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

Drescher-Schneider, R.[1]; de Beaulieu, J. L.[2] & Magny, M.[3]

[1] Institut für Botanik der Karl-Franzens-Universität (Austria).
[2] Institut Méditerranéen d'Ecologie et de Paléoécologie, UMR CNRS 6116, Aix-Marseille III University, France.
[3] Laboratoire de Chronoécologie, UMR-CNRS 6565, UFR des Sciences et Techniques, Besançon, France.

Lago dell'Accesa is located 10km to the south of the town of Massa Maritima, in the Grosseto province, 50 km S-E of Sienna, (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

Behling, H.

Geosciences, University of Bremen, P.O. Box 330440, 28334 Bremen, Germany.
E-mail: Hermann.Behling@unibremen.de

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.

BEHLING, H., 1995. A high resolution Holocene pollen record from Lago do Pires, SE Brazil: Vegetation, climate and fire history. Journal of Paleolimnology, 14: 253-268.

BEHLING, H., 2002. South and Southeast Brazilian grasslands during Late Quaternary times: a synthesis. Palaeogeography, Palaeoclimatology, Palaeoecology 177, 19-27.

BEHLING, H., 2002. Carbon storage increases by major forest ecosystems in tropical South America since the Last Glacial Maximum and the early Holocene. Global and Planetary Change 33, 107-116.

BEHLING, H. and HOOGHIEMSTRA, H., 2001. Neotropical savanna environments in space and time: Late Quaternary interhemispheric comparisons. In: Markgraf, V. (ed.), Interhemispheric Climate Linkages, Academic Press, pp. 307-323.

BEHLING, H. Pillar, V., ORLÓCI, L., BAUERMANN, S.G., 2004. Late Quaternary *Araucaria* forest, grassland (Campos), fire and climate dynamics, studied by high resolution pollen, charcoal and multivariate analysis of the Cambará do Sul core in southern Brazil. Palaeogeography, Palaeoclimatology, Palaeoecology, in press.

ORLÓCI, L., PILLAR, V.D., BEHLING, H. and ANAND, M. 2002. Some interesting characteristics of the vegetation process. Community Ecology, 3(2), 125-146.

Mangroves as environmental indicators in paleoecological reconstructions

González, C.[1]; Urrego, L. E.[1]; Polanía, J.[2] & Urán, G.

[1]Departamento de Ciencias Forestales, Universidad Nacional de Colombia, sede Medellín A.A. 568 Medellín-Colombia.
[2]Universidad Nacional de Colombia, sede San Andrés.

Mangroves are well known for their ecological importance and their strong link to the socio-economical development of tropical and subtropical coasts. In addition, mangroves also result very useful in the monitoring of multiple dimensions of environmental changes of the terrestrial system. Mangroves occupy the transitional zone between earth and ocean, and in such ecotones complex interactions take place among vegetation and climatic, geomorphologic, fluvial and oceanographic factors. This is the reason why these ecosystems are particularly indicative of environmental changes and thus very useful to make ecological interpretations of changes in the present, and therefore in the past.

Mangroves are relatively simple ecosystems in terms of their composition of plant species, and each species has its own, well-defined, set of ecological and environmental tolerances and responses to changes. Spatially, this can be translated into special arrangements (i.e. zonation) of species that can be easily characterized. Recently, there has been a growing interest on the way mangroves are responding to global climate change, particularly to sea level rise phenomenon.

One of the best ways for predicting how will mangroves face present and future climate changes, is comparing past evidences with present ones. Having a vast knowledge on the autoecology of mangrove species and their successional and zonation patterns is the first step for reconstructing quantitatively or qualitatively their living conditions in the past. Palynological reconstructions have been for a long time one of the most important sources of information to reveal the history of mangroves, but quantitative data to establish analogies between modern and past vegetation and their environment are still scarce.

Depending on the scale of the target phenomenon (climatic, anthropogenic, plant succession, etc.) mangroves can provide useful paleoenvironmental information. Our palynological analyses in deep-ocean cores and in coastal lakes have been a rich source of signals of regional changes and broad time scale phenomena. At this scale, mangroves, treated at the community level, have shown a good correspondence with eustatic variations due to global melting processes as happens in the Panama Basin (eastern equatorial Pacific) at the early Holocene, and around 3000 yr BP at the Colombian Caribbean.

At shorter time and space scales, mangroves should be treated at species level, and in this case successional and zonation processes can be inferred from palynological records. Our studies of representation of pollen taxa and the current position of species within the ecological gradients allowed us to characterize different mangrove types and then extrapolate that information to older samples. This could be possible, not only because the plant community is simple, but also because mangrove pollen grains are easily recognizable. Slight changes in composition reflected higher frequency processes like changes in salinity, droughts, hurricanes and human exploitation.

Holocene Paleoecology of Quintana Roo, Mexico

Islebe, G. A.; Sanchez, O. & Torrescano-Valle, N.

El Colegio de la Frontera Sur Unidad Chetumal, Herbario, AP 424, Chetumal, Mexico

Pollen records from different sites in Quintana Roo, southeastern Mexico, give clear evidence of environmental change during the last 5000 ^{14}C yr BP years. Cores taken in mangrove systems show development of the coastline since 3500 ^{14}C yr BP, with *Rhizophora mangle* and *Conocarpus erecta* as the dominant members. Both mangrove species alternate in more humid and drier phases, being *C.erecta* at dry phases in a combination of taxa from the medium statured tropical forest like Leguminosae and Apocynaceae. The most severe dry detected period agrees in time with the Maya cultural collapse, between 1200 and 1000 ^{14}C yr BP. Also a higher proportion of charcoaled particles is detected (ISLEBE & SANCHEZ 2002).

A different core taken in the mangroves of northern Quintana Roo, approximately 35 km south of Cancun shows the establishment of the *R. mangle* vegetation since 3500 radiocarbon years. Sediments were

extremely saline, and other mangrove species appear as the R.mangle type enters in an advanced successional stage (ISLEBE ET AL. IN PREP).

In southern Quintana Roo nearby the Belizean a 5000 yr pollen record was recovered showing the vegetation development of the tropical forest near to the Rio Hondo river (TORRESCANO-VALLE & ISLEBE submitted). Between the period 5000 and 4600 ^{14}C yr BP the tropical forest covered the area and members of the Moraceae and Leguminosae dominated this early forest. The period between 4600 and 4000 ^{14}C yr BP presents a strong change to a mangrove system with *C. erecta* and *R. mangle* as dominant trees. This strong vegetational change is due to flooding of the Rio Hondo river, which continuosly deposits sediments of high salinity. The tropical forest established at some distance from the swamp area. After 4400 ^{14}C yr BP *C. erecta* appears as the dominant mangrove species and the *R. mangle* stands are less predominant in the area. The tropical forest was close to the swamp area and was mainly composed of members of the Moraceae, Palmae and Leguminosae as dominant taxa of this vegetational mosaic.

ISLEBE, G.A. & SANCHEZ, O. 2002. History of Late Holocene vegetation at Quintana Roo, Caribbean coast of Mexico. **Plant Ecology** 160: 187-192.

TORRESCANO-VALLE, N. & ISLEBE, G.A. submitted. Tropical forest and mangrove history from southeastern Mexico: a 5000 yr pollen record.

Evolution of the Atlantic rain forest during the last 200,000 years

Ledru, M. P.[1]; Giannini, P. C.[2]; Riccomini, C.[2]; Sifeddine, A.[3]; Turcq, B.[3] & Martin, L.[3]

[1] IRD, UR 055, 32 av. Henri Varagnat 93143 Bondy cedex France and ISEM/ Univ. Montpellier 2 CP 61, Place Eugène Bataillon 34 Montpellier cedex France.
[2] Departamento de Geologia Sedimentar e Ambiental, IG-USP, SP, Brazil.
[3] IRD 32 av. Henri Varagnat 93143 Bondy cedex France.

A terrestrial record from Colônia, state of São Paulo (23°52'S, 46°42'20 "W, alt. 900m) provides history of vegetation and climate through the last glacial/interglacial. Colônia is a meteoritical crater filled up with black peat during the last 4 million years. Its location near the Atlantic ocean in the Serra do Mar mountain range at an altitude of 900 m contributes to a strong sensitivity to sea level and temperature changes. The domain of vegetation of the area, named atlantic rainforest, is the second species-rich biome in Brazil after the Amazonian rainforest. His wide distribution, from equator to 30°S latitude, along the coast, conduced deforestation and only 7% of its original area is met today mainly as ecological reservations. Rainfall is highly seasonal in São Paulo with a dry season centered in winter although the water deficit during this period is reduced by frequent clouds and drizzle. Radiocarbon dates stop at isotopic stade 3 and ages were interpolated to date back the core to cerca 200,000 years. Correlations with marine, ice and long terrestrial records will be used to propose an age for the floristic changes detected in the Colonia record. The atlantic rain forest show three regressions, attested by low frequencies of arboreal pollen associated with a strong dominance of Poaceae and Asteraceae. These episods were related to cold climatic phases. Expansion of the rain forest is recorded several times along the core, each time being characterized by different associations of taxa, for example *Podocarpus, Araucaria, Myrsine, Ilex* or Myrtaceae, *Symplocos, Myrsine*. The Holocene pollen spectra similar to the composition of the forest today in the region of São Paulo is composed mainly of *Ilex, Weinmannia*, Melastomataceae/Combretaceae e Asteraceae.

The Colonia record confirms that tropical rain forests were submitted to global climatic changes during the Quaternary. These modifications highly contributed to the evolution of its biodiversity and richness in endemic species. This point is important to consider when we are trying to preserve the biodiversity of our planet.

Late Quaternary ecosystem changes in the Pantanal tropical wetland of South America: preliminary palaeoecological data from Laguna La Gaiba

Mayle, F. E.[1,2]; Gosling, W. D.[1,3]; Street-Perrott, F. A.[4] & Loader, N.[4]

[1]Department of Geography, University of Leicester, Leicester LE1 7RH (UK). fem1@leicester.ac.uk.
[2]Present address (from July 2004): Institute of Geography, School of GeoSciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP (UK).
[3]Present address: Department of Biological Sciences, Florida Institute of Technology, 150 W University Boulevard, Melbourne, Florida 32901 (USA).
[4]Department of Geography, University of Wales Swansea, Swansea SA2 8PP (UK).

The Pantanal of South America constitutes the largest tropical wetland in the world (equal to the size of England). An understanding of millennial and multi-millennial variations in the geographical extent of this wetland, in the context of the atmospheric methane record and other wetland areas on Earth, would improve understanding of the global carbon cycle, as well as of the climatic response of the tropics to changes in orbital forcing and boundary conditions. Most of the wetland basin is covered by seasonally-flooded savannas, whilst gallery forests and permanently-flooded wetlands surround the rivers and semi-deciduous forests dominate upland areas.

The overall aim of this project is to determine how the ecosystems of the Pantanal have varied on a glacial-interglacial time scale. The study site is Laguna La Gaiba (17°45'S, 57°35'W), one of the largest lakes in the Pantanal, lying along a N-S trending fault at the western edge of the basin, on the Bolivian/Brazilian border. The uplands are covered by tall, semi-deciduous forests, while the lowlands connect with the seasonally-flooded wetlands of the Pantanal to the east. The lake behaves as an 'overflow lake', collecting flood-waters from the Paraguay river in the rainy season, when its area doubles to 105 km^2.

A 5.6 metre core was collected from the deepest part of the lake. Extrapolation from two AMS radiocarbon dates (8939±56 ^{14}C yr BP and 30,670±390 ^{14}C yr BP) shows that this sedimentary sequence probably spans at least the last 50,000 years. The uppermost two metres of Holocene organic muds grade into Pleistocene clays below. Our preliminary pollen, magnetic susceptibility, and 'total organic' δ^{13}C data constitute the first glacial-Holocene vegetation history for the Pantanal, extending beyond the Last Glacial Maximum (LGM). This pilot study suggests that semi-deciduous dry forests, indicated by key taxa such as *Anadenanthera* and *Astronium fraxinifolium*, which currently dominate the upland areas surrounding the lake, are only Holocene in age. The δ^{13}C data suggest that a combination of savannas and scattered dry forests existed in upland areas in the early Holocene, while the current closed-canopy dry forests probably developed only in the late Holocene. Pollen of arboreal taxa are entirely absent from the Pleistocene inorganic clays, which are instead dominated by herbaceous pollen taxa, principally Poaceae, Cyperaceae, Asteraceae, *Alternanthera*, and *Hyptis*. This herbaceous community is consistent with an open, sparsely-vegetated landscape dominated by active alluvial fans and sand dunes under a more arid climate, as envisaged by ASSINE & SOARES (2003).

The temporal variations in the δ^{13}C values of bulk organic matter through the sequence, and the general shift from herbaceous Pleistocene vegetation to increasing arboreal cover through the Holocene, are broadly similar to those of more detailed, well-dated records further north in the Amazon rainforest-dry forest ecotone of NE Bolivia (MAYLE *et al.* 2000). In particular, the large-amplitude δ^{13}C variations in the Holocene sediments closely match the Holocene lake-level record of Lake Titicaca on the Bolivian Altiplano (CROSS *et al.* 2000) and the GRIP ice-core Holocene atmospheric methane trends (BLUNIER *et al.* 1995). This clearly demonstrates that the ecosystem changes identified at Laguna La Gaiba, albeit preliminary, are not simply a consequence of local site-specific factors, but are instead indicative of regional climatic changes, and may have played a significant role in global methane fluxes.

ASSINE, M.L. & SOARES, P.C. 2003. Quaternary of the Pantanal, west-central Brazil. **Quat. Int**. in press.
BLUNIER, T. *et al.* 1995. Variations in atmospheric methane during the Holocene epoch. **Nature** 374: 46-49.
CROSS, S.L. *et al.* 2000. A new estimate of the Holocene lowstand level of Lake Titicaca, central Andes, and implications for tropical palaeohydrology. **The Holocene** 10(1): 21-32.
MAYLE, F.E. *et al.* 2000. Millennial-scale dynamics of southern Amazonian rain forests. **Science** 290: 2291-2294.

Postglacial and Holocene vegetation changes as recorded in the sediments of a high-altitude tropical lake (laguna las Verdes Alta, Venezuelan Andes)

Rull, V.[1]; Abbott, M.[2]; Polissar, P.[3]; Wolfe, A.[4]; Bezada, M.[5] & Bradley, R.[3]

[1]Dep. Biologia Animal, Vegetal i Ecologia, Univ. Autònoma de Barcelona, 08193 Bellaterra, Barcelona (Spain).
[2]Dep. of Geology and Planetary Science, Univ. of Pittsburgh, Pittsburgh, PA (USA).
[3]Dep. of Geosciences, Univ. of Massachusetts, Amherst, MA (USA).
[4]Dep. of Earth and Atmospheric Sciences. University of Alberta,Edmonton, Alberta (Canada).
[5]Dep. of Earth Sciences, UPEL, Caracas (Venezuela).

This work is part of a multi-proxy high-resolution study aimed to reconstruct the paleoecological and paleoclimatic trends occurred in the Venezuelan Andes since the Last Glacial Maximum (LGM), at decadal to millennial time scales; as well as to test the different hypotheses on their causes, considering global mechanisms of climatic change such as insolation, and the coupled ocean/atmospheric circulation. The sediments studied are from lakes situated along an altitudinal gradient from about 2000 to 4200 m. Detailed chronologies are obtained by AMS ^{14}C, ^{137}C and ^{210}Pb dating. Proxies include physico-chemical properties, stable isotopes (oxygen, nitrogen, carbon), and biological indicators (pollen, diatoms). These proxies are calibrated using modern analogs. As a first step of the palynological approach, we present the analysis of a 3.5 m sediment core obtained in the Laguna Las Verdes Alta (LVA), which is situated at 4200 m altitude, within Superpáramo vegetation. This core records approximately the last 17 cal. ka BP. Five pollen zones were defined that recorded the main vegetational trends. Lake levels were deduced from the percentage of planktonic algae (*Pediastrum, Botryococcus*) with respect to the pollen sum, which included only the identified pollen types.

Between about 17 and 6 cal. ky BP, variations in pollen assemblages from LVA sediments do not correspond to local or regional vegetation changes such as vertical displacements of ecological boundaries, but to oscillations in pollen input from lower elevation forests. During this time, the vegetation around the LVA lake has been a periglacial desert with poor local plant communities. The oscillations in long-distance forest pollen and spores abundance were likely due to the changing intensity in upslope orographic winds, which were generally more intense than today, especially between about 15.5 and 14.5 cal. ka BP. In this way, the indicator character of the tree pollen as proxy for the treeline elevation has been obscured, and its possible vertical shifts, and the related temperature variations, could have not been recorded as in lower páramo localities. A special vegetation type with important contribution of lycopodiaceous ferns, probably *Huperzia*, was recorded between about 11 and 7 cal. ky BP. Afterwards, a typical superpáramo similar to the present-day one occupied the site. Climatically, the postglacial has been characterized by alternating climatic shifts, mainly related to variations in moisture, as deduced from lake levels. After a prolonged and constant rising (ca. 11 to 8 cal. ky BP), more stable, high water levels have been recorded during the Holocene. The paleoecological and paleoclimatic trends recorded here match reasonably well with other records from the tropical Andes.

Notably is that during the late glacial, the lake level index closely matches the GISP2 ^{10}Be record, suggesting an inverse relationship to solar activity. On the contrary, pollen from forest trees, a proxy for wind intensity in this case, shows a less evident but mostly direct relationship with solar irradiance.

A 4900 yr record of changes in hydrology and vegetation from South-West Florida, USA

Wagner, F. & Donders, T.

Department of Palaeoecology, Laboratory of Palaeobotany and Palynology. Utrecht University, 3584 CD Utrecht (Netherlands)

High resolution palynological analysis of a 190 cm long sediment core from south-west Florida, spanning the past 4900 years, reveals significant changes in the vegetation units during the second half of the Holocene. The age assessment of the 'Fakahatchee Strand' core is based on 10 AMS ^{14}C data. Age depth relations indicate three shifts in accumulation rates, with ~ 20 yrs/cm in the lowermost part corresponding to 4900 cal BP to 3600 cal BP. Accumulation slowed down to ~ 50 yrs/cm from 3600 cal BP to 1800 cal BP and increased again to

~ 30 yrs/cm in the uppermost part of the core. The most prominent feature in the assemblages is the changing dominance between *Pinus elliotii* and *Taxodium distichum* pollen.

High *P. elliotii* values, in an assemblage representative for relatively dry conditions in South-Florida wetland systems, dominate the oldest part of the core. From 4600 cal BP to 3000 cal BP *P. elliotii* values fluctuate between ~25% and 65%. From 3000 cal BP to ~ 1800 cal BP *P. elliotii* gradually decreases to levels as low as ~5%. It is replaced by *T. distichum*, presently the dominant tree species in long-hydroperiod environments of the Everglades forest ecosystem, in the uppermost part of the core.

Increasing ENSO-tied precipitation levels from 5000 cal BP onwards initiated peat formation across southern Florida. The Fakahatchee peat record confirms this pattern for the first time for the region west of the Everglades wetland. After ~ 3000 cal. BP the system finally shifts towards the present wet conditions under the influence of rising sea-level.

The pattern emerging from the present study implies that in the Fakahatchee Strand area the hydrological changes induced by the sea-level rise occurred significantly later than e.g. in the Everglades, most likely due to the slightly higher elevation and low permeability of the substrate. Palynological and sedimentological studies from south-eastern Florida indicate overall wet conditions between ~5000 cal BP and 3000 cal BP, caused by the combination of increased sea-level and precipitation.

The relatively long independence of the study site from sea-level increase, makes this site exceptionally well suited for reconstruction of century scale precipitation trends by means of pollen-analysis. The abundance of *P. elliotii* has been demonstrated earlier to be highly sensitive to long term precipitation changes on millennial time scales. The high frequency fluctuations observed in the present pollen records may, thus, indicate natural precipitation changes during the second half of the Holocene.

Climate Change in the northern limit of the American tropics: the records of central Mexico

Lozano-García, M. S.[1]; Sosa , S.[1]; Caballero, M.[2] & Ortega, B.[2]

[1]Institute of Geology, Nacional University of México. 04510, México D.F.
[2]Institute of Geophysics, Nacional University of México. 04510, México D.F.

We present a synthesis of the pollen analyses carried out in several lacustrian sequences of central Mexico (CM). The sites are located: (i) the tropical lowland of the Gulf coast (Lago Verde); (ii) the high altitude basins of Mexico and Upper Lerma; (iii) El Marrano site in the westerns slope of Iztaccíhuatl volcano at 3900 m of altitude; (iv) Zacapu and Cuitzeo basins, located in the western sector of central Mexico.

The chronology of the sequences is based on AMS dates ^{14}C and ^{36}Cl and tephrachronology. The pollen records cover the last 23,000 yr BP. As result of the volcanic activity of some parts of CM well known tephras layers allows correlating pollen signals between basins.

These sequences give information of the late Pleistocene and Holocene vegetation history as well as climatic insights of the environmental change in the northern limits of the American Tropics. The pollen records are correlated with the local glacial advances. Evidence of dry and cold climate during glacial times with expansion of grasslands in the high basins is documented. During the early Holocene a clear signal of forests expansion can be detected in the highlands of CM and culminates with the establishment, at around 3500 yr BP, of modern communities according to the pollen data. Evidences of dry conditions in the lowlands and in the highlands during the late Classic (ca. 800 AD) are recorded.

Holocene vegetation dynamics in West New Britain, PNG

Boyd, W. E.; Lentfer, C. J.; Parr, J. & Jago, L. C. F.

Centre for Geoarchaeology and Palaeoenvironmental Research, Southern Cross University, Lismore, NSW 2480, Australia.

The wet tropical region of West New Britain (Papua New Guinea) has been populated by prehistoric people since the Pleistocene. During this time, the region has been subjected to a series of catastrophic volcanic events related to plate margin vulcanism. In addition to human activity and vulcanism, the coastal zone of West New Britain has also been affected by tectonic activity, climatic change and sea-level fluctuations (WHITE et al. 2002). We have examined the responses of vegetation to these important landscape influences by analysing phytolith and pollen sequences at localities on the coastal lowlands the Willuamez Peninsula and nearby island of Garua. This paper reviews our current results. The results provide details of vegetational change at different scales – local, sub-regional, regional – thus allowing us to create a synthetic overview of vegetation and human interactions across the landscape.

The local scale is investigated at one archaeological site on Garua Island. Using phytolith analysis from discrete horizons at many sediment exposures close to a prehistoric settlement, we are able to map the details of the former village and its immediate impact on the surrounding forest (PARR et al. 2001). At the local landscape scale, we have conducted phytolith analysis from six sites along one part of the coastal plain at which the sediment sequence comprises layers of Holocene tephra's (up to 1m thick) and their associated soils, and at one key site on Garua. These analyses allow us to identify the patterns of volcanic and human disruptions to the vegetation through time. In particular, we can examine the balance between natural and anthropogenic disturbance, especially as it affects the recovery of forest systems in this region. By differentiating the effects of natural and human impacts, we are able to chart the differing ways in which people cleared or partitioned the landscape. This work, in particular, is related to archaeological studies of the area, and we have a strong control over the correlation of environmental history and archaeology (TORRENCE et al. 2000).

Finally, at the regional scale, pollen analysis of layered peats and tephra's deposited in a coastal swamp within our study area, and lake infill sediments in the fringing hills, is providing a macro-level landscape account of the destruction and recovery of the coastal forests during six periods of volcanic activity in the latter part of the Holocene. The pollen analysis allows a finer scale of resolution than much of the phytolith analysis (largely due to the different sediment types). This allows us to examine in greater detail the recovery ecology of the forest, and thus identify key indicators of the processes of recovery. This then allows further interpretation of the phytolith analyses. Currently, we can recognise different recovery pathways, much as we expected by examination of modern analogues (LENTFER & BOYD 2001). This multi-layered landscape approach to site selection and analytical method provides a detailed account of the landscape patterns and diversity through the Holocene, linking the regional patterns of vegetation with localised effects of people and volcanos. While such an approach has long been used in some parts of the world, this is the first such study in the region.

WHITE, P., CORNEOS, C., NEALL, V., BOYD, W. & TORRENCE, R. 2002. FEA site, Boduna Island: Further investigations. In BEDFORD, S., SAND, C. & BURLEY, D. (eds). **Fifty years in the field: Essays in honour and celebration of Richard Shutler Jr's archaeological career.** pp. 101-107. New Zealand Archaeological Society, Auckland.

PARR, J.F., LENTFER, C.F. & BOYD, W.E. 2001. Spatial patterning of a Lapita landscape at an archaeological site in West New Britain province, Papua New Guinea. **Domodomo**, 13/2, 7-18.

TORRENCE, R., PAVLIDES, C., JACKSON, P. & WEBB, J. 2000. Volcanic disasters and cultural discontinuities in the Holocene of West New Britain, Papua New Guinea. In MCGUIRE, W.G., GRIFFITHS, D.R., HANCOCK, P.L. & STEWART, I.S. (eds), **The Archaeology of Geological Catastrophes.** Pp. 225-244. Geological Society, London, Special Publications 171.

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

Pollen records reflect the emergence of agriculture 7800 cal yr BP in the montane tropics of New Guinea

Haberle, S. G.

Research School of Pacific and Asian Studies, Australian National University, Canberra ACT 0200 (Australia).

In the absence of direct evidence for the exploitation of crop plants palaeoecological studies rely on a series of criteria to distinguish human impact from natural processes in a record of vegetation history. These

primarily include the identification of processes that are unprecedented in the palaeoecological record such as indications of forest decline and burning, and increases in secondary forest and herbs. Recent multi-disciplinary investigations at Kuk Swamp, Wahgi Valley, montane tropical New Guinea have yielded direct evidence of mid-Holocene agricultural practices dating to 7000 cal BP (Denham *et al.* 2003). This evidence includes archaeological features representing cultivation, pollen records documenting the emergence of an agricultural landscape in the Upper Wahgi Valley, and phytolith and starch remains of edible plants including the exploitation of taro (*Colocasia esculenta*) and planting of bananas.

The presence of direct evidence for the exploitation of crop plants at Kuk Swamp allows us to examine the veracity of criteria used to distinguish human impact from natural processes in the pollen records. Pollen records from five major highland valleys (1400-1890 m altitude) in New Guinea, covering the period from the last glacial maximum to the present, are reviewed and the implications for development of early agriculture are evaluated. Using "Rate of Change Analysis" as a means of identifying deviations in the rate of vegetation change from that which would be expected under natural climate change, the earliest indications of agricultural impact in the vegetation record can be identified at 7000 cal BP and possibly as early as 7800 cal BP.

Subsequent vegetation change reflects an increase in anthropogenic influence characterized by punctuated episodes leading towards a more open landscape. The emergence of an agricultural landscape in New Guinea is considered to be the result of exploitation of indigenous plants beginning at least 7800 cal BP which are subsequently punctuated by external influences such as introduced domestic plants, climate variability and volcanic activity. Based on these results a conceptual model for the identification of human impact in pollen records is constructed to distinguish between the impact on landscapes of "pre-agricultural" and agricultural activity.

DENHAM, T.P., HABERLE, S.G., LENTFER, C., FULLAGAR, R., FIELD, J., THERIN, M., PORCH, N. & WINSBOROUGH, B. 2003. Origins of agriculture at Kuk Swamp in the Highlands of New Guinea, **Science** 301: 189-193.

Late Holocene records of environmental change from Luzon, Philippines

Stevenson, J.[1]; Siringan, F.[2] & Madulid, D.[3]

[1]Department of Archaeology and Natural History, RSPAS, Australian National University, Canberra 0200, (Australia).
[2]National Institute of Geological Sciences, University of the Philippines, Diliman, 1101, (Philippines).
[3]Botany Division, National Museum of the Philippines, Manila 1000 (Philippines).

The palaeoenvironmental history of Paoay Lake in northern Luzon is being examined through the analysis of pollen, diatoms, charcoal, mineral magnetics and AMS dating. The project is part of a larger program of archaeological research examining the theory of whether a Neolithic expansion took place out of Taiwan and into island southeast Asia around 4,000 years ago. The primary intention of the lake study is to determine if there is evidence of land clearance and agricultural development in the region during the late Holocene.

Paoay Lake is a large coastal lake in the northwest of Luzon, cut off from the sea sometime during the late Quaternary. Two sediment cores collected from two different locations within the lake each span the last 6,000 years. The most important finding to date is that coniferous forest, dominated by *Pinus*, was prevalent in the landscape surrounding the site until around 5,000 BP§ when the pollen signature changes to that more indicative of an open landscape (primarily grass). Charcoal as an indicator of fire is abundant throughout record, although the highest levels occur during the period of forest decline. *Pinus* pollen continues to be present in the record in small amounts almost until the present day.

The discovery that *Pinus* was growing at Paoay between 6,000 and 5,000 BP is significant, as it is only found above 600 m in the present day environment which has been interpreted as the altitudinal limit of *Pinus* in Luzon (Zamora and Co, 1986; Madulid pers comm.). The finding also raises the question of whether the forest decline at 5,000 BP is associated with human activity or a climatic shift, possibly an increase in climatic variability, as no evidence for agricultural plants (eg. rice) is found until around 2,300 BP.

The change at 5,000 BP in the Paoay Lake record also corresponds well with a similar vegetation shift at 5,000 BP in a record from Laguna de Bay, south of Manila (Ward and Bulalacao, 1996). This is the only other

quaternary pollen core from the Philippines and although the pollen composition is different to that at Paoay, the correspondence in a shift to greater grassland suggests that a significant regional event occurred around this time.

§BP = calibrated years before present.

WARD, J.V. & BULALACAO, L. J. 1999. Pollen analysis of Laguna de Bay, Luzon. **National Museum Papers** 9(1): 1-26. Manila: National Museum of the Philippines.
ZAMORA, P. & CO, L. 1986. **Guide to Philippine Flora and Fauna: Ferns and Gymnosperms**. Natural Resources Management Center and University of the Philippines, Quezon City. 271pp.

Development and modification of the Kutai peatlands, eastern Kalimantan (Indonesia)

Hope, G. S.

Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University Canberra 0200 (Australia).

The peat forest of eastern Kalimantan (Borneo) with an approximate area of 38 million Ha is a significant tropical peatland which came to prominence in 1984 and 1997-8 because of El Niño related fires that burnt for several months and caused ill health and accidents across Indonesia, Malaysia and Singapore. A survey of the peatlands was instituted in 2001 by the Centre for International Forest Research to determine how much peat had been removed and how much remained, as well as assessing regeneration status for the peat forests of dipterocarps and other taxa. 480m of cores were examined and dating and palynology used to determine peat losses and the previous fire regime. Extensive shallow lakes in the peatland were also cored.

The peatlands proved to have retained most of their peat resource, with 6-17m of peat present across the basin. The rivers that traverse the peatland have built narrow clay levees that seem to have kept pace with the growth of the peat. The dated peat sections are all Holocene and commence accumulating as clayey shallow lakes dominated by *Pandanus*. This may be the result of backing up by the Mahakam River as sea level attained its present position, but no marine initial stage was found. With peat forest invasion the pH falls to 4 and peat accumulated steadily. Some sections in the burnt area are truncated but only by a few centuries, suggesting that peat loss in the fires has not removed more than a few centimetres of peat on average. However in two lakes the peat surface is more than 4000 years old, arguing for the loss of several metres of peat through fires. The lakes may thus be anthropogenic but their time of formation is unknown. Microscopic charcoal occurs in some cores throughout the record, but in general fire events are only common after ca 3000 BP, suggesting that fire became more common with the spread of rice agriculture. Stable forest, indicated by *Dacridium*, becomes rarer in the last 1000 years. Historical records show that large fires have occurred in the past and that the recent fires, while very extensive, have been matched in the past. These records agree in most respects with the much larger forests of central Kalimantan. (PAGE et al 1999).

PAGE, S.E., RIELEY, J.O., SHOTYK, O.W. AND WEISS, D. 1999. Interdependence of peat andvegetation in a tropical peat swamp forest. *Phil. Trans. R. Soc. Lond. B*, **354:** 1885-1897.

Evidence of change: human responses to palaeoenvironmental change in tropical Australia

Sim, R.[1]; Prebble, M. [2]; Reeves, J. M.[3] & Fink, D.[4]

[1]School of Archaeology and Anthropology, Australian National University, Canberra, ACT 0200, Australia.
[2]Department of Archaeology & Natural History, Research School of Pacific & Asian Studies, Australian National University, Canberra, ACT 0200, Australia.
[3]Department of Geology, Australian National University, Canberra, ACT 0200, Australia.
[4]Australian Nuclear Science and Technical Organisation, Lucas Heights, NSW 2234 Australia.

Results from recent analysis of freshwater lake and swamp cores from Vanderlin Island in the Gulf of Carpentaria, northern Australia provide insights into changing Holocene climatic conditions and the archaeological record. These data complement other palaeoenvironmental research including lake and ocean core analyses in the Gulf region, and further provide a palaeoenvironmental backdrop for Aboriginal occupation in the region (Chivas *et al* 2001, Shulmeister 1991, Shulmeister and Lees 1995). This palaeoclimatic research was undertaken as an adjunct to the Sir Edward Pellew Islands archaeological project. The broader project was focused on the relationship between Holocene tropical island occupation by Aboriginal people and palaeoenvironmental change.

Archaeological evidence indicates that with the post-glacial sea level rise people appear to have abandoned low-lying peripheral areas of the continent in the early Holocene. Offshore islands, the relict areas of the inundated shelf were not re-occupied until after 4,000 BP, that is several thousand years after sea level stabilisation by 6,500 BP. It has been suggested that this lag in island occupation is associated with a broad scale mid-Holocene palaeoclimatic shift, associated with the onset of the ENSO cycle between about 5,000 and 3,500 years ago.

To investigate the question of mid-Holocene climatic change, pollen, phytolith, sediment, ostracod and C14 dating analyses were undertaken on lake and swamp cores from Vanderlin Island, one of the Pellew group in the southwest Gulf of Carpentaria. This study aimed at providing palaeoclimatic data to assist in determining whether the chronology of Aboriginal island occupation, and the development of watercraft in the region, was a cultural response to changing climatic conditions. Results from the core analyses are correlated with other regional palaeoenvironmental research and archaeological findings from other Australian offshore islands.

CHIVAS, A.R., GARCIA, A., VAN DER KAARS, S., COUAPEL, M.J.J., HOLT, S., REEVES, J.M., WHEELER, D.J., SWITZER, A.D., MURRAY-WALLACE, C.V., BANERJEE, D. 2001. Sea-level and environmental changes since the last interglacial in the Gulf of Carpentaria, Australia: an overview. ***Quaternary International***, Vol.83-85. pp 19-46.

SHULMEISTER, J., 1991. Late Quaternary and Holocene environmental history of Groote Eylandt, northern Australia, The Australian National University, PhD thesis.

SHULMEISTER, J. & B. G. LEES. 1995. Pollen evidence from tropical Australia for the onset of an ENSO-dominated climate at c.4000 BP. ***Holocene*** 5: 10–18.

Mangrove deposits as archives of paleomonsoon records: a palynological assessment of the Late Quaternary deposits of West Coast of India

Kumaran, K. P. N.; Shindikar, M. R. & Limaye, R. B.

Geology & Palaeontology Group, Agharkar Research Institute, G.G. Agarkar Road, Pune 411 004, India.

The mangroves and mangrove deposits are unique as the former is a major component of the coastal ecosystem while the latter is a product of the interactions of the geosphere and biosphere of the tropical coastlines. As the climate of India is dominated by two monsoon seasons (southwest and northeast) and the rate of rainfall varies from north to south along both the coasts, the monsoonal records are expected to be stored in this specialized and sensitive environment located near ocean- continent interface where high rate of sediment accumulation takes place. Being the major component, the mangrove vegetation has a considerable role in the hydrodynamic and flushing processes and as such has tremendous influence on sediment accumulation. The root system of the pioneer species holds the sediment intact and enhances the accretion process in the mangrove swamps. Since these sediments are laid down under environmental conditions essentially influenced by the monsoon, the coastal deposits offer an opportunity to unravel the palaeoclimatic history. Accordingly, these swamps develop into potential storage sites with a huge pile of peats, black clays and silts. Natural events and man-made changes have significant impact on the climate, which in turn affect the vegetation and their signatures ought to be reflected in the subsurface sediments.

Peats and organic rich clay layers are valuable markers for environmental changes and form excellent stratigraphic units within the Quaternary sequence of Kerala-Konkan Basin. These organic matter enriched deposits vary from 0.50 to 6.00 m thick and are found at different depths in the boreholes between sandy clays and clayey sedimentary facies. Two generations of organic deposits have been identified, the younger one being 4540-10760 yrs BP of the middle Holocene-Late Pleistocene interval while the older one dated to be around 40000 yrs BP and few beyond the dating range of radiocarbon. Pollen analyses of samples revealed that the peats and organic rich sediments are mostly derived from the mangrove vegetation (Rhizophoraceae and Avicenniaceae) and mangrove swamps and few from coastal (*Acrostichum* and *Ceratopteris*) and upland evergreen forest (*Cullenia exarillata* of Bombacaceae and members of Euphorbiaceae). The scarcity and absence of mangrove pollen in the late Holocene sediments indicate that the mangroves declined drastically from the area.

Palynological data and radiocarbon ages obtained from the mangrove deposits are found to be significant and useful while considering their palaeoclimatic implications during the late Quaternary. The peat accumulation during the period 40000-28000 yrs BP can be correlated with the excess rain fall of the Asian summer monsoon by 40-100% more than the present rate as reported from the multi-proxy records of ice caps, lakes and pollen in the Tibetan Plateau and the tropical peat from southern India. The continental drainage as a result of abundant rainfall must have contributed to the development of excellent mangrove cover and other forest vegetation during this period. The poor occurrence of mangrove pollen between 22000 and 18000 yrs BP can be attributed to the prevailing aridity or reduced precipitation associated with LGM worldwide as exposure surfaces and ferruginous layers are frequently met in these intervals of the bore-holes. The high rainfall of 11000-4000 yrs BP is found to be the most significant as the mangrove reached an optimum growth around 11000 yrs BP but with periods of punctuated of weaker monsoons. Extensive peat accumulation in sediment core from all along the SW continental shelf of India confirms luxuriant mangrove vegetation and a heavy rainfall that must have led to increased runoff and could have been effective in eroding onshore peat formations. In the next phase, after 4000 yrs BP the record of mangrove pollen has been scarce which is a true reflection of the present day mangrove vegetation along the west coast of India.

The available data and radiometric ages of peats and organic matter enriched clays from west coast of India are far from precision due to wide geochronological variations. Accordingly, radiocarbon dates (^{14}C) of different layers and that of sands and sandy clays by luminescence dating in a single core as well as close sampling are necessary to determine high resolution palaeomonsoon records. Further, environmental magnetism, variation in mineral magnetic contents in response to climatic controlled processes such as vegetation succession and soil developments could complement palaeoclimate study of the coastal deposits. The magnetic properties of the clay and silt rich mangrove sediments are expected to sensitively record past changes in rainfall intensity. Thus coupled palynological and mineral magnetic studies would provide invaluable information on vegetation response to monsoon change in India.

Pollen content from New Caledonian coral boring; palaeoclimatological and palaeoenvironmental significance

Sémah, A. M.

IRD UR 055 - 93143 Bondy Cedex, France semah@bondy.ird.fr

In the framework of an European Program about climatic variation effects on the reef constructions development during the last interglacial periods (5, 7, 9..) of New Caledonia Quaternary (Cabioch *et al.*, 2002), a palynological study is carried out.

The aim of this study is to analyse the pollen content of sediments deposited during interruptions of coral growing, *i.e.* during the glacial periods, between the successive reef units. Therefore, pollen analysis from paleosoils gives information to characterize the unknown vegetation of these periods.

The first results concern two cores: Kendec and Ténia islets (± 150 metres deep) located on the west coast of New Caledonia.

The present climatic conditions, on the west side of the 'Grande-Terre', determine the development of the so called scerophyll forest (dry forest) which is supposed to be an original form of vegetation (Jaffré *et al.*, 1993). The sclerophyll forest is now very disturbed by man.

In fact, in the two cores, the oldest layers show very different floristic associations with endemic taxa generally missing in the sclerophyll forest.

Is it possible to characterize the primary vegetation and the installation of the present one?

Then, we have to consider pollen trapped in the coral itself and its significance in the palaeoenvironmental reconstruction.

CABIOCH G., CAMOIN G., CHAZOTTES V., DALMASSO H., FRANK, N., MONTAGGIONI L., PAYRI C., PICHON, M., SÉMAH A.-M. et THOUVENY N., 2002. Effet des variations climatiques sur la

structuration des grands systèmes récifaux lors des derniers stades interglaciaires du Quaternaire: exemple de la Nouvelle-Calédonie. Colloque ECLIPSE, 21-22 octobre, Paris. Environnement et climat du passé : histoire et évolution. CNRS. Poster.
JAFFRE T, MORAT P ET VEILLON J.-M., 1993. Etude floristique et phytogéographique de la forêt sclérophylle de Nauvelle-Calédonie, *Adansonia* n° 1-4, p. 107-146.

Vegetation Dynamics of the Rainforests of Vava'u, Kingdom of Tonga

Fall, P. L.

Department of Geography. Arizona State University. Tempe, Arizona 85287 (USA).

The objectives of this study are to document the history of the rainforests of the Kingdom of Tonga and to understand the role that prehistoric people have played in the development of Tonga's modern vegetation. Tropical islands are ideal places to study and isolate the effects of human impacts because their ecological systems are particularly vulnerable and the effects are often irreversible. Paleoecological records from Tonga document: (1) changes in lowland rainforests over the past 7000 years; (2) a mid-Holocene sea level highstand from 4600 to 2600 years ago; and (3) the extensive burning of the rainforests of Vava'u beginning about 3000 years ago.

Lowland rainforest surrounded Ngofe Marsh on the island of Uta Vava'u, Vava'u, Tonga between 7000 and 3000 years ago. The most abundant pollen taxa represented in this period are rainforest trees and shrubs, including *Maniltoa*, Elaeocarpaceae, *Alphitonia*, *Melastoma*, Sapotaceae, Mytraceae and Papillionaceae. In addition, small amounts of Anacardiaceae (*Pleiogynium* and *Rhus*), *Dysoxylum*, and *Garuga* pollen are found. Several of these rainforest taxa abundant in the record between 7000 and 3500 years ago, including *Maniltoa*, Sapotaceae, Myrtaceae, Elaeocarpaceae and Papillionaceae, are much less frequent after 2000 years ago. In addition, herbaceous pollen becomes more common after 3500 years ago, suggesting that the forest was more open then. Two coastal forest taxa become more abundant after 3500 (*Cocos*) and 1100 (*Pandanus*) years ago. These changes in the vegetation are most likely related to Polynesian influences.

The coastal wetland of Avai' o 'Vuna on Pangaimotu Island, Vava'u documents a higher sea level between 4600 and 2600 years ago when marine bivavles were deposited between terrestrial sediments. This interpretation is in agreement with the timing for a mid-Holocene sea level highstand between 6000 and 3000 years ago documented for the Ha'apai Group, Tonga.

Changes in tropical rainforest vegetation on the tropical islands of Vava'u, Kingdom of Tonga reflect human alterations following the arrival of Polynesians. Significant increases in microscopic charcoal particles appear in sediments deposited after 3000 years ago, suggesting the rainforests of Vava'u were not burned prior to that time.

Vegetation Changes for the last 14 centuries in Western Equatorial Africa deduced from high-resolution pollen record of Lake Kamalété, Central Gabon

Ngomanda, A.[1]; Maley, J.[1]; Chepstow-Lusty, A.[1]; Makaya, M.[2]; Fontugne, M.[3] & Jolly, D.[1]

[1] Institut des Sciences de l'Evolution de Montpellier, University of Montpellier 2. 34095 Montpellier (France).
[2] Laboratoire d'Etude de Géo-Environnements Marins, University of Perpignan. 66000 Perpignan (France).
[3] Laboratoire des Sciences du Climat et de l'Environnement. 91198 Gif sur Yvette (France).

The past 1410 ^{14}C yrs vegetation changes in western equatorial Africa are reconstructed using a high resolution pollen record collected in the Lake Kamalété located in the mosaic of forest-savanna of Lopé Reserve (0°43'S, 11°46'E), centre of Gabon. Our pollen data indicate that, over the past 14 centuries, the floristic composition of the rainforest has significantly varied, whereas savanna areas show low and uniform fluctuations. Three distinct successive stages of the forest dynamics have been identified. At 1410 yr B.P. the establishment of the mature moist semi-evergreen rainforest, related to forest colonization of savanna areas around the lake is evidenced by high pollen percentages of the mature forest trees. From *ca.* 1360 to 500 yr B.P., a sharp decrease of

pollen percentages of these mature forest trees and a noticeable increase of the shade intolerant plant species indicate an opening of forest cover. The persistence of gap-coloniser species, as *Macaranga*, *Tetrorchidium* and *Musanga* for several centuries in the rainforest is explained by recurring disturbances in the composition of the canopy associated to perturbations of water budget. These hydrological changes may be related to shorter and repeated dry episodes, probably entailing a drier and/or a longer dry season than today, as evidenced by the notable presence of *Celtis* and *Bosqueia angolensis*, both indicators of semi-deciduous forests. At 500 yr B.P., the mature forest increased. This last forest expansion corresponding to new savanna colonization and correlated with lithological evidence of an increase of the water lake-level, indicate the beginning of the modern humid period.

Pollen analysis of dung deposits in a desert and Late Quaternary vegetation and climate in Namibia

Scott, L.[1]; Brook, G. A.[2] & Marais, E.[3]

[1] Department of Plant Sciences, University of the Free State, Bloemfontein (South Africa).
[2] University of Georgia, Athens, Georgia (USA).
[3] National Museum, Windhoek (Namibia).

Due to the scarcity of lakes and wetlands in the arid south-west African region palaeoclimatic reconstructions are difficult because conventional pollen analysis is generally not possible. However, shelters in rocky outcrops in the region yielded hyrax and other dung deposits rich in pollen grains ranging as far back as 30 000 yr BP. While several radiocarbon dates are available pollen analyses of these deposits are in progress. At this stage the results promise to provide some potentially high resolution pollen sequences from the Holocene as well as clues about longer-term vegetation changes and climatic conditions in the desert during the Late Pleistocene. Preliminary results indicate that cool shrubby elements spread to the northern Namib during the Last Glacial Maximum. Questions can provisionally be addressed about 1) conditions in the Namib during the last Glacial period, 2) the source and nature of "fynbos" elements recorded previously in offshore sediments along the Northern Namibian coast during this period (Shi et al., 1998), and 3) Holocene climate conditions and human presence in the light of observed settlement history (Kinahan, J., 2000).

SHI, N, DUPONT, L.M. BEUG, H.-J. SCHNEIDER, R. 1998. Vegetation and climate changes during the last 21000 years in SW Africa based on a marine pollen record. **Vegetation History and Archaeobotany** 7: 127-140
KINAHAN, J. 2000. Dâures, the burning mountain – issues of research and conservation in the Brandberg of Namibia. **Cimbebasia Memoir** 9: 1-16.

Session h5

LONG CONTINENTAL RECORDS: THE DEVELOPMENT OF "GROUND TRUTH" FOR THE MARINE OXYGEN ISOTOPE CHRONOLOGY

Long pollen records from northern California and southern Oregon, U.S.A.

Adam, D. P.

18522 Sentinel Court, Middletown, California 95461, U.S.A.

Long sedimentary sequences are common in northern California and southern Oregon as a result of regional tectonic extension of the northwestern Great Basin over the past several million years, and in response to