diffraction methods, conventional petrography of thin sections by petrographic microscope, scanning electron microscopy (SEM with EDAX) and isotopic analyses ($\delta^{13}C$ and $\delta^{18}O$).

This multidisciplinary research has permitted to establish the history of the fluvial-palustrine environment, to identify palaeoenvironmental changes on the aquatic ecosystem from the fossil assemblages as well as from the mineralogical microstructure and composition of the sediments, and to identify palaeoclimatic events and their relationship with the environmental evolution from the vegetation changes.

In the same way, the obtained results in this research show the importance of the multidisciplinary studies in the reconstruction of palaeoenvironments of Quaternary age.

VALDEOLMILLOS, A., DORADO VALIÑO, M., RUIZ ZAPATA, M.B., BARDAJÍ, T., & BUSTAMANTE, I. 2003. Paleoclimatic record of the Last Glacial Cycle at Las Tablas de Daimiel National Park (Southern Iberian Meseta, Spain). In: M.B. RUIZ ZAPATA, M. DORADO VALIÑO, A. VALDEOLMILLOS, M.J. GIL GARCÍA , T. BARDAJÍ, I. DE BUSTAMANTE & I. MARTÍNEZ MENDIZÁBAL (eds.). **Quaternary climatic changes and environmental crises in the Mediterranean Region.**. pp. 221-228. Ministerio de Ciencia y Tecnología-Universidad Alcalá-INQUA. Alcalá de Henares.

Climate variability from Colombian Lake Fuquene: an analysis of period MIS 6-MIS 3 by 25-yr steps and the integration of biotic and abiotic proxies

Berrio, J. C.[1,2]; Groot, M. H. M.[1]; Hooghiemstra, H.[1]; Vandenberghe, J.[3]; Jansen, F.[4]; Sarmineto, G.[2] & Westerhoff, W.[5]

[1] Institute for Biodiversity and Ecosystem Dynamics (IBED), Univ. Amsterdam, Kruislaan 318, 1098 SM Amsterdam (Netherlands).
[2] Inst. Ciencias Naturales (ICN), Univ. Nac. Colombia, A.A. 7495, Bogotá (Colombia).
[3] Inst. Earth Sciences, Free University (VU), De Boelelaan 1085, 1081 HV Amsterdam (Netherlands).
[4] Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Texel (Netherlands).
[5] Netherlands Institute of Applied Geoscience (NITG-TNO), Princentonlaan 6, 3508 TA Utrecht (Netherlands).

We present the initial results of the composite 60-m core from Lake Fuquene, located at 2550 m elevation in the Colombian Andes.

After three decades of palynological research in this area, and being aware of the huge potential of the sediments in this basin, we aim to generate a climate record from 4° latitude for the purpose of examining decadal-to-centennial scale climate variability. We sampled at contiguous 1-cm intervals along the sediment core, producing a resolution that is an order of magnitude higher than that obtained before. Based on ^{14}C dates, stratigraphies obtained in previous studies, and an assumed linear accumulation rate, the age of the core top is c. 27 kyr BP and the bottom sediments extend into MIS 6 (up to c. 140 ka). For the first time in the region vegetation dynamics and inferred climate change will be compared with the evolution of abiotic characteristics in the basin. So in addition to the analyses of biotic proxies (pollen, diatoms, organic matter content), measurements of abiotic indices, such as grain size, stable isotopes, and elements (XRF-Cortex scanner) will be conducted.

Altitudinal vegetation belts have been shifting continuously in the past, and have a sensitive response to climate change. The fossil pollen record indicates a long sequence of stadial-interstadial cycles during the entirety of the period MIS 3 to MIS 6. In an earlier pilot study these c. 2 to 3.5 kyr cycles seemed to approximate the Dansgaard-Oeschger (D/O)-cycles recorded in Greenland ice cores. Initial studies in Colombian long pollen records showed significant D/O-cycles were also present during the last interglacial (MIS 5e) and superimposed on the well known climate shifts of entire MIS 5. The montane forests of the last interglacial were dominated by arboreal taxa including *Hedyosmum, Podocarpus, Weinmannia* and *Quercus*. During cooler stadials and the full glacial period, 'cold' Poaceae-dominated paramo vegetation and 'cool' shrub-dominated subparamo vegetation (*Hypericum*, Asteraceae, Ericaceae) dominated the region. Low lake levels are indicated by a low ratio of shallow water : deep water aquatics (i.e. *Myriophyllum, Ludwigia, Hydrocotyle*, Cyperaceae : *Isoetes*). Element analysis showed increased Fe content in the numerous volcanic ash horizons. Abundance of Al, Si and K may be related to strong weathering. Variations in element abundance (Al, Si, and Ca) may also be suggestive of changes in precipitation. Evidence from clay mineralogy, such as changing smectite : kaolinite ratios also may support climate change.

JANSEN, J.H.F., VAN DER GAAST, S.J. KOSTER, B. & VAARS, A.J. 1998. CORTEX, a shipboard XRF-scanner for element analysis in split sediment cores. **Marine Geology** 151: 143-153.

KONERT, M. & VANDENBERGHE, J. 1997. Comparison of laser grain size analysis with pipette and sieve analysis: a solution for the underestimations of the clay fraction. **Sedimentology** 44: 523-535.
MOMMERSTEEG, H.J.P.M. 1998. Vegetation development and cycli and abrupt climatic change during the Late Quaternary. Palynological evidence from the Eastern Cordillera of Colombia. **Ph.D thesis**, University of Amsterdam.
VAN DER HAMMEN, T. & HOOGHIEMSTRA, H. 2003. Interglacial-glacial Fuquene-3 pollen record from Colombia: an Eemian to Holocene climate record. **Global and Planetary Change** 39: 181-199.

Poster session h6

TAPHONOMY AND ARCHAEOLOGICAL PALYNOLOGY

The Upper Palaeolithic site Bolshaya Akkarzha: palynological records and palaeoenvironmental reconstruction

Medeanic, S.[1] & Sapozhnikov, I.[2]

[1] Institute of Geography, Academy of Sciences of Moldova, Akademiei str., 1, Chisinau, MD 028 Moldova.
[2] Archaeological Institute, National Academy of Sciences of Ukraine, Illichevsk, Odessa dist., Lenin st., 2/18, 68001 Ukraine.

The Late Palaeolithic site Bolishaya Akkarzha is situated in the western steppe zone of Eastern Europe (Northern Black Sea coastal area, Ukraine). The archaeological, lithological, palynological and palaeontological studies were carried out. Stratigraphic subdivision was based on the chronostratigraphic classification of the loess-soil formation of Ukraine (Veklich, 1968). The loess horizon of 0.95 m in thikness included a cultural layer at the depth 0.9-1.0 m between the Holocene black soil (Chernozem) and red subfossil soil. The latter was formed during the Wurmian interstadial (W_2-W_3, df). According to Veklich, the loess is an Early Prichernomorskii subhorizon (W_3, $p\xi_1$) formed during the maximum of the last Pleistocene glaciation. The cultural layer was formed in the middle of the Late Palaeolithic time (16.0-22.5 ka BP).

Traces of four light surface houses with fireplaces and a great number of silicic artifacts were found. The artifacts consist largely of microinventory, which suggests that this site was a seasonal dwelling used by hunters in spring and summer. Also, numerous *Bison priscus* bones were discovered. Analysis of these remains in cultural layer provided a possibility to deduce the annual schedule of domestic activities of population in that region, hunting in particular, which depended on animal migrations and was distinctly seasonal.

Palynological studies were carried out in two lithologically identical sections exposed at distance of some 10 m from each other. A total 40 samples were collected from the loesses and the overlying and underlying horizons. Chemical treatment was executed by Gritchik & Zaklinskaya (1962). Additional ultrasonic treatment of samples was also applied.

The highest concentration of pollen and spores in good conservation was observed in the samples from the Holocene horizon and subfossil soil. Pollen and spores concentration appeared to be lowest in loess horizon included the cultural interval. Such low frequency of pollen and spores in loesses was probably due to the subaerial genesis of loesses, scarcity of vegetation in the harsh glacial climate, and abrupt changes in temperature and humidity, which were highly unfavorable for subfossil pollen and spores, conservation, etc.

The pollen and spores from the underlying horizon of subfossil soil indicate on forest-steppe spreading in the region. In pine-birch forest (predominance of *Betula* and *Pinus*), some temperate species of *Carpinus, Alnus, Ulmus, Tilia, Quercus, Acer, Salix* grew. In steppes both xerophylous(Chenopodiaceae), and mesophylous (Asteraceae, Poaceae, Polygonaceae, Cichoriaceae, and others) species were present. Xerophylous species of *Artemisia* were relatively rare.

Special attention was given to samples from loess horizon and cultural layer in order to reconstruct vegetation and palaeoenvironment that existed during the Wurmian glaciation maximum (18.0-19.0 ka BP), and

estimate the extent of anthropogenic changes in areas surrounding the site of habitation. Periglacial and xerotic steppes were widespread in a setting of arid continental climate. The xerophylous and halophylous species of *Artemisia Asteraceae*, Chenopodiaceae, and Cichoriaceae predominated. The species of mesophylous herbs and Poaceae were more rare. *Ephedra* occurred sporadically. Pine-birch forests were of limited extent. Shrubby boreal species of *Alnus, Betula* sect. *Nanae, Euonymis* cf. *nana,* and *Salix* grew occasionally in small marshy depressions formed in moist perennialy frozen soils. Also, boreal and alpine species, such as *Botrychium boreale, Diphazium, Sphagnum,* and some others were encountered. By analogy with the present-day areal extent of these boreal plants, we may suggest that average temperatures in the study area during habitation time were about -7° C in January, and about + 12°C in July. The pollen of ruderal plants (*Plantago, Polygonum aviculare, Solanum nigrum*), which is usually considered as indicative of prolonged habitation if encountered in abnormally high proportions in spore and pollen assemblages, occurred in this cultural layer in insignificant numbers. The low frequency of pollen of ruderal plants attest to the short-term habitation of this site. This conclusion complies with the opinion of archaeologists that the Bolshaya Akkarzha site was used periodically as a seasonal habitation for bison hunters.

Pollen-and-spores assemblages determinated from the Holocene horizon permit us to choose the three palinozones characterized the Early, Middle and Upper Holocene, reconstruct vegetation and establish the climate variation. The significant impoverishment of pollen and spores taxa in recent sediments was the result of anthropogenic impact in this very inhabitated region.

Preliminary palynological studies at the roman site of Pollenzo (Cuneo, Italy)

Caramiello, R.[1]; Arobba, D.[2]; Fossa, V.[1]; Preacco, M. C.[3] & Micheletto, E.[3]

[1] p. Biol. Veg. University of Turin. 10125 Torino (Italy).
[2] Ist. Int. Studi Liguri. Museo Archeologico del Finale.17024 Finale Ligure (Italy).
[3] Soprintendenza Beni Archeologici del Piemonte.10122 Torino (Italy).

The town of *Pollentia* was founded by the Romans at the end of the second century BC, as part of the gradual occupation of southern Piedmont and may be identified today with the hamlet of Pollenzo (198 m asl) in the municipiality of Bra (Cuneo). *Pollentia*, with *Augusta Bagiennorum* (today Bene Vagienna) and *Alba Pompeia* (today Alba), were important road junctions along the *Via Fulvia*, the main road linking the *Via Postumia* to the alpine passes. Early archaeological excavations conducted at the beginning of the nineteenth century led to the identification of the basic structure of the settlement, with the location of the forum, theatre and amphitheatre, on which in the eigtheenth century a characteristic hamlet of rural houses, know as the "Borgo del Colosseo" was built. The hamlet respected the elliptical shape of the Roman building (GONELLA & RONCHETTA BUSSOLATI 1980). From 2002 works for restoring and enhancing the ancient town have started, conducted by the Ministry for Cultural Heritage and Activities and the Municipality of Bra.

The present study regards the first year of the digs in Piazza Vittorio Emanuele and the area known as "Agenzia" where funeral and burial monuments datable to between the second and fifth centuries AD. On these remains mediaeval (eleventh-twelfth centuries) and late mediaeval anthropic layers have been identified. A short survey in the nearby "Tosco property" has provided evidence of the usage phase of a late antiquity hut dating from the fifth-sixth centuries. From the soil samples taken in various stratigraphic units a palynological study has been started for the reconstruction of the environment and human activities in the south Piedmont area (CARAMIELLO & POTENZA 1998). Extraction has been made using standard methods and enrichment with heavy liquids. The results are summed up both in the graphic percentages of the individual arboreal-shrubby and herbaceous taxa and in cumulative ones regarding various categories: *Querco-Carpinetum*, hydro-hygrophilous plants, Pasture/Meadows, Cereals and Anthropic Indicators (AI). The Absolute Pollen Frequency (APF) values and the Anthropic Frequentation Index (AFI=AI*100/AP) are reported.

In the Roman age, the area is characterised by the presence of *Querco-Carpinetum* (27-20%) with a progressive fall in the Middle Ages (19-8%) and in the modern age (18-7%). The hydro-hygrophilous element remains almost constant at low levels throughout the span of time considered, in agreement with the topographical location of the site. Among the pollens of arboreal species cultivated for food, of particular relevance is that of *Juglans*, which appears already in the deepest layers dating to before the second century AD and preceding the foundations of funeral monuments; those of *Castanea* are a little more recent. The percentages for pasture/meadow species decrease slightly over time and do not seem indicative of a specific use of the territory. As far as cereals are concerned the exclusive presence of *Hordeum* type cereals is found for the Roman age, whilst the cultivation

of *Avena-Triticum* type, found from the late antiquity period, lasts through the Middle Ages down to the present-day; the pollen of *Secale* type is limited to the fifth-sixth centuries AD. The presence of *Cannabis* type is documented without interruption from the Roman age to the eleventh-twelfth centuries; in this late mediaeval period we find the only trace of *Vitis* which does not consent us to hypothesise on when the area took up its vine-growing vocation. The trend of the Anthropic Indicators shows a slight increase from the Roman age to the modern times, except for the survey made in the "Tosco property" which records a sharp increase in Cichorioideae t. *minor* accompanied by Chenopodiaceae and *Plantago* during the fifth and sixth centuries. This situation may reflect the need for cultivating urban spaces in a period characterised by profound socio-economic crises in the territories under the Roman Empire.

In this preliminary study we can highlight, in the sequence investigated, a moderate exploitation of *Querco-Carpinetum*, which is still found in residual form. The percentages of cereals may indicate cultivation in the valley bottom areas; difficult to interpret is the lack, in the Roman period, of pollen of the *Avena-Triticum* type, in contrast with the historical fact. More coherent is the diffusion of *Secale*, present only in the late antiquity period and the cultivation of hemp, which is found as a fibre plant already in the Roman age.

New samples taken in 2003 in various zones of the archaeological site will allow us to integrate and complete the picture given by these preliminary observations.

CARAMIELLO, R. & POTENZA, A. 1998. Ricerche palinologiche in insediamenti tardoromani e altomedievali del Piemonte. In: L. MERCANDO & E. MICHELETTO (eds.) **Archeologia in Piemonte**. Vol. 3, pp.109-120. Allemandi. Torino.

GONELLA, L. & RONCHETTA BUSSOLATI, D. 1980. *Pollentia* romana. Note sull'organizzazione urbanistica e territoriale. In: AA.VV. **Studi di Archeologia dedicati a Pietro Barocelli**. pp. 95-108. Torino.

Pollen data from the Roman period (III-V century AD) in Trento - Northern Italy

Marchesini, M.[1]; Marvelli, S.[1]; Olmi, L.[1]; Torri, P.[1] & Forlani, L.[2]

[1] Archaeoenvironmental Laboratory - Agricultural and Environmental Centre - Via di Mezzo Levante 2233, 40014 Crevalcore (Bologna – Italy) e-mail: palinologia@caa.it.
[2] Department of Evolutionistic Experimental Biology , University of Bologna, Via Irnerio 42, 40126 Bologna (Italy).

In the city of Trento (46° 03' lat. N, 11° 08' long. E; 194 m a.s.l.), located in Trentino Alto Adige - Northeastern Italy, a central site in Piazza Bellesini/Via Rosmini was excavated by the Archaeological Properties Office of the Province in 1994-1996. Based on archeaological data, the chronology of the deposit ranges from the Imperial Roman period (III cent. AD) to the Late Medieval Age (XIV cent. AD) thus recording large part of the history of the city. The deposit was characterised by some ancient water channels. A multidisciplinary research, involving archaeological, stratigraphic, faunal and palynological analyses, was carried out on the site to investigate which palaeoenvironmental context saw the development of the city, and which man-environment relationship took place in the area. Pollen sampling has been jointly planned with archaeologists since the first step of excavation, and a total of 40 samples were collected from a filling-in of a stretch of sewer.

The lower 20 samples referred to the Roman period, III - IV/V cent. AD, and are reported here. Pollen grains were well preserved, and pollen concentration was approx. 9.000 p/g. Floristic list included 133 taxa (mean 52 taxa/sample; 45 woody plants, 88 herbs).

Altogether, a quite open landscape, namely a continuously frequented countryside, characterised pollen spectra. Forest cover was low, mainly constituted by a mixed oak wood (*Quercus* undiff., *Fraxinus ornus, Fraxinus excelsior* type, *Ostrya carpinifolia/Carpinus orientalis, Acer campestre* type, *Tilia, Ulmus*). Hygrophilous vegetation (*Alnus* cf. *glutinosa, Populus, Salix*), from both the channel surrounding the town and the nearby river Adige, was significant.

Two main phases were recognised in the spectra:

a) in the III-IV century AD, the anthropic action was particularly evident, and characterised by an intense agricultural activity. The latter was shown by pollen markers of fields (*Hordeum* gr., *Avena-Triticum* gr., *Triticum* cf. *spelta, Secale cereale*), cultivation of vines (*Vitis vinifera*), hemp (*Cannabis sativa*), possibly vegetables (*Cichorium intybus* type, *Brassica* sp.), and edible fruit trees (*Castanea sativa, Juglans regia, Morus, Malus* and *Prunus*). Meadows and grazing land were testified by Gramineae, Leguminosae (*Trifolium, Lotus,*

Ononis type) and Compositae (Cichorioideae undiff.). Areas devoted to cereal storage or treatment were near channels.

b) from the end of the IV to the beginning of the V century AD, there was a sensible decrease of anthropic activities, even if cultivated plants, including *Vicia faba* and *Malus*, were still present. Forest cover had a significant increase due to the spread of oak wood. The hygrophilous vegetation increased too testifying that damp areas notably widespread.

Preliminary pollen diagram of the Terramara di Montale – profile 1 (Bronze Age - Emilia Romagna, Italy) and the 3D models for museological exhibition

Bosi, G; Accorsi, C. A.; Bandini Mazzanti, M.; Marchesini, M.; Mercuri, A.M. & Trevisan Grandi, G.

Laboratory of Palynology and Palaeobotany, Department of the Museum of Palaeobiology and Botanic Garden, University of Modena and Reggio Emilia – www.palinopaleobot.unimo.it

The Terramara di Montale (44°34' lat. N; 10°55' long. E, 97 m a.s.l.) is one of the most interesting and renowned sites of the Bronze Age in Northern Italy. It has been studied by a multidisciplinary team with the aim of reconstructing the environmental and cultural context in which the terramara developed, inside the project of the creation of a museological park (under the direction of Andrea Cardarelli). Chronology was based on archaeological and radiocarbon data. Archaeobotanical analyses were carried out on pollen, seeds/fruits and wood/charcoal. Two stratigraphic profiles, plus a number of little sequences and single samples inside and around the site, were sampled for pollen.We present here the preliminary pollen diagram of the stratigraphic profile 1, obtained from the first trench opened within the terramara during the 1996 excavation. Its 15 cm bottom precedes the settlement. Altogether, 44 pollen samples were collected from the profile, ca. 375 cm deep, at 5-10 cm intervals. Explorative analyses led to exclude samples intercepting fire episodes and the top disturbed levels. A mean of 450 pollen grains per sample, excluding Cichorioideae over- represented in most samples, were counted. More than 200 pollen types were identified. The pollen diagram showed a vegetal landscape characterised by a forest cover of mesophilous oak wood (mainly *Quercus* and *Carpinus betulus*), and a prevalence of herbs, mainly Gramineae, Compositae and Cyperaceae. Six local pollen zones were recognised depending on climatic and cultural changes. The bottom pollen zone, preceding the onset of the terramara, was mainly visible in the comparative abundance of conifers (*Pinus, Abies, Picea*). Then, the increase and oscillation of broadleaf trees, cereal pollen and Cichorioideae, and the final decreasing trend of forest cover (especially *Quercus*) and cereals showed the history of the influence of the terramara on the environment. Altogether, the diagram was marked by many anthropogenic pollen indicators, i.e. Cerealia pollen (mainly *Avena/Triticum* group and *Hordeum* group, joined by *Panicum* cf. and *Secale cereale*), other cultivated herbs (*Cannabis*, and *Vicia faba*), and woody plants with edible fruits (*Castanea, Juglans, Morus, Prunus, Ribes, Sorbus, Vitis*). The latter woody plants appeared exploited as wild plants, probably cared for, in a trend towards cultivation. The abundant Cichorioideae can be interpreted as an index of breeding practices.

In order to obtain a charming look, attracting and impressing, for the exhibition of pollen data in the museological park, a set of 3D models were prepared following the 3D models of the Palynological Pollen Flora firstly produced by Accorsi *et al.* (1992). Models were made for Cerealia pollen, on the basis of statistical morfobiometrical analyses of pollen grains found in the terramara. Model dimensions (mean P, E, porus + annulus) are at 2000x. The 3D pollen models of the Terramara di Montale, prepared so far, are three: 1) *Hordeum* group; 2) *Avena-Triticum* group; 3) *Triticum* esaploid-type.

ACCORSI C.A., AROBBA D., BANDINI MAZZANTI M., BARBERINI E., DALLAI D., FORLANI L., MARCHESINI M., MERCURI A., TREVISAN GRANDI G., TORRI P., 1992 - *La Flora Palinologica Italiana in edizione "macro"*. Giornale Botanico Italiano, 126: 421.

Advances in the palynology of cave sites: taphonomical and palaeoecological aspects

Carrión, J. S.[1]; Yll, R. [2]; González-Sampériz, P.[3] & Scott, L.[4]

[1] Departamento de Biología Vegetal, Universidad de Murcia, Spain.
[2] Area de Botánica, Universidad Autónoma, Barcelona, Spain.
[3] Instituto Pirenaico de Ecología-CSIC, Campus de Aula Dei, Zaragoza, Spain.
[4] Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa.

Complicated by problems of sedimentary discontinuities, selective preservation and transport, reworking, low chronological resolution, and contamination, research on cave palynology suffers from another draw-back viz., the lack of experimental data capable of demonstrating the effectiveness of cave pollen spectra to reflect the source vegetation. In effect, this branch of palynology is at the stage where open-site palynology was before pollen-vegetation transfer functions were first developed. It is clear that cave palynology still needs more experimentally-based work before we can make reliable inferences in terms of palaeoecology and palaeoclimatology. However, recent advances confirm the potential of cave pollen research. Firstly, from the available data is clear that sediments from caves contain pollen assemblages that reflect the vegetation of local and regional catchment areas reasonably well. Secondly, long pollen sequences have been reported from cave sediments with acceptable palynomorph preservation and concentration, ecological coherence of the pollen assemblages, chronological control, and persuasive correlation with lacustrine sequences. Thirdly, caves are often sites of archaeological excavation and hence the sediments provide palaeoecological data in a multidisciplinary context. Fourthly, caves frequently lie in physiographically different environments from lake and mire sites, and add valuable information, e.g., on montane palaeovegetation and the refugia of thermophilous taxa during glacial periods. Finally, in connection with the latter the presence of pollen bearing coprolites, urine-cemented deposits, and biotically rich cave sediments that complement cave sediments in arid regions has certain advantages in comparison with water-deposited sediments.

Environmental implications of pollen spectra from bat droppings and potential for palaeoenvironmental reconstruction

Carrión, J. S.[1]; Scott, L.[2] & Marais, E.[3]

[1] Departamento de Biología Vegetal, Universidad de Murcia, Spain.
[2] Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa.
[3] National Museum of Namibia, Windhoek, Namibia.

Bat guano has been insufficiently exploited as palynological material for palaeo-landscape reconstruction. This is partly due to a poor experimental background knowledge on bat-guano and pollen-rain relationships. Fossil bat dung deposits are rare and difficult to obtain due to inaccessible cavern localities. Those in more accessible places have often been mined as fertilizer and destroyed. We address one of the primary taphonomic issues, viz., that of the representativity of vegetation in bat guano. We show that pollen analysis of fresh bat guano can reflect local vegetation of the environments surrounding the cavities where bat colonies settle. Likewise, these results bring support to the suggestion that bat guano may be a good tool to obtain information on entomophilous plants otherwise under-represented in peat bogs and lake sediments. Since fossil bat dung appears to be suitable for pollen analysis and palaeoenvironmental reconstruction it should be profitable to find more of these deposits especially in arid lands where palaeobotanical data are scarce. However, data from Arnhem Cave in Namibia seems to suggest that not all fossil dung layers are guaranteed to preserve fossil pollen. It is possible that preservation depends on local post-depositional processes in cave sites, but these secondary taphonomical processes should be investigated further to ascertain to what extent they affect the richness and composition of pollen assemblages.

Pollen records from archaeological sequences at South of Patagonia, Argentina

Mancini, M. V.

Laboratorio de Paleoecología y Palinología, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, Funes 3250, 7600 - Mar del Plata, Argentina.

Climatic conditions and their changes are an important factor for the development of human populations. During the last years, palynological investigations on archaeological and peat bog sequences at south of Patagonia (47-52°S, Argentina) have provided paleoenvironmental information and have permitted the analysis of the relationship between paleoenvironmental changes and the periods of human occupation during the Holocene. Nowadays, coinciding with a rainfall gradient that decreases to the east, forest, grass and shrub steppes and semi-desert are present. Fossil pollen data are shown in pollen percentage and in concentration diagrams. The paleoenvironmental interpretation is based on a comparison between the fossil pollen data and modern pollen data and their relation to the vegetation and the climatic conditions of the study area. The results are compared with archaeological records that indicate local human presence. The paleoenvironmental reconstruction reflects different processes such as climate change and human impact and helps to explain some aspects of the cultural change processes in this region in southern South America.

Modern vegetation became established at the beginning of the Holocene with the expansion of open forests of *Nothofagus* at the west and grass steppe expansion in extra-andean region. Although the cause of low values of *Nothofagus* may be the anthropogenic influence by fires, population densities are low for this interval, and the recently deglaciated substrates may have not permitted the *Nothofagus* expansion.

Between 9000 and 6500 yr B.P. temperature increase facilitated human settlement on the steppe. On the high plateaus, utilizable only in summer, the archaeological evidence of settlement is late. In these areas where the climatic and vegetation variations are related to altitude, evidence of ancient human occupation is given in valleys and ravines. Before ca. 5000 yr B.P. in plateaus and ravines a shrub steppe associated with semi - desert taxa dominated indicating an increase in temperature and precipitation of ca. 200 mm. To the west, between 5000 and 3000 yr BP the ecotone forest-steppe and dense forest at 50° S were present.

From ca. 2000 yr B.P. open forest in Andean area and steppes in the extra-Andean region suggest lower moisture availability. During this period the highest density of archaeological remains is present in the region, including the coast area (Cabo Vírgenes). In this region the pollen analyses realized in the Atlantic coast, south of 52° S, show the development of swamp during the last centuries.

Even though there are records of hunter - gatherers in the area since early Holocene the greatest impact on vegetation corresponds to the last 200 yr with the colonization of the Patagonian region by Europeans. The forest was altered by fire and the displacement of steppe species can be observed. Grazing could be deduced by the presence of Rumex, mainly in grass steppe of the west and southernmost area.

The pile-dwelling site of Palù di Livenza (friulian plain, Northeastern Italy): vegetation history, human impact and land-use changes during the Late Neolithic

Pini, R.

C.N.R. – Istituto per la Dinamica dei Processi Ambientali at Department of Geological Sciences and Geotechnologies, University of Milano – Bicocca (Italy).

The pile-dwelling site of Palù di Livenza offers the opportunity to analyse in detail the history of vegetation and land-use changes during the Late Neolithic in the northeastern sector of Italy, thanks to the abundance and preservation of pollen and macrofossils (PINI submitted). In the 1960s amelioration works through the mire led to the discovery of abundant artefacts of Late Neolithic age (wooden structures, fossil bones, pottery, and lithic artefacts). Extensive archaeobotanical, archaeozoological and anthracological investigations were carried out.

In 1999 a core was drilled and sampled for pollen analyis and ^{14}C dating. 39 samples were analysed: pollen identifications were done to the lowest taxonomic level. The pollen diagram was divided into three pollen zones, reflecting different phases in the history of vegetation and landscape around the mire. ^{14}C dates were linearly interpolated: a mean value of sedimentation rate was calculated, and ages for the base of the studied

section (165 cm depth, 6,585 cal BP) and for the boundary between pollen zones 1 and 2 (118 cm depth, 5,958 cal BP) were estimated. Disturbance starting at 71 cm depth prevents any linear interpolation for the upper part of the section.

Pollen zone 1 reflects the presence of dense broad-leaved forests around the mire of Palù di Livenza between 6,585 – 5,958 cal BP. Trees of *Quercus* deciduous, *Fagus*, *Corylus* and *Alnus glutinosa* type were abundant, together with sporadic *Fraxinus excelsior*, *Tilia*, *Ulmus* and *Betula*. The local presence of well-developed wetlands is indicated by high values of wetland species (mainly Cyperaceae, *Sparganium emersum* and *S. erectum* type). Total pollen % of terrestrial herbs varies between 8 – 27% and is mainly due to Gramineae. Anthropogenic indicators are nearly absent. This phase is interpreted as preceeding the local settlement of the pile-dwelling.

Pollen zone 2 is coeval with the development of the human settlement *in situ*, dated to 5,958 cal BP. Pollen data indicate a reduction of forests (to gain wood for construction and fuel), a sharp contraction of wetlands and the expansion of herbaceous communities with cultivated species (Cerealia, *Linum usitatissimum*), infesting weeds (*Orlaya grandiflora*, *Convolvulus*, *Polygonum persicaria* group, etc.), nitrophilous and ruderal herbs (*Urtica*, Chenopodiaceae, Brassicaceae), plants of pastures and wet meadows. Crop cultivation can be estimated for a radius of several hundred meters around the site. Charcoal concentration rises suddenly, indicating an increasing importance of human activities. Egg cuticles of the parasitic Nematode *Trichuris* and ascospores of Sordariaceae occur frequently and they are mainly related to the droppings of horse, cow and domestic herbivors. The comparison of pollen data with carpological findings allow some considerations about the local/extralocal provenance of *taxa*.

Pollen zone 3 indicates the presence of broad-leaved forests around the site. As part of the original stratigraphy is disturbed above 71 cm, the history of the pile-dwelling after 5,262 cal BP cannot be traced. Pollen zone 3 is considered much younger than the preceeding zone.

Rarefaction analysis was used to estimate changes of palynological richness through time. Low values of $E(T_n)$ (defined as the estimated number of pollen and spore *taxa* standardized to a common count size) are recorded in pollen zone 1 and are interpreted as reflecting the natural density of forests around the mire before the human settlements. $E(T_n)$ greatly increases in pollen zone 2, as an effect of the development of species-rich herbaceous communities.

PINI, R. Vegetation history during the Late Neolithic at the pile-dwelling site of Palù di Livenza (Northeastern Italy). Submitted to: **Journal of Quaternary Science**.

Palynoindication of the modern environmental state and paleoecological reconstructions

Dzyuba, O. F.

All-Russian Petroleum Scientific-Research Geological-Exploration Institute (VNIGRI), Laboratory of Palynology, Russia. E-mail: dof@infos.ru

Nowadays the intensity of harmful agents effect upon the environment and living organisms is extraordinarily great. Under the unfavorable life conditions plants produce a lot of teratomorphical (ugly) and sterile pollen grains, because the processes of pollen forming are very sensible to the exposure of external factors of different genesis. Under worse ecological conditions pathologically developed pollen grains increase in number and vice versa. Investigation of pollen grain morphology allows not only to reveal the existence of gametopathological compounds, but also to compare polluting effect of such compounds in different regions and in different zones of one region without using of traditional technique of direct registration of mutations and without expensive and sometimes difficult of access equipment.

At present the problems, connected with an indication of global ecological processes in historical past of the Earth are broadly discussed. Palynology is one of the scientific disciplines, which is able to approach to the solution of such problems. But before starting to determinate environmental state in the historical past of our planet using spores and pollen investigation it is necessary to research carefully the present processes and the ones which took place in recent geological past.

Investigation of spores and pollen morphology and revealing of teratomorphical (ugly) pollen is one of the main problems. Great amount of teratomorphical pollen in sediments may serve as an indicator of complex paleoecological processes.

For instance, during Kamchatka Miocene sediments investigation it was revealed that despite the low content of microfossils in palynospectra, teratomorphical pollen exists in some of them. It was found mainly on the boundaries of paleoenvironmental periods. Besides this, a lot of teratomorphical pollen grains was found in the middle of one of the suites /N31er/ in 4 samples, taken in series from depth interval 1087-1094 m. It seems, that this fact make doubts about usefulness of palynomorphological investigations in solution of complex problems, connected with definition of event-related related levels and, moreover, with specification of their limits. But in reality it was revealed, that results of pollen grains morphological peculiarities investigation confirmed the records of geophysical investigations. It was that time (depth interval 1087-1094 m), when some complex processes proceeded in the region. May be, they were connected with volcanoes activation, which reflected on the dwelling plants reproductive system. Well-logging record showed increased content of lignite bands in sediments from this depth interval. As a whole, obtained results confirm that palynomorphology and palynoindication of environment quality can and must be among the most promising ways of research of global ecological processes, which took place on our planet in remote past. It is only impotent to choose correct species – indicators, which must be broadly represented along the open-cut. Their polymorphism level is also ought to be rather low. In addition it is very impotent to distinguish true teratomorphical forms from those disturbed during fossilization process.

Alnus sp. (Kamchatka Miocene, bore hole №1, interval 1087-1094 m.) ×1000, LM.

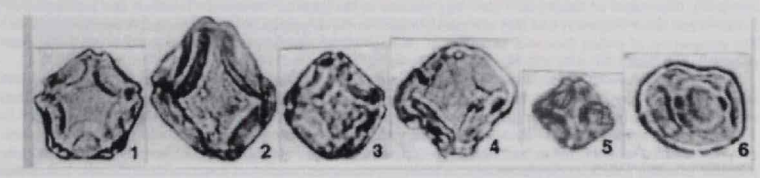

Fig.1. Normally developed pollen grain. Fig.2-6. Teratomorphical pollen grains. Fig.1-5. Polar view. Fig.6.Equatorial view.

Distribution of pollen in surface sediments of two Alaskan lakes

Cwynar, L. C.

Department of Biology, University of New Brunswick, Fredericton New Brunswick (Canada) E3B 6E1.

The distribution of pollen in lake sediments remains relatively unstudied. I have collected 40 random samples of surface sediment (0 – 1 cm) from each of Jan and Windmill Lakes, both of which are in boreal forest. For each sampling point the lake depth and distance to nearest shoreline were measured. The analysis of Jan is complete and that of Windmill is in progress.

At Jan Lake *Betula*, *Alnus crispa*, and *Picea* comprise >80% of the pollen assemblages in decreasing order of representation. *Alnus* abundance is unrelated (p=0.05) to either depth or distance to shore. Both *Betula* and *Picea* show significant relationships to depth and distance to shore with *Picea* declining and *Betula* increasing with increasing depth and distance to shore; for both taxa the relationship is somewhat stronger with depth than distance to shore. *Salix* shows significant negative correlations with both variables. Of the common herbs, Cyperaceae declines significantly in an hyperbolic manner in relation to increases in both depth and distance to shore,whereas Poaceae declines significantly in a linear fashion. The only common aquatic, *Potamogeton natans*-type, also correlates negatively with the two variables.

The proportion of pitted and thinned *Betula* grains was calculated for each sample as an index of corrosion. Corroded *Betula* grains decline significantly in a non-linear fashion with both depth and distance to shore.

Changes in the abundance of the alga *Pediastrum* have been used as indications of changing water depths with higher abundances found in shallower lakes. *Pediastrum* percentages show significant, non-linear declines with both depth and distance to shore.

Contour maps of the distribution of individual pollen types indicate that some types, such as *Picea*, that show significant relationships to depth are nevertheless more abundant at one end of the lake, probably as a result of transport by currents driven by the prevailing wind.

The palynological analysis as a tool for the archaeological correlation of two profiles from Portalón of Cueva Mayor site (Sierra de Atapuerca, Burgos, Spain)

Ruiz Zapata, M. B.[1]; Ortega Martínez, A. I.[2]; Dorado Valiño, M.[1]; Valdeolmillos Rodríguez, A.[1]; Pérez-González, A.[3]; Carretero Díaz, J. M.[2]; Martínez Mendizábal, I.[1]; Gil García, M. J.[1] & Arsuaga Ferreras, J. L.[4]

[1] Departamento de Geología, Edificio de Ciencias, Universidad de Alcalá, 28871, Alcalá de Henares, Madrid, Spain.
[2] Área de Paleontología, Departamento de CC. Históricas y Geografía, Facultad de Humanidades y CC. de la Educación, Edificio de I+D+i, Universidad de Burgos, Plaza Misael Bañuelos s/n, 09001, Burgos, Spain.
[3] Departmento de Geodinámica, Facultad de CC. Geológicas, Universidad Complutense de Madrid, Ciudad Universitaria s/n, 28040, Madrid, Spain.
[4] Centro (UCM-ISCIII) de Evolución y Comportamiento Humanos, Instituto de Salud Carlos III, C/ Sinesio Delgado, 6, Pabellón 14, 28029, Madrid, Spain.

We present the palynological data corresponding to two profiles from Portalón of Cueva Mayor site (Sierra de Atapuerca, Burgos, Spain). The South Profile pollen sequence allowed to reconstruct the vegetation composition as well as its relation with the climate and the human habitation of this site from *ca.* 4000 to *ca.* 2000 yr. BP (Ruiz Zapata *et al.*, 2003). During excavation in 2002, the North Profile presented an archeological stratigraphy problem: the 6 archaeological levels perfectly differentiated at the South Profile were not clearly defined at the North Profile due to the existence of a great rock block (between 190 and 250 cm depth), that fell from the cave ceiling altering the sedimentation process. The North Profile was then sampled in order to try to solve this problem by means of the correlation, not visually apparent, with the South Profile using palynological analyses.

The obtained results show two pollen zones that are easily distinguished in both pollen sequences. The Pollen Zone I, at the base of the sequences, records an open landscape with *Pinus*, *Corylus*, *Juglans* and *Betula* which reflects humid and temperated climatic conditions. Before 3330 ± 70 yr. BP a mediterranean climate can be inferred by the presence of *Olea* and evergreen *Quercus*, with drier and warmer climatic conditions, leading to the expansion of the shrub vegetation (Pollen Zone II). The human activity is clearly detected in both pollen sequences and the evidences of anthropogenic deforestation are shown by the presence of microcharcoal particles.

The archaeological correlation between the two profiles has been based on the pollen changes recorded in both pollen sequences. This correlation evidences the different sensibility for the record of the vegetation changes. The North Profile pollen sequence shows less defined changes due to the greater distance from the cave entrance. Even so, the stratigraphically undistinguishable archaeological levels 3 and 4 have been differentiated in this North Profile, the lack of a great part of level 4 has been confirmed, and levels 5 and 6, which were altered by the fallen block, have been identified.

RUIZ ZAPATA, M.B., ORTEGA MARTÍNEZ, A.I., DORADO VALIÑO, M., VALDEOLMILLOS RODRÍGUEZ, A., GIL GARCÍA, M.J., ARSUAGA FERRERAS, J.L., CARRETERO DÍAZ, J.M., MARTÍNEZ MENDIZÁBAL, I. & PÉREZ-GONZÁLEZ, A. 2003. Vegetational history during Bronze and Iron ages in Portalón Cave (Sierra de Atapuerca, Burgos, Spain). In: M.B. RUIZ ZAPATA, M. DORADO VALIÑO, A. VALDEOLMILLOS, M.J. GIL GARCÍA , T. BARDAJÍ, I. DE BUSTAMANTE & I. MARTÍNEZ MENDIZÁBAL (eds.). **Quaternary climatic changes and environmental crises in the Mediterranean Region.** pp. 99-106. Ministerio de Ciencia y Tecnología-Universidad Alcalá-INQUA. Alcalá de Henares.

Pollinic flora of Nuku Hiva (Marquesas Islands, French Polynesia): Indigenous and introduced plants since the oldest Polynesian settlements

Gourdon, W.[1] &. Sémah, A. M [2]

[1] Department of Prehistory, Institute of Human Palaeontology (National Museum of Natural History, Paris (France) - wgourdon@yahoo.fr
[2] Research Institute for the Development, UR055, Bondy (France) and Departement of Prehistory of National Museum of Natural History, Paris (France) – semah@bondy.ird.fr .

The Marquesas Islands (French Polynesia) are the most isolated archipelago in the world but would be an important centre of dispersion for the first Polynesians, around 150 years before J.C (R.C. Suggs; 1961). That's why one pluridisciplinary study of these volcanic islands has a great interest because it allows to characterize the habitat areas, like the "pae pae" for example (P. Ottino; 1990), but brings too complementary information on the palynology and palaeobotany.

So, to understand the evolution of the marquisian vegetation, it's essential to establish a pollinic atlas of this flora, through the analysis of the different pollinic species, by separating the indigenous plants, which were transported by water, animals or wind, of the introduced plants which were brought with the first Polynesian populations and after them, by the European "re-discoverers". We will also evocate the endemism process, which concerns particularly this archipelago because more than 50 percent of the plants' species are endemic, with especially *Pelagodoxa henryana*.

If we take for example Nuku Hiva Island (most extended island of the Marquesas), it's possible to determine a zonal distribution of vegetation through the climate, precipitations and altitude variations. The actual observations show us an important variability in the vegetal associations, which are related to the different parameters.

At last, we have studied the pollinic content of an archaeological section whom three layers have already been dated. In this case, the pollinic analysis can be a way to follow an evolution of the vegetation. These sediments' studies allow us to show up the appearance or the disappearance, in the stratigraphy, of plants with unknown origin.

Finally, these pollinic data could be compared with the ethnologic behaviours to bring the evidence, for example, of a particular tradition which couldn't be revealed by another way. But we mustn't forget the pluridisciplinary aspect of archaeological studies; each domain must be bound with the other ones for a better approach of a site.

OTTINO,P.R. 1985b. Archéologie des îles Marquises, contribution à la connaissance de l'île De *Ua Pou*. Thèse de troisième cycle, Université de Paris 1, Panthéon-Sorbonne. Institut d'ethnologie, Paris 1989.

SUGGS, R.C. 1961. The archaeology of *Nuku Hiva* , Marquesas Islands, French Polynesia, American Museum Natural History, Anthropological Papers, N° 49, New York.

Italian palaeoenvironments and palaeoclimates from Lower to Upper Palaeolithic.

Renault-Miskovsky, J.; Karatsori, E.; Lebreton, V. & Kaniewski, D.

Muséum National d'Histoire Naturelle, Département de Préhistoire, UMR CNRS, Unité de Palynologie, Institut de Paléontologie Humaine, 1 rue René Panhard F-75013 Paris.
Tel: (00 33) 1 55 43 27 34, Fax: (00 33) 1 43 31 22 79, e-mail: jrm@mnhn.fr

Palynological analyses of five Italian Palaeolithic sites (Ca'Belvedere di Monte Poggiolo, La Pineta, Arma delle Manie, Santa Lucia Superiore and Abri Mochi) gave several new palaeoenvironmental and palaeoclimatic data.

Pollen analyses of the Lower Palaeolithic sites of Ca'Belvedere di Monte Poggiolo (Emilia-Romagna) and La Pineta (Isernia, Molise) document the environmental and climatic conditions at the time of the earliest human occupations in Italy (Lebreton, 2001). The marine pollen record from Monte Poggiolo illustrates the vegetation evolution during a short time covering two interglacial periods with temperate and humid climate, separated by a glacial period with cool and dry conditions. In La Pineta (lacustrine basin of Isernia-Venafro), the lower profile refers to a steppic open landscape correlated to a glacial episode with marked dryness under cool temperatures, synchronous with the minimal extension of the lake. The upper sequence attests to the progressive filling of the lake during an interglacial period with new favourable moisture conditions.

This poster also presents a discontinued local vegetation history of western Liguria, northwest Italy, based on pollen analysis of three archaeological sites, Arma delle Manie (Karatsori, 2003), Santa Lucia superiore (Kaniewski, 2002) and Abri Mochi (Renault-Miskovsky, 1972), which extended from the Middle Palaeolithic to the Holocene. The main interest of this area is that the Mediterranean region has been free from continental ice sheets that covered northern Europe, which allowed the settlement of *Homo neanderthalensis* and *Homo sapiens sapiens* populations in this karstic area.

Pollen analysis of Arma delle Manie (Finale Liguria) revealed nine vegetation phases that occurred between the Middle Palaeolithic and the Holocene. The largest part of the sequence can be attributed to interstadial or interglacial episodes with several extensions of mesophilous and Mediterranean trees. Only one stadial episode with cold and dry climatic conditions was evident. The major part of the profile indicated a temperate climate.

Santa Lucia superiore (Toirano) pollen profile only shows two weak AP extensions during a steppe-landscape episode. The dry and cold phases were broken by an increase of moisture and by higher temperatures, which allowed the expansion of Mediterranean trees and shrubs during the Lower Pleniglacial.

Included in the Upper Palaeolithic layers, the pollen record from Abri Mochi documents an AP expansion episode, which was correlated with the Arcy interstadial. In fact, the typical Aurignacian level is characterized by an enlargement of mesophilous and Mediterranean trees due to an increase of temperatures.

KANIEWSKI, D., 2002. Reconstitution des paysages et des climats contemporains des *Homo neanderthalensis* d'après l'analyse pollinique de deux sites moustériens ligures : la grotte de Madonna dell'Arma (San Remo) et la grotte de Santa Lucia superiore (Toirano). Ph.D. thesis, Muséum National d'Histoire Naturelle, Paris, France, 355p.

KARATSORI, E., 2003. Environnement Végétal de l'Homme Fossile et Climats en Ligurie pendant le Dernier Cycle Climatique et le Postglaciaire. British Archaeological Reports (BAR) S1159, 250p.

LEBRETON, V., 2001. Paysages et climats contemporains des premiers Hominidés en Italie. Analyse pollinique des sites du Pléistocène inférieur et moyen de Ca'Belvedere di Monte Poggiolo (Forlì, Emilie-Romagne) et de la Pineta (Isernia, Molise). Ph.D. thesis, Muséum National d'Histoire Naturelle, Paris, France, 261p.

RENAULT-MISKOVSKY, J., 1972. Contribution à la paléoclimatologie du midi méditerranéen pendant la dernière glaciation et le post-glaciaire d'après l'étude palynologique de remplissage de grottes et abris-sous-roche. *Bull. Musée d'Anthropologie préhistorique de Monaco* 18, 145-210.

A new Palynological application: Pollen analysis from terrigenous deposited inside of weathercock of "Real Basílica de San Isidoro" (León, Spain)

Fombella Blanco, M. A. & García-Rovés Fernández, E.

Department of Vegetal Biology, León University, 24071 - León (Spain).

In order to provide new information about the work of art, a palynological analysis from sediment deposited inside of it, have been carried out. The weathercock was situated at the top of the tower of the "Real Basílica de San Isidoro". This construction constitutes a most interesting example of early Romanesque art in Spain, though the present-day the Basilica is a mixture of buildings belonging to several different time periods. The tower dates from twelfth century but the age and the origin of the weathercock are unknown. This spectacular work of art of 2m high, is made from copper with lead and covered over with gold.

The weathercock was taken down to clean it, when the tower was restored. There wasn't any information about it, how and when arrived to León. Artistic, historical, palaeographical, metallic, entomological and palynological studies have been carried out. About pollen analysis the first question was if the terrigenous deposited inside of the tail of the cock would have got pollen and if this pollen would belong to a León vegetation. The other question was if the weathercock was made in León.

The data of this palynological analysis were a very important tool to know the geographical origin of t weathercock. Pollen types of Mediterranean biogeographical distribution were identified: *Arbutus unedo, Olea europaea, Halimium halimifolium, Cistus psilosepalus, Castanea sativa, Juglans regia, Pinus halepensis, Cedrus deodara, Pisum* and *Picea*. The pollen types *Ranunculus Illyricus, Ranunculus velutinus*, Palmae and Podocarpaceae, were also identified. The pollen assemblage suggests the hypothesis that the origin of samples could be Asian, therefore also the work of art. On account of these data a replica was made to put it on the top of the tower and the original weathercock is now in the Museum of the "Real Basilica de San Isidoro".

Key words: pollen analysis, geographical origin, San Isidoro weathercock, Leon, NW Spain

Late Holocene paleoenvironmental history of two estuaries in Dhofar (Sultanate of Oman)

Hoorn, C.[1] & Cremaschi, M.[2]

[1] Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Kruislaan 318, 1098 SM Amsterdam, The Netherlands, e-mail: carina.hoorn@milne.cc
[2] Dipartimento di Scienze della Terra, via Mangiagalli 34, 20133 Milan, Italy, e-mail: mauro.cremaschi@libero.it

The coastal wetlands in Dhofar (Sultanate of Oman) provide a record of Late Holocene paleoenvironmental history. The age of the surface sediments at some selected sites in the estuaries, locally known as *khawrs* and *qurms*, ranges from 750-390 calendar years (cal y) BC to Present. Geomorphological data suggest that prior to 270-420 cal y BC these estuaries were open to the sea and received a high input of fresh water from the mountains. At least from 270-420 cal y BC onwards, the physiography of the estuaries changed as a consequence of dwindling fresh water input from the mountains. As a result, the open estuaries changed into barrier dominated estuaries with periodical input of saline and fresh water. Palynological data indicate that the estuaries are mainly filled with (i) pollen and spores from the surrounding vegetation; (ii) a regional input of pollen and spores through surface and subsurface runoff from mountains, coastal plain and, *wadis*; (iii) pollen and spores from East Africa and the Indian subcontinent brought in by the monsoon. Between 750-390 cal y BC and 270-420 cal y BC the local input of *khawr* taxa prevailed whereas from 270-420 cal y BC to Present coastal plain and *wadi* taxa prevail. Both geomorphological and palynological data suggest the ancient centers of trade such as Samhuram at Khawr Rawri (ca. 100 BC to 400 AD) and Zafar at Khawr Al Balid (12th to 15th centuries AD) were affected by important hydrological changes related to desertification of the region as a consequence of a weakening SW (summer) monsoon.

Vegetational changes and human presence in the low and subalpine zone in Val Febbraro, upper Spluga Valley (Central Alps), northern Italy, from the Neolithic to 1 AD

Moe, D.[1]; Engan, A. (Maude)[2]; Fedele, F. C.[3] & Kvamme, M.[4]

[1] Museum of Botany, DNS, University of Bergen, Allégaten 41, N-5007 Bergen, Norway.
[2] Gamle Vegsundveg 30, N-6012 Ålesund, Norway.
[3] Section and Museum of Anthropology, University of Naples, Via Mezzocannone 8, I-80134 Napoli, Italy.
[4] Lyngheisenteret, Hordaland fylkeskommune, Agnes Mowinckelsgate 5, N-5020 Bergen, Norway.

An interdisciplinary palaeoecological study in Val Febbraro, the upper Spluga Valley (I), between 1830m and 2304m asl, suggests temporary presence of early Neolithic man at around 6,000 BP. Local forest clearance and charcoal dust are found. Stages of forest and treeline disturbances, and increased human presence are seen from around 5,500 BP, 5,100 BP, and 4,000 BP. A marked increase of disturbances, mainly pasturing, is dated to the beginning of the Bronze Age. The last major stage of human made impact on the vegetation corresponds with the beginning of Iron Age, with a small temporary reduction seen during the Roman Period. Local archaeological sites, finds and 14C dates coincide with the vegetational and noticeable phases.

Poster session h7

NON-POLLEN PALYNOMORPHS FROM FRESH-WATER SEDIMENTS, PEAT DEPOSITS AND ARCHAEOLOGICAL SITES

Alpine extrafossils in palynological preparations from Austria – A contribution to the new Innsbruck-Extrafossil-Database ttp://botany.uibk.ac.at/downloads/extrafossils.pdf

Wild, V.[1]; Walde, C.[1] & Haas, J. N.[1]

[1] Department of Botany, University of Innsbruck, Austria.

Extrafossils or non-pollen palynomorphs are often completely overlooked in palynological studies. Here we present some detailed microscopical studies on all kind of reproductive and vegetative remains of algae and fungi, as well as on zoological remains (e.g. arthropoda, turbellaria), which show that extrafossils may be as abundant as pollen in Quaternary studies.

Palynological analyses performed on peat stratigraphies from the Ziller Valley in Tyrol, Austria (Schwarzensteinmoor and Schwarzensteinalpe within the interdisciplinary research project 'HOLA – Evidence and Analysis of Holocene Avalanche Events', http://fbva.forvie.ac.at/800/hola.html) allow to assess the importance of extrafossils for the interpretation of high Alpine long-term environmental change.

Extrafossils such as *Botryococcus*, *Chloromonas*, *Chlamydomonas*, *Ustulina deusta*, *Gaeumannomyces* or Mycorrhiza spores (e.g. *Glomus*) indirectly add to the reconstruction of soil conditions, hydrological change, timberline fluctuations and of Alpine forest density, whereas spores of coprophilous fungi (eg. *Podospora*, *Sporormiella*, *Cercophora* and Sordariaceae) may account for the 6500 year old history of human and grazing impact in Austria.

Digital photographs of all determined and undetermined extrafossils allow now to set up a new Internet-Database in order to firm as a forum for palynologists working on extrafossils in mountainous regions worldwide, and to allow determination and discussion in this field of rising interest to environmental scientists, archaeologists, geographers and geologists.

The abundance of snow algae (Chloromonas and Chlamydomonas) in Holocene bog sediments linked to shifts in Alpine Timberline and snow-avalanche frequency in Tyrol, Austria

Walde, C.[1]; Wild, V.[1]; Remias, D.[1]; Lütz, C.[1]; Luzian, R.[2] & Haas, J. N.[1]

[1] Department of Botany, University of Innsbruck, Austria.
[2] Department of Avalanche and Torrent Research, Austrian Federal Office and Research Centre for Forests, Innsbruck, Austria.

The Quaternary history of snow algae is completely unknown today. Blooms of the Chlorophyceaen unicellular algae *Chlamydomonas nivalis* and *Chloromonas nivalis* frequently cause „Red Snow" in artic and alpine snowfields at summertime due to the massive accumulation of secondary carotenoids. Many of these snow algae survive a snowmelt and other unfavourable conditions by building cyst-like resting stages. These cysts have a well developed, long-lasting cell wall with species-specific ornamentation and can be recognized in palynological studies.

Here we present the first comparative study on *Chlamydomonas* and *Chloromonas* cysts found in Holocene sediments from two bogs in the Austrian Alps (Schwarzensteinmoor & Schwarzensteinalpe in Zillertal, see also our project homepage HOLA – Evidence and Analysis of Holocene Avalanche Events',