Annual Report

2013-2014



Birbal Sahni Institute of Palaeobotany, Lucknow

An Autonomous Institute under Department of Science & Technology
Government of India, New Delhi

We are grateful to
The Department of Science and Technology,
Government of India, New Delhi,
to
the Governing Body
and
the Research Advisory Council
of the Institute for
continued support and guidance

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2013-2014

1946

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ISSN No	:	0972 - 2726

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Produced by **:** Research Development and Coordination Cell (RDCC) & Publication Unit

October, 2014





BSIP at a *Glance*

Prof. Birbal Sahni, FRS established the Institute in the year 1946 for development of the science of palaeobotany visualizing its potential to understand the origin and evolution of plant life, and to use the knowledge of fossil plants in resolving various geologic problems, including exploration of fossil fuels. The institute is named after him as the Birbal Sahni Institute of Palaeobotany (BSIP). It is devoted to develop both basic and applied aspects of palaeobotany, and has adopted an integrated and multidisciplinary approach for fulfilling its aims and objectives:

- to develop palaeobotany, including palaeopalynology, in all its botanical and geological aspects,
- to constantly update the data for interaction with allied disciplines,
- to co-ordinate with other knowledge centres in areas of mutual interest, such as early life, exploration of fossil fuels, vegetation dynamics, climatic modelling, conservation of forests, etc., and
- to disseminate palaeobotanical knowledge.

BSIP's main mission is to achieve excellence in R&D work through a dedicated scientific team and continuous development of palaeobotany through integrated scientific approach with innovative ideas in basic and applied research; interpret the data gathered in relation to plant life evolution and geological processes, and to understand environmental evolution through time.

Research areas:

Initially, the Institute laid emphasis on fundamental aspects of Indian fossil floras. Later, the research activities were diversified to include biostratigraphic dating, correlation of surface and subsurface sediments, and exploring areas favourable for fossil fuel deposits. The main research work is concerned with the understanding of plant evolution through geological time. Emphasis has been laid to derive knowledge about the diversification of Precambrian life, diversity, distribution and inter-basinal correlation of Gondwana and Tertiary floras, coal/lignite quality and to understand the interaction between the climate and change of vegetation in Quaternary Period.

The palaeofloristic scenarios of bygone eras help us figuring out the past climatic and environmental changes. But it is important to tag these climate change events to a time scale. Scientists also study tree-rings to deduce palaeomonsoon/climate. Dating and study of samples of archaeobotanical interest is critical to understand the evolution of culture and civilization. Work is also done on the organic petrology to evaluate the quality of lignites/ coals for their economic utilization, besides depositional conditions. The samples for all these studies are collected from all over the globe including polar (Arctic/ Antarctic) regions.

The museum of the Institute is a rich repository of fossils collected from India and received from all over the world. A special attraction is the foundation stone with 77 fossils embedded by Prof. Sahni which was laid by Pt. Jawaharlal Nehru in 1949. The Institute boasts of one of the richest collection of literature on the subject. It has a herbarium for offering comparison between the past and present vegetation. It also has the radiocarbon dating laboratory, the only such national facility in the country. The Institute holds national/international scientific meets from time to time, and publishes catalogues, atlases, etc. on special occasions, besides an international journal *The Palaeobotanist* periodically. The Institute is presently functioning as an autonomous research organization under the Department of Science and Technology (DST), Ministry of Science and Technology, Government of India.

"*here we study not only fossil plants but also the rocks in which they are found*"

– Birbal Sahni (April 03, 1949)

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Foreword



It is a matter of great pleasure for me to present the 2013-14 Annual Report of the Birbal Sahni Institute of Palaeobotany (BSIP), a unique institution of international repute with a long history of research in past life and climates and several allied aspects. This document reflects our aspirations and endeavours.

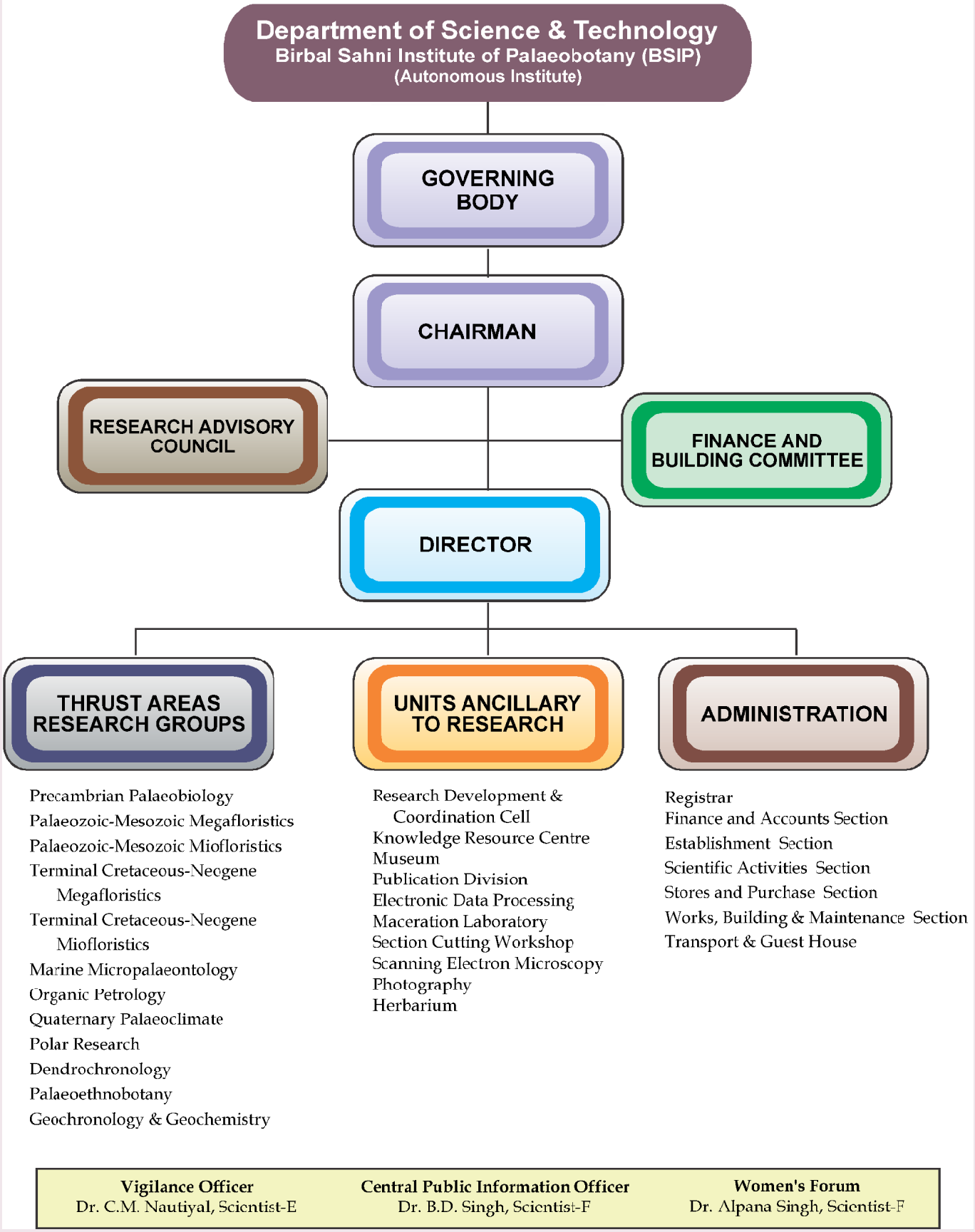
In recent years, research in the science of palaeontology, encompassing both palaeobotany and palaeozoology, has witnessed several important advances that essentially emphasize the much-needed multidisciplinary approach to our understanding of the evolution of life, ecosystems and climates through time. The spectrum of scientific issues and themes having an interface with the fossil data on plants and animals is truly remarkable, and encompasses diverse perspectives as origin, evolution and extinction of biota, palaeobiogeography, palaeoclimates, form and function, dating and correlation of rock formations, and many others. Also remarkable is the range of temporal and spatial resolution made possible by the fossil data, with studies ranging from individual organisms to larger taxonomic assemblages; ultrastructure to whole organisms; empirical to theoretical; local to global; and qualitative to quantitative. All this has been made possible through an integration of the fossil data with stratigraphy, sedimentology, isotope and organic geochemistry, tectonics, clay mineralogy, environmental magnetism, molecular phylogenetics, evolutionary developmental biology, and even biomechanics.

Recognizing the need to increase the scope of palaeobotany, plans are being drawn up to strengthen the existing as well as to develop new analytical infrastructure at BSIP, including instrumentation for geochemical analysis (elemental, isotopic, organic), Thermoluminescence Dating, XRD, Confocal Imaging System with Raman Spectroscopy. I am sure the new initiatives will go a long way in furthering our understanding of aspects relating to evolution, deep time as well and Holocene/Anthropocene climate change, palaeoecology, palaeobiogeography and other related areas.

I record my sincere thanks and acknowledgement for the dedicated efforts made by the Research Development and Coordination Cell (RDCC) of the institute with generous support from scientists and various technical and administrative sections of the Institute, in producing this document. Also, as always, the constant support from the Department of Science and Technology (DST), the Governing Body and the Research Advisory Council continues to be the source of our strength. We express our gratitude and look forward to their continued support.

(Sunil Bajpai)
Director

Organization Structure



Vigilance Officer	Central Public Information Officer	Women's Forum
Dr. C.M. Nautiyal, Scientist-E	Dr. B.D. Singh, Scientist-F	Dr. Alpana Singh, Scientist-F

Research Highlights

Birbal Sahni Institute of Palaeobotany (BSIP) is devoted to development of both fundamental and applied aspects of Palaeobotany and allied Earth System Sciences, especially focusing on past plant life, palaeoclimate and palaeobiogeography. Research on Palaeobotany and allied disciplines is being conducted on sedimentary sequences from Archaean to Recent (3200 Ma to 400 AD) with an integrated and multidisciplinary approach. To achieve the targets of the XII Five Year Plan, 14 thematic research projects have been continued under the umbrella of nine identified Thrust Areas:

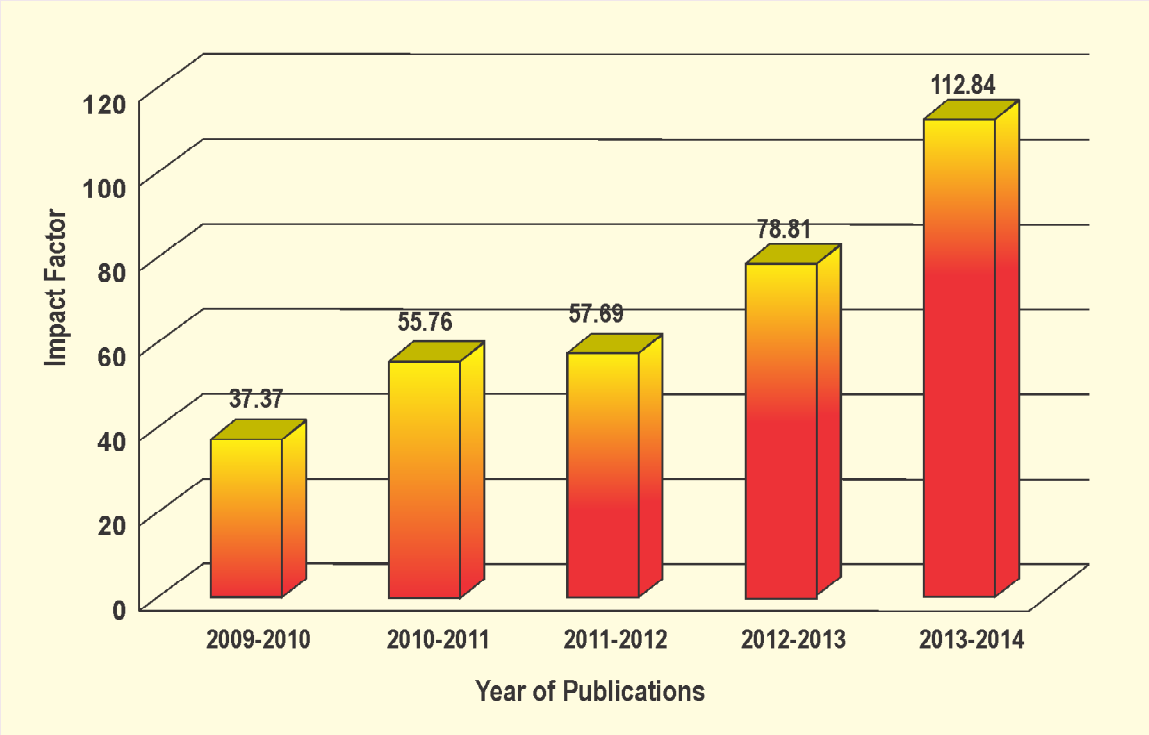
1. Early life and environment: Evidence from Indian Precambrian basins.
2. Phanerozoic terrestrial and coastal ecosystems: Biostratigraphical, palaeoenvironmental, palaeoecological and palaeobiogeographical aspects.
3. Integrative marine micropalaeontology: Focus on high resolution biostratigraphy, sea level changes, palaeo-oceanographic and palaeoclimatic events.
4. Organic petrology: Characterization of solid fossil fuel for depositional and utilizational aspects.
5. Quaternary palaeoclimate reconstructions, vegetation dynamics and relative sea level changes.
6. Domestication of plants, early farming and ecosystem dynamics during Holocene/ Anthropocene.
7. Geochronological and geochemical parameters for high resolution dating, correlation, palaeoclimatic, tectonic and provenance studies.
8. India-Asia collision and Himalayan uplifts: palaeobotanical and associated biotic signatures from sedimentary records of western Himalaya.
9. Preparation of books, catalogues, atlases, databases, digitization of library, museum, herbarium and other holdings.

Some of the significant outcome of scientific research during the year 2013-2014 are summarized as under:

- Demarcation of three biozones in the Early Cambrian succession of Rajasthan based on varied trace fossils recovered from the Nagaur Sandstone of Marwar Supergroup exposed in Dulmera quarry (Bikaner district).
- Assignment of an Early Cryogenian (800-700 Ma) age for the Semaria Formation of Bhander Group exposed around Kondar village, Karauli district (Rajasthan), based on the biotic remains.
- Discovery of a large number of in-situ preserved *Vertebraria* plant fossils in the grey shale indicates the presence of palaeosol in the upper part of Jhingurdah Top coal seam, Singrauli Coalfield (MP).
- Record of *Vertebraria indica* for the first time from Goutham Khani coal mine of Kothagudem area, Godavari Basin (Andhra Pradesh).
- Documentation of thecamoebians from the famous Permian-Triassic boundary Guryul Ravine Section of Kashmir, and their evolutionary and palaeoecological significance.
- Identification of two new species of Conifer taxa– *Araucarites raghavapuramensis* and *Pityospermum gadavarianum* from the Early Cretaceous Krishna-Godavari Basin.
- First report of permineralized thermally altered/un-altered specimens of cyatheaceous tree ferns from the Bhuj Formation (Early Cretaceous) exposed in Trambau, Kachchh district (Gujarat).
- Reconstruction of Early Cretaceous ecosystem from Trambau indicates that the area was well developed sub-tropical forest of conifers, cycadophytes, and tree ferns with understory ferns.

- Documentation of the spores-pollen assemblages from the Palaeozoic sequences of Godavari Valley (AP), Mand-Raigarh and Ramkola-Tatapani (Chhattisgarh), Ib-River (Odisha), South Karanpura (Jharkhand), and Johilla (MP) coalfields in order to work out their significance in biostratigraphical and palaeoenvironmental interpretations.
- Global correlation of the Early and Late Permian assemblages of Godavari Basin to find their equivalents in Antarctica, Australia, Africa and South America, which are all characterized by more or less similar palyno-compositions with minor discrepancies.
- Recovery of a megaspore assemblage from the early Triassic section of Ramkola-Tatapani Coalfield (Chhattisgarh), hitherto unknown from the sequence.
- Description of a new fossil leaf *Bridelia* of the family Phyllanthaceae from the Tertiary sediments of Assam. It is inferred that the genus evolved in India during the Late Oligocene and speciation took place during the Neogene. The emergence and speciation of the genus in Asia and Africa might be the result of climatic change during the Cenozoic.
- Description of a new fossils leaf species of *Uvaria* (Annonaceae) from the Early Eocene sediments of Gurha lignite mine, Bikaner district (Rajasthan). The genus is thought to be originated in Africa and the present finding gives an idea about its geologic distribution in Asia and Australasia via India relying on 'stepping stone' hypothesis.
- Assignment of an Early-Middle Ypresian age and reconstruction of various depositional environments such as fresh water swamp, mangrove swamp, open bay and restricted bay for the lignite-bearing Bhavnagar section (Gujarat), based on dinocyst, palynofloral and palynofacies records.
- Reconstruction of depositional environment of the Akri lignite-bearing sequence (Kachchh Basin). The results indicate that the lower part of sequence was deposited in a shallow marine environment, whereas the upper part under terrestrial environment close to mangrove vegetation, based on palynofossils records.
- Recovery of diversified palynoflora with new pollen assemblage of the family Dipterocarpaceae from the lignite-bearing sequence of Matasukh mine, Nagaur district (Rajasthan).
- Record of both Maastrichtian and Early Palaeocene palynofossils from the Deccan Intertrappean section near Anjar (Gujarat).
- Identification of parasequences in the Late Palaeocene carbonate succession of Lakadong Limestone Member exposed in two sections of Khasi Hills (Meghalaya), based on palynofacies study.
- Evidence for the earliest transgressive event in Kachchh Basin during Pleinsbachian, approximately 12 Ma earlier than Late Bajocian, based on nannofossil studies.
- Report on the occurrence of an ancient reef in Little Andaman Island through benthic calcareous algae and foraminifers from late Middle Miocene (Long Formation) sediments.
- Characterization of the Tertiary lignites from Matasukh (Rajasthan Basin) and Surkha (Saurashtra Basin) mines, and Permian coal from Koyagudem area (Godavari Basin).
- Documentation of as many as seven shifts in vegetation, climatic and human occupation through the pollen-spore analysis of Deepor beel sediment sequence from Kamrup district (Assam) for the last 13,083 cal BP.
- Elucidation of the inception of agrarian practices around 7,353 cal yr BP in Barehata Lake (Narsinghpur district, MP) and around 10,000 cal y BP in Lashoda Tal (Raebareli district, UP) areas, based on Cerealia pollen records from sediment profiles.
- Evidence showing that the middle part of Krishna River delta prograded and evolved since ~4 ka experiencing two intermittent relative sea level rise and fall during Late Holocene covering a distance of about 15 km from the present shoreline, based on pollen records.

- Evidence showing that the pollen of local vegetation (i.e. mangroves) are more dominant in the pollen spectra, which is strongly related to the proximity of source vegetation around Pakhiralaya village of Sundarbans.
- Report on the existence of a 185 km long palaeolake during the Late Quaternary (~20 ka BP) in the Ladakh Himalayas, occupying the present day Tangtse and Shyok River valleys, covering an area of 1,150 sq. km, based on multi-proxy studies.
- Evidence for the prevalence of a dense C3 species-dominated moist semi-evergreen forest in the Ziro Lake Basin, Arunachal Pradesh until the Last Glacial Maxima (LGM), based on pollen, phytolith and stable carbon isotopic data.
- Record of dinoflagellate cysts and thecamoebians from the Fjord sediments of Arctic region (Ny-Alesund, Svalbard), helpful in understanding the impact of warming induced melt water flow on the productivity of the Fjord.
- Dating of Kumaon Himalaya cedar (*Cedrus deodara*) tree core samples collected from Jageshwar resulted in the preparation of ring-width chronology extending back to AD 1536. The trees sampled from Gangolihat are relatively younger (AD 1668) to those in Jageshwar.
- Generation of the relationship of stream-flow records of Lachen River with tree-ring chronologies of *Larix griffithiana* from Lachen, North Sikkim (Eastern Himalaya).
- Evidence for the exploitation of botanical resources by ancient settlers through remains from ancient site Kampil, the capital city of Panchala in Farrukhabad district (UP) and from Khirsara, a Harappan site in Kachchh district (Gujarat).
- Dating of core samples from coral reef collected from off Jam Nagar coast in the range of about 3000 BC (calibrated) to modern.
- Development of an information system– Indian Gondwana Megaspore Information System for storage and retrieval of megaspore records in a selective manner.



Cumulative Impact Factor of Published Research Papers

Integrated collaborative research activities in several spheres with institutions in India and abroad (Brazil, China, Germany, Nepal, Russia, UK, USA, etc.) have helped to expand scientific knowledge. The collective research efforts are expressed in the form of 130 published papers. Three Ph.D. degrees were awarded during the year. One scientist was deputed abroad (Czech Republic) under Inter-academy Exchange Programme of INSA, and one scientist under Indo-Australian Senior Scientist S&T Visiting Fellowship. Director and one scientist were conferred with the National Geoscience Award–2012 of Union Ministry of Mines, Govt. of India for their outstanding contributions. Three scientists were awarded Third World Academy of Sciences-Chinese Academy of Sciences Visiting Scholar Fellowships to work at Institute of Botany, Beijing. Four scientists and one Project Fellow were deputed for attending various conferences abroad (in France, Germany, Iran, Poland, Russia and Spain). Forty-four scientists, 8 Birbal Sahni Research Scholars, and 6 Project Fellows were deputed to attend various national and international conferences/ workshops held in the country. About 150 research papers were presented in these scientific meetings at different centers of India and abroad. New initiatives have been taken to develop analytical infrastructure for elemental, isotopic and organic geochemistry and Thermoluminescence Dating.

A *Conclave on understanding the life of bygone eras: Emerging trends* was successfully organized during November on the occasion of Founders' Day celebration. The conclave was aimed to understand how biotic and abiotic researches may be utilized in solving issues of global importance. Several scientific posters were displayed during the conclave highlighting the Institutes' research activities. The 1st Symposium of the International Geoscience Programme Project (IGCP-608): *Cretaceous ecosystems and their responses to palaeoenvironmental changes in Asia and the Western Pacific* was also successfully hosted during December 2013. Besides, two short courses, one on the *Study of fossil soils*, and the other on *Acritarchs* were also organized in the Institute, conducted by the visiting scientists from USA. In collaboration with District Science Club (Lucknow), a Workshop on Science Writing was organized. An international Field Workshop on the Marwar Supergroup, Rajasthan was also successfully organized jointly with the Society of Earth Scientists, Lucknow.

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(w.e.f. 22.02.2011)

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Secretary
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(Reconstituted w.e.f. 11.03.2014)

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Prof. Sunil Bajpai
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Birbal Sahni Institute of Palaeobotany
Lucknow-226 007

Non-Member Secretary
Registrar
Birbal Sahni Institute of Palaeobotany
Lucknow-226 007



Prof. Deepak Pental, new Chairman, BSIP Governing Body

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(w.e.f. 01.04.2011 to 31.03.2014)

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Ex-Chairman, Geology Department, AMU
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Member-Convener (Ex-officio)

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Co-opted Member
Dr. Prabhash Pande
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Member (Ex-officio)
Deputy Director General
In-charge, Northern Region
Geological Survey of India
GSI Complex, Vasundhara
Sector-E, Aliganj, Lucknow-226 024

Finance and Building Committee

Chairman (Ex-officio)

Chairman, Governing Body
Birbal Sahni Institute of Palaeobotany, Lucknow

Members

Nominee of the Secretary, DST, New Delhi

Finance Adviser, DST, New Delhi

Shri Parvez Mahmood (till 10.03.2014)
Sr. Superintending Engineer
Laboratory Service Engineering, CDRI, Lucknow

Director
Birbal Sahni Institute of Palaeobotany, Lucknow

Non-Member Secretary

Registrar
Birbal Sahni Institute of Palaeobotany, Lucknow



Independence Day (August 15, 2013)

Republic Day (January 26, 2014)

Foundation Day

The Institute celebrated its 67th Foundation Day on September 10, 2013. On this occasion Shri S.K. Srivastava, Chairman and Managing Director, Oil India Limited, New Delhi delivered the "17th Jubilee Commemoration Lecture" on the topic *The Changing Scenario of Hydrocarbon Industry: Demand, Supply and Future Growth*.

Dr. S.B. Nimse, Vice-Chancellor, University of Lucknow, Lucknow presided over the function. Prof. P.K. Seth, Chief Executive Officer, Biotech Park, Lucknow and Prof. Mrinal K. Sen, Director, National Geophysical Research Institute, Hyderabad also graced the occasion as the Chief Guest and Guest of Honour, respectively. Many guests and scientists from outside the Institute attended the function. On this occasion, a number of Institute's medals were awarded to staff members.



Founder's Day

The Institute celebrated its Founder Professor Birbal Sahni's 122nd birth anniversary on November 14, 2013. On this day, the Institute's staff and distinguished guests from other organizations offered *Pushpanjali* on the *Samadhi* of Prof. Birbal Sahni, FRS in the campus.

On the same day, Prof. Gregory J. Retallack of Department of Geological Sciences, University of Oregon, Eugene, USA delivered the "43rd Birbal Sahni Memorial Lecture" entitled *Precambrian Life on Land.* Dr. S.W.A. Naqvi, FNA, Director, National Institute of Oceanography, Goa presided over the function. Many guests and scientists from outside the Institute attended the function.



Seward Memorial Lecture

Prof. Shuhai Xiao of the Department of Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, USA delivered the "59th Sir Albert Charles Seward Memorial Lecture" entitled *On the Eve of the Cambrian Explosion* on January 15, 2014. Several guests and scientists attended the function. On this occasion "Dr. B.S. Venkatachala Memorial Medal" was also awarded to Dr. M.F. Quamar, Scientist-B under the Young Scientist category of the Institute.



Conclave on Life of Bygone Eras

Over the years, considerable progress has been made by the BSIP in describing the fossilized remains of plants, assigning them taxonomic positions, evolutionary history based on the palaeobotanical data, and palaeoclimatic interpretations. It is generally recognized that in order to give shape to a larger, clearer picture of the past, classical palaeobotany has to be buttressed with diverse lines of investigation. This basic realization gave birth to the idea of a *Conclave on Understanding the Life of Bygone Eras: Emerging Trends*, which was successfully organised at BSIP during November 14-15, 2013 on the occasion of Founder's Day celebration. The Conclave was aimed to bring together seemingly different specializations that though look far apart at times, are in reality knitted together, and when worked upon together show considerable promise in solving issues of global importance. In order to achieve the set goals, experts from different fields were invited for delivering a series of lectures. In all, 13 talks were delivered by the scientists; followed by lively discussions related to the topics.

Biomechanics is one of the new tools in the area of palaeontology that has gained significance during the last decade. Dr. Sanjay Mishra (DST, New Delhi) talked about potential of biomechanics in the evolutionary studies. He showed that biomechanical investigations can be used to study the relationship between environmental demand and the physical or mechanical design of an organism; mechanical constraints under which the organism lived emphasizing functional significance with respect to evolutionary change.

Palaeobiogeography, an integrative field of inquiry that unites palaeoecology, evolutionary biology and plate tectonics, was put on view by Dr. Praveen Karanth (IISc, Bengaluru), who discussed about combining fossil studies with molecular systematics to date evolutionary divergence events. In his talk with few case histories he stressed that molecular phylogeny in conjunction with biogeographical analysis helps us to better understand the origin and evolution of Indian biota.

Dr. Manoj Prasad (NIPGR, New Delhi) elaborated about phylogenetic methods in plants that are now being used for estimating the relationships amongst the plant species. Organic biomarkers (= geochemical fossils) are molecules that have lost their functional groups but whose basic skeleton is preserved and can provide information of the class of organism from which they have derived.

Dr. Suryendu Dutta (IIT, Mumbai) spoke about the utilization of organic biomarkers in palaeochemotaxonomic studies in solving palaeobiogeography of Dipterocarpaceae plant family. Knowledge of extant plant and animal diversity patterns along with their ecological preferences are a prerequisite to correctly understand the past ecosystem.

Dr. Jayshree Ratnam (NCBS, Bengaluru) illustrated the functional ecology of mixed tree-grass ecosystem and described how fossil studies can help in understanding the long term effect of climate change on mixed tree grass Savannah ecosystem.

Identification of facies and sedimentological studies help in the correct assessment of depositional environment in plant and animal fossil studies. Palaeosol (or fossil soil) is soil that formed on a landscape of the past. Dr. B.P. Singh (BHU, Varanasi) explained the use of palaeosol studies in palaeoclimatology. He illustrated how palaeosol studies can be utilized for the estimation of ancient mean annual precipitation and pCO_2 values. Dr. Subir Sarkar (Jadhavpur Univ., Kolkata) emphasized significance of microbial studies in Precambrian rocks.

Climate change is one of the major concerns for humans today. Dr. D.K. Upreti (NBRI, Lucknow) showed that lichenometry is an upcoming potential tool to document climate change in Alpine regions of India. Dr. Neloy Khare (MoES, New Delhi) brought out the use of multiproxy studies in palaeoclimatology. Dr. Rajeev Saraswat (Delhi University) illustrated the use of Ba/Ca ratio of foraminifera in ocean studies for higher resolution palaeoclimatic interpretations.

Since the cryosphere plays a significant role in global climate and in climate model response to global changes, Dr. Thamban Meloth (NCAOR, Goa), making use of geochemical investigations showed that Antarctic ice core records can provide reliable proxy data of atmospheric circulation, temperature, precipitation and sea-ice condition of the past that effectively extend beyond the instrumental records.

Dr. Debajyoti Paul (IIT, Kanpur) showed that stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotopic compositions of carbonate nodules and $\delta^{13}C$ values of bulk sediment organic matter of alluvial sediments from Ghaggar plains, NW India can be utilized for the interpretation of variability in the intensity of SW Indian monsoon and palaeovegetation patterns during Late Quaternary. Finally, Dr. Shailesh Agrawal (BSIP) by providing a case history from Ganga plains showed that the $\delta^{13}C$ values of selected long-chain fatty acids can help in the reconstruction of palaeovegetation.

The Conclave contributed significantly to our understanding of the role of biotic and abiotic factors in the evolution of life.


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Symposium on Cretaceous Ecosystems

The 1st Symposium of the International Geoscience Programme Project (IGCP-608): *Cretaceous Ecosystems and their responses to Palaeoenvironmental changes in Asia and the Western Pacific* was successfully hosted by BSIP during December 20-27, 2013. The Project IGCP-608 (short title: *Asia-Pacific Cretaceous Ecosystems*) aims to enhance understanding of the Asia-Pacific Cretaceous marine and terrestrial ecosystems and their responses to palaeoenvironmental changes based on the study of well-preserved geological records through a variety of lithological, biotic and geochemical proxy data. The major objectives are to discuss and delineate variations and evolution of the Cretaceous ecosystems in Asia and the Western Pacific region. In view, the Symposium was aimed to review the current state-of-the-art knowledge of Cretaceous geology and paleontology in Asia, especially south Asia as part of the first year activities under IGCP 608.

The Symposium and related post-Symposium field trip brought together over 45 earth scientists and research scholars from India, Japan, Mongolia, South Korea and Vietnam. Altogether 35 scientific papers were presented including 4 poster presentations. An abstract volume with 41 contributions was produced in advance of the meeting. Additionally, a Field Guide entitled *Bagh-Lameta Sequences of Central and Western India*, prepared by Sunil Bajpai, Rahul Garg, S.C. Tripathi & D.M. Mohabey, was also produced for the excursion. The booklet outlined the current state of knowledge regarding the upper Cretaceous Bagh–Lameta Beds and the overlying Deccan Trap succession in central and western Indian peninsula.

The Inaugural Function was presided over by the Chief Guest, Shri S.K. Sharma, Deputy Director General, Northern Region, Geological Survey of India. Prof. Sunil Bajpai, Director and Co-leader of IGCP-608 welcomed the delegates attending the Symposium. Prof. Hisao Ando of Department of Earth Sciences, Ibaraki University, Japan introduced the theme of the project IGCP 608, and released the Abstract Volume. Prof. G.V.R. Prasad, Regional Co-ordinator from India also addressed the audience highlighting the significance of research activities on the Indian Cretaceous successions under the project. The Field Guide for the post-Symposium field excursion was released by Prof. Yong Il Lee of Seoul National University, Korea.

Scientific deliberations, spread over seven scientific sessions during 20th to 23rd December, covered diverse themes including invertebrate and vertebrate palaeontology, palaeobotany (fossil flora and palynology), micropalaeontology, palaeobiogeography, biotic evolution, taphonomy, palaeoecology, sedimentology, geochemistry, palaeoenvironment, tectonic evolution, oceanic anoxic events, mass extinctions and time boundaries of terrestrial and marine Cretaceous sedimentary records from Japan, South Korea, Vietnam, Mongolia and India. All the presentations generated very lively discussions and interactions amongst the participating delegates and also benefited the young researchers attending the Symposium. The scientific sessions were followed by the business meeting to plan and discuss future course of activities regarding scientific meetings and field excursions under the project in other countries. In the last, Dr. Tohru Ohta of Japan made an excellent presentation welcoming delegates to the next 2nd International Symposium of IGCP-608, to be held during September 04-10, 2014 at the Department of Earth Sciences, Waseda University, Japan.

A four day field excursion was undertaken during December 24-27, 2013 after the scientific meeting at BSIP. During the field excursion, several sections of the fossiliferous Cretaceous non-marine to shallow-marine Bagh-Lameta sequences (9 Excursion Stops in the Bagh area), and the dinosaur fossil-bearing localities (2 Excursion Stops in the Balasinor area) were visited that witnessed lively discussions and interactions amongst the participants. These sequences consist of the famous Bagh Beds (Turonian-Coniacian) with a prolific marine fauna and the overlying dinosaur-bearing Lameta Formation (late Cretaceous; Maastrichtian). The overlying Deccan Trap succession with sedimentary Intertrappean beds and Red Bole succession were also visited. The visit to Balasinor included Dinosaur Fossil Park at Rahioli, a government protected site for *in situ* dinosaur fossil remains and egg nests. During the field excursion, the necessity of synthesizing the palaeogeographic and palaeoecological reconstructions on the basis of the detailed and precise stratigraphic works was emphasized by several delegates.

Prof. Sunil Bajpai (Director), Dr. Rahul Garg, Dr. Jyotsana Rai, Dr. Neeru Prakash, and Dr. Shailesh Agrawal accompanied the delegates in the post-Symposium field excursion, and collected samples (rocks/

fossil woods) from various members of Bagh and Lameta sedimentaries. The valedictory meeting of the Symposium was held at the Gir Foundation, Gandhinagar, which was followed by a visit to its park containing fossils and models of dinosaurs collected from the nearby areas in the State of Gujarat.

The details of the activities of the IGCP-608 can be accessed from its official website (http://igcp608.sci.ibaraki.ac.jp/). The Symposium provided a unique opportunity for discussions and overviews on diverse aspects of the Indian and other Asian Cretaceous marine and terrestrial successions.



Outreach Activities

In collaboration with District Science Club (Lucknow), a five day Workshop on *Science Writing* was organized at BSIP which was inaugurated on July 12, 2013 by Dr. H.S. Das, IAS, Principal Secretary, Science and Technology (UP). The workshop was attended by over 40 practicing and aspiring journalists as well as scientists. The Chief Guest emphasized the role of science communication and science journalism in the society and exhorted the participants to constantly upgrade and enhance their skills and knowledge to be able to help in transferring the benefits of science to the society. Prof. Sunil Bajpai, Director BSIP chaired the session and said that with media penetrating deeper and wider, its role becomes more and more critical. Renowned geologist Prof. Ashok Sahni spoke on climate change and its impact on human beings. Shri S.K. Singh, Project Director, Rural Development for Lucknow also addressed



the session and highlighted the collaborative effort and appreciated the active support provided by the Institute. The academic coordinator of the programme Dr. C.M. Nautiyal outlined the programme and the philosophy behind the exercise. The inaugural session was attended by several senior scientists and officers from Institute, Council of Science & Technology-UP and Geological Survey of India (Northern Region), and District Science Club coordinator Shri R. Srivastava. During the course of workshop, several senior scientists and journalists from reputed establishments imparted training on various media, formats and aspects related to science writing.

As in the previous years, Science Day-2014 was celebrated through a series of activities for the Institute staff as well as the city students. An essay competition was organized on the topic *How to promote Scientific Temper* for school and college students. A total of 62 entries were received in Hindi and English.

On Science Day (28th February), 108 students from 12 schools of Lucknow submitted entries for the 'On the Spot Slogan Competition' on the theme *Nurture Scientific Temper*. The students were briefed about the background of Science Day and Prof. C.V. Raman's Nobel winning discovery of Raman Effect by the Science Day Convener Dr. C.M. Nautiyal. A film on the Arctic Expedition was shown to the visitors and staff with an introduction by Dr. Mukund Sharma. The film showed the participation of Dr. M.N. Bose, former Director of the Institute in the Arctic Expedition as early as 1962.



The winners of the essay and slogan competitions were awarded prizes by Prof. Sunil Bajpai, Director of the Institute. In his address, Prof. Bajpai encouraged students to opt for science and said that now enough opportunities and funding are available for the bright students willing to put in sincere efforts. The day was observed as Open House and hundreds of students and their teachers and parents visited various laboratories, museum and herbarium of the Institute.



Research

Thrust Areas and Projects

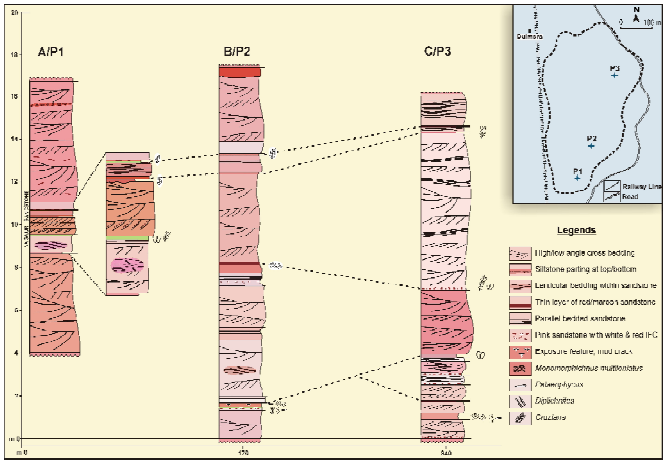
Thrust Area 1: EARLY LIFE AND ENVIRONMENT: EVIDENCE FROM INDIAN PRECAMBRIAN BASINS

Precambrian Palaeobiology Group

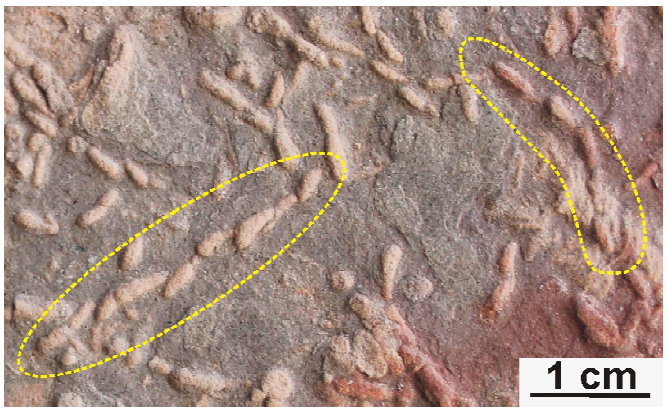
Project- 1.1: Palaeobiological, biostratigraphical and evolutionary aspects of the Precambrian biota: Evidence from Neoproterozoic basins of India

Investigators : Mukund Sharma, S.K. Pandey, A.H. Ansari & Bandana Dimri

Varied trace fossils, recorded from the Nagaur Sandstone of Marwar Supergroup exposed in Dulmera quarry of Bikaner district (Rajasthan), have been studied. The assemblage includes *Rusophycus, Cruziana, Chondrites, Dimorphichnus, Monomorphichnus, Diplichnites, Skolithos, Palaeophycus, Gyrphyllite, Lockeia, Merosstomichnites, Psammichnites,* few trail and scratch marks. On the basis of present assemblage, three biozones have been demarcated in the Early Cambrian succession of Rajasthan. These are – i) *Cruziana* zone, ii) *Monomorphichnus* zone, and iii) *Rusophycus*, *Cruziana*, Worm zone. The comprehensive lithologs of quarry sections exposed at Dulmera have been prepared. Statistical analyses, photo-documentation and line sketches have been completed for the recorded fossils assemblage. True affinities of Microbially Induced Sedimentary Structures (MISS) of Sonia Sandstone are being examined. A detailed paper has been prepared on the MISS and distribution and significance of *Monomorphichnus multilineatus*. At present Marwar Supergroup has been considered Ediacaran-Cambrian succession.



Lithologs depicting measured sections of the Nagaur Sandstone (P1, P2, P3) in Dulmera quarry



Well preserved *Treptichnus pedum* exposed on the bedding plane of brick colour Nagaur Sandstone, yellow dotted ellipse shows two such clusters of trace fossils

With newly inducted scientific personnel in the project, a new line of investigation on the genesis of cherts is being explored to determine the behaviour of chert deposition through geological history (silica isotopes as proxy). The Precambrian cherts found associated with carbonates are targeted for the measurement of silica isotope. Besides, problem of genesis of chert in the Salkhan Limestone of the Vindhyan Supergroup exposed in the Son Valley has been taken with palaeobiological perspective. Petrographic thin sections (170 in number) of bedded, stromatolitic and cherty stromatolites collected from Salkhan, Jatashankar, Badgaon and Newari areas of Sonbhadra district have been studied. Various types of microfossils found in three different types of cherts are recorded. Carbonate samples (57) of Pataudh area, Sonbhadra district have also been studied, seven samples revealed the presence of β quartz; indicating the addition of high temperature silica in the depositional realm.

Project- 1.2: Meso-Neoproterozoic palaeobiology of Chambal Valley of Vindhyan Basin, Rajasthan

Investigator : Rupendra Babu

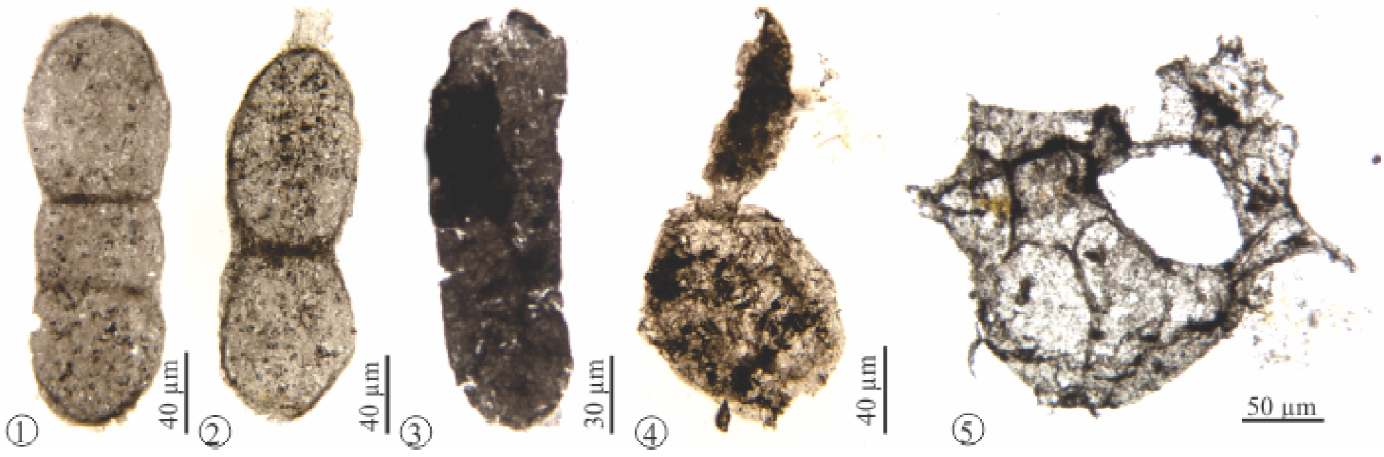
Samples of different formations of Bhander Group exposed in Karauli-Sapotra-Dholpur sub-basin (north-eastern part of western Vindhyan Basin) have been studied for biotic assemblages, biorelics (algal mats & stromatolites), and for sedimentary structures (ripple marks & mud cracks). Biotic and sedimentary signatures were found in shales, siltstone and chert of the Semaria Formation exposed in Kondar village, Karauli district. The microbiotas have been studied in thin sections and macerated residues of rock samples. Rich and diversified microbiotic assemblage, in macerated residue of grey shales, comprises abundant acritarchs– sphaeromorphs (simple & ornamented, 7 species) and acanthomorphs (5 species) as well as low amount of prokaryotes (colonial algae & rare filaments). The various types of recovered cyanobacterial remains (solitary & colonies) are compared well with known forms of *Myxococcoides, Eoentophysalis, Eomicrocoleus Oscillatoriopsis* and *Palaeolyngbya*. In addition, the small-medium sized dolomitic stromatolites have been identified as *Collenia columnaris* and *Collenia baicalica*, based on field observations and through thin section study. The recovered microbiota, preserved in the laminae of stromatolites, comprise of different prokaryotes, eukaryotes (acritarchs) as well as appendages of juvenile (larval stage) of arthropods. Different microbial sedimentary structures (algal mats) have been characterized on the bedding surface of light green-grey brown silty shales belonging to upper part of the Semaria Formation.

Based on the critical analysis of recovered biota and sedimentary structures, an early Cryogenian (800-700 Ma) age has been interpreted for the Semaria Formation, besides variant depositional environments to the sequence. The similar data are also known from the equivalent sediments of Australia, China, Namibia Spitsbergen and Russian platforms. The preserved microbiota particularly spinated acritarchs, VSM, larvae of arthropods and consuming activity of arthropods based on the low frequency of algal filaments are being recorded for the first time from the dolomitic stromatolites of the Bhander Group.

Project- 1.3: Palaeobiological investigations of the Proterozoic Chhattisgarh Supergroup in Khariar Basin and Barapahar Protobasin

Investigators : Mukund Sharma & V.K. Singh

Exceptionally well-preserved and diversified microbial assemblages have been recorded from the Chhattisgarh Supergroup exposed in Bargarh district (Odisha). Their implications and evolutionary status in Proterozoic biosphere are documented. *Jacutianema-Tappania* bearing organic-walled microfossils (OWMs) association has been studied from the lower and upper heterolithic successions of the Chhaporadih Formation belonging to the Chandarpur Group. The assemblage was dominated by eukaryotic remains represented by large



Neoproterozoic OWM– *Jacutianema solubila* Butterfield (1 – 3), *Germinosphaera unispinosa* Jankauskas (4), *Tappania* sp. (5)

size sphaeromorphs and acanthomorphs (spinated) belonging to Sphaeromorphitae, Polygonomorphytae, Pteromorphitae and Acanthomorphitae subgroups of acritarchs and followed by prokaryotes. The overlying Kansapathar Formation has yielded moderately well-preserved *Leiosphaeridia-Trachysphaeridium* (Sphaeromorphs) type OWMs, followed by lesser number of unicellular prokaryotes. The prokaryotes, in both the assemblages, comprise coccoidal and filamentous microfossils belonging to cyanobacteria. Geochronologically, the base of the Chandarpur Group is known as the Mesoproterozoic (?1641 ±120 Ma) however, the biostratigraphic correlation of recovered OWMs from the Chhattisgarh with other known global occurrences indicates Neoproterozoic age of the sediments. In addition, dolerite dykes in the Chandarpur Group at Pandkipali, Samardarha Nala and Karla sections and volcanic tuffs in the underlying Singhora Group at Samardarha village section have been collected.

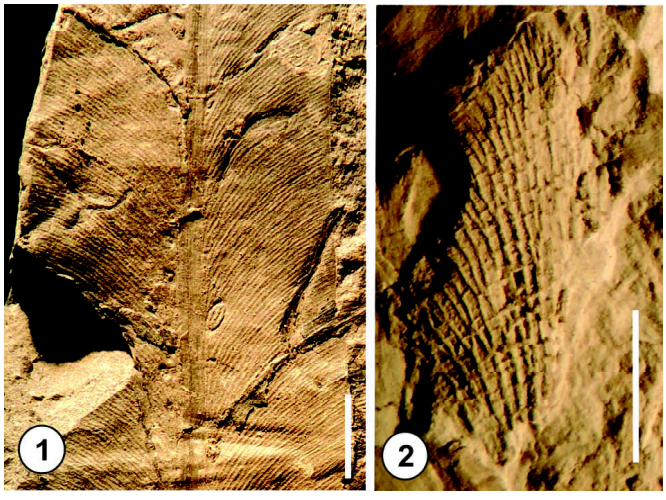
Thrust Area 2: PHANEROZOIC TERRESTRIAL AND COASTAL ECOSYSTEMS: BIOSTRATIGRAPHICAL, PALAEOENVIRONMENTAL, PALAEO-ECOLOGICAL AND PALAEOBIOGEOGRAPHICAL ASPECTS

Palaeozoic-Mesozoic Megafloristics Group

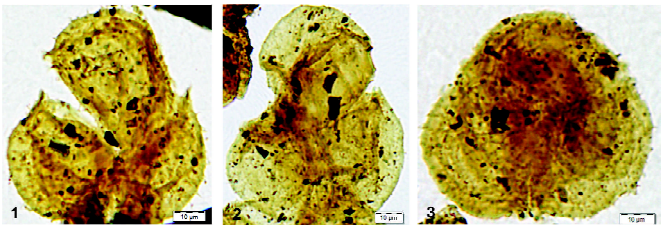
Project- 2.1: Palaeofloristics and palaeoecology of Palaeozoic rocks of Singrauli and Kuresia coalfields (Son-Mahanadi Basin) and northwest Himalayas (Himachal & Uttarakhand)

Investigators : K.J. Singh & Anju Saxena

Detailed analysis of megafossil assemblage from the Bina and Jhingurdah collieries of Singrauli Coalfield has revealed the occurrence of *Noeggerathiopsis*, *Euryphyllum*, *Macrotaeniopteris*, *Glossopteris* and *Vertebraria*. *Glossopteris* is represented by 27 species (22 in Jhingurdah & 10 in Bina), and the rest with one species each. Five *Glossopteris* species (*G. gigas*, *G. tenuifolia*, *G. browniana*, *G.* cf. *G. feistmanteli* & *G. communis*) are common to both the collieries. All the *Glossopteris* species are either narrow or middle mesh forms and relatively smaller in size. Jhingurdah assemblage also includes *Macrotaeniopteris*, ?*Euryphyllum*, Equisetalean axes and many vertically preserved *Vertebraria* axes (55 specimens). The occurrence of such a large number of in-situ preserved *Vertebraria* specimens in the grey shale indicates the presence of palaeosol in the upper part of Jhingurdah Colliery.



1. *Glossopteris tenuifolia* with insect gall impression from Raniganj Formation, Jhingurdah Colliery, 2. An impression of insect wing recovered in association with fossil leaves



Tetrad spores recovered from the Turra Seam, Bina Colliery

Palynological analysis of the subsurface samples from the top of the lowermost Turra Seam in Bina Colliery has revealed the dominance of non striate bisaccate pollen taxa *(Scheuringipollenites)*, subdominance of striate bisaccate *(Faunipollenites)* followed by other palynomorphs in the palynoassemblage. These strata are comparable with the *Scheuringipollenites barakarensis* palynozone of Lower Barakar Formation of Damodar Basin, and indicate an Early Permian age (Artinskian). The palynoassemblage from the Jhingurdah Top Seam shows the dominance of striate bisaccate *Striatopodocarpites*, subdominance of *Faunipollenites* followed by *Distriatites* and *Striamonosaccites* equating these beds with the *Gondisporites raniganjensis* assemblage zone of Raniganj Formation in Damodar

Basin, assigning a Late Permian age (Lopingian). A large number of tetrad spores have also been reported from the Turra Seam assignable to the dispersed microspore genera *Indotriradites*, *Microbaculispora* and *Microfoveolatispora*. This is the first report of such tetrads from the Lower Barakar Formation of Indian Gondwana. In addition, a field excursion to the coalfield has been undertaken in five other collieries (Nigahi, Block-B, Dudhichua, Khadia & Krishnashila) and collected about 250 megafossil specimens from the exposed carbonaceous and grey shale beds.

Project- 2.2: Palaeobotanical investigations from Johilla and Sohagpur coalfields, South Rewa Gondwana Basin: Implications for basinal correlation and evolutionary, biostratigraphical and palaeoecological aspects

Investigators : Rajni Tewari, S.S.K. Pillai & Deepa Agnitotri

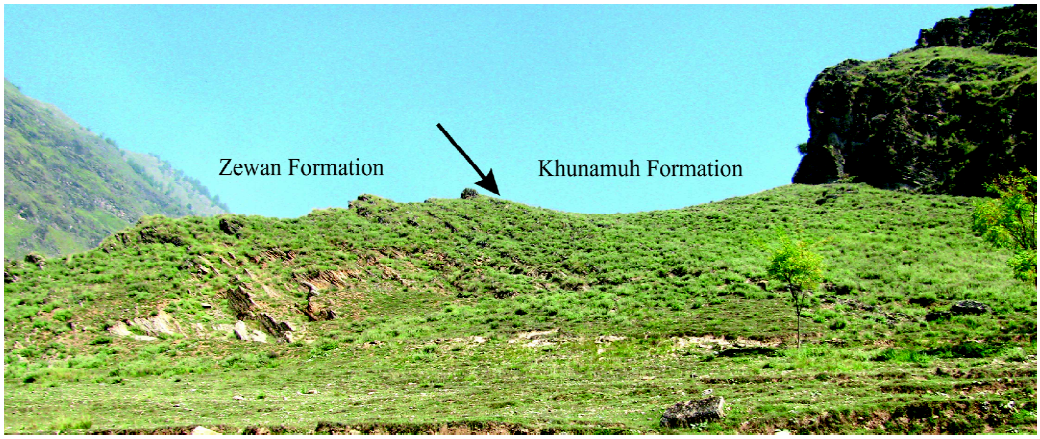
The mega- and microfossil studies have been carried out from the Early Permian sediments of Johilla River-Ganjra Nala confluence of the Johilla Coalfield (MP). Megafloral assemblage is represented by *Gangamopteris major, G. cyclopteroides, Glossopteris indica, G. gigas, G. conspicua, G. mohudaensis, Noeggerathiopsis hislopii, Samaropsis goraiensis, Cordaicarpus zeilleri, Alatocarpus indicus,* few platyspermic seeds and Equisetalean axis. The palynological assemblage shows the dominance of monosaccate pollen (*Parasaccites, Plicatipollenites* & *Pachysaccus*) in association with *Callumispora gretensis, Crucisaccites monoletus, Barakarites indicus, Faunipollenites varius, Lunatisporites diffusus* and *Crescentipollenites fuscus*. Study of these mega- and microfossils suggests an Early Permian age equivalent to basal Barakar Formation. Plant megafossils, collected from the Late Permian Pali Formation of Sohagpur Coalfield, have been grouped, cleaned, sorted and tentatively identified. The megafloral assemblage yielded a good number of *Gangamopteris* and *Glossopteris* species. Detailed study including morphotaxonomy and systematic analysis of the flora is in progress. Chemical processing of samples for recovery of palynomorphs was also carried out (with Ram Awatar & Saurabh Gautam). However, no microfossils were recovered.

About 400 samples collected from Burhar VI top seam of Dhanpuri Colliery (lat. 23°12', long. 81°40'), and IV and VI seams of Sharda Open Cast Mine of Sohagpur Taluk, Shahdol district (MP) have been grouped, cleaned and sorted. Tentative identification of the megafloral elements indicates presence of the orders– Equisetales, Filicales, Glossopteridales, Cordaitales, Ginkgoales and Coniferales, and include the genera *Phyllotheca, Dizeugotheca Gangamopteris, Glossopteris, Noeggerathiopsis, Buriadia,* and seeds, besides equisetaceous stems. Photo-documentation, morphotaxonomy and systematic analysis of the floral components and chemical processing of the samples for recovery of palynomorphs are in progress.

Project- 2.3: Mega- and microfloristics of the Permo-Carboniferous sediments of Kashmir Region: Evolutionary, biostratigraphical, palaeoecological and palaeophytogeographical implications

Investigators : Rajni Tewari, Ram Awatar, S.S.K. Pillai, Deepa Agnihotri & Kamlesh Kumar

Studies on palynology and sedimentary organic matter from the Permian-Triassic boundary sequence of the Guryul Ravine Section (Kashmir) have been finalized (with SK Pandita**,** Stephen McLoughlin, GD Bhat & Vartika Singh). The palynoassemblage from the Late Permian Zewan Formation (C & D Members) includes trilete, striate/ non striate bisaccate and taeniate grains. The presence of stratigraphic marker palynotaxa, *Densipollenites magnicorpus* and *Klausipollenites decipiens* palynoassemblage zones indicating Late Permian and Early Triassic affinities, respectively, are identified from the Unit E_1 of the Khunamuh Formation (Early Triassic). The Unit E_2 comprises the trilete ornamented, monosaccate, non striate bisaccate and taeniate grains. Occurrence of some of the Late Permian palynomorphs like *Faunipollenites, Alisporites* and *Lunatisporites* in the Early Triassic indicates their resilience towards the changing climatic conditions. The organic matter study represents a continuous record of structured and unstructured remains throughout the



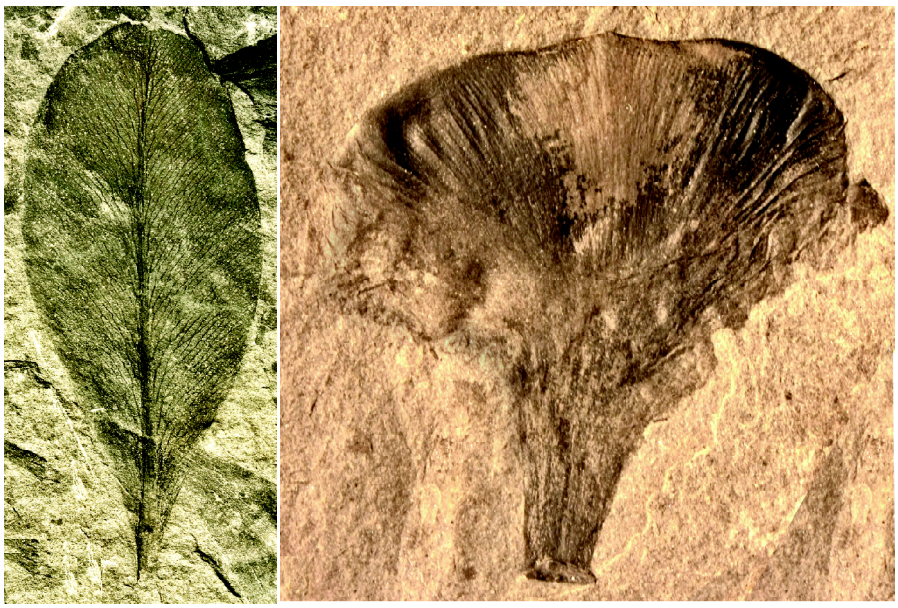
section, and indicates both terrestrial and marine conditions. A near shore palaeoenvironment is indicated.

Investigations carried out on the thecamoebians recovered from the Zewan and the Khunamuh formations reveal their resemblance with the members of the families Centropyxidae and Arcellidae. However, majority of them belong to the family Centropyxidae. The study, besides manifesting the hardy nature of the thecamoebians which survived the Permian-Triassic catastrophe, attests their evolutionary and palaeoecological significance, and adds to the faunal record at the PT boundary section. In addition, petrographical studies carried out on samples from the same section to decipher the depositional environment and eustatic sea level change across the boundary reveal presence of good amount of quartz, biogenic calcite, muscovite, etc. in the Zewan Formation. Whereas, negligible quartz and other accessory minerals are noticed in the Khunamuh Formation, besides few Fe/S oxides; indicating the reducing environment. Besides, Field work has been undertaken in different Carboniferous and Permian sections exposed in Anantnag and Srinagar districts of Kashmir region. Faint impressions of Lycopsids and equisetalean axes have been collected from Kotsu Hills (near Kunjdori village). Palynological samples have also been collected from *Fenestella* shale sections (Early Carboniferous) and type locality of Mamal Formation (Early Permian). Well-preserved leaves of *Gangamopteris*, *Glossopteris*, *Cordaites*, equisetalean axes and seeds have been collected from the carbonaceous shales of Nishatbagh Formation (Early Permian). Rock samples have also been collected from this sequence and from P/T boundary Guryul Ravine section (exposed near Khunamuh village) for palynological and geochemical studies.

Project- 2.4: Gondwana floristics of India (Wardha-Godavari Basin) and Antarctica: Evolutionary, biostratigraphical, palaeoecological and palaeophytogeographical significance

Investigators : Rajni Tewari & Arun Joshi

Result of Late Permian and Triassic palynomorphs from the Allan Hills, central Transantarctic Mountains, South Victoria Land, Antarctica has been finalized (with Ram Awatar, Sankar Chatterjee, SSK Pillai, KL Meena & Deepa Agnihotri). The palynomorphs retrieved from the Weller and Lashly formations have been investigated for precise age determination. Forty-five different groups of palynomorphs have been recovered from these formations. The palynoflora of Weller Formation shows dominance of striate bisaccate pollen; suggesting a Late Permian age, which was earlier assigned an Early Permian age. The finding is



Glossopteris browniana (left) and Scale leaf of *Eretmonia* from Weller Formation, Antarctica

corroborated by similarity of palynoassemblage with that of the Upper Stage-5 (Late Permian) of Australia. The younger palynoassemblage of the Lashly Formation contains *Klausipollenites*, *Falcisporites* and *Alisporites* in prominence; indicating Early to Middle Triassic age, and showing affiliation with *Aratrisporites parvispinosus* zone of Australia, *Alisporites* zone (A&B) of Feather Conglomerate and Fremouw Formation of Antarctica. Detailed investigations on plant fossils from the Weller Formation have also been carried out (with Sankar Chatterjee & Deepa Agnihotri). The *Glossopteris* floral assemblage from the area is highly diverse and comprises pteridophytes (Calamitales & Equisetales of sphenopsids) and gymnosperms (represented by Glossopteridales, Cordaitales & Ginkgoales). The flora is dominated by the Glossopteridales, represented by 9 species of the genus *Gangamopteris*; 35 species of *Glossopteris* with 2 new species and 5 scale leaves. The orders Cordaitales and Ginkgoales are represented by one taxon each.

Morphotaxonomical analyses of plant fossils collected from Prakasham Khani (OCP II & OCP IV) of Manuguru area and Goutham Khani OCP of Kothagudem area, Andhra Pradesh have been carried out (with SSK Pillai & Deepa Agnihotri). The megafloral assemblage of Prakasham Khani includes the genera *Glossopteris* (with 10 species), *Noeggerathiopsis*, *Cordaites*, *Phyllotheca*, *Vertebraria* and Equisetalean axes. Systematic description of *Vertebraria indica* collected from Goutham Khani OCP has also been done, which has been recorded for the first time from this area. Its occurrence indicates existence of a rich *Glossopteris* floral assemblage. Interestingly, no other megafossils are found in Goutham Khani OCP.



Vertebraria indica

Project- 2.5: Palaeobiology of Mesozoic Gondwana of Pranhita-Krishna-Godavari basins

Investigators : A. Rajanikanth & Chinnappa Chopparapu

A detailed systematic study on diversification patterns of Vemavaram Formation, Krishna Depression (Krishna-Godavari Basin) has been carried out and palaeoecological and palaeoenvironmental conditions of deposition have been inferred. Floristic studies have helped to establish some new species of plant taxa, namely *Dictyozamites ommevaramensis, Ptilophyllum heterophylla, Elatocladus loyolii, Pagiophyllum ommevaramensis* and *Thinnfeldia ommevaramensis*, enriching the floristic diversity. Diversity and ecology of gymnosperms from Gangapur Formation have been studied, and a new species of plant taxon *Elatocladus andhrii* has also been systematically described. Detailed study on composite diversity of entire Early Cretaceous Krishna-Godavari Basin has been carried out. Two new species of Conifer taxa–*Araucarites raghavapuramensis* and *Pityospermum gadavarianum* have been identified. Taphonomic implications of the flora are under consideration. Besides, flora of continental Jurassic of India has been synthesized and its stratigraphic and chronographic significance have been analysed. Comparative xylotomic studies on Jurassic wood flora of India have also been carried out.

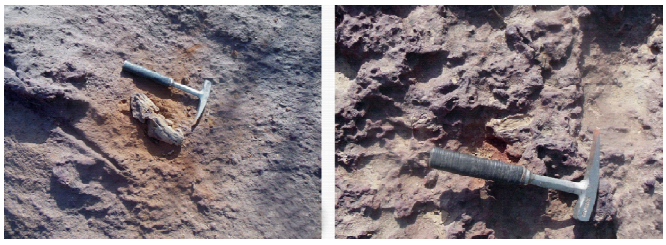


Gymnospermous twig of *Pagiophyllum ommevaramensis* n. sp. from the Vemavaram Formation, Krishna-Godavari Basin

Project- 2.6: Mesozoic palaeofloral diversity, biostratigraphy and palaeoclimatic studies in Saurashtra and Kachchh basins

Investigators : Neeru Prakash & Neelam

Permineralised thermally altered and un-altered specimens of cyatheaceous tree ferns are reported for the first time from reddish compact sandstone of Bhuj Formation (Early Cretaceous) exposed in Trambau, Kachchh district (Gujarat). It is observed that the parenchymatous cells in cortex have been distorted due to shrinkage of protoplasmic materials. Fossil of *Trapa* like fruits have also been recovered from coarse grained sandstones of Daduamota plant fossil locality. They are obcuneate in shape, have spiny upper and lower horns, hilum of peduncle seen, sometimes fruits are also found attached with peduncle. Permineralised fossil woods have been recorded from Gangtabet of Kachchh. Sections studied under high power light microscope revealed two types of gymnospermous fossil woods– *Araucarioxylon wagadaensis* (possess 2-5 araucariod type), and *Podocarpoxylon gantabetaensis* (possess 2-5 podocarpoid cross field pits).



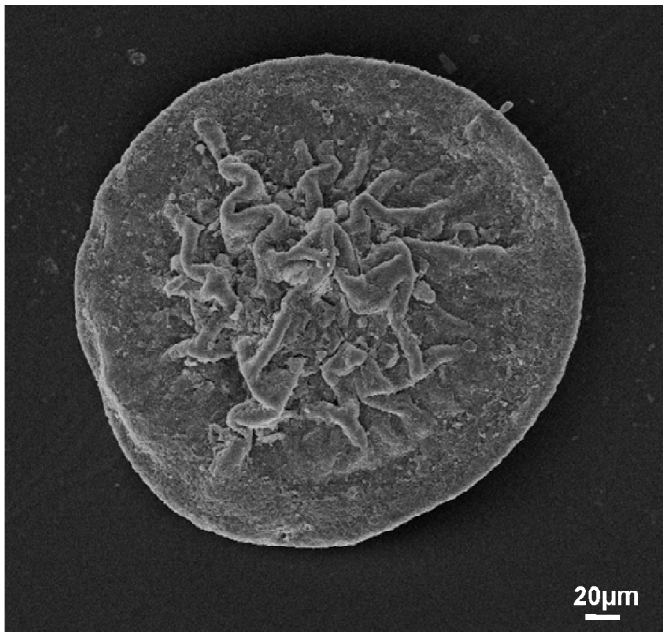
Cyatheaceous fossil wood associated with sandstone of Bhuj Formation (Kachchh)

In continuation with earliest record of *Williamsonia* flower, one more closed type of flower *Williamsonia* has been found from Nara Shale Member (Washtawa Formation) of Callovian-Oxfordian age. After Sahni's record of *W. sewardiana*, this is a first cast of closed flower of *Williamsonia* recorded from Kachchh. Its detailed morphotaxonomic study and vegetational scenario of bennettitalean forest has been carried out. In addition, rock samples have been macerated and observed under microscope. They are found full of microspores with few megaspores and dispersed cuticles.

Project- 2.7: Floral diversity, biostratigraphy and palaeoecology of the Triassic sequence from South Rewa (Ramkola-Tatapani Coalfield) and Satpura Gondwana basins

Investigators : A.K. Ghosh, Ratan Kar & Reshmi Chatterjee

Samples from the Permo-Triassic section of Ramkola-Tatapani Coalfield have been processed for the study of megaspores, miospores and cuticles. Megaspore assemblage is hitherto unknown from this stratigraphic unit of early Triassic. A megaspore assemblage has been recovered from the studied section, characterized by species of the genera– *Banksisporites*, *Noniasporites*, *Paxillitriletes*, *Bokarosporites*, *Nathorstisporites*, *Erlansonisporites* and *Horstisporites*. The assemblage has been correlated with other known Peninsular Triassic megaspore assemblages. Besides, an attempt has also been made to reconstruct the palaeoecology based on the assemblage. Palynological resolution of the megaspore yielding sediments has also confirmed an early Triassic age. The palynoassemblage zone is marked by the presence of genera such as *Falcisporites*, *Playfordiaspora*, *Klausipollenites* and other associated palynomorphs. In addition, field work has been undertaken in the coalfield, and collected Khaki coloured shales (from the early Triassic succession), bearing the compression



SEM of *Noniasporites* sp. a megaspore (in proximal view)

and impression of megafossils. Rock samples have also been collected from the measured sections for the study of megaspores and palynomorphs. The megaflora is represented by *Dicroidium* sp., *Yabiella* sp., *Desmiophyllum* sp. and small sized leaves of *Glossopteris* sp. Isolated seeds, cuticles, detached pinnules have also been recovered from the sediments. Samples have been photographed and further study is in progress. Smaller sized *Glossopteris* and *Dicroidium* have been observed in the same bedding plane.

A restudy of the megafloral assemblage of the Parsora Formation has also been done. The megafloral elements have been reassessed, and based on the palaeofloristics the age of the Parsora Formation has been redefined. Besides, a critical review of the literature reveals that the specimens of *Dicroidium* Gothan described so far from India requires reassessment, because similar specimens have often been placed under different species names and sometimes dissimilar elements have been assigned to the same species. In view of this, a thorough analysis of Indian *Dicroidium* has been undertaken based on fresh collections together with materials worked out by previous workers.

Palaeozoic-Mesozoic Miofloristics Group

Project- 3.1: Palynology of Gondwana sediments of Satpura–Wardha-Godavari basins: Biostratigraphical, palaeoenvironmental and palaeophytogeographical implications

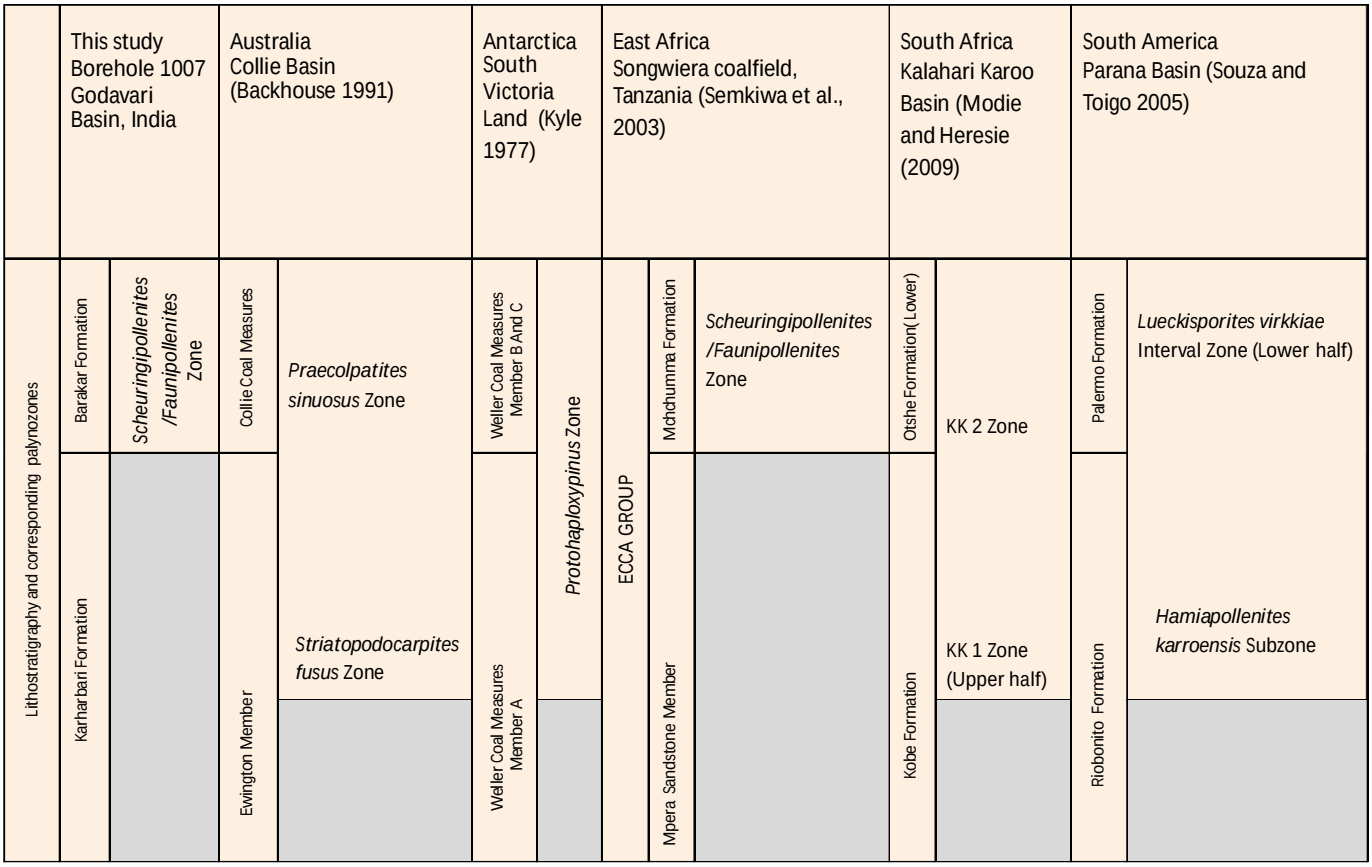
Investigators : Neerja Jha, K. Pauline Sabina, Neha Aggarwal, Harinam Joshi & Shreya Mishra

Palynological and dispersed organic matter (DOM) studies have been carried out in subsurface sediments of Chintalapudi area (Godavari Basin). In bore-core MCP-9, an Early Permian (Asselian-Sakmarian) Talchir palynoflora, and in MCP-8 Late Permian Raniganj palynoflora is recorded. Some unidentified operculate pollen grains are also recorded in the core samples of MCP-7 and MCP-8. In addition, processing of samples (102) from bore-core MSP-21 of Sattupalli area has been done for recovery of palynomorphs. Quantitative and qualitative study of spores-pollen is in progress. Eight distinct palynozones belonging to Talchir (*Parasaccites* palynozone), Lower Karharbari (*Callumispora* + *Parasaccites* palynozone), Upper Karharbari (*Parasaccites* + *Scheuringipollenites* palynozone), Barakar (*Scheuringipollenites* palynozone), and Raniganj (*Faunipollenites* + *Striatopodocarpites* palynozone, *Striasulcites* palynozone, *Parasaccites* palynozone & *Crescentipollenites* palynozone) have been identified in Lingala-Koyagudem Coalbelt of Godavari Basin. Correlation of these palynozones with other Gondwana continents indicates existence of two coal horizons.

Global palyno-correlation of the *Scheuringipollenites-Faunipollenites* assemblage of the Early Permian Barakar Formation (Artinskian) from Manuguru area of Godavari Basin has been worked out to find its equivalents in Antarctica, Australia, Africa and South America, which are all characterized by more or less similar palyno-composition with minor discrepancies. These discrepancies have been attributed to different palaeolatitudinal belts occupied by each basin during the Early Permian and also due to local ecological factors. The Late Permian palynoassemblages from various bore-cores of Chintalapudi sub-basin have also been globally correlated. Results indicate that the Raniganj Formation of the Godavari Basin is equivalent to certain Late Permian palynoassemblages of Antarctica, eastern Australia, Africa and South America.

DOM studies in bore-core MLG-23 from Gundala area of Godavari Basin show that the charcoal and degraded terrestrial are the main constituents. Spore-pollen and structured terrestrial occur in moderate frequencies, whereas amorphous and fungi are very low. Distribution pattern of palynofacies and absence of marine elements suggest the lacustrine and intertidal environment (oxidizing to partially oxidizing conditions) of deposition. Palynological analysis of bore-cores (SGK-2, SGK-3 & SGK-4) suggests Upper Karharbari (Late Sakmarian-Early Artinskian) palynoflora in lithologically designated Lower Barakar Formation. Similar studies in bore-cores MGP-4 and MGP-11 of Gauridevipet area (Chintalapudi sub-basin) indicate dominance of sub-arborescent/ arborescent vegetation; suggesting development of forest swamp probably in a small distant marginal part of the mire or periods of standing water. This flooding environment favoured the growth of herbaceous lycopsids, filicopsids and sphenopsids in the palaeomire.

Palynomorphs from megafossil bearing sediments of bore-core MJR-11 have revealed a Jurassic-



Correlation of the *Scheurinipollenites/Faunipollenites* assemblage of selected Gondwana regions

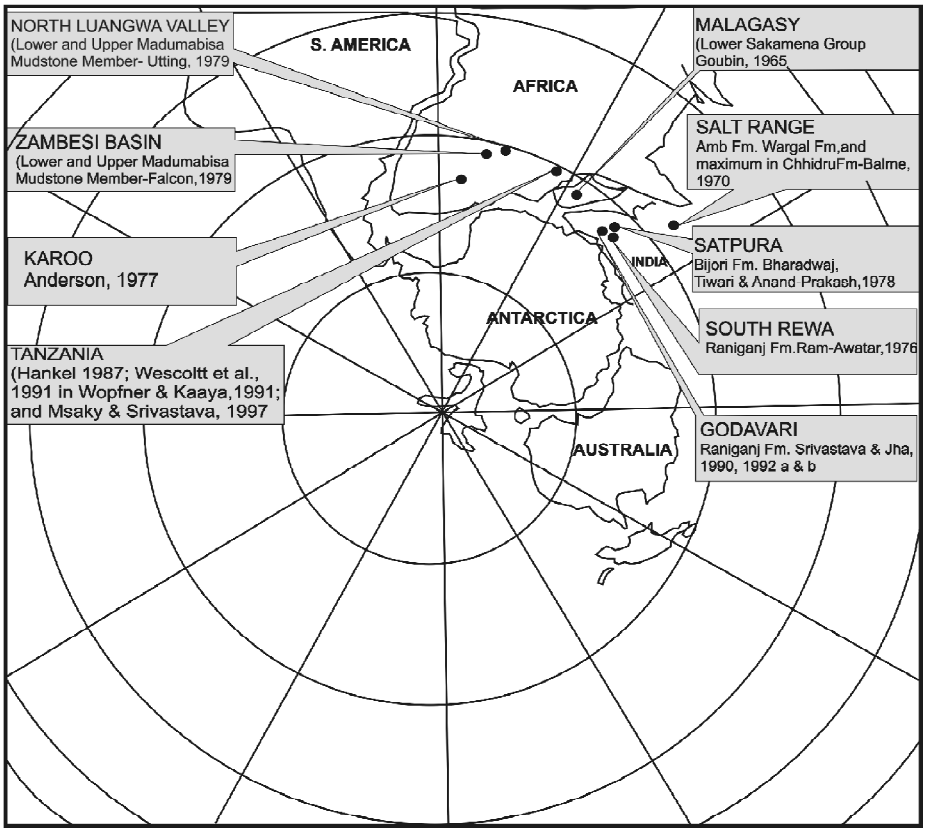
Cretaceous age to the sediments, based on the presence of various species of *Callialasporites, Contignisporites, Cicatricosisporites, Coptospora, Dictyophyllidites*, etc. Studies for finer age resolution are in progress. Fungal remains (fruiting bodies, fungal spores & mycelia) and megaspores exosporia, along with Jurassic-Cretaceous spores-pollen, have also been observed in these sediments of Jangareddygudem area (Chintalapudi sub-basin). The fungal remains recorded in sediments may be rendered for the environmental interpretations. In addition, qualitative analysis of samples from Nibugudem area has revealed the presence of *Callialasporites* spp. *Cicatricosisporites* sp. *Classopollis* sp.; indicating Late Jurassic-?Early Cretaceous age.

Project- 3.2: Palynostratigraphy, palaeoclimate and evolutionary trends of palynofloras in Gondwana sequences of Son-Mahanadi–Damodar basins

Investigators : Ram Awatar, K.L. Meena & Srikanta Murthy

Palynofloras recorded from the Barakar Formation encountered in bore-core MBKW-3 of Barpali-Karmitikra Block of Mand-Raigarh Coalfield (Son Basin) has revealed three distinct palynoassemblage zones– i) *Gondisporites raniganjensis* (latest Permian), ii) *Faunipollenites varius* (latest Early Permian), and iii) *Scheuringipollenites barakarensis* (late Early Permian). The First Appearance Datum (FAD) of *Arcuatipollenites pellucidus, A. ovatus, Guttulapollenites hannonicus, Lundbladispora microconata, Alisporites opii, Klausipollenites* sp., and *Goubinispora indica* (at 41.95, 45.90, 98.35 m depths) indicate the closing phase of Permian, as these are the key species that mark a transition from Permian to Lower Triassic. An attempt has also been made to reconstruct the phytogeographical provincialism on the basis of *Guttulapollenites*, which is a key taxon recorded in the basin.

A rich assemblage of megaspores and miospores, recorded from the bore-core IBKAN-2, has denoted the Early Triassic age to the sequence in Kuraloi Block-A of Ib-River Coalfield (Odisha). The miofloral assemblage



Distribution of stratigraphically significant and geographically restricted palynotaxa during Late Permian time showing *Guttulapollenites* palaeophytogeographic province in the central part of Gondwana (after Jha, 2006).

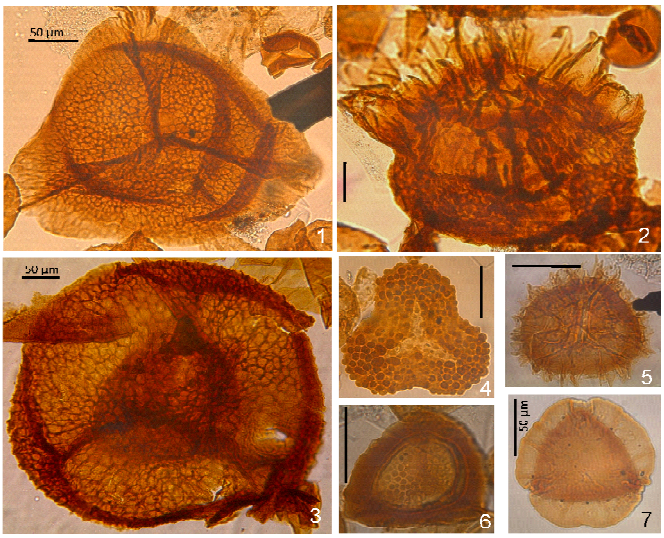
includes *Alisporites* in dominance, and *Klausipollenites*, *Gondwanipollenites*, *Weylandites* are in sub-dominance along with associated taxa. The assemblage is comparable with the palynoassemblages of the same age known from the Damodar Basin of India. Samples from the bore-core IBKAN-4 have also been studied palynologically. In addition, two palynoassemblages have been recovered from the bore-core TCS-6 drilled in Talcher Coalfield (Mahanadi Basin). The palynoassemblage-I has *Faunipollenites* as dominant form, and *Scheuringipollenites* as the subdominant genus; showing resemblance with Upper Barakar Formation. The palynoassemblage-II shows a high frequency of *Densipollenites* and *Striatopodocarpites*, followed by *Scheuringipollenites, Lahirites, Distriatites,* etc.; suggesting affiliation with the Barren Measure Formation of the Permian sequence in the coalfield.

Two distinct palynoassemblages have been identified from bore-core SKB-1 drilled in Binja Block of South Karanpura Coalfield (Damodar Basin). Palynoassemblage-II in the lithologically designated Barren Measures and Barakar formations (between 552.00-53.20 m depth) shows dominance of striate bisaccate (*Striatopodocarpites, Crescentipollenites* & *Faunipollenites*), and abundance of non-striate bisaccate (*Scheuringipollenites*). Upward, the Palynoassemblage-I (39.50-13.80 m depth) is rich in striate bisaccate, and significant enveloping monosaccate (*Densipollenites magnicorpus*) pollen. These strata have been equated with the Raniganj Formation (Late Permian). The FAD's of *Guttulapollenites* spp. (at 49.10 & 504.70 m), *Goubinispora morondavensis* (at 415.90 m), and *Alisporites ovalis* and *Arcuatipollenites* sp. (at 526.70 m) is also suggesting Late Permian age. The FAD of *Arcuatipollenites pellucidus, Playfordiaspora cancellosa, Alisporites* sp., *Falcisporites* sp. and *Krempipollenites indicus,* observed at 13.80 and 39.50 m depth, marks the transition of Permian into the Lower Triassic.

Project- 3.3: Sedimentary organic matter, palynofloral characteristics and depositional environments of the Early Cretaceous sediments of Kachchh and Saurashtra basins

Investigator : Madhav Kumar

Sedimentary sequences of the Bhuj Formation (Early Cretaceous) exposed around Trambau village situated at 30 km NE of the Bhuj town of Kachchh district (Gujarat) have been studied for their palynological and palynofacies analyses. Four sections at different places containing thin seams of coal, carbonaceous shales, clay and siliceous clay, have yielded marker miospores, megaspores, pollen grains, colonies of algae (*Botryococcus brownii*), dinoflagellate cysts, and sedimentary organic matter (SOM). Megaspores and colonies of algae show dominance over miospores. Pollen grains and dinoflagellate cysts are comparatively better preserved in coal and carbonaceous shales. Various types of SOM (structured terrestrial, biodegraded terrestrial, amorphous, resins, black debris & charcoalified plant fragments) are abundant in the assemblages. A combination of data derived from quantitative and qualitative analyses of palynofloras, dinoflagellates and palynofacies in the samples from each strata help in deciphering biostratigraphy of sections situated at different heights and the role of edaphic and environmental factors during their deposition. The palynofloras recorded, along with *Botryococcus* and dinoflagellate cysts, indicate their deposition along the estuarine swamps. On the basis of frequency analysis of all palynotaxa, it is inferred that vegetation around Trambau area of Kachchh during Early Cretaceous was well developed sub-tropical forest of conifers, cycadophytes, and tree ferns with understory ferns. Such vegetation was thriving around the swamps situated along the coast. These swampy areas were occasionally flooded with fluvial and brackish water during deposition of the various sediments.



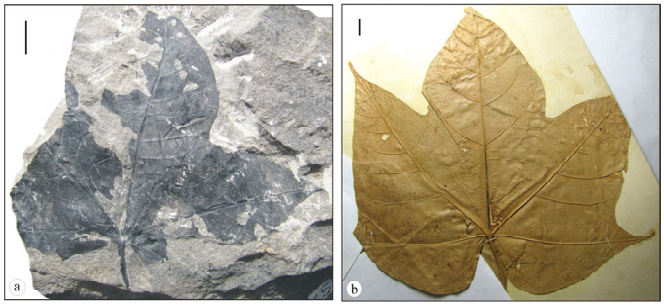
Palynofloras recovered from the sediments around Trambau: 1. *Minerisporites auriculatus*, 2. *Proxillitriletes alius*, 3. *Dijkstraisporites filiformis*, 4. *Trilobosporites apiverrucatus*, 5. *Retitriletes* sp., 6. *Murospora florida*, 7. *Callialasporites discoidalis*

Terminal Cretaceous-Neogene Megafloristics Group

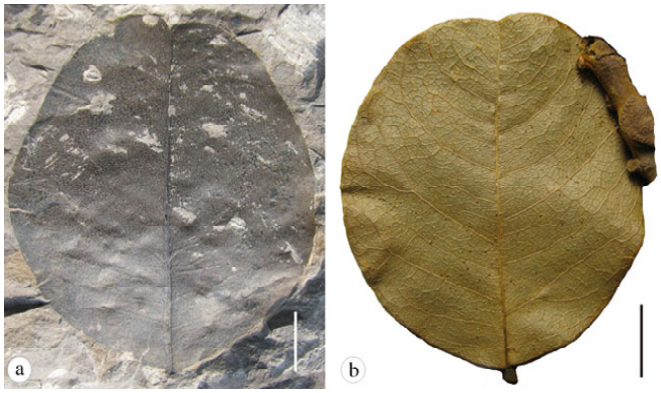
Project- 4.1: Tertiary plant mega remains of northeast India: Floristic and climatic changes

Investigators : R.C. Mehrotra & Gaurav Srivastava

Palaeobiogeographic implications have been worked out based on the new fossil leaf of *Bridelia* (Phyllanthaceae) from the Late Oligocene (Chattian, 28.1-23 Ma) sediments of Assam. Based on close affinities of fossil *Bridelia* leaves with the extant *Bridelia ovata*, *B. retusa* and *B. stipularis* species, and other known fossil records from the Tertiary sediments of India and Nepal, it is inferred that the genus evolved in India during the Late Oligocene and its speciation took place during the Neogene. It is deciphered that the stem lineage of the genus migrated to Africa via 'Iranian route' and again speciosed in Africa-Madagascar during the late Neogene resulting in the emergence of African endemic clades. Similarly, the genus also migrated to Southeast Asia via Myanmar after the land connection of the Indian and



(a) Fossil leaf of *Firmiana oligocenica* sp. nov. from the Makum Coalfield (Assam), (b) modern leaf of *Sterculia urens* (scale bar = 1 cm).



(a) Fossil leaf of *Sapindus palaeoemarginatus* sp. nov. from the Makum Coalfield, (b) modern leaf of *Sapindus emarginatus* (scale bar=1 cm)

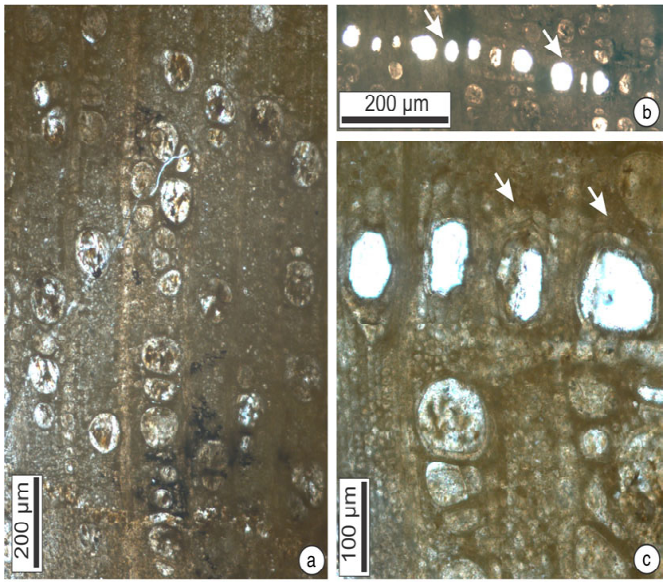
Eurasian plates. The emergence and speciation of the genus in Asia and Africa might be the result of climatic change during the Cenozoic.

Fossil woods collected from the late Plio-Pleistocene sediments of Arunachal Pradesh suggest affinities with the angiospermic families– Annonaceae, Combretaceae, Clusiaceae, Ebenaceae, Fabaceae and Lythraceae. Besides, plant remains have been collected from the Disang sediments of Manipur and Nagaland, and fossil woods from the Tipam Sandstone of Assam. The Central National Herbarium (Howrah) was consulted to identify fossil leaves collected from the Dafla and Subansiri formations of Arunachal Pradesh.

Project- 4.2: Plant mega remains from the Tertiary successions of western India and their bearing on palaeofloristic and palaeoclimatic interpretations

Investigators : R.C. Mehrotra & Anumeha Shukla

Fossil leaves, fruits and flowers collected from the Early Eocene sediments of Bikaner have been identified and assigned to the families– Anacardiaceae, Combretaceae, Fabaceae, Lauraceae, Malvaceae, Myrtaceae, Rubiaceae, etc. Palaeobiogeographic interpretations have been made based on the fossil leaf from the Early Eocene of Bikaner that shows similarity with the genus *Uvaria* of the family Annonaceae. The genus is thought to have originated in Africa, and the present finding gives an idea about its geologic distribution in Asia and Australasia via India (Stepping Stone hypothesis) during the Early Eocene Climatic Optimum (EECO) when climatic conditions were favourable for the luxuriant growth of tropical vegetation. A general cooling trend after EECO and change in the configuration of land and sea affected the climate on the regional scale causing total devastation of tropical evergreen forests, which existed in western India during Early Eocene. This change was ultimately responsible for the dry and desertic conditions prevailing in the area at present.



Fossil wood of *Hopea* (*Hopenium pondicherriense*) of Dipterocarpaceae from the Bhumbali Conglomerate (Miocene) of Bhavnagar, Gujarat : T.S. of wood showing vessels (a), tangentialy arranged gum canals (b), and gum canals enclosed in parenchyma bands (c), marked by arrows

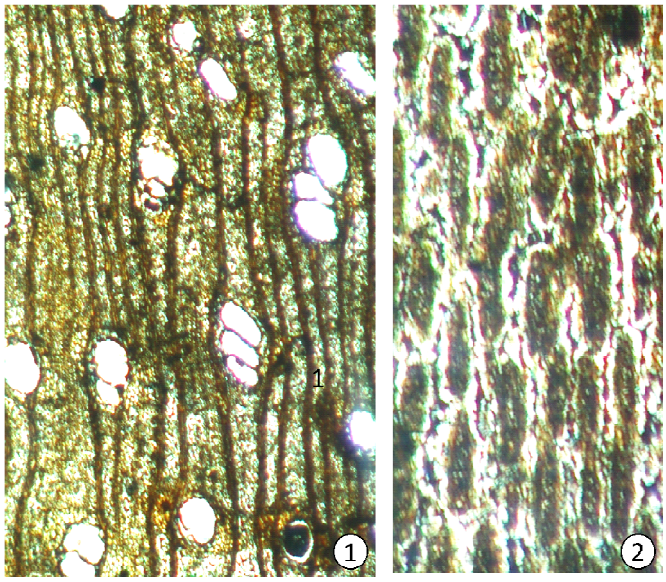
Project- 4.3: Siwalik floral diversity and palaeoclimatic changes in the Himalayan Foreland Basin

Investigator: Mahesh Prasad

Fossil leaf and fruit impressions collected from the Siwalik sediments of Sarda River bank near Thuligad, Champawat district (Uttarakhand) have showed affinity with the extant taxa of the families– Dipterocarpaceae, Tiliaceae, Fabaceae and Lauraceae. Five new taxa of these families have been reported for the first time from lower Siwalik sediments of the area. Based on the distribution pattern of extant taxa, tropical evergreen forest vegetation has been reconstructed for the Middle Miocene fossil assemblages, which is in contrast with the mixed deciduous forest at present in the area of study. Based on the distribution pattern of extant genera of Dipterocarpaceae that shows affinity with the fossil taxa– *Dipterocarpus koilabasensis* (Prasad et al., 1999) and



Fossil wood embedded in Middle Siwalik sediment of Ghish River Section, Darjeeling district (WB)



Fossil wood section from Siwalik of Tanakpur area (Uttarakhand), showing resemblance with an evergreen taxa, *Albizia lebbeck* (Fabaceae)

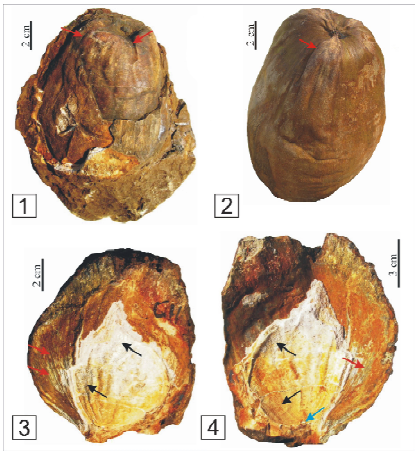
Dipterocarpus miogracilis (n. sp.) phytogeographical implications suggest its migration towards north-eastward (NE India, Malaya, Myanmar, etc.) after Middle Miocene due to unfavorable climatic conditions in the present area of Himalayan foot hills. The palynological assemblage (fungal, pteridophytic spores, gymnosperms & angiosperm pollen) recovered from the sediments also supports tropical-subtropical humid climate during the sedimentation of lower Siwalik.

The fossil wood comparable to extant genera *Terminalia tomentosa*, collected from Holocene sediments (1100 AD +80 yr) exposed at the bank of Sarda River has been studied in detail. The finding is phytogeographically important, as it provides the evidence of its entry in the Himalayan foot hills before 913 yrs, and flourished there luxuriantly since then. Besides, a large number of fossil woods have been collected from the Siwalik sediments near Tanakpur area showing affinity with the extant taxa belonging to the family Fabaceae. On the basis of the distribution pattern of extant taxa, tropical evergreen to moist deciduous climate has been envisaged in the Himalayan foot hills of Uttarakhand during Mio-Pliocene times. Additionally, a variety of plant fossils (carbonized woods, leaf and fruit impressions) and palynological samples were also collected from the Siwalik sediments of Darjeeling district, West Bengal.

Project- 4.4: Megaflora from sedimentary sequences associated with Deccan Traps: Diversification of angiosperms in India

Investigator : Rashmi Srivastava

A number of fossil dicotyledonous woods collected from a new locality at Dhangaon, Mandla district (MP) have been studied. The fossil forms have been tentatively identified with the genera– *Grewia* (Malvaceae), *Bursera/ Canarium* (Burseraceae), *Euphoria/ Otonephelium* (Sapindaceae), *Eucalyptus* (Myrtaceae), a myrtaceous wood, and *Stemoneurus* =*Gomphandra* (Icacinaceae). Further work is in progress to confirm their identification. Preliminary documentation has been made on the fossil palm leaves (*Sabalites*) collected from Umaria, near Ghughua, Dindori district (MP). Besides, finding of fossil fruit resembling *Cocos* from Seoni district has been revised as per the suggestions from the journal Acta Palaeobotanica.



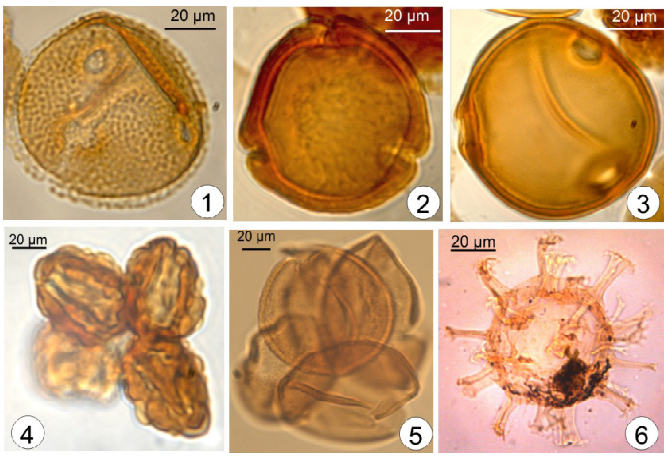
1. Fossil fruit of *Cocos binoriensis* sp. nov. reported from Seoni district (MP), 2. Modern fruit of *Cocos nucifera*, 3. Longitudinally broken part of the fossil, 4. Counterpart of the same fossil fruit

Terminal Cretaceous-Neogene Miofloristics Group

Project- 5.1: Biota from Palaeogene lignite-bearing sequences of western India: Climatic, tectonic, stratigraphic, ecologic and biogeographic signatures

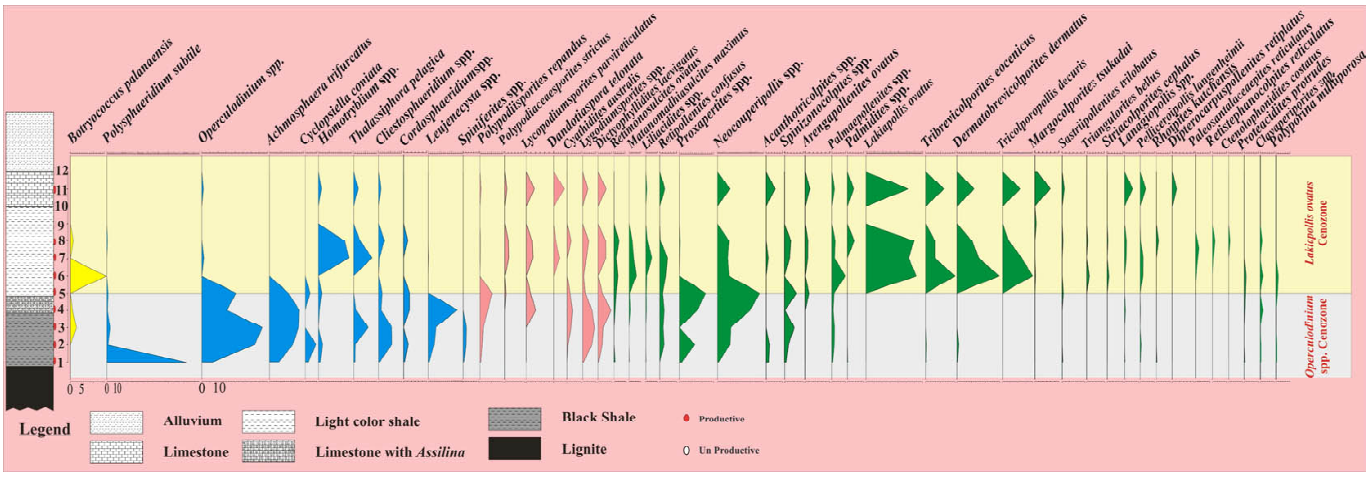
Investigators : **Sunil Bajpai, M.R. Rao, Madhav Kumar, Vandana Prasad, Hukam Singh, Poonam Verma, Shailesh Agrawal, V.V. Kapur, Priyanka Monga, D.S. Seetharam & Rahul Garg**

Dinocyst biostratigraphy, palynostratigraphy and palynofacies studies have been carried out in four lignite mine sections in southern Gujarat. An Early-Middle Ypresian age and various depositional environments such as fresh water swamp, mangrove swamp, open bay and restricted bay have been reconstructed for 28 m thick lignite-bearing Bhavnagar section (Surkha mine). The lower and upper lignite seams are considered to have been deposited in a fresh water swamp and mangrove swamp respectively separated by tidal creek. In Surkha and Khadsaliya sections of Saurashtra Basin, the presence of pyrites (framboidal & euhedral) indicates anoxic/ dysoxic condition during burial. The qualitative and quantitative analyses of sedimentary organic matter types suggests fluvial flood plain, swampy and mangrove swamp environment of deposition. The Early Eocene palynoflora recorded from Valia lignite mine (Cambay Basin) is dominated by several angiospermic and fungal remains along with algal cysts and pteridophytic spores. Based on the study, a tropical-subtropical humid climate has been envisaged. Besides, a new laboratory processing technique for the release of pollen grain from the amber of the Vastan lignite mine (Cambay Basin) has been developed. A large number of pollen belonging to tropical rain forest and mangroves as well as grass phytoliths, broken insect parts, cysts of theca-amoeba have been retrieved from the amber, which suggests the presence of a diverse low land coastal forest during Early Eocene.



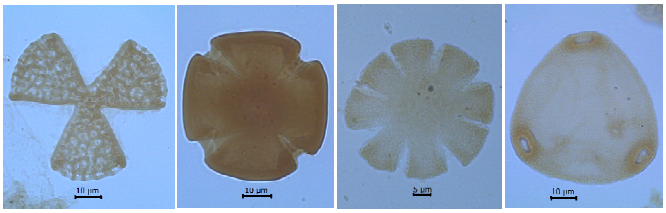
Palynofloras from Surkha lignite, Bhavnagar district (Gujarat) : 1. *Lakiapollis matanomadhensis, 2. Dermatobrevicolporites dermatus, 3. Lakiapollis ovatus, 4. Paripollis broachensis, 5.* Tetrad of *Arecipites wodehousei, 6. Homotryblium tenuispinosum*

Palynological investigation has been carried out in five sections of Kachchh (Gujarat). In Akri lignite mine, two cenozones have been recognized: i) *Operculodinium* spp. Cenozone, and ii) *Lakiapollis ovatus* Cenozone, based on first appearance, acme and decline of palynotaxa. It is inferred that the lower part of the sequence was deposited in a shallow marine environment, whereas the



Palynostratigraphic zonation in Akri lignite mine, Kachchh (Gujarat)

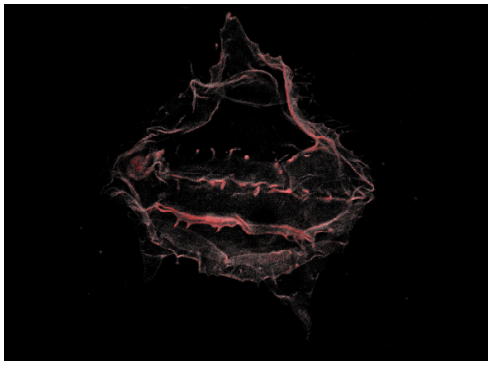
upper part under terrestrial environment close to mangrove vegetation. The assemblage (dominantly angiosperms) recorded from the Naredi Formation exposed at Nareda village has indicated a warm and humid climate of a coastal zone with a dense tropical rain forest in vicinity of the site. A rich palynoflora (pteridophytic spores, angiospermic pollen & dinoflagellate cysts) has also been recorded from the Matanomadh and Panandhro lignite mines, and a section from Madhwali River in western Kachchh. The interpretation and compilation of data are under progress.



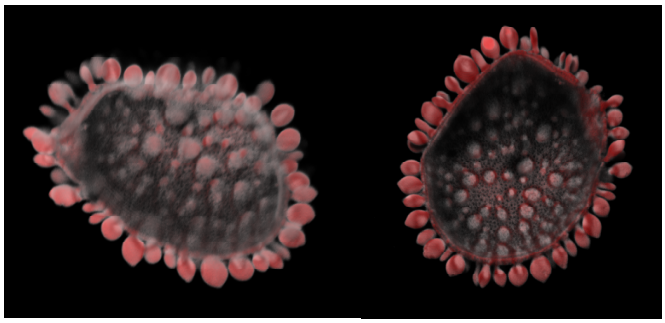
Margocolporites complexum | *Meliapollis ramanujamii* | *Retistephanocolpites* sp. | *Trilatoporites kutchensis*

Pollen grains from Matasukh lignite, Nagaur (Rajasthan)

Rich and diversified palynoflora (angiosperm pollen grains, pteridophytic spores & fresh water algal remains) recorded from the lignite-bearing succession of Gurha mine, Bikaner district (Rajasthan) also suggests tropical evergreen forest during Early Eocene. Presence of microscopic charcoal indicates the effect of fire on fossil vegetation. The preliminary observation on samples from Giral lignite mine, Barmer district has showed that they contain rich dinoflagellate cysts, spores, pollen grains and sedimentary organic matter. In addition, diversified palynoflora with new pollen assemblage of the family Dipterocarpaceae (*Dipterocarpuspollenites retipilatus*,



Dinocyst – *Spinidinium densispinatum* from Giral lignite



Palm pollen from Giral lignite, Barmer (Rajasthan)

Shorea sumatrana, *Shorea guiso*, *Doona gardneri*) has been recorded for the first time from the lignite-bearing Marh Formation exposed in Matasukh mine, Nagaur district (Rajasthan). Field work has also been undertaken in various lignite mines of Rajasthan– Kapurdi and Giral (Barmer district), Barsingsar (Bikaner district) and Matasukh (Nagaur district), and Gujarat– Valia (Surat district). Palynological and geochemical studies on the collected sediment samples are in progress.

Project- 5.2: Palynology of the Deccan Volcano-sedimentary Province (Central India) and the Khasi Hills (Meghalaya)

Investigators : R.S. Singh, Ratan Kar & M.F. Quamar

Samples collected from different Deccan Intertrappean localities of Gujarat (Anjar, Lakshmipar, Dayapar & Kora) have been processed, and initiated the palynological study from the Anjar Intertrappean beds. The section encompasses the K-Pg boundary as manifested by absolute dates, however stratigraphic control in the form of index marker fossils have been so far lacking. For the first time from any Intertrappean section, both Maastrichtian and Early Palaeocene palynofossils have been recovered. The study is in progress to document the transition of flora across the K-Pg boundary. The samples from Padwar (MP) have yielded Myxomycetes fossils of slime moulds in different stages of their life cycle. Morphological studies have been completed and the different fossil forms like spores, swarm cells and zygotes have been assigned to new genera and species. Important findings include the earliest record of Myxomycetes. An assemblage of fresh water diatoms has also been recorded from Padwar Intertrappean and is being studied. Samples from Ninama Intertrappean (Gujarat) have yielded rich fungal spike zone; indicating proximity to a major climatic event. In addition, Late Cretaceous marine deposits of Meghalaya have also been chemically processed and the recovered palynomorphs are being studied.

Project- 5.3: Palynological investigation of the Miocene sediments of Mizoram and Tripura

Investigator : B.D. Mandaokar

Analysis of rich and diverse palynofloral assemblage from the Bhuban Formation exposed at Bortila Hill section in Agartala district, Tripura has revealed the presence of dinoflagellate cysts, fungal remains, pteridophytic spores, gymnospermous pollen and angiosperm pollen grains, besides some reworked Permian elements. The present day distribution of recorded pteridophytic spore's families is in tropical and temperate regions. Gymnospermous pollen representatives (*Pinuspollenites crestus, Podocarpidites cognatus, Piceapollenites excellensus*, etc.) grow in tropical as well as temperate regions. Angiosperm pollens have been represented by families Arecaceae, Poaceae, Bombacaceae, Combretaceae, Oleaceae, Fagaceae, Lecythidaceae, etc. Most of these families are distributed in subtropical and tropical regions. Thus, the studied succession contains (in lower part) a mixed palynoflora which indicates the prevalence of coastal marine environments of deposition. Occurrence of *Palmidites* sp. and *Spinizonocolpites echinatus* shows closed proximity to the shoreline. A majority of the fungal remains like *Helicospores, Phragmospores, Amerospores, Ascostromata, Erisiphe, Uncinula, Arthrocladiella, Notothyrites, Protocolletotrichum,* etc. are inferred to have been transported to the site of deposition. Recorded palynofossils in the assemblage indicates the prevalence of a tropical humid climate during deposition of sediments.

Project 5.4: Palynological investigation of Palaeogene sedimentary rocks of Garo Hills, Meghalaya: Palaeoecological and palaeogeographical interpretations

Investigator : G.K. Trivedi

A rich palynoassemblage has been recorded from the Rewak Formation exposed along Tura-Dalu Road Section, West Garo Hills district, and represented by algae, fungi, pteridophytic spores, gymnospermous and angiospermous pollen grains, besides reworked Permian palynofossils. The assemblage is dominated by pteridophytes, particularly those belonging to families Cyatheaceae, Polypodiaceae, Parkeriaceae, Schizaeaceae, and angiospermous pollen particularly by Leguminosae and Alangiaceae. Presence of gymnospermous bisaccate pollen (*Pinuspollenites* & *Podocarpidites*) suggests that the topographically elevated areas were not far away from the basin. The assemblage indicates that the area enjoyed moist, warm and humid, tropical to subtropical climate. Presence of mangrove elements, together with dinoflagellate cysts and wet evergreen forest inland elements, suggest a marginal marine to coastal environment of deposition for the Rewak Formation with high precipitation which would have led to large fresh water influx. Reworked Permian palynofossils, such as *Indotriradites sparsus* have also been recorded. Permian exposures occurring in a small patch at nearby Singrimari, NW of the area under investigation in Garo Hills, could possibly be the source area of Permian palynomorphs. The recovered palynoassemblage is quite similar to Kopili assemblage which is Late Eocene in age, hence a similar age i.e. Late Eocene has been assigned to the sequence.

Thrust Area 3: INTEGRATIVE MARINE MICROPALAEONTOLOGY: FOCUS ON HIGH RESOLUTION BIOSTRATIGRAPHY, SEA LEVEL CHANGES, PALAEO-OCEANOGRAPHIC AND PALAEOCLIMATIC EVENTS

Marine Micropalaeontology Group

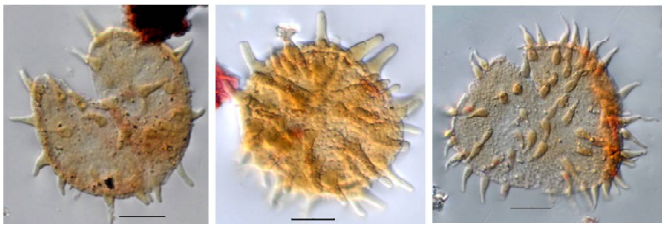
Project- 6.1: Study of Late Cretaceous-Early Palaeogene successions of South Shillong Plateau: Implications for climate and relative sea level changes

Investigators : Vandana Prasad, Anupam Sharma, Abha Singh, Jyoti Srivastava & Rahul Garg

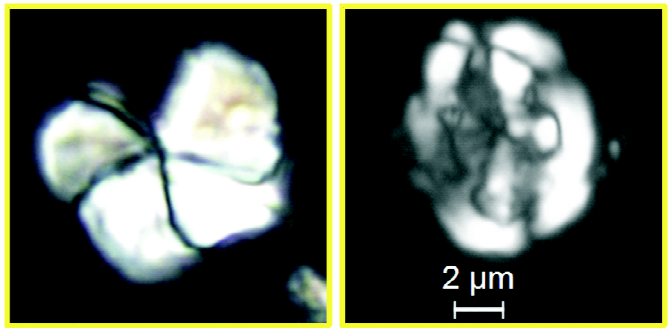
Palynofacies analysis has been carried out on two Late Palaeocene carbonate successions of Lakadong Limestone Member exposed in Kurtinsiang and Laitmowksing of Khasi Hills (Meghalaya). The sections

were dated as Late Palaeocene based on the larger benthic foraminiferal assemblages belonging to SBZ 3 and SBZ 4 Zones. Transgressive deposits have been characterized by the high proportion of black oxidized palynomaceral and dinoflagellate cysts, whereas varied degraded brown palynomaceral have found to occur in highstand progradational phases. Transgressive deposit followed by progradational sequence forms one parasequence. Four parasequences in Kurtinsiang and three in the Laitmowksing Section have been identified. The proposed subdivision of 3rd order Systems Tract of the Lakadong Limestone in to higher-order cycles offers a logical approach in the correlation of parasequences and improves the prediction of lateral and vertical facies variation in petroleum exploration studies.

To trace the diversity pattern of the mangrove vegetation during Early Palaeogene warming, species diversity of *Spinizonocolpites* pollen (*Nypa*) has been studied across the Palaeocene/Eocene boundary interval from two sections– Ranikor-Barsora and Jathang in East Khasi Hills. Standing diversity of palaeo-mangroves shows higher diversity of fossil *Nypa* during Palaeocene/Eocene boundary and significant decline during late Ypresian. This data is further complemented by the estimation of diversity through Shannon-Wiener index and Simpson diversity index. It is concluded that high precipitation, low seasonality, good upstream runoff created an oligohaline condition in the palaeo-equatorial coastal regions during PETM interval, a condition ideal for the diversification of brackish mangrove *Nypa*. However, during post warming event in late Ypresian, mangrove diversity declined due to decreased precipitation and freshwater runoff as a result of climate change. In addition, field data and samples have been collected from Cretaceous-Early Palaeogene sedimentary successions exposed around Cherrapunji, Mawsynram and Pynursla areas of East Khasi Hills for phytoplankton, palynological and palynofacies investigations. Only one out of 95 samples collected from Late Cretaceous succession at Pynursla-Wahlyngkhat traverse was found productive for nannofossils. The recorded assemblage suggests a Campanian-Maastrichtian age.



Pollen morphospecies of mangrove palm *Nypa*

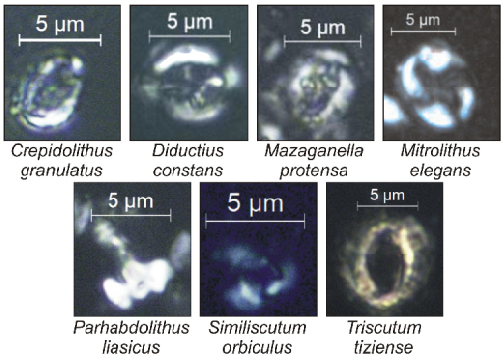


Nannofossil recorded from Late Cretaceous sediments of Pynursla-Wahlynghat traverse, East Khasi Hills (Meghalaya)

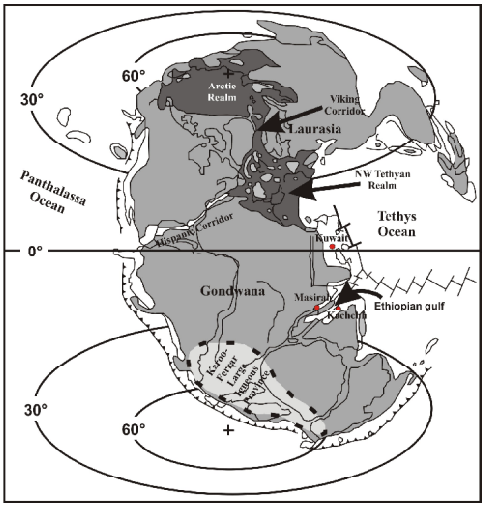
Project- 6.2: Calcareous nannofossils from western Indian Jurassic continental shelves: Biostratigraphic, palaeoenvironmental and palaeogeographic implications

Investigators : Jyotsana Rai, Abha Singh & Mridul Gupta

Nannofossil studies have been carried out in various domes (Pachchham, Jara, Jumara & Habo) and bet areas (Allahband & Trangdi) of Kachchh, Gujarat. Pleinsbachian to Torcian age reworked nannofossils of NJ5 to NJ7 zones (Bown et al., 1988) have been recorded from Point 16 in Kuar Bet, Pachchham Island and from other domes also. NJ5 represents upper Pleinsbachian, whereas NJ6-7 indicates lower Toarcian. This suggests that the earliest transgressive event in Kachchh Basin have been taken place during Pleinsbachian, approximately 12 my earlier than Late Bajocian (ammonite: *Leptosphinctes* sp. & coral: *Isastrea bernardiana* records). Lower Callovian to Oxfordian age calcareous nannofossil assemblage has been recorded from Jumara Dome, and the record of marker nannofossil taxa from various levels demarcates Bajocian/Bathonian, Bathonian/Callovian and Callovian/Oxfordian boundaries. In Habo Dome, Upper Bajocian-Lower Bathonian age nannofossils have been recorded from the Jhurio Formation and Late Callovian-Oxfordian nannofossil assemblage from the Upper Jumara Formation. On the basis of presence of limited marker taxa, the Bathonian/Callovian, Callovian/Oxfordian and the Oxfordian/Kimmeridgian boundaries have been delineated from Jhurio, Jumara and Jhuran formations exposed in Habo Dome.



Early Jurassic transgressive event and opening of Indian Ocean



In Rajasthan, datable nannofossils have been recorded from the Bhadasar Formation and Pariwar Formation, Jaisalmer Basin. Late Early Tithonian (NJ 17b) age nannofossils have been recorded from the sediments associated with *Himalayaites* aff. *sideli* ammonite (a late Late Tithonian global marker), recovered from type Rupsi Shale Member, Bhadasar Formation. Nannofossils recorded from Pariwar Formation indicate a precise early Middle Albian age (upper part of *Chiastozygus litterarius* Zone CC7b/ *Prediscosphaera columnata* Zone CC8 of Sissingh 1978 corresponding with NC8/9 zones of Bown et al., 1998). Presence of nannoconids in the assemblage indicates Tethyan affinity and *Seribiscutum primitivum* showed presence of bipolar high-latitude cold water taxon from Austal province to mid latitudinal position. The Tethyan warm water current appeared to have been mixed with cold water current during Aptian-Albian time and continued up to Campanian time. Record of *B. constans*, *Z. erectus* indicates nutrient rich, upwelling conditions.

Project- 6.3: Micropalaeontology of the Subathu sediments of Lesser Himalaya, Himachal Pradesh

Investigators : Samir Sarkar & V.V. Kapur

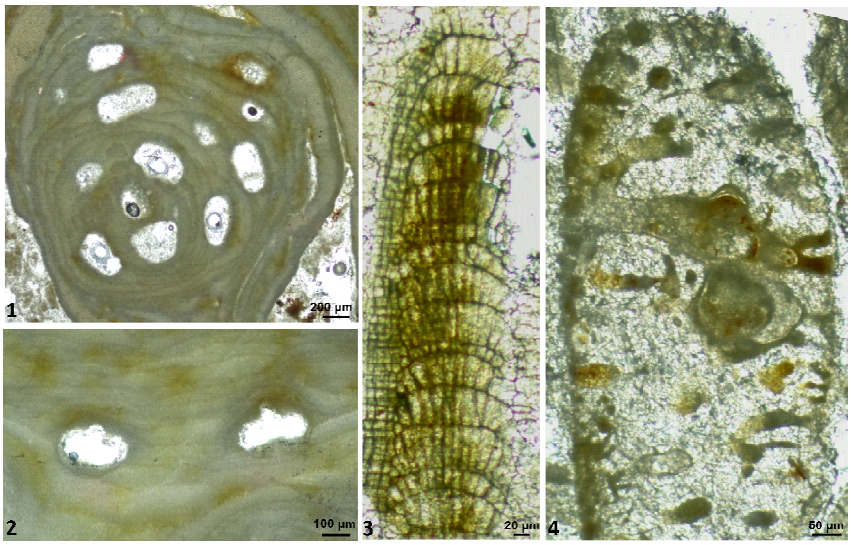
Seven distinct palynofloral assemblage zones have been recognized in Tertiary sediments from Janauri Deep Well-2 (between 10-4,290 m depth). The lower horizon has rich assemblage of pteridophytic, gymnospermous and angiospermic pollen grains. The angiosperm pollen grains dominate the middle portion, whereas pteridophytic spores decline in the younger horizons. A gradual increase in fungal spores and sclerotia has been observed from older to younger horizon. A significant change in the composition of floral assemblage has been observed in the younger horizon, as the coniferous pollen become dominant. On the basis of recovered palynofossils, Middle-Upper Miocene age has been assigned to the studied sequence. The occurrence of Parkeriaceae, Polypodiaceae and Cyatheaceae spores indicates the prevalence of a tropical to sub-tropical humid vegetation during the deposition of sediments. The sediments seem to have been deposited under freshwater condition. The recovery of reworked microplanktons and other forms in older horizons are indicative of brackish environment during the Subathu sedimentation.

The palynoassemblage of Subathu sediments (from basal part) from Morni Hills, Haryana has indicated that the dinocysts/spores-pollen ratios run in inverse proportion from base to the top of succession. This suggests that there was one major phase of transgression of the Palaeocene-Eocene epicontinental sea followed by a west ward regression at the close of Subathu sedimentation. Based on the palynofossils, palaeoclimate has been estimated to be tropical generally, and the environment of deposition was shallow marine. However, evidences for the existence of tidal flat to fresh water conditions have also been found at Kharag area. Besides, analysis of palynoassemblages from the measured sections of Dharamsala Formation (Early Miocene) from Palampur and its adjoining areas has indicated the prevalence of wet semi-evergreen type of vegetation and warm-humid climate during the deposition of Lower Dharamsala sediments.

Project- 6.4: Biofacies analysis of the Cenozoic sediments of Andaman-Nicobar Basin and its implications for palaeogeography, palaeoecology and palaeobathymetry

Investigators : A.K. Ghosh & Abhijit Mazumder

Samples collected from Andaman and Nicobar Group of Islands have been analysed in thin sections for calcareous algae and benthic foraminifera. In addition, for the studies of other microfossils, namely diatoms, radiolaria and nannofossils, slides have been prepared and studied for detailed micropalaeontological analyses. Late Middle Miocene (Long Formation) of Little Andaman Island has yielded benthic calcareous algae and foraminifers in thin sections. The overall assemblage indicates the occurrence of an ancient reef. Isotopic study on the samples has been initiated. The non-geniculate coralline algal forms are represented by the genera *Sporolithon*, *Spongites*, *Lithoporella*, *Phymatolithon*, *Lithoporella* and *Lithophyllum* along with some geniculate coralline forms assignable to the genera *Amphiroa* and *Corallina*. In addition, coral fragments, operculinoid and texularid benthic foraminifers as well as some planktic foraminifers have also been recovered in thin sections.



Coralline red algae and halimedacean green algae from the Serravallian-Tortonian of Little Andaman (Kalapathar Section): 1. Melobesioid coralline *Lithothamnion* sp. forming rhodolith, 2. Mastophoroid coralline *Lithophyllum pustulatum*, 3. Geniculate coralline *Amphiroa* sp., 4. Green alga *Halimeda* sp.

Analyses of diatoms, radiolaria and nannofossils have been undertaken on the samples collected from the outcrop exposed in Vijaynagar village near Kalapathar Beach of Havelock Island. The section is situated on the east coast of the island and is about 6.5 m thick. Lithologically it is composed of soft, creamish white nanoforum chalk with interbedded calcareous silty band and calcareous shales. The assemblage of diatoms is represented by marker diatom taxon *Rosseilla paleacea* that broadly indicates Early to Late Miocene age. Marker Miocene radiolarians have also been recorded from this outcrop. Well-preserved planktic foraminifera have been isolated from these sediments for isotopic analysis. Based on nannofossils, it has been dated as late Burdigalian-Langhian (NN4-NN5 Zone of Martini, 1971). The ratio of centric and pennate diatoms and other parameters including size ratios have been taken into consideration for the interpretation of palaeoenvironment.

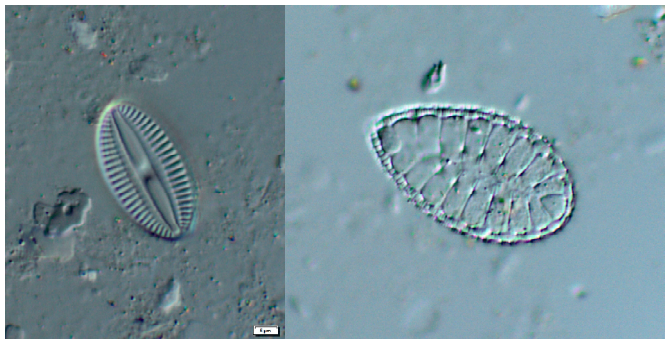
Project- 6.5: Phytoplankton response to palaeoclimatic fluctuations along the Kerala-Konkan Coast

Investigators : Vandana Prasad, Biswajit Thakur & Manoj M.C.

The factors controlling the distribution of marine and terrestrial palynomorphs in coastal ecosystem have been studied from surface sediments from 17 stations from 76°10'3.2" E to 76°22'57.41" E longitudes, and 9°30'48.74" to 10°10'41.39" latitude of Vembanad wetland, Kerala. Marine and terrestrial organic matter, mangrove and terrestrial pollen, dinoflagellate cysts, diatoms, total organic carbon, % of sand, silt and clay, TDS and salinity were recorded in sediment samples from each station. Study showed numeral constancy of terrestrial and mangrove pollen in the 8 stations of the northern Vembanad ecosystem pointing to tidal influence. Low dinocysts but a fair number of diatoms in the central part of Vembanad indicated prevalence of oxidizing environment. High number of terrestrial pollen in the southern stations was due to its proximal setting with respect to the terrestrial source. Three ecological zones have been identified in the Vembanad wetland: i) marine influenced tide dominated northern region, ii) high energy middle portion, and iii) low energy, restricted proximal

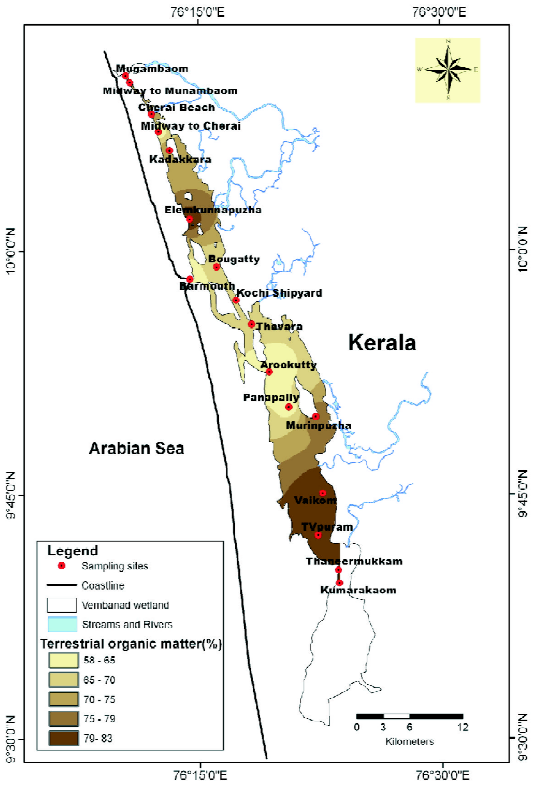
setting at southern region. This study helped elucidate the role of different factors, i.e. proximal-distal trend, tidal flushing, hydrodynamic conditions, climate and redox state of the depositional environment in determining the distribution of marine and terrestrial palynomorphs in coastal environment.

A sediment core from Bougatty (Barmouth), Vembanad wetland has been studied for diatoms and dinoflagellates to infer the palaeoenvironment and sea-level fluctuations. The study showed varying assemblages of freshwater, brackish and marine diatoms and dinoflagellates at different levels in the core. High proportion of freshwater centric and pennate forms in the upper part (0-12 cm), dominance of brackish pennate diatoms *Nitzschia panduriformis* in the middle (13-32 cm), and marked increase in the marine diatoms (*Thalassiosira weissflogii*, *Diploneis didyma*, *Diploneis ovalis*, *Actinocyclus*, *Actinoptychus*, etc.) along with silicoflagellates and dinoflagellates in the bottom (33-50 cm) has been observed. It is interpreted that lower part of the section is marine influenced, while the upper is influenced by increased freshwater discharge due to high precipitation.

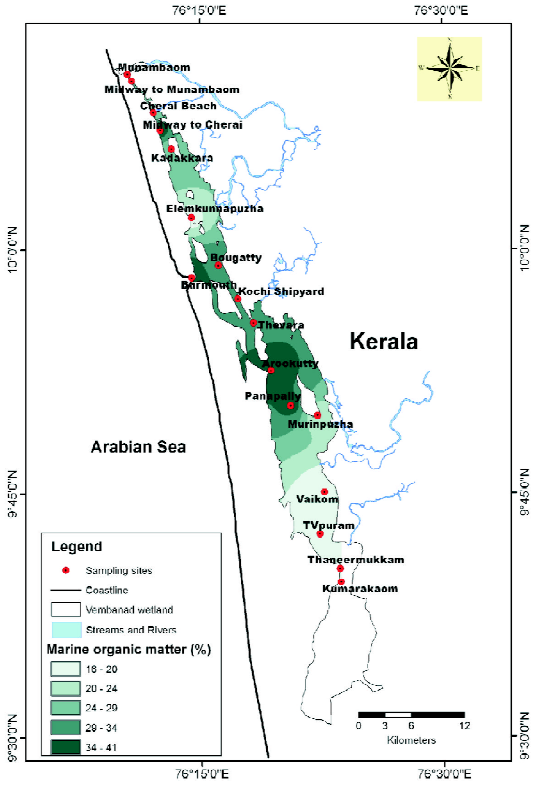


Diploneis *Surirella*

Diatoms from Vembanad wetland, Kerala



Distribution of terrestrial organic matter in the Vembanad wetland



Distribution of marine organic matter in the Vembanad wetland

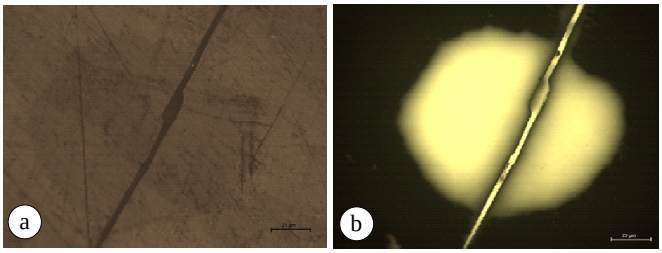
Thrust Area 4: ORGANIC PETROLOGY: CHARACTERIZATION OF SOLID FOSSIL FUEL FOR DEPOSITIONAL AND UTILIZATIONAL ASPECTS

Organic Petrology Group

Project- 7.1: Petrology of coals from Wardha-Godavari Valley Coalfield and its impact on coal bed methane potential and depositional environments

Investigator : O.S. Sarate

The biopetrological maceral and vitrinite reflectance ($R_{o\ mean}$%) study of two coal seams (Index above Queen and the Queen Seam) intersected in bore-hole 353 drilled in Koyagudem area of the Kothagudem sub-basin, Godavari Valley Coalfield has been carried out. The coal maceral study has revealed that these seams of Koyagudem area contain vitrinite-rich or vitric type of coal. The Index above Queen Seam has recorded the vitrinite reflectance of 0.62%, which indicates that the coal of this seam has attained high-volatile bituminous C stage of the rank. In general, vitrinite reflectivity of the Queen Seam ranges between 0.48% and 0.62%, which suggests that the coal of this seam has also attained high-volatile bituminous C rank. However, some of the coal bands in this seam have shown higher vitrinite reflectance of 0.72%, which indicates the attainment of high-volatile bituminous B stage of the rank.



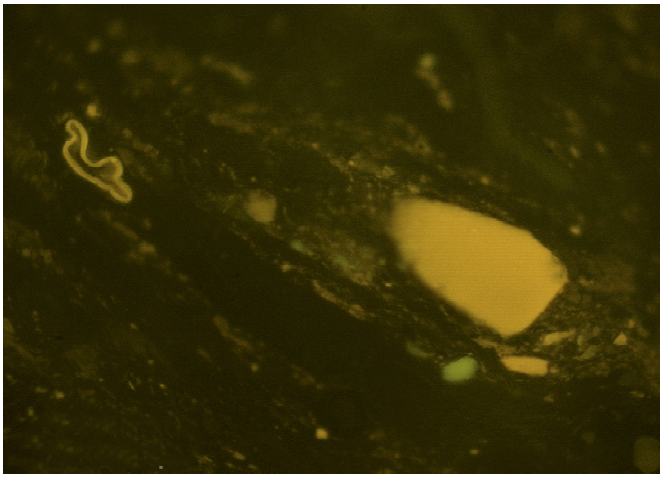
Vitrinite cracks showing expulsion of bituminite in coal of Koyagudem area: a. Normal (reflected light), b. Fluorescence mode

The facies diagram based upon the maceral matter contents has been plotted to ascertain the depositional scenario of the Index above Queen and the Queen seam suggests that both these seams have experienced oxic and anoxic condition as the dominant phase. However, Queen Seam has experienced change in the depositional scenario having oxic (dry) moor with sudden high flooding and wet moor with intermittent moderate to high flooding for a very short period.

Project- 7.2: Organic matter characterization of western Indian lignites through petrological studies

Investigators : Alpana Singh, B.D. Singh, R.P. Mathews, S. Mahesh & V.P. Singh

The data from petrographic, palynofacies and Rock-Eval pyrolysis on the lignite and shale samples from Matasukh mine (Nagaur district, Rajasthan) has been used to infer depositional conditions and hydrocarbon potential of the deposits. Lignites are huminite-rich (average 60%) with moderate liptinites (23%), and low inertinite (9%) and mineral matter (8%) contents. The huminite reflectance values (average $R_{r\ mean}$: 0.26%) have indicated lignitic stage/low maturity. The maceral composition and a high Gelification Index (GI) and low Tissue Preservation Index (TPI) values have indicated the deposition of two lignite seams in telmatic environment under upper deltaic regime. The facies concept of GI-TPI suggests the prevalence of herbaceous vegetation susceptible to degradation; reflected in the high percentage of detrohuminite (attrinite+densinite). Palynofacies study showed the abundance of amorphous organic matter (AOM) and phytoclasts with low content of palynomorphs. AOM is generated from degradation of



Resinite in Matasukh lignite (Nagaur district, Rajasthan)

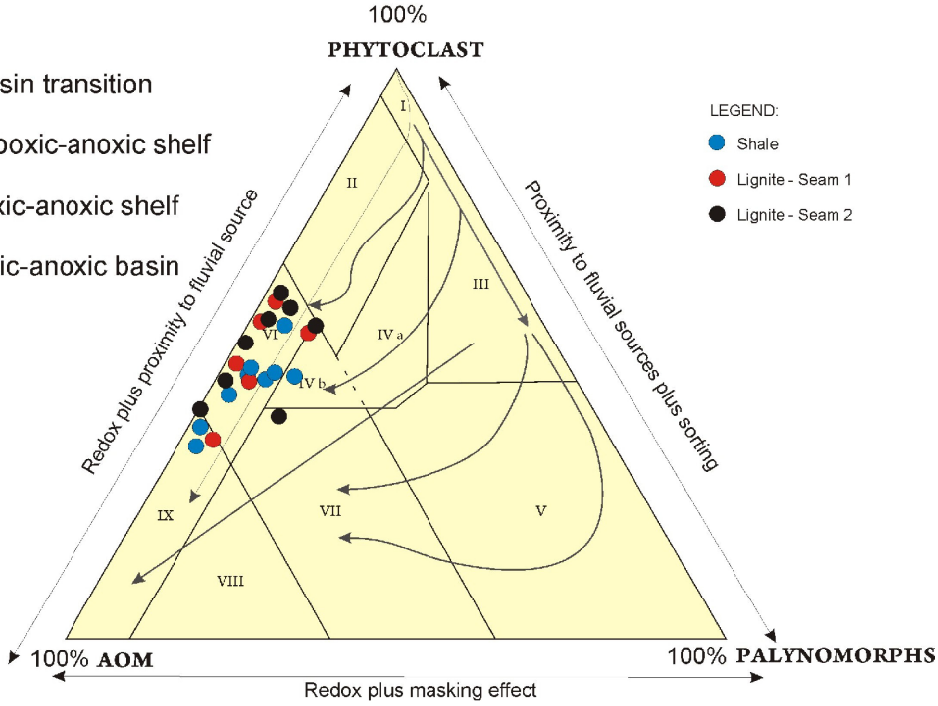
Depositional environment

Palynofacies field - IVb - Shelf to Basin transition

Palynofacies field - VI - Proximal suboxic-anoxic shelf

Palynofacies field - VII - Distal dysoxic-anoxic shelf

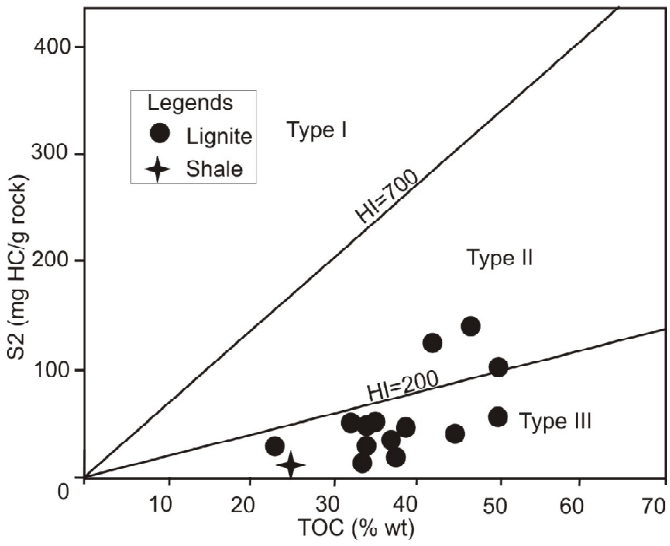
Palynofacies field - IX - Distal suboxic-anoxic basin



Depositional environment of Matasukh lignite (Nagaur district, Rajasthan) based on palynofacies analysis

terrestrial OM, andbelong to kerogen Type-II. Occurrence of oxidized black phytoclasts indicates the oxidizing conditions of palaeomires. Extrapolation of palynofacies components on Tyson's APP diagram showed the deposition of lignite-bearing sequence in a proximal suboxic-anoxic shelf. The reducing conditions in the depositional site are evident by framboidal pyrite present in lignite seams. High total organic carbon (TOC) along with Type-II/III kerogen (determined by Rock-Eval) has indicated the ability of lignites to generate liquid/gaseous hydrocarbon.

Petrography of lignites from three working seams of the Surkha mine (Bhavnagar district, Gujarat) has revealed the evident dominance of huminite (57-72%) over the liptinite (11-26%) and inertinite (7-16%) macerals, along with moderate amount of associated mineral matters (argillaceous & pyrite). Among the huminite group of macerals, detrohuminite (attrinite+densinite) is dominant in these lignites followed by structured telohuminite (textinite+ulminite). The liptinite group is chiefly constituted of liptodetrinite and resinite, besides sporinite, cutinite, suberinite, etc. Inertinite is mainly contributed by funginite and semifusinite/fusinite macerals. The huminite reflectance values ($R_{r\ mean}$: 0.28-0.33%) indicate that the lignites are less mature and have reached up to lignitic stage of coalification. GI, TPI, GWI (Ground Water Index) and VI (Vegetation Index) indices of studied lignites have suggested the limno-telmatic depositional conditions under mesotrophic to rheotrophic hydrological regime in a fast subsiding basin. The low rank and predominance of huminite point towards their utilization in thermal power plants/industries for steam/ heat generation. Fair amounts of hydrogen-rich macerals (liptinites+perhydrous or fluorescing huminite) indicate theirhydrocarbons ptential. The high TOC (21-45%) and mixture of Type III/ II kerogen have indicated ability of Surkha lignites to generate oil and gaseous hydrocarbons upon maturation.



Rock-Eval pyrolysis data of Surkha lignites (Bhavnagar district, Gujarat) showing S_2 vs.TOC plot

Project- 7.3: Biopetrological characterization of Tertiary lignitic beds from Cauvery Basin and adjoining areas

Investigators : Rakesh Saxena & R.P. Mathews

The study area has been extended throughout all the Miocene lignite-bearing deposits of south India which mainly comprises lignites of Neyveli and nearby areas of Tamil Nadu, Warkkalli of Kerala, and Ratnagiri of Maharashtra. Organic geochemical analysis of amber/ fossil resin collected from Ratnagiri has been carried out in collaboration with IIT Bombay. The study has revealed the presence of polar tetracyclic dammarene type of compound– hydroxydammarenone, which are the biological markers of *Dipterocarpaceae*; detected for the first time in geological samples of Miocene. The preservation potential of this type of compound during diagenesis is reported for the first time by this method. This study also demonstrates the importance of biomarker analysis in palaeochemostatistics especially in the evolution of biosynthetic mechanisms in angiosperms. RPM, a newly recruited scientist, is assigned to carry out organic geochemical investigation, besides organic microconstituents in lignites and associated sediments. He has consulted literature on the given study area in regard to the changes made in the project.

Thrust Area 5: QUATERNARY PALAEOCLIMATE RECONSTRUCTIONS, VEGETATION DYNAMICS AND RELATIVE SEA LEVEL CHANGES

Quaternary Palaeoclimate Group

Project- 8.1: Holocene climatic variations and vegetation succession in endangered wetland ecosystems and adjacent reserve forests in Brahmaputra and Barak valleys, Assam

Investigators : S.K. Bera, Swati Tripathi & Kanupriya Gupta

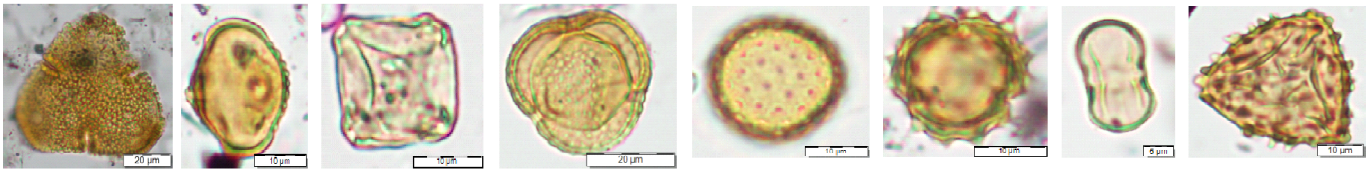
Twenty soil samples have been palynologically examined to retrieve surface pollen-spore and deduce its relationship to contemporary vegetation from Chaurbazar village of Karimganj district situated at Indo-Bangladesh



A view showing Kushiara River, Karimganj



Luxuriant growth of *Gynandropsis gynandra* in Chaurbazar village, Karimganj



Salmalia malabaricum | *Duabanga grandiflora* | *Alnus* sp. | *Xanthium strumarium* | Cheno/Ams | Tubuliflorae | *Coriandrum sativum* | Trilete spore

Pollen-spore recovered from surface soil of Karimganj district, Indo-Bangladesh border

border. Recovered palynoassemblage depicted the abundance of non-arboreals like *Xanthium*, Tubuliflorae, Cereal, Apiaceae and Cheno/Ams; indicating pastoral activity in and around the area. Arboriculture practices are also well evidenced by the presence of scattered arboreals, namely *Salmalia*, *Syzygium*, *Lagerstroemia*, *Duabanga*, *Dillenia*, Moraceae, Sapotaceae, Anacardiaceae and *Gynandropsis*. High land taxa like *Betula*, *Carpinus*, *Alnus*, *Pinus* and *Corylus* are also observed in fair frequency, displaying high wind and river flow in and around the studied site. A 100 cm deep sediment profile from the same site has also been processed to deduce palaeoecological conditions since Late Holocene through pollen, diatom and thecamoebians.

As many as seven vegetation, climatic and human occupation shifts have been deciphered through the pollen-spore analysis of Deepor beel sediment sequence from Kamrup district for the last 13,083 cal BP. Between 13,083 and 11,417 cal BP, the dominance of grasses, *Plantago* and Chenopodiaceae with meagre presence of *Xanthium*, *Artemisia*, Tubuliflorae, and low frequencies of *Salmalia malabaricum*, *Syzygium cumini*, *Impatiens* and *Polygonum* reflects dry climate with reduced monsoon precipitation. Debut of *Shorea robusta* along with immense increment in *Lagerstroemia parviflora* since 8,385 cal BP signals relatively increased humid climate. Consequently, a warm and relatively more humid climate prevailed between 1,519 and 759 cal BP as reflected by palynoassemblage enriched with main ingredients of tropical mixed deciduous forest along with relative decline in Cereal and culture pollen taxa. From 759 cal BP to present, the region experienced a warm and relatively dry climate as a consequence of reduction in monsoon precipitation. In addition, field work has been undertaken in Kamrup and Cachar districts of Assam and procured surface soil, subsurface profiles, moss polsters and fresh polliniferous materials of some important constituents (arboreals & non-arboreals).

Project- 8.2: Reconstruction of Quaternary vegetation dynamics and climate change in southern Madhya Pradesh

Investigators : M.S. Chauhan & Kamlesh Kumar

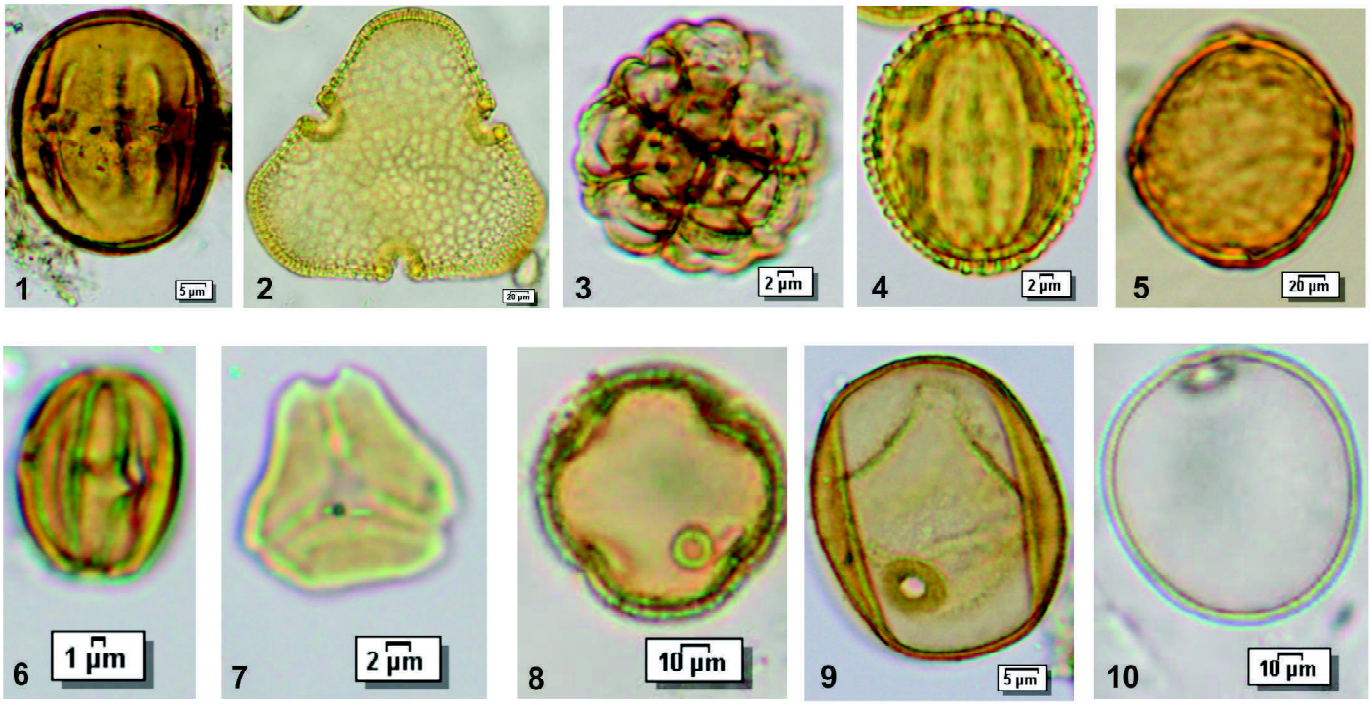
Pollen evidence from a 2 m deep sediment profile from Barehata Lake, Narsinghpur reveals that around 8,678 to 6,543 cal yr BP, open mixed deciduous forests comprising a few trees such as *Holoptelea*, *Acacia*, *Aegle marmelos*, etc. occupied the region under a warm and less-humid climate. The presence of Cerealia pollen around 7,353 cal yr BP along with Cheno/Am and Caryophyllaceae suggests the beginning of cereal-based agrarian practice. Between 6,543 and 4,873 cal yr BP, the mixed deciduous forests got established with the expansion of prominent trees and incursion of *Butea* and *Lannea coromandelica*, etc. with the initiation of a warm and more-humid climate. Around 4,873 to 1,200 cal yr BP, the forests became sparse as indicated by the depletion in trees due to prevalence of a warm and dry climate. Since 1,200 yr BP onwards, the diversification of mixed deciduous forests reflects a warm and humid climate with the increased monsoon precipitation.

Six surface samples from Barehata Tal have also been studied for pollen rain-vegetation relationship. The pollen assemblage reveals the dominance of non-arboreals and reduced frequencies of the arboreals. The consistent representation of trees– *Madhuca indica*, *Acacia*, *Holoptelea*, *Aegle marmelos* and *Terminalia* with moderate values corresponds with their presence in the forest. Whereas, *Adina cordifolia*, *Tectona grandis*, *Buchanania lanzan*, etc. are sporadic, despite their frequent presence in the forest. This erratic display of most of the trees could be attributed to their low pollen productivity and selective preservation of pollen in the sediments. The arboreals constitute average 22% fraction of the total pollen influx, comprising tree (av. 18.46%) and shrubby (av. 3.55%) pollen. Grasses and other major non-arboreals record cohere with the presence of these taxa in the ground flora. The non-arboreals form the major chunk (av. 78%) of pollen rain. The retrieval of Cerealia and culture taxa denotes the proximity of cultivated land.

Project- 8.3: Quaternary palaeoclimate reconstruction and palaeovegetation dynamics in the central Ganga Plain

Investigators : M.S. Chauhan, Anju Saxena, Anjali Trivedi & Kamlesh Kumar

Pollen analysed from 10 surface samples from Kirak Tal, Raebareli district (UP) reflects the dominance of non-arboreals over the arboreals. The irregular display of most of trees is attributed to low pollen productivity as



Pollen recovered from surface samples of Kirak Tal (Raebareli district,U.P.) : 1. *Madhuca indica*, 2. *Bombax ceiba*, 3. *Acacia nilotica*, 4. *Maytenus*, 5. *Holoptelea integrifolia*, 6. *Terminalia*, 7. *Syzygium cumini*, 8. *Emblica officinalis*, 9. Cerealia, 10. Poaceae

they are entomophilous. The trees constitute a small fraction (av. 9.5%) of pollen. Preponderance of grasses, Cheno/Am, Tubuliflorae, *Polygonum*, etc. pollen corresponds with their presence in the ground flora, representing a fraction of average 82.5% pollen. Pollen rain data from Lashoda Tal also shows dominance of non-arboreals. The high frequencies of tree *Acacia* portray their abundance in the area. The consistent record of *Holoptelea*, *Madhuca indica* and Myrtaceae conforms to their factual presence. The meager presence of the trees infers their low pollen production. Trees constitute about 22.5% fraction of the pollen rain. The retrieval of non-arboreals coheres with their presence in the ground flora. Occurrence of Cerealia and culture taxa implies the agrarian practice. Non-arboreals constitute a chunk of average 75% pollen.

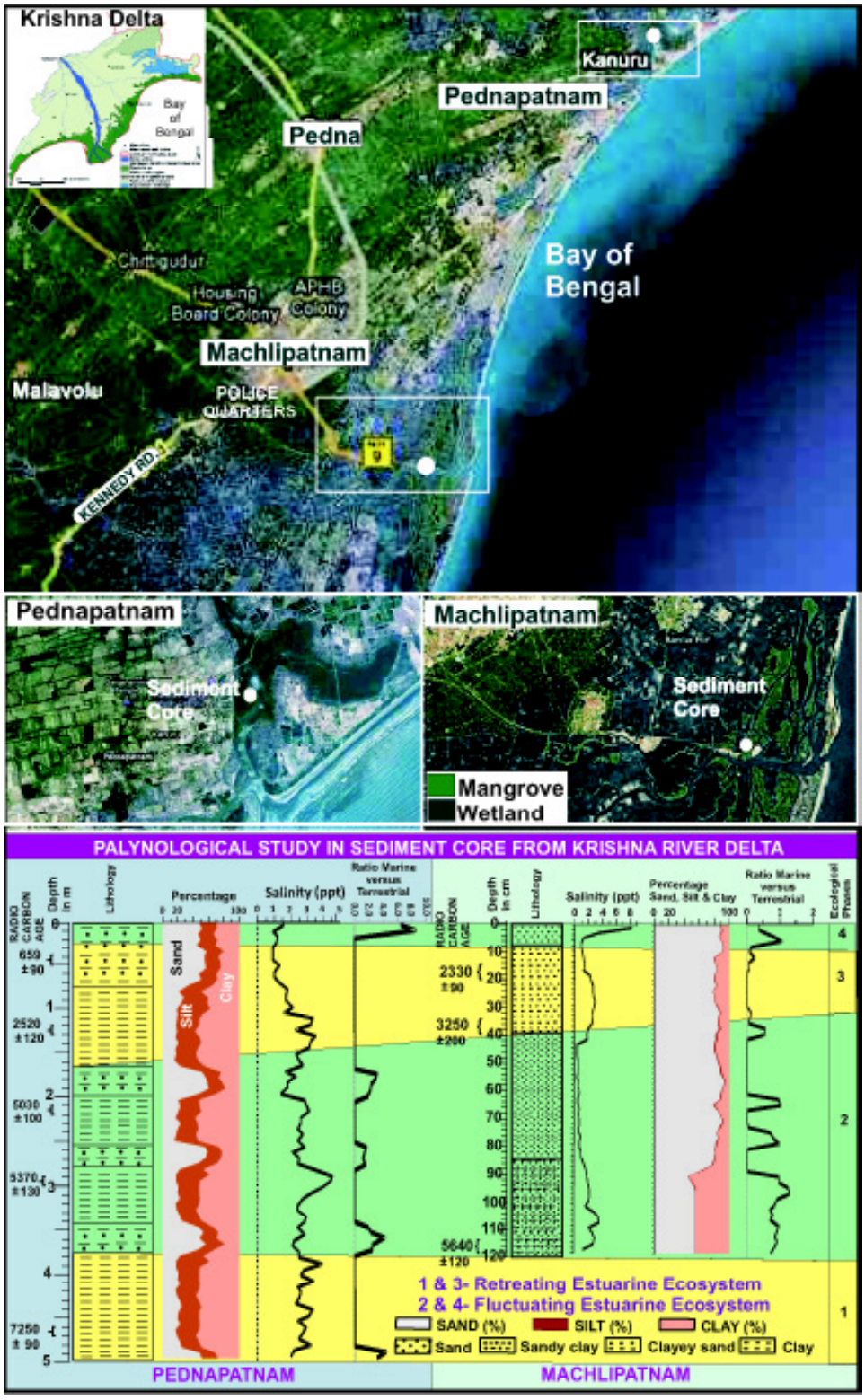
Pollen sequence from a 2.4 m deep profile from Lashoda Tal reveals that around 18,000 to 16,156 cal yr BP the grasslands with stray trees of *Holoptelea* thrived in the region under a cool and dry climate. Around 16,156-13,026 cal yr BP a few more trees (*Madhuca indica*, *Acacia*, *Syzygium*, etc.) invaded the grasslands with the amelioration of climate. The debut of cereal pollen around 10,000 cal yr BP elucidates the inception of agrarian practice. The expansion of trees between ~13,026 and 5,916 cal yr BP suggests the establishment of forest groves interspersed with grasslands, depicting warm and humid climate. The forest groves became varied between ~5,916 and 2,000 cal yr BP under a warm and more-humid climate. Since 2,000 cal yr BP, sharp decline in arboreals suggests a warm and dry climate.

The pollen analysis of 2.1 m deep Chaudahry ka Tal sediment profile has revealed the vegetation and climate change during Holocene. Around 8,470-6,422 cal yr BP the region supported grasslands with few trees (*Madhuca indica*, *Holoptelea*, *Acacia*, etc.), indicating a warm and humid climate. The retrieval of Cerealia pollen 7,500 cal yr BP suggests the inception of agrarian practice. Between 6,422 and 3,150 cal yr BP, the forest groves became diversified due to warm and more-humid climate. Around 3,150 to 1,110 cal yr BP, decline in trees deciphers a warm and moderately-humid climate. Since 1,110 cal yr BP, the further depletion in arboreals denotes a warm and dry climate.

Project- 8.4: Late Quaternary vegetation and climate studies from lakes of Andhra Pradesh and northwest Uttar Pradesh

Investigators : Anjum Farooqui, S.K. Shukla & Ranjana

A 500 cm sediment core from Narsinghpur (middle deltaic part), Krishna River Delta has been studied for pollen/spores and physico-chemical characteristics of soil. The radiocarbon dates show that 5 m sediment was deposited since ~4 ka. Two events of estuarine depositional environment have been recorded. A short span of estuarine deposition bearing evidences of mangrove pollen, foraminiferal linings and dinoflagellate cysts have been recorded ~3.7 ka, followed by fresh water deposition until ~2.5 ka, and then a second phase of estuarine deposition. Thus, it is inferred that the middle part of Krishna River delta prograded and evolved since ~4 ka experiencing two intermittent relative sea level rise and fall during Late Holocene covering a distance of about 15 km from the present shoreline. Since about 1.5 ka, that the middle part of northern Krishna River delta has prograded without any signatures of relative sea level rise. Besides, the exhaustive survey of coastal areas in southern part of the delta has also been carried out in areas within 15 km range from the present shoreline. Deep core and surface samples have been collected from areas ranging between 5 and 12 km from the shoreline. Soil samples from sediment-water interface have also been collected through piston auger in the river channels from land towards sea at an interval of 10 m for the study of diatoms, pollen/spores and thecamoebians.



Location and palynological interpretation of sediment cores from Krishna River Delta (AP)

The surface sediments studied for pollen/spores and thecamoebians from Nawabganj Bird Sanctuary and lakes around Lucknow have revealed strong association between thecamoebian community and the type of vegetation in this climatic zone. The assemblage of dry/ moist deciduous pollen along with stressed thecamoebian community belonging mostly to *Centropyxis* and *Arcella* species suggest high seasonality during which the ecosystem was stressed under lake desiccation and expansion. Overall, results reveal that different morphotypes of *Centropyxis laevigata* are good markers of lake expansion and desiccation responding to seasonal hydrological changes in the lake. The study of diatoms in terrestrial lake sediments was taken up for preparing modern analogue to be applied during the study of coastal sediments in order to assess the fresh water assemblages. In addition, the study of diatoms in terrestrial lake sediments has been taken up for preparing modern analogue to be applied during the study of coastal sediments in order to assess the fresh water assemblages.

Project- 8.5: Vegetation succession and climate change in Garo Hills, Meghalaya and adjoining areas since Holocene

Investigator : S.K. Basumatary

The modern pollen database of 120 surface samples examined from Balpakram Valley has revealed a good correlation of modern pollen, extant vegetation and climate as found today. Five pollen zones (forest types) have been recorded based on the regional pollen marker taxa corresponding to the ratio of evergreen and deciduous forest elements (>30% signify the forest type). The recovery of *Duabanga-Schima-Nepenthes* assemblage is identified as a high monsoonal activity with strong perennial river and streamlet system in the area. Pollen of *Nepenthes khasiana* in sediments signifies warm and humid climate in response to high precipitation in the region.

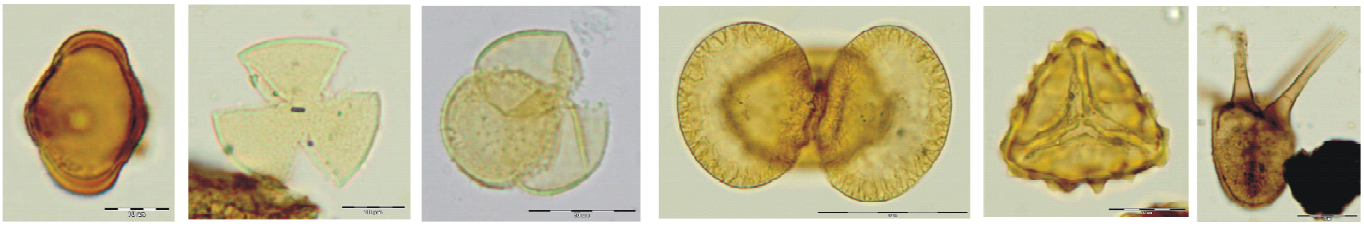
The palynological study on bat guano from Siju Cave is the first such study in India. The palynodata from both the modern bat guano and surface samples from the immediate vicinity of the cave are very similar and indicate the existence of mainly riparian forest consisting of *Duabanga*, *Syzygium* and *Schima*, which closely



Entrance of Siju Cave in Meghalaya



A view of the bat colony in their resting chamber inside Siju Cave



Duabanga *Shorea robusta* *Nepenthes khasiana* *Pinus* Trilete *Tetraploa*

Palynoassemblage recovered from bat guano in Siju Cave

matches the extant vegetation. The bat guano deposit in Siju Cave can be considered as a reliable source of palaeoecological data that can be used to support data from surface and sedimentary soil profiles and to substitute for the scarcity of lakes, swamps, and wetlands in Meghalaya. In addition, palynological study of a 29 cm sedimentary core soil profile from Pynursla of East Khasi Hills has revealed the existence of a subtropical evergreen forest consisting of *Schima*, *Symplocos*, *Ilex* and *Quercus* along with *Pinus kesiya* under warm and wet climatic condition with high monsoonal activity in the region. Besides, field work has been conducted in Garo and East Khasi Hills to collect polliniferous material, surface, cave, and sedimentary soil samples for palynological study.

Project- 8.6: Quaternary mangrove ecosystem dynamics and sea level changes of the Mahanadi Delta and comparative assessment with Sunderbans Delta

Investigator : Shilpa Pandey

Thirty surface sediment samples have been palynologically analysed from the Pakhiralaya village of Sundarbans to understand the relationship between the modern pollen assemblages with their respective present day vegetation. The results indicate that the pollen of local vegetation (i.e. mangroves) is more dominant in the pollen spectra, which is strongly related to the proximity of source vegetation. The major mangrove pollen taxa (*Rhizophora, Avicennia, Sonneratia, Bruguiera, Aegiceras, Excoecaria* & *Heritiera*) recovered from the sediments are compatible with the present-day vegetation of the study area. However, mangrove associates pollen, such as *Acanthus, Lumnitzera, Acrostichum, Suaeda* and *Phoenix* are poorly represented. Other palynomorphs of different groups, such as hyper saline and cosmopolitan herbs, fresh water taxa, fungal spores, dinoflagellate cysts are also recorded. Anthropogenic impact on this region is also accentuated by pollen of introduced plants, such as *Eucalyptus*, *Casuarina* and others.

A 2.8 m deep sediment profile from the Kaikhali village of Sundarban Forest has also been investigated for palynological studies. The entire profile is mainly composed of silt and clay sediments. The pollen analytical results indicate that pollen zone K-I is characterized by the dominance of mangrove pollen (about 65%), whereas presence of mangrove associates pollen (6-10%), herbs (2-6%) and fern spores (1-3%) are relatively stable throughout the record. K-II zone is marked by a relatively high pollen representation of the midland and ubiquitous taxa groups. Mangrove pollen shows relatively low values, represented by *Avicennia, Excoecaria*, etc. Pollen zone K-III is also represented by high values of mangrove pollen, pollen sums for the midland and other groups are low. Herbaceous pollen decline but Poaceae and Cyperaceae pollen are rather abundant. In addition, 15 spider webs collected from different islands of Sundarban Forest were also studied to unfold the pollen deposition pattern.

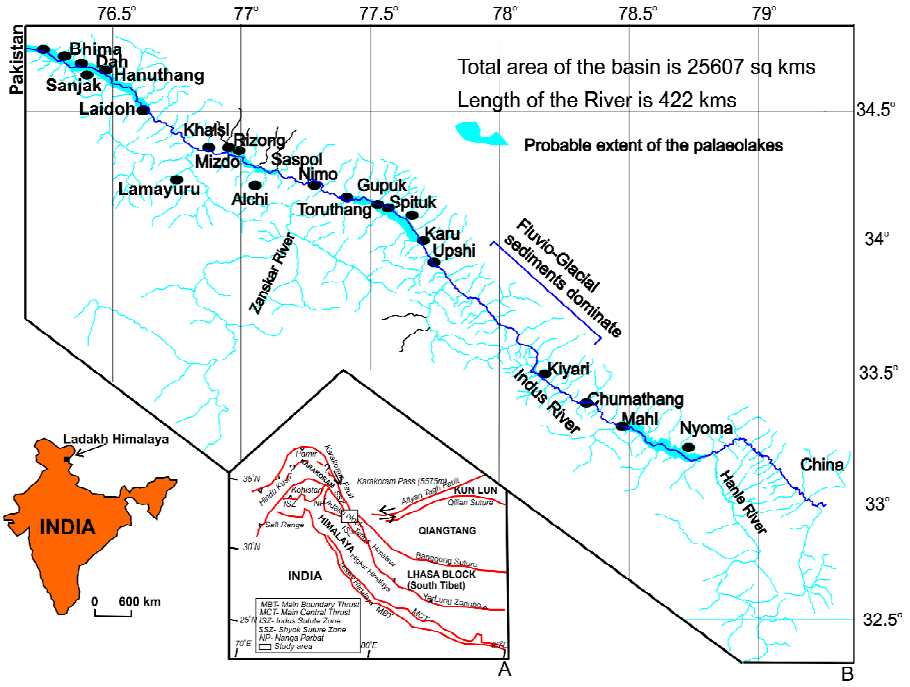
Project- 8.7: Geomorphological and tectono-climatic signatures in Trans and Tethyan Himalaya during Quaternary Period: A multi-proxy approach

Investigators : Binita Phartiyal, Anupam Sharma, S.N. Ali, P. Morthekai & Debarati Nag

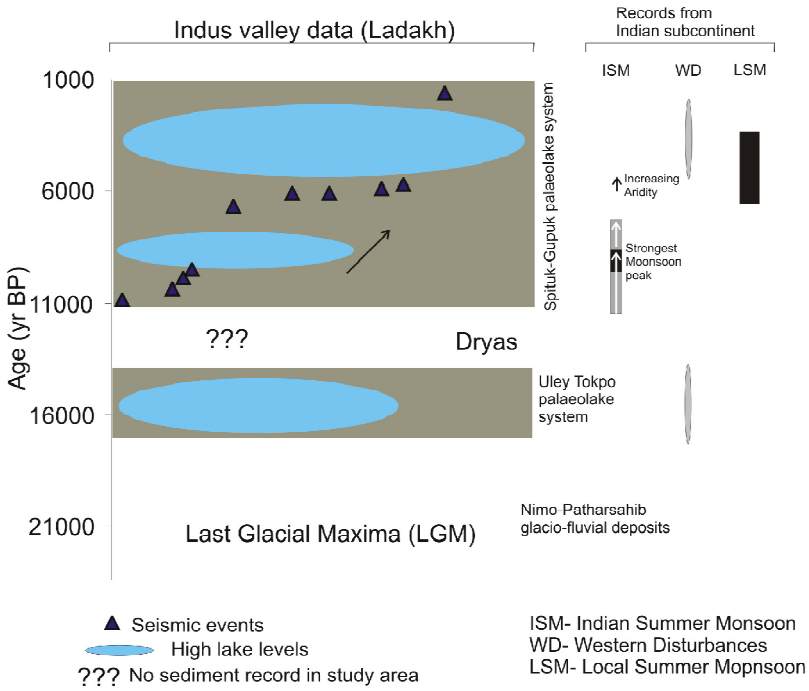
In the vicinity of Khardungla (altitude 5602 m) in Ladakh region, one of the highest passes in the world, two lakes at North Pulu (NP) and South Pulu (SP) have been studied. The 14C AMS chronology bracket the NP section from 4,585 to 360 yrs BP, and SP section to 3,800 to 320 yrs BP. A multi-proxy study using textural, sedimentological, mineral magnetic, geochemical and biotic (palynofacies and diatoms) study has been conducted. Besides, the existence of a 185 km long palaeolake during the Late Quaternary (~20 ka BP) in the Ladakh Himalayas, occupying the present day Tangtse and Shyok River valleys, covering an area of 1,150 sq. km is reported. This lake was the western extension of the present day Pangong Tso lake. The area lies in the active zones of Karakorum Fault and Shyok Suture in NW Trans Himalaya.

Morphological, mineral magnetic and sedimentological studies have been carried out in four sections (KI-20 m; BH-10 m; LS-20 m and IH 6 m in thickness) along the Indus catchment. The mineral magnetic proxy is proving to be a very good tool for palaeoclimate interpretation in these Trans Himalayan lacustrine facies where the biotic proxies are either absent

or deficient. Here the gap in data in case of the biotic proxies is also resolved. The chronological and textural analysis results are awaited and as soon as they come the papers on palaeoclimatic variations will be finalized. In addition, along the Indus River Valley from Nyoma to Batalik damming phases have been demarcated and recorded the existence of four major palaeolakes in the Late Quaternary Period. Two of them existed during post LGM and Early Holocene. The commencement and breeching of the palaeolake sequences and the seismites preserved therein are evidence of the tectonic pluses in the area, but the contribution of climate cannot be ruled out. These palaeolake records are being studied for multi-proxy high resolution climatic variations.



Structural setup of Himalayan syntaxis and drainage network of the River Indus in study area showing the extent of four palaeolakes that existed during Late Quaternary and Holocene



Schematic model showing the events along the river Indus in the study area with the chronology and their comparison to the ISM, western disturbances and LSM records of the Indian subcontinent

Project- 8.8: Late Quaternary climate and glacial history from the western Himalayan region

Investigator : P.S. Ranhotra

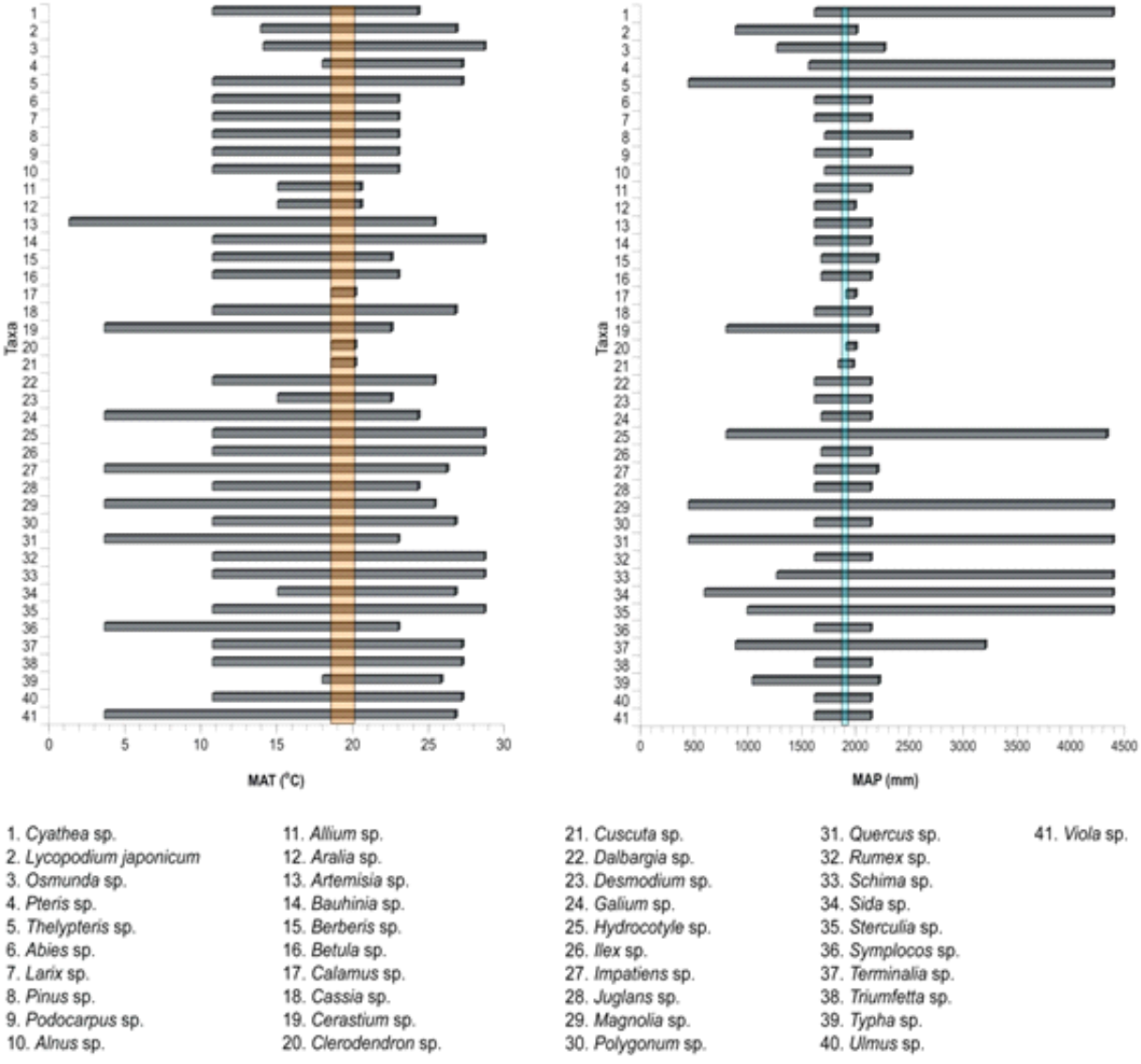
A 2.35 m deep sedimentary profile, from the Tapovan palaeolake of Gangotri Valley, is being analysed for the lake history and climate. The initial studies through sedimentological analysis show the alternate lacustrine and fluvial phases. Presently the lake, at an altitude of ~4300 masl, is a triangular flat at the left bank of the

main Gangotri Valley, and above the altitude of present glacier snout level (~3980 masl). The area is characterized by the growth of Cyperaceae due to marshy conditions produced by melt water streams that flow down to join main valley. Steppe taxa are restricted on the dry margins and slopes around the lake. Three major phases of erosion have been encountered within the whole sedimentary sequence and individual sequence shows the grain size decreasing upwards till the major erosion phase. The OSL dates of the sediments at various depths cover the upper Late Holocene part with the available dates of ~1141±127 yrs BP and ~937±100 yrs BP respectively near the base and surface of the profile. This shows not much variation in the deposition time and filling of the lake. The breaching of lake might be around early Little Ice Age time (~1200-~1500 AD) followed by no deposition phase.

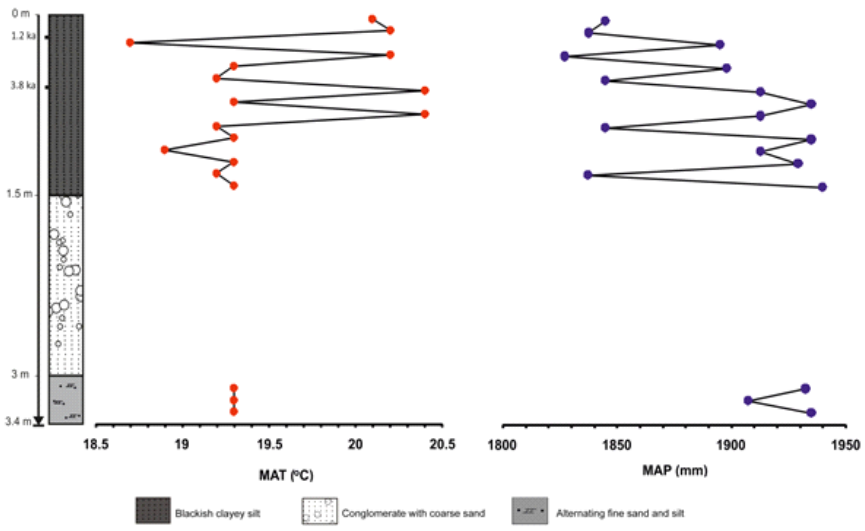
Project- 8.9: Vegetation based reconstruction of Late Quaternary climate of the eastern Himalayas

Investigator: Ruby Ghosh

Pollen, phytolith and stable carbon isotopic data gathered from a 3.4 meter deep profile in Ziro Lake Basin, Arunachal Pradesh have provided new insights into the palaeoenvironmental and palaeoclimatic changes since pre-LGM time. Both pollen and non-pollen palynomorph data suggest prevalence of a dense C3 species-dominated



Coexistence intervals of palynoflora for Mean Annual Temperature (MAT) and Mean Annual Precipitation (MAP) recovered from Soro nala profile, Ziro Lake Basin



Changes in MAT and MAP derived through coexistence approach along Soro nala profile, Ziro Lake Basin

moist semi-evergreen forest in the area until the LGM which shows conformity with ä^{13}C data. The phytolith assemblage indicates an alteration in forest cover with expansion of C4 grasses during the LGM. The study further indicates a climatic amelioration with intensification of south-west monsoon during 10.2-3.8 ka and an expansion of forest cover. After 3.8 ka there was a rising trend of dryness, shrinkage in forest cover, and a slight increase in C4 species while C3 plants dominated. Application of coexistence approach on pollen data reveals that prior to the LGM the mean annual temperature (MAT) and mean annual precipitation (MAP) were approximately 19.3 ±0.001°C and 1925 ±15 mm respectively. Between 10.2 and 3.8 ka MAT was about 19.4 ±0.5°C, while MAP was 1901 ±41.3 mm. Between 3.8 and 1.2 ka and onwards a slight increase in MAT (~0.3°C) was observed with further decrease in MAP to 1861 ±33.4 mm.

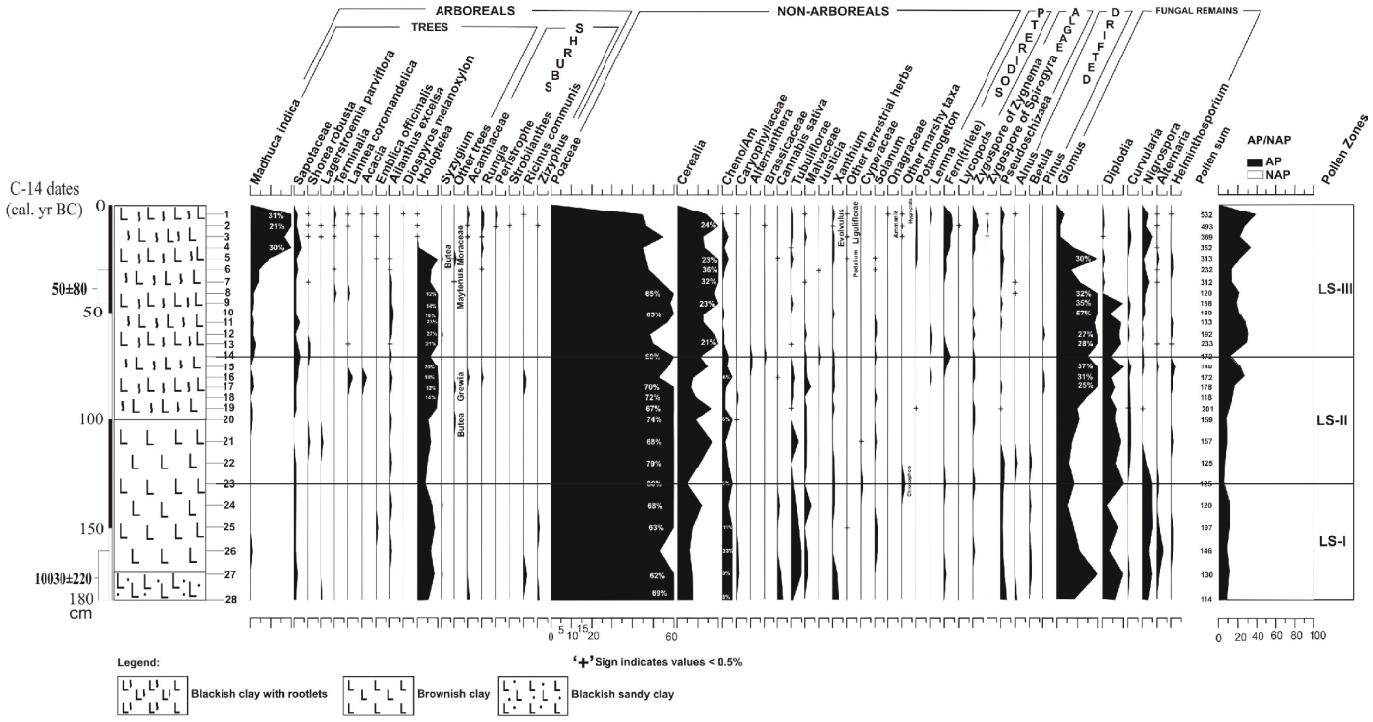
The samples collected from Darjeeling district have been macerated for pollen and phytolith studies. Besides, a field visit has been undertaken in Arunachal Pradesh to collect more surface soils and sub-surface sediments for further study to establish a relationship between modern pollen/phytolith spectra reflected in surface sediments of different vegetation zones of eastern Himalayas along altitudinal gradient. The data may provide a basis for the reconstruction of Late Quaternary environmental changes in area.

Project- 8.10: Quaternary vegetation and climate change in north and northwestern regions of Chhattisgarh

Investigators : S.K. Bera & M.F. Quamar

Pollen analysis of a 1.80 m deep sediment profile from Lakadandh Swamp (Baikunthpur Forest Range), Koriya district reveals that during 12,785 to 9,035 cal. yrs BP, tree savannah vegetation occurred in the region under a cool and dry climate with reduced monsoon precipitation. Between 9,035 and 4,535 cal. yrs BP, the proliferation of existing taxa (*Holoptelea*, Sapotaceae, *Madhuca indica*, *Ailanthus excelsa*, *Lagerstroemia*) along with debut of *Acacia* and *Shorea robusta* witnessed under a warm and moderately humid climate owing to increase in monsoon precipitation, where the open mixed tropical deciduous forest replaced the tree savannah vegetation. Since 4,535 cal. yrs BP onwards, with the improvement of most of the forest constituents, along with immigration of some more arboreal including *Terminalia*, *Diospyros*, *Butea*, *Maytenus* in lower values, the forest became comparatively dense and diversified with the inception of a warm and relatively more humid climate with further increase in monsoon precipitation.

The recovered palynoassemblage from surface samples/moss polsters of Matijharia Lake of Baikunthpur Forest Range has revealed the dominance of non-arboreals over the arboreal taxa. Among the arboreal, trees constitute on average 18.8% pollen in the total pollen rain, whereas the contribution of shrubby element is meager (0.94%). Herbaceous Poaceae has higher frequencies (31.2-65%). Cerealia including other culture pollen taxa indicate the cereal-based agriculture practice in and around the area of investigation. In addition, pollen analysis of a 1.8 m deep sediment core from Matijharia Lake has demonstrated that during 6,410 to 4,250 cal. yrs BP, tree savannah vegetation occurred in the region under a regime of dry climate with reduced monsoon precipitation. Between 4,250 and 1,000 cal. yrs BP, the mixed tropical deciduous forest replaced the tree savannah vegetation under a warm and humid climate with increased monsoon precipitation. Since 1,000 cal. yrs BP onwards, the forest became comparatively more dense and



Pollen diagram from Lakadandh swamp of Baikunthpur Forest Range, Chhattisgarh

diversified with the inception of a warm and relatively more humid climate with further increase in monsoon precipitation. The region was under the cereal-based agricultural practice however, it has got accelerated due to prevalence of active SW monsoon.

Polar Research Group

Project- 9.1: Deciphering the Quaternary climate history of the Polar Regions: Multi-proxy studies from Antarctica and Arctic

Investigators : Ratan Kar, Abhijit Mazumder & Pawan Govil

Aeropalynology of the Ny-Alesund region, Svalbard has been carried out and developed pollen calendars for the three successive summer months of visits (August 2009, July 2010 & July 2011). This involved the study of dispersed air-borne palynomorphs trapped in the exposed slides smeared with glycerin jelly. The slides have yielded a diversity of pollen, algal and fungal remains of both local and extra-local provenance. It is observed that the representation of palynomorphs is best during the second and third week of July. This is compatible with the melting of snow in the region during the sampling years, as the plants flower during a short phase just after the snow melts and disperse the pollen. Besides, quartz grain microstructure studies of the sediments of a one meter profile from Kolhamna Lagoon, Ny Alesund have been finalized. Surface samples from the Brogger Peninsula are being analysed for developing the modern analogues.

Three random samples from the sediment core from lake L-49/27 from Schirmacher Oasis, East Antarctica have been studied for diatom. However, except few broken strands of *Nitzschia* sp., no major diatom population is found. Four random samples of the sediment core collected from lake ESL have also been analysed for its microbiota content (foraminifera & diatom) and found barren. The sand sized particles are preserved for morphology of quartz grains. Sediment samples studied from the sediment core P-11 are barren of diatom. The relative percentage of sand and the microtextures of the sand sized particles have been studied to decipher the deposition environment. It can be concluded that two glacial periods existed along with one possible interglacial period sandwiched within in and around the core location. In addition, four fresh water lake sediment cores from different parts of Schirmacher Oasis have been collected;

one core from Proglacial Lake (P-11), two from Land locked lakes (L-49/27 & L-51), and one from Epishelf Lake; during the 32nd Indian Scientific Antarctic Expedition. 100 sediment samples for grain size, 127 samples for Biogenic Silica concentration, and 27 sediment samples for total organic carbon and nitrogen have been analysed. The chosen sediment samples from three sediment cores have been sent for AMS dating. Grain size data have been generated (with D.S. Singh, Lucknow Univ.). Under the BSIP polar program, one Geochemistry lab has been established with new UV spectrophotometer equipment. This instrument is useful for the nutrient analysis in the water and sediment samples.



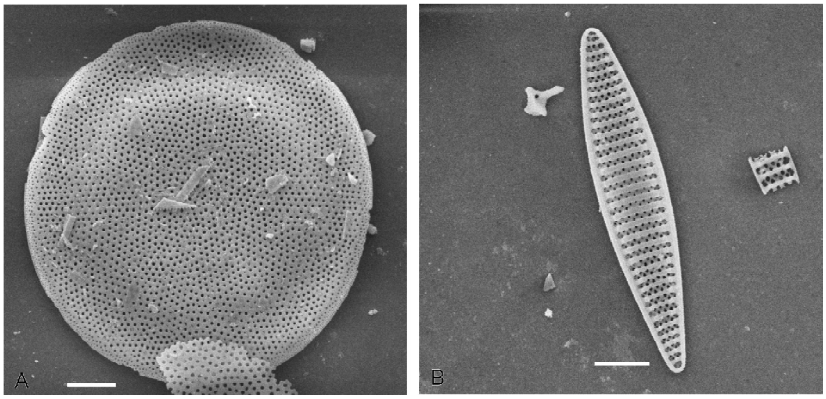
UV Spectrophotometer

Project- 9.2: A study of Quaternary climatic conditions of the Polar regions using integrated multi-proxy data

Investigator : Vartika Singh

The dinoflagellate cysts of *Bitectatodinium*, *Operculodinium*, and thecamoebians like *Arcella* and *Difflugia* have been recorded from the Fjord sediments collected during the Arctic Summer Expedition-2012. The study has helped to understand the impact of warming induced melt water flow on the productivity of the Fjord. Samples from Ny-Alesund, Svalbard have also been analysed for assessing the late Quaternary climate and significant occurrence of the dinoflagellate cysts of *Operculodinium centrocarpum.* Results indicate that the North Atlantic Current (NAC) influenced the western coast of Svalbard around 27,200 yrs BP.

The recorded marine diatoms from Antarctica include *Thalassiosira lentiginosa* and *Fragilariopsis kerguelensis*, which are open ocean dwelling forms. *F. kerguelensis* prefers warm waters (1-7°C sea surface temperature) of the Antarctic and sub-Antarctic realms, beyond which its amount decreases. Dissolution experiments have revealed that *F. kerguelensis* is less prone to dissolution as compared to *Eucampia Antarctica* and *T. lentiginosa*. They are least prone to dissolution. *E. antarctica* has also been studied from the coastal Antarctic sediments. It produces morphologically different summer and winter stages, different terminal and intercalary valves and also different warm and cold varieties. This ratio can be used to study sea-ice extent. In the surface sediments, a low ratio indicates greater winter diatom production and less sea ice. The other significant diatom is *A. actinochilus*, which is confined to the south of the Polar Front (PF). It has been considered as cool water Antarctic species limited to the north by the PF and maximum winter sea ice edge. In addition, the study of lake sediments has revealed diatom assemblage associated with algal mats. The water bodies around research bases with high human activity during summer season produce slightly eutrophic conditions and abundance of diatoms.



Thalassiosira lentiginosa *Fragilariopsis kerguelensis*

Antarctic diatoms

Dendrochronology Group

Project- 10.1: High-resolution palaeoclimatology of western Himalaya

Investigators : R.R. Yadav & K.G. Misra

Tree-ring samples of *Cedrus deodara* from different sites in Jageshwar and Gangolihat, Kumaon Himalaya (Uttarakhand) have been collected and processed to prepare ring-width chronologies. Dating of Himalayan cedar tree core samples (40 increment cores from 31 trees) collected from Jageshwar resulted in the preparation of ring-width chronology extending back to AD 1536. The trees sampled from Gangolihat (42 increment cores from 33 trees) are relatively younger (AD 1668) to those in Jageshwar; indicating that the plantation of Himalayan cedar trees could have started first in Jageshwar temple area, and gradually spread to other regions in Kumaon. February-May precipitation reconstruction using two chronologies is done. The reconstruction capturing 58% of the variance in the regional mean precipitation series (1901-1968) is the strongest so far developed from the Himalayan region in India. The most revealing pluvial phases in 20th century occurred around 1910-1918, 1978-1988, and dry phases around 1920-1924, 1964-1974, and 1993-2001, which are consistent with the precipitation records from the region.



More than 1000 years old Jageshwar temple with Himalayan cedar trees

Project- 10.2: Tree-ring analysis from high altitude areas of Himalayan region: A comparative approach with emphasis on the eastern sector

Investigator : S.K. Shah

The relationship of streamflow records of the Lachen River with tree-ring parameters of total tree-ring width (TRW), earlywood width (EWW) and latewood width (LWW) chronologies of *Larix griffithiana* from Lachen, North Sikkim (Eastern Himalaya) has been generated. These chronologies correlate significantly with the observed discharge of the Lachen River where the EWW chronology explains highest variance with streamflow. Based on this result, Lachen River discharge for the period from the previous year March to current year February has been reconstructed using EWW chronology, which extends back to AD 1790. The reconstructed streamflow data was compared with historical drought records. In addition, aberration in succession pattern of two conifers, *Pinus roxburghii* (Chir pine) and *Cedrus deodara* (Deodar) from Kullu, Western Himalaya has also been studied based on tree-ring data. Besides, 46 tree-ring samples of *Abies densa* collected from Lachen, North Sikkim have been cross-dated and measured.

Thrust Area 6: DOMESTICATION OF PLANTS, EARLY FARMING AND ECOSYSTEM DYNAMICS DURING HOLOCENE/ ANTHROPOCENE

Palaeoethnobotany Group

Project- 11.1: Palaeoethnobotany: Ancient man, plants and environment in northern, eastern and northwestern India

Investigators : Chanchala Srivastava & A.K. Pokharia

Morphological investigation of seed and fruit remains collected from ancient site Kampil, the capital city of ancient south Panchala in Farrukhabad district (UP), from the cultural horizon of pre-P.G.W. (Ochre-



a. Archaeological site at Khirsara (Kachchh, Gujarat) a Harappan site under excavation, b. room showing hearth, scattered artifacts and earthern griddle (tawa). Carbonized plant remains recovered by water floatation technique : c. *Hordeum vulgarel*, d. *Vigna radiata*, e. *Setaria* sp., f. *Ziziphus nummularia*, g. *Sesamum indicum*, h. *Triticum aestivum*, i. *Sorghum bicolor*, j. *Linum usitatissium*, k. *Macrotyloma uniflorum*, l. *Cicer arietinum*, m. *Gossypium arboreuml herbaceum*

Colored Pottery) and Painted Grey Ware (c. 1500-800 BC), Northern Black Polished Ware (c. 800-200 BC), Sunga-Kushana (c. 200 BC-300 AD), and Gupta up to Medieval times (c. 300-800 AD) have been carried out. Both winter and summer season crops with their associates are recorded, reflecting on the advanced agriculture pattern practiced by the ancient settlers. The study incorporated field-crop finds belonging to cereals–barley, rice, bread wheat and dwarf wheat along with crop of Job's tears, millets of sawan, Italian millet, pulses (lentil, khesari/grass-pea, field-pea, green-gram, black-gram, gram (*Cicer arietinum*), horse-gram/kulthi, aconite/ moth-bean, etc.), seeds of fiber yielding plants (silk-cotton & cotton), oil-seeds (sesame, linseed), and fruit remains (jujube, grape pips & emblic). The dominance of jujube and emblic/anwala fruit-stones, of high medicinal value, has been recorded from nearly all phases. Additionally, a visit to the ancient site at Maner, district Patna (Bihar) has been undertaken (by CS) for collection of botanical remains in collaboration with the excavation team from ASI (Patna circle).

Further investigations on the botanical remains from Khirsara, a Harappan site in Kachchh district, Gujarat have added to our understanding of the exploitation of botanical resources by ancient settlers at the site from 2500-2000 B.C. In addition to the crops already reported, the additional remains of dwarf wheat, ragi millet, Italian millet, proso millet, field pea, grass pea, chick pea, sponge gourd, and linseed are new finds. Remains of weeds and other wild taxa encountered have been identified as belonging to *Setaria* sp., *Celosia* sp., *Trianthema triquetra*, *Abutilon* sp., *Sida* sp., *Asphodelus* sp., *Scleria* sp., *Scirpus* sp., *Rumex* sp., *Polygonum* sp., *Cyperus* sp., *Indigofera* sp., *Ipomoea* sp., *Trigonella occulta*, *Solanum* sp., and *Ziziphus nummularia*. Besides, AKP participated in the excavations for collection of botanical remains from Chandravati archaeological site in district Sirohi, Rajasthan.

Project- 11.2: Floristics of UP and Amarkantak-Achanakpur, MP biosphere reserve

Investigator : D.C. Saini

The final draft of a manuscript on 1000 species belonging to 759 genera and 110 families, and general part (introduction, geology, soil, topography, forest types, drainage & vegetation of special habitat) has been completed. A general key to the families has been provided for family level identification. Each family is provided with key to the genera and each genus is provided with key to the species. Each species is provided with its correct name, basionym if present, synonyms and a short description along with ecological notes followed by flowering and fruiting times, local names if any, and a colored photograph with illustrations of each plant species has been given. Further work is in progress.

Thrust Area 7: GEOCHRONOLOGICAL AND GEOCHEMICAL PARAMETERS FOR HIGH RESOLUTION DATING, CORRELATION, PALAEOCLIMATIC, TECTONIC AND PROVENANCE STUDIES

Geochronology and Geochemistry Group

Project- 12.1: Carbon dating and its application in Quaternary studies

Investigator : C.M. Nautiyal

A total of 171 samples have been processed for benzene, and 159 samples counted in the Ultra Low Background Liquid Scintillation Counter and calibrated ages calculated for the samples of late Quaternary period; inclusive of samples of consultancy, Institute's projects and collaborative work. These included sediment samples such as coral reef, charcoal/ wood from archaeological sites, lake shores, etc. and also the standard/ background samples. The C/N measurements have been done on 125 aliquots from sediment samples of various sites including Spiti and standards. Besides, the international calibration samples under 6th such exercise (SIRI) have been undertaken for measurements. Several components of the benzene preparation system are maintained/ modified, and work on another system has been started. A new oxalic acid standard (NIST) is undergoing a series of tests for comparison with the old standard and for regular use.

Seven core samples from coral reef have been collected from off Jam Nagar coast and they are dated in the range of about 3000 BC (calibrated) to modern (work in collaboration with GEER, Gandhi Nagar). This complements the earlier results some of which had shown modern ages for the bottom of the coral rocks. The sediment samples from Vadgam and Banaskantha (Gujarat) have been dated in joint study with Institute and Baroda University researchers to learn about channel shifting, landform evolution and stratigraphy of the areas. In joint work with HNBGU, Srinagar, a charcoal sample from Kanam (Kinnaur, HP) has also been dated to be about 2500 BP (calibrated) indicating the burial practice to be an ancient one in the region. Also with Institute's colleagues, dating of West Odisha sediments for climate change has been continued that indicated climatic oscillations in the late Mid-Eocene. Besides, dating has been undertaken on the deposits from Siju caves (Assam), Lamahatta (Darjeeling) and Kailhali (Sundarbans).

Project- 12.2: Development of OSL, geochemical and stable isotope laboratories

Investigators : Sunil Bajpai, Anupam Sharma, Pawan Govil, Kamlesh Kumar, Shailesh Agrawal, S.N. Ali, P. Morthekai & Manoj M. C.

After finalizing the specifications for ICP-MS, IRMS-GCMS and TL/OSL, a global tender notice was floated. The technical specifications were evaluated by the concerned technical committee and the financial bids of only those firms which satisfied the technical requirements were opened. The recommendations of the technical committee for L1 of respective equipments were considered and approved by the purchase

committee. The purchase of the equipments was then approved, and purchase orders for the equipment were issued and LC were opened by the bank. Establishment of labs for all the four instruments and procurement of all the necessary lab accessories and installations have been initiated.

Thrust Area 8: INDIA-ASIA COLLISION AND HIMALAYAN UPLIFTS: PALAEOBOTANICAL AND ASSOCIATED BIOTIC SIGNATURES FROM SEDIMENTARY RECORDS OF WESTERN HIMALAYA

Project- 13.1: Biota from sedimentary sequences of Indus-Suture Zone, Ladakh Himalaya: Biostratigraphical, palaeoenvironmental and palaeogeobiographical implications

Investigators : Sunil Bajpai, Madhav Kumar, Anupam Sharma, Gaurav Srivastava, V.V. Kapur & Shailesh Agrawal

The India-Asia collision is one of the most pronounced tectonic events to have occurred in earth's history. However, several aspects of this event including timing, initiation of continental sedimentation in the collision one and the biotic and climatic responses are not well understood. Given the availability of palaeobiological and geochemical expertise of BSIP, this project has recently been initiated to address these research issues. After having consulted the relevant literature and maps, it was decided to undertake field work in some identified sections of Ladakh during June-July 2014. Sections to be investigated include: i) Nimu-Chilling road along the Zanskar River, ii) Upshi section on the Leh-Manali Road, iii) around Taruche-Yangthame, iv) around Hemis Monastery, v) around Kargil, and vi) around Chumathong area.

Thrust Area 9: PREPARATION OF BOOKS, CATALOGUES, ATLASES, DATABASES, DIGITIZATION OF LIBRARY, MUSEUM, HERBARIUM AND OTHER HOLDINGS

Project- 14.1: An atlas of Vindhyan stromatolites

Investigator : Mukund Sharma

The Kajrahat, Fawn and Rohtas Limestones of the Semri Group, and Bhander Limestone of Son Valley, and Sirbu and Balban Limestone of Chambal Valley, the two sub-basins of Vindhyan Supergroup hosting various types of stromatolites, have been identified in the Vindhyan Basin for incorporation in the atlas. In recent years, these carbonate units are extensively mined for cement industry or are submerged under water of large dams. The stromatolites found in these successions are being photo-documented for preparation of an atlas.

Project- 14.2: Revision of Indian species of *Glossopteris*

Investigators : K. J. Singh & Anju Saxena

Research account of 7 species of *Glossopteris* from the Kamthi Formation of Talcher Coalfield (Odisha) has been compiled for the monographic work, as these were not recorded in previous existing monograph. Some other new species of *Glossopteris* which has been erected in the past three decades are also identified and work on them is in progress.

Project- 14.3: A catalogue on Upper Gondwana (Jurassic-Cretaceous) plant megafossils of India

Investigators : Neeru Prakash & Neelam

Relevant literature on megafossils recorded from Indian Jurassic-Cretaceous sequences have been consulted and prepared reference cards along with their abstracts. A database has been prepared indicating author's name, year of publication, abstract, locality and age.

Project- 14.4: An annotated bibliography on Indian Gondwana palynology

Investigators : Neerja Jha & Neha Aggarwal

Palynological literature on Indian Gondwana is widely scattered in various national and international scientific journals ranging from well known to obscure. Search for palynological papers and collection of literature on Gondwana palynology is being carried out. More than 300 references have been collected, and abstracts have been added or noted. Editing and abbreviation of abstracts have also been done.

Project- 14.5: Tertiary plant megafossils from India (2006-2017)

Investigators : Rashmi Srivastava

Data of Indian Cenozoic plant megafossils records have been added in the catalogue, especially published in the journal Palaeobotanist.

Project- 14.6: Calcareous nannofossil records from India

Investigators : Jyotsana Rai & Abha Singh

Over hundred sketches of various nannofossil taxa belonging to families Axopodorhabdaceae, Stephanolithiaceae, Watznaueriaceae, Chiastozygaceae, Biscutaceae, etc. from publications after 2007 from India have been prepared and the catalogue work is in progress. The prepared sketches containing details of anatomical and morphological features with labelled diagrams, explains clearly the family and genera characters useful for identification. It will also help in comparing LM and SEM images of the same nannofossil taxa.

Project- 14.7: Pollen flora of tropical deciduous forest, Assam, Northeast India

Investigators : S. K. Bera, Swati Tripathi & Kanupriya Gupta

Pollen morphological survey has been performed from the published archive pertinent to pollen morphometric studies of tropical forests of India. Pollen morphological examination of 20 marshy and aquatic taxa including *Nymphaea, Nymphoides, Eichhornia, Typha, Potamogeton, Ipomoea, Geranium, Impatiens, Ludwigia, Jussiaea, Myriophyllum, Nelumbo, Trapa, Polygonum*, etc. has been done. Formulation of phenological table, photo-documentation and comparative interpretation is in progress.

Work other than Institute Projects

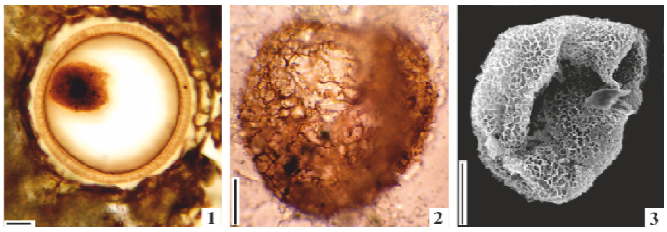
Well established and exposed field stops in the Marwar Basin have been marked for International Field Workshop held in early 2014, and related logistic arrangements for the field workshop have been made. Besides, a Field-Guide book entitled 'the International Field Workshop on the Marwar Supergroup, Rajasthan, India' has been prepared. The workshop was successfully organized with 32 participants from India and abroad. Scientists and scholars from many leading scientific earth science organizations participated in the meeting. In addition, a special volume of the *Journal of Asian Earth Sciences* published by Elsevier on 'Proterozoic Basins of India' has been edited with DM Banerjee, University of Delhi and M Santosh, China University of Geosciences, Beijing. The volume comprises papers by leading researchers.

Mukund Sharma

Two manuscripts on the biological remains of algae (microbiota & megaremains) from the basal formation of Upper Raipur Group (Chhattisgarh Supergroup) have been prepared. The sediments in Hirri sub-basin of Chhattisgarh Basin are exposed in and around Kodwa, Bemetara district. The recovered microbiotic assemblage in cherts and shales comprises 19 taxa including acritarchs (8 taxa), micro-algal remains (10 taxa), and a single enigmatic fan-shaped form. Epilithic macroscopic remains preserved on the bedding planes of shales are uni-multicelled, millimeter to centimeter of varied shapes-circular to discoidal, ribbon, tubular, palmate-like leafy thalloid films representing 7 carbonaceous and one calcified taxa. Comprehensive analysis of the fossil assemblage suggests a Cryogenian (800-700 Ma) age, the transition of two types of environmental (shallow subtidal and intertidal) set up, and warmer sea water for lithounits representing lower part of the Upper Raipur Group.

Rupendra Babu

Light microscopy and SEM of black chert veins of Palaeoproterozoic Chitrakut Formation of Semri Group (Vindhyan Supergroup) have been completed. Recovered assemblage includes 3 taxa of large sized ornamented acritarchs (*Shuiyousphaeridium*, *Cymatiosphaeroides* & *Trachysphaeridium*) belonging to Sphaeromorphida and Sphaerohystrichomorphida subgroups. The assemblage represents the third and possibly the oldest occurrence of acanthomorphic acritarchs during Palaeoproterozoic outside China and Australia.



Shuiyousphaeridium echinulatum Yin acanthomorphic acritarch population from the Late Palaeoproterozoic Chitrakut Formation (Vindhyan Supergroup)

V.K. Singh & Mukund Sharma

Two bore-cores SJ-1 (2.00-311.80 m depth) and SMP-1 (14.00-141.30 m depth) have been analysed from Sohagpur Coalfield to document palynoflora of the area. In SJ-1, two palynoassemblages have been identified. At the depth 2.00-85.30 m, *Faunipollenites* dominates over *Scheuringipollenites* showing affinity with the Upper Barakar palynoflora, and at 85.30-283.00 m depth interval dominance of *Scheuringipollenites* over *Faunipollenites* shows affinity with the Lower Barakar palynoflora. Both the assemblages indicate a early Late Permian age. In bore-core SMP-1, two assemblage zones have been identified. At 14.00-15.20 m depth, the occurrence of the palynotaxa *Callumispora* and *Jayantisporites* shows affinity with the Upper Karharbari palynoflora. At 19.10-141.30 m depth, the presence of the monosaccate pollen taxa *Parasaccites* and *Plicatipollenites* indicates an Early Permian age. (work jointly with Saurabh Gautam).

Rajni Tewari

Indian Gondwana Megaspore Information System (IGMIS)– an information system for storage and retrieval of Indian Gondwana megaspore (female reproductive unit of early land plants) records in a selective manner has been developed. At present, it provides information on 45 genera and 159 species recorded from Palaeozoic and Mesozoic sediments of India. The use of the database is to store and organize information on Indian Gondwana megaspores accrued over the past 70 years. This information system is a significant step towards ensuring safety and accessibility of the data on the dispersed Indian fossil megaspores, besides providing accessibility for handling the information in future, including new and

emerging types of data format. Each record has a unique code number for further reference. Addition, deletion, modification and search facility are provided. Additionally, search can be performed in terms of different morphotaxonomical characteristics (single or combination of characters). The program is useful for a quick and classified megaspore search on datagrid, especially of the published information on fossil megaspores and their horizontal and vertical distribution in India. The program and associated database are capable of computer-aided identification of megaspores and help avoid assigning multiple/ different genera or species to the same category. IGMIS is an attempt to digitize and provide an updated knowledge of Indian Gondwana megaspores, including their morphotaxonomical characters, distribution and photo-documentation in an information system.

Rajni Tewari, S.S.K. Pillai, Nilay Govind & Arun Joshi

The genus *Caytonanthus* has been recorded for the first time from India. The caytonialean microsporophyll *Caytonanthus* and seed cupule *Caytonia* have been recovered from Early Cretaceous beds of Taken and Bansa localities of South Rewa Basin. Morphotaxonomic study has been carried out; efforts are being made to trace their phytogeographical path. So far these genera are most commonly recorded from northern hemisphere and probably have a northern origin, but recent studies have revealed their probable southern origin. Detailed work is under progress.

Neeru Prakash & Neelam

The occurrence of a diverse range of conifers and Bennettitales is characteristic of the megaflora from the Early Cretaceous of Rajmahal Basin. Two new conifer taxa belonging to the families Cupressaceae and Podocarpaceae have been instituted from the intertrappean sediments of the Rajmahal Formation in the basin. The remains are silicified, composed of sterile and fertile shoots, detached leaves and dispersed seeds. The specimens, those have been placed under the family Cupressaceae, have been described as *Hirandubia cupressoides* gen. et sp. nov. show close affinity with the extant cupressaceous genera *Biota* Endlicher and *Chamaecyparis* Spach, and provide the first comprehensive record of Cupressaceae from the Early Cretaceous of India. *Elatocladus*-type shoots and detached leaves have also been recovered. In association with the shoot fragments and detached leaves, a new kind of podocarpaceous dispersed seed assigned to *Rajmahaliospermum podocarpoides* gen. et sp. nov., occurs together with a male cone *Podostrobus rajmahalensis* (Rao) Rao and Bose, having in situ bisaccate pollen grains. These remains are all attributed to the family Podocarpaceae and have some similarities to extant *Podocarpus* L'Herit ex Pers. Based on the occurrence of diverse range of conifers and Bennettitales in the Early Cretaceous flora of Rajmahal Formation, palaeoecological interpretation has been done. Global distribution, phytogeography as well as migration of Cupressaceae and Podocarpaceae also have been discussed. (work jointly with Jayasri Banerji)

A.K. Ghosh, Ratan Kar & Reshmi Chatterjee

Fifteen fossil woods collected from the Tipam Sandstone Formation of Laljuri near Sonaimuri, Unakoti district, Tripura have been investigated in detail and identified. They belong to Clusiaceae, Dipterocarpaceae and Fabaceae families. Further study is in progress.

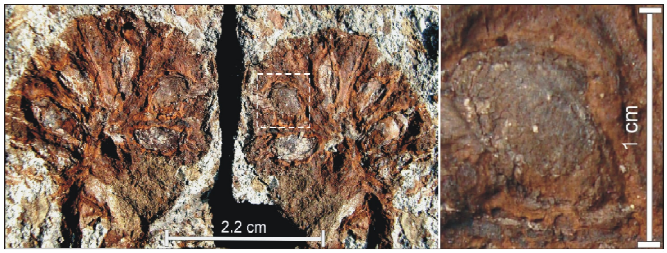
R.C. Mehrotra, Gaurav Srivastava & Nivedita Mehrotra

A systematic study on the plant megafossils from Tertiary sediments of Mahuadanr Valley, Jharkhand has revealed the occurrence of fossil fruit showing close resemblance with the extant taxa *Mangifera indica* Linn. of the family Anacardiaceae.

Mahesh Prasad & S.K. Singh

The family Annonaceae with Gondwanan affinity has been recorded from the Cambay Shale of Vastan lignite mine (Gujarat) on the basis of well-preserved fruit (in counterpart), leaves and pollen grains. This finding is significant because it is yet another example of an angiosperm family, found in South America and Africa that may have boarded the Indian raft when India was attached to Madagascar. The Vastan occurrences represent a continuous record from the Indian latest Cretaceous, through the Palaeocene based on multiple vegetative entities. The fruit is morphologically similar to *Annona palustris* L. The Neogene history of Annonaceae is reported from Upper Siwalik of Haripur Khol (Himachal Pradesh) and from the Lower Siwalik of Tanakpur (Uttarakhand) localities. At present, the dispersal history of the family into India represents an origin in the Lower Cretaceous of North America with later dispersal to South America and Africa then on to India. Another angiosperm family such as the Dipterocarpaceae, also found in Vastan, has similar, though not identical geological history.

Hukam Singh, Mahesh Prasad & S.K. Singh



Annona fossil fruit and fossil seed from Vastan lignite mine

The hydrocarbon source rock evaluation and reconstruction of depositional environment of Lower Palaeogene sediments from bore-core MMK-26 of Barmer basin, Rajasthan have been done. Hydrocarbon potential of these sediments is estimated on the basis of plant derived sedimentary organic matter (SOM) analysis. The analysis indicates that the sediments are rich in organic matter, constituted chiefly with amorphous organic, in the lower part of the bore-core, whereas the phytoclasts dominate in the upper part. The dominance of sapropelic facies (amorphous OM) at a depth of 152 m and below suggests that these sediments are a good source for hydrocarbon generation. Further the categorized palynofacies components are plotted on Tyson's Amorphous Oganic Matter-Phytoclast-Palynomorph diagram which reveals that the studied sediments are characterized by type-II (oil generating) and type-III kerogen deposited in a dysoxic-anoxic shelf. Thermal Alteration Index values have been determined to assess the organic maturity of the sediments and a maturation value of 2.80-3.0 for the lower part of the bore-core suggest that the sediments have attained an optimum maturation level to produce hydrocarbons. The increasing frequency of marine palynomorphs in association with continental components indicates a transgressive phase of sea level during the deposition of the studied sediments.

Hukam Singh & S. Mahesh

The maceral inertinite from Early Cretaceous Thangad coals of the Saurashtra Basin (Gujarat) has been studied. The presence of inertinite, which are similar to charcoal in physical, chemical and optical properties, is equated with the fire occurrences and oxygenated environmental conditions. High content (25%) of inertinite and its morphographic features, observed by petrographic, macerate and SEM studies, of Thangad coals suggest its generation from wildfire. Woody conifers and herbaceous angiosperms provided the source material for the formation of coal-forming peat biomass. The reflectance values of inertinite (0.75%-1.7%) and the characteristic charcoal features observed indicate that the studied inertinite were formed at a low to medium wildfire temperatures.

Alpana Singh, S. Mahesh & B.D. Singh

Pollen analysis of two honey samples from Jhansi and Bahraich (UP) has shown diversified pollen assemblage. In the sample from Jhansi, moderate to high frequencies of trees viz., *Flacourtia indica*, *Capparis*, *Ficus* and *Murrraya koenghii* coupled with herbaceous element, *Ageratum conyzoides* depict that these plants were major sources of nectar. On the other hand, the honey sample from Bahraich exhibits a less-varied pollen assemblage encompassing only a few pollen types. In this case, *Ageratum conyzoides* together with tree-*Syzygium cumini* are the principal sources for nectar and pollen forage as indicated by their high frequencies. In addition, *Brassica campestris* and *Pimpinella* followed by *Eucalyptus* were also preferred by the bees for nectar. The pollen assemblages of both the honeys suggest that the nectar flow occurred from late winter to early summer since most of the plants attain full bloom during this period and the honeys analysed are of multifloral type.

M.S. Chauhan, Anjum Farooqui & Anjali Trivedi

Thecamoebians from Late Permian sediments (from Mamakannu & Kachinapalli areas) of Godavari Basin have been studied. The study elucidates the minimal morphological evolution in thecamoebians and their survival during mass extinction periods and stressful environmental conditions over the geological timescale. Two species such as *Centropyxis aculeata* and *Arcella vulgaris* show diatom frustules, which is a unique finding as diatoms are largely reported since Tertiary period. While the former is an agglutinated form and shows diatom frustules as a xenosome, the latter is autogenous and the diatom frustules are seen inside the shell, which was perhaps engulfed by amoeba as food.

Anjum Farooqui, Neerja Jha & Neha Aggarwal

Nine surface sediments have been studied for thecamoebian and diatom from glacial lake (Changla Lake) of Ladakh. A unique assemblage of about more than 24 species of thecamoebians has been recorded from higher altitudes for the first time in India. The community assemblage is different as compared to the community studied from central part and coastal sediments of India. Approximately 20 species of diatoms have also been recorded in these sediments and out of which most of them are periphytic.

Anjum Farooqui, S.K. Shukla & Binita Phartiyal

The pollen morphology of *Nepenthes khasiana* (pitcher plant) has been investigated by using both light and scanning electron microscopes to examine finer details that might contribute to taxonomic characterization of species as well as utilize the knowledge of its morphology in order to correlate it with Bornean *Nepenthes* species (worked jointly with Subodh Kumar). Additionally, a manuscript entitled 'Modern pollen assemblages of surface samples from Cherrapunjee and its adjoining areas, Meghalaya, northeast India' has been finalized (jointly with R.C. Mehrotra).

S.K. Basumatary, Swati Tripathi & S.K. Bera

Palynological examination has been carried out on a 200 cm deep trenched sedimentary profile from Mahanadi river side, located near the Barpahar hillock of Bargarh district, Odisha. Five shifts in vegetation and consequently climate have been noticed since 5,840 cal BP.

Swati Tripathi, S.K. Basumatary, V.K. Singh, S.K. Bera, C.M. Nautiyal & Biswajeet Thakur

Two papers, one on 'Phytolith spectra in respiratory aerial roots of some mangrove plants of the Indian Sunderbans and its efficacy in ancient deltaic environment reconstruction' and the other on 'Man-environment interaction and its impact since ca. 3600 years BP in West Bengal, India: A multiproxy approach' have been finalized.

Ruby Ghosh

A manuscript entitled 'August-July precipitation in Abakan from tree-rings' has been finalized. This is the outcome of participation in International Summer School on Tree Rings held in Russia during August 2013. A paper 'Review of palaeoclimate records from Northeast India based on pollen proxy data of Late Pleistocene-Holocene' has been co-authored. Another co-authored research paper is 'Analysis of vegetation and climate change during Late Pleistocene from Ziro Valley, Arunachal Pradesh, Eastern Himalaya Region'.

S.K. Shah

Under the CAS-TWAS Post Doctoral fellowship at the Institute of Botany, Beijing, a 88 cm deep sedimentary core from the Tibetan region has been processed palynologically with an objective to reconstruct the past climate and monsoonal variations within the region on high resolution basis. Palynological analysis of the sequence covering the Late Holocene part (since ~2000 yr BP) shows signatures of Medieval Warm Period (MWP) and Little Ice Age (LIA). Also the change in vegetation succession from temperate broad-leaved during MWP to cool conifers during LIA at the eastern and south-eastern margins of Tibet is well reflected in the study. In addition, a study on atmospheric CO_2 reconstruction during the Plio-Pliestocene transition phase (PPT), based on terrestrial proxy has been conducted. This study revealed the intermittent transient warm phase with high CO_2 during the PPT, which provides an evidence to understand the CO_2 fluctuations during climatic transitions.

P.S. Ranhotra

Collaborative Work

Unique microbiological remains have been recorded from the phosphatic chert of Tal Group (Cambrian), Lesser Himalaya. The light brown to black fossils comprise multicellular sheet of pseudo-parenchyma in association with two types of pitcher shaped bodies, one with collar and the other with long neck more than 4 cells (rectangular/-barrel shaped) linear arranged. The posterior portion (ventral) is subspherical-spherical filled with varied shaped numerous cells with and without dark body. Comprehensive analysis of the recovered forms in thin sections and macerated residue of rocks suggests that these forms may represent the sporophytic stage of a non-vascular plant, possibly a primitive bryophyte.

Rupendra Babu [**& V.K. Mathur, S. Shome & S. Nath** (GSI, Northern Region, Lucknow)]

Palynological studies on Permian-Triassic sequence in WYB-12 samples from Wybung area of Eastern Australia have yielded a Permian palynoassemblage. Recovered taxa include *Microbaculispora* spp., *Quadrisporites* along with some Arcellacians *Centropycsis* spp. A comparative study between Indian and Australian assemblages, and dispersed organic matter study is in progress.

Neerja Jha
[**& Micheal Brookfield** (Univ. of Massachusetts, Boston, USA)]

A morphographic study of Mesozoic Cicatricose palynomorphs has been carried out for their evolutionary and palaeoclimatic significance. The fossil spores of type *Cicatricosisporites* (family Anemiaceae) in Indian and Brazilian basins are being studied.

Neerja Jha [**& Sarah G Duarte** (UFRG, Brazil)]

Some fossil woods collected from the Chhasra Formation (Early Miocene) of Palasava, Kachchh have been investigated in detail and identified. They belong to *Bauhinia malabarica* of the Fabaceae and *Diospyros brandisiana* of the Ebenaceae. Because the modern representatives of the present and previously described taxa from the same horizon are thermophilic in nature and grow in evergreen to deciduous forests, a warm and humid climate is interpreted during the depositional period.

R.C. Mehrotra & Anumeha Shukla
[**& Nivedita Mandal** (IIT, Roorkee) **& M.G. Thakkar** (Kutch Univ., Bhuj)]

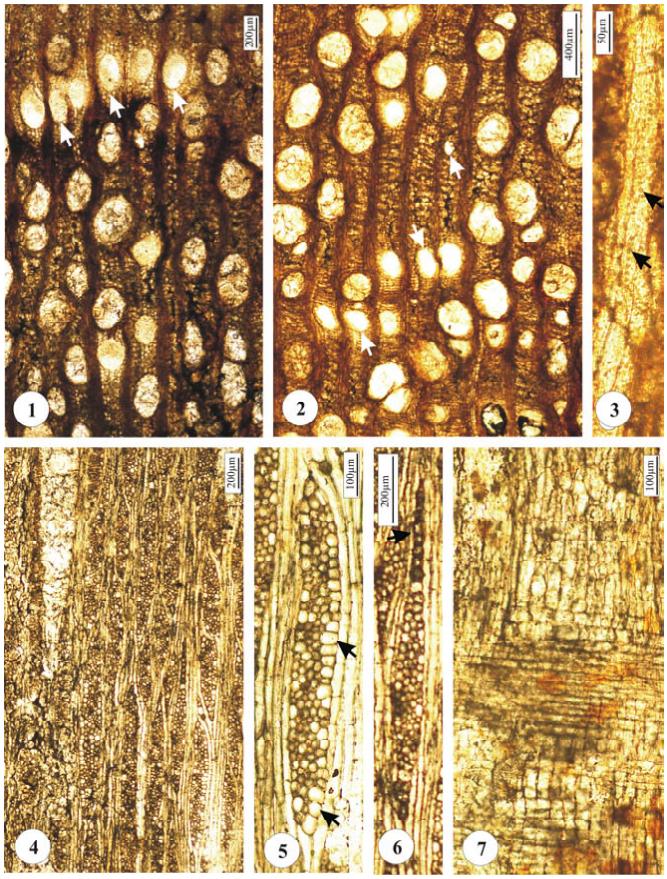
CLAMP (multivariate foliar physiognomic) analysis of the fossil leaves collected from two horizons of Gurha lignite mine of Bikaner (Rajasthan) has been carried out. The lower assemblage consisting of 54 leaf morphotypes and the upper assemblage of 57 leaf forms yielded mean annual temperatures of 24.7° and 23.9°C, respectively. The uncertainty (± 2.82°C) means these temperature regimes are identical despite few similarities in the morphotypes between the two assemblages. The mean annual range of temperature was approximately 9.7°C for both assemblages and is similar to those experienced today at 10° N on the west coast of India. The tropical to paratropical fossil floras also suggest a moist regime (80% annual relative humidity) and high mean annual precipitation of ~1800 mm for both assemblages, but with a pronounced wet/dry seasonality indicative of a pronounced monsoonal regime.

R.C. Mehrotra & Anumeha Shukla
[**& R.A. Spicer** (Open Univ., UK)]

A large quantity of tree trunks, embedded in the carbonaceous and silty clays at different stratigraphic levels at several locations along the Kollam-Kodungallur stretch (South Kerala Sedimentary Basin) has been investigated. The natural affinity of the carbonized woods and subfossil logs with their nearest-living-relative forms, retrieved from the wetlands and associated landforms of southwestern Kerala, has been studied while appraising the vegetation and climate dynamics of the Holocene period. These fossil woods belong to the genera *Dipterocarpus*, *Calophyllum*, *Diospyros*, *Careya*, *Artocarpus*, *Rhizophora* and *Neolamarckia*. As these woods belong to the Late Pleistocene and Holocene, they form a valuable source of climate data that alleviates the lack of contemporaneous meteorological records.

Anumeha Shukla
[**& K.P.N. Kumaran** (ARI, Pune)]

Silicified woods (*Dipterocarpoxylon* species) from Nagri Formation of Middle Siwalik subgroup in Saharanpur district have been studied and documented.



Dipterocarpoxylon arcotense Awasthi, 1980 : 1. Transverse section of the fossil showing solitary, tylosed vessels and vertical gum canals in short tangential rows (marked by arrows), 2. Another TS showing tylosed solitary vessels, distribution of parenchyma and scattered gum canals embedded in parenchymatous tissue (marked by arrows), 3. Vasicentric tracheids showing pits on tangential walls (marked by arrows), 4. Tangential longitudinal section showing heterocellular multiseriate rays, 5. TLS magnified showing sheath cells on the flanks of a multiseraite ray, 6. TLS magnified showing long uniseiate extension (marked by arrows), 7. Radial longitudinal section showing heterocellular ray tissue

Rashmi Srivastava

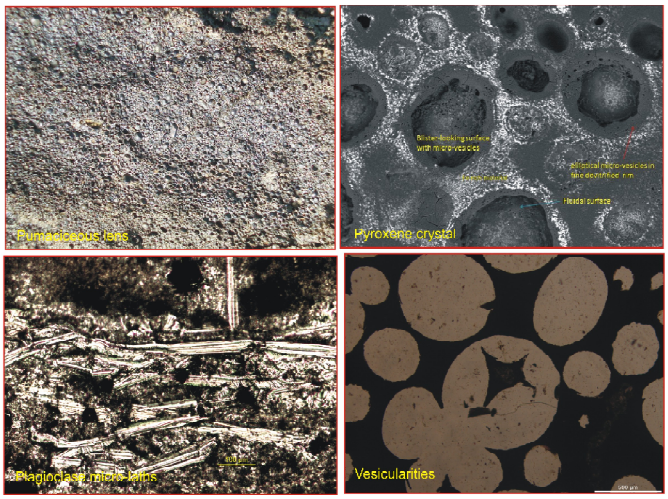
[**& R.S. Chandel & S. Singh** (GSI, Lucknow)]

A recently discovered fossiliferous amber deposit from the Early Eocene of India for the first time provides an opportunity to study fossils of the most species rich group of terrestrial organisms, i.e. insects, and to investigate India's geological history and get insights in to a terrestrial ecosystem in tropical latitudes at the beginning of the Early Eocene climatic optimum. The present work focuses on the Nematocera which are represented by >500 inclusions from 11 families, and thus comprise the most common and diverse inclusions in this amber. Initial analyses of selected taxa reveal high potential for biogeographic and ecological studies. The Sychodine subfamily Sycoracinae, for example, which is represented by 5 specimens in Indian amber, is generally rare in the fossil record and has only a few disjunct distributed extant species, none of which known from India. A fungus gnat in Indian amber reveals affinities to the Lygistorrhinid genus *Palaeognoriste* from the Eocene Baltic amber. Additionally, almost all nematoceran groups in Indian amber include taxa of ecological importance in terms of feeding or habitat requirements, like the aquatic larvae of Chaoboridae and Chironomidae or the blood feeding Corethrellidae and Sycoracinae.

Hukam Singh

[**& Frauke Stebner & Jes Rust** (Univ. of Bonn, Germany)]

Several cm-thick discontinuous pumice lenses have been reported within Early Eocene Vastan lignite mine sedimentary sequences of Gujarat, about 5 m above a biostratigraphically constrained 52 Ma level. The pumice is inferred to have been sourced by ~ 50 Ma submerged basaltic volcanism related to sea-floor spreading in the western Arabian Sea, probably along the Carlsberg Ridge.



The Vastan pyroclasts are characterized by skeletal plagioclase crystals with horsetail morphologies with rare amounts of pyroxene and other Fe-oxide euhedral crystals. Their essential character is 'microvesicular' (>40-60%) spherical polymodal (larger $\geq$ 400 µm, smaller $\leq$ 250 µm diameter), mostly non-coalescing and very weakly elongated vesicles. The record of pyroclastic rocks preserved in sedimentary environments far from source is uncommon. Hence the present record of pumice lenses in the Lower Eocene Cambay Shale sequences assumes some importance as a pointer to active spreading centers in the opening of the Arabian Sea, oceanic transport directions off the western passive margin of India and submarine mafic volcanism.

Hukam Singh

[**& S. Sharma, R.S. Rana** (Garhwal Univ., Srinagar) **& Ashok Sahni** (Lucknow)]

Amongst the angiosperms, grasses represent the most important and dominant constituents of the terrestrial ecosystems. Silicified plant tissues (phytoliths) preserved in herbivorous titanosaurid sauropod dinosaur coprolites from the Lameta Formation, Central India, showed that at least 5 taxa of the Poaceae subclades were present on the Indian subcontinent during the latest Cretaceous. Gondwanatheria mammals, well known by high-crowned teeth with hypsodont dentition represent a distinctive group of mammals known only from Gondwana continents of the Late Cretaceous period. Acquisition of hypsodont dentition signifies adaptation to a diet consisting of abrasive food material, e.g. grasses. Two gondwanatherian Intertrappean localities, Naskal and Kisalpuri have been explored for grass remains. The study shows the presence of well-preserved diversified grass phytoliths in the same stratigraphic horizon that has yielded gondwanatheria mammals. It is deduced, that the early evolution of hypsodonty in gondwanathere mammals was in response to an adaptation to abrasive diet consisting of grasses. The study thus supports co-evolution of grasses and gondwanatheria mammals during Late Cretaceous.

Vandana Prasad
[**& G.V.R. Prasad** (Delhi Univ.) **& Ashu Khosala** (Punjab Univ.)]

Samples from the Ruata Quarry, Turial Bungalow Section and Turial Prayer Point Section representing Bhuban Formation have yielded datable nannofossil assemblages. R1 sample from Ruata Quarry is dated as Late Burdigalian-Early Langhian of Early-Middle Miocene (NN2-NN4) whereas, R3 sample is dated as Messinian, i.e. of late Late Miocene in age (NN11B-NN12). Two productive levels are recorded from the Turial Bungalow Section. TB3 sample is dated Middle-late Late Miocene (NN8-NN12) and TB2 sample is dated Pliocene age (NN13-NN19). Very close sampling is required in this section to resolve and calibrate the Mio-Pliocene global boundary. Only one sample (TP3) was found productive from Turial Prayer Point section and has been dated Middle to latest Miocene age (NN5-NN11B).

Jyotsana Rai
[**& J. Malsawma, C. Lalrinchhana, Paul Lalnuntluanga, V.Z. Ralte & R.P. Tiwari** (Mizoram University, Aizawl)]

A very diverse and well-preserved nannofossil assemblage of Quaternary age has been recorded from a core of 124 cm depth from Bay of Bengal area (BOB Core 1). Sixty two samples have been analysed for calcareous nannofossils and recoded rich diverse assemblage with variety of ascidian spicules. The decrease in calcium carbonate percentage is marked by a sharp fall in the productivity of coccoliths.

Jyotsana Rai
[**& Hema Achutan & Nagasundaram** (Chennai)]

Latest Maastrichtian (~0.5 My years preceding the K/T boundary) nannofossils have been recorded from the Ariyalur Formation, north of the Aladi village (lat. 11°37'47"N; long. 79°21'4"E). a moderately diversified low frequency nannofossil assemblage comprising over 20 species were recorded from one (S-13) calcareous marl sample. The assemblage is assigned to CC 26b Zone (Perch-Nielsen, 1985) corresponding with UC 20d^{TP} of Burnett in Bown (1998) of latest Maastrichtian age on the basis of the occurrence of zonal marker taxa *Micula prinsii*.

Jyotsana Rai & Abha Singh
[**& N. Malarkudi** (Bangalore Univ., Bengaluru)]

Palynological investigation on Upper Siwalik sediments of Kala-Amb area, Sirmaur district (Himachal Pradesh) has revealed the presence of 26 genera and 36 species of algal and fungal remains, pteridophytic spores, gymnospermous and angiospermous pollen grains. Palynofloral distribution shows a mixture of ecological groups such as lowland, fresh water swamp, montane and back mangrove taxa. The record of *Striatriletes*, *Palmidites* and *Cycadopites* in the assemblage indicates that a tropical-subtropical climate was prevailed during the deposition of these sediments. Presence of algal zygospore of Zygnemataceae is indicative of stagnant shallow fresh water ponding conditions during sedimentation in the area. The montane taxa like *Podocarpidites* appear to be transported from the upland areas in the north.

Samir Sarkar
[**& N.N. Dogra & O.P. Thakur** (Kurukshetra Univ.)]

The Upper Cretaceous palynomorphs from the bore-core samples of Bohemian Basin (Czech Republic) and some pilot samples from outcrops of the Lower Gosau Group, Nothern Calcareous Alps (Austria) have been studied. The palaeogeographic significance of reworked Permian and Cretaceous palynofossils along with characteristic Late Ypresian and Early Lutetian palynofloras in the Subathu Formation of India have also been interpreted. These works were carried out under bilateral exchange programme of INSA and ASCR.

Samir Sarkar
[**& M. Svobodova** (Institute of Geology, Praha, Czech Republic)]

For the compilation of an edited volume on different aspects of Palaeobotany and its allied disciplines, Springer India has been approached for the publication of book entitled 'Recent Advances in Palaeobotanical Research'. The book will include articles/ research papers contributed by authors from India and abroad.

A.K. Ghosh
[**& D.K. Chauhan** (Univ. of Allahabad)]

Chemical processing of the sediment cores (Site 1404 & 1405, received from the archive of Bremen, Germany) belonging to Oligocene-Miocene transition, for Post Cruise Research of IODP Expedition, has been done and over 700 slides have been prepared for the study of diatoms and palynomorphs. Microscopic study reveals that the sediments are rich in diatoms, silicoflagellates, radiolarians and palynomorphs. Photomicrography and preliminary identification of the taxa have been done.

A.K. Ghosh, Arindam Chakraborty & Reshmi Chatterjee
[**& Scientists** (of IODP Expedition 342)]

In order to assess the health of the Vasishthi River Estuary at Dabhol in central west coast of Maharashtra, and to identify the cause/s for the same, spatial distribution of foraminifera, diatoms and heavy metals have been studied in the benthic sediments collected along the length of the estuary. Foraminifera have been encountered in sediments as far as 20 km inland. No planktonic species were found in the estuary. Benthic biodiversity is low but abundance is high throughout. The assemblage is largely represented by a few species of *Ammonia* and *Nonion*. Most specimens are well-preserved and show no signs of dissolution. Spatial distribution of diatoms indicates extreme diversity in the estuary. A very high abundance of marine, centric and pinnate forms marked by species *Thalassiosira* and *Grammatophora* with inclusions of silicoflagellates and radiolarians, indicate strong marine influence in the estuary. Proliferation of forms tolerant to toxic conditions and bio-accumulating oyster species indicate influence of heavy metal toxicity in the estuary, which is reinforced by the metal concentrations measured during the study. The present data set offers significant clues to the dynamics of the complex anthropogenic activities in the upper reaches of the Vasishthi River, which have detrimental effects on biodiversity of the estuarine and mangrove ecosystems, and can be mistaken for increasing sea levels and climate change.

Biswajeet Thakur
[**& Rajani Panchang** (ARI, Pune)]

Petrographic and organic geochemical data have been documented for characterization of the lignite-bearing Eocene sequence from Vastan mine of Surat district (Gujarat). The sequence has been analyzed to assess its hydrocarbon-generating potential and to reconstruct the palaeovegetation and palaeoenvironment. Based on maceral composition, rock-eval and FTIR spectroscopic data, the kerogen is classified as mixed type II/type III with potential to generate both oil and gas on maturation. The saturated fraction of the extracted hydrocarbon is characterized by *n*-alkanes, acyclic isoprenoids and triterpenoids. The normal alkanes display a bimodal distribution, suggesting two different organic matter inputs (microbes & higher plants). The hopanes and hopenes are mainly derived from microbial components. Oleanenes, ursenes and des–A–triterpenoids are primarily derived from precursor α– and β–amyrin suggesting angiosperm contribution. Fernenes identified in the samples probably suggests pteridophytic input. The extrapolation of petrographic composition, tissue preservation (TPI), and gelification (GI) indices demonstrate that these lignites originate from a woody forest, and wet, acidic and swampy environment.

Alpana Singh & B.D. Singh
[**& Monalisa Mallick, Suryendu Dutta & Sharmila Bhattacharya** (IIT Bombay, Mumbai)]

Pollen analysis of 20 samples from 1.5 m deep sediment core from Trilokinath Lake from Lahul Valley (HP) has been accomplished. The study shows good pollen assemblage comprising broad-leaved taxa including *Corylus*, *Carpinus*, *Quercus* and *Rhododendron* in variable frequencies. The conifers (*Abies*, *Cedrus*, *Picea* & *Pinus* cf. *wallichiana*) have also been recovered in good frequencies together with sporadic presence of alpine scrubs (*Juniperus* & *Ephedra*). The meadow elements include grasses, Asteraceae, Caryophyllaceae, *Ranunculus*, *Palemonium* and *Polygonum* sp. The aquatic flora is marked by the meagre presence of *Potamogeton*, *Typha* and *Ludwigia*. Ferns are preponderant throughout.

M.S. Chauhan
[**& Rameshwar Bali** (Lucknow Univ., Lucknow)]

For the first time an attempt has been made to trace the age of a wonder tree, *Randia uliginosa* (Retz.) DC., (Rubiaceae), locally known as 'Bakhar Begena' in Sibsagar district (from Bokota) of Assam through palynological and radiocarbon analyses. Detailed pollen

morphology of *R. uliginosa* has been studied using light and scanning electron microscopes. *Randia* pollen could only be recovered in the top 80 cm (of 150 cm deep soil profile) of the sediment which signifies its existence at least for 580 years consistent with the Assam history. This record may be utilized as background information for biologists.

S.K. Basumatary, Swati Tripathi, S.K. Bera & C.M. Nautiyal [**& Dipak Nath** (Dima Hasao, Haflong, Assam)]

Late Pleistocene palaeoclimatic conditions have been inferred from a 250 cm deep sedimentary profile in the Subankhata swamp of Baksha district, Assam (Eastern Himalayan foothills).

S.K. Basumatary, Swati Tripathi, S.K. Bera & C.M. Nautiyal [**& Nelakshi Devi & G.C. Sarma** (Gauhati University, Guwahati)]

A 200 cm peat bog profile from Koti-Knasar village, Himachal Pradesh comprising 41 soil samples is being studied for palynological analysis.

Swati Tripathi & S.K. Bera
[**& B.S. Kotlia** (Kumaun University, Nainital)]

Pollen analysis of 1.5 m deep core from Shuanghaizi Lake, southwestern China has revealed that around 11,200 to11,000 yr BP, mixed chirpine-oak forests occurred in the region under a cool and wet climate. Between 11,000 and 9,295 yr BP, the conifer broad-leaved forests continued. However the expansion of broad-leaved elements implies the initiation of a warm and humid climate. Around 9,295 to 6,300 yr BP, the conifer broad-leaved forests were replaced by mixed broad-leaved-oak-conifer forests due to the prevalence of a warm and more-humid climate. Around 6,300 to 4,200 yr BP, the vegetation changed to mixed conifer forests with scanty broad-leaved elements, indicating a cool and moderately humid climate. From 4,200 to 1,575 yr BP, conifer-oak-broad-leaved forests were succeeded by mixed oak-broad-leaved-conifer forests as a result of a warm and wet climate. Since 1,575 yr BP, dominance of conifer forests with sporadic broad-leaved taxa denotes a cool and dry climate.

Anjali Trivedi
[**& Chen Sen Li** (CAS, Institute of Botany, Beijing, China)]

Pollen analysis of 5 surface samples from Dokriani Glacier, Garhwal Himalaya has been carried out. The pollen assemblage reveals dominance of arboreals and reduced numbers of non-arboreals. Conifers are represented by *Pinus*, *Cedrus*, *Abies* and *Picea* in good numbers. *Quercus*, *Betula*, *Alnus*, etc. are the prominent broad-leaved elements Poaceae, Cheno/Am, Caryophyllaceae, Asteraceae, Rosaceae, etc. are also frequent.

Anjali Trivedi
[**& Ajay Mishra** (Lucknow Univ., Lucknow)]

A one m thick sediment profile collected from relict mud flat near Diu Island in southern Saurashtra coast, western India has been palynologically investigated to reconstruct the history of changes in land-sea configuration during the mid-Holocene.

Shilpa Pandey
[**& Navin Juyal** (PRL, Ahmedabad)]

To identify the signal of phytoliths retrieved from aerial respiratory roots in the modern deltaic environments, the phytolith contents of pneumatophores and/or pneumatothodes of 13 mangrove species have been analysed and compared their representation in assemblages of stems and leaves of 108 taxa, and 26 surface soil samples collected from different deltaic sub-environments of the Indian Sunderbans along a salinity gradient. The result shows that most of the phytolith morphotypes occurring in these respiratory roots are redundant, having low taxonomic significance. Despite the morphological symmetry of the phytolith morphotypes, size differences of blocky polyhedral and blocky elongated bodies can be attributed to discriminate their source of origin reliably. Discriminant function analysis shows that 97.7% of stem and 66.5% aerating root data on blocky polyhedral morphotypes can be correctly classified. Blocky elongated morphotypes can accurately classify 75.7% of stem data and 81.1% of aerating root data. Results indicate that size parameters of certain phytolith morphotypes can successfully discriminate between stem and respiratory aerial root. Study of sediments from a Late Quaternary profile (4215 ± 35 BP at a depth of 390 cm and 2810 ± 25 BP at a depth of 30 cm) also confirms the conclusions. The implications of these findings lie in distinguishing true mangrove environments from other deltaic sub-environments, as pneumatophores/ pneumatothodes are only produced in plants inhabiting tidal or intertidal sub-environments. The creation of a comprehensive analogue of aerating root phytoliths from the Indian Sunderbans has provided the necessary ground work for interpretation of Late Quaternary environmental studies in the region.

Agricultural development, subsistence strategies and dynamic behaviour of climate in the Lower Gangetic plains of West Bengal since ca. 3600 cal a BP (Chalcolithic period) and post-Chalcolithic period (ca. 2350–2120 cal a BP to recent) have been explored using multiproxy approach including plant-animal macro remains, wood charcoals and pollen and non-pollen palynomorphs from an archaeological site at Pakhanna, District Bankura.

Ruby Ghosh
[**& Subir Bera** (Univ. of Calcutta, Kolkata)]

Tree-ring samples *Picea smithiana* (Wall.) Boiss collected from Bajhang district in Khaptad National Park (in western Nepal Himalaya) have been analysed to develop 422 yrs long tree-ring chronology dating back to AD 1591. The tree-ring chronology has been correlated with climate (temperature and precipitation) of Mukteshwar station, India. The result showed significant negative correlations with March-May temperature and positive correlations with March-May precipitation. We also developed 362 yrs (AD 1650-2012) long tree-ring chronology of *Abies pindrow* growing in the plateau of mixed forest in this Park. The influence of climate on radial growth was studied.

S.K. Shah
[**& D.R. Bhuju** (TU-CDES, Nepal), **N.P. Gaire** (NAST, Nepal) & **U. Thapa** (Golden Gate International College, Nepal]

Further investigation of botanical remains has been carried out from well stratified layers of Neolithic, Chalcolithic, Iron Age and Early Historic periods (3200 BC to 800/700 BC) of a proto-historic site Raipura in Belan Valley, Sonbhadra district (UP). The site is located very close to Kaimur hills and on a small Nala connecting Belan river.

Chanchala Srivastava
[**& Prabhakar Upadhyay** (BHU, Varanasi)]

The deposition of southern ocean diatoms and other siliceous remains indicate transport of carbon and its re-deposition in the SW Indian Ocean. This study thus provides substantial evidence of northward transport and biogenic silica deposition, which could be a reason behind very low global oceanic carbon inventory in the southern ocean, despite a high carbon uptake.

Vartika Singh
[**& Neelu Singh** (NCAOR, Goa]

Sponsored Projects

1. **Project—Biofacies analysis of Palaeogene and Neogene carbonate sediments in India with special reference to calcareous algae** (CSIR JRF (NET) Fellowship, CSIR Grant No. 09/528 (0016)/ 2009-EMR-I).

Investigators: Suman Sarkar & A.K. Ghosh

Detailed biofacies analyses of Palaeogene carbonate sediments from the Sylhet Limestone Group (Meghalaya) have been carried out with special emphasis on calcareous algae. Benthic foraminifera, especially the larger forms have been recorded in high abundance and played a major role in the biofacies data interpretation with respect to palaeobathymetry and palaeoecology. Nummulitids and alveolinids are recorded in very high abundance. Mastophoroid and melobesioid coralline algae have been recorded throughout the course of study of Palaeogene sediments ranging from Late Palaeocene to Middle Eocene. However, the lithophylloids are very rare to absent. Green calcareous algae and geniculate coralline algae are very abundant in Umlatdoh and Prang lithounits. Based on the biogenic forms and their abundance, a shallow bathymetry ranging from 10-40 m has been deduced for the overall deposition of the various Sylhet carbonate units. Mesotrophic to partly oligotrophic nutrient regime has been deciphered.

Neogene biofacies have been studied from the Late Pliocene sediments from the Guitar Formation in Car Nicobar Island. In this sequence, grainstones are the dominant facies types and denote a typical coralgal reefal environment with rich assemblages of coralline red algae and coral blocks. Numerous species of geniculate coralline alga *Amphiroa* is most abundant algal form in the studied Neogene sediments, besides the major benthic foraminiferal forms. In addition to biofacies, modern coral reefs have also been studied with the objective of comparing them with the Neogene coral forms as recorded in the thin-sections. Important phenomena like coral bleaching and analysis of coral-algae phases have been included in the overall ecosystem assessment.

2. **Project— Hydrological changes in western Himalayan region during the last millennium** (sponsored by DST, New Delhi; No. SR/S4/ES-468/ 2009)

Investigators: R.R. Yadav, B. Sekar & A.K. Yadava

Tree ring samples of *Pinus gerardiana* and *Cedrus deodara* collected from different sites in Kinnaur, Himachal Pradesh collected in various field trips in 2012 have been studied to prepare ring-width chronologies. Eleven chronologies of *C. deodara* and five of *P. gerardiana* have been used to develop boreal spring precipitation back to 1030 C.E. The reconstruction has revealed centennial scale variations in precipitation. Detailed analysis of the reconstruction is being finalized.

3. **Project— Development of long-term high resolution climate records for western Himalaya, India using multi proxy tree-ring parameters** (sponsored by ISRO-GBP)

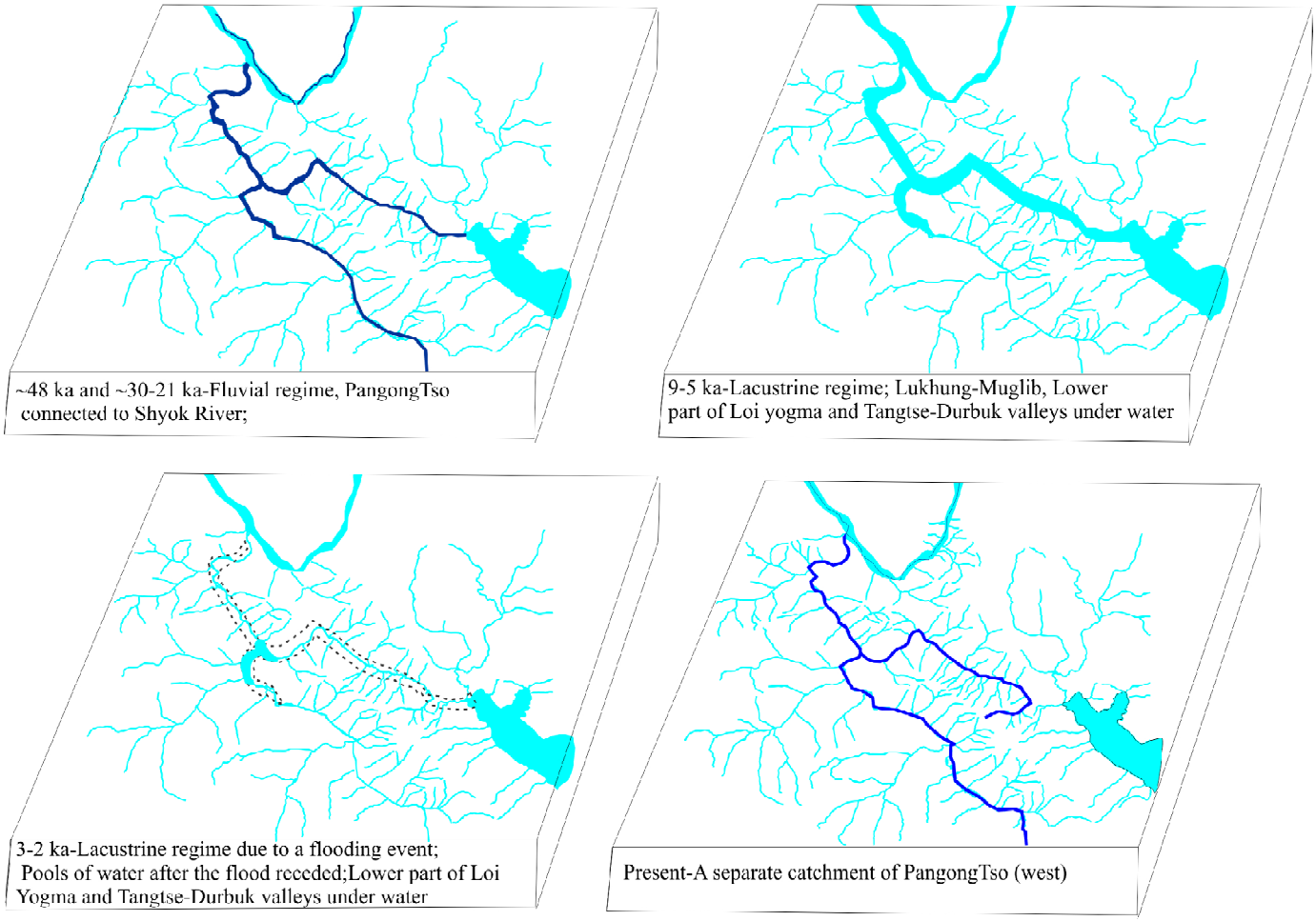
Investigator: R.R. Yadav

The project completion report has been finalized, based on the study of tree ring chronologies from Lahaul region.

4. **Project— Tectono-climatic variations during Late Quaternary in the Tangtse Valley, Ladakh, NW India** (sponsored by DST, New Delhi; No. SR/ FTP/ES-123/2009)

Investigators: Binita Phartiyal & Randheer Singh [& G.C. Kothari, ISR, Gandhinagar]

The Tangtse valley in the Trans Himalayas shows a varied sedimentary architecture with fluvial episodes, lacustrine deposits, flood events and colluvial as well as aeolian deposits from ~50 ka to present. The valley is important, as it served as spillway of the Pangong Tso/ Bangong Co (Tso/Co=lake) one of the biggest lakes in Tibet and has records of a lake environment in Late Quaternary times. Today, the Pangong Tso is a chain of five basins separated by shallow sills and evolves as a series of lakes of connected rivers. During high stands the lake drains into the Shyok River, through the Tangtse River Valley. The sediments record from the region show evidences of a sixth basin of the Pangong Tso towards west occupying the present day Tangtse Valley during 42-31 ka BP and 20- 2 ka BP, coinciding with the periods of high lake levels in Tibet and China as well as the intensified monsoon periods in the Indian subcontinent. This lacustrine environment is intermittently replaced by a fluvial regime between 48-43 and 30-21 ka BP as evident by river terraces with comparatively less humid conditions and dry phases. Field work was also carried out in the Tangtse Valley (Pangong Tso, Muglib, Sasakul, Durbuk, Shyok), Ladakh.



Models showing geomorphologic evolution of Tangtse Valley in the Late Quaternary

5. Project— Integrated nannofossil-ammonite biostratigraphy of Wagad Island, Kachchh Basin: Palaeoenvironmental and palaeobiogeographic implications (sponsored by DST, New Delhi; No. SR/S4/ES-521/2010(G))

Investigators: Jyotsana Rai, Rahul Garg, Neeru Prakash, Surabhi Garg & Abha Singh [& D.K. Pandey, Jaipur]

First bennetitalean fossil flower, represented by *Williamsonia* sp. along with Carpolithes (seed), from the upper part of the Callovo-Oxfordian Washtawa Formation (Nara Shale Member) has been recorded from Wagad Uplift, Kachchh area. The specimen is comparable with *W. kakadbhitensis* of Albian age from the Bhuj Formation of Kachchh Mainland area. All the known record of *Williamsonia* is from Early to Late Cretaceous sediments in India and this is about 40 million years earlier record. The horizon with plant fossils is rich in datable ammonites and also contains nannofossils. The mainland sections display exceptional preservation of Callovian age calcareous nannofossils, but in Oxfordian strata nannofossils are not well-preserved.

Gangta Bet is located between the Khadir Island and Wagad Uplift (N 23°46' to N 23°43' longitude, E 70°30' to E 70°33' latitude). Two new fossil woods have been recovered and anatomically studied from top of the Gangta Bet Member of Khadir Formation exposed around the core of the central dome of Gangta Bet. The fossils have been designated as *Aurocarioxylon wagadiensis* n. sp. and *Podocarpoxylon gangtensis* n. sp. The samples were collected from the youngest level of five designated members of Biswas (1971, 1977). Callovian-late Middle Oxfordian age ammonites are known from Gangta Bet and the marker Gangta Ammonite band was assigned to Helenae Assemblage Zone of late Middle Oxfordian age. Presence of low diversity nannofossil assemblage with moderate preservation from all the five samples indicates Callovian to Kimmeridgian/ Tithonian age assignment. Presence of *Faviconus multicolumnatus*, *Nannoconus* sp., *Placozygus fibuliformis*, *Prediscosphaera cretacea* in the nannofossil assemblage suggests Early Cretaceous sediments in the vicinity.

6. **Project— Biosphere across Vendian-Cambrian and Permian-Triassic periods and their response to global Late Proterozoic and Late Palaeozoic glaciations** (DST-RFBR project Research-INT/RFBR/P-102/1 dated 29/08/2011)

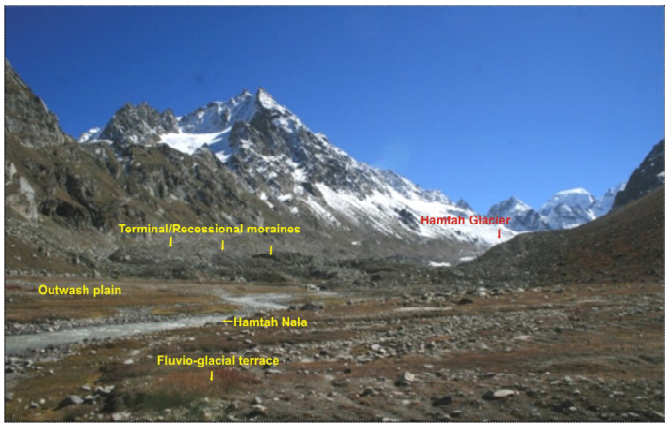
Investigators: Mukund Sharma, K.J. Singh, Rajni Tewari & A.S. Rathore

A study of large acanthomorphic acritarchs and sponge spicules from the chert nodules found in the Krol Formation, and stromatolites of the Tal Formation has been completed. The Lower Gondwana genus *Euryphyllum* Feistmantel has been reviewed taking into consideration the morphology, cuticular studies and the affinities. The study advocates independent generic status of *Euryphyllum* among similar genera such as *Noeggerathiopsis* and *Rubidgea*, based on regularity in the arching pattern in the lateral veins (work jointly with Anju Saxena). The plant fossils near Gund and Arbal in the Pir Panjal Range have been recorded. The assemblage compares well with other Gondwanan floras of this age that have been assigned to the Paraca floral realm indicating relatively warm climatic conditions that existed just prior to the onset of the Carboniferous-Permian ice age. The taxa *Flabellofolium*, *Botrychiopsis*, *Annularia* and *Cordaites* have been recorded for the first time from Indian Carboniferous sediments. The results of studies on the diversity in the biosphere across Vendian-Cambrian and Permian-Triassic Periods are being compiled for submission to the DST.

7. **Project— Analysis of climatic changes during the Quaternary from glacial sites in India based on multi-proxy data** (sponsored by DST, New Delhi; No. DST/CCP/PR/07/2011(G), dated 16.11.2011).

Investigators: Sunil Bajpai, Ratan Kar, Amalava Bhattacharyya & Ruchika Bajpai

Pollen studies of 15 surface samples collected from the outwash plain of the Hamtah Glacier (Lahaul-Spiti) and 10 samples collected from the Chhatru glacial valley along Chhatru Nala have been completed. The alpine vegetation is well represented by the presence of non-arboreal elements. However, overall dominance of arboreal taxa has been observed represented by conifers (*Pinus*, *Abies* & *Picea*), which can be attributed to their being high pollen producers that are carried by wind currents, from the adjoining forests and eventually



Outwash plain of the Hamtah Glacier (Lahaul Spiti, H.P.) with the glacier in the background

deposited around the study area. Broad-leaved elements such as *Alnus* and *Ulmus* have also marked their presence in Chhatru. The present data on modern pollen-vegetation relationship will be useful in understanding the vegetational changes with respect to past climatic fluctuations from the high altitude Trans-Himalayan regions. In addition, palynological analysis of samples from a 90 cm trial trench dug on the outwash plain of the Hamtah Glacier has also been completed. Similarly palynological work has been done on a 160 cm trench from the outwash plain of Chaurabari Glacier (Kedarnath). From both the areas, samples have yielded a diverse range of palynomorphs, represented by both arboreals (conifers & broad-leaved tree taxa) and non-arboreals (herbaceous taxa). Based



Outwash plain of the Chaurabari Glacier (Kedarnath) showing typical U-shaped valley vacated by the glacier due to recession in the recent past

on available ^{14}C dates, climatic fluctuations are being deciphered on the changes in the frequencies of arboreal and non-arboreal pollen (AP/NAP Ratio).

8. **Project— Analysis of Holocene climate change in northeast India based on pollen data** (CSIR SRF {DIRECT} Fellowship: Grant- 09/528/(0017)/ 2012/EMR-I)

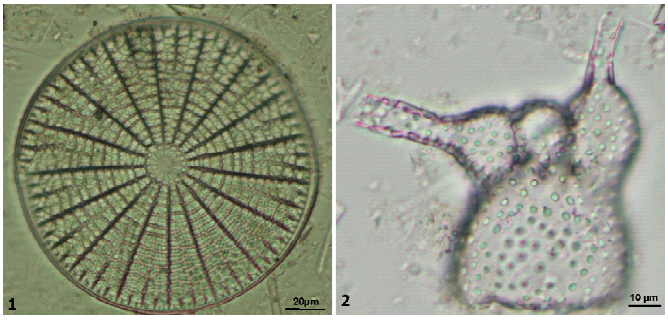
Investigators: Nivedita Mehrotra & A. Bhattacharyya

A synthesis of pollen data of Quaternary pollen studies conducted in north-eastern India has been compiled and a new scheme of scale to represent vegetation and climate variation is created to standardize the present terminology used in such studies. In addition, palynological studies have been carried out on 47 sub-surface sediment samples from Ziro Valley, Arunachal Pradesh. A pollen study has also been conducted for a 170 cm long sub-surface sample profile from Chari Lam, Tripura to infer vegetation and climate variations. Besides, field work has been carried out at Tripura, and 6 subsurface sediment profiles (namely RudraSagar, Bisramganj, Khowai, Agartala, Sonai Muri, Kumarghat) and 39 surface soil and moss cushion samples have been collected for pollen analysis. The profile samples from RudraSagar, Bisramganj and Sonai Muri districts, and surface soil and moss cushion samples have been are processed and/or macerated for palynological analysis. Litholog of all the subsurface sediment profiles was prepared. Pollen counts of 20 moss cushions samples from transect towards Zemu glacier in Sikkim has been completed and further studies are underway. Palynological studies of a subsurface sediment profile dated up to 4.6 Ka. of P. T. Tso Lake in Tawang district in Arunachal Pradesh is in progress.

9. **Project— Diversity and palaeoecology of the benthic and planktic biotic assemblages from the Neogene sequence of Andaman and Nicobar Islands** (DST Inspire Fellowship: Grant- IF120842/ 2013-14)

Investigators: Arindam Chakraborty & A.K. Ghosh

Samples collected from Andaman and Nicobar group of islands have been analysed. The diatom assemblage from the Cave Point Section (Late Miocene-Early Pliocene), Neil Island shows dominance of genus *Actinocyclus ellipticus*, *Actinoptychus undulatus*, *Coscinodiscus excentricus*, *Hemidiscus cuneiformis*, etc. amongst the centric and *Nitzschia* sp., *Diploneis* sp., etc. amongst the pennates. There is a marked change in centric-pennate ratios at different levels of the outcrop. From this outcrop *Acrobotrys disolenia*, a radiolarian taxon has been recognized for the first time in Indian Neogene sediments. Well preserved benthic foraminifers



1. *Arachnoidiscus ornatus*, a centric diatom, and 2. *Acrobotrys disolenia*, a radiolarian from the Late Miocene of Neil Island (Cave Point Section) of South Andaman

have been recovered in thin section analysis from the hard limestones of Neil West Coast (Pliocene-Pleistocene). Samples collected from the Meleville point, Havelock Island contains no biogenic entities except some small ostracods. It also contains abundant crystals which may be tuff or volcanic glass shards. Lacam Point Section of Havelock Island (late early-early Middle Miocene) also contains diatoms but the size is comparatively smaller. The major diatom genera are *Coscinodiscus* and *Navicula*. The samples collected from Sippighat Quarry Section, Port Blair have yielded well-preserved fungal fruiting bodies along with some Cenozoic palynomorphs.

10. **Project— High resolution palaeoclimatic studies from Bay of Bengal** (sponsored by MoES, New Delhi; No. MOES/SIBER/NIO(RN)/11)

Investigators: Jyotsana Rai, Vandana Prasad & Premraj Uddandam

The study has been undertaken to assess the monsoon driven productivity changes and runoff related climatic fluctuations through proxies, such as palynofacies, dinoflagellate cysts and calcareous nannofossils from the Bay of Bengal. The 44 surface sediment samples (SSK 35/SC 1-22) and 150 subsurface sediment samples (SSK-35/GC-3) collected from the coastal region along the northern Bay (Ganga-Brahmaputra) have been analysed for dinoflagellate cysts and calcareous nannofossils. The samples showed paucity of these microfossils. Another set of sediment samples of SK-187/GC-7 have been



Lejeunecysta sp. *Stelladinium* sp. *Brigantdinuim* sp.

Dinoflagellate cysts

analysed for palynofacies studies and dinoflagellate cysts, and the samples showed dinoflagellate cysts of both autotrophic and heterotrophic nature, and also other palynomorphs (scolecodonts, copepod egg envelopes, foraminiferal test linings, acritarchs, fungal elements, etc.) In total, 23 species belonging to 15 genera have been identified in which 7 species are autotrophs and rest of the species are represented by heterotrophic cysts. Besides, calcareous nanoplanktons analyzed from the surface and subsurface samples showed low nannofossils turnout. In SK-187/GC-7, nannofossil recovery is better in the assemblages. In addition, a field trip has been undertaken during the cruise Sagar Kanya from the western Bay of Bengal for collection of sediment samples from different locations of Chennai to Paradip (in collaboration with NIO, Goa). The surface samples have been processed for palynofacies and dinoflagellate cysts studies and detailed study is in progress.

11. **Project— Late Quaternary climate and glacial study from Dokriani and adjoining area, upper Bhagirathi Valley, Western Himalaya** (sponsored by DST, New Delhi; No. SB/DGH/44/2012).

    Investigators: P.S. Ranhotra, A. Bhattacharyya, S.K. Shah, Mayank Shekhar & Jooly Jaiswal

Literature related to palaeoclimate and past glacial history of Dokriani and adjoining area, upper Bhagirathi Valley of western Himalaya has been consulted. Surface samples and a subsurface sedimentary profile have been macerated for the palynological analysis and processed for the stable isotope ($\delta^{13}C$) studies. Gridded climate and glacier (front variation and mass balance) data of Dokriani and adjoining area have been downscaled as a part of data base to reconstruct modern climate-vegetation-pollen analogue for the reconstruction of past climate vs. glacial fluctuations.

12. **Project— Past climate change and tree line dynamics based on tree-ring data from the Himalayan region** (sponsored by DST, New Delhi; No. SB/S4/ES-621/2012)

Investigators: S.K. Shah, A. Bhattacharyya & D. Jayaswal

Recruitment of JRF has been completed and appointed on January 01, 2014. Basic training of tree-ring analysis– sample preparation, counting, plotting, cross-dating and measurements of tree-ring sample has been imparted to him. Literature survey related to the theme of the project has been done.

13. **Project—Palynological investigations of mangroves from South Andaman Island, India: Implications in vegetation change, palaeoclimate and sea-level fluctuations during Late Quaternary** (Sponsored by DST, New Delhi, No. SR/FTP/ES-97/2012; dated 17.07.2013)

Investigator: Shilpa Pandey

A field excursion to different areas such as Shoal Bay, Wandoor, Dhanikhadi, Barratang, Chidiyatapu and Havelock, Corbyns Cove, etc. of South Andaman Islands, Andaman and Nicobar Islands has been conducted to collect polliniferous, surface (mud) and sub-surface sediment samples. In addition, 20 spider webs were also collected for pollen studies. Palynological investigation of samples is in progress.

14. **Project— High Resolution palaeoclimatic and palaeoceanographic study on eastern Arabian Sea off Saurashtra based on foraminifera and their geochemical signature**. (Sponsored by DST, New Delhi, No. SR/FTP/ES-53/2013, dated 22.11.2013)

Investigator: Pawan Govil

One JRF has been appointed in January 2014. Out of the three marine sediment cores from Arabian Sea off Saurashtra, one sediment core no. SK240-485 (length: 3.5m; water depth: 88m) has been sub-sampled at 2 cm interval. The total 175 sediment samples have been treated with wet chemistry procedure to extract the planktonic foraminifera. The picking and identification of the planktonic foraminifera is under process. Efforts will be initiated for the isotopic and geochemical elemental concentration from the picked specific species.

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Ali SN, Pandey P, Bhardwaj A, Shekhar M & Singh S 2014. Report— Indian Himalayan Capacity and Adaptation Programme-Capacity Building in Himalayan Glaciology. *Curr. Sci.* **106**: 346.

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Singh BD 2014. Report— 65th ICCP/30th TSOP Meeting: Advances in coal and organic Petrology and Geochemistry, University of Silesia, Sosnowiec (Katowice), Poland (August 25- September 04, 2013). *J. Geol. Soc. India* **83**: 109-111.

Deputation to Conferences/Seminars/Workshops

Abroad

R.R. Yadav participated in the *III International Conference of Asian Dendrochronology Association* held at University of Tehran, Iran during April 11-14, 2013.

Binita Phartiyal participated in the *28th Himalayan-Karakorum-Tibet Workshop* & *6th International Symposium on Tibetan Plateau* held at University of Tübingen, Tübingen, Germany during August 21-26, 2013.

B.D. Singh participated in the *65th ICCP (International Committee for Coal and Organic Petrology)/ 30th TSOP (The Society for Organic Petrology) Annual Meeting* & *Symposium on Advances in Coal and Organic Petrology and Geochemistry* held at University of Silesia, Sosnowiec, Poland during August 25-September 04, 2013. Also participated in the post-ICCP Meeting field trip to the Ojców National Park and Tarnowskie Góry Silver Mine in the broader Silesia Region on August 31, 2013.

Binita Phartiyal participated in the *8th IAG International Conference on Geomorphology* held at Paris, France during August 27-31, 2013.

Nivedita Mehrotra participated in the *11th International Conference of Paleoceanography* held at Sitges, Barcelona, Spain during September 01-06, 2013.

Vandana Prasad participated in the *14th Annual NECLIME (Neogene Climate Evolution in Eurasia* held at Saint Petersburg, Russia during October 01-04, 2013.

In India

Binita Phartiyal participated in the *4th TPE Workshop* held at Dehradun during April 01-03, 2013.

C.M. Nautiyal participated in the *Discussion-Meeting on Carbon Tuned Atomic Mass Spectrometry* held at University of Bombay, Mumbai during April 09-10, 2013.

Shilpa Pandey participated in the *4th IGCP-588: Preparing for Coastal Change* held at Chennai during May 20-24, 2013.

Arindam Chakraborty participated in the *National Seminar on Recent Trends in Marine and Estuarine Sciences* organized by University of Calcutta and held at Technology Campus (CRNN), Kolkata during June 21-22, 2013.

A.K. Pokharia participated in the *Workshop on Application of Sciences in Archaeology* held at Kolkata during August 06-08, 2013.

M.F. Quamar participated in the *International Conference on Conserving Biodiversity for Sustainable Development* held at NIT Rourkela, Odisha during August 16-18, 2013.

R.R. Yadav, K.G. Misra & Debarati Nag participated in the *International AvH Conference on Third Pole Demands Protection (HOPE-2013)* organized by Humboldt House of Uttarakhand at Nainital during September 12-14, 2013.

Swati Tripathi participated in the *3rd National Conference on Environment and Biodiversity of India* held at Pune on October 06, 2013.

Vandana Prasad participated in the *Belmont Forum Workshop on Seasonal to Decadal Predictability of Regional Climate for Decision Making: Bridging the Gap between Users' Needs and the State of Climate Knowledge* held at Goa during October 23-25, 2013.

K.G. Misra participated in the *4th National Conference on Climate Change* organized by Indian Climate Research Network (ICRN) and held at IIT Madras, Chennai during October 26-27, 2013.

A.K. Pokharia participated in the *National Seminar on History and Traditional Technology of Storage and Agrarian Systems* held at Udaipur during October 27-28 2013.

All the Scientists, Research Associates and Research Scholars participated in the *Conclave on Understanding the Life of Bygone Eras: Emerging Trends* held at BSIP, Lucknow during November 14-15, 2013.

R.R. Yadav, M.R. Rao, Rahul Garg, Samir Sarkar, Amlava Bhattacharyya, Mukund Sharma, Jyotsana Rai, O.S. Sarate, B.D. Mandaokar, Vandana Prasad, Anjum Farooqui, Pavan Govil, Srikanta Murthy, Hukam Singh, V.K. Singh, Biswajeet Thakur, Anju Saxena, S.S.K. Pillai, Ruby Ghosh, Poonam Verma, Swati Tripathi, Shilpa Pandey, Abha Singh, S.K. Pandey, Kanupriya Gupta, Priyanka Monga, Shreya Mishra,

Arun Joshi, Mridul Gupta, Ranjana, Bandana Dimri, D.S. Seetharam, Suman Sarkar, Premraj U. & Surabhi Garg participated in the XXIV *Indian Colloquium on Micropalaeontology and Stratigraphy* held at Wadia Institute of Himalayan Geology, Dehradun during November 18-20, 2013.

Neelam Das participated in the *International Conference on Health, Environmental & Industrial Biotechnology* held at MNNIT, Allahabad (UP) during November 21-23, 2013.

All the Scientists, Research Associates and Research Scholars participated in the *National Conference on Recent Developments in Plant and Earth Sciences* held at BSIP, Lucknow during November 28-29, 2013.

Ram Awatar, R.C. Mehrotra, Rajni Tewari, Deepa Agnihotri & Gaurav Srivastava participated in the *National Conference on Sedimentation and Tectonics with Special Reference to Energy Resources of North-East India* & *30th Convention of Indian Association of Sedimentologists* held at Manipur University, Imphal during November 28-30, 2013.

Anju Saxena participated in the *International Conference on Recent Developments in Stratigraphy (ICRDS-2013)* held at Fergusson College, Pune during December 14-16, 2013.

All the Scientists, Research Associates and Research Scholars participated in the 1st Symposium of the International Geoscience Programme (IGCP-608): *Cretaceous Ecosystems and their responses to Palaeoenvironmental changes in Asia and the Western Pacific* held at BSIP, Lucknow during December 20-22, 2013.

D.S. Seetharam participated in the *National Seminar cum Workshop on Indian Petroleum and Non-Conventional Energy Resources– Present Trends and Futuristic Initiatives (Petro fest–2013)* held at Delta Studies Institute, Visakhapatnam during December 27-29, 2013.

C.M. Nautiyal participated in the *Session on Foundations of Science in India* during the XXXVII Indian Social Science Congress (ISSC) held at AMU, Aligarh on December 30, 2013.

Neerja Jha, Jyotsana Rai, Neeru Prakash, Abha Singh, Harinam Joshi, C. Chinnappa & Surabhi Garg participated in the *9th International Congress on the Jurassic System* held at University of Rajasthan, Jaipur during January 06-09, 2014. JR, AS and SG also participated in the pre-Congress field excursion to Kachchh during December 28, 2013 to January 04, 2014.

Sunil Bajpai & S. Nawaz Ali participated in the *DST ABC-2014* (*Department of Science and Technology-Autonomous Bodies Conclave*) held at SN Bose National Centre for Basic Sciences, Kolkata during January 28-29, 2014.

A. Rajanikanth participated in the *National Seminar on Biodiversity Conservation– Present Status* held at JMJ College, Tenali (AP) in January 2014.

Shreya Mishra & Ranjana participated in the *5th All India Students Symposium in Geology- GEOYOUTH-2014* held at Dept. of Geology, MS University, Udaipur during February 11-12, 2014.

Anjum Farooqui, Biswajeet Thakur & Debarati Nag participated in the *National Seminar on Groundwater and Lakes: Recent Advancement and Environmental Aspects in Water Quality and Palaeoclimatic Conditions* held at Nagpur during February 20-21, 2014.

Biswajeet Thakur & Debarati Nag participated in the *International Workshop on Recent Advancements in the Application of Diatoms and Lake Sediments in Determining Environmental Changes in Water Quality and Palaeoclimatic Conditions* held at RTM Nagpur University, Nagpur during February 22-24, 2014.

Chanchala Srivastava & C.M. Nautiyal participated in the *International Seminar on Determining Cultural Continuity since Vedic & Epic Eras: Through Sequential Dating of Astronomical References and other Corroborating Scientific Evidences* organized by I- SERVE at CSOI, New Delhi during February 22-24, 2014.

C.M. Nautiyal participated in the *Workshop on Suitable Dating Techniques for Indian Rock Art* held at Indira Gandhi National Centre for Arts, New Delhi during February 25-26, 2014.

Anupam Sharma participated in the *National Conference on Recent Trends in Chemical and Environmental Science* held at Arni University, Kathgarh (Indora), Dist. Kangra (HP) during February 27-28, 2014.

Chanchala Srivastava participated in the *National Seminar on Technological Basis of Cultures of*

Vindhya-Ganga Region held at Department of AIHC and Archaeology, BHU, Varanasi during March 03-04, 2014.

Anupam Sharma & Ratan Kar participated in the *National Conference on Implications of Climate Change on Himalayan Environment* held at Central University of Himachal Pradesh, Dharamshala during March 20-21, 2014.

A. Rajanikanth & C. Chinnappa participated in the *National Seminar on Current Trends in Lakes, Rivers and Coastal Environments* held at Annamalai University, Chidambaram during March 28-29, 2014.

Y.P. Singh, TO participated in the *2nd NKN (National Knowledge Network) Workshop* held at IISc, Bengaluru during October 17-19, 2013.

S.K. Singh, TA participated in the *Conference on Community Heritage and Museum* held at State Museum, Ranchi during November 20-22, 2013.



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Training/Study Visits

Abroad

S.K. Shah participated in the International Summer School on Tree Rings, Climate, Natural Resources and Human Interaction held at Khakasian Technical Institute (affiliated to Siberian Federal University), Abakan, Russia during August 05-19, 2013.

Ratan Kar visited the Institute of Botany, Chinese Academy of Sciences, Beijing under the Third World Academy of Sciences-Chinese Academy of Sciences (TWAS-CAS) Visiting Scholar Fellowship for 60 days (during August-September, 2013). Worked on the palynological aspects of a 90 cm core from the Tibetan region with regards to Holocene palaeoclimatic interpretations

Samir Sarkar visited the Institute of Geology, Prague under Exchange of Scientist Programe of Academies of Sciences of India (INSA) and Czech Republic (ASCR) during August 10- September 08, 2013.

Anjali Trivedi visited the Institute of Botany, Chinese Academy of Sciences, Beijing under the Third World Academy of Sciences-Chinese Academy of Sciences (TWAS-CAS) Visiting Scholar Fellowship Scheme during August 11-October 25, 2013.

Mukund Sharma visited Australia under the Indo-Australian Senior Scientist S&T Visiting Fellowship. Had discussions with workers at School of Geosciences, Monash University (Melbourne), and South Australian Museum, North Terrace (Adelaide), South Australia during October 14-29, 2013.

P.S. Ranhotra visiting Institute of Botany, Chinese Academy of Sciences, Beijing (China) under CAS-TWAS Fellowship for one year (since August 27, 2013) to carryout research work on 'High resolution climatic studies during Late Quaternary from Tibetan Plateau: A multi proxy approach'.

In India

C.M. Nautiyal & S. Nawaz Ali attended in the Workshop on Indo-Swiss Capacity Building in Himalayan Glaciology-Level-II held at JNU, New Delhi during October-November 2013.

Debarati Nag visited K.S. Krishnan Geomagnetic Research Laboratory, Allahabad during November 16-23, 2013 and January 24-28, 2014 for mineral magnetic analysis.

Biswajeet Thakur participated in the Workshop on Climate Modeling: Simulations and Analysis held at Centre for Atmospheric Sciences, IIT Delhi during December 09-21, 2013.

Nivedita Mehrotra attended the Winter School in Geomathematics sponsored by SERB-DST, New Delhi and held at Wadia Institute of Himalayan Geology, Dehradun during December 16-30, 2013.

Debarati Nag & Nivedita Mehrotra attended the DST-SERB sponsored Winter School on Quaternary Geology and Climate Change organized at Department of Geology, Pune University, Pune during January 06-19, 2014.

Mukund Sharma, Rajni Tewari, V.K. Singh, A.H. Ansari, S.K. Pandey, Bandana Dimri, A.S. Rathore & Samim Ahmad attended International Field Workshop on the Marwar Supergroup, Rajasthan, western India jointly organised by The Society of Earth Scientists and BSIP during January 20-28, 2014.

V.V. Kapur attended the Climate Science Training Program organized at Devcha Centre for Climate Change, Indian Institute of Science, Bengaluru during January 20-31, 2014.

Jyotsana Rai attended the 25th Group Monitoring Workshop held at Thiruvananthapuram during February 18-23, 2014.

S. Nawaz Ali visited PRL, Ahmedabad in March (8th)-April (5th), 2014 for carrying out geochemistry and OSL dating of the samples.

P. Morthekai visited IIT, Kanpur on March 12, 2014 for technical assistance in OSL Dating laboratory. Also visited PRL, Ahmedabad in March (18th)-April (11th), 2014 for OSL sample processing and measurement.

Arun Joshi participated in the Science Writing Training Workshop during July 12-16, 2013 organised by District Science Club Lucknow in association with BSIP, Lucknow.

Course on Fossil Soils

A two-day short course on the *Study of Fossil Soils (Palaeopedology)* was successfully organized at BSIP during November 2013. The course was conducted by visiting scientist Prof. Gregory J. Retallack of Department of Geological Sciences, University of Oregon, Eugene, Oregon (USA). A series of lectures and laboratory practices were arranged for research students and scientists as part of this short course, which included study of hand specimens, thin sections and illustrations of palaeosols. The titles of lectures and demonstrations are listed below:

- *Recognition of Palaeosols* (on 5th November at 10:00 hrs)
- *Interpretation of Palaeosols* (on 5th November at 14:00 hrs)

November 6th was devoted to six two-hour modules of instruction and then demonstrations of:

- *Root traces in palaeosols*
- *Soil structures*
- *Soil petrography*
- *Soil horizons*
- *Soil geochemistry*, and
- *Diagenesis of fossils soils.*

Field work (over 4 days) was undertaken around Solan area of Himachal Pradesh, in which Prof. Sunil Bajpai (Director), Dr. V.V. Kapur and Dr. S.K. Pandey actively participated along with Prof. Retallack and officers from GSI. Certain major sections representing Subathu, Dagshai and Kasauli Formations of Eocene-Miocene age were visited. Detailed sampling was carried out for the study of palaeosols. All the collected fossils (from Dagshai Formation) and palaeosol samples have been deposited in the BSIP museum.

On return from field work, the following illustrative lectures were also delivered by Prof. Retallack:

- *Why did the fish leave the water: Palaeosols & Devonian tetrapod evolution* (on November 11, 2013)
- *Permian and Triassic greenhouse crises* (on November 11, 2013)
- *Changing climate and vegetation of Oregon over the past 50 million years* (on November 12, 2013)
- *Global cooling by grasslands in the geological past and near future* (on November 12, 2013)

The course and lectures were coordinated by Dr. Mukund Sharma.



Course on Acritarch

A short course on *Acritarch: Morphological aspects and significance in Palaeobiological studies* was successfully organized at BSIP during January 07-10, 2014. The course was conducted by visiting scientist Prof. Shuhai Xiao of Department of Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia (USA). Four thematic lectures, each lasting 2 to 2.5 hours, were given by him during the course. The titles of these lectures are as follow:

- *Proterozoic Acritarchs: An overview* (on 7th January)
- *Ediacaran Acritarch Biostratigraphy and Chemostratigraphy* (on 8th January)
- *Acritarch Ultrastructures and Microchemistry* (on 9th January)
- *Acritarch Morphometric analysis* (on 10th January)

Participants included scientists and research students from the Institute. New methods of microfossil preparation, characterization, and quantification were presented and illustrated. There was much discussion during and after each lecture. Several BSIP research students and scientists had extended discussions with Prof. Shuhai Xioa after the lectures.

After the second lecture, the participants were given the opportunity to examine thin sections of the Ediacaran Doushantuo Formation from South China. These thin sections contain exceptionally well-preserved acritarchs and were brought to BSIP for the students and young scientists to examine. The course was arranged and coordinated by Dr. Mukund Sharma.



Lectures Delivered

Northward Movement of Indian Plate: Biotic Response (Foundation Day Lecture, Society of Earth Scientists) at Remote Sensing Centre, Lucknow (April 17, 2013). – delivered by Sunil Bajpai

Evolution of Life: Examples from Indian Fossil record (Valedictory Lecture, Science Writing Training Workshop, Council of Science & Technology, UP) at BSIP, Lucknow (July 16, 2013). – delivered by Sunil Bajpai

Processing of Palynological Samples through Maceration Technique at Botany Department, Ewing Christen College, Allahabad (February 01, 2014). – delivered by Neerja Jha

Palaeopalynology: Its Application in Stratigraphy, Palaeoclimate and Phytogeography (organised by National Academy of Sciences) at Botany Department, Allahabad University, Allahabad (February 03, 2014). – delivered by Neerja Jha

Tertiary Palynofloral Assemblages of India: Palaeoclimatic and Palaeoenvironmental Implications at Institute of Geology, Praha, Czech Republic (September 04, 2013). – delivered by Samir Sarkar

The Ediacaran and Cambrian fossils from the Marwar Supergroup, Rajasthan, India and their significance in Ediacaran biotic realm at School of Geosciences, Monash University, Melbourne, Australia (October 25, 2013). – delivered by Mukund Sharma

Search for Past Climate and Future Prediction: Ocean Research, and *Co-evolution: Plant Animal Interaction* in Summer School on Progress in modern science: Theory and applications, for faculty members of University and Colleges organized by Academic Staff College, University of Burdwan (September 13, 2013). – delivered by A.K. Ghosh

Origin of Life in Orientation Programme for faculty members of University and Colleges organized by Academic Staff College, University of Burdwan (September 14, 2013). – delivered by A.K. Ghosh

Scientific inventions and inventors at Bal Vidya Mandir on Technology Day in a function by District Science Club, Lucknow (May 11, 2013). – delivered by C.M. Nautiyal

Water on Earth: History and Future in a Seminar by BN Parishad at Rai Umanath Bali Auditorium, Lucknow (June 05, 2013). – delivered by C.M. Nautiyal

Possibilities and Careers in Science in the Educational Conclave at Indira Gandhi Pratishthan, Lucknow by The Times of India Group (June 23, 2013). – delivered by C.M. Nautiyal

The Earth as a Planet: Sensing with waves at UP Remote Sensing Agency, Lucknow (July 05, 2013). – delivered by C.M. Nautiyal

Biodiversity: A Multi-disciplinary Science. Biodiversity Awareness campaign under NCSTC (DST) programme at JN Youth Hostel, Lucknow (August 31, 2013). – delivered by C.M. Nautiyal

Innovation: Meaning and Significance on Innovation Day Celebration by UP Council for Science & Technology, Lucknow (October 15, 2013). – delivered by C.M. Nautiyal

Vigyan aur Praudyogikee, Naye Vichar, Nayee Shabdavalee at Vigyan Parishad, Prayag with Commission of Scientific & Technical Terminology, New Delhi (October 18, 2013). – delivered by C.M. Nautiyal

Dating Techniques suitable for Glacial Environment and *Radiocarbon Dating and Palynology* (4 half day sessions) in Indo-Swiss Capacity Building Workshop at JNU, New Delhi (November 6-7, 2013). – delivered by C.M. Nautiyal

The Messengers from Space and *A date with Cosmic Rays* at Dept. of Physics, University of Lucknow (November 24, 2013 & in December 2013). – delivered by C.M. Nautiyal

A Date with Dating during INSPIRE programme (DST) at Amity University, Lucknow (December 17, 2013). – delivered by C.M. Nautiyal

Communicating Disaster- related Issues to Public at Vigyan Prasar- RSC-L workshop during Science Expo (February 02, 2014). – delivered by C.M. Nautiyal

Four lectures on the theme of *Isotopes: The Methods for Measurements and the Applications* and *Search for Life in the Universe and conditions in Solar System* in the Refresher Course at Staff

Training College, University of Lucknow (February 21 & March 01, 2014). – delivered by C.M. Nautiyal

Mid-late Holocene Monsoonal Variations from Mainland Gujarat, India: A Multiproxy Study for Evaluating Climate Culture Relationship at Belmont Forum Workshop, Goa (in October, 2013). – delivered by Vandana Prasad

Conservation of Geo-Phyto Resource in the Context of Sustainability Paradigm at Nagarjuna University, Guntur district, AP (in January, 2014). – delivered by A. Rajanikanth

Himalayan past climate variability reconstructed from Tree-rings (Invited Lecture) at Central Department of Environmental Science, Tribhuvan University, Nepal (February 06, 2014). – delivered by S.K. Shah

Series of lectures as a resource person during *Training Workshop on Reconstructing Climate Using Dendrochronological Tools* at Kathmandu organized by Tree-ring Society of Nepal (February 03-07, 2014). – delivered by S.K. Shah

Palynological studies in the sediments of Northeast India at Department of Botany and Geology, DS College, Aligarh (February 28, 2014). – delivered by Swati Tripathi

Facets of Palaeobotany Science Camp under INSPIRE Programme sponsored by DST at Bundelkhand University, Jhansi (in January 2014). – delivered by Shilpa Pandey

Series of lectures on *Luminescence Dating: Principles to Methodologies* in DST-SERB Winter School on Quaternary Geology and Climate Change at Pune University, Pune (January 16-17, 2014). – delivered by P. Morthekai

Early Paleogene Hyperthermal Events (particularly PETM) in the Context of India's Changing Biogeographic and Geodynamic Setting during the Terminal Phase of its Northward Drift in Climate Science Training Program at Divecha Centre for Climate Change, IISc, Bengaluru (in January 2014). – delivered by V.V. Kapur

Glaciations in the Indian Himalaya during the past hundred thousand years: Climatic Implications in DST ABC-2014 at SN Bose National Centre for Basic Sciences, Kolkata (January 29, 2014). – delivered by S. Nawaj Ali

Analysis of Late Quaternary Vegetation vis-à-vis Climate - at Altitudinal Gradients of North-East India at Winter School on Quaternary Science and Climate Change, Pune University, Pune (in January 2014). – delivered by Nivedita Mehrotra

Lectures by Visiting Scientists



Science Journalism in Asia. – delivered by Mr. Richard Stone, International News Editor, Science Magazine, USA (April 01, 2013)



Application of Statistical Tools and Techniques in Fossils studies. – delivered by Prof. Kuldeep Kumar, Bond University, Gold Coast, Queensland, Australia (May 02, 2013)

Challenges and Opportunities in Subsurface Imaging. – delivered by Dr. Mrinal K. Sen, Director, National Geophysical Research Institute, Hyderabad (September 10, 2013)





Integrated Ecosystem Analysis of a Rift Basin: The Jurassic of Kachchh, western India. – delivered by Prof. Franz T. Fürsich, Chair of Palaeontology, University of Erlangen-Nürnberg, Germany (February 04, 2014)

Fossils as Palaeoenvironmental Indicators: Potential and Limitations. – delivered by Prof. Franz T. Fürsich, Chair of Palaeontology, University of Erlangen-Nürnberg, Germany (February 04, 2014)

Consultancy/Technical Support Rendered

The Radiocarbon Laboratory also served as a national facility for researchers from various organizations and workers across the country for dating materials like sediments, charcoal, shells and other carbonates, etc. under consultancy. Scientists from the following organizations availed of the consultancy services:

GEER Foundation, Gandhinagar (Gujarat)
Deccan College of PG Research Institute, Pune
Archaeological Survey of India (Nagpur & Lucknow)
Gorakhpur University, Gorakhpur
Dept. of Botany, University of Lucknow, Lucknow
Centre for Earth Sciences, IISc, Bengaluru
Calcutta University, Kolkata
PG Institute of Archaeology, Colombo, Sri Lanka
Deccan College, Pune
Akshay Kumar Maitrey Museum, Univ. of North Bengal, Darjeeling)
VRS Centre for Earth Science Studies, Trivandrum
Dept. of History and Archaeology, Kohima
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru
Wadia Institute of Himalayan Geology, Dehradun
Geological Survey of India, Jaipur

The electron microscopes equipped in SEM unit are being used as a central facility. The facility has also been provided to other institutions in spare times. The unit has provided consultancy in investigating the ultra structural morphology and micro-analysis of samples received from 73 researchers of following organizations/ universities:

National Botanical Research Institute, Lucknow
Central Drug Research Institute, Lucknow
Saraswati Dental College, Lucknow
KG Medical University, Lucknow
Babu Banarsi Das National Institute of Technology and Management, Lucknow
Central Institute for Plastic Engineering and Technology, Lucknow
Lucknow University, Lucknow
Career Post Graduate College of Dental Sciences, Lucknow
Integral University, Lucknow
Kothiwal Dental College and Research Centre, Moradabad (UP)
Allahabad University, Allahabad (UP)
Bundelkhand University, Jhansi (UP)
Sardar Patel P.G. Institute of Dental and Medical Sciences, Lucknow
Institute of Dental Sciences, Barielly (UP)
Motilal Nehru National Institute of Technology, Allahabad (UP)
Thirthankar Mahaveer College of Pharmacy, Mooradabad (UP)
Government Nagarjun Post Graduate College of Science, Raipur (Chhattisgarh)
Mahatma Gandhi PG College, Gorakhpur (UP)
Deendayal Upadhayay Gorakhpur University, Gorakhpur (UP)
MMM Engineering College, Gorakhpur (UP)
Model Art and Commerce College, Wardha (Maharashtra)
Devi Ahilya University, Indore (MP)
Chandra Dental College and Hospital, Barabanki (UP)
Saroj Institute of Technology and Management, Lucknow

In addition, summer training was imparted to a number of students from the various institutions as detailed below:

Imparted summer training to Ms. Anuradha Awasthi, M.Sc. (Environmental Science) student of Babasaheb Bhimrao Ambedkar University, Lucknow during (June 3rd to July 25th, 2013) on Tertiary palynology and its applications with special reference to spore-pollen and dinoflagellate cysts of Naredi Formation (Early Eocene), Exposed at Nareda, Kutch Basin, Gujarat. – by M.R. Rao & Poonam Verma

Provided guidance in documentation of petrographical data (lithotypes, macerals and vitrinite reflectance) accumulated on the Lower Gondwana coals of Bisrampur Coalfield (Son Basin) to Ms. Anjana Vyas, Research Scholar of School of Studies in Geology, Vikram University, Ujjain (during May-June 2013). – by B.D. Singh

Provided guidance in documentation of huminite reflectance (rank) data generated on Panandhro lignite samples (Kachchh Basin) to Mr. Sandip Singh, Research Scholar of Kurukshetra University, Kurukshetra (in April 2013). – by Alpana Singh

Supervised M.Sc. (Geology) 4th Semester report entitled 'Calcareous Nannofossils biostratigraphy of Habo Dome and its palaeoenvironmental interpretation' of Mr. Hitendra Shukla, Bundelkhand University, Jhansi (during January-April, 2013). – by Jyotsana Rai

Imparted technical training to two M.Sc. (Geology) students– Mr. Yashvir Singh and Mr. Prabal Kumar Singh) from Kachchh University, Bhuj and guided their dissertation work on 'Palaeoenvironmental studies of the core sediments of the Raan of Kachchh using nannofossils'. – by Jyotsana Rai

Offered technical advice as a Member, Committee for inspection of an equipment at CDRI, Lucknow. – by C.M. Nautiyal

Guided summer training project on Palaeoethnobotanical investigations of a M.Sc. (II Semester) student- Ms. Snigdha Singh of Environmental Sciences from Babasaheb Bhimrao Ambedkar University, Lucknow (during May-June 2013). – by Chanchala Srivastava

Imparted training on palynofacies analysis of Khasi Hills Meghalaya to Mr. Ravi Tripathi, M.Sc. student under the Summer Research Fellowship Programme (Inspire/KVYP). – by Vandana Prasad

Imparted training to two M.Sc. students Mr. Gaurav Chand and Mr. Ujjwal Sharma of Department of Earth Sciences, IIT, Roorkee on palynological and palynofacies analysis of Bhavnagar lignite mine sediments, and of Tarkeshwar lignite mine sediments, respectively. – by Vandana Prasad

Imparted training to two M.Tech. students Mr. Champoungam Panmei and Mr. Tushar Bishnoi of Department of Earth Sciences, IIT, Roorkee on palynofacies study of lower Tertiary sequences exposed along Kohima-Dimapur road (Nagaland), and on palynology and palynofacies studies of upper Tertiary sequences exposed along Kohima-Dimapur road (Nagaland), respectively. – by Vandana Prasad

Imparted palynological training to Ms. Blessy, M.Tech. student from CUSAT, Cochin. – by Anjum Farooqui

Studied and compiled palynological report of 18 samples received from Geological Survey of India, Jaipur under the Institute's consultancy programme. – by Anjum Farooqui

Guided M.Sc. Dissertation of a student from Cochin University of Science and Technology, Cochin. – by Abhijit Mazumder

Guided M.Sc. Dissertation of a student from Babasaheb Bhim Rao Ambedkar University, Lucknow. – by Pawan Govil

Imparted technical training to two PG (Environmental Science) students Ms. Khushboo Anand and Ms. Shalini Singh of Babasaheb Bhimrao Ambedkar University, Lucknow and guided their M.Sc. dissertation work on diatoms studies of Cherai beach sediments (Vembanad estuary, Kerala), and from Karela Jheel (Lucknow), respectively. – by Biswajeet Thakur

Imparted training on 'An introduction to palaeofloristics and sedimentological characters of Lower Gondwana sequences of Singrauli coalfield, India' to Ms. Antara Gupta, M.Sc. (Geology) of Lucknow University (during May-June 2013). – by Anju Saxena & KJ Singh

Guided dissertation work (Masters in Geology) of Mr. Vinitesh Joshi, a student of Department of Geology, Kumaon University, Nainital (during November 2013). – by K.G. Misra

Guided dissertation work (Masters in Environmental Sciences) of Mr. Mukesh Rajput, a student of Department of Environmental Sciences, Jawaharlal Nehru University, New Delhi (during February 2014). – by K.G. Misra

Provided technical training in preparation methodology of sedimentary organic matter (palynofacies study) to Dr. A.K. Singh of RGIPT, Raebareli (in February 2014). – by S. Mahesh

Provided scientific assistance in measurement of vitrinite reflectance on coal samples of Damodar Basin to Mr. Piyush Das of ONGC, registered for Ph.D. degree at Indian School of Mines University, Dhanbad (in March 2014). – by S. Mahesh & V.P. Singh

Recognition

Sunil Bajpai

Conferred with the "National Geoscience Award–2012" of Union Ministry of Mines, Govt. of India for his outstanding contribution in the field of basic geosciences.

R.R. Yadav

Conferred with the "National Geoscience Award–2012" of Union Ministry of Mines, Govt. of India for his outstanding contribution in the geo-environmental fields.

Mukund Sharma

Awarded "Diamond Jubilee Medal–2010" of BSIP for publishing the papers in high quality refereed journals during the preceding two years (2008 & 2009).



Awarded "Indo-Australian Senior Scientist Fellowship" of DST-ASA 2012-13.

Chaired a Session on Stratigraphy of Indian Proterozoic basins with emphasis on Vindhyan Supergroup in the XXIV Indian Colloquium on Micropalaeontology and Stratigraphy held at WIHG, Dehradun in November 2013.

Madhav Kumar

Awarded "Diamond Jubilee Medal-2012" of BSIP for publishing the papers in high quality refereed journals during the preceding two years (2010 & 2011).



K.J. Singh

Awarded "Scientific Output Medal–2010" of BSIP for the best piece of research work done amongst Scientists- E, F and G during the preceding two years (2008 & 2009).



R.C. Mehrotra

Awarded "Scientific Output Medal–2012" of BSIP for the best piece of research work done amongst Scientists- E, F and G during the preceding two years (2010 & 2011).



B.D. Singh

Awarded "External Budgetary Resource Medal–2010" for providing external budgetary resources to the Institute by offering consultancy services (on CBM related coal petrographic studies) during the preceding two years (2008 & 2009).



Madhav Kumar & Subodh Kumar

Awarded "External Budgetary Resource Medal–2012" for obtaining external budgetary resources for the Institute (through consultancy services on SEM) during the preceding two years (2010 & 2011).



Hukam Singh

Awarded "Team Medal–2010" for excelling to inculcate team spirit and collaborative integrated work within the Institute or in collaboration with other institution during the preceding two years (2008 & 2009).



Rupendra Babu

Awarded "Team Medal–2012" for excelling to inculcate team spirit and collaborative integrated work within the Institute or in collaboration with other institution during the preceding two years (2010 & 2011).



Vandana Prasad

Nominated as Guide for Summer Research Fellowship Programme (Inspire/KVPY)-2013, jointly sponsored by the three National Science Academies of the country.

A. Rajanikanth

Session Chairman and Invited Speaker, *Session on Biodiversity* at JMJ College, Nagarjuna University, Tenali (Guntur district), Andhra Pradesh.

Session Chairman and Invited Speaker, *Session on Coastal Environments* at Annamalai University, Chidambaram, Tamil Nadu.

Binita Phartiyal

Awarded "Shri Chandra Dutt Pant Memorial Medal–2011" for the best piece of research work done amongst Scientist- C of the Institute during the preceding three years (2008-2010).

S.K. Shah

Elected as Fellow, East Himalayan Society for Spermatophyte Taxonomy.

Invited as 'Resource Person' at the Training Workshop on Reconstructing Climate using Dendro-chronological Tools, Kathmandu organised by Tree-ring Society of Nepal in February 2014.

Veeru Kant Singh

Co-Chaired a Technical Session of the XXIV Indian Colloquium on Micropalaeontology and Stratigraphy held at WIHG, Dehradun in November 2013.

Anju Saxena

Received "First Prize for Best Poster Presentation" for the paper entitled 'Palaeozoic floras from the sedimentary basins of north-west Himalaya and their depositional environment' displayed in the International Conference on *Recent Developments in Stratigraphy*, Pune in December 2013).



Anjali Trivedi, Swati Tripathi, Suman Sarkar, Reshmi Chatterjee & Ruchika Bajpai

Received "Best Poster Presentation Awards" for their



papers displayed in the National Conference on *Recent Development in Plant and Earth Sciences* (organized by The Palaeobotanical Society, Lucknow and BSIP in November 2013).

Shilpa Pandey

Chaired a Session 'Sea Level Studies II' at the 4th IGCP-588: Preparing for Coastal Change held at Chennai (in May 2013).

Invited as Mentor in Science Camp under DST-INSPIRE Programme at Bundelkhand University, Jhansi (during January 20-24, 2014).

Swati Tripathi

Invited to deliver Lead Lecture under Biodiversity Section in '3rd National Conference on Environment and Biodiversity of India' held at Pune in October 2013.

P. Morthekai

Invited as 'Resource Person' at the DST-SERB Winter School on Quaternary Geology and Climate Change organized in Pune University, Pune during January 2014.

M.F. Quamar

Awarded "Dr. B.S. Venkatachala Memorial Medal-2014" for the outstanding piece of research work in Palaeobotany under research students' category of BSIP, Lucknow.



Awarded "Best Poster Presentation Award" for the paper displayed in the International Conference on *Conserving Biodiversity for Sustainable Development* at NIT Rourkela in August 2013.

Suman Sarkar & Bandana Dimri

Received "Best Poster Presentation Awards" for their papers displayed in the XXIV Indian Colloquium on Micropaleontology and Stratigraphy at WIHG, Dehradun in November 2013.



D.S. Seetharam

Received "Best Oral Presentation Award" for the paper entitled 'Palynological investigation of Mangrol lignite, Cambay Basin, Gujarat: Palaeoenvironmental and palaeoclimatic implications' presented in the *Petro Fest-2013*, Visakhapatnam in December 2013.

Shreya Mishra

Received "Best Presentation Prize" for the paper entitled 'Late Permian (Raniganj) palynoflora from Chintalapudi area, Godavari Graben, South India' displayed in the GEOYOUTH-2014, Udaipur in February 2014.

Arun Joshi

Received "Best Participant Award" in Science Writing Training Workshop organised by UP Council of



Science and Technology, Lucknow in association with BSIP during July 12-16, 2013.

Nivedita Mehrotra

Awarded "*Nature* Journal Annual Subscription Award" for presentation of poster entitled 'Reconstruction of Holocene paleoclimate based on benthic foraminiferal assemblages from Soledad Basin' at the *11th International Conference of Paleoceanogeaphy*, Barcelona, Spain during September 2013.

V. Nirmala

Awarded "Efficient Administrative Staff Medal–2010" for discharging services with utmost promptness and efficiency during the preceding two years (2008-2009).



Ashok Kumar

Awarded "Efficient Administrative Staff Medal–2012" for discharging services with utmost promptness and efficiency during the preceding two (2010-2011).



Avanish Kumar

Awarded "BSIP Employee Medal–2010" for working diligently and efficiently with extra efforts in discharging the duties of the Technical staff (Group I & II).



D.B. Kunwar

Awarded "BSIP Employee Medal–2010" for working diligently and efficiently with extra efforts in discharging the duties of the Group D staff (Multi Tasking staff).



Beena

Awarded "BSIP Employee Medal–2011" for working diligently and efficiently with extra efforts in discharging the duties of the Group D staff (Multi Tasking staff).



Mohammad Shakil

Awarded "BSIP Employee Medal–2012" for working diligently and efficiently with extra efforts in discharging the duties of the Multi Tasking staff.



R.K. Awasthi

Awarded "BSIP Employee Medal–2013" for working diligently and efficiently with extra efforts in discharging the duties of the Multi Tasking staff.





Group photograph at Sursagar Sandstone mine, Jodhpur during International Field Workshop on the Marwar Supergroup (Rajasthan) organised jointly with the Society of Earth Scientists, Lucknow during January, 2014

Representation in Committees/Boards

Sunil Bajpai

- Member, Editorial Board, *Current Science*.
- Member, Editorial Board, *Journal of the Geological Society of India* (for Fast Track Articles).
- Chief Editor, *The Palaeobotanist*.
- Member, CSIR Research Committee on Earth and Atmospheric Sciences (2011-2014).
- Co-leader, IGCP 608 (Cretaceous ecosystem of Asia Pacific).
- Chairman, Organizing Committee, Conclave on Understanding the Life of Bygone Eras: Emerging Trends (BSIP).
- Patron, National Conference on Recent Developments in Plant and Earth Sciences (BSIP, November 2013).
- Convener, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

R.R. Yadav

- President, The Palaeobotanical Society, Lucknow.
- Member, Editorial Board, *Himalayan Geology*.
- Member, Editorial Board, *Phytomorphology*.

Rupendra Babu

- Judge, State Level Inspire award on Science Exhibition, SCERT, Lucknow.

M.S. Chauhan

- Councillor, The Palaeobotanical Society, Lucknow.

Neerja Jha

- Vice-President, The Palaeobotanical Society, Lucknow.
- Transparency Officer, BSIP (under RTI Act-2005).
- Member, Subject Expert Committee, Women Scientist Scheme of DST (Earth & Atmospheric Sciences–2013-2015).

Madhav Kumar

- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

Mahesh Prasad

- Treasurer, The Palaeobotanical Society, Lucknow.

Jyotsana Rai

- Member, Executive Council, Palaeontological Society of India, Lucknow.
- Member, National Advisory Committee, 9th International Congress on the Jurassic System, Jaipur (January 2014).
- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

Mukund Sharma

- President, The Society of Earth Scientists, Lucknow.
- Joint Secretary, The Palaeontological Society of India, Lucknow
- Voting Member, Cryogenian Sub-commission of ICS (2012-17)
- Corresponding Member, Ediacaran Sub-commission of ICS (2012-17)
- Member, Research Development and Coordination Cell, BSIP.
- Organizing Secretary, International Field Workshop on the Marwar Supergroup, Rajasthan (organized by the Society of Earth Scientists in January 2014)

Alpana Singh

- Member, Solid Mineral Fuel Sectional Committee–PCD-7.4: Methods of Analysis Subcommittee, Bureau of Indian Standards, New Delhi.
- Alternate Member, Solid Mineral Fuel Sectional Committee– PCD-7.5: Methods for the Petrographic Analysis of Coal, Coke and Lignite, Bureau of Indian Standards.
- Member, Executive Council, Coal Petrological Society of India.
- Member, The Society for Organic Petrology (TSOP).
- Councillor, The Palaeobotanical Society, Lucknow.

B.D. Singh

- Associate Member, International Committee for Coal and Organic Petrology (ICCP).
- Principal Member, Solid Mineral Fuel Sectional

Committee– PCD-7.4: Methods of Analysis Subcommittee, Bureau of Indian Standards, New Delhi.

- Member, Executive Council, Coal Petrological Society of India.
- Principal Member, Solid Mineral Fuel Sectional Committee– PCD-7.5: Methods for the Petrographic Analysis of Coal, Coke and Lignite, Bureau of Indian Standards, New Delhi.
- Member, Research Development and Coordination Cell, BSIP.
- Member, Board of Examiners (Ph.D. Thesis), Vinoba Bhave University, Hazaribagh.

R.S. Singh

- Secretary, The Palaeobotanical Society, Lucknow.
- Member, Editorial Board, *Geophytology*.
- Organising Secretary, National Conference on Recent Developments in Plant and Earth Sciences (BSIP, November 2013).
- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

Rajni Tewari

- Editor, *The Palaeobotanist*.
- Member, National Working Group for IGCP Project-597.

Anjum Farooqui

- Member, International Society of Plant and Environment, Lucknow.
- Member, International Geological Correlation Programme (IGCP-495).

A.K. Ghosh

- Councillor, The Palaeobotanical Society, Lucknow.
- Joint Secretary, National Conference on Recent Development in Plant and Earth Sciences (BSIP, November 2013).
- Vice-President, Boys' Anglo Bengali Inter College, Lucknow.

B.D. Mandaokar

- Joint Secretary, The Palaeobotanical Society of India, Lucknow.

C.M. Nautiyal

- Member, National Committee on Archaeological Science (ASI, Ministry of Culture).
- Member, Local Advisory Committee, Regional Science City, Lucknow.
- Advisor, Coordination Committee, National Children's Science Congress, UP.
- Member of Panel, Hindi Sansthan Committee for awards.
- Evaluator, Biodiversity Awareness campaign under NCSTC (DST) programme at JN Youth Hostel, Lucknow.
- Member, Organising Committee, Science Expo (RSC-L).
- Member, Organizing Committee, Young Scientists' Meet (INSA function) at BSIP.
- Co-coordinator, Session on Foundation of Science in India, Indian Social Science Congress, Aligarh.
- Outstation Member, Executive Committee Vigyan Parishad, Allahabad.
- Part of Organizing Committee, Bhasha Sangoshthi under joint auspices of Bharatiya Bhasha Pratishthapan Rashtriya Parishad & BSIP (March 23, 2014).

Neeru Prakash

- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).
- Member, National Organizing Committee, 9th International Congress on the Jurassic System, Jaipur (January 2014).
- Assistant Transparency Officer, BSIP

Vandana Prasad

- Expert Member, DST Fast Track Programme for Young Scientists (Earth Science; 2012-2015).
- Councillor, The Palaeobotanical Society, Lucknow.
- Member, Research Development and Coordination Cell, BSIP.
- Organizing Secretary, Conclave on Understanding the Life of Bygone Eras: Emerging Trends (BSIP, November 2013).

- Joint Secretary, National Conference on Recent Development in Plant and Earth Sciences (BSIP, November 2013).
- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

A. Rajanikanth

- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

Chanchala Srivastava

- Executive Member, Indian Society for Prehistoric and Quaternary Studies, Pune.
- Councillor, The Palaeobotanical Society, Lucknow.

Rashmi Srivastava

- Member, Editorial Board, Indian Journal of Scientific Research, Varanasi.

Ratan Kar

- Member, Terrestrial Working Group, International Arctic Science Committee.
- Assistant Editor, *The Palaeobotanist*.

Anju Saxena

- Co-Editor, Editorial Board of an open access journal *Earth Science India*.
- Member, Research Development and Coordination Cell, BSIP.

Vartika Singh

- Scientific Reviewer, International Climate Literacy and Energy Awareness Network, (CLEAN), funded by the National Science Foundation & National Oceanic & Atmospheric Administration, USA.

Biswajeet Thakur

- Co-editor, Earth Science India Website (an Open Access Journal).

Poonam Verma

- Member, Organizing Committee, 1st Symposium International Geoscience Programe Project (IGCP-608), Lucknow (December 2013).

Swati Tripathi

- Member, Editorial Board, Journal of Plant Science and Research.

P.S. Katiyar

- Member, Selection Committee for the post of Data Entry Operator, CDRI New Campus, Lucknow (April 13, 2013).
- Member, Selection Committee for the position of Project Assistance, CDRI Lucknow (August 12, 2013).
- Member, Assessment Committee of Sr. Technical Officer, CDRI Lucknow (February 15, 2014).
- Member, Technical Committee Meeting, Statistics Dept., Univ. of Lucknow (February 21, 2014).
- Member, Assessment Committee of Technical Assistant, CDRI Lucknow (March 13, 2014).

Ph.D. Programmes

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
R.K. Tantua	Geology	April 2013 Awarded	Vikram University, Ujjain	Dr. Samir Sarkar (BSIP) Prof. P Dev	A contribution to Tertiary palynology of Kumaun Himalaya, Uttaranchal
Subodh Kumar	Physics	May 2013 Awarded	University of Lucknow, Lucknow	Dr. CM Nautiyal (BSIP) Prof. Poonam Tandon	Molecular Modelling Spectral Simulation and characterization of materials of Biomedical importance
Sandhya Sharma	Botany	September 2013 Awarded	University of Lucknow, Lucknow	Dr. Amalava Bhattacharyya (BSIP)	Analysis of climate change since late Pleistocene from south-west continental margin of India using pollen and diatom data
Sandeep Kumar	Geology	March 2008 Continuing	Kurukshetra University, Kurukshetra	Dr. Alpana Singh (BSIP) Prof. NN Dogra	Palynostratigraphy and petrology of Panandhro lignites, Kutch Basin, Gujarat, India
Anjana Vyas	Geology	August 2008 Continuing	Vikram University, Ujjain	Dr. BD Singh (BSIP) Prof. KN Singh	Petrological evaluation of coals from parts of Bisrampur Coalfield, Son Valley, Chhattisgarh
Prabha Sharma	Geology	August 2008 Continuing	Vikram University, Ujjain	Dr. Alpana Singh (BSIP) Prof. KN Singh	Petrological studies of coals and associated sediments from parts of Lakhanpur Coalfield, Son Valley, Chhattisgarh
Mayank Shekhar	Botany	March 2010 Submitted	University of Lucknow, Lucknow	Dr. Amalava Bhattacharyya (BSIP)	Application of multi-proxy tree-ring parameters in the reconstruction of climate vis-à-vis glacial fluctuations from the Eastern Himalaya
Nivedita Mehrotra	Geology	September 2011 Continuing	University of Lucknow, Lucknow	Dr. Amalava Bhattacharyya Prof. Munendra Singh	Analysis of Quaternary climate change in north-east India based on multi-proxy data
Suman Sarkar	Botany	October 2011 Continuing	Andhra University, Visakhapattnam	Dr. AK Ghosh (BSIP) Dr. GM Narasimha Rao	Biofacies analysis of Palaeogene and Neogene carbonate sediments of India with special reference to calcareous algae
Akhilesh Kumar Yadava	Botany	September 2012 Continuing	University of Lucknow, Lucknow	Dr. RR Yadav (BSIP) Prof. YK Sharma	Application of tree-ring chronologies to understand climate variability in the western Himalaya, India
Vikram Partap Singh	Geology	September 2012 Continuing	Banaras Hindu University, Varanasi	Dr. BD Singh (BSIP) Prof. MP Singh	Petrological and Geochemical characterization of lignite deposits of Saurashtra Basin (Gujarat), India: Implications to economic potential and depositional setting

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
Chinnappa Chopparapu	Botany	January 2013 Continuing	Andhra University, Visakhapattnam	Dr. A Rajanikanth (BSIP) Prof. YV Rao	Contribution to plant ecosystem of Early Cretaceous sequences of East Coast, India-Floral diversification and ecological implication
D. S. Seetharam	Botany	January 2013 Continuing	Osmania University, Hyderabad	Dr. MR Rao (BSIP) Dr. H Ramakrishna	High resolution biostratigraphy and depositional environment of Tertiary lignites and associated sediments of Western India
Reshmi Chatterjee	Botany	January 2013 Continuing	Andhra University, Visakhapattnam	Dr. AK Ghosh (BSIP) Prof. GM Narasimha Rao	Floral diversity, biostratigraphy and palaeoecology of the Triassic sequences from the South Rewa and Satpura Gondwana basins
Saurabh Gautam	Botany	February 2013 continuing	Ravenshaw University, Cuttack	Dr. Rajni Tewari Dr. Shreerup Goswami	Palynostratigraphy of Gondwana sediments in Sohagpur Coalfield, South Rewa Basin, Madhya Pradesh, India
Debarati Nag	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Binita Phartiyal (BSIP) Prof. Mallickarjun Joshi	Geomorphology, palaeoclimate and neotectonics during Quaternary Period of the Indus Valley between Leh and Batalik, Ladakh Himalaya
Arun Joshi	Botany	March 2013 Continuing	Garhwal University, Srinagar	Dr. Rajni Tewari (BSIP) Dr. RK Jain	The *Glossopteris* flora of Manuguru area, Godavari graben: palaeoecological implications, evolutionary perspectives and basinal correlation
Randheer Singh	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Binita Phartiyal (BSIP) Dr. Bindhyachal Pandey	Geomorphology, Tectonics and Climate during Quaternary Period of the Tangtse Valley Ladakh, NW Himalaya
Ruchika Bajpai	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Ratan Kar (BSIP) Prof. AD Singh	Analysis of Climate changes during the Quaternary from glacial sites in India based on multi proxy data
Arindam Chakraborty	Botany	March 2013 Continuing	University of Burdwan	Dr. AK Ghosh (BSIP) Prof. PK Pal	Diversity and palaeoecology of the benthic and planktonic assemblages from the Neogene sequence of Andaman & Nicobar Islands
Bandana Dimri	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Mukund Sharma (BSIP) Prof. RK Srivastava	Genesis of Mesoproterozoic Chert: A case study from the Salkhan Limestone of the Semri Group, Vindhyan Supergroup and its implication on life in extreme conditions
Veeru Kant Singh	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Mukund Sharma (BSIP) Prof. RK Srivastava	Biostratigraphy of the Mesoproterozoic Chhattishgarh Basin exposed in the Bargarh District, Odisha, India

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
Surabhi Garg	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Jyotsana Rai (BSIP) Prof. AK Jaitely	Integrated nannofossil-ammonite biostratigraphy of Wagad, Kachchh: palaeoenvironmental and palaeobiogeographic implications
Mridul Gupta	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Jyotsana Rai (BSIP) Prof. AK Jaitely	Calcareous nannofossil ammonite biostratigraphy from Jumara Dome Kachchh
Kriti Misra	Geology	September 2013 Continuing	University of Lucknow, Lucknow	Dr. Ratan Kar (BSIP) Prof. Munendra Singh	Holocene Climatic variability around Chora-Bari Glacier (Kedarnath), Western Himalaya, India
Shreya Mishra	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Neerja Jha (BSIP) Prof. SS Gahlain	Permian and Triassic palynology, correlation of Gondwana sediments in Ayyanapalli-Sattupalli-Chintalapudi coal belt and its palaeoenvironmental implications
Ranjana	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Anjum Farooqui (BSIP) Dr. Yogesh Joshi	Climate induced relative sea level changes and coastal vegetation in Krishna delta, south east coast of India
Priyanka Monga	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Madhav Kumar (BSIP) Dr. Yogesh Joshi	Palynostratigraphy, palynofacies and depositional environment of Early Tertiary sediments of Cambay Basin, Gujarat
Harinam Joshi	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Neerja Jha (BSIP) Dr. Yogesh Joshi	Palynology of subsurface Gondwana sediments in Chintalapudi sub-basin, south India, its stratigraphical and palaeoenvironmental implication
Kanupriya Gupta	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. SK Bera (BSIP) Dr. Yogesh Joshi	Holocene vegetation development and climate change from tropical forests of Barak Valley Assam, North east India: phytodiversity, pollen deposition, human impact and conservation
Premraj Uddandam	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Vandana Prasad (BSIP) Prof. Hema Joshi	High resolution palaeoclimatic studies from the western Bay of Bengal

Units

Publication

Journal— *The Palaeobotanist*

This year two issues of BSIP's flagship journal *The Palaeobotanist* were published. The first 62(1) incorporated 9 research papers including one monographic work on *Permian spores from the Gondwana Succession in India*. The second 62(2) contained 7 research papers and a short communication. The abstracts of all the research papers were also published in Hindi.



Annual Report

Bilingual Annual Report of the Institute was published in Hindi and English containing pertinent information related to research work carried out under different projects during the period April 01, 2012–March 31, 2013. Besides, research papers published/accepted, conference participation, awards, training/deputation, Foundation/Founders' Day celebrations, reports of different Units, annual accounts and related aspects with relevant graphics and photographs were included.



Booklet

A booklet containing Biodata and Abstracts of all the 13 speakers for Conclave on *Understanding the Life of Bygone Eras: Emerging Trends* was published. The conclave was organized at BSIP during November 14-15, 2013.

Abstract Volume & Field Guide

An abstract volume containing 41 thematic abstracts for IGCP-608: 1st International Symposium on *Cretaceous Ecosystems and their Responses to Palaeoenvironmental Changes in Asia and the Western Pacific* was published. The symposium was hosted at BSIP during December 20-22, 2013. A full colour field guide for the post-symposium field trip was also published.



Miscellaneous

Biographical profiles and abstracts of lectures delivered by eminent speakers on various occasions were printed.



Release of the Institute's Compendium Volume 2013-14

Knowledge Resource Centre

Knowledge Resource Centre (KRC) is committed to provide best information services and support to its users in the era of information sharing and fulfill its mission to disseminate the knowledge. Besides holding an excellent collection of Palaeobotany and its allied subjects, KRC also provides immediate access of articles by subscribing online databases, e-journals and through National Knowledge Resource Consortium (NKRC) of CSIR-DST. Weekly services of 'New Arrivals' having content pages of journals/ books acquired by KRC and 'News Clippings' having scientific contents from newspapers and magazines purchased are regularly being communicated to its users by e-mail. Libsys software supports all in-house operations like cataloguing, circulation, serial control and binding management. The holdings are accessible by OPAC (Online Public Access Catalogue). OPAC is searchable by author, title, accession number, subject and several other fields. The procured new literature is continuously added to the database.

The current holdings of library are as under:

Particulars	Additions during 2013-14	Total
Books	83	6,172
Journals (bound volumes)	214	16,651
Reprints	2	40,099
Reference Books	2	348
Books in Hindi	20	530
Ph.D. Thesis	1	103
Reports	-	46
Maps & Atlases	-	61
Microfilm/ Fisches	-	294
Compact Disk	-	74

Currently the library is receiving 173 journals (103 through subscription and 70 through exchange). There are 174 registered card holders using the library facilities.

e-Journals

Web based access of the journals is available over the Institute's LAN from the following publishers– Elsevier (Science Direct: http://www.sciencedirect.com/), Nature Publishing Group: (Nature: http://www.nature.com/nature/index.htmal), Oxford University Press (http://www.oxfordjournals.org/), AAAS Science (http://www.sciencemag.org/), and Taylor and Francis (http://www.tandf.co.uk/journals/).

Databases

Scopus (http://www.scopus.com/), Web of Science (http://apps.isiknowledge.com), and Online access of GeoRef database (http://search.proquest.com/science/?accountid=145004).

KRC Facilities

KRC resource sharing activities— The library shares its resources with all important academic/ research institutions in India. As a member of National Knowledge Resource Consortium (NKRC), the library keeps close contacts with libraries under DST and CSIR.

Book exhibition— KRC has conducted book exhibition within the Centre's campus for selection of useful books for the KRC. Book suppliers attended the exhibition with their variety of publications. Scientists of the institute enjoyed the exhibition and select books for the Library.

Library is for leisure— Library has a separate section for Hindi and English fiction, classic literature, novels, books on general interest and six daily news papers, etc.

Institutional repository— Library has an institutional digital repository available over the web (http://203.190.147.141:8080/pbrep/) and the institute in-house Journal *The Palaeobotanist*, Annual Reports, Prof. Sahni's work, Institute Special publications are accessible over it

Reprographic activity— KRC has a printer cum photocopy machine; photocopying facility of relevant scientific literature is being extended to institute scientists, as well as to outside scientists on their demand. KRC also has lamination machine to preserve the old and fragile scientific literature.

Exchange Facility

Institutions on exchange panel with our Journal *The Palaeobotanist*	39
Journals received from different institutes on exchange basis	68

Training

KRC is providing 12 months training to two Apprentice trainees for library working.

Museum

Museum plays a vital role in popularizing and dissemination of the palaeontological knowledge amongst students and the scholars within the country and abroad. In this connection, BSIP participated in *Science Expo-2014* from January 29th to February 2nd organized at Regional Science City, Lucknow. Participants and the visitors took keen interest in Institute's exhibition depicting palaeobotanical marvels and the achievements at this center.





Research materials (plant fossils and rock/sediment samples) have been collected from 287 localities spreading in different parts of the country by the scientists working on different projects as well as on various sponsored projects. Type materials of 30 research papers are submitted by the scientists in the repository during this period. In addition, renovation and conservation works of main showcase and the showcase with model of *Williamsonia sewardiana*, kept in the central hall, have been carried out. The repairing and re-colouring work on a Model depicting Oil Exploration has also been completed.

Four sets of plant fossils and slides have been gifted to various colleges within the country, and fossil specimens are also presented to the distinguished guests as gifts from time to time.

Museum Holdings

Particulars	Addition during 2013-2014	Total
Type and Figured specimens	145	7,934
Type and figured slides	206	14,431
CDs	25	65

Specimens/samples collected during the field work under various projects:

Samples deposited under Sponsored/ Collaborative Projects:

Project	Specimens (Megafossils)	Samples
Project– 1	7	691
Project– 2	995	84
Project– 3	-	386
Project– 4	275	120
Project– 5	86	479
Project– 6	128	265
Project– 7	-	497
Project– 8	-	635
Project– 9	-	756
Project– 11	26	-
Project– 13	-	93

SRF/CSIR-HRDG : 67
DST Project No. SR/FTP/ES-123/2009 : 212
DST Sponsored Project : 91
DST Project No. SR/FTP/ES-97/2012 : 307
DST Project No. SR/FTP/ES-49/2012 : 167

Specimens / Slides gifted to:

Smt. Allum Sumangalamma Memorial College for Women, Bellary (Karnataka)

Jagdamba Saran Singh Educational Institute, Belsar, Gonda (UP)

Millenium National School and Junior College, Karvenagar, Pune (Maharashtra)

Janta College Bakewar, Etawah (UP)

Institutional Visitors

Forest Training Research Institute, Kanpur (UP)

S. R. Institute of Management and Technology, B.K.T., Lucknow (UP)

J. M. Patel College, Bhandara (Maharashtra)

Vigyan Manthan Yatra-2014, Council of Science & Technology, Bhopal (MP)

Department of Botany, University of Lucknow, Lucknow

Department of Botany, Mizoram University, Aizawl

Department of Botany, Osmania University, Hyderabad

Delegates of 1st International Symposium of IGCP-608.





Students visiting the Institute's Museum

Electronic Data Processing

National Knowledge Network (NKN) connectivity in the Institute has been commissioned. Internet connection 2 MBPS (1:1) with Radio link facility from Software Technology Park of India, Lucknow is running in the Institute as a backup. Proxy, Mail and DNS servers are successfully running and provide 24 hours internet facility to the Institute staff. E-mail accounts for staff and various Units/Sections have been opened through Google Mail Server on Institute Domain (BSIP.RES.IN). An anti virus program Symantec Endpoint Protection has been renewed with 150 user license to protect the system from viruses/worms.

Computer Section has procured one HP DL 380P G8 server and 5KVA UPS for unit. The section is maintaining and updating the Institute's website regularly. Intranet website has also been launched for Institute users and various utility forms are uploaded in PDF and word format. Wireless Internet Connectivity is running within the campus. In addition, Payroll, Form16 and pension packages are also modified as per the requirements of the Account Section. Computer Section is providing help to the scientists in preparing the multimedia presentations, charts, graphs, lithologs and diagrams for their scientific publications and documentation.

Scanning Electron Microscopy

The scanning electron microscopy (SEM) unit provides the facility to researchers for analyzing their specimen on more resolution which help them to study the ultra structures of the object. The unit is supporting frontline researches in the palaeobotanical, geological, biological, material, etc. sciences, for the scientists and research scholars of the Institute. The unit is equipped with SEM (Leo 430), POLARON Sputter Coater and Bal-Tec Critical Point Dryer (CPD) and running well.

Around 30 scientists of the Institute have used SEM facility for analyzing their over 200 samples of varied nature/discipline. In addition of Institute's scientific works, such facility has also been rendered in spare time to the researchers of other academic institutions, Universities, etc. of the country. The rendering consultancy is not only provides the source income but also helps to disperse the scientific knowledge/ publicity of the Institute.

Reservations and Concessions

The Institute is following General Reservation Orders of the Government of India as applicable to Autonomous Bodies and amended from time to time for the reservations and concessions of Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes (OBC) and Physically Handicapped Persons for the posts meant for direct recruitment in Group 'A', 'B', 'C' and 'D' as per Govt. of India Orders.

Distinguished Visitors

Shri S.K. Srivastava, Chairman and MD, Oil India Limited, New Delhi

Dr. H.S. Das, Principal Secretary, Science and Technology, UP, Lucknow

Prof. S.B. Nimse, Vice-Chancellor, University of Lucknow, Lucknow

Prof. S.K. Tandon, Delhi University, Delhi

Prof. G.J. Retallack, University of Oregon, USA

Dr. S.W.A. Naqvi, Director, National Institute of Oceanography, Goa

Prof. M.K. Sen, Director, National Geophysical Research Institute, Hyderabad

Mr. Richard Stone, International News Editor, Science Magazine, USA

Prof. Hisao Ando, Ibaraki University, Japan

Prof. Yong Il Lee, Seoul National University, Korea

Dr. Krishan Lal, President, INSA, New Delhi

Shri B.S. Rawat, Director, DST, New Delhi

Prof. N.N. Dogra, Kurukshetra University, Kurukshetra

Prof. P.K. Seth, Chief Executive Officer, Biotech Park, Lucknow

Prof. Shuhai Xiao, Virginia Polytechnic Institute and State University, Blacksburg, USA

Dr. Tohru Ohta, Waseda University, Japan

Prof. Kuldeep Kumar, Bond University, Gold Coast, Queensland, Australia

Prof. B.P. Singh, Banaras Hindu University, Varanasi

Prof. R.K. Khandal, Vice-Chancellor, U.P.T.U., Lucknow

Dr. S.K. Mishra, Advisor, Department of Science & Technology, New Delhi

Dr. M.J.K. Siddiqui, Director, UP Council of Science and Technology, Lucknow

Dr. S.K. Singh, Project Director, UP Council of Science and Technology, Lucknow









Status of Official Language

The Institute continues to strive to achieve the set target for Official Language implementation. The Institute participated in both the Half Yearly meetings of Town Official Language Implementation Committee during the year 2013-14. The scientists and technical officers/ employees of the Institute also took active part in science communication in Hindi through various media. These included popular science lectures in various institutions/ schools; radio talks, interactions during exhibitions and popular science articles.

Hindi Fortnight

Hindi Fortnight was celebrated during September 13-27, 2013. During the Hindi Fortnight, 61 staff members participated in a series of competitions including *Hindi Typing* (Computer), *Spot the Errors*, *Noting* and *Research Highlight Presentation by Young Researchers*. The Director encouraged the participants during the competitions too. *Kavi Sammelan* was also organized on 26th September. The valedictory function was held on September 27th in which Dr. Ashwani Kumar, IFS was the chief guest. Hindi books of reputed authors were given away as prizes.

Results of various competitions are given below:

Typing	:	I – Mr. Rahul Gupta, II – Ms. Anupam Jain, III – Mr. Ram Ujagar
Spot the Errors	:	I – Mr. Rahul Gupta, II – Dr. Anju Saxena, III – Mr. T.K. Mandal
Essay	:	I – Mr. V.K. Nigam, II – Mr. T.K. Mandal, III – Mr. D.K. Pal



A view of Hindi Fortnight celebrations

Research Highlight Presentation by Young Researchers— Dr. Swati Tripathi, Dr. Mahesh S., Ms. Bandana Dimri, Ms. Reshmi Chatterjee and one technical staff Mrs. Sunita Khanna made presentations of their research work in Hindi on September 20, 2013.

Hindi Workshop

The quarterly Workshops were organized on the following subjects. The Workshops were followed by lively discussions related to the topics of talks and related terminology:

Google Indic Megh Hindi mein Tankan kaise ho [by Dr. C.M. Nautiyal & Mr. P.S. Katiyar of BSIP] on June 28, 2013.

Hamaari Paramparaon mein Jaiv Vividhata Sanrankshan [by Dr. Ashwani Kumar, IFS] on September 27, 2013.



Brahmaand ki kuchh Jhalkiyaan and *Hindi Digi Board Demonstration* [by Dr. Murali Manohar Verma of Lucknow University] on December 16, 2013.

Jal tatha Jeevan aur Prashasnik and *Vaijnanik Kaaryon mein Raj Bhasha ka Upayog* [by Dr. D.D. Ojha, Ex.Scientist of Ground Water Department, Jodhpur] on February 21, 2014)



Bhasha Utsav

A programme *Bhasha Utsav* was organized on March 23, 2014 jointly with Bhartiya Bhasha Pratishthapan Rashtriya Parishad and Hindi Sansthan, Uttar Pradesh. A number of persons from various cities of the country presented papers in the Symposium on *Raj Bhasha ka Sankraman Kaal evam Bhavishya*. Several Hindi experts presented their views. Among those who spoke were Prof. Sunil Bajpai, Director BSIP; Dr. V.C. Pandeya, IAS; Shri Mahesh Chandra Dwivedi, IPS; Shri R.D. Goel; Prof. Usha Sinha; Dr. M.L. Agarwal; Dr. M.H. Naasir; and others. Dr. C.M. Nautiyal of BSIP spoke on *Hindi mein Vigyan Lekhan Sankraman Kaal mein: Vishleshan evam Sujhav* during the Sangosthi. The Souvenir-cum-abstract book was also released on this occasion.

Miscellaneous

Meetings of Official Language Implementation Committee of the Institute were organised in each quarter. The computers of the Institute with net facility have access to multi-lingual software. The process of making forms bilingual is near completion. The Annual Report of the Institute for the year 2012-13 was published in Hindi also. In the international journal of the Institute *'The Palaeobotanist'* abstracts of all the research papers in Hindi were also published In adherence to the section 3(3) of the Official Language Act–1963, efforts are continued to improve correspondence in Hindi.



Staff

Director

Prof. Sunil Bajpai

Scientists

Scientist 'G'

Dr. Samir Sarkar (w.e.f. 01.01.2014)
Dr. Ram R. Yadav

Scientist 'F'

Dr. Rupendra Babu (w.e.f. 01.01.2014)
Dr. Samir K. Bera (w.e.f. 01.01.2014)
Dr. Mohan S. Chauhan (w.e.f. 01.07.2013)
Dr. (Mrs) Neerja Jha
Dr. Madhav Kumar (w.e.f. 01.07.2013)
Dr. Rakesh C. Mehrotra (w.e.f. 01.07.2013)
Dr. Mahesh Prasad (w.e.f. 01.01.2014)
Dr. (Mrs) Jyotsana Rai (w.e.f. 01.01.2014)
Dr. Ram Awatar (retired w.e.f. 31.01.2014 AN)
Dr. Mulagalapalli R. Rao (retired w.e.f. 31.07.2013 AN)
Dr. Mukund Sharma (w.e.f. 01.07.2013)
Dr. (Mrs) Alpana Singh (w.e.f. 01.01.2014)
Dr. Bhagwan D. Singh (w.e.f. 01.01.2014)
Dr. Kamal J. Singh (w.e.f. 01.01.2014)
Dr. Rama S. Singh
Dr. (Mrs) Rajni Tewari (w.e.f. 01.01.2014)
Dr. Surya K.M. Tripathi (retired w.e.f. 30.06.2013 AN)

Scientist 'E'

Dr. (Mrs) Anjum Farooqui (w.e.f. 01.07.2013)
Dr. Amit K. Ghosh (w.e.f. 01.07.2013)
Dr. Bhagwan D. Mandaokar
Dr. Kindu L. Meena (w.e.f. 01.01.2014)
Dr. Chandra M. Nautiyal
Dr. (Mrs) Neeru Prakash
Dr. (Mrs) Vandana Prasad
Dr. Annamraju Rajanikanth
Dr. Dinesh C. Saini
Dr. Omprakash S. Sarate
Dr. Rakesh Saxena (retired w.e.f. 31.08.2013 AN)
Dr. Anupam Sharma (repatriated w.e.f. 22.01.2014 after lien period)
Dr. (Mrs) Chanchala Srivastava
Dr. (Mrs) Rashmi Srivastava
Dr. Gyanendra K. Trivedi (w.e.f. 01.01.2014)

Scientist 'D'

Dr. Ratan Kar (w.e.f. 01.07.2013)
Dr. (Mrs) Binita Phartiyal (w.e.f. 01.07.2013)
Dr. Anil K. Pokharia (w.e.f. 01.07.2013)

Scientist 'C'

Dr. Sadhan K. Basumatary
Dr. Pawan Govil
Dr. Abhijit Mazumder
Dr. Krishna G. Misra (w.e.f. 01.01.2014)
Dr. Srikanta Murthy
Dr. S. Suresh K. Pillai (w.e.f. 01.07.2013)
Dr. Parminder S. Ranhotra (w.e.f. 01.07.2013)
Dr. (Mrs) K. Pauline Sabina (w.e.f. 01.07.2013)
Dr. (Mrs) Anju Saxena (w.e.f. 01.07.2013)
Dr. Santosh K. Shah
Dr. Hukam Singh
Dr. (Ms) Vartika Singh (w.e.f. 01.01.2014)
Mr. Veeru K. Singh
Dr. Biswajeet Thakur

Scientist 'B'

Dr. (Ms) Deepa Agnihotri
Dr. (Ms) Ruby Ghosh
Dr. Kamlesh Kumar
Dr. (Mrs) Shilpa (Singh) Pandey
Dr. (Mrs) Anumeha Shukla
Dr. (Mrs) Abha Singh
Dr. Gaurav Srivastava
Dr. (Mrs) Swati (Dixit) Tripathi
Dr. (Mrs) Anjali Trivedi
Dr. (Mrs) Poonam Verma

Scientist Emeritus

Dr. Amalava Bhattacharyya (tenure completed w.e.f. 31.01.2014 AN)

Birbal Sahni Research Associate

Dr. (Mrs) Neha Aggarwal (resigned w.e.f. 28.10.2013 AN)
Dr. S. Mahesh
Dr. Santosh K. Pandey (resigned w.e.f. 28.10.2013 AN)
Dr. Mohammad F. Quamar (resigned w.e.f. 28.10.2013 AN)
Dr. (Mrs) Yogmaya Shukla (resigned w.e.f. 20.08.2013)

(The names are in alphabetical order according to 'surnames')

Birbal Sahni Research Scholar

Ms. Reshmi Chatterjee
Mr. Chinnappa Chopparapu
Ms. Bandana Dimri
Ms. Kanupriya Gupta
Ms. Mridul Gupta (resigned w.e.f. 24.11.2013)
Mr. Arun Joshi
Mr. Harinam Joshi
Ms. Shreya Mishra
Ms. Priyanka Monga
Ms. Debrati Nag
Ms. Ranjana
Mr. D.S. Seetharam
Mr. Vikram P. Singh

Technical Personnel

Technical Officer 'D'

Mr. P.S. Katiyar
Dr. E.G. Khare (retired w.e.f. 28.02.2014 AN)
Mr. T.K. Mandal
Mr. V.K. Singh

Technical Officer 'C'

Mrs. Reeta Banerjee
Mrs. Sunita Khanna
Mrs. Kavita Kumar
Mr. Chandra Pal
Mr. Prem Prakash
Mr. V.P. Singh
Mr. Y.P. Singh
Mr. Avinesh K. Srivastava

Technical Officer 'B'

Mr. Madhukar Arvind
Dr. Subodh Kumar
Mr. R.L. Mehra
Mr. R.C. Mishra
Mr. Pradeep Mohan
Mr. V.K. Nigam
Mr. Keshav Ram

Technical Assistant 'E'

Mr. S.R. Ali
Mr. Chandra Bali
Mr. D.S. Bisht
Mr. D.K. Pal
Mr. Dhirendra Sharma
Dr. S.K. Singh
Mr. C.L. Verma
Dr. S.M. Vethanayagam

Technical Assistant 'D'

Mr. Sumit Bisht
Dr. Nilay Govind
Mr. Avanish Kumar
Mr. M.S. Rana
Ms. Kirti Singh
Mr. S.C. Singh
Mr. Ajay K. Srivastava

Technical Assistant 'B'

Mr. Pawan Kumar
Mr. Om Prakash

Technical Assistant 'A'

Mr. J. Baskaran
Mr. A.K. Sharma
Ms. Richa Tiwari
Mr. Ram Ujagar

Administrative Personnel

Registrar: Dr. S.C. Bajpai (retired w.e.f. 31.08.2013 AN)
Accounts Officer: Mr. N.B. Tewari
Private Secretary

Mrs. M. Jagath Janani (repatriated w.e.f. 01.08.2013 after deputation period)

Section Officer

Mrs. Ruchita Bose (w.e.f. 13.05.2013)
Mr. Hari Lal (w.e.f. 13.05.2013)
Mrs. Swapna Mazumdar (w.e.f. 13.05.2013)
Mrs. V. Nirmala (retired w.e.f. 31.07.2013 AN)
Mrs. Pennamma Thomas

Stenographer: Mr. Murukan Pillai
Assistant

Mr. Mishri Lal (w.e.f. 13.05.2013)
Mr. S.S. Panwar (w.e.f. 13.05.2013)
Mr. Rameshwar Prasad
Mr. Gopal Singh
Mr. K.P. Singh
Mr. Avinash K. Srivastava (w.e.f. 13.05.2013)
Mrs. Renu Srivastava (w.e.f. 13.05.2013)
Mr. Koshy Thomas
Mr. N.Unnikannan (w.e.f. 13.05.2013)

Hindi Translator: Mr. Ashok K. Sharma
Upper Division Clerk

Ms. Chitra Chatterjee
Mrs. Sudha Kureel
Ms. Manisha Tharu

Lower Division Clerk

Mr. R.K. Mishra

(The names are in alphabetical order according to 'surnames')

Driver

Mr. Nafis Ahmed ('IV')
Mr. D.K. Mishra ('IV', w.e.f. 16.08.2013 AN)
Mr. M.M. Mishra ('IV', w.e.f. 16.08.2013 AN)
Mr. V.P. Singh ('IV', w.e.f. 16.08.2013 AN)
Mr. P.K. Mishra ('III')

Multi Tasking Staff

MTS: Mr. K.C. Chandola

MTS 'II'

Mr. K.K. Bajpai
Mr. Prem Chandra
Mr. Kesho Ram
Mr. D.B. Kunwar
Mr. Mohammad Shakil
Mr. Mani Lal Pal
Mr. Ram Dheeraj
Mr. Bam Singh
Mr. Ram Singh

MTS 'I'

Mr. R.K. Awasthi
Mrs. Beena
Mr. V.S. Gaikwad
Mr. Hari Kishan
Mr. Deepak Kumar
Mr. Inder Kumar
Mr. Ramesh Kumar
Mr. Haradhan Mahanti
Ms. Nandani
Mr. Kailash Nath
Mr. Mathura Prasad
Mr. Ram Chander
Mr. Ram Deen (retired w.e.f. 31.07.2013 AN)
Mrs. Ram Kali
Mr. Ram Kewal
Mr. Ravi Shankar
Mr. Shree Ram (retired w.e.f. 31.12.2013 AN)

Attendant 'II'

Mr. K.N.Yadav (under suspension w.e.f. 25.05.2011)

Sponsored Project Personnel

Dr. Arjun S. Rathore, RA (tenure completed w.e.f. 18.09.2013 AN)
Ms. Nivedita Mehrotra, SRF
Mr. Suman Sarkar, SRF
Ms. Ruchika Bajpai, JRF
Mr. Arindam Chakraborty, JRF
Mr. Premraj Uddandam, JRF
Mr. Abhishek K. Singh, JRF (resigned w.e.f. 01.11.2013)
Mr. Randheer Singh, JRF
Mr. Akhilesh K. Yadava, JRF
Mr. Raja Ram, Project Assistant
Mr. Saheb Lal Yadav, Field Assistant



A view of farewell to retired staff

Appointments

Dr. Mulagalapalli R. Rao, Emeritus Scientist w.e.f. 01.08.2013.

Dr. Rahul Garg, Emeritus Scientist w.e.f. 17.12.2013.

Dr. (Mrs) Neha Aggarwal, Scientist-B w.e.f. 29.10.2013.

Dr. Shailesh Agrawal, Scientist-B w.e.f. 29.10.2013.

Dr. Sheikh Nawaz Ali, Scientist-B w.e.f. 29.10.2013.

Dr. Arif Hussain Ansari, Scientist-B w.e.f. 29.10.2013.

Dr. Vivesh Vir Kapur, Scientist-B w.e.f. 29.10.2013.

Dr. (Mrs) Neelam, Scientist-B w.e.f. 29.10.2013.

Dr. Santosh Kumar Pandey, Scientist-B w.e.f. 29.10.2013.

Dr. Mohammad Firoze Quamar, Scientist-B w.e.f. 29.10.2013.

Dr. Sunil Kumar Shukla, Scientist-B w.e.f. 29.10.2013.

Dr. (Mrs) Jyoti Srivastava, Scientist-B w.e.f. 29.10.2013.

Mr. Manoj M.C., Scientist-B w.e.f. 04.11.2013.

Dr. P. Morthekai, Scientist-B w.e.f. 10.01.2014.

Dr. Runcie Paul Mathews, Scientist-B w.e.f. 29.01.2014.

Dr. (Mrs) Sandhya Misra, Research Associate w.e.f. 11.09.2013 (under Emeritus Scientist Scheme, tenure completed w.e.f. 31.01.2014 AN).

Mr. Rahul Gupta, Lower Division Clerk w.e.f. 24.06.2013.

Ms. Anupam Jain, Lower Division Clerk w.e.f. 24.06.2013.

Mr. Mahesh Nayar, Lower Division Clerk w.e.f. 24.06.2013.

Mr. Manoj Singh, Lower Division Clerk w.e.f. 24.06.2013.

Dr. S.C. Bajpai, Registrar (re-employed on Contract Basis after superannuation) w.e.f. 01.09.2013 (tenure completed on 28.02.2014, AN)

Mrs. V. Nirmala, Section Officer (re-employed on Contract Basis after superannuation) w.e.f. 01.08.2013 (tenure completed on 31.12.2013, AN)

Mr. Ram Deen, MTS 'I' (re-employed on Contract Basis after superannuation) w.e.f. 01.08.2013.

Mr. Shailesh Kumar, Multi Tasking Staff-I w.e.f. 02.01.2014.

Mr. Suneet Kumar, Multi Tasking Staff-I w.e.f. 02.01.2014.

Mr. Raj Kumar, Multi Tasking Staff-I w.e.f. 07.01.2014.

Ms. Sandhya Singh, Multi Tasking Staff-I w.e.f. 10.01.2014.

Mr. Rinku Kumar, Multi Tasking Staff-I w.e.f. 15.01.2014 (resigned w.e.f. 16.01.2014).

Ms. Bhawana Bajpai, Multi Tasking Staff-I w.e.f. 20.01.2014.

Mr. Ankit Pratap Singh, Multi Tasking Staff-I w.e.f. 29.01.2014.

Sponsored Project Personnel

Mr Mayank Shekhar, Research Associate w.e.f. 02.09.2013.

Mr. Shamim Ahmad, CSIR-Senior Research Fellow w.e.f. 01.04.2013.

Ms. Surabhi Garg, Junior Research Fellow w.e.f. 18.04.2013.

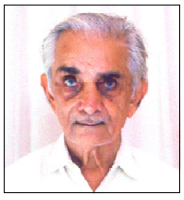
Ms. Jooly Jaiswal, Junior Research Fellow w.e.f. 02.09.2013.

Ms. Kriti Mishra, CSIR-Junior Research Fellow w.e.f. 10.10.2013.

Mr. Deepanshu Jayaswal, Junior Research Fellow w.e.f. 01.01.2014.

Mr. Syed Azharuddin, Junior Research Fellow w.e.f. 21.01.2014.

Obituary



Shri V.P. Gulati
Ex-Deputy Registrar
passed away on 17.07.2013.



Mrs Maya Devi
Multi Tasking Staff 'I'
passed away on 19.10.2013.



Dr. Sukhdev
Ex-Assistant Director (SG)
passed away on 24.01.2014.

AUDIT REPORT

To,
The Governing Body of
The Birbal Sahni Institute of Palaeobotany
53, University Road, Lucknow

We have audited the attached Balance Sheet of ***"Birbal Sahni Institute of Palaeobotany, Lucknow"*** as at 31-Mar-2014 and also the Income and Expenditure account and Receipt and Payment account for the year ended on that date annexed thereto. These financial statements are the responsibility of Institute's management. Our responsibility is to express an opinion on these financial-statements based on our audit.

We conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material mis-statement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

Further to our comments in the ***"Annexure-A"*** attached to above, we report that:

(i) We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purposes of our audit;

(ii) In our opinion, proper books of account as required by law have been kept by the Institute so far as appears from our examination of those books;

(iii) The Balance Sheet, Income & Expenditure account and Receipt & Payment account dealt with by this report are in agreement with the books of account;

(iv) In our opinion and to the best of our information and according to the explanations given to us, the said accounts give the information, in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India;

a) In the case of the Balance Sheet, of the state of affairs of the Institute as at 31st March 2014;

b) In the case of the Income & Expenditure account, of the surplus for the year ended on that date; and

c) In the case of Receipt & Payment account, of the receipts and payments of the Institute for the year ended on that date.

For **Khanna Thaker & Company**
Chartered Accountants



CA. Abhinav Khanna
(Partner)
Membership No- 405987
FRN-001265C

Place : Lucknow
Date : September 7, 2014

ANNEXURE - 'A'

Comments / Audit Observations on Accounts of Birbal Sahni Institute of Palaeobotany, Lucknow by the Chartered Accountants and Actions taken by the Institute

<table>
<tr><th>S No.</th><th>Comments/Observations by the Chartered Accountants</th><th>Actions taken by the Institute</th></tr>
<tr><td>01.</td><td><u>ACCOUNTS</u>:
Single entry system was prevalent till 2012, in current year double entry system have been adopted throughout the year but still it needs improvement in some areas. Further, the Institute has also implemented computerised accounting from FY 2012-13.</td><td>Improvement in some areas i.e. the system is also required to be implemented in other Sections/Units of the administrative with the guidance/supervision of the Chartered Accountant action for which is in process.</td></tr>
<tr><td>02.</td><td>Advances unsettled and pending for recovery/ adjustment as on 31.03.2014 (₹ 7,83,08,045.89) under different heads out of amount advanced upto 2013-14, are to be properly taken care of at Institute level for early adjustment there of. Details of which are available in annexed schedule of unsettled advances.</td><td>Out of the above outstanding advance settlement has been made for ₹ 15,79,139.00 and settlement of remaining amount ₹ 7,67,28,906.89 (against letter of Credit) will be adjusted on satisfactory installation of the equipment and receipt of final adjustment bills from stores and purchase section. A sum of ₹ 2,20,529.00 will be settled on receipt of grants from the sponsored agencies viz DST and INSA.</td></tr>
<tr><td>03.</td><td>Filing system of documents say vouchers etc. is also not adequate. There are no separate files for Journal / Imprest Vouchers.</td><td>Separate files for Journal and Imprest Vouchers are being maintained w.e.f. 01.04.2014 and will be shown to the audit.</td></tr>
<tr><td>04.</td><td>A certificate in prescribed format from school principals should be taken from employees while claiming RTF, but such format found blank in all cases.</td><td>As per rules on the subject submission of fee receipt or certificate from the school is sufficient for reimbursement and as such on submission of receipts, forms are filled in partly but certificates (therein) from school were not asked.</td></tr>
<tr><td>05.</td><td>TDS amounting to ₹ 44,56,022.00 is pending for refund/ adjustment with Income Tax Department. Mainly this issue is pending for want of Exemption Certificate from the Department and as per concerned authority of the Institute, it is pending at their end and being followed up by the Institute. However serious efforts are required to be made by the Institute to recover said amount. Fund wise TDS details are given as follows: (₹)
<table>
<tr><th>Financial Year</th><th>GPF</th><th>CPF</th><th>Pension</th><th>Total</th></tr>
<tr><td>2013-14</td><td>295,674.00</td><td>1,012.00</td><td>8,44,974.00</td><td>11,41,660.00</td></tr>
<tr><td>2012-13</td><td>284,217.00</td><td>8,483.00</td><td>785,487.00</td><td>1,078,187.00</td></tr>
<tr><td>2011-12</td><td>161,052.00</td><td>16,927.00</td><td>581,873.00</td><td>759,852.00</td></tr>
<tr><td>2010-11</td><td>354,549.00</td><td>18,167.00</td><td>475,352.00</td><td>848,068.00</td></tr>
<tr><td>2009-10</td><td>125,377.00</td><td>2,238.00</td><td>108,904.00</td><td>236,519.00</td></tr>
<tr><td>2008-09</td><td>116,654.00</td><td>-</td><td>2,223.00</td><td>118,877.00</td></tr>
<tr><td>2007-08</td><td>21,033.00</td><td>-</td><td>2,880.00</td><td>23,913.00</td></tr>
<tr><td>2006-07</td><td>28,916.00</td><td>-</td><td>71,663.00</td><td>100,579.00</td></tr>
<tr><td>2005-06</td><td>86,188.00</td><td>-</td><td>62,179.00</td><td>148,367.00</td></tr>
<tr><td>Total</td><td>14,73,660.00</td><td>46,827.00</td><td>29,35,535.00</td><td>44,56,022.00</td></tr>
</table></td><td>Institute has now been approved as 'Scientific Research Association' w.e.f. from the financial year 2013-14. A copy of Notification issued by Central Board of Direct Taxes, Ministry of Finance, Government of India, New Delhi along with comments of Chartered Accountant of the Institute is enclosed. A sum of ₹ 5,56,230/- (Five Lac Fiftysix Thousand Two Hundred Thirty only) has been refunded by I.T. authorities and application for refund of balance amount of TDS is pending with Income Tax authorities which is in process.</td></tr>
</table>

S No.	Comments/Observations by the Chartered Accountants	Actions taken by the Institute
06.	***EMPLOYEES PROVIDENT FUND(GPF/CPF):*** Fixed Assets Register haven't been maintained properly, FAR should disclose opening balances, acquired assets during the year, assets disposed off and closing balances. But FAR kept by institute only shows acquisition/ disposal during the year and it will result in difficulty of calculation of depreciation. Fixed assets schedule of previous could not be reconciled with Current FAR due to lack of proper information.	Asset Register have been made properly as per GFR.
07.	***STORES, WORKS & BUILDING:*** In schedule of Assets created during the financial Year 2013-2014 figures reported under the head Assets created upto 2012-2013 are after charging of Depreciation while figures reported under the head Assets created during the reporting period are before charging of Depreciation. It is suggested that uniform accounting policy should be adopted for the purpose of comparison.	Noted Please.
08.	Proper records/ Stock Register is to be maintained in every department for items issued to them from stores.	Proper records of consumable/non consumable Stock Register have been made accordingly.
09.	***LEGAL CASES AND CONTINGENT LIABILITY:*** In case of payment made to Babloo Caters TDS under Section 194C is deducted @2.06% instead of 1% throughout the Financial Year.	Noted for future compliance.
10.	In Voucher No.53 dated 04/04/2013 payment of ₹ 27856.00 is made to Satya Advertising Agency.TDS under Section 194C is deducted @2.06% instead of 1%.	
11.	In Voucher No.26 dated 08/06/2013 payment is made of ₹ 17388.00 for AMC. TDS under Section 194C is deducted @2.06% instead of 1%.	
12.	In Voucher No.30 dated 06/06/2013 payment of ₹ 69017.00 is made to Agray Infosolutions for AMC. TDS under Section 194C is deducted @2.06% instead of 1%	

(N B Tiwari)
Accounts Officer

(R S Singh)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)

Birbal Sahni Institute of Palaeobotany, Lucknow

Balance Sheet as at March 31, 2014

(Amount - Rs.)

CORPUS/CAPITAL FUND AND LIABILITIES	Schedule	Current Year	Previous Year
CORPUS/CAPITAL FUND	1	168,225,772.24	125,512,850.14
RESERVES ANS SURPLUS	2	33,210,903.00	38,210,903.00
EARMARKED/ENDOWMENT FUNDS	3	258,014,208.49	232,048,125.49
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	5,787,756.64	2,831,104.64
TOTAL		**465,238,640.37**	**398,602,983.27**
ASSETS			
FIXED ASSETS	8	101,084,811.67	92,538,258.50
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	9	258,014,208.49	232,048,125.49
INVESTMENTS-OTHERS	10	22,063,744.00	24,000,379.00
CURRENT ASSETS,LOANS,ADVANCES ETC.	11	84,075,876.21	50,016,220.28
MISCELLANDEOUS EXPENDITURE			
(to the extent not written off or adjusted)			
TOTAL		**465,238,640.37**	**398,602,983.27**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

For **Khanna Thaker & Company**
Chartered Accountants

CA. Abhinav Khanna
(Partner)

(N B Tiwari)
Accounts Officer

(R S Singh)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)

Birbal Sahni Institute of Palaeobotany, Lucknow

Income and Expenditure Account for the period / year ending March 31, 2014

Fig. in Rupees

INCOME	Schedule	Current Year	Previous Year
Income from Sales/Services	12	892,668.00	877,935.00
Grants/subsidies (OB, Deposit A/C and Transfer from Cap. Fund)	13	264,825,000.00	212,762,000.00
fees/Subscriptions	14	-	-
Income from Investments (Income on Invest. From earmarked/endow.Funds transferred to Funds)	15	3,063,365.00	984,865.00
Income from Royalty,Publication etc.	16	122,700.00	405,719.00
Interest Earned	17	3,518,963.02	2,241,123.00
Other Income/Adjustments	18	1,095,433.00	953,794.00
Increase/(decrease)in stock of Finished goods and works-in-progress	19	-	-
TOTAL(A)		**273,518,129.02**	**218,225,436.00**
EXPENDITURE			
Establishment Expenses	20	171,663,177.00	145,307,569.00
Other Administrative Expenses etc.	21	42,821,062.80	34,266,805.10
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end-corresponding to Schedule 8)		15,320,967.12	14,128,086.43
TOTAL (B)		**229,805,206.92**	**193,702,460.53**
Balance being excess of Income over Expenditure**(A-B)**		43,712,922.10	24,522,975.47
Transfer to Special Reserve (Sepecify each)		66,000,000.00	13,100,000.00
Transfer to/from General Reserve to Pension Fund		65,000,000.00	
BALANCE BEING SURPLUS/DEFICIT CARRIED TO CORPUS/CAPITAL FUND		**42,712,922.10**	**11,422,975.47**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

For **Khanna Thaker & Company**
Chartered Accountants

KHANNA THAKER & COMPANY LUCKNOW CHARTERED ACCOUNTANTS

CA. Abhinav Khanna
(Partner)

(N B Tiwari)
Accounts Officer

(R S Singh)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)
Birbal Sahni Institute of Palaeobotany, Lucknow
Receipts and Payments Account for the period / year ended March 31, 2014

Fig. in Rupees

RECEIPT			PAYMENTS		
	Current Year	Previous Year		Current Year	Previous Year
I. Opening Balances			1) Expenses		
a) Cash in hand		-	a) Establishment Expenses(Corresponding to Schedule 20)	171,663,177.00	145,307,569.00
b) Bank Balances	22,287,901.00	78,827.00	b) Administrative Expenses(Corresponding to Schedule 21)	42,821,062.80	34,266,805.10
i) In current accounts					
ii) In deposit accounts					
iii) Endowment deposits					
iv) Salary Account		2,297,212.00			
II. Grants Received					
a) From Government of India	181,225,000.00	212,762,000.00	II) Payments made against funds for various projects	7,197,862.00	
b) From State Government			(Name of the fund or project should be shown along with		
c) From other sources(details)	-		the particulars of payments made for each project)		
(Grant for capital & revenue exp.	83,600,000.00				
To be shown separately)					
d) Deposit Account					
III. Income on Investment from			III. Investments and deposits made		
a) Earmarked/Endow. Funds	-		a) Out of Earmarked/Endpwment funds		
b) Own Funds (Utilized)			b) Out of Own Funds (Investments-Others)		56,000,000.00
IV. Interest Received			IV. Expenditure on Fixed Assets & Capital Work-in-Progress		
a) On Bank deposits	2,432,424.02	1,596,921.00	a) Purchase of Fixed Assets	23,867,520.29	3,600,708.50
b) Loans, Advances etc.	1,086,539.00	1,629,067.00	b) Expenditure on Capital Work-in-Progress		
V. Other Income (specify)			V. Refund of surplus money/ Loans		
i) Sale proceeds of Publications	93,411.00	405,719.00			
ii) Miscellaneous Income	1,124,722.00	953,794.00	a) To the Government of India		
iii) Sale of Services (Consultancy)	892,668.00	877,935.00	b) To the State Government		
iv) Group Insurance		155,830.00	c) To other providers of funds		
VI. Amount Borrowed			VI. Finance Charges (Interest)		
VII. Any other receipts (give details)			VII. Other Payments (Specify)		
(Pension Contribution)			i) Advances to Staff	11,656,440.00	308,000.00
Transfer from Reserve Fund	65,000,000.00	55,000,000.00	ii) Earnest Money Refunded	227,200.00	10,000.00
Net Receipt from Project	9,340,509.00	2,271,748.00	iii) Advances to Parties	80,528,265.00	35,945,744.25
			iv) Pension Fund	6,000,000.00	386,406.00
i) Recovery of Advances	41,634,540.38	20,103,737.85	v) Transfer to reserve & surplus	60,000,000.00	
ii) Earnest Money Deposit	1,021,200.00	10,000.00	VIII. Closing Balances		
iii) FDR Matured			a) Cash in hand		
iv) Recovery from Parties			b) Bank Balances		
			i) In current accounts		
			ii) In deposit accounts		
			iii) Saving account	5,777,387.32	22,317,558.00
			iv) Endowment deposit account		
			v) Excess Expenditure	-	
TOTAL	409,738,914.40	298,142,790.85		409,738,914.41	298,142,790.85

For **Khanna Thaker & Company**
Chartered Accountants

CA. Abhinav Khanna
(Partner)

(N B Tiwari)
Accounts Officer

(R S Singh)
Registrar

(Sunil Bajpai)
Director


BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY
1946
OUR EXPERTISE
Evolution
Morphology & Taxonomy
Biostratigraphy
Palaeobiogeography
Palaeoclimate & Palaeoenvironment
Geochronology
Organic Petrology
Archaeobotany
Dendrochronology
Aerobiology
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Consultancy Services
Contract Research
Contract Training Services (in Palynology and Coal & Lignite Petrology
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ISSN 0972-2726

army printing press
www.armyprintingpress.com
Lucknow (0522) 656333