. 2017; Servera-Vives et al. 2018). In this transformation, a plant landscape dominated by *Juniperus*, *Corylus*, deciduous *Quercus* and *Buxus* was replaced in a short lapse of time by thermophilus communities mainly characterized by *Olea*, *Quercus ilex*-type, *Pistacia* and *Erica*. These vegetal communities have prevailed in the Gymnesic during the last five/four millennia. Sedimentological analysis shows at least five sedimentary environments related to a coastal barrier, coastal lagoons, and fluvial interferences. Globally sedimentary sequences show a transition from coastal shallow water deposits to coastal lagoon sedimentation with punctual terrigenous inputs. At this moment we account for 6 radiocarbon dates indicating that the 12m-depth core of SP3 covers a time span of 8,000yr approximatively. We have developed a holistic approach combining off-site paleoenvironmental studies, archaeobotany and archaeology. Synanthropic and cultural plants from archaeological sites (on-site) mainly offer a local signal of the human action in the nearby environment, while off-site records provide a vegetation picture at a micro-regional or regional scale (Mercuri et al. 2019). The anthracological results of Puig de Sa Morisca allow us to approach how this *Olea*-dominated mosaic landscapes were used as a supply source of woody biomass offering energy sources and raw materials.

Conclusions

The integration of paleoenvironmental, archaeobotanical and archaeological data constitute a key strategy to decipher the main triggers of environmental change and to understand the social use of the landscape. We propose that a mosaic-like landscape structure with the expansion of maquis, garrigues and open areas were favoured by human action in a context of increasing dryness and seasonality that promoted vegetation flammability and the substitution of mesic communities to thermophilous vegetation (Servera-Vives et al. 2018).

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PALYNOLOGICAL RECONSTRUCTION OF LATE HOLOCENE PALAEOENVIRONMENTAL EVOLUTION IN CORSICAN COASTAL WETLANDS

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Introduction

The interest of reconstructing the palaeoenvironmental evolution during the Holocene lies in the interaction between climatic oscillations and a substantial increase in anthropogenic impact following the adoption of the farming practices since Neolithic (Roberts et al. 2019). In the case of coastal areas, additional interest is placed in the palaeoenvironmental impact of the sea level rise during the Holocene in relation to global warming (Revelles et al. 2019; Vacchi et al. 2020; Brisset et al. 2020). This study is focused on the reconstruction of palaeoenvironmental evolution of coastal wetlands of Corsica (France) during the Late Holocene. In this paper, we show the potential of palynology in the study of the evolution of local environmental conditions. The identification of aquatic organisms such as macrophytes, freshwater algae and cyanobacteria provides detailed information about limnological conditions, salinity and trophism of waters; while other microremains inform about processes such as soil erosion episodes and animal frequentation of coastal wetlands.

Materials and Methods

In this paper we focus on the palynological study of 3 sites: Macinaggio, in North Corsica (42°57'50.929"N, 9°27'3.754"E, 0 m asl.) dated in 4.7-0.1 kyr cal BP; Saint Florent, in North Corsica (42°40'19.69"N, 9°18'15.85"E, 0.47 m asl.), dated in 6.3-0.5 kyr cal BP; and Girolata 2, in West Corsica (N42.350009°, E8.612269°, 0 m asl.), dated in 3.8-0.5 kyr cal BP. Samples for pollen and NPP analysis were processed following standard methods (Girard and Renault-Miskovsky 1969). Around 300-350 pollen grains of terrestrial taxa were counted, excluding Cyperaceae, *Typha latifolia*, *Typha/Sparganium*, *Myriophyllum* and Amaranthaceae. All pollen types are defined according to Reille (1992) and Cerealia-type was defined according to the morphometric criteria of Faegri and Iversen (1989) (>40 µm pollen grain, >8 µm pore).

Results and Discussion

Macinaggio (North Corsica) (Figure 1):

- Sub-aerial dry environments in relation to 4.2 and 3.2-2.8 kyr cal BP cooling events. Peaks of *Pseudoschizaea* suggest desiccation episodes/high evaporation, peaks in ferns (monoletes spores) and minimum values of riparian trees suggest low water availability at local scale.
- Humid conditions in a freshwater wetland in 2.6-0.9 kyr cal BP coincide with higher evidence of human impact during the Iron age, the Roman period and the Middle Ages.

Saint Florent (North Corsica) (Revelles et al. 2019):

- Increase in salinity (Amaranthaceae) since ca. 4.0 kyr cal BP (transition from shallow marine and riparian forest to the establishment of a marshland) and peak of salinity/aridity in 3.2-2.8 kyr cal BP.
- Human impact during Late Neolithic (5.9-5.0 kyr cal BP), Chalcolithic (4.5 kyr cal BP), Bronze Age (4.0-3.5 kyr cal BP), Roman period and Middle Ages.

Girolata 2 (West Corsica) (Figure 2):

- Establishment of a freshwater lagoon in a wetter phase in 2.6-1.5 kyr cal BP (Iron Age and Roman Period) and late expansion of marshlands (1.5 kyr cal BP onwards).
- High human impact during Iron age and Roman period.

Conclusions

This study has shown a general trend to the transition from lagoons to brackish swamps and marshlands during the Late Holocene playing a significant role the cooling climate events in 4.2 and 3.2-2.8 kyr cal BP. It is also remarkable the wetter phase during Iron Age and Roman period, with the establishment of freshwater coastal lagoons.

On the one hand, the evidence of human impact decreases or disappears in relation to dry phases in relation to the 4.2, 3.2-2.8 kyr cal BP events. On the other, there is a correlation between higher evidence of human impact and phases of freshwater lagoons/wetlands during the Iron Age and Roman period in Girolata 2 and Macinaggio. In that sense, this palynological study suggests that during the Iron Age and the Roman period wetter conditions would have existed, favouring the settling of communities in coastal areas.

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Figures

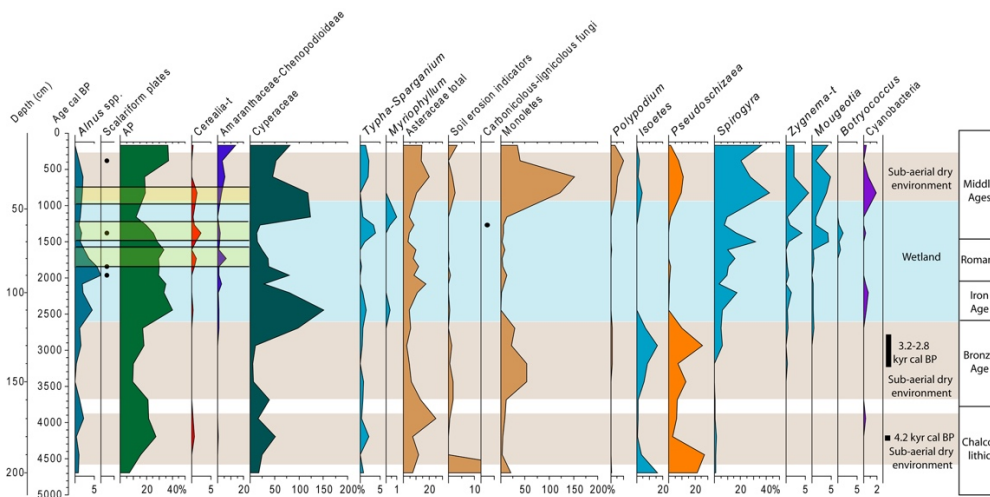


Figure 1. Pollen and NPP diagram from Macinaggio (North Corsica). Occurrence of rare taxa (<1%) represented by dots. Yellow frames represent phases of higher human impact.

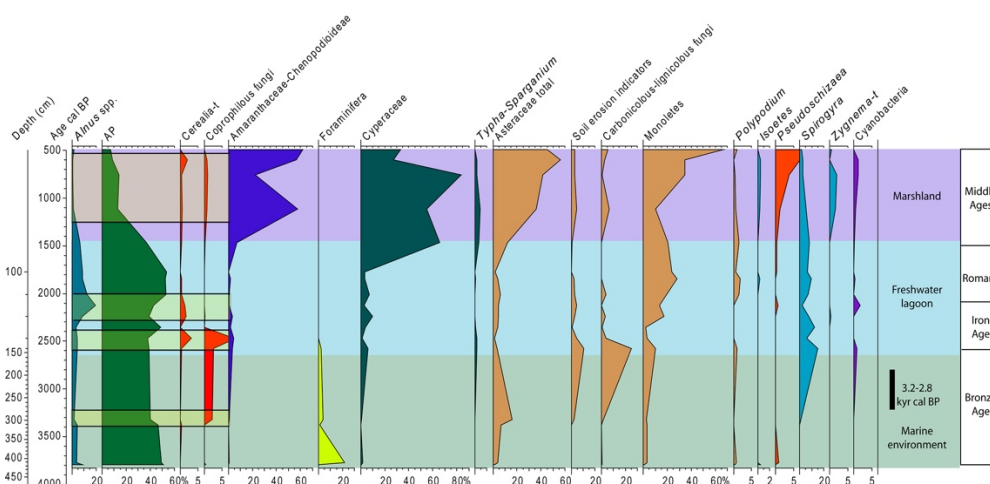


Figure 2. Pollen and NPP diagram from Girolata 2 (West Corsica). Occurrence of rare taxa (<1%) represented by dots. Yellow frames represent phases of higher human impact.

LONG-TERM ENVIRONMENTAL CHANGES IN THE CENTRAL PO PLAIN: INFERENCES FROM PALYNOLOGICAL ANALYSIS ON THREE TERRESTRIAL CORES

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Introduction

Based on pollen records, a reconstruction of flora and vegetation characterizing the central Po Plain (northern Italy) for at least the last 15,000 years is presented. The palynological analysis was carried out as part of a PhD project (Course in *Models and Methods for Material and Environmental Sciences*–UNIMORE) with the aim of investigating environmental changes that occurred in the Po River floodplain as a twofold result of climate changes and human actions. The study area certainly favored the development of complex human–water systems, particularly evident starting from the Bronze Age during which the persistence of resources exploitation shaped the landscape with long-term effects (Cremaschi et al. 2016).

Materials and Methods

Pollen samples were collected from three terrestrial cores (S1-S3) drilled at different distances N from the Terramara S. Rosa di Poviglio (Giudici et al. 2021), as part of the SUCCESSO-TERRA Project (PRIN-20158KBLNB). The S3 core, the closest to the site, has been analysed entirely (77 samples of which the deepest are dated at least 15,000 BP), while S1 and S2 have been analysed for Holocene sediments (90 and 28 samples respectively).

Results and Discussion

Pollen spectra show consistent trends of the main curves throughout the three cores, albeit with different stratigraphic resolution, adding detailed information about vegetation changes from the Late Glacial to more recent chronological phases (e.g., Ravazzi et al. 2007). Arboreal Pollen reflects the rapid and extensive climate change that occurred at the Late Glacial-Holocene transition. An open landscape characterized the deepest levels when tree cover was dominated by *Pinus*. Then, at the beginning of Holocene, the increase in forest cover was characterized by the progressive decline of *Pinus* and the sustained rise in broadleaf trees, among which the spread of mixed oak wood was observed first, followed by an increase of hygrophilous wood. Wet environment was widespread locally due to the presence of a palaeochannel of the Po River bordering the site. Hygrophilous herbs (mainly Cyperaceae and *Sparganium emersum* type) increased subsequently to phases marked by high percentages of reworked pollen grains which testify flooding events. The subsequent spread of

hygrophilous wood, consisting of *Alnus* and *Salix*, testifies local stable hydrological conditions. The API curve (Anthropogenic Pollen Indicators; Mercuri et al. 2013) highlights the transition from human influence to impact, that became evident from the Bronze Age. The spread of a cultural vegetation landscape is marked by cereal cultivation, pastures and the spread of synanthropic plants concurrent with extensive deforestation (Mercuri et al. 2019). In the levels that intercept the terramara, as initially assumed, the anthropogenic indicators show higher percentages near the site which gradually decreased at greater distances (ca. 28%, 24% and 23% respectively). Furthermore, a higher number of pollen taxa was observed near the site reflecting a greater biodiversity, probably favored by the voluntary/involuntary transport of plants (or parts of them) by the population.

Conclusions

These data on flora and vegetation are a further useful element to better understand the evolution of the current landscape, that has undoubtedly been shaped in the long term by both climatic and anthropic factors.

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Samples come from the archaeological excavation of the Terramara S. Rosa di Poviglio, directed by Prof. Mauro Cremašchi and Andrea Zerboni. All authorisations to carry out the excavation and sampling has been released by the SABAP-BO (MiC) to the Dipartimento di Scienze della Terra “A. Desio” of the Università degli Studi di Milano.

LANDSCAPES AND LAND USE IN THE SARNO RIVER PLAIN (CAMPANIA-ITALY) OVER THE LAST 5000 YEARS

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Introduction

Pollen analysis was carried on the infilling succession of the Fossa San Vito sinkhole. This depression is located at the foot of the carbonate slopes bounding the Sarno Plain towards NE. Here, a thick sequence of alluvial fan deposits is present, interfingering with debris slope deposits. These fan gravels cover the 39 Ka Campanian Ignimbrite that represents a relevant stratigraphic marker in the entire study area. Boreholes' stratigraphy intercepted 45m of infilling deposits consisting in laminated lacustrine silts interbedded with primary tephra layers, reworked volcanic material and alluvial debris (Santo et al. 2019).

Materials and Methods

Pollen analysis was realized on borehole B24, collected in the center of the sinkhole. The base of the infilling succession is dated to ca. 5500 cal yr BP (Santo et al. 2019). Samples were treated with standard procedures and percentage pollen diagrams were plotted. Further C14 dating and tephrostratigraphy allowed better constraining the succession whose closure is dated to the Late Medieval Age.

Results and Discussion

Preliminary data shows that in the bottom part of the core, the high forest cover (mainly oaks) suggests the presence of a closed environment where a few signs of human activities are recorded. From the Greek-Roman age, anthropogenic indicators increase indicating the exploitation of the area for grazing and crop activities. The forest cover did not suffer a marked decrease until the Medieval Period, in agreement with other data from Southern Italy (Di Donato et al. 2008; Russo Ermolli et al. 2018; Russo Ermolli 2019; Di Lorenzo et al. 2021).

Conclusions

The Sarno pollen record provides milestone data for the last 5000 yr in a region that witnessed the development of important urban centers such as Poggiomarino and Pompeii.

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THE VEGETATION RECONSTRUCTION OF THE POMPEII AREA BETWEEN THE 1ST MILLENNIUM BC AND AD 79

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Introduction

The AD 79 eruption of the Vesuvius severely affected the Sarno River floodplain in the surrounding of Pompeii. The landscape was covered with volcanic materials that destroyed the ecosystem but, at the same time, preserved the traces of former environmental conditions (Vogel and Märker 2010). The palaeoenvironmental reconstruction of the floodplain and its evolution in relation to the past urbanization has recently benefited from new archaeological (Furlan et al. 2019) and geomorphological (Nicosia et al. 2019) data from the area between the city, the river meander belt, and the sea. In particular, this study provides the first pollen sequence reconstructing the plant landscape before and during the life phases of the city.

Materials and Methods

In order to outline the natural and anthropogenic features of the local vegetation, a total of 29 pollen samples have been recovered from two sediment cores (S5 and S6) drilled immediately south to the Sarno Baths, the thermal complex located along the southern section of the city wall. A succession of organic layers were identified under the AD 79 eruption deposits as result of flooding activity of the Sarno River from 900-750 BC onwards.

Results and Discussion

Results of the palynological analysis depict an open environment with a mosaic of vegetation types since the Early Iron Age. The local presence of Mediterranean coastal shrubland, hygrophilous riverine forest, and mesophilous plain forest is combined with the regional contribution of mountain vegetation. Oscillations between inundated and wet ground characterized the area (Nicosia et al. 2019). Such a natural environment shows anthropogenic traits since the base of the sequence: pasturelands, cultivated fields, and olive groves which probably occupied drier soils. The most

important change in the land use system was the introduction of cabbage cultivation in the 4th century BC and its intensification from the 2nd century BC, when Roman influence grew. The presence of tree crops and of ornamental trees reveals the opulence of the Imperial age, until the catastrophic eruption (Vignola et al. 2021).

Conclusions

This study has revealed for the first time the main traits of the local and regional vegetation in the Sarno River floodplain during the whole 1st millennium BC, before and during the birth, rise, and destruction of Pompeii.

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A PALAEOECOLOGICAL RECORD OF LAND-USE CHANGES IN SE SICILY DURING THE LAST 400 YEARS

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Introduction

During the last few centuries, human activity assumed such a pervasive role in determining environmental changes to become the main driver of landscape transformation and ecological shifts, with unprecedented effects on a global scale (Lewis and Maslin 2015). Investigating the timing and effects of the human influence in the recent past of current ecosystems is fundamental for a better understanding the long-term implications and legacy effects, and to hypothesize future landscapes trajectories. In this context, palynological investigations provide a measure of past environmental variability in relation to land management policies and socio-economic processes of historical relevance (Di Rita et al. 2019; Mensing 2020).

This study presents a new high-resolution marine pollen record from SE Sicily spanning the last 400 years. The combined analysis of pollen data and documentary sources from historical archives allowed us to reconstruct the effect of the last few centuries land use management policies on present vegetation in the light of historical events and ecological dynamics.

Materials and Methods

The marine core SW104-ND2 was collected 20 km from the coast in the Sicilian channel at a depth of 93 m (36°33'52"N, 14°52'59"E). Three radiocarbon dates were combined to ²¹⁰Pb and ¹³⁷Cs analysis to construct an age-depth model spanning from 1583 to 2013 AD.

Pollen samples were chemically treated following the standard procedure (Magri and Di Rita 2015). The identification of pollen grains and Non-Pollen Palynomorphs (NPPs) was carried out by light microscopy (400 to 640 magnifications). Percentage values were calculated for each pollen taxon based on the sum of terrestrial pollen grains. Aquatic plants, fern spores, and NPPs were not included in the main pollen sum.

Results and Discussion

A total of 100 pollen and spore types and 29 NPPs were identified throughout the sequence, with a mean time resolution of 8 years.

The pollen analysis depicts a permanently open regional vegetation with sparse tree cover mainly composed of *Pinus*, *Olea*, and *Quercus*, accompanied by Mediterranean shrubby taxa such as *Phillyrea* and *Pistacia*. The herbaceous vegetation dominates throughout the record reflecting a broad spectrum of dry natural and anthropogenic steppes and grasslands, crops, pastures, and fallow fields.

The palaeovegetational reconstruction revealed remarkable environmental stability during most of the record, with a marked vegetational shift only in the second half of the 20th century AD. The presence of stable vegetational landscapes characterized by sparse oaks and olive tree cover with a grazed herbaceous understory reflects the vegetational structure of the traditional olive agroforestry systems of Sicily, and their persistence until 1950 is consistent with a human-induced environmental stability related to the long-lasting feudal history of Sicily. After centuries of environmental stability, an abrupt change in vegetation structure occurred around 1950 AD. The sudden increase in *Pinus* percentages testifies the massive afforestation processes linked to the land reclamation practices of the fascist and post-war period. The detection of *Eucalyptus* pollen around 1940 reflects the extensive plantations historically documented in the interior of the island.

Conclusions

The direct comparison of historical and palaeoecological records provides new insights on past disturbance regimes, elucidating the role of human activity both in preserving environmental stability related to the feudal land-use practices and in fostering environmental changes in modern land management policies and socio-economic processes. The considerable stability in the arboreal composition and tree cover during the feudal period suggests a fundamental role of traditional agrosilvo-pastoral activities in maintaining natural resources fairly constant in time and preserving the cultural landscape of SE Sicily over centuries.

The profound environmental transformations recorded in the mid-twentieth century reveal a clear breakpoint in both the vegetational and socio-economic dynamics, which is consistent with the end of semi-feudal land management policies and with the agricultural reforms and technological development occurred during the “Great acceleration” period.

Our palaeoecological record traced the environmental trajectories undertaken during the last centuries, showing the transition between past land management practices and post-war industrialization processes and pointing to the conservation and valorization of the economic and ecosystemic multifunctional role of traditional rural landscapes.

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POSTER SESSIONS

Chairs: G. Servera-Vives, E. Clò

STATUS AND TREND OF THE MAIN ALLERGENIC POLLEN GRAINS IN THE CITY OF ROME ITALY (2003-2019)

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Introduction

This work describes the 2019 status of the presence of the main allergenic pollen grains and the *Alternaria* spore in the city of Rome, Italy and their air concentration trends, measured, from 2003 to 2019, by the Aerobiological Monitoring Center of Tor Vergata (Rome).

The analyzed pollen data refer to the following botanical families, all of significant allergological interest: Betulaceae, Asteraceae, Corylaceae, Cupressaceae/Taxaceae, Poaceae, Oleaceae, Urticaceae and the *Alternaria* spore. Air concentration data were homogeneously analyzed, to compare historical data series produced in different sampling points and to provide a representative evaluation of the urban air quality and its potential effects on human health.

Materials and Methods

Pollen samples were collected and measured in two sampling sites by the Aerobiological monitoring center of Tor Vergata. Climate variables were provided by the Italian National System for the Collection, Processing and Dissemination of Climate Data (SCIA, ISPRA).

Temporal trends of pollutants and pollen were realized using the Seasonal Kendall test in R software. The statistical analysis allowed to highlight when concomitant high levels of allergenic species and air pollution occur and the influence of meteorological parameters and of the flowering calendar.

Results and Discussion

The analysis of concentration trends showed a statistically significant decrease of Betulaceae in RM5, Asteraceae in both stations, Cupressaceae/Taxaceae in both stations, Poaceae in both stations, Oleaceae in both stations, Urticaceae and the *Alternaria* spore in both stations (while concentrations of Corylaceae were stable, see. Table 1).

Conclusions

The statistical analysis, conducted with the Kendall test corrected for seasonality, on the eight taxa examined, allowed to highlight that in most cases the two stations located in the study area showed a consistent trend, supporting the hypothesis that the trend is not due to local situations, but may be indicative of a general trend in the territory under examination. It, also, highlighted the influence of meteorological parameters and of the flowering calendar on concentration levels during the four seasons (Di Menno di Bucchianico et al. 2021).

These results are offered as supplementary tools for a more complete assessment of air quality and its effects on human health in an urban environment.

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Tables

Table 1. Kendall trend test results for the main allergenic taxa in Rome (2010-2019)

| KENDALL TREND TEST RESULTS (2010-2019) | | | | | | | |
|--|--------------|------------------|--------------------------|---------------|---|--------------|--------------|
| Taxon | Station code | Station name | STATISTICAL SIGNIFICANCE | | | | |
| | | | P stars | P | Dy (P m ⁻³ y ⁻¹) | Significance | Trend |
| BETULACEAE | RM5 | Rome Tor Vergata | *** | 0.00 | -0.00472 | Yes | Descending |
| | RM6 | Rome San Pietro | | 0.68 | 0.00580 | No | - |
| ASTERACEAE | RM5 | Rome Tor Vergata | *** | 0.00 | -0.03616 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0.00 | -0.05442 | Yes | Descending |
| CORYLACEAE | RM5 | Rome Tor Vergata | | 0.25 | -0.00129 | No | - |
| | RM6 | Rome San Pietro | | 0.10 | -0.09828 | No | - |
| CUPRESSACEAE / TAXACEAE | RM5 | Rome Tor Vergata | *** | 0.00 | -0.21697 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0.00 | -1.94034 | Yes | Descending |
| POACEAE | RM5 | Rome Tor Vergata | * | 0.03 | -0.06948 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0.00 | -0.62167 | Yes | Descending |
| OLEACEAE | RM5 | Rome Tor Vergata | *** | 0 | -0.02165 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0 | -0.16523 | Yes | Descending |
| URTICACEAE | RM5 | Rome Tor Vergata | ** | 0.01 | -0.79704 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0.00 | -3.76304 | Yes | Descending |
| ALTERNARIA | RM5 | Rome Tor Vergata | *** | 0 | -1.11417 | Yes | Descending |
| | RM6 | Rome San Pietro | *** | 0 | -0.59523 | Yes | Descending |
| P stars meaning | *** | p<0.001 | ** | 0.001<p ≤0.01 | | * | 0.01<p ≤0.05 |
| | + | 0.05<p ≤0.1 | [] | 0.1<p ≤1 | | | |

ASSESSING THE ALLERGENIC POTENTIAL OF THE URBAN PARKS OF FLORENCE (ITALY)

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Introduction

The key role of green spaces in urban contexts is linked to their capacity to limit the increasing environmental stresses and provide social well-being benefits improving environmental quality (Tzoulas et al. 2007; Latinopoulos et al. 2016). On the other hand, the extensive use of ornamental plants may cause allergic sensitization in the city inhabitants (Cariñanos et al. 2017). Aerobiological studies lead in urban environments becomes of great interest to evaluate the real contribution of the ornamental trees to the total airborne pollen. From this point of view, geographic information system (GIS) software has become a necessary analytical tool to understand the relationships between airborne pollen and its sources (Ciani et al. 2020). Against this background, the present study aims to quantify the allergenic potential of several public parks of Florence (Italy), providing useful information for the current state of urban green management and future planning.

Materials and Methods

The allergenic potential of seven urban parks of Florence (Figure 1) has been investigated using the Urban Green Zone Allergenicity Index (I_{UGZA}) developed by Carinanos et al. (2014). The index takes into account several characteristics of the trees to estimate a Potential Allergenicity Value (VPA) for each species; these values are combined with the biometric parameters of the species to estimate the cumulative I_{UGZA} of the urban green area. The index varies between 0 (no allergenic potential) and 1 (maximum allergenic potential): the value of 0.3 is considered as a threshold for inducing symptoms in the sensitive population (Carinanos et al. 2017), while a value of 0.5 is indicative of high allergenicity (Carinanos et al. 2014). The data about the number and the position of each tree of the seven parks of Florence refer to the latest database version made in 2016 by the Municipality of Florence: these data have been updated by direct field observations.

Results and Discussion

The results highlight an I_{UGZA} ranging between 0.09 and 0.53: three of the seven considered parks exceed the threshold value of 0.3, while one of these shows high allergenicity (0.53). It is interesting to note that the parks with the highest index also show the lowest number of genera and a scarce extension of the park, underling the allergenic potential of few species concentrated in restricted areas that flowering at the same time. The lowest allergenic index is shown respectively by a new-founded park and a recently redeveloped urban green area: this result probably reflects a correct

planning of the urban parks, which should take into account both the aesthetics of the landscape and the assessment of the impact on citizens' health.

Conclusions

This study underlines the utility of allergenic index as tool for a conscious selection of the plants used in urban green areas with the aim of minimizing the negative effects related to their potential impacts on public health.

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Figures

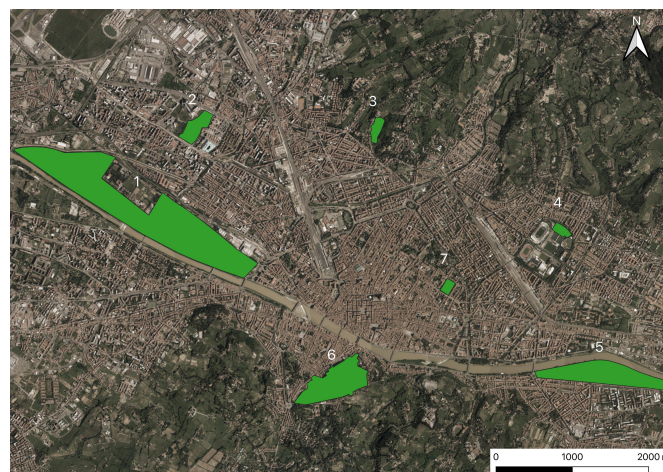


Figure 4. Geographical location of the seven urban parks of Florence considered in this study.

PHENOLOGICAL MONITORING OF *CUPRESSUS SEMPERVIRENS* L. COMPARISON BETWEEN URBAN AND EXTRA-URBAN AREA

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Introduction

Pollen can have a strong negative impact on human health, causing an allergic response in 30-40% of the world population (Bousquet et al. 2008). Among the various allergenic species, the cypress, and Cupressaceae in general, are an important cause of allergy. Cupressaceae pollen has been identified as a source of growing pollinosis in Mediterranean countries such as France, Spain and Italy and is primarily responsible for "winter pollinosis". Although *Cupressus sempervirens* L. has spread in Southern Europe since ancient times, cypress pollen allergy was not reported until at least 1945 (Charpin et al. 2005). The increase in the incidence of this allergic disease could largely depend on the growing use of Cupressaceae for ornamental purposes, aggravated by air pollution. Predicting the pollen season of Cupressaceae is particularly important for the allergic population. The pollen emission period can last more than a month, also due to the gradual maturation of the microsporophylls, from the bottom to the top of the cone. The aim of the study is to compare the phenophases trend in urban and extra-urban areas, although in a short time, in order to predict beginning, end and severity of the cypress pollen season at the local level, in based on weather conditions. The cypress phenophases are easy to be observed so it is possible to simply involve citizens scientists. So it has been possible to collect data over the years from many urban stations. More recently, the study was conducted under the supervision of the Aerobiological Monitoring Center also in some extra-urban centers in order to assess which is the effect of the urban heat island on flowering of cypresses.

Materials and Methods

The surveys carried out are communicated on a BBCH scale, but there are two other detection keys: the scale adopted by the Italian Phenological Gardens (GFI) and a scale designed specifically for cypress flowering by Torrigiani et al. (2007). The phase to be indicated in the survey form is the most advanced reached in each individual by at least 10% of the reproductive organs. The phenological study was carried out on ten trees of *C. sempervirens*, selected during the winter-spring 2020-2021 for each monitoring station, in three different locations: Palestrina (450 m asl; 41° 50' N, 12° 54' E) and Castel San Pietro Romano (763 m asl; 41° 50' 45" N, 12° 53' 42" E), and in Capranica Prenestina (915 m asl; 41° 52' N, 12° 57' E).

Results and Discussion

The phenological monitoring data, carried out in extra-urban areas on the Prenestini mountains, were compared with both the observations conducted in Rome at Monte Ciocchi (78 m asl; 41° 54' 18" N, 12° 26' 27" E), and with the data of the aerobiological monitoring, carried out by the Aerobiological Monitoring Center of the University of Rome Tor Vergata, using the volumetric sampler VPPS 2000. Although the trend of the phases is very similar, it is interesting to note one aspect in particular: the period of the beginning of the pollen emission is very premature in Rome, compared to the beginning of flowering in the provincial areas, where, instead, there is a month late. In fact, in Castel San Pietro Romano the pollen emission begins on February 16, while in Palestrina and Capranica on February 23. The date of early flowering in Rome, January 29, is also confirmed by an increase in the daily concentration to 29 pollen grains/m³, detected by the sampler. On the Prenestini hills observations sites are at high altitudes, while in the city of Rome occurs the microclimatic phenomenon, called heat island, caused by intense urbanization, which mainly involves local overheating with an increase in temperatures up to 4-5°C both in winter and in summer, compared to the peripheral areas.

Conclusions

On Prenestini hills we find ourselves at high altitudes, while in the city of Rome there is the microclimatic phenomenon, called heat island, caused by intense urbanization, which mainly involves local overheating with an increase in temperatures up to 4-5°C both in winter and in summer, compared to the peripheral areas. This phenomenon can therefore lead to accelerate the physiological rhythms of some processes of the plant, such as flowering, in fact in this study we note the early flowering of one month.

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THE DIMORPHISM OF *VITIS* POLLEN: A DIFFERENT PALYNOLOGICAL IMPRINT OF WILD AND DOMESTICATED *V. VINIFERA* L.

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Introduction

This presentation reports data on the dimorphism of *Vitis* pollen. Despite this character is well-known in agrarian studies on the cultivated grapevine, we observed that the different reproductive biology of wild and domesticated grapevine is ignored in the archaeobotanical research (Mercuri et al. 2021). This can affect the interpretation of crop history and should be considered for palaeoenvironmental reconstructions.

Pollen dimorphism is known in several species and is associated with different factors, e.g., abnormal microsporogenesis. The pollen dimorphism of *Vitis* is a case of functional dioecy which includes trizonocolporate and inaperturate pollen. It occurs in several species, e.g. *V. riparia* Michx., *V. aestivalis* Michx., *V. coignetiae* Pulliat. Therefore, three types of flowers can be ascribed to the domesticated *V. vinifera* subsp. *vinifera*: the hermaphroditic flower, with fully developed ovary and anthers producing trizonocolporate pollen, and two others morphologically hermaphroditic but functionally unisexual flowers (male or female flowers; Oberle 1938; Vasconcelos et al. 2009). The presence of functionally unisexual flowers is the common condition of the wild, dioecious, subspecies *V. vinifera* subsp. *sylvestris*.

Materials and Methods

Pollen morphology was studied in flowers taken from 5 wild specimens and 4 cultivars of the domesticated subspecies (cultivars: Covra, Lambrusco Grasparossa, Malbo Gentile and Bianca di Poggio). The cultivars analysed in this research are considered ancient cultivars, according to agrarian and historical studies. A total of 262 trizonocolporate and 120 inaperturate pollen grains were measured (see Mercuri et al. 2021 for details). The anthers were subjected to dehydration followed by acetolysis. The observed parameters of trizonocolporate pollen were (a) equatorial view: polar axis (P), equatorial diameter (E), P/E ratio, maximum distance between colpi in mesocolpium (MES), polar and equatorial axes of porus (P-porus, E-porus); and (b) polar view:

equatorial diameters (E1 and E2) and exine thickness (Ex). The observed parameters of inaperturate pollen were the largest (DM) and smallest diameter (dm), DM/dm ratio, and exine thickness (Ex). Tests on viability and germination were performed on pollen of the cultivar Malbo Gentile which owns almost totally inaperturate pollen grains.

Results and Discussion

Observation of pollen morphology confirms that trizonocolporate and inaperturate pollen grains can occur in both the *Vitis* subspecies. Hermaphroditic and male flowers produce pollen grains that are morphologically similar in the subspecies *vinifera* and *sylvestris* since they are all trizonocolporate with micro-reticulate exine. Inaperturate pollen was observed in functionally female flowers of the two female accessions of the subspecies *sylvestris* and in the cv. Malbo Gentile. The evidence is corroborated by several studies (e.g., Gallardo et al. 2009 on wild plants) and confirms that the wild subspecies produces two types of pollen from male and female plants while the domesticated subspecies usually produces only trizonocolporate pollen. The inaperturate pollen occurs only in some ancient cultivars.

Conclusions

The inaperturate pollen can be considered a rare (plesiomorphic) trait in the domesticated grapevine. Most of the domesticated grapevine produces only trizonocolporate pollen while the wild grapevine usually produces also inaperturate pollen. Pollen dimorphism demonstrates that pollen production and dispersal differ in the wild and domesticated subspecies of *Vitis*. This makes grapevine botanically different from the other Mediterranean cultural trees like *Olea*, *Castanea* and *Juglans* (included in the OJC index). The dimorphism peculiar trait of grapevine must be carefully taken into account in the interpretation of past arboriculture development because the signal of *Vitis* pollen in ancient records changed depending on which subspecies was present.

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PALYNOLOGICAL FLORA OF THE COASTAL HABITATS IN DHOFAR (SULTANATE OF OMAN)

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Introduction

Dhofar is the southernmost region of the Sultanate of Oman, located south of the Tropic of Cancer. It is a highly varied territory ranging from the desert plateau to the forested mountain slopes and the coastal plain affected by the influence of the monsoon. Because of this great variety of environments, Dhofar has a very rich flora, still worthy of further investigation. Within the context of archaeobotanical research conducted by the University of Florence in collaboration with IMTO (Italian Mission To Oman) of the University of Pisa, studies were also carried out on the flora and vegetation of this territory, with a special focus on the pollen morphology of the species occurring in the area. The collected material (plant specimens and pertaining pollen samples) was the subject of publications (e.g., Mariotti Lippi et al. 2007; Bellini et al. 2015), and, later, of several still unpublished degree theses. This paper presents partial results from these investigations, with a particular focus on the plants growing along the coast. Indeed, the Dhofari coast is interrupted by numerous wadi estuaries, which during the dry season are separated from the sea by sand bars giving rise to small basins around which a rich vegetation develops. Many small estuaries house mangrove groves of *Avicennia marina* (Forssk.) Vierh. that are particularly sensitive to climatic changes and have been affected by human activities for a long time, or harbour a different, more unsteady kind of vegetation, its appearance changing remarkably between the wet and the dry season. Today, these estuaries constitute fragile coastal ecosystems heavily threatened by real estate development.

Materials and Methods

The composition of the vegetation of the different estuary habitats was investigated by means of surveys carried out in ecologically homogeneous areas. The species and their relative coverage were recorded. Flowers were collected to examine their pollen morphology. Pollen grains were acetolysed and observed at light microscope and under scanning electron microscope after critical point drying and golden coating.

Results and Discussion

A floristic list was obtained, including numerous plants adapted to salty soils mainly belonging to Poaceae and Amaranthaceae, in addition to *A. marina* from the mangrove groves. *Tamarix mascatensis* Bunge (Tamaricaceae) and *Phyla nodiflora* (L.) Greene (Verbenaceae) are frequent in the marginal dry wadi vegetation, *Prosopis juliflora* (Sw.) DC. (Mimosaceae) grows on the coast sand or sabkah, *Pluchea arabica* (Boiss.) Qaiser & Lack (Asteraceae) and *Indigofera oblongifolia* Forssk. (Fabaceae) are part of the low plain calcareous shore vegetation. The morphometric features of the pollen grains were accurately observed and described. These represent contributions to the palynological flora of the region and, due to the ecologically based field survey, also include indications on the kind/s of vegetation in which the species occur, as well as their “weight” within it in terms of abundance/coverage. All of the information is crucial for the correct interpretation of modern and ancient pollen spectra (Bellini et al. 2020).

Conclusions

Morphometric pollen records, particularly those derived from habitat-based survey and sampling, provide valuable support to future analysis of airborne pollen and archaeopalynological investigations. These lasts are very important for reconstructing the history of the southern Arabic territory - involved in the remunerative commerce of Frankincense - and its ports, which were important nodes of the trade routes across the Indian Ocean.

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EVOLUTION OF THE DIVERSITY OF THE TYPE OF POLLEN FORAGED BY BEES IN RELATION TO THE VEGETAL COMPOSITION OF THE ENVIRONMENT AND THE STAGE OF COLLECTION

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Introduction

The abundance and diversity in the collection of botanical species represent a very important point in the nutritional status of the bee colonies, and, therefore, in their healthy state, as discussed in different bibliography (Di Pasquale et al. 2013 among other authors). Under this premise, a study has been approached with the aim of showing the importance of recognizing the vegetation around the hives to deduce the main sources of protein feeding of the bee colonies throughout a year of activity.

Materials and Methods

The study was carried out in the apiaries of the Center for Beekeeping and Agroenvironment Research in Marchamalo. For this study, a periodic analysis of the pollen balls collected by the bee every fifteen days, and the identification of the composition and flowering of the vegetation around the apiary within a radius of between 1 and 3 km was carried out. The pollen analysis of the pellets pollen samples collected for each date and the field study of the density and coverage of the existing bee flora in the surroundings of the apiary, was the methodology used for this. The identification and representation of the collected pollen types was analyzed through the separation of the sample into balls of different color and / or tonality, and the subsequent identification of the taxon corresponding to each color through pollen analysis. To know the representation of each identified taxon in the overall sample, the set of balls of each color was weighed and it was related to the total weight of the sample. To analyze the coverage of each botanical species in the environment, the classic patterns used in any ecology study were followed.

Results and Discussion

For the first case, the spectrum of the visited plants presented according to their percentage of representation in each sample and date as well as the variation in the diversity and succession of

pollens collected over time were the results obtained. While for the second case, the profile of the plant composition of the environment according to density and flowering was obtained.

Conclusions

It is interesting to observe how families of plants that maintain a certain succession of blooms over time (e.g., Brassicaceae), are replaced in other periods, between May and July, by genera of families such as composites or Rosaceae. Or, as crop or ruderal plants they take a certain interest in increasing the diversity of foraged species in midsummer (June-August). And as from early spring, with low pollen diversity, the number of plants present in the samples increases as the beekeeping period passes.

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AEROBIOLOGY AND POTATO CULTIVARS AS AN EFFECTIVE TOOL TO REDUCE THE INCIDENCE OF LATE BLIGHT AND AVOID YIELD LOSSES

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Introduction

Among the factors that affect the yield of potato crop, the oomycete called *Phytophthora infestans* (Mont.) De Bary, is one of the most destructive potato pathogens. Under favorable climatic conditions, the infection cycle is very quickly and short, destroying the crop in a few days. Factors affecting *P. infestans* development are well known but the cultivar response and the impact of disease progression in the field is not well understood. Several potato cultivars are predicted to be less effective than others in suppressing disease when initial inoculum is abundant and well distributed. Therefore, the aim of this work is to study the susceptibility of different potato cultivars under late blight pressure.

Materials and Methods

The study was carried out in a plot located in Betán (Baños de Molgas, NW Spain) during the years 2019 and 2020. Seven cultivars of potato were planted under the same environmental conditions and cultural tasks highlighting the non-irrigating technique and the non-spraying with fungicides. Four phenological stages (emergence, foliar development, maturity and senescence) were considered to quantified grow development during each crop season. The presence of *Phytophthora* sporangia in the field environment was measured using a Burkard-type volumetric air collector and, at the same time, weather parameters were recorded. The severity and disease progression were determined using AUDPC and r-AUDPC parameters.

Results and Discussion

The two potato crop seasons were very different in terms of the concentration of *Phytophthora* sporangia. The year 2019 had low concentrations, always below 5 sporangia/m³ per day. The crop season after plant emergence was dry with few periods of rain and relative humidity highly variable but frequently low. The year 2020 was characterized by abundant rainfall at the beginning of crop and emergence, affecting *P. infestans* development and the release of sporangia in the environment. In terms of spore concentration, the 2020 season had maximum values of 40 sporangia/m³ per day with a higher presence in the environment during the leaf development phenological stage.

Furthermore, differences in the phenological development were observed between seasons. In general, 2019 season was longer than 2020 season. The foliar development in 2019 was longer for all cultivars, highlighting large interannual differences in Agria, Frisia, Kennebec, Red Pontiac and Fleur Bleue. The same occurs with the maturation stage except in Agria and Red Pontiac, which were the first cultivars of 2020 to ripen. The senescence lasted more days in the year 2020.

In terms of severity, different responses could be observed depending on the cultivar. The highest percentage of severity were observed in Red Pontiac, Agria, Kennebec and Frisia cultivars. The lower damages were in Fleur Bleue, Desiree and Fontane cultivars. The infection rate that shows the progression of the disease, was higher in Red Pontiac, Frisia, Kennebec and Agria, with Red Pontiac standing out for its rapid infection rate.

The different response of the cultivars to the presence of *P. infestans* were related with the final yield. Cultivars like Agria and Red Pontiac, the most susceptible of the cultivars studied, had greater yield losses when they are affected for late blight.

Conclusions

P. infestans sporangia were present in both crop cycles but in different concentrations, which generated different cultivar responses, therefore the level of spores in the environment is a factor to consider. In addition, cultivars presented different disease progression when spores are present in the environment. The choice of the cultivar can be an effective tool to reduce fungicide treatments to control late blight and avoid yield losses within a sustainable and respectful agriculture landscape.

Acknowledgements (Funds)

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AEROBIOLOGICAL DATA TO INTERPRET THE TERRITORY

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Introduction

Pollen and spores are a fundamental part of bioaerosols and many of them produce allergic diseases. For this reason, many countries developed pollen aerobiological network and established a common sampling methodology. The aerobiological network of Castilla y León (RACYL) was established in 2006 (Castro Alfageme et al. 2008). Nowadays, consist of 13 Hirst-type pollen traps all over the region. The aim of this network is to provide weekly pollen information to both inhabitants and medical doctors. This region is the largest into Spain, because of this it presents a heterogenic biogeography that also can be observed in the aerobiological spectra.

The aim of this study is to know the representativeness of each pollen trap into the aerobiological network and to analyze the differences or similitudes of the monitoring stations regarding the main pollen season of the most abundant taxa in Castilla y León in the period 2013-2020.

Materials and methods

The study was carried out in Castilla y León in central-northwestern part of the Iberian Peninsula with 94,222 km². The aerobiological data were provided by RACYL and the samples were prepared and analyzed by the method proposed by CEN Ref. No. FprEN 16868:2018 E.

The analysis was made for the ten most abundant pollen types in the region (*Quercus* L., Cupressaceae, Poaceae, *Platanus* L., *Pinus* L., *Populus* L., Urticaceae, *Olea* L., *Plantago* L., *Castanea* Mill.). For calculating the Spearman correlation coefficients, firstly, it was calculated yearly the period of the main pollen season for each pollen type. Pollen seasons were defined following the 95% percentage method proposed by Andersen (1991). Then, it was made a matrix with all the correlation coefficients for all pollen types and stations. This matrix was used as raw data for a clustering analysis. Euclidean distances between each two stations were calculated. Hierarchical clustering following Ward method was applied for calculating homogeneous groups of stations and depicted by a dendrogram.

Results and Discussion

Regarding the obtained clusters, the 13 monitoring stations can be divided in two groups (Figure 1). The first one (LE, BU, SO, PON, MI) corresponds with the stations which are in the north of the

region. The second group (ARE, BEJ, AV, SG, PA, VA, SA, ZA) is formed by the stations which are in the south. This result corresponds with the division of the area by bioclimatic conditions (del Rio 2005), where the temperature and precipitation are the most important variables for pollen release. However, it is difficult to establish differences with floristic areas because some selected taxa are ornamental plants which are presented in all urban areas. As for the subgroups formed by (MI and PON) and (ARE and BEJ) this connection can be a result of artificial cluster due to these stations being the most different of the network, even between them. Also, their bioclimatic conditions are different.

Conclusions

The Castilla y León aerobiological network can be divided in two groups that represent the two geographic areas in the region. The first one includes the stations located in the north of the region, and the second one contains the stations with south location. For this reason, the airborne pollen can be used as tool for defining biogeographical areas.

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Figures

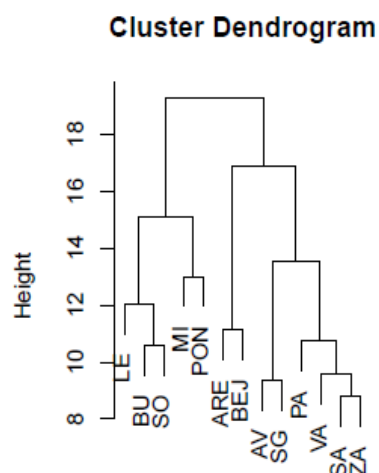


Figure 1. Hierarchical clusters calculated with Euclidean distant methods for main seasons of the pollen types selects. Cluster A: subcluster 1 (LE, BU, SO) and subcluster 2 (MI, PO). Cluster B: subcluster 3 (ARE, BEJ), subcluster 4 (AV, SG), subcluster 5 (PA,VA,SA,ZA).

THREE SAMPLERS IN ROME: A YEAR COMPARED

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Introduction

The Rome city has an extension of 1285 km² and it has a varied morphology, also characterized by the presence of small mountains (Mt. Mario: 139 meters above sea level), resulting in a heterogeneity of environments (Blasi 1994). Furthermore, the climate of urban centres is subject to the phenomenon known as "urban island heat" (Horbert 1992). The analysis of pollen presence is a very useful instrument for understanding both the effects of pollen on human health and the effects of anthropic activities on vegetation.

The study aims to verify the difference in pollen concentration in three different sites in the city and verify any adherence with the surrounding vegetation.

Materials and Methods

The pollen data are those recorded at the aerobiological stations of Tor Vergata Monitoring Center Rome. Pollen data were obtained and analysed using the standard method (UNI EN 2019). One year of data (2020) of three monitoring samplers in Rome was considered: Villa San Pietro Hospital – Rome North, University Tor Vergata – Rome South, Cipro – Rome Center.

8 taxa were considered: 2 herbaceous - Poaceae and Urticaceae - and 6 arboreal - *Alnus*, Cupressaceae-Taxaceae, *Castanea*, *Quercus*, *Olea*, *Platanus*. For each pollen taxon the intensity of the pollen season (annual pollen integral - API) was calculated, considering both phenological indicators - start dates, end dates, length (number of days) - and production indicators - the timing and magnitude of the peak day (the highest daily average pollen concentration during pollen season). The limits of the pollen season were calculated by using the method Jäger (1996). The pollen presence has analysed with Spearman rank correlation statistics. For the statistical analysis it was used 25.0 IBM-SPSS Statistics Software (2017).

Results and Discussion

The data of all the qualitative and quantitative parameters of the three samplers are correlated in a highly significant way ($p < 0.01$), indicating a homogeneous trend of the blooms.

The values of API and max peak ($\mu\text{g}/\text{m}^3$) are interesting, highlighting the different characteristic floristic present in the various areas of the city, different for landscape, naturalistic and urban characteristics (Figure 1).

The greater presence of the herbaceous Poaceae and Urticaceae taxa in suburbs is probably attributed in part to the abandonment of farming practices, and in part a progressive worsening of maintenance of green areas, as well as the high API values of the Platanaceae pollen are the result of the use of *Platanus* for road trees in the city center.

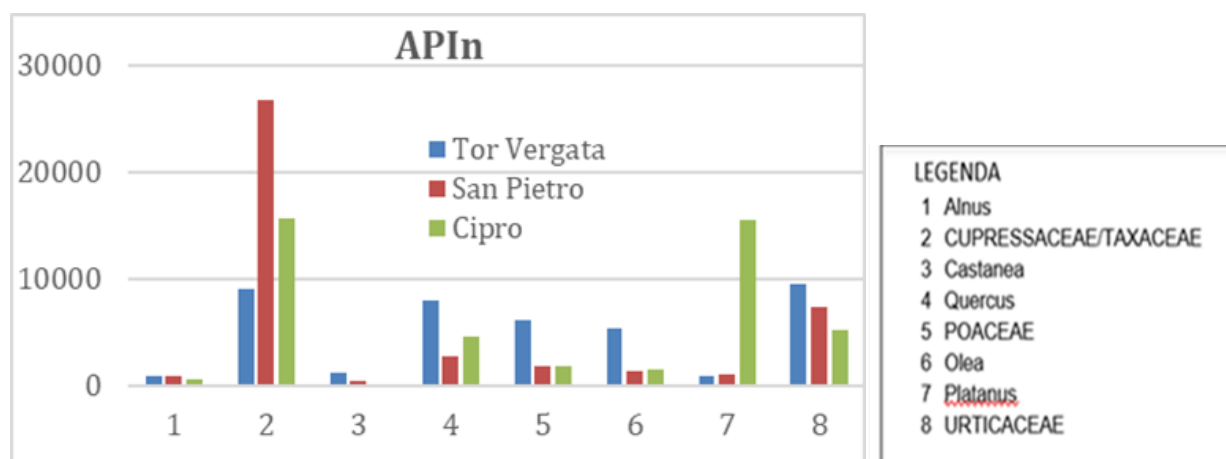
Conclusions

The data highlight the importance of installing multiple aerobiological stations also within big cities with heterogeneity areas characterized by of a different floristic composition; in fact, the sampling of airborne pollen is a useful tool both for the prevention and containment of symptoms in allergy sufferers, in that the severity of the symptoms also depends on the pollen exposure (Arasi et al. 2021), both to verify the trend of vegetation and the maintenance state of green spaces in cities.

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Figures



AEROBIOLOGICAL STUDY OF THE ATMOSPHERE OF BRAGANÇA (NE PORTUGAL): PRELIMINARY RESULTS

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Introduction

Pollen and fungal spores (especially *Alternaria*) are the main causes of human respiratory allergies. The present study analyses the presence of these particles in Bragança, Northeast of Portugal, and the influence of weather variables on their airborne concentrations. This new station in Bragança covers an area, the Northeast of Portugal, that has not been monitored before.

Materials and Methods

The methodology used was the one established by the Spanish Aerobiology Network (REA) (Galán et al. 2007). The monitoring was performed by using a Hirst type volumetric trap (Lanzoni VPPS 2000), located on the roof of the Bragança hospital, continuously, from July 2nd, 2020, to May 15th, 2021. Spearman correlation analysis was carried out between meteorological and aerobiological data. These are preliminary results and will be completed until July 2nd, 2021, to include information of a full year of sampling.

Results and Discussion

The 10 most representative pollen types (84,54% of the total) were *Alnus*, *Castanea*, Cupressaceae, Ericaceae, *Fraxinus*, *Pinus*, *Platanus*, Poaceae, *Quercus* and Urticaceae. Cupressaceae, *Alnus* and *Fraxinus* registered their maximum daily peaks between December and January. *Platanus*, *Pinus*, *Quercus*, Urticaceae and Ericaceae did it between March and May. *Castanea* and Poaceae in July. *Alternaria* peak day was July 14th, 2020.

Quercus was the most abundant, contrary to Urticaceae, with a daily peak of 540,76 grains/m³ and 12,76 grains/m³, respectively.

Cupressaceae, *Alnus*, *Fraxinus*, Poaceae, *Platanus*, *Quercus* and Ericaceae were mainly captured between 8h and 20h, while *Pinus*, Urticaceae, *Castanea* and *Alternaria* levels were higher between 20h and 8h.

Temperature and winds coming from the fourth quadrant showed to have a positive influence on pollen and *Alternaria* levels while the correlation coefficient was negative with humidity.

Conclusions

The most abundant pollen type during the sampling period was *Quercus*, being mainly detected along April. Temperature, relative humidity and wind coming from the NW direction were the main meteorological parameters influencing the airborne pollen/*Alternaria* content.

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PRELIMINARY PALYNOLOGICAL ANALYSIS OF THE LATE NEOLITHIC AND COPPER AGE SITE OF COLOMBARE DI VILLA (NEGRAR DI VALPOLICELLA, VERONA, ITALY)

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Introduction

Palynology from archaeological sites may be problematic due to the low pollen preservation and different agent of transport that make quite difficult the interpretation of pollen spectra (Faegri et al. 1989; Mercuri et al. 2010). However, an accurate pollen sampling and the interdisciplinary – geo-archaeo and bio stratigraphical study – allow the reconstruction of very local past environments with high chronological resolution, useful to give answers to the archaeological questions (Mercuri 2014). The interdisciplinary research project of Colombare di Villa started in 2019 from the excavation made by Francesco Zorzi in the 50s, and included palynology to contribute to the palaeoenvironmental and economic reconstruction of people that settled in the N Italy site from late Neolithic to the beginning of early Bronze Age.

Materials and Methods

In 2020, 7 pollen samples were taken from the stratigraphic section ‘survey 5’, which includes the settlement layers of the site (Figure 1). Pollen and Non-Pollen Palynomorphs (NPPs) were counted in the same slides and identified at light microscope (x1000).

Results and Discussion

Pollen was found in all samples, sometimes broken and folded but with good concentration (between 15,275 p/g in US3 to 221,886 p/g in US3). The floristic list includes 70 pollen types, 18 arboreal and 52 non arboreal taxa, suggesting that the archaeological layers were deposited in a plant landscape covered with a good floristic richness. The Arboreal/Non Arboreal Pollen ratio was 23/77. The most represented trees/shrubs are deciduous *Quercus* and *Corylus* (4.0% each, on average, and ubiquitous) and *Tilia* (4.3% on average, but present only in US3 and US6; Figure 2); in sample 6 (US6) *Tilia* reaches 14% suggesting a very local presence of linden. *Vitis* is present in all

samples (2.7% on average) while *Alnus*, *Ostrya/Carpinus orientalis*, *Juglans* and *Pinus* are ubiquitous with low values (<1% on average, each). Cereals are well represented and ubiquitous (5.4% on average) and mark the anthropic environments together with *Plantago*.

Conclusions

The preliminary pollen data from the Colombare site suggest that the settlement was established close to a mixed oak wood, which provided wood and fruits for fuel and food. Cereals could have been cultivated in adjacent areas and then processed in the site.

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Figures

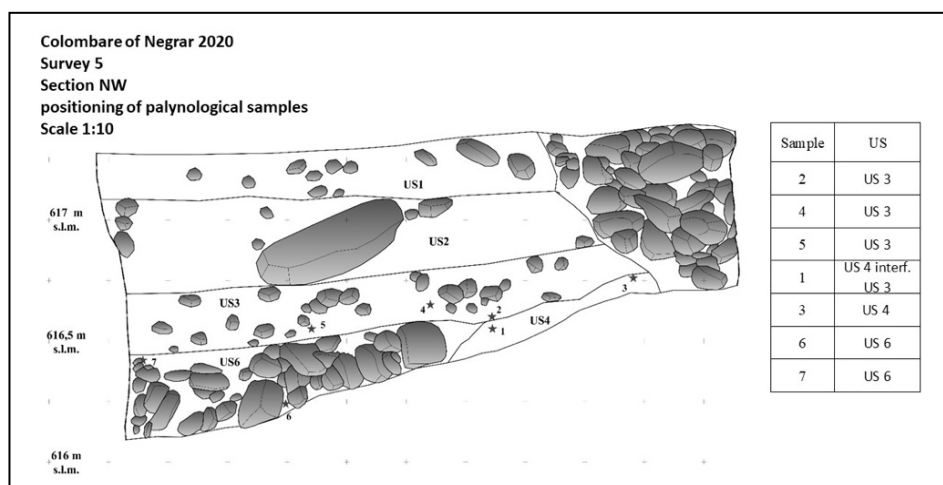


Figure 1. Pollen sampling, samples 2,4,5, they refer to US3; the samples 1,3, they refer to US 4; and the samples 6,7 they refer to US 6.

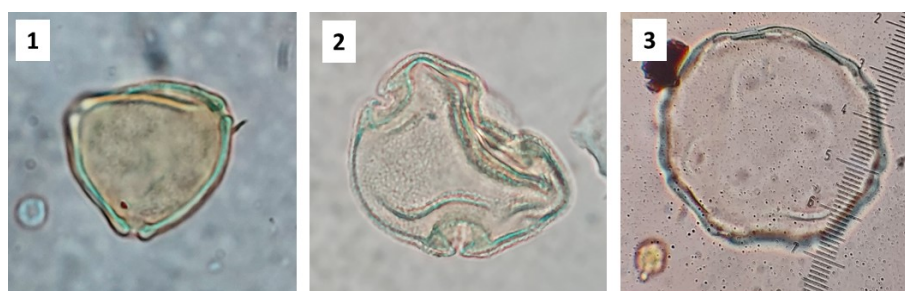


Figure 2. Pollen grains from the Colombare site: 1- *Corylus*, sample 2, US3, 26 µm; 2- *Tilia*, sample 4, US4, 40 µm; 3- *Juglans*, sample 1, US3, 43 µm.

RIVULARIA HETEROCYSTS AS INDICATOR OF LONG-TERM CHANGES OF MOISTURE AND NUTRIENTS IN SOILS: A QUALI-QUANTITATIVE STUDY AT THE TERRAMARA S. ROSA DI POVIGLIO (REGGIO EMILIA, ITALY)

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Introduction

This work is part of the constantly updated research on non-pollen palynomorphs (NPP). The study was focused on the identification of *Rivularia*, a cyanobacterium that is an excellent bioindicator as it requires certain trophic, climatic and environmental conditions at different stages of the life cycle (Whitton and Mateo 2012).

Materials and Methods

A quali-quantitative analysis of *Rivularia*'s heterocysts (*Rivularia*-Type: Van Geel et al. 1982-1983; HdV 170: Miola 2012) was carried out on 77 sediment samples from the terrestrial core drilled 150 meters N from the Terramara S. Rosa di Poviglio (RE, northern Italy). Heterocysts, extracted from the sediment according to the method in use in the Laboratory of Palynology and Palaeobotany of Modena, have been divided into categories (Figure 1) based on morphology (ellipsoidal or elongated) and the state of preservation of the sheaths (presence or absence).

Results and Discussion

The results obtained show a very variable presence of these structures throughout the sequence, usually with different morphologies. Could this be an indication of the contemporary presence of different species of *Rivularia*? A phase preceding 15,000 years from the present, identified in the deepest levels of the core, was characterized by low concentrations of heterocysts, while the Holocene sediments show a greater average presence of these structures reflecting higher humidity, temperature and nutrient levels.

Conclusions

An in-depth morphological analysis of these structures could prove useful to improve *Rivularia* taxonomic identification, in addition to get indications regarding fluctuations in organic phosphorus, nitrogen compounds and soil moisture levels. This information supports and integrates pollen data relating to wet environments and the establishment of different conditions influencing the formation of plant successions.

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Acknowledgements (Funds)

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Figures

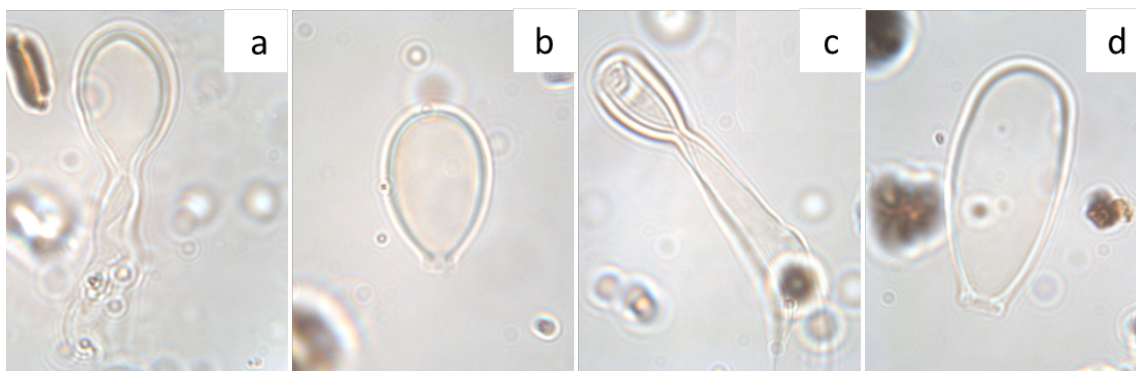


Figure 1. Categories of *Rivularia* heterocysts identified:
a) ellipsoidal with sheaths (23.6x14.2 μm), b) ellipsoidal without sheaths (15.3x9.4 μm),
c) elongated with sheaths (13x7 μm) and d) elongated without sheaths (28.3x13 μm).

ENVIRONMENTAL AND LAND USE CHANGES IN A MEDITERRANEAN LANDSCAPE: THE CASE STUDY OF THE ANCIENT *METAPONTUM* (PANTANELLO, S ITALY)

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Introduction

The integrated palynological-geoarchaeological approach to the research on archaeological contexts is useful to better understand the natural and anthropic contribution to landscape evolution (e.g., Cremaschi et al. 2016). This combined methodology is especially worthwhile in palaeoenvironmental studies across the Mediterranean Basin, cradle of world civilization since ancient times. While many works investigate the climate and human contributions in shaping landscape during prehistoric times (e.g., Mercuri et al. 2019), few studies have investigated the effects of natural and anthropic actions on landscape in historical times. This paper focuses on the integrated palynological-geoarchaeological investigation carried out at the Greek-Roman site of Pantanello, located in the Metaponto Plain - southern Italy (Florenzano et al. in press). This study provides information for palaeoenvironmental and economical reconstructions of the ancient *Metapontum* area, providing essential details on how human-environment interactions may have changed landscapes and land uses in the territory on a long-term perspective.

Materials and Methods

The site of Pantanello is located in the lower Basento Valley, at 3 km from the ancient city of *Metapontum*, settled in 640 BC on the Ionian coastline. This area, archaeologically investigated since the '70s, incorporates an Eneolithic village, a Greek rural sanctuary centered on springs belonging to the *chora* of *Metapontum*, and a Roman tile factory and kiln deposit (Carter and Swift 2018). The archaeological contexts were completely submerged underwater, allowing for a good preservation of organic materials in the deposits. A total of 29 pollen samples and 43 bulk samples for sedimentological and mineralogical analyses were collected from three 2-meters-deep trenches excavated near the archaeological contexts (P1) and between the site and the alluvial plain of the Basento River (P2,P3). Pollen samples from P1 and P3 trenches and two modern surface soil samples were subjected to pollen and non-pollen palynomorphs extraction and microscopic analyses. Physical and chemical characterization of sediments was performed in the three trenches.

Results and Discussion

Pollen sequences describe the main habitats spreading at the site and its surroundings, both influenced by the continuous presence of wet environments in the vicinity of the site. Since before the 6th century BC, a permanent reservoir is documented by hygrophilous trees (*Alnus*, *Populus*, *Salix*), hygrophytes (mainly Cyperaceae) and other aquatics, and by algal remains (e.g., *Rivularia* type and *Pseudoschizaea*). The pollen spectra testify to several fluctuations of the water level of the reservoir, with a gradual trend to become shallower. From the 6th-4th BC phase, vegetation shift towards the current anthropized Mediterranean landscape. The landscape was open, covered by grasslands (Asteraceae and Poaceae) with scanty broadleaved oak woods, Mediterranean shrubs and conifers distributed in the hinterland areas. Human activities influenced the landscape with the spread of pasturelands (mainly attested by Cichorieae and *Plantago*) and cultivations (cereal fields, olive groves). Sedimentary data confirm that colluvial processes are especially evident in units associated to human activities (wood clearance, crop cultivation and pastoral practices).

Conclusions

The integrated palynological-geoarchaeological research at Pantanello allowed to reconstruct recent dynamics of environments and land use in the area. Since the 6th century BC, the Mediterranean landscape has been subject to continuous transformations tuned by climatic forcing and human agency. The sylvo-agropastoral activities in the Metaponto plain changed the land cover and increased the intensity of surface processes. This study suggests that human impact have locally prevailed over climate influence on environmental changes.

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A PALYNOLOGICAL APPROACH TO THE RECONSTRUCTION OF MEDIEVAL LANDSCAPE IN TUSCANY, CENTRAL ITALY (NEU-MED PROJECT)

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Introduction

The palynological analyses presented here are part of the ERC funded nEU-Med project. The main aim of the nEU-Med project is to analyse the changes in the natural and anthropic landscape between the 7th and 12th centuries AD to better understand the processes of economic growth that took place during that time period in Tuscany (Bianchi and Hodges 2017). Such archaeobotanical/palynological research was employed to potentially reconstruct plant landscape, land-use and ethnobotanical-agricultural exploitation in the area (Florenzano et al. 2012).

Materials and Methods

Four cores were drilled in the distal part of the Cornia and Pecora river coastal plains, located in southwestern Tuscany (Italy), between the Colline Metallifere and the Tyrrhenian Sea. A total of 76 selected sediment samples were collected and analysed. All the samples were treated according to the method in use in the laboratory of Modena (Florenzano et al. 2012) and analysed for pollen. Permanent pollen slides were mounted in glycerol jelly. *Lycopodium* spores were added to calculate concentrations, which were expressed as number of pollen grains per gram (=p/g). Pollen and microcharcoals were counted in the same samples. Pollen identification was made at 1000x magnification while analyses on microcharcoals has been done at 400x, on selected lines. The microcharcoals were divided in 3 class sizes, 10-50 µm, 50-125 µm and >125 µm (Sadori et al. 2015).

Results and Discussion

At least 300 pollen grains were counted in each sample. Pollen appears mostly well preserved, especially in the Cornia cores, while pollen in the Pecora samples, being closer to the archaeological site of Vetricella appears to be broken or crumpled as is usual for archaeological contexts; nevertheless, pollen identification was generally achieved at genus or species level. Woodlands of *Quercus* and trees that usually associate with it, like *Ostrya/Carpinus* and *Carpinus*, represent most of the trees found in these cores, with a presence of wetter environments represented by *Salix*

and *Alnus* and *Typha/Sparganium*. In regard to human activities, we find presence of both cereals, anthropogenic indicators (API; Mercuri et al. 2013) and of indicators of grazing (LPPI; Mazier et al. 2009).

Conclusions

All the cores present a low percentage of tree pollen, describing a mostly open landscape, especially in the two Pecora cores that are closer to the archaeological site of Vetricella. A slightly higher concentration of trees pollen was found in the Cornia cores. Most of the cores have a high percentage of hydro-hygrophilous herbs, indicating a fluctuating presence of water, and a high percentage of *Alnus* was found in the Pecora 4 core, possibly due to flooding of the area. Cereal pollen is low in all the cores, hence the area near these rivers was probably not used for cereal fields. At the same time LPPI show high percentages, especially in Pecora 3, showing that the area was probably used for grazing. Microcharcoals have been compared with both the trees and shrubs sum and the percentages of *Erica*, and in some cores an increment can be seen in of both microcharcoals and *Erica* during or right after a decrease of trees. The reconstruction of the landscape and of the use of the area by the population through the study of pollen, integrated with all the information obtained from the strongly multidisciplinary approach of the nEU-Med project, has given insight on the changes in the landscape and exploitation of the land that took place in the area.

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Acknowledgements (Funds)

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THE TOLEDO MOUNTAINS (CENTRAL SPAIN) THE RISE OF AN ANTHROPOGENIC LANDSCAPE

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Introduction

Mid-mountain ecosystems present wide resource diversity, heterogeneous relief and a mild climate useful for human interests, allowing strategies such as terracing the slopes and a crop diversification. This close relationship with the landscape leads to a parallel co-evolution with human societies, with fire and grazing as the most effective environment management tools (Tremblay et al. 2006; Pausas and Keeley 2009; Allende Álvarez et al. 2020).

The Toledo Mountains is a mid-elevation range complex placed between the Tagus and Guadiana basins, in the centre of the Iberian Peninsula, with typical Mediterranean vegetation with some Atlantic influence on the westernmost side of the range (Luelmo-Lautenschlaeger et al. 2018; Morales-Molino et al. 2019). During the Holocene, the Toledo Mountains have also served as a refugium for many species such as *Betula* spp., *Corylus*, or *Myrica gale*, among others (Sánchez Del Álamo et al. 2010; López-Sáez et al. 2015). Eight mires along the mountain complex have been studied through pollen analysis, fire history reconstruction, loss on ignition, geochemistry and magnetic susceptibility, in order to disentangle the Toledo Mountains vegetation history from Late Neolithic until today.

Results and Discussion

This study showed the relevant role played by mires for first agricultural societies in the Toledo Mountains during the Late Neolithic, and how the short distance transhumance movements took place supported by these water supplies spots, as it shows La Ventilla mire. During the Late Iron Age it took place the first abrupt forest transformation due to the human activities, as it is possible to see in La Botija mire (Luelmo-Lautenschlaeger et al. 2018). Since then, anthropic influence over the vegetation increased. The Middle Age was a turning point for these lands, when Christian repopulation set new inhabitants along the mountains and the pressure over the landscape was extended farther and higher in the mountains, perfectly visible in Bermú and El Perro mires (Luelmo-Lautenschlaeger et al. 2018, 2019). The trend reached the peak in the Contemporary Age, when it is possible to see how rural exodus, afforestation policies, property changes and conservation efforts drove the landscape shaping.

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VEGETAL ANTHROPOGENIC DYNAMICS FROM THE HOLOCENE TO THE ANTHROPOCENE ON THE CANTABRIAN COAST (NORTHERN IBERIA)

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Introduction

The Anthropocene concept refers to the recent history of our planet characterized by a rapid and profound geological change provoked by numerous human activities and reflected globally in the sedimentary record since 1950 CE. This impact can be studied through a great variety of proxies as, for example, fossil pollen in estuarine deposits. The objective of this work is to reconstruct the process of anthropization of the coastal vegetal landscape on the eastern Cantabrian coast (northern Iberian Peninsula).

Materials and Methods

Different sedimentary records have been studied: long boreholes that extend to Holocene dates, and short cores dated approximately in the last 200 years. This study presents, on the one hand, the results of the Requejada (43°23.572 N, 4°01.146 W) long borehole and, on the other hand, the Miengo (43°24.586 N, 4°01.430 W) short core, both in the Saja-Besaya estuary (Cantabria). In the case of the Requejada borehole, 52 samples (1 cm thick) have been analysed every 30 cm for a total depth of 16 m. In the Miengo core, 26 samples (1 cm thick) have been analysed every 2 cm for a total depth of 50 cm. They were chemically (HCl, KOH, HF) and densimetrically (Thoulet solution) treated for the extraction of pollen and nonpollen palynomorphs (NPPs) at the Institute of History-CSIC in Madrid. In addition, each sample was mounted in glycerine for the correct observation and identification of palynomorphs under an optical microscope at 400x and 600x magnification. A minimum of 500 pollen grains per sample were taxonomically identified while aquatic taxa, fungal spores and other NPPs were excluded from the terrestrial pollen sum.

Results and Discussion

The presence of a hiatus in the Requejada borehole at 792 cm depth separates two significantly different pollen associations. In the first association (8000-7300 years cal. BP) the dominant taxon is *Betula*, together with a greater presence of *Pinus pinaster* and *Corylus*. The presence of deciduous *Quercus* also stands out. There are values of up to 25% of Poaceae, as the predominant herbaceous species. In the upper part of the sedimentary sequence, the most recent pollen association (1850

cal. BP - 2000 CE) shows the substitution of *Betula* by *Alnus* as the dominant genus together with an increase in the percentages of deciduous *Quercus*.

The presence of NPPs such as *Sordaria* sp. indicates possible livestock activity from the middle Holocene and, therefore, the beginning of human presence in the area. The appearing of *Alnus* after the hiatus would be related to the increased presence of water in this estuarine zone, probably due to the continuous rise in sea level during the Holocene. In addition, already in recent times, this record shows a considerable reduction in the percentages of *Pinus*, a tree that has been heavily exploited throughout history by humans. Also, the presence of *Eucalyptus* sp., *Cerealia* and a rebound of Poaceae in the most recent samples indicate that human impact increased.

Conclusions

The general dynamics shown during the most recent times in the Miengo (1855 – 2018 CE) core, suggest a progressive growth of forest areas, since the arboreal pollen of the modern taxa (e.g., *Alnus*, *Betula*, deciduous *Quercus* and *Pinus* sp.) increases through time. Other anthropogenic taxa as *Cerealia* t., Poaceae (whose expansion is often linked to deforestation and infrastructure construction) and *Sordaria* t. appear with significant percentages in some parts of the core, suggesting the presence of intense agricultural activities and livestock animals. The replanting activities of the “National Reforestation Plan”, which began in 1940, ended up modifying the natural plant dynamics in favor of species such as *Pinus pinaster*.

LATE HOLOCENE PALEOECOLOGICAL CHANGES IN THE ECUADORIAN PARAMOS

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Introduction

Páramo (or Páramos) is a neotropical grassland ecosystem that is widespread in the northern Andes between the upper limit of the cloud forest (c. 3000 m asl) and the upper limit of plant life (4700 m asl). Páramos bear high levels of biodiversity and the high elevation vegetation has an important ecological function for regional water storage, which reaches the high Andes from two main sources, one from the annual amount of rainfall that form the edaphic moisture supply, the other one from the upslope cloud convection between the Amazon basin and the summits (Ledru et al. 2013).

Previous analyses of a pollen record that covered the last 1000 years showed that the Páramo vegetation is highly sensitive to changing amounts of precipitation (Ledru et al. 2013). Here we extend the pollen and charcoal record of Papallacta to 5000 years and explore the longer-term drivers of changes in hydrological conditions, fire and vegetation in this high elevation ecosystem of the tropics.

Materials and Methods

The peat bog of Papallacta is located on the slope of the Antisana at an elevation of 3815 m asl (00°2'30''S, 78°11'37'' W) in the Eastern Cordillera of the high Andes (Ecuador). In the region of Papallacta, the cloud forest (or upper montane rain forest) occurs between ca. 2500 m a.s.l. (Eastern Cordillera) and 3400-3600 m a.s.l. and is dominated by *Weinmannia pinata*, *Schefflera sodiroi*, *Myrcianthes rhopaloides*, *Hedyosmum cumbalense*, *H. luteynii*, *Oreopanax ecuadoriensis*, *Hesperomeles ferruginea*, *Weinmannia fagaroides*. Between 3600 and 4300 m asl, in the Paramos, *Gynoxys acostae*, *Escallonia myrtilloides*, *Buddleia*, and *Polylepis* occur and super paramos extend between 4200 and 4600 m on the eastern side. A shrubby vegetation with dominant *Loricaria antisanensis* on the eastern humid side at ca. 4200 m (Sklenar and Jorgensen 1999).

We collected a 9-m long sediment core (PA 1-08) from the Papallacta bog in 2008 with the aid of a Russian-type corer. The sediments are composed of brown peat intercalated with eighteen tephra layers, M1 to M18. The chronology is based on a total of 35 bulk sediment samples measured at the Laboratoire de Mesure du Carbone14 (LMC14) –UMS 2572 (CEA/DSM –CNRS –IRD–IRSN –Ministère de la Culture et de la Communication). In addition to radiocarbon dating we used tephrochronology when tephra layers (volcanic ash layers) of known volcanic eruptions were available. Charcoal and pollen analyses were performed on the first 7 m of the core.

Results and Discussion

The age model performed with Bacon gave an age of 5000 cal yr BP for the base of the PA 1-08 core. According to our modern pollen survey, a convective index expressed by the Transported / Poaceae pollen ratio (Tr/P, whereby pollen of transported taxa are produced by trees growing in the Andean cloud forest (*Alnus*, *Hedyosmum*, *Podocarpus*), whereas Poaceae grow in the Paramos) can be used to characterize the source of moisture supply (upslope convective activity versus edaphic moisture). We found one major ecological change at 2500 cal yr BP in the vegetation and fire records. Before 2500 cal yr BP frequent fires and high Poaceae frequencies are related to low monsoon activity and low ENSO variability. After 2500 cal yr BP fires were rare and abrupt changes in the floristic composition of the Paramos are observed responding to changes in temperature and water cycle. Century-scale events are observed within these two intervals. The last centuries show the highest convective activity related to strong adiabatic moisture between Amazonia and the Andes.

Conclusions

Our results show that the Paramos is a very sensitive ecosystem to moisture changes and responds to two types of changes: the edaphic one with the expansion (regression) of Poaceae (Asteraceae) and the atmospheric one with enhanced cloud dripping due to the adiabatic upslope cloud convection between the Amazon basin and the summits of the eastern Cordillera. In agreement with other studies, during the last 5000 years, the upper limit of the Andean forest never reached the elevation of the bog at Papallacta. Long-term, precession scale, and short-term, multi centennial to multidecadal scales, climate events were able to strongly modify the floristic composition of the Paramos. The high humidity from the cloud upslope dripping observed today is masking the ongoing edaphic drought, putting a threat to the water supply of the Andean big cities.

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