

never marginal but, on the contrary, which they were to all times integrated in processes of the human societies development.

Late-quaternary dynamics of western Tierra del Fuego, southern most Chile

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The southernmost part of South America (south of 48S) today supports vegetation types ranging from Magellanic moorland in the west, to forest, and then to steppe grasslands in the east (Moore 1983). This spatial pattern broadly follows a rainfall gradient, with highest values in the west, and lowest values on the east side of the continent. The composition of the modern forest and grasslands is well-studied, and there is also data on the dynamics of both vegetation types since the last glacial period (Markgraf 1989; Markgraf 1993). However, Magellanic moorland is less well-known, and the dynamics of the ecotone between moorland and forest are unknown. There is even uncertainty about the exact location of the peatland-forest ecotone. Pisano V. (1977) suggests that all the islands, even to the southern and western extremes have coastal forest. But Chilean aeronautical maps and aerial photographs show that the forest is restricted to the inner, sheltered parts of the archipelago, and the outer parts are peatland or even unvegetated (pers. obs.). There has been exceptionally little scientific observation in the region, and the writings of early explorers, especially from Britain (Darwin 1839) and Sweden (Skottsberg 1911) are still valuable.

During several fieldtrips we have collected lake sediment cores across the region, and present 2 radiocarbon dated pollen diagrams with results from LOI and MSCL. According to the first core that have been processed it appears that forest is still expanding into the region, possibly in relation to episodes of volcanic activity (Mt Burney) and tephra deposition. The second core to present will be analysed during the spring and presented at the IPC congress July 2004.

Palynological investigations in Ohalo II – a 23,000 years old prehistoric site on the shore of the sea of Galilee, Israel

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The fisher-hunter-gatherers' prehistoric camp of Ohalo II (dated to ca. 19,500 BP; 23,000 cal. BP) is located on the shore of the Sea of Galilee, Israel, on top of Lisan marls (the precursor of the current lake), 212-213 m below msl. The excavated remains include six brush huts, fireplaces, a human burial and various installations and midden deposits.

The Lisan spectra are rich in arboreal pollen (40%), mainly *Quercus* sp. with some *Pistacia* sp. and *Pinus halepensis*, indicating the spread of a humid Mediterranean maquis on the hills surrounding the lake in the time of deposition. Poaceae and Chen/Ams (20% each) dominate the NAP. A drying out of the lake, immediately before occupation, is indicated by a marked drop in AP (to 2.5%) and a rise in Chen/Ams (up to 77%). The latter may also suggest an increased salinity.

Relatively high AP levels (33%) in samples taken outside the huts suggest a relatively humid period during the habitation of the site. High *Quercus* sp. levels and the occurrence of *Pistacia* sp. and *Pinus halepensis* indicate that Mediterranean maquis expanded again on the surrounding hills. The dominance of Chen/Ams (26.5%) within the NAP may be partly due to the salinity of the underlying sediments. Pollen from within the huts is highly concentrated and the spectra are clearly biased towards Chen/Ams (over 90%).

While the surface pollen represents the vegetation and climate of the area when the site was inhabited, the huts' pollen is a result of localized, human activities. This pollen accords well with other archaeobotanical data, mainly with the retrieved charred seeds. Many Chenopodiaceae species are edible, suggesting dietary use. It is also possible that they were used as matting or roofing material.

Optimizing the detection of cereal pollen: evidence from Scotland and the Faroe Islands

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In many parts of the North Atlantic region during prehistoric and historical times, cereal cultivation was always of less importance than pastoral activity. Given that cereal pollen may be the best indicator of human presence and agricultural activity, the detection of Cerealia pollen is clearly paramount; finding cereal-type pollen grains is a prerequisite for their assessment as cereal or other large, but wild, grass grains.

The cereals typically responsible for crop representation in the North Atlantic area – species of *Hordeum* (barley), *Triticum* (wheat) and *Avena* (oat) – are self-pollinating and do not liberate much pollen into the atmosphere. Large cereal pollen grains travel short distances and there is a good chance that they will not be encountered with routine counting sums. In an effort to enhance the probability of detecting cereal pollen, site types and coring locations can be carefully chosen, samples may be sieved and microscope slides, especially from contiguous samples, may be scanned at low magnifications.

Such 'optimization' is illustrated by efforts to detect pre-elm decline cereal-type pollen in sites from Scotland as a prelude to presenting new evidence based on rapid scanning of microscope slides. A site in Shetland had initially produced no cereal-type pollen of Bronze or Iron Age provenance, in spite of reasonable pollen counts (500 total land pollen) and archaeological evidence for local crop processing. Rapid scanning of contiguous samples revealed a rather different picture with fairly regular occurrences of cereal-type grains. A site in Suðuroy, Faroe Islands, had produced no cereal-type pollen prior to the inferred Norse *landnám* level. Rapid scanning showed this the presence of cereal-type pollen several centuries before this date, adding to the queries regarding an earlier settlement in the islands.

Session h3

EVOLUTION OF THE LANDSCAPE AND CLIMATE IN THE MEDITERRANEAN ECOSYSTEM

Biotic responses and climatic changes during the Late Glacial and Early Holocene in Northwestern Italy

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Biotic responses during the Late Glacial and at the transition to the Holocene were influenced by a number of factors such as climatic changes, migrational rates, competition, and by the location of refugia. During the Late Glacial, thermophilous species (*Quercus*, *Corylus*) were found, amongst other species, on the Italian peninsula. At the onset of the Last Termination, it was suggested that these species expanded northwards with

different migrational lags. However, BREWER ET AL. (2002) suggested that the expansion of deciduous oak was correlated with the oscillations in the North Atlantic Polar Front. Because of the presence of a clear pre-Younger Dryas oak expansion, the Lago Piccolo di Avigliana was chosen in order to assess the influence of climatic changes on tree migrations and expansions. A multi-proxy approach was used to obtain reliable independent climate reconstructions.

The chronology is given by ^{14}C dates and by microtephra analysis, whereas vegetation and fire activity are reconstructed by the use of plant macrofossil, pollen, and microcharcoal analyses. Independent climate reconstructions are based on variations in hydrogen isotopes (δD) of palmitic acids, oxygen isotopes ($\delta^{18}\text{O}$) of bulk carbonates, and by chironomid analysis.

The late Allerød *Quercus* expansion, accompanied by *Pinus sylvestris* increase and *Betula* decrease, could show a warming of the climate but no signal could be detected in both isotope records. Thus, the migration lag hypothesis cannot be rejected. During the YD *Artemisia* and Gramineae increase while deciduous oak as well as other deciduous broadleaf trees were reduced, but no signal is recorded in the isotopes. In contrast, abrupt changes in δD values coincide well with a sharp increase in *Quercus* deciduous and an abrupt decrease in *Betula* at the onset of the Holocene. The pronounced decrease of δD at this climatic boundary could indicate a switch to winter precipitation, as the isotope fractionation would be associated with colder (winter) temperatures. In this case, the beginning of a submediterranean precipitation regime could be inferred for the northwestern Italian region. On the other hand, also an over increase in P-E, which can be brought about by increased precipitation alone, without significant changes in evaporation (temperature) may have produced the same isotopic signal.

Charcoal influx during the Late Glacial is low in comparison to the early Holocene. When *Corylus* expanded into the mixed *Quercus* and *Pinus* forests (ca. 8500 BC), forest fires increased and were subsequently reduced after *Alnus* expanded (7700 BC). The comparison with Lago di Origgio (TINNER ET AL., 1999), also located in the southern Alps, supports the hypothesis of a regional signal of higher fire frequency. Such vegetation–fire dynamic may explain the invasion of *Corylus* into the previously established deciduous vegetation. Forest fires may have been enhanced by a dry season, possibly linked to high summer insolation during the Early Holocene.

Overall, it appears from the δD record that vegetation is responding to precipitation (amount and season), whereas temperature effect is minimal. The impact of the Younger Dryas in the region, as inferred from δD , is subdued. Finally, high fire activity appears of crucial importance for the *Corylus* expansion.

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TINNER, W., HUBSCHMID, P., WEHRLI, M., AMMANN, B. & CONEDERA, M. 1999. Long-term forest fire ecology and dynamics in southern Switzerland. *Journal of Ecology* 87: 273–289.

Man/environment interactions in Mediterranean mountainous areas during the Holocene: an integrated research program for the reconstruction of patterns and chronologies of human occupations in the Champsaur valley (Southern French Alps)

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It is now widely accepted that human impact has been the most important factor effecting vegetation change, at least in Europe, during the last 6000 years. With the onset of agriculture and stock breeding, at the so-called Neolithic revolution, the human role changed from a passive component to an active element which directly affects nature. This change had dramatic consequences for the natural environment and landscape development. Arable and pastoral farming, the actual settlements themselves and the consequent changes in the economy significantly altered the natural vegetation and created the cultural landscape with its many different and varying aspects. In the XIXth century, a discussion on the causes of erosion and increase in natural disasters in the southern French Alps led to an aggressive policy of reforestation, while intensive grazing and agricultural activities were considered the main factor of the forest cover deterioration.

In order to better understand anthropogenic/natural processes interactions in these mountainous ecosystems and with the aim of elucidating human action on the vegetation history, an integrated research program based on a multi-proxy approach has recently been undertaken in a homogeneous environmental unit (climate, mountainous topography, socio-economic systems), the Champsaur valley. The investigations initiated in this interdisciplinary project involving palaeoecology, history and archaeology begin to fill the gap in our knowledge of the development of the cultural landscape in the French Alps, and propose to highlight the complexity of the causalities which determine the vegetation cover of the alpine valley. The project aims at studying a small area at high spatial and temporal resolution to investigate the human occupation dynamics and agropastoral rhythms. The goal is to define accurately the variations of the type of land-use since the first Neolithic forest clearances.

Palaeoecological approach (palynology, dendrochronology, plant macro-remains, fossil insects, micro- and macro-charcoal analyses, fungal spores and other microfossils) is developed in an attempt of reconstructing palaeoenvironmental evolution throughout the last ten thousand years, especially by distinguishing human impact from natural trends since prehistoric times. Although previous pollen analyses have been carried out in these regions and have outlined the general vegetation features, none of them was employed in combination with archaeological data to trace the history of habitation and settlement and to elucidate the different forms of agricultural economies in both the prehistoric and historical periods. Cores were collected from several lakes and peat bogs situated in different vegetation structures and at various altitudes in order to provide good examples of different landscape exploitations by mountain populations.

Palaeoenvironmental records are then synthesized and compared with the results of archaeological and historical researches carried out in the area of study, which allow us to better understand the man/environment interactions in different site types and for different periods in the past, from the origin of the alpine massif populating up to the present. Reconstructed rhythms of landscape evolution and exploitation systems are finally related to the Holocene climate variable.

Key Words: Human impact, Mountain ecosystems, Holocene, Palaeoecology, Archaeology, Southern French Alps.

Genesis and evolution of the cultural landscape in Italy as suggested by Central Adriatic pollen diagrams (PALICLAS project)

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The cultural landscape, that is the landscape more or less deeply shaped by human influence, characterises most part of the territory in Italy, today. The genesis of the cultural landscape has roots that possibly anticipate the Holocene due to the previous presence of humans in the land, but clear signs of its onset have not been recognised in pollen diagrams before the early stages of the Holocene so far.

The present paper is a contribution to the Holocene history of the cultural landscape in Italy using three pollen diagrams obtained from Central Adriatic Sea cores, PAL94-8, PAL94-9 and RF93-30, sampled by the CNR-IGM team of Bologna. Pollen investigation was carried out inside the multi-proxy PALICLAS project (1994–1996; co-ordinator Frank Oldfield; Lowe *et al.*, 1996). PAL94-8 core, 500 cm long, was collected at a water depth of 150 m and spans approx. the last 18,000 years and; PAL95-9, 680 cm long, was collected at 104 m depth and spans approx. the last 12,000 years. The third core, RF95-30, 627 cm long, collected at 77 m depth, is an high resolution late Holocene core spanning approx. the last 5500 years. Chronology was established by radiocarbon dates, plus foraminifera and stratigraphic correlations

In these pollen diagrams, the main markers of the development of cultural landscape in the area are the curves of: 1) *Castanea*, *Juglans* and *Olea*, which showed the passage of their parent plants from wild to cultivated; 2) Cerealia types (mainly *Avena/Triticum* group and *Hordeum* group), which testified the starting of cereal cultivation; 3) wild anthropogenic indicators; 4) total woody plants. After the full development of deciduous forest (65-85%, mainly deciduous *Quercus*, prior to 8,500 cal. yrs. BP), a first decrease in the forest curve was contemporaneous to increase in wild anthropogenic indicators and presence of cerealia pollen, between 8,500 and 7,500 cal. yrs BP, and could be linked to neolithic cultures. The pollen evidence as a whole, however, also suggests cooling of climate (decrease of *Quercus*, and increase of *Betula*) after ca. 8,100 cal yrs. BP. After this period, *Olea* and *Castanea* became more continuous. Then, also *Juglans* increased, and clear vegetation changes reflecting human activities were detected from 3,600 cal. yrs BP, the Bronze Age, in RP93-30 (Oldfield *et al.*, 2003). The problem to disentangle human from climate influence is discussed to search for elements helping to understand which was the most important factor in the development of this cultural landscape.

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Vegetation and climate history of the Dead Sea region during the last 10,000 years

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The Dead Sea region is an excellent location for the analysis of climate, vegetation, and settlement history in the Near East. Several plant-geographical territories such as the Mediterranean, the Irano-Turanian steppe and the Sahara-Sindian desert vegetation converge in this region due to the steep precipitation gradient. In addition, the region is part of the so-called Fertile Crescent, where the origins of agriculture and the human impact extend back to about 11,000 years ago. We discuss first results of detailed palynological and paleoclimatological investigations based on lacustrine sediments of the Dead Sea covering the last 10,000 years. Characteristic features of the pollen sequence can be interpreted as reflecting the human impact on the geo-biosphere caused by settlement activities since the Pre-Pottery Neolithic period. Based on botanical-climatological transfer functions, the palynological proxy data of the Dead Sea profile can also be transferred into climate parameters such as summer and winter temperature as well as precipitation. We use a newly developed procedure, the *pdf* method (probability density function), for the quantitative paleoclimate reconstruction. Preliminary results indicate that precipitation is the most important parameter which shows remarkable fluctuations during the last 10,000 years. The relationship between climate and settlement phases is discussed as well.

The role of man in shaping the environment in central Italy during the Holocene

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In the Mediterranean basin, in regions where man has been present since the Palaeolithic age, and whose impact on the environment became stronger and stronger through the millennia, the difficulty exists of singling out the changes induced by human populations on vegetation. As Mediterranean Italy is a sensitive region

from a climatic perspective and as many prehistoric sites are found in the surroundings of Lago di Mezzano, a multi-disciplinary approach in the study of its sediments turned out a precious tool to disentangle human impact from natural trends. New pollen and microcharcoals data throws new light upon the chronological framed record for which many proxies were already published (RAMRATH, 1997, RAMRATH *et al.*, 2000, SADORI *et al.*, 2004).

In central Italy, in Latium, clear signs of extensive human land use are found only since Etruscan and Roman times and drastic and previous forest reduction mostly interpreted as the consequence of abrupt climate change. However the use of fire in forest clearance deserved to be investigated.

At Lago di Mezzano (Latium, 42°37'N, 11°56'E, 452 m a.s.l.), a maar lake located 100 km NW of Rome, the human impact on the environment was strong, effective, and undiscussed, even if not continuous, since the Bronze age. Previous human land use could not be excluded *a priori*, as early people are thought to have modified flora and vegetation in a variety of ways, each of which producing a characteristic vegetation pattern. Each way of land use by the lake left traces in the sediments and some of them were found in the pollen and micro-charcoal record.

The comparison of pollen and charcoals data indicates that they show similar and coherent patterns. Fire events were frequent and of high intensity in periods with decreased arboreal percentage; they were always preceded by sudden drops of arboreal concentration, suggesting that the climate was a triggering factor for fire. Fires characterized the late glacial and the beginning of the Holocene with high climate instability, and phases with strong human impact. Between 9500 and 4000 cal. years BP when annually laminated, organic rich diatom gyttja was deposited, AP percentage and concentration values were very high, with deciduous oaks and beech alternately dominant and charcoals almost absent. In this period only two isolated fires, soon after important changes in the forest composition and/or biomass, around 6500 and 4800 cal. years BP were found. The interfingering of climate and human impact effects on the environment turned out particularly clear during the Bronze age period, from about 4100 to about 2900 cal. years BP. At around 3800 cal. years BP a sudden, strong climate change to drier conditions is found in the pollen record. Moreover, no evidence of major fires matches this dramatic change of vegetation. Therefore, human impact as a triggering factor can be ruled out for this shift. Even if human presence in the area has been detected during the whole Bronze Age period, the human populations caused a strong impact only in two periods centred around 3600 and 3200 cal. years BP when they settled along the lake shore, cultivating cereals and legumes, cutting trees to build piles, heat, cook and produce metals, and around 3400 cal. years BP when they caused an increase in erosion leading to the beginning of the deposition of turbidites in the whole catchment. Fires played an important role in modifying the landscape also during the Roman and the Middle Ages periods, as well as in the last centuries, when a strong human pressure on the environment was pointed out.

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Similarities and dissimilarities, synchronisms and diachronisms in the Holocene vegetation history of the western Mediterranean region

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In some continental and insular sites of the western Mediterranean basin timing and extension of the Holocene vegetation and climate dynamics seem to undergo the same pattern. Striking similarities and synchronisms have been found between Sicily and Balearic islands. Nevertheless, different synchronism scenarios were proposed from other South-European, North-African and Near-Eastern pollen records from the Mediterranean basin.

Lago di Pergusa (SADORI, 2001; SADORI & NARCISI, 2001) is the only natural inland lake of Sicily and for its geographical location it has a good potential sensitivity to the climate changes of the Mediterranean basin.

Likewise, littoral sediments from Minorca, Balearic islands (YLL *et al.*, 1997) have similar peculiarities. Both Sicily and Balearic islands have different bioclimatic influences and have been used to illustrate the main trends of vegetation and climate dynamics.

During the Postglacial, in Sicily, wet conditions occurred for about two millennia since 9000 years BP when the maximum arboreal biomass expansion, with a culmination at the estimated age of 8100 years BP, was recorded. The same phenomenon took place in Balearic Islands where, at ca. 8000 years BP, the climate favoured the formation of a mesophilous vegetation in a landscape which has no present-day analogous. No evidence of the aridity crisis of around 7200-6800 years BP recorded at Lago di Pergusa is found at Minorca. On the contrary, in both Mediterranean insular areas, the middle Holocene marks important changes (at ca. 4400 years BP in Sicily and approximately around 4500-5000 years BP in Balears) when the AP concentrations declined in a few centuries and never significantly recovered. In Sicily, until about 2800 years BP the structure of the vegetation showed some changes, with deciduous oaks decreasing and evergreen elements becoming relatively more important, the main vegetation change being found in the reduced arboreal plant biomass. Then, between about 2800 and 2400 years BP evergreen elements became dominant. In these centuries the maximum expansion of *Olea* was found and interpreted as the clear effect of the human impact on the landscape. In the last two millennia evergreen and deciduous vegetation types showed similar low frequencies. In the Balearic islands, the process was similar with differences in the vegetation composition. The strong change of vegetational landscape is reflected in composition and structure, resulting in a vegetation adapted to Mediterranean conditions. The change in taxa is complex and some sclerophyllous taxa such *Olea* have played an important role in the transformation of the landscape physiognomy from the mid-Holocene until the present day.

Although human activities have removed most of the Mediterranean vegetation in the Balearic islands and Sicily, it seems clear that the anthropic changes have been partially brought about because of an increase in dryness.

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Holocene vegetation of the river Liz valley (Portugal)

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This paper presents the results of palynological study of 2 borings drilled in alluvial deposits in the valley of the river Liz. S4 is situated at Junqueira (Lat: 39° 52' 22" N; Long: 8° 51' 30" W; Altitude 6m; 7km inland). The sequence in S4 is made up of black clay with plant remains (3.00-6.00m) and fine grey sand (6.00-6.55m). Boring S8 is located at Galeota (Lat: 39° 53' 24" N; Long: 8° 54' 12" W; Altitude 6m; 5km inland). It shows a very clayey black peat (0.90-4.95m) intercalated in very clayey sand (0-0.90m) on top and fine greyish sand at the base (4.95-6.25m).

Aspects such as general characteristics of the palinoflora identified and present day vegetation were previously exposed (Diniz, 1995). In this paper will be presented the evolution of the landscape concerning the pollen zones established.

S4: Four zones have been taken into consideration: J1 (3.00 - 1.90 m) regional vegetation is made up of woodland essentially comprised of *Quercus* and *Pinus*; the *Alnus* woodland might be riparian vegetation along with some *Salix* or part of the regional vegetation; Ericaceae are, in part, related to local peat-bog but can also constitute a shrubby substrata of woods along with Cistaceae, Poaceae and other herbaceous taxa. Local vegetation made up of Cyperaceae, *Isoetes*, *Typha* and Polypodiaceae, all with low values; Amaranthaceae-Chenopodiaceae

pollen represents halophytic vegetation. J2 (1.90-1.30m) maintenance of the woodland composed by *Quercus*, *Pinus* and *Corylus*, progressive decline of the riparian vegetation. Graduate reduction in the percentage of arboreal pollen; development of Poaceae, Apiaceae, etc. which may indicate open vegetation. As regards local vegetation a strong increase of Polypodiaceae (*Thelypteris*) was noted; Amaranthaceae-Chenopodiaceae give way to Cyperaceae, *Myriophyllum*, *Nymphaea*, etc moving towards to an environment where marine influences are less evident. *Myrica* increases. J3 (1.30 - 0.70m) woodland composed mainly by *Quercus*; progressive increase of *Alnus* and Ericaceae; decline of Poaceae and Apiaceae, *Artemisia* shows the maximum frequency. Drastic reduction of Polypodiaceae and decrease of Cyperaceae, vestigial presence of *Potamogeton*, *Isoetes*, etc. J4 (0.70 - 0.00m) woodland mainly formed by *Pinus*, followed by *Corylus* and *Quercus*. Riparian vegetation with *Alnus* and *Salix*. Presence of Oleaceae. Decline of Ericaceae. *Plantago*, *Rumex* and other herbs shows modest percentages; expansion of Polypodiaceae and increase of Cyperaceae values. *Myrica* increases. The radiometric dating relative to the top is 1860 ± 60BP and to the bottom is 5890 ± 70BP.

S8: Three zones are under consideration: G1 (4.10 - 5.00 m), fundamentally characterized by high percentages of *Alnus* at the base and posterior slope; *Quercus* as well as *Pinus*, in weak frequencies; good frequencies of Poaceae, *Plantago* and Asteraceae; G2 (3.10 - 4.10 m) a considerable increase in *Quercus* may be observed, drastic falling off in *Alnus*. Cyperaceae is on the increase; slight decline in Poaceae and Asteraceae. These elements are going to be substituted by a series of aquatic plants linked to open water as well as Polypodiaceae; G3 (2.50 - 3.10 m) *Alnus* retains a weak percentage. *Fraxinus* is present as well as *Olea*, Oleaceae and *Q. ilex-coecifera* but in slight frequencies. The previous mentioned herbaceous values (Poaceae, Apiaceae, etc.) have dropped considerably. *Myrica* reached higher values; G4 (1.50 - 2.50 m) increase in *Quercus*, *Pinus* and *Alnus*; reduction in *Fraxinus* and development of *Salix*. The Ericaceae curve remains steady. Radiometric dating at the top is 1370 ± 60BP and 2510 ± 60BP at the bottom.

This vegetation shows more atlantic than mediterranean connection; a change in the rainfall seasonality may be inferred from a variation of the physiognomy of the dominant vegetation from deciduous to evergreen (or viceversa).

This pollen diagrams reveal affinities with others from the SW coast of Portugal (Mateus, 1989).

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Late Pleistocene environmental and vegetational changes on Lesvos Island, Greece

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A 40.2 m composite sequence of two adjacent sediment cores, from Megali Limni on Lesvos Island, Greece, is presented. In total, six tephra layers have been identified. The chronological framework of the sequence is based on tephrochronology and several AMS dates and conventional radiocarbon bulk dates. The sequence covers the intervals broadly equivalent to Marine Isotope Stage [MIS] 3 and part of MIS 2 and 4, making it the first record from any island of the Mediterranean Sea that covers most of the Last Pleistiglacial. The pollen record shows a series of high frequency vegetational changes mainly between *Pinus* (and to a lesser extent *Quercus* and

Juniperus) and non-arboreal taxa. Steppe vegetation is interspersed with periods of forest-steppe suggesting the occurrence of a series of climatic oscillations during the last glacial period. The vegetational and environmental changes observed on Lesvos Island are a response to changes primarily in water availability and to a secondary extent temperature. Precipitation levels oscillated resulting to phases of high lake levels and expansion of arboreal populations, at one end of the spectrum, and low lake levels and contraction of arboreal populations, at the other end. During the former, tree cover was never complete, while during the latter the record suggests that small populations of trees managed to survive in favourable locations on the island. During the Early Pleniglacial Chenopodiaceae and Liguliflorae steppe vegetation dominated the landscape. This interval is the most treeless phase of the record and suggests extremely arid and cold conditions. The transition from MIS 4 to MIS 3 is clearly marked by the rapid expansion of arboreal populations. Steppe intervals during MIS 3 are dominated by *Artemisia* and Chenopodiaceae suggesting less arid and cold conditions than during MIS 4. Mediterranean thermophilous taxa, such as *Olea*, and *Quercus* evergreen are mainly present at the first part of MIS 3. A general trend towards decreased arboreal populations during the second part of the Middle Pleniglacial is observed. During the arboreal expansions no succession is apparent, probably due to the rapidity of the events. Comparisons with other established records, such as from Lago Grande di Monticchio, MD95-2042 from the Portuguese margin and Greenland ice cores, are made, and the possibility that the observed fluctuations are a response to the millennial scale climatic variability of the North Atlantic is suggested.

A cross-comparison of insect and pollen data of the last 13 ka in the French Pyrénées

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An integrated insect-pollen analysis was carried out on the Lateglacial-Holocene sequence of La Restanque (1620 m). The 4 m profile was divided into 77 samples, each of them was subsampled for pollen analysis and cross-checked; 322 insect taxa and 7 orders were identified. Unlike pollen data which indicates a pioneer *Pinus* forest at the onset of the Holocene (10-9 ka), the abundance of cold-adapted insect species suggests that no forest cover was present. Tmax were probably below 10°C. High *Pinus* pollen percentages should be attributed to extra local apert, however some scarce occurrences of *Pinus stomata* suggest that isolated trees were possibly present on the sunny slopes. At the onset of the Holocene, the disappearance of cold-adapted species of Coleoptera is dramatic. This event is synchronous with a sharp peak of *Drusus discolor* that lives today in cold and rapid streams of mountainous regions. In his turn this taxa disappears quickly, suggesting a rapid evolution of the environment induced by the Holocene warming. This warming is followed by a long period (from 9000 to 4700 BP) characterized by regular occurrences of arboreal Coleoptera. The presence of deciduous and coniferous trees in pollen assemblages indicate that the site of La Restanque was possibly situated in an ecotone zone. Surprisingly few forest-dependent ground Coleoptera were identified, this suggests that the forest cover was light. High temperatures are marked by several taxa including the tree dependent ant *Dolichoderus quadripunctatus*. During the Subboreal (4700-2700 BP) the human impact on the forest cover is suggested by a decrease in conifer dependent Coleoptera, the reappearance of open environment Coleoptera and a peak of *Camponotus*, dependent on dead wood. At the same time the *Fagus* forest become established nearby as recorded in the pollen diagramme and also attested by the weevil *Rhynchonotus fagi* exclusively dependent on beech. *Oribitis cyanea* that feeds on *Viola* in the underwood suggests that a true forest environment prevailed then. The Restanque site was obviously located at that time at the limit between a ruined pine forest and an expanding beech forest. At the last recorded stage the arboreal cover is eradicated to the benefit of a heath land with Ericaceae community as proved by the oligophagous weevil *Micrelus ericae*.

Severe droughts and human impacts during the the MWP-LIA interval in a semi-arid Mediterranean environment: the multi-proxy record of Archidona lake (Málaga, S Spain)

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Laguna Grande of Archidona is located in the province of Málaga (Andalucía, S Spain), in the Subbetic ranges (800 m a.s.l.). Climate is characterized by a semi-arid mediterranean regime.

The lake is carbonated, located on a gypsum dominated substratum. Maximum water depth is 13.2 m. The lake is monomictic with a water stratification from March to September. The lake has a negligible catchment area and it is mainly fed by underground springs.

A sediment core 237 cm thick was collected in the deeper zone of the Laguna Grande of Archidona, with the aim to reconstruct the paleoenvironmental changes. Multi-proxy analyses were carried out. Proxies analyzed were: lithology, mineralogical composition, water and Total Carbon content, Total Nitrogen content, ostracod content, microcharcoal particles, pollen and non-pollen microfossils. Our aim was to identify reliable human indicators and to decipher human v. natural signals as a cause of environmental change in semi-arid regions.

Chronological model was built using radiocarbon dates and historical data of land use with a strong correlation with changes in the pollen record.

Lithology and sedimentological proxies show two main changes at 192 cm depth (change from laminated to nodular facies) and at 105 cm depth (change from nodular to massive facies).

The lithological and sedimentological intervals are:

- between 237-192 cm depth: laminated facies composed by dark and light laminae.
- between 192-110 cm depth: nodular facies composed by gypsum. This interval is constituted by nodules showing 0.5-3 cm in diameter.
- between 110-107 cm depth: gypsum level. This sedimentological level is detected in all the sediment cores collected in the Lake Archidona, reflecting the existence of an important water level drop.
- between 107-105 cm depth: level composed by a high concentration of *Carex* seeds. The seeds give a radiocarbon date (AMS) of 1645 AD ($\delta^{13}C = -27.9\text{‰}$).
- between 105-0 cm depth: facies composed by massive gray silt.

Sedimentological data allowed us to identify an episode of low water level at 107 cm depth, dated at 1650 cal AD. This decline in water level could be attributed to a period of severe drought during the LIA. Multi-proxy data allowed us to establish the limnological and biotic response to the dry event and, consequently, to identify climate indicators in the sequence. Land use changes as a human response to dry episode have been also documented.

The development of the Mediterranean landscape of the Southern Levant

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As part of the joint LaTrobe University (Melbourne)/Arizona State University (USA) project to investigate the archaeology and paleoenvironments of the ancient Dead Sea, eight sediment cores were collected from the northwestern surface of the Lisan Peninsula (ca. -404 m below sea level) during winter 2000. Analyses by Accelerator Mass Spectrometer (AMS) of detrital plant fragments, varve counts, $\delta^{13}C$ and $\delta^{18}O$ isotopes, and pollen provide inferences regarding the past environments of the Dead Sea. We compare the paleoenvironmental conditions during three key junctures in the cultural development of the Southern Levant: (1) the Last Glacial

Maximum (LGM) (20-12 thousand years ago) when incipient agriculture began; (2) the Bronze Age urban florescence (3500-1500 BCE); and (3) the late Holocene Roman/Byzantine empires (200-600 CE).

Laminated carbonate and detrital sediments were deposited when lake levels were higher than today. AMS ages reveal that sediments deposited 700-1200 cm below the surface of the modern Lisan Peninsula (in Lisan Core 3) span the period from 20-12 ka. Counts of laminated couplets for Lisan Core 3 demonstrate a 1:1 correspondence between ^{14}C age and varve counts. Carbon and oxygen isotopes from Lisan Core 3 sediments reveal a paleoclimate that was cooler than today; dry before 15 ka, but much wetter thereafter. These latest Pleistocene sediments were deposited in relatively deep water when the Dead Sea was much higher in elevation (-280 mbsl).

Laminated sediments from Dead Sea Core 3 were collected from the nearshore surface of the Lisan Peninsula. Sediments from the surface to 1m depth represent the Roman/Byzantine period in this region. These sediments were deposited when the lake was deeper than it is today and probably represent the wettest interval in the late Holocene. Isotope analyses confirm that the Roman and Byzantine climate was more similar to the present than to the LGM, but represents cooler and wetter conditions than today.

Oak (*Quercus*) woodlands covered the greatest geographic area during the LGM from 20,000 to 12,000 years ago. Olive (*Olea*) pollen percentages increase during the Chalcolithic Period with the beginning of olive cultivation and expansion of orchards during the rise of cities and the development of market economies during the Bronze Age. Increases in cereal (*Cerealia*) pollen show the development of grain agriculture in the area.

Olive pollen percentages are highest during the late Roman and throughout the Byzantine Period, reflecting the expansion of olive orchards and the contraction of oak woodlands. Grape (*Vitis*) pollen percentages also reach their highest levels during this period. Cereal and grass (Poaceae) pollen reflect the expansion of grain agriculture with a subsequent decrease in desert taxa. Plant fragments near the surface of the Lisan Peninsula have been AMS dated to 630 CE, the beginning of the Islamic (Umayyad) Period, suggesting that the water level of the Dead Sea dropped at the end of the classical periods.

Lago dell'Accesa—A key site for the reconstruction of environmental and climatic changes in Tuscany

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Lago dell'Accesa is located 10km to the south of the town of Massa Maritima, in the Grosseto province, 50 km S-E of Siena, (42°59'11" N, 1°33'31" W of Roma, 157 m asl). The pollen study presented here is a part of multidisciplinary investigations funded by the French CNRS program "ECLIPSE". A transect of cores taken from the southern margin of this deep karstic lake shows the presence of a thick layer of sediments dating to the end of the last glaciation. We present here results from core AC3-4, which was taken from a depth of 17.5m. The deposits are composed of clayey silts in the lower part, followed by alternating layers of lake marls and peat, attributed to periods of lake-level lowering. The chronology of the pollen sequence is supported by the identification of a tephra (AV Walter-Simonnet) and by 8 ^{14}C dates. Pollen analysis shows that the Lateglacial is well represented in the core, with an oldest Dryas (down core - 1600 cm) characterised by dominant herbaceous taxa and *Juniperus*, a Lateglacial Interstadial (1600 cm-1385 cm) with an open deciduous oak forest including a large number of mesophilous trees, and an two-part, unforested Younger Dryas (1385 cm - 1220 cm). The transition to the Holocene is abrupt and marked by the expansion of deciduous oaks, *Hedera helix*, *Quercus cerris/suber*-type and several other thermophilous taxa. The deciduous oak forest is generally dominant throughout the Holocene. Fir and beech play an important role between 9000 and 4000 years B.P. uncal. in the "Colli metalliferi" North-East of the lake. A zone of absolute dominance of evergreen oaks (ca 7500-7200 years B.P. uncal.), and two phases with high percentages of this taxon (ca 5500-4000 and 3300-3000 years B.P. uncal.) are correlated with periods of peat accumulation and low lake levels. Indices of human activities appear from ca 7000 years B.P. uncal. These are always faint, which is surprising as an Etruscan village was situated in close proximity to the lake.

Session h4

TROPICAL PALEOECOLOGY: SENSITIVE ARCHIVES OF ENVIRONMENTAL CHANGE

Vegetation, biodiversity, fire, climate and human impact in neotropical ecosystems during the late Quaternary

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In respect to the issue of global change, the question is raised how stable tropical ecosystems are and how far they react on climate change. Important is also to understand how biodiversity changes in view of natural and anthropogenic environmental changes.

Palaeoecological studies in different neotropical ecosystems provide inside on past vegetation dynamics and biodiversity changes, as well as on climate and fire history. Four examples will be given.

A long pollen record from eastern Amazonia, covering several glacial and interglacial periods, document marked changes between Amazon rain forest and savanna vegetation. The Amazon rain forest must have been markedly reduced during glacial periods. There is evidence of lower pollen and spore diversity reflecting lower plant diversity during periods of dry climatic conditions and high diversity during wetter ones.

A pollen record from the SE Brazilian Atlantic lowland shows the replacement of savanna (cerrado) by semi-deciduous forests during the mid Holocene, indicating a change from a dry climate with long annual dry periods and frequent fires to wetter climatic conditions with less fire. There was a marked increase in plant diversity during that time.

Palaeoecological data from the SE Brazilian Atlantic mountain forest and high elevation grassland (campos de altitude) region show that drier climatic conditions and a higher fire frequency during the early Holocene caused an expansion of the high elevation grassland and a reduction of the local biodiversity.

A high resolution pollen and charcoal record from the *Araucaria* forest region in S Brazilian, highland, which spans back to the last-42,000 yr BP, documents that the grasslands (campos) have been markedly replaced only since the late Holocene. Dry climatic conditions during glacial, early and mid Holocene times block the expansion of *Araucaria* forest. The marked increase of fire frequency, probably of anthropogenic origin, caused a decrease of plant diversity during the dry early to mid Holocene period.

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