

(SS16) Holocene Palynology and Tropical Palaeoecology

Date: August 25

Place: Room 5335 (oral), Room 6309 (poster)

Organizers: Navnith K.P. Kumaran & Ruta Limaye

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Purpose: Holocene epoch represents the last 10,000 years of earth's history. There have been dramatic changes in sea level and climate during this epoch. The present landscape and ecology have been substantially modified as a result of Holocene events. Generation of bio-georesources has also been seriously affected due to climate and anthropogenic changes in the recent past. There is considerable concern on the changing scenario of the monsoon pattern and its effects on the vegetation in the tropics. The phenological pattern, pollen production and dispersal aspects can be decoded using the preserved pollen as signatures in the sediments. Since Holocene constitutes the latest geological epoch and also concerned with our environment in which the interactions of both the biosphere and Geosphere, application of Palynology will be an effective tool to understand how the vegetation responded to climate change/monsoonal variations. Considering the immense potential preserved in the marine and terrestrial sediment archives, the vegetation dynamics of the Tropics during the Holocene is to be focused in the proposed symposium.

This session welcomes contributions from scientists working on Holocene Palynology and vegetation dynamics with special reference to aspects of Tropical Palaeoecology.

Oral Presentation

Aug. 25 [AM1] Room: 5335

Chairs: Navnith K.P. Kumaran, Ruta Limaye B., Maria Lúcia Absy

9:00-9:20 **Holocene palaeoecology of mountain rainforests in Central Sulawesi (Indonesia)**
[SS16-O01 \(35\)](#)

Siria Biagioni, Petra Lembcke, Hermann Behling

9:20-9:40 **Changing scenario of mangroves in response to climate and sea level changes in Southwestern India since last 10 k years** [SS16-O02 \(284\)](#)

Ruta B. Limaye, K.P.N. Kumaran

9:40-10:00 **Key to mangrove pollen and spores of southern China: an aid to tropical palynological and paleoecological interpretation of Quaternary deposits in the South China Sea**
[SS16-O03 \(308\)](#)

Limi Mao, David J. Batten, Toshiyuki Fujiki, Zhen Li, Lu Dai, Chengyu Weng

10:00-10:20 **Late Holocene vegetational and climatic changes as inferred from radiocarbon dates and palynodata of older alluvial sediments on the south bank of the Brahmaputra flood plain, Northeast India** [SS16-O04 \(28\)](#)

Samir Kumar Bera, Swati Dixit, Kanupriya Gupta

Aug. 25 [AM2] Room: 5335

Chairs: Navnith K.P. Kumaran, Ruta Limaye B., Maria Lúcia Absy

10:50-11:10 **Palynological records and environmental changes during the Holocene in the Amazon basin, Brazil** [SS16-O05 \(2\)](#)

Maria Lúcia Absy, Carlos D'Apollito, Isabella Dessaune Rodrigues, Natália de Paula Sá

- 11:10-11:30 **Late Glacial - Holocene vegetation and climate dynamics in southern Siberia, Russia** [SS16-O06 \(32\)](#)

E.V. Bezrukova, P.E. Tarasov

- 11:30-11:50 **Palaeo-palynology of late quaternary peat deposit from Lower Bengal Basin, India: A palaeoecological approach** [SS16-O07 \(89\)](#)

Sauren Das

- 11:50-12:10 **Sedimentological, palynological and stable isotope evidences of palaeoclimate and sea level records in the Holocene sedimentary archives of Central Kerala, SW India** [SS16-O08 \(394\)](#)

D. Padmalal, K.P.N. Kumaran, Ruta B. Limaye, B. Baburaj

Aug. 25 [PM2] Room: 5335

Chairs: Navnith K.P. Kumaran, Ruta Limaye B., Maria Lúcia Absy

- 14:30-14:50 **Recent (1483 to 1994) variability of gonyaulacoid-peridinioid cysts, in the Gulf of California, Mexico** [SS16-O09 \(129\)](#)

Juan Gabriel Flores-Trujillo, Javier Helenes

- 14:50-15:10 **Holocene landscape change from the seasonally Dry Tropics of north-eastern Australia** [SS16-O10 \(352\)](#)

Patrick Moss, Michael Bird, James Shulmeister, Christopher Wurster, Sasha Collecutt, Sean Ulm

- 15:10-15:30 **Holocene vegetation dynamics in southwestern India: palynological and palaeoecological appraisal of terrestrial and marine archives** [SS16-O11 \(256\)](#)

K.P.N. Kumaran, Ruta B. Limaye, D. Padmalal

Poster Presentation

Aug. 25 [PM1] Room: 6309

- 13:30-14:30 **Palynological behaviour of teak (*Tectona grandis* Linn. F.) and sal (*Shorea robusta* Geartn. F.): An overview** [SS16-P01 \(423\)](#)

Md. Firoze Quamar

Environmental change and anthropogenic activity from 2.6 kyr BP, evidenced by the pollen and charcoal record of Li-yu Tan, central Taiwan [SS16-P02 \(265\)](#)

Chengyi Sep Lee, Chioulian Chang, Pingmei Liew, Tehquei Lee, Shengrong Song

Holocene palynology in the Choshi area, Central Japan [SS16-P03 \(535\)](#)

Takashi Uchiyama

Vegetation change in Rarotonga, Cook Islands [SS16-P04 \(137\)](#)

Toshiyuki Fujiki, Mitsuru Okuno, Kei Kawai, Hiroshi Moriwaki

SS16-O01 (35)

Holocene palaeoecology of mountain rainforests in Central Sulawesi (Indonesia)

Siria Biagioni, Petra Lembcke, Hermann Behling

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In order to obtain a deeper understanding of future environment/ecosystem interactions in tropical ecosystems a long-term perspective of the interaction between vegetation dynamics, climate change and human impact in the past is needed. Due to the complexity of tropical ecosystems and site-specific differences on the sedimentary process, it is very important to have data from multiple sites in order to better identify the dynamics and vegetation community responses under different conditions (e.g. human land use change, climate change). We present the results of pollen and charcoal analyses of three sediment cores located about 30 km apart, close to the north-eastern border of the protected area of the Lore Lindu National Park. The park is situated in Central Sulawesi and has been a UNESCO “Man and Biosphere Reserve” since 1977. The vegetation of the study region consists of species-rich tropical montane forest. The vegetation gradient ranges from lowland rainforests below 1000 m dominated by Fagaceae, to upper montane above 2000 m a.s.l. where conifers are well represented. The climate of the area is best described by rainfall pattern with humidity increasing towards higher elevation. The interannual conditions are influenced by the occurrence of El Niño event which can lead to severe reduction in rainfall. The coring sites are located at different altitudes: 1) Rore Katimbu (1°16'44" S, 120°18'34" E) situated at about 2400 m a.s.l. within the upper montane forest, 2) Lake Kalimpaa (1°19'35" S, 120°18'32" E) at 1700 m a.s.l., within the mid-montane forest and 3) Lake Lindu (1°19'16" S, 120°04'36" E) at 1000 m a.s.l. surrounded by sub-montane forest. The three sites differ in level of human impact and the records span through the Holocene with similar temporal resolution. The multi-sites palaeoecological study allows us to test the following hypotheses: I) The response of the vegetation communities to climate change and ENSO events were different along the altitudinal and moisture gradients; II) The montane rainforest was impacted by human activities in the area only in recent times. The comparative study will lead to a better understanding of how human and climate have shaped the montane tropical rainforest of Central Sulawesi from the early Holocene until modern times.

Keywords: palynology, charcoal analysis, human impact, climate change.

SS16-O02 (284)

Changing scenario of mangroves in response to climate and sea level changes in Southwestern India since last 10 k years

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Indian mangrove vegetation covers about 6,749 km² along the 7516 km long coast line. The distribution is influenced by geomorphology, climate, tidal amplitude and duration and quantity of freshwater inflow. The available data indicated that west coast of India harbored an excellent cover of mangroves until the Neogene. However, the mangrove area has shrunken considerably since then and it is now confined largely to river mouths and tidal creeks of Kerala-Konkan basin. In view of the alarming trend of the decline and further degradation of mangrove cover during the past few

thousand years, aspects of environmental and climate changes of the coastal ecosystem have been addressed using the signatures in the subsurface sediments. The palynological and chronological data revealed that the mangroves of southern west coast are essentially of Middle Holocene age (7220 - 3880 yrs BP). Such mangrove development seems to be of global significance as Mid-Holocene establishment of mangroves has been well recorded elsewhere when sea level got stabilized. This period also coincides with the Holocene climate optimum when Monsoon Asia witnessed heavy precipitation. However, the mangroves responded to environmental changes due to freshwater influx controlled by monsoon rainfall and sea level changes leading to change in species composition as revealed by their pollen signatures. The decline of mangroves since 3500 yrs BP and further degradation except at a few sites have been attributed to the prevailing arid climate and weakening of monsoon until 1500 yrs BP. However, mangrove development and sustenance in West Kallada may be due to steady flow of fresh water and gradual development of deltaic conditions and as such this area has excellent potential for the rehabilitation. The positive trend in emergence of mangroves in the least disturbed areas of south Konkan may be attributed to strengthening of summer monsoon in the recent past.

Keywords: mangrove responses, palynology, geochronology, palaeoclimate, Holocene.

SS16-O03 (308)

Key to mangrove pollen and spores of southern China: an aid to tropical palynological and paleoecological interpretation of Quaternary deposits in the South China Sea

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Illustrations of, and keys to, mangrove pollen and spores from extant taxa are essential to studies of tropical Quaternary palynology and palaeoecology of estuarine and marine deposits. In this paper we present a pollen morphological “atlas” and identification keys for most of the mangrove flora of the coastal areas of south China, including an interspecific key to the major mangrove elements *Rhizophora* and *Sonneratia*. The morphology of the pollen and spores of 38 species of living mangrove and associated plants is described and illustrated by transmitted light photographs and scanning electron micrographs. These descriptions and illustrations, and the identification keys are presented at an achievable taxonomic level. The keys are open for future development so that pollen of other mangrove and associated plants can be accommodated when available. In their present state they should, nevertheless, aid palynological analyses of Quaternary mangrove and associated estuarine and marine deposits, particularly in the South China Sea and surrounding regions, but also elsewhere in tropical and subtropical regions.

Keywords: mangrove, pollen morphology, Quaternary, marine deposits, South China Sea.

SS16-O04 (28)

Late Holocene vegetational and climatic changes as inferred from radiocarbon dates and palynodata of older alluvial sediments on the south bank of the Brahmaputra flood plain,

Northeast India

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A late Holocene pollen sequence under three climatic regimes followed by a barren fluvial zone at 220 cm to 250 cm bottom column (palaeoflood) has been documented from a 2.5 meter deep sedimentary profile in southern bank of Brahmaputra flood plain, Northeast India. Surface pollen data were generated by using multivariate substrates like forest humus, moss polsters, spider meshes and tree barks to demonstrate regional pollen/vegetation relationship. Relatively higher frequency of nonarboreals over arboreals reflects overall existence of open forest. Air pollen data has also supplemented surface pollen assemblage. Occurrence of high land pollen taxa hints long distance pollen transport. The sedimentary profile reflects a mixed assemblage of angiosperms, ferns and conifers belong to subtropical to temperate taxa indicating climatic sequence starting from relatively cooler & humid climate followed by warm & humid to deterioration in climate since 4,800 years BP. Scattered semi evergreen elements in the grassland predict relatively cooler and humid climate during 4,800-2,800 yrs BP. During the next phase the increase of both cool loving semi evergreen and deciduous taxa namely *Ilex*, *Mesua*, *Schima wallichii*, Ericaceae, *Carya alba* and *Tsuga* along with *Gleichenia* and *Pteris pentaphylla* indicate warm and humid condition at 2,800-1,650 yrs BP. The prevalence of grasses, cerealia and other ruderal pollen taxa suggest primitive agricultural practice. The steady presence of *Ludwigia*, *Polygonum*, *Potamogeton*, *Nymphaea* and *Botryococcus* confirms the existence of wider lake condition. Afterward the area became comparatively more warmer during 1,650-850 yrs BP as evidenced by the replacement of cool loving mixed tropical deciduous elements, viz., *Terminalia myriocarpa*, *Emblica*, *Lagerstroemia*, *Dillenia pentagyna*, *Melastoma*, *Dipterocarpus* and Oleaceae. However, during 850 yrs BP onward reduction in floristics have been envisaged a changed climate turned to warm and relatively dry perhaps attributable to the weak monsoon rainfall. Human settlement was evident and increase in *Melastoma*, *Ziziphus*, *Areca catechu* and *Mimosa pudica* implying forest clearance. The sharp reduction in aquatic taxa indicate existence of less water body. The presence of degraded palynomorphs festooned with fungal remains is suggestive of biological degradation in sediment. The assemblage of *Carya alba*, *Tsuga* along with some temperate ferns not growing in study area hints for a migratory connection between India and part of northwest Asia during the time of deposition need more investigation. The present study suggests a scope for interpretation of palaeoflood episodes hidden in huge older alluvial sediment in flood prone Northeast India.

Keywords: Palynostratigraphy, vegetation shift, depositional environment, fluvial activity, northeast India.

SS16-O05 (2)

Palynological records and environmental changes during the Holocene in the Amazon basin, Brazil

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In Amazonia, effort has been expended on the reconstruction of changes in vegetation and climate during the last 10,000 years Before Present (BP). Studies of past environmental conditions have led to a better understanding of fluctuations in water level in the central Amazon basin and adjacent areas. During the Late Holocene, periods of lower effective rainfall were recorded in the range of 2700-2100 years BP and identified by pollen analysis of sediments of the Negro and Solimões rivers. In Lake Cajú, Negro river, the increase in grass pollen combined with the presence of *Borreria* and *Polygala* indicate open vegetation. This zone points to a dry phase and correlates well with the dry period as indicated by the increase in frequency of terra firme forest elements in the interval of 2700-2500 of Lake Cabaliana (at the Solimões river floodplain), which is interpreted as weaker floods caused by decreased precipitation. Climatic variations in northern Brazilian Amazonia savannas, Roraima, revealed by pollen data of Caracaranã Lake, have shown that the break of climatic stability caused by the transition of different climatic regimes may have altered the floristic composition of savannas, riparian forests, and seasonal forests from 6750 years BP onwards, especially by the occurrence of dry seasons. Palynological evidence in Southern Serra dos Carajás, eastern part of the Amazon region, has shown that the reduction in precipitation caused changes in the vegetation during the Early–Middle Holocene. The drier period between ca 8900 and 4460 years BP caused the replacement of forest by open savanna. With increasing precipitation during the Late Holocene, around 3000 years BP, this area was replaced by forest, which correlates with an increased seasonal latitudinal migration of the Intertropical Convergence Zone as seen in southwestern Amazon (Noel Kempff Mercado National Park). The full recovery of forest during Middle-Late Holocene is also detected in Northwestern Amazon at Pata and Eastern at Maicuru. Palaeovegetation sites like Carajás, Pata, Maicuru and others, indicate the presence of forest cover throughout the whole Holocene, without any strong replacement of biomes. Nevertheless, Early to Mid-Holocene samples show some differences between Late Holocene ones, namely the presence or higher abundance of pioneer elements such as *Alchornea*, *Celtis*, *Trema*, *Cecropia*, etc. Sedimentary records point to a climatic optimum being reached from Mid-Holocene onwards, with higher sedimentation rates and higher abundance of dense humid forest taxa as well as late Holocene thick alluvial deposits in central Amazonia.

Keywords: Holocene, pollen analysis, Amazon basin, precipitation, climatic changes.

SS16-O06 (32)

Late Glacial - Holocene vegetation and climate dynamics in southern Siberia, Russia

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Objective reconstructions of the past climate and environment are among the priority tasks for the scientific community working in the field of past global changes and the Earth's system modeling (PAGES: <http://www.pages.unibe.ch/>). Since the 1990s Lake Baikal – the world's largest, deepest and oldest freshwater reservoir – is in the focus of several large-scale national and international multidisciplinary projects (e.g. BDP-Members, 1997; BDP-Members, 2005). Here we present the new detailed and adequately dated Late Glacial-Holocene pollen records from Lake Baikal and smaller neighboring lakes. The results of the biome reconstruction along with quantitative reconstruction of the four bioclimatic variables – mean temperature of the coldest month T_c , mean temperature of the warmest month T_w , mean annual precipitation P_{ann} and moisture index α , are presented. The biome reconstruction shows that tundra and steppe biomes have the highest scores during ca. 15,000–13,300 cal. years B.P. and that taiga becomes a dominant vegetation type after ca.

13,300 cal. years B.P. The most favorable warm and wet climate has been reconstructed for ca. 9000–7000 cal. years B.P. During this time interval taiga started to be a dominant biome in the region. After ca. 6500 cal. years B.P. the climate reconstruction shows a decrease in all reconstructed variables. The minima in Tc, Pann and α values are reconstructed at ca. 6000 cal. years B.P. and a major decrease in Tw is dated to ca. 5500–5000 cal. years B.P. An interval between 6000 and 4000 cal. years B.P. is characterized by relatively high scores of the steppe biome with a short-term oscillation around 5000 cal. years B.P. corresponding to a short-term interval with a slight increase in precipitation and the moisture index. The reconstruction demonstrates a more or less gradual increase in winter and summer temperatures and a decrease in precipitation and the moisture index from ca. 5000 to 2500 cal. years B.P. Reconstructed changes in the winter temperature correlate well with changes in the sea level and global ice volume, while the summer temperatures derived from the lake pollen records track changes in the summer insolation.

Keywords: biome reconstruction method, best modern analog approach, Early-Mid-Holocene climatic optimum, inter-regional comparison with global stratotype sections.

SS16-O07 (89)

Palaeo-palynology of late quaternary peat deposit from Lower Bengal Basin, India: A palaeoecological approach

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Palynological evidences are recognized as a logical deduction of palaeo-climatic inference as the ecosystem, especially coastal vegetation is so specialized that any minor changes in hydrological or tidal influences cause drastic variations in the vegetational succession. Sedimentological and biological characteristics in terms of pollen/spore analysis of the peat along with dating of subsurface deposits are highly instructive in reconstructing the vegetational history, ecological status and palaeoenvironment of the quaternary period. A quantitative estimation and comparative study of fossil pollen morphology was carried out with an objective towards the assessment of past vegetation and their similarity, if any with the modern habitat. In the present study, palaeopalynological investigation accompanied with ^{14}C dating of undisturbed borehole peat samples collected from Garia, a suburb of Calcutta (Lower Bengal Basin), located in the extreme southern part of the city (88° 23' 58.15" E and 22° 28' 1.45" N) which is neighboring of the world's largest mangrove forest, the Sundarbans. Bore-hole samples were radiocarbon dated and the three successive peat layers (7000 \pm 170 yrs. B.P. to 2650 \pm 150) yrs. B.P.) were considered for pollen composition analysis. Pollen data indicates the existence of typical mangrove vegetation in and around Calcutta, which are presently confined to the Sundarbans forest, the further south of the studied area. The lower most peat layer (ca. 7000 – 6500 yrs B.P.) reveals that the vegetation sequence was comparatively uniform and mainly comprised of typical mangrove families such as *Heritiera*, *Rhizophora*, *Sonneratia*, *Excoecaria*, *Phoenix pludosa* and grasses, implying insignificant fluctuations in climatic conditions. The middle layer indicates a mixed vegetational type of fern spores, mangroves and some terrestrial plants (e.g. *Acanthus*, *Cynometra*, *Suaeda*, and grass). The lower part of the middle peat layer (ca. 6450 – 6100 yrs B.P.) consisted of marshy habitat as evidenced by fern spores, whereas their absence in the upper part implies relatively dry environmental conditions. The upper peat layer (ca. 2600 yrs B.P.) is dominated by grass, pollen grains terrestrial habitats (*Typha*, *Cassia*, *Eucalyptus*, *Deamodium*, *Salicornia*, Fabaceae and Rhamnaceae) and some of typical mangroves (*Heritiera* and *Excoecaria*). Low amounts of fern spores indicating the Lower Bengal change towards the terrestrial habitats. The pollen/spore assemblages in the three successive peat layers indicate the presence of

typical mangrove vegetation, of the type currently observed in the Sundarbans region. Frequent sea water inundation mixed with fresh water flow from the northern upstream at the low lying topography of Basin seems to have led to the formation of peat by deposition rather than by drifting.

Keywords: late Quaternary, Lower Bengal Basin, mangroves, pollen grains, Sundarbans.

SS16-O08 (394)

Sedimentological, palynological and stable isotope evidences of palaeoclimate and sea level records in the Holocene sedimentary archives of Central Kerala, SW India

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The interactions of palaeoclimate and sea level oscillations have significant impact on the geomorphic evolution of the coastal environments. A better understanding of the chronologic events of these changes is utmost essential for ensuring accuracy of the climate /sea level prediction systems developed essentially from instrumental measurements. The present study is confined mainly to the sedimentological, palynological and stable isotopic ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) evidences of palaeoclimate and sea level records in the Holocene sedimentary archives of the Central Kerala coast falling within the lowlands of Periyar river- the longest river in Kerala. The Holocene deposits in the study area are composed mainly of sand and clay dominant sediments with an age range of 5390 ± 140 yrs BP to 10110 ± 80 yrs BP. The palynological and non- pollen palynomorph assemblages in the sediments together with the textural attributes indicate that Holocene sedimentation took place under fluctuating environmental settings with markedly changing climate and sea level conditions. Pollen signatures of *Cullenia exarillata* and Euphorbiaceae indicate prevalence of wet evergreen forests during the Early Holocene, followed by ecological shifts as shown by desmids and *Botryococcus*. The scarcity of wet evergreen elements and occurrence of Thecamoebians towards Late Holocene are attributed to reduced rainfall. The stable isotopic results exhibit an increasing trend towards the top of the cores indicating predominance of organic detritus derived from high order plants in the hinterlands. The degraded marine organic detritus in the upper half of the bore hole core shows that marine transgression and inland beach build up in the latter part of Early Holocene. The upper sandy layer with broken and unbroken molluscan shells of littoral origin reiterates this view.

Keywords: coastal dynamics, borehole cores, biological and physical proxies, rainfall.

SS16-O09 (129)

Recent (1483 to 1994) variability of gonyaulacoid-peridinioid cysts, in the Gulf of California, Mexico

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The stratigraphic record of peridinioid (P) and gonyaulacoid (G) dinoflagellate cysts during the last

~500 years, in the southern Gulf of California, Mexico allows to assess their potential relationship with environmental variables such as sea surface temperature, and upwelling conditions at a decadal scale. Samples from two cores of laminated sediments dated with ^{14}C , represent conditions in the area from 1483 to 1994, and were treated with normal palynological processing, without oxidation, and using *Lycopodium* spores for quantification. The palynological assemblages observed contain varied and abundant terrestrial and marine components. However, we focus on the abundance of P and G dinoflagellate cysts. There are 21 species of cysts in the cores, with a maximum concentration of 771 G and 3276 P cysts per gram of sediment. The most abundant species were *Brigantedinium* spp. and *Bitectodinium spongium*. Decadal variability of the G and P taxa shows a significant correlation with the northwesterly winds and with the sea surface temperature, indicating that the absolute abundances of these taxa are greater during periods with common upwellings. Additionally, the G/P relationship shows an increase in G-cysts related to higher sea surface temperature, while P increases during periods of lower SST.

Keywords: dinoflagellate cysts, Holocene, upwelling, sea surface temperature.

SS16-O10 (352)

Holocene landscape change from the seasonally Dry Tropics of north-eastern Australia

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The Kinarra site is a wetland situated within the seasonally Dry Tropics of north-eastern Australia, which was formed as a result of a basalt flow damming a spring-fed creek and is located in close proximity (within 100 km) to the well studied Atherton Tableland region, which has several long palynological records (extending past the Last Glacial Maximum) for the Wet Tropics of north-eastern Australia. Pollen and charcoal analysis was undertaken on a three metre core that was extracted from the wetland and provides an almost complete Holocene (i.e. last 10,000 years) record of landscape change for the Dry Tropics on north-eastern Australia that can be directly compared with the existing records from the Wet Tropics. Alterations in sclerophyll forest, grassland, salt-marsh and aquatic taxa appear to reflect climatic alterations, possibly associated with changes in the Australian monsoon linked to climatic variability associated with the El Niño Southern Oscillation (ENSO) phenomena. In addition, changes in the carbonized particles may provide insight into the relative impacts of natural climate and human fire regimes on the Holocene environments of the seasonally Dry Tropics on north-eastern Australia.

Keywords: palynology, fire regimes, seasonally Dry Tropics, environmental impacts, Holocene.

SS16-O11 (256)

Holocene vegetation dynamics in southwestern India: palynological and palaeoecological appraisal of terrestrial and marine archives

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Palynological signatures decoded from the sedimentary archives have been analyzed while addressing the vegetation responses to monsoon variations during the Holocene. The sea level oscillations coupled with climate change have significant impact on the land forms and associated vegetation development and accordingly both the marine and fresh water palynomorphs have been used as proxies. The qualitative and quantitative analyses of the palynological contents and other microfossils have helped in identifying the ecological shifts, depositional environment and appraisal of vegetation dynamics. The subsurface palynological data from Kerala and Konkan basin undoubtedly proved that the entire terrain west of the Sahyadri was thickly forested during the Holocene climate optimum (HCO) ca 9000 - 5000 yrs BP. The pollen signatures and their relative abundance of wet evergreen forest members, *Cullenia exarillata* (Bombacaceae), *Fahreneita zeylanica*, *Agrostistachys meeboldii* (Euphorbiaceae) and *Lophopetalum wightianum* (Celastraceae) in all the studied intervals indicate improved and extended southwest and northeast monsoon during the Early Holocene. High rainfall coupled with a rising sea level inundated >75% of the coastal plain land converting it into a veritable lagoon - lake system in Kerala with virtually abrupt termination of the forest ecosystem towards Middle Holocene. The dated peat layers and sub-fossil logs in the wetlands of Kerala add testimony to the above episode. The marine palynomorphs and dominance of mangrove elements in the Middle Holocene sequence suggest that the greater part of the land has been modified for establishment of mangroves between 6250 and 3880 yrs BP. Such mangrove development seems to be of global significance as Mid-Holocene establishment of mangroves has been well recorded elsewhere when sea level got stabilized during this period. The decline of mangroves since 3500 yrs BP and further degradation have been attributed to the prevailing arid climate and weakening of monsoon system until 1500 yrs BP. There is a progressive reduction of terrestrial inputs and a corresponding increase in the marine / brackish elements towards the Late Holocene which is attributed to reduction of rainfall since 6 - 5.5 k yrs BP. Palynological evidence of the Late Holocene (< 3,000 yrs BP) fluvio-lacustral sediments reveals that the evergreen forest persisted until Late Pleistocene could not reappear / rejuvenate in Konkan due to reduced monsoon. The pollen spectra reflect that the Late Holocene sequence has mainly C4 type of vegetation as compared to abundance of C3 vegetation of the Early - Middle Holocene.

Keywords: Pollen signatures, tropical evergreen forests, mangroves, climate change, SW-NE monsoon systems.

SS16-P01 (423)

**Palynological behaviour of teak (*Tectona grandis* Linn. F.) and sal (*Shorea robusta* Geartn. F.):
An overview**

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Teak (*Tectona grandis* Linn. F.) of the family Verbenaceae and Sal (*Shorea robusta* Geartn. F.) of Dipterocarpaceae, both are important as well as dominating constituents of tropical deciduous forests of India, in general, and Madhya Pradesh, in particular, and are high pollen producers (Bhattacharya et al., 1999; Bera, 1990 and Atluri et al., 2004, respectively) but their pollen grains are retrieved in less frequencies in the sediments (surface samples, moss cushions, samples of profiles/cores, etc.).

This peculiar behaviour in the representation of their pollen grains could be attributed to poor (pollen) preservation in the sediments. However, microbial as well as chemical degradation of their pollen in the sediments cannot be ruled out. The study could be of importance, in addition to know about the pollen productivity of the concerned taxa, in assessing the representation of the taxa in extant vegetation which is helpful in establishing the pollen/vegetation relationship as well as in the appropriate explanation of the fossil pollen diagram for the reconstruction of past vegetation and climate.

Keywords: tropical deciduous forests, pollen productivity, pollen/vegetation relationship, pollen diagram, climate.

SS16-P02 (265)

Environmental change and anthropogenic activity from 2.6 kyr BP, evidenced by the pollen and charcoal record of Li-yu Tan, central Taiwan

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Pollen record sampled from Li-yu Tan, central Taiwan, provides valuable information of vegetation history, climate change, and anthropogenic activity from 2.6 kyr BP. The palaeovegetation record shows that uplands surrounding Li-yu Tan were dominated by subtropical evergreen forests from 2.6 kyr BP. Warm-temperate forest appeared prior to 2.3 kyr BP and between 1.6 and 1.2 kyr BP, given evidence for the relatively cool climate condition than today. Also, this study provides the first charcoal record in Taiwan which elucidates fire history around the lake. Fires related to dry condition occurred frequently during the interval 2.6 to 1.7 kyr BP, which is shown by continuous and stable charcoal influx as well as the appearance of *Artemisia* pollen, an index for dry condition. Between 1.6 and 1.2 kyr BP, fires were induced both by the dry condition and anthropogenic activity, evidenced by *Artemisia* and the emergence of agricultural pollen (*Poaceae* size >40 µm, *Melia*, and *Lagerstroemia*). The highly charcoal influx during this period also indicates the increase in charcoal production by anthropogenic activity near the lake. Fire events reduced during the interval 1.7 to 1.6 kyr BP and from 0.8 kyr BP. Moreover, the remarkable increase in agricultural pollen from 0.8 kyr BP indicates conspicuous impact of anthropogenic activity on the environment surrounding the lake, which caused the emergency of secondary forest components, such as *Mallotus* and *Trema*.

Keywords: biomisation, agricultural pollen, forest history, climate change, fire events.

SS16-P03 (535)

Holocene palynology in the Choshi area, Central Japan

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This study aims to clarify the vegetation change in the Holocene around the Choshi area with a particular focus on *Castanopsis* pollen under SEM. The murus variations of *Castanopsis* and

Castanea pollen are useful for present pollen identification. As the pollen analysis, the following four forests stages were recognized: 1) Deciduous broad-leaved pioneer forest (DBP) with *Castanopsis*, 2) Conifer and deciduous broad leaved mixed forest (CDBM), 3) Mid temperate forest with Laurel (ML), and 4) Pine secondary forest (Ps). The continuous vegetation changes were considered the result of soil disturbance on riverside and coastline change associated with the climatic change. The *Zelkova* – Elm dominated DBP, which occupied the disturbed area in the Post-glacial early period, and *Castanopsis* already distributed c. 8000 Cal BP with *Castanea*. Also, Araliaceae emerged sporadically, at the exposed coastal land due to transgression in the early period between c.10000 Cal BP and c.8000 Cal BP. Continuously, coniferous trees increased in DBP and changed to CDBM, after which *Cyclobalanopsis* appeared in the CDBM and ML developed around the upland area from c. 8000 Cal BP to c. 6000 Cal BP. Upon investigation however, the comparatively high coniferous pollen rate appears to be an overestimation in pollen sedimentation by the Neves effect; coniferous trees did not dominate the vegetation of the period. On the other hand, *Cyclobalanopsis* spread upland c. 7000 Cal BP and formed the ML, but it developed along the coastal area during a period of coastal regression c. 4000 Cal BP. In contrast, previous works (e.g., Oota et al., 1985; Matsushita 1991), have indicated that the Laurel forest existed c. 5500 yr. BP and that the Pine forest formed the dominant vegetation c. 4000 yr. BP, and have expressed the possibility that the circumstance was not related to human activities. Although this study acknowledges the development of Laurel forest c. 4000 Cal BP and human activity in the increased *Pinus* pollen c. 2000 Cal BP, due to a lack of sufficient data between c. 2000 Cal BP and c. 3000 Cal BP, c. 5000 Cal BP the time lag between the two works could not be examined.

Keywords: pollen analysis, deciduous broad-leaved pioneer forest, Laurel forest, *Castanopsis cuspidata*, SEM.

SS16-P04 (137)

Vegetation change in Rarotonga, Cook Islands

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Rarotonga is a small island in central Polynesia having the circumference of approximately 32km. The highest peak is 652 m above sea level and a lagoon extends several hundred yards to the reef that then slopes steeply to deep water surrounds the island. Merlin (1985) has divided the forests of Rarotonga into three principal types: 1) the *Homalium* mountain forest; 2) the *Fagraea*–*Fitchia* ridge forest; and 3) the *Metrosideros* cloud forest. We gathered marsh deposits in the coastal area for pollen analysis, and discussed the vegetation change of the island. The sampling point is a back swamp in a mangrove forest located in the northeast of the island (21° 12' 57.5"S, 159° 44' 23.1"W). The back swamp sediments are 340 cm deep: sandy peat from 0 to 90 cm, undegraded peat from 90 to 250 cm, and dark brown peat from 250 to 340 cm. *Barringtonia* and *Arecaceae* pollen grains are dominant in all layers. While *Barringtonia* pollen decreases rapidly in the upper part, *Arecaceae* pollen continues to increase. The appearance ratio of *Pandanus* pollen is high in the lower part, but it decreases rapidly in upper layers. The appearance ratio of herbal plants such as Gramineae and Cyperaceae is remarkable in the upper layers. Considering that *Barringtonia* and *Pandanus* grow in the hinterland of mangrove forests, decrease in *Barringtonia* and *Pandanus* and increase in herbal plants suggest a disturbance of the hinterland vegetation. The appearance ratio of *Arecaceae* pollen in this area increases. It is contemplated that the forest destruction proceeded over time and finally led to the spread of grassland vegetation.

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Keywords: pollen analysis, mangrove, Southeast Pacific, human impact, pollen morphology.