

The total thickness of the Čejské jezero Lake sediments sampled by the borehole Čej 27 is 2 m. Radiocarbon dating on the profile base - 14C: 9990±275 B.P. (preboreal 10250-9100 B.P.: Hv-18924, Hv - 14C und 3H - Laboratorium, Niedersächsisches Landesamt für Bodenforschung, Hannover), but most of all the found pollen community dates the lake origin into the Late Glacial (15000/13000-10250 B.P.), as it is with other lakes (e.g. Vracov, Vácenovice). During its development, deposition of sediment occurred mainly in the Holocene. The vegetation assemblage consists of species with various ecological requirements. Their development and these relations were objects of research. By virtue of favourable circumstances, it has been scheduled for protection and proclaimed the Čejské jezero Lake Natural Monument.

The landscape vegetation during the Upper Pleistocene in the Benzú shelter site (Ceuta)

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The pollen data of Benzú shelter (Ceuta), is presented. The site is located to 200 m of the coast and 60 m ssm, in the west of Ceuta. This space, Arco de Gibraltar or Bético-Rifeño, with Atlantic and Mediterranean characteristic, is limited by the Rift and the Béticas mountains ranges (around the Alborán sea). The shelter is developed in dolomite formation of the Triassic age, of the Unidad Beni Mesala.

Litology point of view, the 10 levels identified in the filler of the shelter, to define three sequences that correspond to successive soliflución laundries associated to cold and humid climates and bound espeleotemas to warmer moments. On the other hand, in the first seven levels, next to the existence of boney fragments and the lithic industry of MODO-3 (Musteriense). The lithic industry, attests the human occupation. The sequence is close by blocks with stalaectic mantle.

Vegetation point of view, on have been identified a total of 42 taxa, of which 9 correspond to arboreal taxa, 5 to shrub and the rest are the herbaceous and aquatic plants. Their distribution defines a relatively open and homogeneous landscape, constituted by *Cedrus* and *Quercus* type evergreen, Ericaceae and *Juniperus*, next to a varied herbaceous retinue; always inside the mediterranean environment.

Along the sequence the widespread descent of the forest mass, the substitution of Ericaceae for *Juniperus* and the progressive loss of botanic diversity and of the rate of humidity, is detected.

On the other hand, is verified a correlation, between the polinic zones and the sedimentary cycles, and also it is observed like along the same ones they are accentuated the loss of diversity and of humidity. This could be interpreted like a general tendency toward some drier conditions.

Domestic fires and vegetation along Mousterian and Early Upper Palaeolithic occupations (60-30 KA. BP) in Cantabrian, Northern Spain

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Charcoal analyses from several sites located in Northern Spain have yielded floristic data concerning the fuelwood employed by humans in domestic fires developed along their Mousterian and Early Upper Palaeolithic occupations. Chronology spans from 70-60 to 30 Ka. BP.

Betula, *Pinus* and *Sorbus* have been the main taxa employed in these fires followed by a great diversity of shrubs *Hippophae rhamnoides*, *Leguminosae*, *Arbutus unedo*, *Prunus* spp., *Erica* sp., among others. The way in which these taxa appear depend on the different geographical position of sites.

This work have been placed into a interdisciplinary discussion, taken into account palynological data, glaciation patterns and palaeoclimatic events of Southern Europe during middle Pleniglacial period.

The landscape around prehistoric settlements was essentially open with pioneer vegetation cover on soils ice-free but under some periglacial conditions due to the existence and proximity of some mountain glaciers. The latter explain the altitudinal shift of the vegetation. Daily routes taken by Humans in search of economical resources including woodfire, were influenced not only by palaeoenvironmental conditions but economic and technological factors too.

Key-words: Domestic fires, Mousterian, Early Upper Palaeolithic, Middle Pleniglacial, Cantabria.

Holocene vegetation history and palaeoenvironmental conditions on the temperate Atlantic coast of Argentina

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Holocene vegetation history and palaeoenvironmental conditions are investigated at the south coast of Buenos Aires Province, Argentina. La Olla 1 and Laguna del Sauce Grande sediment sequences are analysed for pollen, calcareous microfossil (ostracods and foraminifers) and macro remains (mainly seeds and charophyte oospores). Supplementary information is provided by sedimentological analysis. Modern surface sample data is used to assist in the interpretation of the fossil records. La Olla 1 sequence covers the period 7890 to 7630 cal. BP. The microfauna recovered is characteristic of a shallow marginal marine environment such as coastal lagoon. The microfossils indicate a marine connection between 7850 and 7800 cal. BP. Plant macro remains and pollen analyses indicate an extension of the water body after 7780 cal. BP. The pollen record reveals the development of a halophytic plant community in a coastal environment. The sediment record from Laguna del Sauce Grande comprises the last 3000 years. Microfossils and macro remains indicate that the lake history begins with a temporary brackish-water phase. This is followed by more stable conditions between 1940-900 cal. BP. Periods of water level fluctuations occur after 900 cal. BP, with high water levels between 660-270 cal. BP. The uppermost samples of the sequence show similar conditions to present day. Pollen spectra indicate a relatively stable vegetation composition once the lake was formed. Pollen assemblages reflect the present regional grassland vegetation with taxa characteristic of the surrounding dune communities. Human settlement was indicated in the pollen spectra by the presence of introduced taxa in the uppermost samples.

Poster session h3

EVOLUTION OF THE LANDSCAPE AND CLIMATE IN THE MEDITERRANEAN ECOSYSTEM

Vegetation history and impact of metallurgical activities on Mont Lozère (French Massif Central) according to pollen and geochemical analysis

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In the Massif Central (France) several pollen studies have been conducted during the last decades. These studies have reconstructed the main features of the vegetation and climate history since the last glaciation.

They have pointed out that for at least 9000 years, the area has been continuously forested, first of all with pine forests, then with oak, and finally with beech forests around 4500 BP.

In the western part of Mont Lozère about 50 lead slag sites have been found, located at an altitude between 1360 and 1430 m in a 7 km² zone. These lead smelting sites are also located near peatlands, allowing the opportunity to study the consequences of past metallurgical activities on the forest dynamics at a fine temporal scale using paleobotanical (pollen, plant-macrofossils) and geochemical (lead) indicators. This metallurgical activities indeed used large quantities of wood for combustion, in particular beech, a tree species almost absent from the altitudinal range where lead smelting sites were found. In pollen diagrams human impacts are generally associated with agro-pastoral activities. In Mont Lozère, it is hypothesised that metallurgical activities also play a significant role on the long term vegetation dynamics. This is why a pluridisciplinary research activities were thus engaged, in partnership with archaeologists, geochemists and geomorphologists.

Pollen and geochemical analyses of the Narses Mortes peatland (1400 m) show that past metallurgical activities have had strong and significant effects on the vegetation of Mont Lozère. Two major periods of deforestation have occurred during the last 2000 years: the first one was characterised by a decrease in beech and birch. This period is linked to metallurgical activities, and occurred during the Antic period. The second episode happened more recently during the Medieval period leading to the complete disappearance of beech and oak in the area where lead smelting sites are located.

Evidences of mining activities from the Antic period was unexpected for this region because all archaeological remnants are of Medieval age.

Upper Würm and Early Holocene in the mountains of NW Iberia: biostratigraphy, chronology and tree colonization

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Palaeoenvironmental reconstructions performed during the last decade confirmed that the principal climatic changes occurring along the Pleistocene/Holocene transition affected the whole of Europe. However early attempts to evaluate these changes in SW Europe have been problematic. The major difficulties arise for integrate data from distant or dissimilar regions, due to the transgressional character of the global changes, the anomalies in ¹⁴C production during some periods and the ambiguous uses of biozones and chronozones. In the case of Iberia some key sequences might be also affected by problems of dating and taphonomy (post-depositional processes), because a critical attitude towards ¹⁴C dates and precautions against reservoir effects are always required. Nevertheless, it seems likely that in some relatively low-altitude parts of NW Iberia post-glacial sedimentation commenced considerably earlier than 18,000 B.P. On the other hand, in a wide and dissimilar region as NW Iberia, comparable pollen stratigraphies recorded in different sites might not be necessarily synchronic. Several factors (altitude, latitude, orientation, distance from the sea, rain shadow, etc) could explain why these sites have different sensitivities in relation to global changes, and also why the characteristic composition of synchronous pollen zones can be different for each site (MUÑOZ SOBRINO et al., in press).

Here we propose a new approach to the problem, which not directly depends on the available radiocarbon chronologies. It is based on the acceptance that the main climatic reversals affecting NW Iberia during the Late-Glacial/Early Holocene should be equivalent to those seen in other independent and well-dated climatic records from comparable areas. Greenland ice cores may be our best option to contrast, given that they archived for thousands of years the major climatic variations affecting the North Atlantic (WALKER et al., 1999). We argue that a consistent correlation between pollen zones in NW Iberia might previously require being able to identify the signals of the most important Greenland Events in each diagram. Several well-dated pollen sequences from massifs situated from Serra do Gerês (North Portugal) to Serra do Xistral (Cantabrian Coastal Mountains), all of them placed near the current Eurosiberian-Mediterranean border, are used to identify the main climatic signals in each site; and subsequently, a correlation between the pollen spectra from all these localities is proposed. Following this methodology, the Oldest Dryas, Younger Dryas and GH-8.2 event result as the main climatic reversals affecting NW Iberia along the analysed period. Other minor oscillations, like the Older Dryas or the GH-

11.2 event, could eventually be recognised in some very sensitive pollen sites (MUÑOZ SOBRINO et al. 2001). This interpretation is in coherence with the biogeographical characteristics of the region, with most of the available environmental data and also with the global climatic models currently accepted. Therefore the systematic recognition of a series of climatic events in a large area like NW Iberia, where intra-regional migrations or uncoupled vegetation changes during the Late-Glacial might be possible, seems to be a successful way to correlate sequences. On the other hand, to be able to compare the pollen percentages for the same taxa as simultaneously recorded in different areas of NW Iberia through time, constitute a useful tool to deduce any of the intra-regional refuges and also the most probable migration routes in the whole area. The existence of this spatial component, which sometimes was not taking in account, might contribute to explain some of the biostratigraphies or chronologies earlier considerate as erratic.

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MUÑOZ SOBRINO C., RAMIL-REGO P., GÓMEZ-ORELLANA L. (in press). Vegetation of the Lago de Sanabria area (NW Iberia) since the end of the Pleistocene: a palaeoecological reconstruction on the basis of two new pollen sequences. *Vegetation History and Archaeobotany*.

WALKER M. C. J., BJÖRCK S., LOWE J. J., CWYNAR L. C., JOHNSEN S., KNUDSEN K. L., WOHLFARTH B. & INTIMATE Group (1999). Isotopic "events" in the GRIP ice core: a stratotype for the Late Pleistocene. *Quaternary Science Reviews* 18: 1143-1150.

The Late Pleistocene-Holocene evolution of the coastal plain of the Ligurian sea (Tuscany and Liguria, Italy) by means of palynological analysis

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Several drillings and archaeological excavations have been carried out in the coastal plain of Liguria and Northern Tuscany. Pollen analyses of some of them supply us many frames on the vegetational and climatic changes in the area, during Quaternary. Particularly, a long drilling (90 m) in the Massaciuccoli Lake basin, near Pisa, may be used as a reference series for the chronology of other sequences.

In Pisa, archaeological excavations brought to light an ancient harbour which dates back from the Etruscan period to the Roman age (8th century BC-6th century AD). The most ancient sediments are characterised by significant percentages of mountain trees, especially *Abies* and *Fagus*, whose percentages decrease along the sequence. Later, the pollen spectra are dominated by herbaceous taxa, with numerous fresh water plants; among trees, *Quercus* (deciduous type) and other mixed oak forest elements are listed. With the aim of studying the evolution of the area, drillings (15 m long) were effectuated in the same site and subjected to palynological analysis. In the earlier Holocene sediments, as well as in the whole lower part of the sequence, *Abies* and *Pinus mugo/sylvestris* pollen is abundant, occasionally accompanied by pollen of fresh water plants; in the upper part, *Quercus* and other broadleaved trees prevail. At the top of the sequence, an *Abies* and *Fagus* pollen increasing makes possible to link these layers to those of the Etruscan period from the archaeological excavation.

In the Massaciuccoli Lake basin (NW Tuscany) geobotanical remarks have been made also on the basis of pollen analysis. Despite the discontinuity of the pollen content, it was possible to profile some of the vegetation phases that occurred from 130,000 years BP. It is likely that the forest cover has never been interrupted, though its floristic composition changes: initially, microthermic elements dominate, then deciduous *Quercus* and other allied plants prevail; later, anthropogenic indicators begin to increase, particularly *Vitis*, in sediments dated 4,000-3,000 BP. Indicators of wetlands have been thoroughly recorded: during periods of climate deterioration, this particular environment acted as a refuge for mountain or boreal species, as well as for subtropical plants, which can be currently found as relics.

In the city area of Genova (Liguria) pollen analysis has been carried out on a series of cores from continental sediments, at the mouths of the streams Bisagno and Polcevera: between 8500 and 5500 BP, the coastal lowland vegetation is characterised by forests in which *Abies* was abundant, together with deciduous *Quercus*, *Pinus*, *Ulmus*, *Tilia*, *Alnus*, ferns, etc. Accordingly, investigations on coastal-marine sediments in

Western Liguria have recorded decreasing pollen percentages of *Abies* from at least 2500 BP until it disappears in late Middle Ages. Moreover, also the appearing and spreading of crops such as *Olea*, *Juglans*, and *Vitis* can be traced. Further information, though scattered and often concerning single layers, was obtained from other coastal sites, mainly in Eastern Liguria. A pollen spectrum coming from the subsoil in the town of Rapallo shows a swampy forest vegetation dominated by *Alnus*, with Cyperaceae, Juncaceae and aquatic plants. *Abies*, again, must have been widespread in the surroundings (30% of total pollen). The age is 2390 ± 60 BP at the depth of ca. 8 m; this is likely the evidence of an unexploited coastal marshland, in connection with the mouth of a small stream. A 12 m core was drilled in the proximity of an Iron Age cemetery and a Bronze Age sea-shore site, in the town of Chiavari; the pollen analysis of the richest layers (between 7 and 9 m depth) has shown that Ericaceae are constantly prevailing, often together with Compositae Tubuliflorae; tree pollen is thoroughly scarce. Therefore, the palaeoenvironment seems to have been a Mediterranean chaparral.

These results allow us to profile the vegetation history in Liguria and North-Western Tuscany, during the last 130,000 years. Initially, the area was prevalently covered by microthermic elements, such as *Pinus mugolsylvestris*; however, deciduous broadleaved trees, such as *Quercus* and *Corylus*, never disappeared. Arboreal and non arboreal plant pollen testify the occurrence of fresh water environments. Along the sequences, *Abies* and *Fagus* percentages increase, then *Quercus* and other deciduous trees dominate. Sea level variations strongly interested the area, producing the spreading of salty or fresh water bodies and the decrease of the arboreal cover. Cold phases, such as the early Etruscan period, are marked by the spreading of *Fagus* at low altitudes. Everywhere, the Mediterranean evergreen vegetation is scarcely represented; its diffusion is probably due to the exploitation of deciduous woodlands. The human impact is evident: noticeable pollen percentages of *Vitis* are recorded in sediments which date 4000-3000 years BP, suggesting cultivation.

The evolution of the Battaglia Lake (Eastern Gargano coast, Apulia Italy) during the Middle-Late Holocene. A multidisciplinary approach

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Along almost all the Apulia coastland, during the Holocene existed a number of brackish basins whose presence is testified by stratigraphic, geomorphological and documentary evidence. Many of these coastal lakes disappeared through the time because of natural infilling processes, others existed until recent times or still survive as marshy areas. Just a few still exist as lagoons. The origin of these basins is due to the Holocene sea level rise, but it is possible to think that they were set up in different conditions, depending on local topographic context, sediments availability and so on (BOENZI *et al.*, in press; SIMONE, 2003).

On the sinuous coast of the Gargano Headland there is a number of promontories and fluvial valleys barred by sand ridges and dune belts. During the high stand that followed the peak of the Holocene transgression, these valleys were first flooded deep inland and then gradually infilled by alluvial sediments (BOENZI *et al.*, in press). Among these lakes the Battaglia Lake is the larger one. This basin is clearly represented on ancient maps. These documents show that this lake was in existence around the mid 16th century (e.g., the map by CARTARO and STIGLIOLA, 1590-97). It is still present in the map of MARZOLLA (1836) but either the basin and its toponym do not appear in the first IGM map (Italian Military Geographic Institute F.° 157 IV "Vieste"), realized in 1869.

The evolution of this small basin was reconstructed through the study of a core drilled in its middle. Foraminifers, molluscs and pollen associations were considered. The obtained data, were integrated with on-field surveying and documentary evidence analysis (i. e. old maps). The Battaglia Lake in the origin was a deep *ria*, well connected to the open sea. Gradually, the bay was closed and a small lagoon developed. The barring of this embayment started during the Neolithic Age (5180±50 BP uncal). Finally, a fresh lake environment existed at least during the Middle Ages (990±40 BP uncal) and survived up to the first half of the XIX century.

Pollen record shows that at least since 5180±50 uncal BP the natural vegetation was characterized by a deciduous mixed oak forest (deciduous *Quercus*, *Quercus cerris/suber*, *Quercus ilex* type, *Fagus*, *Ostrya/Carpinus orientalis*, *Carpinus betulus*). Pollen concentration and diversity gradually diminish upcore. In addition, the upper part is dominated by non-arboreal pollen and spores. The low counts in the upper part of the sequence could be explained as a consequence of taphonomic processes, given the bad preservation of the grains. Nevertheless, we cannot exclude the anthropic influence, especially during modern times. In fact, the extinction of Battaglia Lake

occurred during the mid-late 1800s (BOENZI *et al.* in press). The lake may have been infilled after the deforestation of northern areas of the Gargano Promontory in the 18th and early 19th centuries (MANICONE, 1806-07). The clearance activity would have resulted in increased soil erosion that caused an acceleration of the infilling processes.

BOENZI, F.; CALDARA, M.; PENNETTA, L. & SIMONE, O. (in press). Environmental aspects related to the physical evolution of some wetlands along the Adriatic coast of Apulia (Southern Italy): a review. *Journal of Coastal Research*. Special Issue 37.

MANICONE, M., 1806-07. *La Fisica Appula*. Tomes I-V. Neaples. 1037 pp.

SIMONE, O. 2003. Evoluzione olocenica e dinamica ambientale delle piane costiere pugliesi. Unpublished PhD Thesis. Università degli Studi di Bari - Bari, 171 pp.

Pollen analysis of marine sedimentary successions in the Etna region (E-Sicily, Italy) to evaluate the impact of volcanic explosive activity during the Holocene

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For its geographical position at the centre of the Mediterranean basin, Sicily represents a key-site for estimating the environmental evolution of this region during the Holocene. In the Etna area, vegetation and environmental changes are related not only to climate variations and human impact, but also to the volcanic activity of Mount Etna, especially the explosive eruptions. Unfortunately, palynological studies in this area are not frequent, because of the scarcity of moist sites, favourable to pollen preservation.

This work is included in a project financed by the National Institute of Geophysics and Volcanology (INGV). The task of this project is to trace the history of the explosive eruptions of Mt. Etna and to evaluate their impact on the environment by means of stratigraphical, mineralogical, paleomagnetic, pedological and palynological analyses on marine and continental deposits. Pollen analysis was carried out on marine sediments of the Catania Gulf. Here, 25 cores were collected along the Catania coast, SE to Mt. Etna, a favourable zone for recording the pyroclastic deposits ejected by the volcano. The presence of marker layers (tephra layers) provides an age-point control and allows the correlation of different cores to obtain a composite profile covering 15 ka BP (COLTELLI *et al.* 2000).

So far, pollen analysis was carried out on the ET 99-18 core collected at 1 083 m depth, east to Acireale (37° 32' 39" N, 15° 15' 51" E), over 100 cm going beyond the FG tephra (2 180±60 BP, COLTELLI *et al.* 2000) present at 90 cm depth. Further analyses are still in progress.

In the lower part of the sequence (pollen zone ET 6), the vegetation is dominated by grasslands and wooded steppe with Poaceae, Chenopodiaceae, Cichorioideae and *Artemisia*, typical of arid-temperate stands. Warm-mediterranean and submediterranean forests (with evergreen and deciduous *Quercus*) were developed in the moister zones, while *Fagus*, *Abies* and *Pinus* woodlands were present at higher altitudes (probably Mt. Etna slopes). A clear variation in the pollen assemblage and a decreasing of pollen concentration verifies in pollen zone ET 5. The tephra layer FG (deposited after the explosive eruption in 122 b.c.) is present in the middle of this zone. Here a decline of mesophilous woodlands is noticed, together with an expansion of Poaceae and Cichorioideae grasslands. We would expect a strong vegetation change caused by the catastrophic eruption, but the variation in the pollen content is situated stratigraphically 2 cm below (prior to) the tephra layer. A hypothesis would explain this picture with a different sedimentation rate of pollen and pyroclastic material (due to high altitude emission of volcanic ash). Then, after a new forest expansion, mainly by mesophilous elements (evergreen and deciduous *Quercus*), the progressive reduction of forested areas and the development of steppe communities together with cultivated plants (*Corylus*, *Olea*, *Vitis*) in the upper part of the diagram, would suggest an increase of human exploitation in the region.

Further analyses would extend to the lower part of the sequence, in order to trace the vegetation history of the region throughout the Holocene.

COLTELLI, M.; DEL CARLO, P. & VEZZOLI, L. 2000. Stratigraphic constraints for explosive activity in the past 100 ka at Etna Volcano, Italy. *Int. Journ. Earth Sci.* 89: 665-677.

A palynological record of 40000 years forest evolution in Northern Tunisia

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Palynological analysis of sedimentary sequences issued from peat bogs of different areas of NW Tunisia revealed that important climatic events and anthropic impacts on environment occurred during the last 40 millennia.

During Upper Pleistocene, from ca. 40000 to ca. 25000 years BP, a fresh climate favoured a large extension of a *Quercus canariensis* deciduous oak forest. At the end of the period, during the pronounced glacial phase of ca. 20000-18000 years BP and till ca. 10000 years BP, a resinous forest of *Abies*, *Cedrus* and *Pinus* superseded the oak forest which was confined to the lowlands. At this time, Northern Tunisia could offer refuges for woody taxa coming from Algeria where highlands were only covered by grassy vegetation because of the cooling.

At the beginning of Holocene, climate became gradually warmer and wetter. The resinous forest was on the decline and the occurrence of a cool-wet climate, ca. 8500 years BP, and later of a warm-wet one, ca. 6000 years BP, favoured the return of the *Quercus canariensis* deciduous forest which reached its largest extension during this period.

Around 4000 years BP, an aridity peak observed in the Maghreb and also in all the Mediterranean area, was pointed out by an extension of grasslands and a decline of forests. After that, climate evolved to its present situation, again warmer and wetter. This one induced a renewal of forests but human influence on environment became progressively more intensive.

The first effects of human activities happened at the Bronze Age, accentuating the one's of the drought occurring ca. 4000 years BP. During the Carthaginian and the Roman periods, important clearings of woods were made for needing timbers. Then, with the settlement of Arabs in the Maghreb, in the course of the 7th century AD, appeared another system of environmental exploitation; *Quercus suber* protected towards *Quercus canariensis* became the main species in the oak forest and pastoralism practices induced progression of matorrals, a secondary scrub vegetation. During the last centuries, the progression of a mixed *Quercus suber* - *Quercus canariensis* oak forest, principally on the slopes and in the valleys, is perhaps due to fresh conditions led by the "Little Glacial Age".

The chronology of the events pointing out the environmental evolution in Tunisia for the last 40000 years enters in the larger scope of the Mediterranean and African one's for Upper Pleistocene and Holocene periods.

Late Holocene environments in Las Tablas de Daimiel (South Central Iberian peninsula, Spain)

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Present abstract summarizes the main palynological conclusions obtained from the 50 cm to 100 cm sedimentary record of core PVC 4-1. This core was drilled at the right margin of the Cigüela River, inside the Las Tablas de Daimiel National Park.

A detailed stratigraphical section and careful sampling allowed to obtain a continuous sampling with an average thickness of 0.5 cm. These samples were split in order to obtain palynological, geochemical and sedimentary data from the same levels. In addition, some pieces of these samples have been dated by AMS 14C.

Samples corresponding to the 490 to 3440 yr cal BP interval reveal a climatic trend towards a clearer mediterranean conditions with some aridity pulses to the start of this period. In addition, obvious changes in depth and water extent are recorded.

Submerged vegetation was more affected by such variations and it was substituted by emergent vegetation. This emergent vegetation demands smaller water amounts and, therefore, it can develop into aquatic environments subjected to important seasonal fluctuations of the water table and even it can remain after several years of drought.

The anthropic activity in the environment has been detected by the presence of man-induced flora, indicative of grasslands (meadows and pastures) and removed lands, as well as by a reduction in the flora composition and botanic diversity due to a certain degree of water eutrophication.

Geochemical data reveal that these changes are also recorded in the sediments and they can also induce changes in the quality of waters.

Long-term forest dynamics during the past 26,000 years at Colli Euganei (near Padova, Italy)

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Forest dynamics such as immigration, expansion, and decline of tree taxa are of great interest but difficult to observe because of the long time scale involved. We focus on the time period between glacial times and the Late Holocene. It has generally been assumed that the glacial refugia for European deciduous tree species are located in Central or Southern Italy, the Iberian Peninsula and the Balkans.

The research will be linked to a large-scale inter-comparison along both, latitudinal and longitudinal transects through the Po Plain. The aim of this collaboration is a better understanding of the forest and climate dynamics during last glacial and postglacial times as well as the Holocene.

Our study site Lago della Costa (7m a.s.l., 45° 16' N, 11° 45' E) at Arqua Petrarca (Colli Euganei) is a small lake (3 ha) situated in the south eastern part of Colli Euganei (Padova, Southern Po Plain), a hill region of volcanic origin. On silicate sites *Quercus* woods are dominant including some Mediterranean elements; on northern aspects *Castanea sativa* is the main tree species, whereas on calcareous substrate *Ostrya* and *Quercus* stands are prevailing. The site is located outside the maximum extent of the last glaciation. Up to 30m of continuous cores have been recovered from the present and former lacustrine basin. Time control by AMS-radiocarbon dating (on terrestrial plant macrofossils) is important in order to estimate migration rates, establishment times and rates of population expansion. The recovered sediments date back to 22,800¹⁴C yr BP (ca. 26,000 yr Cal. BP) and consist mostly of calcareous gyttja and lake marl with clay and silt layers. First results by means of pollen, plant macrofossils, LOI, and ostracods show rather complex patterns of varying Full and Late Glacial vegetational composition.

The sediment records of Arqua Petrarca provide a high temporal resolution series which can be compared with the ice-core d¹⁸O records (e.g. GRIP, Dansgaard et al., 1993). Based on our ¹⁴C-chronology they appear to fall into the Interstadials 2 and 3 (22kyr/25kyr Cal. BP), if the GRIP core is used for comparison.

During the LGM, the palynostratigraphic record suggests a predominance of cold-steppe vegetation with the main herbaceous taxa of Poaceae, *Artemisia* and Chenopodiaceae. In addition, *Pinus* (20%) and *Juniperus* (10%) are the most important woody taxa. It is striking that pollen of thermophilous deciduous tree taxa is regularly present reaching total peak values of ca. 1% per taxa (e.g. *Tilia*, *Fraxinus*, *Quercus*, *Ulmus*, *Fagus*, *Carpinus*). Taken together the mixed oak forest pollen types reached ca. 4%. In addition, we found continuous pollen values of *Larix* with an average of 1-2%. In Southern Europe, *Quercus* percentages were higher only in Ioannina in northwest Greece, whereas the values of other thermophilous taxa (e.g. *Tilia*, *Fraxinus*, *Ulmus*, *Fagus*, *Carpinus*) did not exceed those of Arqua Petrarca neither in Greece nor in the Central and Southern Italian sites. The pollen were recovered from fine-detritus gyttja deposits, which indicates stable local environmental conditions. Our results suggest that the above-mentioned thermophilous taxa survived the last Full Glacial on favorable micro habitats (sheltered, humid sites) of the Colli Euganei region. This conclusion implies that the Colli Euganei are one of the northernmost refugial areas of thermophilous taxa of Europe.

DANSGAARD, W. JOHNSEN, S.J., CLAUSEN, H.B., DAHL-JENSEN, D., GUNDESTROP, N.S., HAMMER, C.U., HVIDBERG, C.S., STEFFENSEN, J.P., SVEINBJÖRNSDÓTTIR, A.E., JOUZEL, J. & BOND, G., 1993. Evidence for general instability of past climate from a 250-kyr ice-core record. *Nature* 364: 218-220

Palynological analysis of a peat-bog sited in the Sierra de las Villuercas (Cáceres, Western Spain)

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A new Holocene pollen sequence, recovered from a peat-bog sited close to the river Mesto gorge (Sierra de Villuercas, Cáceres) at an altitude of 1120 m.a.s.l., is presented. The lack of pollen data from west and southwest Spain makes this study an interesting approximation to the vegetation dynamics of this territory. In addition, the studied peat-bog is close to one of the few locations where the relict populations of *Prunus lusitanica* can be found at the Iberian peninsula.

However, a fact to take into account is the small size of the basin which occurs in an enlargement area of the very narrow Mesto valley, limited by mountains of approximately 1400 m.a.s.l. This geographical position is the reason why the peat-bog receives so much local pollen. Supporting this explanation is the continuous dominance of *Alnus* throughout the pollen diagram which could be hiding other meaningful taxa like *Quercus*. Other interesting taxa, are *Betula*, usually in colder and wetter conditions than those present at this area; *Corylus*, whose naturalness in this territory is put in doubt by some authors or *Ilex*, more widespread in the past. The scarce representation of *Pinus* along the pollen sequence leads to think of a distant arrival pollen.

The human impact is noticeable at the most recent part of the diagram by an increase in shrubs pollen (Ericaceae) or herbs (Poaceae).

Fossil evidence of North-Western Iberian Peninsula forest ecosystem refugia (Villaviciosa, Asturias, Spain)

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The north-west part of the Iberian peninsula, between temperate and subtropical climate regions, has a complex climate system characterised by humid and mild winters with occasional cold spells. Deciduous trees accompanied by evergreen elements dominate the natural forest vegetation. In addition to the geographical position, the proximity of the Atlantic Ocean and the low altitudes of the region play a significant role in moderating the climate extremes of the area.

Coastal sediments dated from 7.000 to 4.000 B.P. located in Villaviciosa (Asturias, Spain, U.T.M. 30TUP31), have been studied in order to get a better understanding of the past and present distribution of the forest ecosystems and their adaptations to climate changes. Palynological analyses, identification of fossil wood (more than fifty wood fragments were identified) and the determination of other plant remains buried in the sediments give evidence for the presence of deciduous forests, enriched with evergreen and mediterranean elements, during this period.

From the research of the paleo-flora composition in Villaviciosa, it can be concluded that the north coast of Spain acted as a refuge area for the thermophilous elements, and that these territories played a major role as transitional pathways in altitudinal and latitudinal migration.

Paleovegetation in the Upper Pleistocene of the peat bog of Padul (Granada)

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A palynological study of the lower 25 m. of the borehole from Padul (Granada), situated in the peat bog of the same name at 20 Km to the South of the city of Granada, was done. The analysis covered the late pleistocene (130,000BP) to the base of the last glacial (Weichselian, 70 - 75,000BP).

In this period, changes were detected in the composition of the flora indicated by the fluctuations in the abundance of *Pinus* as well as the transformation from a typical steppe type vegetation (arid and open) at the base of the bore, characterised by the abundance of *Artemisia*, *Ephedra*, *Chenopodiaceae* and *Pinus*, to a different vegetation characteristic of more humid conditions such as Poaceae, Cyperaceae and marked peaks of spores that Florschütz *et al.* (1971) already demonstrated at the base of the last Glacier (Weichselian's area R and S).

FLORSCHÜTZ, F., MENÉNDEZ AMOR, J. & WUMSTRA, T.A. 1971. Palynology of a thick Quaternary sucesión in southern Spain. *Palaeogeog., Palaeoclimatol., Palaeoecol.*, 10:233-264

Holocene palaeoenvironmental changes in the coastal plain of Marathon (Attica, Greece)

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Great interest has been expressed the last decade to identify the Holocene palaeoenvironmental conditions of the Marathon coastal plain -famous from the ancient battle of 490 BC between the Athenians and the Persians- due to its great environmental and archaeological importance.

Palynological, micropalaeontological and micromorphological analysis of samples from 2 boreholes and 4 trenches along a transect in the marshy area of Marathon coastal plain, enabled the tracing of the vegetation development and the main environmental changes for the last 6.000 years. Pollen grains from aquatic and hydrophilous plants, dinoflagellate cysts, algal remains and other palynomorphs were used in order to finger out and represent the various depositional environments of the area as well as their evolution throughout the area.

Palynodata have been correlated with ostracod-foraminifera data and sedimentological-micromorphological data - pointing all of them to a continuous change from palustrine to alluvial depositional environment for the area. Palynological data suggest the environment of open vegetation with *Quercus*, *Pinus*, *Juniperus* and Ericaceae for the area, since potential use of selected palynomorphs as palaeoenvironmental proxies is being discussed.

Late Quaternary vegetation history at Stracciaccappa (Rome, central Italy)

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The Stracciaccappa crater, active between 80 ka and 40 ka, is located in the eastern sector of the Sabatini volcanic district, about 35 km north of Rome. The lake bed, artificially dried out, lies at 220 m a. s. l., 30-40 m below the surrounding landscape. Its shape is circular, its diameter is approx. 1 km. The present day vegetation of the area consists of deciduous forests with *Quercus cerris* L., *Q. frainetto* Ten., *Fraxinus ornus* L., *Carpinus betulus* L., *Acer campestre* L. However, most of the landscape has been almost completely modified by human activity for pasture and crops.

A continuous borehole, drilled in the centre of the lake bed, reached the volcanic basement at around 29 m. The lacustrine sediments contained pollen only in the uppermost 14 m. The pollen record from Stracciaccappa, starting during the last Pleniglacial, does not include any major forest phase before the Holocene. The chronological framework of the record, based on seven conventional or AMS radiocarbon dates and on a

comparison with other long palynological sequences of central Italy, suggests for the bottom of the Stracciaccapa pollen record an age of approx. 60,000 years.

Five radiocarbon dates, all of the last glacial period, ranging from around 36,000 and 19,000 years BP help in defining the age of some minor arboreal spreads interrupting the succession of steppe and grassland formations dominated by *Artemisia*, other Asteroideae, Gramineae and Chenopodiaceae. Stracciaccapa turned out one of the most sensitive sites of the Lazio region to the pleniglacial climatic changes. In fact the pollen sequence shows a number of slight expansions of angiosperm trees, corresponding to the middle pleniglacial interstadials recognized in other long pollen records of Europe. Compared to central and northern Europe, the record of Stracciaccapa shows a significant vegetational complexity and a wealth of minor oscillations, as many other Italian sites (FOLLIERI *et al.* 1998). In these weak expansions the pollen of angiosperm trees has similar floristic and vegetational features and is constituted mainly by deciduous oaks (*Quercus robur* type) and *Corylus*, accompanied in very low percentages by *Betula*, *Alnus*, *Tilia*, *Ulmus*, *Fagus* and *Zelkova*. The pollen diagram records the last presence of *Zelkova* before the radiocarbon date 36,330 ± 1630 years BP, whose extinction was found in central Italy sometime before 30,000 years BP. In these forest expansions *Picea* is always present, and reaches in some cases values of 5-7%, indicating a local presence for this conifer tree, whose diffusion area is nowadays restricted to the Alps and to only few relic stations in northern Apennines.

A preliminary palynological work carried out in 1993 by GIARDINI on the sedimentary record pointed out that the Holocene vegetation history had anomalies; a careful microscopic observation of the sediment led to establish that a reworking of sediments had happened during the industrial coring in well defined Postglacial levels. Several hand-operated piston corers were used in the following years obtaining again unreliable pollen and radiocarbon results, caused by a particular slippery level which provoked a reworking of the sediment during the coring. In the last years an artificial dig was excavated in the centre of the crater and the sampling carried out on the outcrop of the trench, obtaining a new, finally reliable, sediment record.

The pollen diagram shows that the Holocene reforestation is mainly due to *Quercus robur* type accompanied by *Corylus*, *Tilia* and *Betula*, and later by *Q. ilex* and *Q. cerris* type and *Ulmus*. The record ends few centimetres after the AMS radiocarbon date of 7495 ± 80 years BP. The Holocene sediments from Stracciaccapa do not contain therefore the last thousands years of vegetation history.

FOLLIERI, M., GIARDINI, M., MAGRI, D. & SADORI, L. 1998. Palynostratigraphy of the last glacial period in the volcanic region of central Italy. *Quat. International*, 47-48: 3-20.

GIARDINI, M. 1993. Late Pleistocene and Holocene history of vegetation at Stracciaccapa, Monti Sabatini volcanic district (central Italy). Abstracts INQUA SEQS Symposium "Quaternary stratigraphy in volcanic areas". Rome, September 20-22, 1993, p. 34.

The biogeographical role of *Pinus* forests in the central Spanish meseta

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The study of several well-dated holocene pollen sites in the inner of the Spanish northern meseta allows us to understand the landscape changes in an area intensely disturbed by humans during the last thousand years. Traditionally, a potential vegetation dominated by evergreen and semideciduous oaks, mainly *Quercus ilex* subsp. *ballota*, *Quercus faginea* and *Quercus pyrenaica*, has been assumed for this territory. However, the *Pinus* species that nowadays live with them (*Pinus pinaster*, *P. nigra* and *P. pinea*) have been interpreted as having a secondary role in the forest succession. Nevertheless, the derived pollen results call this widely accepted model into question. The continuous dominance of pinewoods in all the studied sites throughout the Holocene provides a very different interpretation. The characteristic Holocene substitution of conifers by broadleaf-species visible in other parts of the Iberian peninsula, never takes place in these sites where a continental climate prevails. Moreover, special substrata such as sands, have favoured the persistence of stable landscapes since the Lateglacial. Merely, the recent intense anthropogenic activity could have broken out the process, so relevant for the classic interpretation of the vegetation of the area, where conifers were outcompeted by a deciduous-species expansion. Local differences have been observed in recent times due to the diverse human land use. Pinewoods persist in those sandy areas of

the Tierra de Pinares Region till today. This fact is mainly due to the soils not being suitable for agriculture whereas in more favourable sites, a major deforestation along the last millennium took place.

Poster session h4

TROPICAL PALEOECOLOGY: SENSITIVE ARCHIVES OF ENVIRONMENTAL CHANGE

The Big Bang! Again and again and again. How wet tropical rainforest copes with repeated volcanic destruction

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The Holocene of West New Britain, Papua New Guinea, is characterised by periodic catastrophic volcanism. The region is mantled in dense wet tropical rainforest, and has been occupied by people since the Pleistocene. The region is an excellent laboratory to examine the resilience of tropical rainforest to major environmental change. This poster will describe the results of pollen analysis of layered peats and tephra deposited in a coastal swamp on the north coast of West New Britain. The analyses provide us with a macro-level landscape account of the periodic destruction and recovery of the coastal forests during seven periods of volcanic activity in the latter part (last 3000 years) of the Holocene. Based on c.4 m sediment sequences, the stratigraphy comprises peat dating from around 2850 - 1850 BP, c.1700 - c.1450 BP, c.1450 - c.1300 BP, c.1300 - c.800 BP, c.700 - c.550 BP, and c.500 BP - recent (two layers of peat).

The pollen analysis allows a fine-scale of resolution, permitting us to examine in detail the recovery ecology of the forest. This allows us, in turn, to identify key indicators of the processes of recovery, which will enhance, for example, further interpretation of phytolith analyses currently being undertaken at other localities in the study area. At present, the pollen analysis lets us recognise different ecological recovery pathways, much as expected by examination of modern analogues (LENTFER & BOYD 2001; THORNTON 1996). Once recovery commences, the forests generally re-established themselves quite rapidly, reaching relative maturity within a century or less.

Of interest here, is the role of ground ferns in the initial recolonisation of the barren tephra land surfaces following several of the volcanic eruptions. Of note, palynologically, we find that the fern spore flora is particularly rich and useful for ecological interpretation. In this floristically-rich tropical rainforest, for example, we find the pollen flora to be relatively depauperate. In particular, many of the upper canopy flowering trees tends to be underrepresented within the pollen spectra, and it is largely the presence of epiphytic ferns that confirms for us the local presence of a forest canopy at times when we may have little pollen evidence for this.

LENTFER, C. & BOYD, B. 2001. *Maunten Paia: Volcanoes, people and environment: The 1994 Rabaul volcanic eruptions*. Southern Cross University Press, Lismore.

THORNTON, I. 1996. *Krakatau: The destruction and reassembly of an island ecosystem*. Harvard University Press, Cambridge, Massachusetts.