Annual Report
2014-2015

1946

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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Cover :
Khalsi palaeolake sequence, Ladakh Trans-Himalaya. 34º20.03'N, 76º52.54'E; Altitude 3287 m, 20 m lacustrine deposit at ~150m from the present day Indus river level (~14690 yr to 5000 yrs BP). Soft-sediment deformation structure recorded at 11020 yrs BP.

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

October, 2015

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.

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 TL/OSL system has recently been added for precise dating of archaeological artefacts and Quaternary sediments. 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.

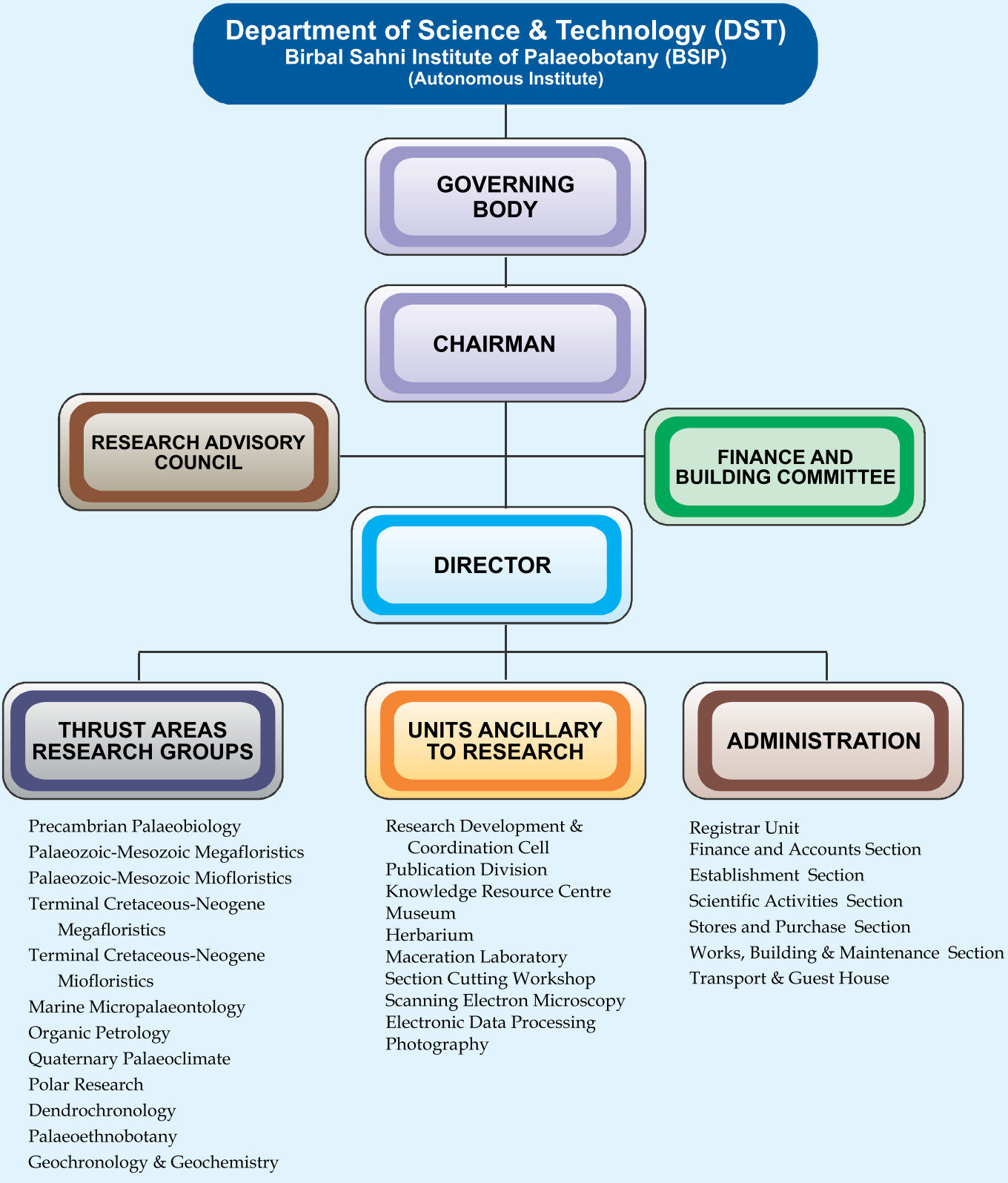
"*here we study not only fossil plants but also the rocks in which they are found*"

– Birbal Sahni (April 03, 1949)


BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY
1946
OUR EXPERTISE
Evolution
Morphology & Taxonomy
Biostratigraphy
Palaeobiogeography
Palaeoclimate & Palaeoenvironment
Geochronology
Organic Petrology
Archaeobotany
Dendrochronology
Aerobiology
Industrial Palynology
Consultancy Services
Contract Research
Contract Training Services (in Palynology and Coal & Lignite Petrology)
Identification of Fossils
Scanning Electron Microscopy
Petrological Analysis
Palynological Analysis of Pre-Quaternary & Quaternary Sediments
Radiocarbon Dating

Contents

Organization Structure



Central Public Information Officer
Dr. B.D. Singh, Scientist-F

Vigilance Officer
Dr. C.M. Nautiyal, Scientist-E
(till 03.11.2014)
Dr. Mukund Sharma, Scientist-F
(w.e.f. 01.12.2014)

Women's Forum
Dr. Alpana Singh, Scientist-F

Foreword

I am immensely pleased to present the 2014-15 Annual Report of the Birbal Sahni Institute of Palaeobotany (BSIP), a unique Institute solely dedicated to research in palaeosciences with a focus on the evolution of plants, ecosystems, climates and other related aspects. This document provides a glimpse of our achievements and growth trajectory, and the future directions.

The challenge ahead is to transform BSIP into a thriving, global centre of research in palaeosciences. I am confident that the recent and ongoing efforts will bring about the long-felt transformational changes in BSIP that are in tune with the times and that will offer exciting and diverse research opportunities in the vast field of palaeosciences. Owing to its strong interface with a number of disciplines, the spectrum of scientific issues and themes in palaeosciences is truly vast and to achieve this potential fully is not easy. With available resources and constraints, BSIP is striving hard to successfully deal with this challenge. A major current thrust is on addressing research problems in palaeosciences with multi- and interdisciplinary approaches and, to this end, sincere efforts are currently being made to develop a variety of new analytical facilities at BSIP. Efforts in this direction will continue, and I hope to develop in-house expertise even in areas as diverse as magnetic stratigraphy, molecular phylogenetics and modelling. With support from our technical and administrative staff, I am quite certain that BSIP, with its large, hard-working and enthusiastic workforce of scientists will go from strength to strength in the coming months and years.

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 other scientists as well as the technical and administrative sections of the Institute, in producing this document. I also extend my sincere thanks for the constant encouragement and support I received from the Department of Science and Technology (DST), Govt. of India and the Governing Body and Research Advisory Council of the Institute. I am especially grateful to Prof. Deepak Pental, Chairman, Governing Body for unstinted support and personal attention both in administrative and scientific matters of the Institute. On behalf of BSIP, I look forward to the continued support from all of the above in days to come.

(Sunil Bajpai)
Director

Research Highlights

Birbal Sahni Institute of Palaeobotany (BSIP), established in 1946, 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 research projects have been initiated under the umbrella of eight identified Thrust Areas, besides documentation and digitization of data. Some of the significant outcome of scientific research during the year 2014-2015 is summarized as under:

1. **Early life and environment: Evidence from Indian Precambrian basins**
   - Indication of the presence of cm-sized Ediacaran age seaweed in the Marwar Supergroup, based on the study of enigmatic tubular structures closely associated with the Microbially Induced sedimentary structures on the bedding planes of Sonia Sandstone (Rajasthan).
   - Record of large sized coccoidal microfossils from the Salkhan Limestone of Semri Group (Vindhyan Supergroup); suggesting the morphological shift in the biosphere in prokaryotic forms around Late Palaeoproterozoic to Early Mesoproterozoic.
2. **Phanerozoic terrestrial and coastal ecosystems: Biostratigraphical, palaeoenvironmental, palaeoecological and palaeobiogeographical aspects**
   - Reconstruction of Late Permian ecosystems from the Jhingurdah Colliery of Singrauli Coalfield (MP) indicates that semi-arid climatic conditions did not allow the Glossopterids to blossom as is evidenced by the fact that the entire flora is completely devoid of fructifications.
   - Investigation of megafloral assemblage from the Pali Formation (near Pali village, MP) indicates the presence of both pteridophytes and gymnosperms including the orders Filicales and Glossopteridales.
   - Record of pteridophytes (sphenopsid order Equisetales) and gymnosperms (Glossopteridales) megafloral assemblage from the Weller Formation of Allan Hills (Antarctica) shows close similarity with the Late Permian assemblages of India, South Africa and Australia.
   - Discovery of *Sahniophyllum* gen. nov. with ribbon shaped leaves arranged in rosette with parallel venation from the Gangapur Formation (Pranhita-Godavari Graben) substantiates evolution of angiosperms on Indian sub-continent.
   - Identification of two new permineralised gymnospermous woods– *Araucarioxylon wagadensis* and *Podocarpoxylon gangtabetensis* from the Gangta bet (Kachchh).
   - First unequivocal report of insect-plant interactions (as disc-like galls on corystosperm leaf– *Dicroidium hughesii*) from the Triassic succession (Parsora Formation) of peninsular India.
   - Documentation of the spores-pollen assemblages from the Palaeozoic sequences of Godavari Valley (AP), Ib-River (Odisha), Jharia (Jharkhand), Sohagpur and Johilla (MP), and Ramkola-Tatapani (Chhattisgarh) coalfields in order to work out their significance in biostratigraphical and palaeoenvironmental interpretations.
   - Record of the conspicuous spheroidal inclusions in saccate gymnosperm pollen grains from the Late Permian (±253-275 Ma) sediments of the Godavari Valley indicates that those pollen grains represent highly likely host substrates and habitats for microorganisms.
   - First report of palynoassemblage from the Fenestella Shale Formation (Carboniferous) of Gund village (Banihal, Kashmir); showing dominance of monosaccates grains, and comparable with the Early Permian palynoassemblages of peninsular India.
   - Record of microscopic charcoal from the sediments exposed along the Khari Nadi (near Bhuj, Gujarat) provides direct evidence of wildfire on the vegetation existed during the Early Cretaceous.
   - First report of fossil leaves, one identified as *Bauhinia* (family Fabaceae), in amber from NE India collected

from the Bhuban Formation (Early-Middle Miocene) of Surma Group exposed in Thingdawl Hmar Veng quarry, Mizoram.

- Description of a fossil fruit *Cocos* (*Cocos nucifera* L.) of the Arecaceae from the Early Eocene sediments of Tarkeshwar lignite mine, Cambay Basin (Gujarat). It supports the equatorial position of Indian subcontinent at the time of deposition, and coastal conditions in the region in contrast to arid to semi-arid climate prevailing there at present.
- Discovery of around 65 million years old palm leaves (*Sabalites dindoriensis*) from Dindori district (MP).
- Indication of the presence of the Thanetian-Ypresian boundary, due to the appearance of dinoflagellate cyst– *Apectodinium homomorphum*, whereas the appearance of *Homotryblium floripes* may point to the Ypresian-Lutetian boundary in the lower part of Panandhro lignite mine succession (Kachchh Basin).
- Abundant record of a colonial alga *Botryococcus braunii* from the lignite-bearing successions of Gurha (Rajasthan) and Surkha (Gujarat) mines helps in recognizing petroliferous organic deposits in western India.
- Documentation of Maastrichtian fresh water diatom genera from the Naskal Intertrappean bed reflects evolutionary shift of the habitat from saline to the freshwater environment.

3. Integrative marine micropalaeontology: Focus on high resolution biostratigraphy, sea level changes, palaeo-oceanographic and palaeoclimatic events

- Demarcation of a distinct vegetational turnover from palm dominated rain forest during the pre-CIE to highly diversified dicotyledonous megathermal rain forest during the 'body' of the CIE and post-CIE interval, based on continental palynomorphs from the Palaeocene-Eocene succession of Jathang, East Khasi Hills (Meghalaya).
- Assignments an Oxfordian-Upper Kimmeridgian age to the Katrol Formation exposed in Gangeshwar dome (Kachchh Basin), based on calcareous nannofossils.
- Identification of Rhodoliths formed by Sporolithoid, Mastophoroid and Melobesioid non-geniculate coralline red algae, in thin section of the samples from late Middle Miocene (Long Formation) of Hut Bay, Little Andaman Island.

4. Organic petrology: Characterization of solid fossil fuel for depositional and utilizational aspects

- Characterization of the Tertiary lignites from Khadsaliya (Saurashtra Basin) and Matasukh (Rajasthan Basin) mines, and Permian coal from Ashtona area (Yeotmal district, Wardha Basin).
- Indication of the potential of lignite-bearing sequences to produce oil/gaseous hydrocarbons, based on the types of organic matter and TOC contents.

5. Quaternary palaeoclimate reconstructions, vegetation dynamics and relative sea level changes

- Recognition of four distinct phases of vegetation succession, contemporary climate and human occupation in Karimganj district situated at Indo-Bangladesh border for the last 5,000 yrs BP (covering the Mid-Holocene), based on the palyno-chronological records.
- Documentation of the vegetation shifts and concurrent climatic events in the region of southern MP since the last 7,467 cal yr BP, based on the pollen, organic/inorganic carbon ratio and moisture content analyses of sediments profile from Simariya Tal (Chhindwara district).
- Evidence showing the mangrove/estuarine ecosystem since 6-3 ka in the north-eastern part of present day Krishna River Delta; indicating palaeo-shoreline about 8-10 km inland from the present shoreline.
- Recovery of *Melastoma* pollen along with cerealia and *Brassica* indicates the forest deterioration and human activity in the Garobada area of west Garo Hills (Meghalaya).
- Recognition of three phases of lake formation in the 136 km stretch between Nimo and Batalik along the Indus River in Ladakh, as Lamayuru, Rizong, and Khalsi-Saspol palaeolakes, having the highest lake levels. The lake formation is attributed to deglaciation after the LGM and Holocene warming.
- Comparison between monsoonal rainfall, MAT and palaeoatmospheric CO_2 with floral dynamics since last ~50 ka of the Darjeeling foothill region, eastern Himalayas indicates that the fluctuations in plant succession were mainly driven by monsoonal variations.

- Reconstruction of standardized precipitation index (SPI), a drought index using tree-ring width chronologies of Himalayan cedar (*Cedrus deodara*) prepared from two ecologically homogeneous settings in Kumaun region, extending 7-month SPI of May (SPI7-May) back to 1720 CE.
- Preparation of 180 years long tree-ring width chronology (spanning A.D. 1824-2003) of *Toona ciliata* Roem. (Toon) from the subtropical wet hill forests of Kalimpong, Eastern Himalaya.

6. Domestication of plants, early farming and ecosystem dynamics during Holocene/ Anthropocene

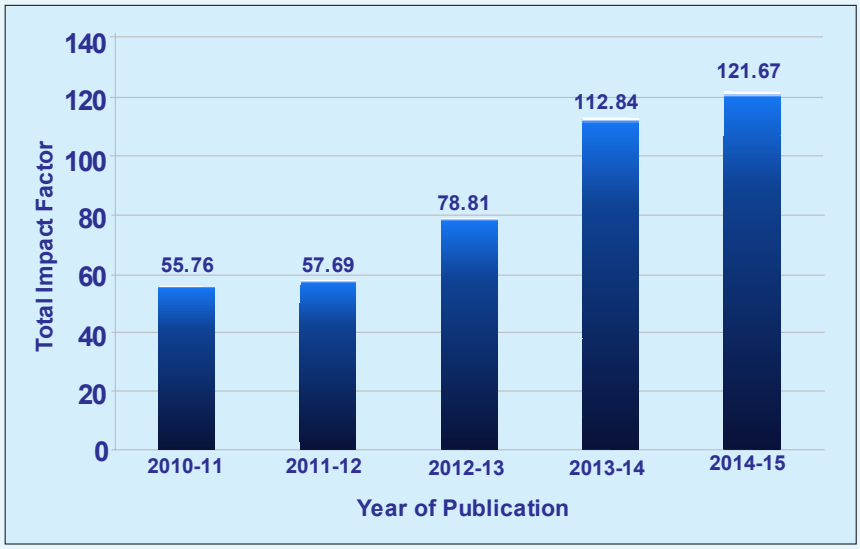
- Evidence for the exploitation of botanical resources by ancient settlers through remains from ancient site Maner (Patna district, Bihar) and from Rajdhani (Maharajganj district, UP) in Ganga Plain.

7. Geochronological and geochemical parameters for high resolution dating, correlation, palaeoclimatic, tectonic and provenance studies

- Dating of sediment samples from the archaeological sites and lake shores and also the standard and background samples.
- Installation of the Thermo Luminescence/Optically Stimulated Luminescence (TL/OSL) system, useful for dating of the Quaternary sediments and archaeological artefacts.

8. India-Asia collision and Himalayan uplifts: palaeobotanical and associated biotic signatures from sedimentary records of western Himalaya

- Recovery of foraminifers, palynomorphs and certain microfaunal elements from the rocks of Indus Tsangpo Suture Zone.



Cumulative Impact Factor of Published Research Papers

Integrated collaborative research activities in several spheres with institutions in India and abroad (Brazil, China, Germany, Nepal, Netherlands, UK, USA, etc.) have helped to expand scientific knowledge. The collective research efforts are expressed in the form of 104 published papers. Three Ph.D. degrees were awarded during the year. Three scientists were deputed abroad (China, Germany) under Inter-academy Exchange Programme of INSA, and two scientists under Indo-Brazilian DST sponsored project. One scientist was awarded Post-Doctoral Fellowship to work at the Geosciences Institute, University of Sao Paulo (Brazil). Eleven scientists were deputed for attending various conferences abroad (in Canada, China, France, Japan, Nepal, New Zealand, Russia, Spain, USA and Vietnam). Thirty-five scientists, 3 Birbal Sahni Research Scholars, and 5 Project Fellows were deputed to attend various national and international conferences/ workshops held in the country. About 135 research papers were presented in these scientific meetings at different centers of India and abroad.

An international conference on *Current Perspectives and Emerging Issues in Gondwana Evolution* was successfully organized during February 2015. The conference was attended by scientists from seven countries. A national conference on *Quaternary Climate Change: New Approaches and Emerging Challenges*" was also successfully hosted during December 2014 in which researchers from seventeen institutions of the country were participated. It also included two foreign delegates from Nepal and Bangladesh. Besides, a workshop on *Phylogenetic Biology* was also organized in the Institute, conducted by Prof. R. Geeta of Department of Botany, University of Delhi during March 2015. Under a MoU between Indira Gandhi National Centre for Arts (New Delhi) and BSIP, a one day multidisciplinary *Orientation Workshop on Rock Art* was conducted in December 2014.

Foundation Day

The Institute observed its 68th Foundation Day on September 10, 2014. On this occasion Chief Guest Shri Harbans Singh, Director General, Geological Survey of India (GSI), Kolkata praised the unique contribution of Prof. Birbal Sahni in the form of this Institute and said that in this age of inter-disciplinary sciences, palaeobotanical data are becoming extremely useful in interpreting the past climate changes. He added that we can learn a lot from the acquired knowledge about the past vegetation which can also guide us in choosing the suitable agricultural practices for the given circumstances. He said that all scientific disciplines are interlinked today and this relationship is essential to achieve the common goal of all the sciences which is welfare of the society, country and the world. Shri Singh invited BSIP to come up with more proposals of collaboration with GSI.

Shri S.K. Sharma, Dy. Director General and Head of the Northern Region GSI, Lucknow briefed about the International Geological Congress (IGC). GSI is a big stakeholder in this event to be held in Noida in 2020 which will be 56 years after the last time it was held in India in 1964. He informed that the IGC is held every 4th year and it was in 2012 meeting at Brisbane, Australia that India's bid was accepted. The event is being coordinated by the Ministries of Mines and of Earth Sciences. Many guests and scientists from outside the Institute attended the function.

Founder's Day

The Institute celebrated its Founder Professor Birbal Sahni's 123rd birth anniversary on November 14, 2014. 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. Same day following Memorial Lectures were organized:

Prof. Nicole J. Butterfield of the Department of Earth Sciences, University of Cambridge, UK delivered the "44th Birbal Sahni Memorial Lecture" entitled *Inventing the Eukaryotic Biosphere– Convergence of Evolutionary Contingencies.*

Prof. Joseph G. Meert of the Department of Geological Sciences, University of Florida, USA delivered the "60th Sir Albert Charles Seward Memorial Lecture" entitled *Rapid changes in Magnetic Field Polarity during the Late Ediacaran– Trigger for the Substrate Revolution and the Demise of the Ediacaran Fauna.*

His Excellency Governor of Uttar Pradesh Shri Ram Naik presided over the function, who admired the multi-disciplinary growth of the Institute. Dr. H.S. Das, Principal Secretary, Department of Science & Technology, Govt. of Uttar Pradesh and Director General, UP Council of Science & Technology was the Guest of Honour on the occasion. 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.

Conference on Quaternary Climate Change

A National Conference on *Quaternary Climate Change: New Approaches and Emerging Challenges*" was organized at BSIP during December 15-16, 2014. Prof. S.K. Tandon, MoES Chair Professor, Department of Earth Science, IIT Kanpur was the Chief Guest of the conference and Dr. Rupak De, Principal Chief Conservator of Forest (Wild Life) was the Guest of Honour. In all, 120 delegates participated from 17 universities/colleges from all over the country. It also included two foreign delegates from Nepal and Bangladesh.

Prof. Tandon, in his Plenary lecture on the topic *Twentieth Century Climate Change–Present, Past and Future* gave comprehensive account on the climate change and global warming in context to significant increase in green house gases in the atmosphere due to escalating human activities, including the widespread use of fossil fuel during the last century. He stressed on the need to reconstruct the long- and short-term climatic sequences of the past on millennial, centennial and decadal time scales using multidisciplinary approach.

The conference was held under six themes– 1) Vegetation succession and long-term climatic variability, 2) High-resolution palaeoclimatic change, 3) Geology and geomorphology, 4) Sea-level change and coastal environment, 5) Extreme climatic events of the past, and 6) Human habitation and cultural history. A total number of 45 papers were presented orally, and the remaining (64) papers were presented as posters on two days of the conference.

Two keynote lectures were delivered by A.K. Singhvi, FNA, Physical Research Laboratory, Ahmedabad and I.B. Singh, FNA, Lucknow- two eminent scientists of the country. Prof. Singhvi emphasized on the proxy studies and the unrealistic one to one correlation of the marine and the continental records. He alerted the delegates on the mis-interpretation of the results by such one to one correlation as different depositional environments react differently to the climatic phenomena

at different spatial and temporal scales. Prof. Singh delivered his keynote on the topic "*Geoarchaeology of the middle Ganga Plain*". According to him, this vast alluvial tract was formed during the Late Pleistocene-Holocene by fluvial processes as a result of climatic variability, base-level change and tectonics.

In the recommendations, it was emphasized to undertake joint research work by the Geologists, Quaternary Palynologists, Archaeobotanists and Archeologists in collaboration with Archaeological Survey of India, State Archeology Departments, and Universities already perusing such studies. This joint venture will provide valuable information in unfolding the cultural history, initiation of agriculture practice and state of course as well as the change vegetation scenarios and landform eolution and climatic variability of the past.

A one day post-Conference field excursion highlighting the geomorphology and archeology of Lucknow region was also conducted under the expertise of Prof. I.B. Singh, and officers of UP State Archeological Dept. All along the day, Prof. Singh explained the geomorphological processes responsible for the landscape evolution of the Lucknow region showing field evidences of T_1 and T_2 river terrace surfaces, signatures of palaeochannel, sedimentological characteristics of exposed cliff sections and happily satisfied queries of the participants. The last point of the excursion was Hulaskhera Archeological site wherein cultural history of past 3,000 years showing evidences of 5 different settlements including Sunga-Kushana, Gupta and post Gupta and Early-Late Medieval is preserved.

The conference was a grand success, an elite gathering of the stalwarts in Quaternary sciences all over India and the budding Quaternary scientists in making. With the recommendations of the delegates were well taken in and with the help of our sponsors, university and institutions collaborative efforts these recommendations will be made true in the coming years.

Conference on Gondwana Evolution

An International Conference on *Current Perspectives and Emerging Issues in Gondwana Evolution* was successfully hosted by BSIP during February19-20, 2015 followed by post-Conference field trip from February 21-25, 2015. The Conference was attended by around 90 scientists from different countries, namely Brazil, USA, South Africa, UK, Germany and Nepal, and different parts of India including Aligarh, Amrawati, Bengaluru, Bhandara, Chandigarh, Chennai, Dehradun, Dhanbad, Ghazipur, Gwalior, Hyderabad, Itanagar, Kharagpur, Kolkata, Nagpur, Navi Mumbai, New Delhi, Sangli, and Lucknow including Institute scientists to contribute their research findings. About 90 abstracts were published. Chief Guest Dr. S.K. Acharyya, Ex-Director General, GSI delivered Inaugural lecture on *Gondwana basin development and stratigraphy in Indian subcontinent.* There were 6 keynote lectures, 46 oral presentations distributed in four sessions and a poster session including 43 poster presentations.

The first session on 'Gondwana assembly and fragmentation' included keynote lectures by Sankar Chatterjee (USA), O.P. Pandey, and Ulf Linnemann (Germany). Forest fires have lately proved to be of immense significance in palaeoclimatic interpretation and evolution of new floras. Andre Jasper's (Brazil) keynote address in Session-2 on 'Gondwana climate, sedimentation patterns and palaeoenvironments' provided an insight to the palaeobotanical approach on the Late Palaeozoic Gondwanan palaeo-wildfires. In the session, Prosenjit Ghosh and his colleagues emphasized significance of isotopic studies in palaeoclimatic reconstructions, whereas R. Subin Prakash provided clue to the clay mineralogy and geochemistry of fine-grained clastic sediments of the Terani Formation, Cauvery Basin with implications on palaeoclimate and provenance. Abdulla Khan's presentation included sedimentological information of Denwa and Bagra formations of Satpura Gondwana Basin.

On Day 2, an interesting paper was presented by Etiene Fabbrin Pires (Brazil) on Geotouristic sites of Parnaíba Basin, Tocantins indicating protection of fossil sites followed by presentations by V.A. Mendhe and his team on different aspects of energy resources in Session-3. Session-4 on 'Biodiversity during Gondwana Period' was divided into three parts since there were 20 presentations in this session including both on Palaeobotany and Vertebrate Palaeontology. This session included a keynote address by Chris Cleal (UK) on plant biodiversity in deep time– a Gondwana perspective. Presentations by Rosemary Prevec provided an insight to the morphological diversity of South African glossopterid fructifications, and implications for their homologies and evolution. David Dilcher (USA) gave an account of a new monocot from Early Cretaceous of Brazil. An elaborate account of Indian *Glossopteris* flora was provided by A.K. Srivastava. The session also included presentations on Charophytes from Lameta Formation of Jabalpur, foraminifers from Jurassic sequence of Kutch, Late Jurassic-Early Cretaceous wood from Nepal, and Late Cretaceous mammalian fauna from central India by Ashu Khosla, S.M. Wasim, Khum Paudayal and Omkar Verma, respectively. Ashok Sahni's keynote lecture on a unified perspective of terrestrial Jurassic and Cretaceous vertebrates from the Indian subcontinent was followed by presentations of Sanghmitra Ray and her team, Debarati Mukherjee, Saradee Sengupta, Debaji Dutta and Mohd. Shafi Bhat on Triassic vertebrates.

A post-Conference field trip was organized to the South Rewa Gondwana Basin to visit the classical sections of Late Permian Pali Formation, Anisian-Ladinian Karki Formation, Late Triassic Tiki and Parsora formations, Early Cretaceous Jabalpur Formation and Late Cretaceous Lameta Formation. The field excursion stops were Patbaba Ridge, Bara Simla, Chui Hills and Lameta Ghat, Jabalpur area; Karki, Tiki and Beohari villages, Shahdol area; and Birsinghpur Pali village and Dhaurai Hill, Birsinghpur Pali area.

Outreach Activities

A multidisciplinary *Orientation Workshop on Rock Art* was conducted at the Institute on December 13, 2014. The workshop was a joint venture, under a MoU between Indira Gandhi National Centre for the Arts (IGNCA), New Delhi and BSIP, Lucknow. Welcoming the guests, Prof. Sunil Bajpai, Director said that rock art presents a lively example of a multidisciplinary field where BSIP can provide valuable inputs. He added that exploration and documentation is the initial step which will lead to further investigations. The workshop was inaugurated by Dr. H.S. Das, Principal Secretary, Science and Technology, Uttar Pradesh who highlighted the significance of rock art as archive of the evolution of human race. He said that the rock art is valuable heritage and it is everyone's duty to work towards conserving rock art in our state and bring it to the knowledge of the authorities where action was needed.

The keynote address was delivered by Prof. Adiga Sundara of Mysore, who exposed the audience to the tremendous potential that rock art holds in the study of human evolution. He stated that India has the richest collection of rock art in the world, and good work can be done if people from various disciplines get together. Dr. B.L. Malla, Project Director, Rock Art at IGNCA, gave an enlightening introduction to the subject of rock art and stated that Bhimbedka in MP is a UNESCO Heritage site, but UP may be the richest of all Indian states. He informed that 12 states are already active and UP has also now joined the stream. Dr. C.M. Nautiyal, coordinator of the workshop, outlined the plan for the workshop for UP. He said that Sonbhadra, Mirzapur, Shankargadh, Banda, Chandauli are just a few of many places in UP with sites full of rock and shelter art created by the primitive men which need documentation and scientific study.

During the technical session, Dr. Malla outlined the project. Prof. K.K. Agarwal opined that help from GSI can be valuable as they are usually the first to reach the places considered inaccessible. Prof. D.P. Tewari from Lucknow University shared his experience in rock art in the Vindhyans. In his lecture, Dr. Nautiyal introduced the radiocarbon and uranium series dating and said that with advent of AMS dating and other sophisticated equipments, it is possible to make measurements even with minute quantities of samples obtained by scraping the paint or the deposited calcite on rocks or that in the engraving. Among others who attended the workshop included Dr. Jitendra K. Singh, a rock art enthusuast from Sonbhadra, research scholars and scientists from BSIP and over three dozen PG and doctoral students from local institutions– LU and Mahila PG College at Geology, History, Anthropology departments.

The Science Day was celebrated on February 27th as Open House and with a popular lecture by Dr. Rajeev Mohan, Director (Offtg.), UP Remote Sensing Agency. Dr. Mohan spoke on *Remote Sensing: For the Society*. In his very well-illustrated lecture, the speaker explained the basic principles of remote sensing, and citing from the field of survey, agriculture, disaster management and wild life protection and forestry to monitor implementation of schemes, he highlighted the role of remote sensing from the societal angle. The students of Lucknow and near-by areas were also invited for the Science Day declaring it as Open House. Students and people from all walks of life visited the museum and laboratories on this day. Institute's museum continued to remain an attraction and a large number of students visited museum as well as the radiocarbon laboratory and scanning electron microscope section all through the year. Institute scientists interacted with students at various forums and delivered lectures in institutions in several cities. The scientists also participated in many events organized under state and central government programmes in UP and elsewhere spreading knowledge about science, in general, and Earth Science including Palaeobotany in particular.

Research

Thrust Areas and Projects

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

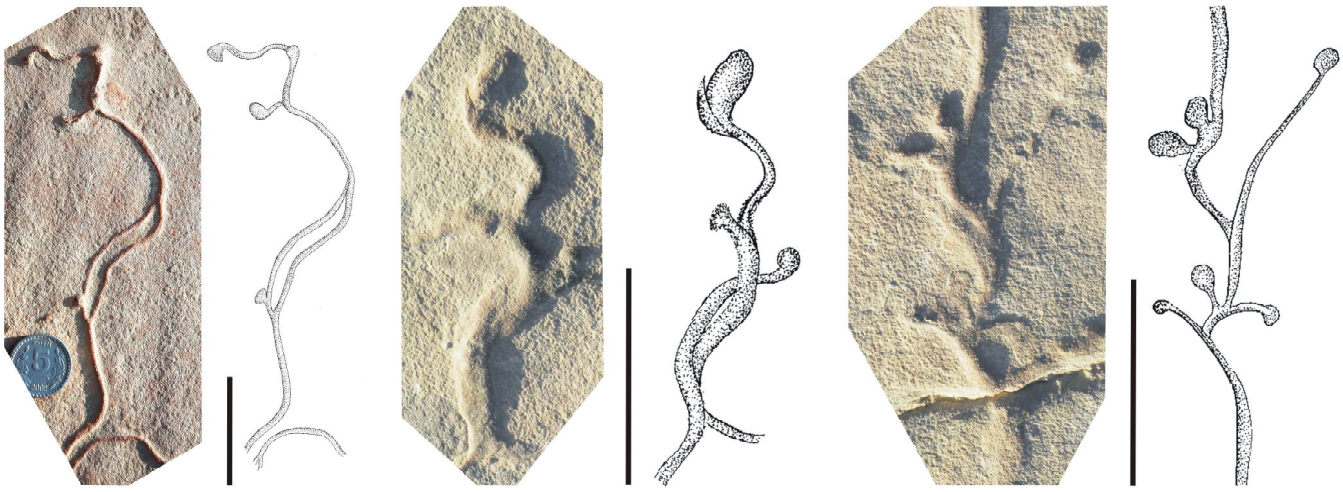
Precambrian Palaeobiology Group

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

Enigmatic tubular structures found on the bedding planes of the Sonia Sandstone of the Marwar Supergroup exposed in the Sursagar area, Jodhpur (Rajasthan) have been investigated. These structures are closely associated with the Microbially Induced Sedimentary Structures. Detailed morphological features, biogenecity, affinity, statistical analysis, population index, depositional environment, palaeoecology, and taphonomic interplay have been documented. Block models are constructed demonstrating the environment of deposition of the tubular enigmatic structure. On the basis of study of these components, a plausible interpretation on the origin and affinity of tubular bedding plane structure is suggested to be of benthic seaweed. These structures indicate the presence of centimeter sized Ediacaran age seaweed in the Marwar Supergroup. Various other studies have suggested the presence of the Precambrian-Cambrian transition/ boundary in the Bilara Group. Since the Cambrian trace fossils are well-documented from the Nagaur Group and Ediacaran age fossils are recorded from the Jodhpur Group, the carbonate succession lying in between the two groups is the most likely succession to possess Pc-C boundary.

Closely spaced carbonate samples have been collected on the measured sections to decipher geochemical and stable carbon isotope compositions of the three carbonate units of the Bilara Group to record the Pc-C boundary. Total 500 carbonate samples are collected from ten localities spread over Pali, Jodhpur and Nagaur districts of the Rajasthan, and are being processed for geochemical analysis. The *Treptichnus pedum*, an index fossil for the beginning of the Cambrian, is being investigated for its palaeoecology, taphonomy and behavioural trends. A detailed paper has been prepared on these aspects of *T. pedum* reported from the Nagaur



Engimatic tubular structures preserved on the bedding plane of Sonia Sandstone, Marwar Supergroup (scale bar = 5.0 cm)

Sandstone of Marwar Supergroup. Its FAD is yet to be documented. It is considered as feeding burrows and formed by the boring activity of the *Priapulid* and has a special type of burrow geometry, which infers that the animal lived close to the sediment-water interface.

Well-preserved large sized coccoidal microfossils are recorded from the Salkhan Limestone (>1600 Ma) of the Semri Group of Vindhyan Supergroup. These coccoidal fossils have been recovered from the sporadically found black chert in the Salkhan Limestone. Morphology and size criterion have been discussed to consider the nature of these large sized vesicles and their affinity. Large sized coccoidal forms suggest the morphological shift in the biosphere in the prokaryotic forms around Late Palaeoproterozoic to Early Mesoproterozoic.

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

Investigator: Rupendra Babu

The heterogeneous lithofacies– cherts, shales and siltstones of Semaria Formation (Bhander Group), exposed in and around Kondar and Pahri Meran areas in Karauli district, have been studied both in thin sections and macerated residues. Recovered two/-three dimensional and diverse microbiological fossil assemblage is characterized by celluloid, permineralised and mineralic preservations, and comprised of acritarchs (ornamented sphaeromorphs, acanthomorphs), algal forms (solitary & colonies groups of sphaeroidal cells, trichomes both septate & non-septate) with/ without mucilaginous sheath, multicellular thalloid with sporangia like structures belong to Cynophyta, Chlorophyta and Rhodophyta, and VSM. The yielded biotas from chert are– acritarchs (11 genera), algal remains (*Palaeastrum, Eomicrocystis, Gloeodiniopsis, Oscillatoriopsis, Palaeolyngbya, Siphonophycus*), and single taxa of VSM (*Melanocyrillium*). The soft brown shale intercalated between Semaria and Lower Bhander formations has yielded only ornamented sphaeromorphs acritarchs (*Osculosphaera hyaline, Lophosphaeridium, Granomarginata, Stictosphaeridium, Satka, Trachysphaeridium*), and algal remains including multicellular alga– *Thallophyca.*

The preservation, qualitative (complete/ fragments), frequency, shape and size of the newly recorded biotic assemblage (acritarchs & algae) from the cherts and shales of the Semaria Formation indicate early upper Cryogenian (750-650 Ma) age, and variant depositional environments, viz. shallow and moderate deep water condition. The similar data is also known from the equivalent sediments of Australia, China, Nimbia Spitsbergen and Russian platforms. In addition, Proterozoic rock samples of Semri, Kaimur Rewa and Bhander groups have been collected from the outcrops and quarries in Karauli district (Rajasthan). Eight traverses (Motiapura-Pahri Meran, Jirota-Mijora, Sapotra-Bapoti, Kurgaon-Gangapur city, Jakhorda-Nayagaon, Kailagaon-Amarbad Jatav Basti, Kallavari Ballahet-Naroli & Bajna-Birwas) have been made to collect the palynological and megafossil-bearing rocks. The lithocolumns of the collected samples are also prepared.

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

Investigators: Mukund Sharma & V.K. Singh

Micropalaeontological studies have been carried out from the different stratigraphic units, viz. Chandarpur Group and Pairi Group (= Singhora Group) exposed in Bargarh and Nuapada districts, Odisha. Systematically collected 19 black shale samples from the mud dominated sequence Chaporadih Formation (exposed near Mundkati village) are processed for acritarchs and other organic-walled microfossils (OWMs) investigations. The assemblage is dominated by large size sphaeromorphs and few acanthomorphs belonging to Sphaeromorphitae, Acanthomorphitae, Pteromorphitae, Prismatomorphitae subgroups of acritarchs. Exceptionally well-preserved *Kildinosphaera-Leiosphaeridia- Trachysphaeridium-Pterospermopsimorpha-Octaedryxium* type OWMs of eukaryotic affinity are dominant in the assemblage with subordinate number of unicellular cyanoprokaryotes. OWMs are represented by *Jacutianema-Cheilofilum-Milanocyrillium* type association. *Jacutianema* is assigned to a vaucheriacean xanthophyte algae whereas, *Cheilofilum* is considered as annellophore of the anamorphic phase of loculoascomycete fungi. Complex morphology, viz. cell division, wall structures and size parameter show eukaryotic affinities for the Chaporadih microfossils. The biostratigraphic correlation of recovered

Flanged filamentous microfossils (*Cheilofilum hysteriopsis)* in Chaporadih Formation (scale bar = 50 µm)

OWMs with other known global occurrences indicates the Neoproterozoic age of the sediments. At present, the Chhattisgarh Supergroup is considered as the Mesoproterozoic succession, but our study indicates the Neoproterozoic age for the upper part of the Supergroup. Layer by layer controlled maceration technique (duration-24 hrs) was attempted to recover OWMs from the upper part of the Chaporadih Formation exposed at Amabhona Ghat. Recovered microfossils reveal variation in the composition of the assemblage at different levels.

A field work in parts of the Chhattisgarh and Odisha states has been undertaken (by VKS) for the collection of samples from the Chhattisgarh Supergroup for the palaeobiological studies. Complete measurements and comprehensive lithologs of newly marked sections have been prepared for the correlations of the stratigraphic setup. Dolerite dykes piercing in the Chandarpur and Raipur Groups and volcanic tuffs from the Singhora and Raipur Groups have been collected to resolve the geochronological problem of the Chhattisgarh Supergroup. Carbonaceous remains, possibly remnants of higher algae, have also been collected from the Saraipali and Chhuiapali Formations of Singhora Group and are presently under investigation.

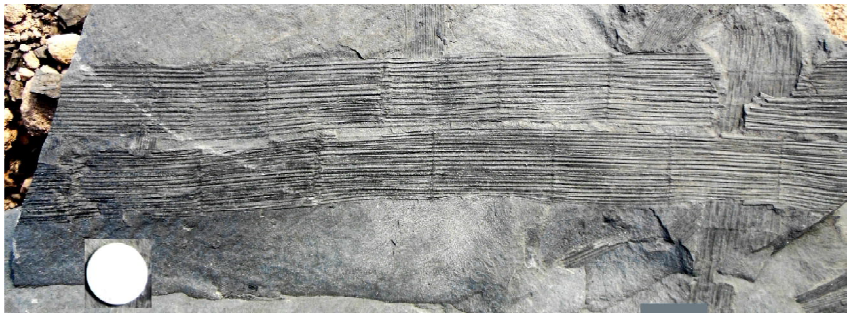
Thrust Area 2: PHANEROZOIC TERRESTRIAL AND COASTAL ECOSYSTEMS: BIOSTRATIGRAPHICAL, PALAEOENVIRONMENTAL, PALAEOECOLOGICAL AND PALAEOBIOGEOGRAPHICAL ASPECTS

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

Around 160 megafossil specimens collected from Nigahi, B-Block, Dudhichua, Krishnashila and Khadia collieries of the Singrauli Coalfield have been processed, photographed (some) and analyzed. The genera *Gangamopteris, Noeggerathiopsis*, *Paracalamites* and *Glossopteris* are the only elements of the *Glossopteris* flora preserved in these areas. The assemblage is completely devoid of the macrofloral elements of the groups lycopodiales, sphenophyllales, ginkgoales, cycadaleas, coniferales and filicales. Additionally, a manuscript entitled 'End Permian (Lopingian) floral diversity in Singrauli Coalfield: Evidences from Jhingurdah Colliery, Son-Mahanadi Basin, India' has been finalized. Complete assemblage of Jhingurdah Colliery consists of 5 genera with 26 species representing four orders, viz. Equisetales (*Paracalamites*), Cordaitales (*Euryphyllum*), Cycadales (*Macrotaeniopteris*), and Glossopteridales (*Glossopteris* & *Vertebraria*). The study pertaining to autochthonous and allochthonous depositions in Jhingurdah Colliery, nature and preservation of *Vertebraria* roots and



Paracalamites australis

their palaeoecological significance has also been finalized. Based on the nature and characteristics of the taphofloral assemblages of the colliery, semi-arid conditions prevailing in the area during Lopingian have been envisaged; that probably retarded the normal growth of these plants. Such non-congenial climatic conditions also did not allow the Glossopterids to blossom as is evidenced by the fact that the entire flora is completely devoid of fructifications.

A manuscript entitled 'Spore tetrads- ?Indicators of intense climatic regimes – A case study from Early Permian of Singrauli Coalfield, Son-Mahanadi Basin, India' has been finalized and revised (with Srikanta Murthy). Two types of tetrads (ornamented & zonate) assignable to the genera *Indotriradites*, *Microbaculispora* and *Microfoveolatispora* are reported from the Barakar Formation of Bina colliery. This is the first record of the spore tetrads from any Artinskian strata in the world. This study puts forward reasons affecting the sporogenesis process in the past, in the light of other available global records pertaining to fossil spore tetrads as well as significant physiological and biochemical analyses carried on the anthers of modern plants related to reproductive biology to understand the conditions and changes responsible for the formation of tetrads. A correlation between extreme climatic conditions, specific pH values inside the microsporangium and the formation of tetrad is envisaged. It is deduced that extreme climatic conditions (extreme cold/extreme hot) might have triggered some sort of malfunctioning in the sporogenesis process apprehending the dissociation of tetrads into monads.

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

Megafloral assemblage from the carbonaceous shales of the Pali Formation exposed along Pali-Manthar Road cutting section (near Pali village) has been investigated. The morphological analysis of plant fossils indicates presence of both pteridophytes and gymnosperms including the orders Filicales and Glossopteridales. The order Filicales comprises *Dizeugotheca* sp., and Glossopteridales is represented by different *Glossopteris* species namely, *G. arberii*, *G. communis, G. damudica*, *G. emarginata*, *G. indica*, *G. intermittens*, *G. nautiyalii*, *G. recurva*, *G. rewaensis*, *G. tenuifolia*, besides *Vertebraria indica*. Chemical processing of the samples from the sequence yielded a rich assemblage of palynomorphs that include *Crescentipollenites globosus*, *C. fuscus*, *C. latisulcatus*, *Striatopodocarpites brevis*, *S. circularis* and *Aruatipollenites* sp. The palynological analysis indicates dominance of disaccate pollen-grains. Detailed studies are in progress. The mega- and microfloral studies from the Pali Formation will help to discuss the stratigraphic position of this sequence which is still controversial. Maceration of the samples from Barakar Formation of Seam VI, Dhanpuri Open Cast Mine, Sohagpur Coalfield has yielded a rich assemblage of megaspores.

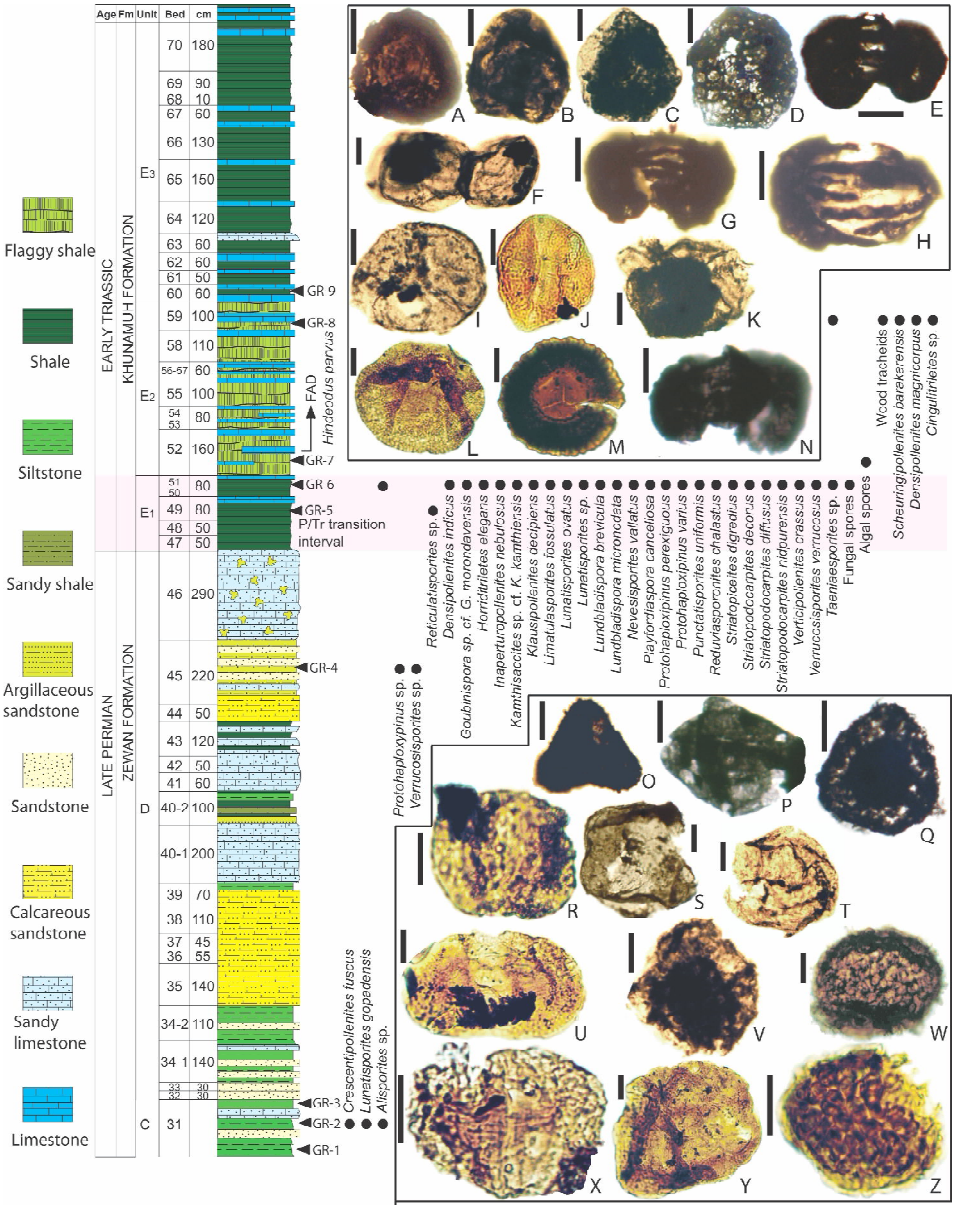
A field work has also been undertaken (with AK Ghosh & Arun Joshi) in different areas of Shahdol and Umaria districts (MP), and collected plant megafossils and sediment samples (for the recovery of megaspores, seeds etc.) from different localities of the Pali and Tiki formations. Plant megafossils are collected from argillaceous/ carbonaceous shale (Pali Formation, exposed along Manthar road, one km away from Pali village in Johilla Coalfield) and the assemblage is represented by equisetalean axes, ferns, different species of *Glossopteris* and seeds. Additionally, fragmentary plant fossils are collected from another section of the Pali Formation exposed in Lunah Nala near Naugahi village. Besides, the road sections of Tiki Formation, exposed near the Karki village and Bhugai Nala, one km southwest of Tiki village are also visited. Palynological samples from these localities are collected as well. Carbonaceous shale samples are also collected from the outcrop of Barakar coal seam exposed in the Ganjra Nala.

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

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

A manuscript entitled 'The Permian-Triassic palynological transition in the Guryul Ravine Section, Kashmir, India: Implications for Tethyan-Gondwanan correlations' has been revised (with Ram Awatar, SK Pandita, Stephen McLoughlin, GD Bhat & Vartika Singh). This first palynological study carried out on the Permian-Triassic succession in the Guryul Ravine reveals impoverished latest Permian spore-pollen assemblages in the uppermost Zewan Formation; a rich palynoassemblage from the basal Khunamuh Formation, characteristic of the PT transition zone; and depleted Triassic assemblages from higher in the Khunamuh Formation. The collective assemblages can be broadly correlated to the *Densipollenites magnicorpus* and *Klausipollenites decipiens* palynozones of peninsular India and to palynofloras spanning the PT boundary elsewhere in Gondwana. Generally, low spore-pollen yields and poor preservational quality of the studied assemblages hinder more precise correlations, and are inferred to be a function of an offshore marine depositional setting on the margin of the Neotethys Ocean, and thermal alteration associated with Cenozoic collisional tectonism between India and Asia.

A manuscript on thecamoebians recovered from the PT boundary sequence of the Guryul Ravine Section has been finalized (with Vartika Singh, SK Pandita, PJ van Hengstum & GD Bhat). Previous biostratigraphic analysis provides chronological control for the section, and a perspective of faunal turnover in the brachiopods, ammonoids, bivalves, conodonts, gastropods and foraminifera. This is the first record of thecamoebians from the area. The thecamoebians demonstrate exceptional similarity to the modern thecamoebian families– Centropyxidae, Arcellidae, Hyalospheniidae and Trigonopyxidae, however the vast majority belong to the Centropyxidae. The study further confirms the morphologic stability of the thecamoebian lineages through the Phanerozoic, and most



Different Late Permian and Early Triassic horizons of Guryul Ravine Section with palynological sampling intervals and distribution of identified palynomorphs

importantly, their apparent little response to one of the greatest mass extinction (Permian-Triassic) events in the earth's history.

Palynological studies from the Fenestella Shale Formation (Carboniferous) of Gund village, Banihal have been carried out (with Ram-Awatar) for the first time. Well-preserved palynoassemblage shows dominance of monosaccates grains. Assemblage is comparable with the Early Permian palynoassemblages of peninsular India. Besides, grouping, sorting, cleaning, identification and photo-documentation of plant fossils from the Nishatbagh Formation, Srinagar area has been done. Equisetalean axes, *Gangamopteris, Glossopteris, Psygmophyllum*, *Cordaites* and seeds have been tentatively identified. Chemical processing of the samples has yielded well-preserved palynomorphs showing dominance of monosaccate forms. This is the first record of palynomorphs from Nishatbagh Formation of Kashmir. Thin sections of the samples from Zewan and Khunamuh formations of Guryul Ravine PT boundary section have also been prepared for petrographic studies. In addition, geochemical analysis (including major, trace, rare earth elements & XRD) has been carried out on Carboniferous sediments of Fenestella Shale Formation, and sediment samples of Early Permian Nishatbagh Formation, and from PT of Guryul Ravine Section.

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

Investigators: Rajni Tewari & Arun Joshi

A manuscript on plant fossils from the Weller Formation, Allan Hills, South Victoria Land, Antarctica has been revised (with Sankar Chatterjee & Deepa Agnihotri). The Permo-Triassic Victoria Group in SVL is a heterogeneous sequence of glacial tillite beds, carbonaceous and non-carbonaceous fluvial deposits and volcaniclastic strata. The carbonaceous beds are rich in plant fossils associated with coal seams. In Antarctica, the geological record of the Late Palaeozoic Ice Age is restricted to the Early Permian. After deglaciation, the *Glossopteris* flora thrived in polar forests in Antarctica throughout the Permian, but disappeared at the end-Permian extinction. First comprehensive record of the *Glossopteris* flora from the Permian Weller Formation of Allan Hills has been described. The flora is well-preserved and comprises pteridophytes (sphenopsid order Equisetales) and gymnosperms (Glossopteridales). Equisetales are represented by branched and unbranched axes, whereas Glossopteridales are highly diverse encompassing *Gangamopteris*, *Glossopteris*, *Surangephyllum*, sterile scale leaves (*Scirroma* sp.), *Nautiyalolepis* sp., *Utkaliolepis indica,* scale leaf A, and scale leaf of male fructification (*Eretmonia*). The recorded flora shows close similarity with the Late Permian assemblages of India, South Africa and Australia. *Gangamopteris*, an index fossil of the Early Permian formations of different Gondwana continents, had extended stratigraphic range in the Late Permian Weller Formation of Allan Hills.

Megaspores have been recovered from the Barakar Formation of Index Seam of the Goutham Khani mine, Kothagudem area, Godavari Graben. This is the first record of the megaspores from the mine. The assemblage comprises the taxa– *Singhisporites surangei*, *S. radialis*, *Biharisporites spinosus*, *Ramispinatispora nautiyalii*, *R. indica*, a new species of *Ramispinatispora*, *Jhariatriletes filiformis*, *Jhariatriletes* sp., and *Biharisporites* sp. Systematic study of megaspores is in progress. Preliminary investigations carried out on plant fossils collected from the Barakar Formation of Prakasham Khani mines II and IV of Kothagudem region reveal presence of equisetalean axes and *Glossopteris* species (*G. longicaulis*, *G. taenoides*, *G. damudica*, etc.) in mine II, and *Gangamopteris cyclopteroides,* several leaves of *Noeggerathiopsis hislopii*, equisetalean axes and *Glossopteris* species (*G. gigas, G. indica, G. longicaulis, G. angustifolia*, etc.) in mine IV. In addition, a field work has been undertaken in different areas of Kothagudem region [open cast mines: Goutham Khani (Kothagudem area), Jalagam Vengala Rao (Sattupalli area) and Prakasham Khani II & IV (Manuguru area)] for the collection of plant fossils. From Goutham Khani mine, shale samples are collected from the thick bottom seam for palynological study, and a stem axis from within the vicinity of the colliery. Equisetalean axes and *Vertebraria indica* are collected from top layer of B thick seam of JVR mine. Besides, a rich megafloral assemblage consisting of *Gangamopteris*, *Glossopteris, Noeggerathiopsis* and equisetalean axes has been collected from Prakasham Khani mines.

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

Investigators: A. Rajanikanth & Chinnappa Chopparapu

An analysis of east coastal phyto-evidences of paralic/ fluvial settings revealed occurrence of non-flowering (pteridophytes, gymnosperms) and flowering vascular plants (angiosperms). The latter represented by enigmatic aquatic forms. The coexistence of pteridophytes– Equisetaceae, Marattiaceae, Osmundaceae, Gleicheniaceae, Dipteridaceae, Matoniaceae, Cyatheaceae, Dicksoniaceae, Polypodiaceae, along with gymnosperms– Pteridospermales, Cycadophytes, Bennettitales, Coniferales, Ginkgoales, Taxales with aquatic monocot association suggest prevalence of coastal and back swamp flora along the east coast of India during the Early Cretaceous times.

A unique aquatic macro-plant fossil with a small lateral branch assigned to the taxa *Montsechia* cf. *ferreri* (Zeiller) Teixeira from the Gangapur Formation, Pranhita-Godavari Graben has been recorded. The finding of *Sahniophyllum* gen. nov. with ribbon shaped leaves arranged in rosette with parallel venation substantiate evolution of angiosperms on Indian sub-continent. Other angiosperm fossil remains preserved in the form of fruit, spike, petal, leaves and axis corroborate explicit occurrence in the east coast particularly K-G Basin. Additionally, field work at Pranhita-Godavari and Krishna-Godavari basins has been carried out and a number of leaf, wood and palynological samples have been collected.

Sahniophyllum indica gen. et sp. nov.— A new monocot leaf from the Early Cretaceous sediments of Gangapur Formation

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

Investigators: Neeru Prakash & Neelam

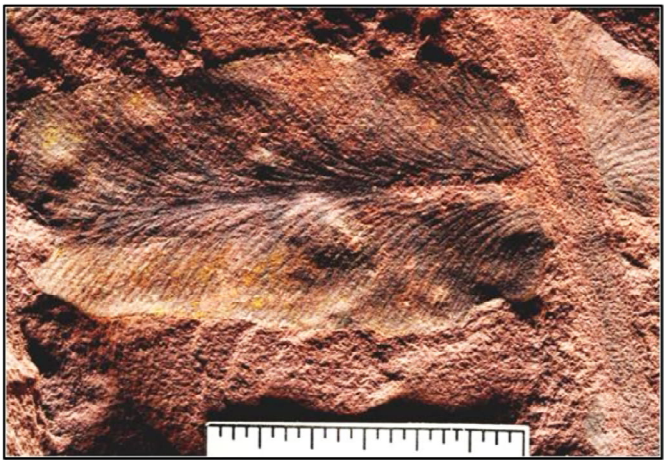
Morphotaxonomic study of the fossils collected from sedimentary deposits (Dhrangdhra Formation) exposed at Tarnetar area of Saurashtra Basin has been carried out. The deposits consist of ferruginous feldspathic sandstone of variegated colours intercalated with thin bands and lenses of sandy shales and clay. Thin coal bands are associated with fossiliferous carbonaceous shales. The recorded fossil floral assemblage is characterized by the dominance of pteridophytic fronds (*Equisetum, Matonidium, Phlebopteris, Gleichenites, Cladophlebis, Sphenopteris*) followed by co-occurrence of conifers (*Allocladus, Brachyphyllum, Araucarites & Coniferocaulon*). However, pteridosperm is represented by only one genus, i.e. *Cycadopteris*. Overall, the floral assemblage is dominated by pteridophytes and is represented by 60%, in contrast to conifers (36%), and pteridosperms is represented by 9% only. Cycads and bennettitales are totally absent in the floral assemblage. The flora is correlatable and equivalent to the floral assemblages known from the Bansa (South Rewa), Bhuj (Kachchh), and Himmatnagar Sandstone Formation of Gujarat main land.

Two new permineralised gymnospermous woods have been recorded from the Gangta bet of Kachchh. Their sections are prepared and studied; resulting into two new species— *Araucarioxylon wagadensis* sp. nov. (possess 2-5 araucariod type of pits in cross field area), and *Podocarpoxylon gantabetensis* sp. nov. (possess 2-5, podocarpoid type of pits in cross field area). The fossil woods are characterized by the presence of growth rings and divisible into early and late wood by its shape, size and wall thickness of the tracheidial cells. The presence of growth rings in the secondary woods is considered as one of the possible climatic signals and the evidence of seasonality during the growth of plant. The ring width ratio of early-late wood and other anatomical features are directly influenced by ambient environmental conditions, like sunlight, water and related ecological factors during the growth period. Dendrochronological data indicate that the climate was characterized by cyclic alternation of dry and rainy periods influenced by cyclical precipitations, typical of tropical wet and dry or savanna climate.

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

A field work has been undertaken at the outcrops of Birsinghpur-Pali area, Dhaurai Hill, Janar River Section, Jaisinghnargar, Karki, Tiki and Beohari localities of Shahdol district (MP). It consists of a basal Pali Formation of Late Permian to Early Triassic age, an intermediate and newly designated Karki Formation (Early to Middle Triassic), the overlying mud-dominant Tiki Formation (Carnian) and the uppermost Parsora Formation (Norian-Rhaetian). Disc-like galls have been reported on the Triassic corystosperm leaf *Dicroidium hughesii* (Feistmantel) Gothan from the Parsora Formation of South Rewa Basin. Although there have been numerous reports of insect-plant interactions from Permian and Lower Cretaceous successions, this is the first unequivocal report of insect-plant interactions from the Triassic succession of peninsular India. The new record adds to global evidence that arthropod herbivory and gall formation in particular, had rediversified by the Late Triassic in the wake of the end-Permian mass extinction.



Insect galls on *Dicroidium hughesii* from the Parsora Formation

A critical review of the literature revealed that the specimens of *Dicroidium* Gothan described so far from India require reassessment, because specimens of same type have often been placed under different species names and sometimes dissimilar elements have been assigned to same species. In view of this, a thorough analysis of Indian *Dicroidium* has been done based on fresh collections together with materials worked out by previous workers. Besides, the phenomenon of dwarfism or 'Lilliput Effect' observed in the species of *Glossopteris* known from the different Late Permian and Early Triassic formations of peninsular India has been carried out to unravel the changes in morphological traits of seven species of *Glossopteris*, whose existence continued surpassing the Permian-Triassic mass extinction event.

Palynological resolution of the megaspore yielding (represented by the genera *Banksisporites*, *Noniasporites*, *Paxillitriletes*, *Bokarosporites*, *Nathorstisporites*, *Erlansonisporites* and *Horstisporites*) sediments has been confirmed an Early Triassic age for the Triassic outcrop of Ramkola-Tatapani Coalfield, exposed near Premnagar, Balrampur district (Chhattisgarh). The palynoassemblage zone is marked by the presence of genera, viz. *Falcisporites*, *Playfordiaspora* and *Klausipollenites*. Associated palynomorphs are represented by species of *Densoisporites*, *Alisporites*, *Chordasporites*, *Goubinispora*, *Callumispora*, *Cyathidites* and *Verrucostsporites*. The Early Triassic macroflora of the studied outcrop is represented by *Dicroidium* sp., *Yabiella* sp., *Desmiophyllum* sp. and small sized leaves of *Glossopteris* sp.

Project- 2.8: Morphotaxonomic study of plant fossils from Tekan locality of South Rewa Basin

Investigators: Neeru Prakash & Neelam

Morphotaxonomical study of plant fossils collected from Tekan area, situated about 15-20 km north of Chandia town, has been undertaken. The well-diversified megafloral assemblage comprised number of species of pteridophytes, e.g. *Todites*, *Weichselia* and *Phlebopteris*, and branched or unbranched twigs of *Gleichenia* are commonly found. The conifers are represented by number of species of *Elatocladus, Brachyphyllum, Pagiophyllum, Araucarites* and *Podozamites*, along with few *Ptilophyllum* fronds. Besides morphotaxonomic study of Tekan flora, a pollen organ genus *Caytonanthus* has been recorded for the first time from the Gondwanan Indian sub-continent. This is a very fascinating and important find as so far only one record of genus *Caytonanthus* is made from Antarctica of Southern Hemisphere by Rees (1993). Hence, we have discussed its plausible Southern Gondwanan origin.

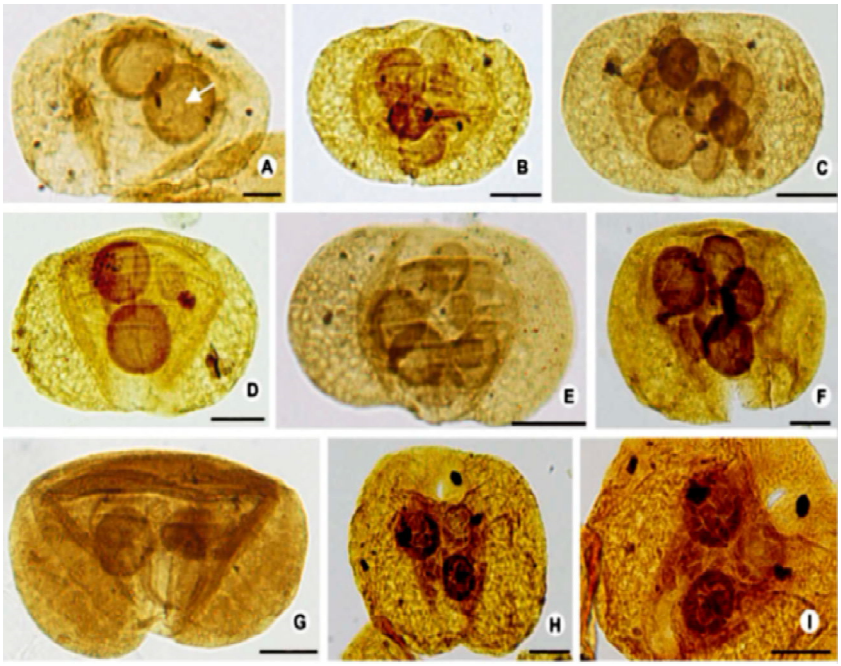
Palaeozoic-Mesozoic Miofloristics Group

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

The conspicuous spheroidal inclusions infrequently encountered in saccate gymnosperm pollen grains (e.g. *Striatopodocarpites subcircularis, S. multistriatus, Faunipollenites varius, Ibisporites diplosaccus, Scheuringipollenites maximus, Barakarites indicus*) have been studied from the Late Permian (±253-275 Ma) sediments of the Godavari Graben. These structures, occurring singly or in clusters of 2 to 8 in the central body of the pollen grain, are the remains of a pollen colonizing organism, perhaps the endobiotic zoosporangia of a chytrid or member in the Hyphochytridiomycota. These pollen grains represent highly likely host substrates and habitats for microorganisms. Similar structures earlier interpreted as the microgametophyte is implausible for several reasons. Additionally, a review of the Late Palaeozoic (Early & Late Permian) and Early Mesozoic (Triassic) pollen-spores recorded in 7 bore-holes from Manuguru area of the graben has been attempted in order to understand the palynological succession and nature of the distribution of Gondwana sediments in the area, and the spatial and temporal relationships of the Indian Gondwana Sequence.

Four distinct palynological assemblages have been identified in 601 m thick sedimentary sequence of bore core MCP-8 from Chintalapudi area, Chintalapudi sub-basin. Palynoassemblage- I, II, and III belong to Raniganj Formation, and IV belongs to Panchet Formation. Dominance of striate disaccates (*Faunipollenites* & *Striatopodocarpites*) along with the presence of some stratigraphically significant taxa viz., *Densipollenites, Guttulapollenites*, *Lundbladispora*, *Lunatisporites*, etc. in Assemblages I-III indicates the Late Permian age, and abundance of cingulate-cavate spores along with high *Lunatisporites* indicates Early Triassic age to Assemblage IV.



Pollen grains containing spheroidal inclusions: A-B) *Striatopodocarpites subcircularis*, arrow points circular opening in the wall of one of the inclusions; C) *Striatopodocarpites decorus*; D-E,G) *S. multistriatus*; F) *Faunipollenites varius*; H) *Ibisporites diplosaccus*; I) Detail of H. [scale bar = 10 µm (A), 20 µm (B-I), enlarged ca. 40x (A-H), ca. 100x (I)]

Palynological studies have been carried out on outcrop samples exposed in nala of Nimugudem area, Godavari sub-basin. Permian (Lower Gondwana) and Late Jurassic-Early Cretaceous (Upper Gondwana) palynomorphs are recorded. Presence of different species of palynomorphs of Upper Gondwana affinity viz., *Callialasporites* spp., *Araucariacites, Alsophyllidites, Biretisporites*, *Cicatricosisporites*, *Classopollis, Foveosporites cf. canalis*, *Laricoidites, Podocarpidites, Stereisporites,* in sandstone bed indicates Late Jurassic-?Early Cretaceous (Tithonian-Barriasian) age for these sediments. It is equivalent to Kota/Gangapur Formation of Godavari Graben. The coal exposure has yielded Late Permian palynomorphs belonging to Raniganj Formation. In addition, palynological and DOM studies have also been carried out in bore-hole MJR-11 at different depths. Jurassic-Cretaceous age is assigned to these sediments on the basis of presence of various species of *Callialasporites, Contignisporites, Cicatricosisporites, Coptospora, Dictyophyllidites,* etc. Studies for finer age zonation and interpretations are in progress.

The palynological studies in borecore MGK-6 revealed that the sequence falls under two groups: Palynoassemblage-I belonging to Artinskian age, and the rest two (II & III) belonging to Guadalupian age. The palynoflora present at the depth of 314.25-346.55 m shows continuation of Artinskian palynoflora, while the sediments between 220.70-298 m and 46.75-206.70 m have its equivalence with the Guadalupian palynoflora. The complete succession represents a clear picture of the fluvial river channel deposits along with some sub-environments like flood plain, lake, lagoon, swamp and wetlands. The peat-forming community mainly composed of glossopterids, cordaites and conifers. Contributory, trilete pteridophytic spores belonging to lycopsids, sphenopsids and filicopsides are less and variable in percentage. Algae like elements (*Maculatasporites*) are very few or rarely present. Dominance of woody seed plants, variable-low percentage of pteridophytic plants along with scarce percentage of algal form suggest the peat swamp forming vegetation in telmatic environment (forest moor) in a habitat with periods of standing water.

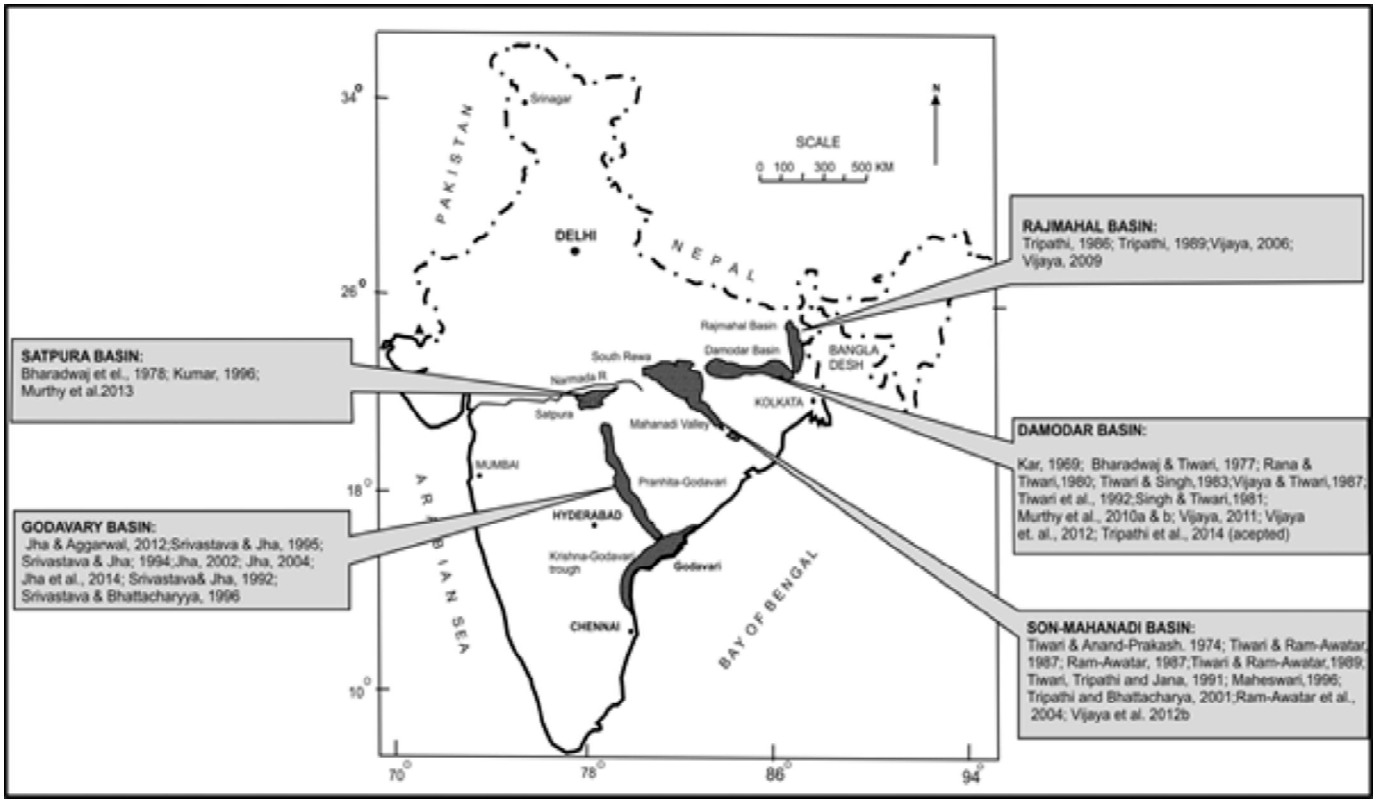
Project- 3.2: Palynostratigraphy, palaeoclimate and evolutionary trends of palynofloras in Gondwana sequences of Son-Mahanadi–Damodar basins

Investigators: K.L. Meena & Srikanta Murthy

A rich assemblage of Early Triassic palynomorphs has been recorded from the bore-holes IBKAN-5 and 6 drilled in Kuraloi Block-A (SW part of Ib-River Coalfield), Jharsuguda district, Odisha. The palynoassemblage shows dominance of the taxa– *Arcuatipollenites, Striatapodocarpites* and *Crescentipollenites* along with *Klausipollenites*, *Gondwanipollenites, Weylandites*, etc. and other associated taxa. Marker palynomorphs of Early Triassic in the assemblage are *Aratrisporites paenulatus, A. fishcheri, Lundbladispora bravicula, Lahirites striassicus, Rhizomospora radiata, Descisporis panchetensis, Faunipollenites gopandensis* and *Guttatisporites guttatus*. The decreased percentage of bisaccate pollen grains and increased frequency of singulate zonate pollen grains show affinities with Early Triassic age (for the sediments of Panchet Formation). The recorded assemblage is comparable with the palynoassemblages of the same age from the Damodar Basin.

Two palynoassemblages have been identified in sediments exposed along the Chaturdhara Nala section, Bakibihar area (near Gopalpur village), Sundargarh district, Odisha. Palynoassemblage-I is characterized by the dominance of *Faunipollenites-Striatopodocarpites* along with striate disaccate taxa followed by non-striate disaccate spores; representing Upper Barakar and Raniganj palynoassemblages. Palynoassemblage-II is recognized with the dominance of striate disaccate and sub-dominance of non striate palynomorphs along with scanty distribution of trilete spores and appearance of *Arcuattipollenites, Lundbladispora* and *Densoisporites*; assigning Late Permian age (Raniganj Formation).

The palynological data of latest Permian succession from the outcrop section on Bokaro-Dhanbad road, Jharia Coalfield, Damodar Basin has been finalized. Age determination for the sequence has also been attempted by comparison with similar assemblages known from different Indian Gondwana basins. A general analysis of taxa from the Jharia Coalfield favours a broad tentative correlation with the Late Permian assemblages from South America, Africa, Antarctica and Australia. The assemblages from the Indian basins has revealed a closer degree of similarity with those from East Antarctica, South Africa rather than with the assemblages from South America, west Africa and Australia which reveal palaeogeographic connections with the former during the Permian Period.

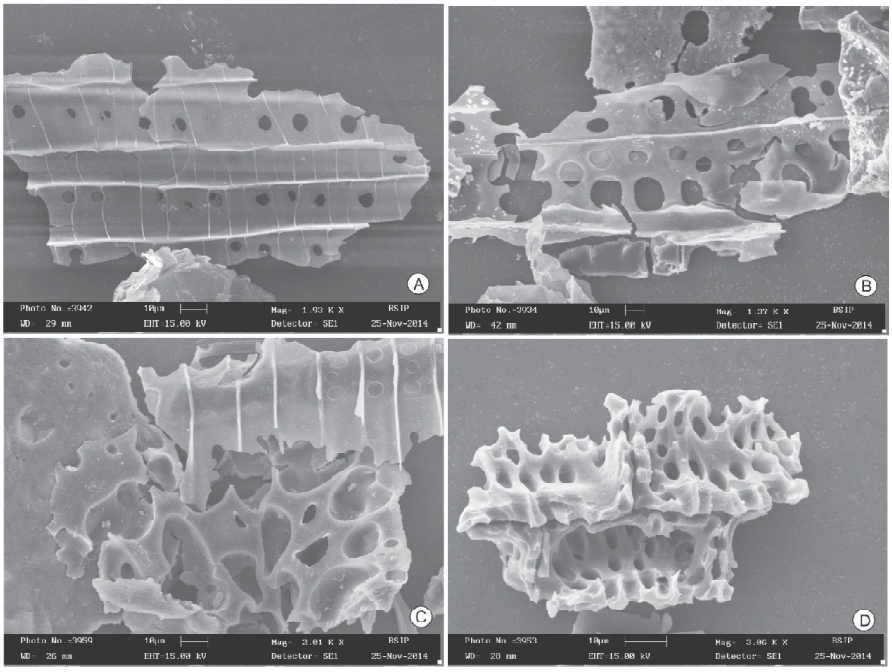


Reports of latest Permian palynoassemblage from the Gondwana basins of peninsular India

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

Investigator: Madhav Kumar

Megaspores, microspores and bisaccate pollen grains recovered from 4 sedimentary successions of Bhuj Formation (Early Cretaceous), exposed around Trambau village, have been described and illustrated through light microscope. The palynoflora comprises of *Cyathidites ghuneriensis*, *Concavissimisporites* sp., *C. punctatus*, *Contignisporites glebulentus*, *Trilobosporites* sp., *Impardispora* sp., *Murospora florida*, *Retitriletes circolumenus*, *Verrutriletes* sp., *Hughesissporites* sp., *Erlansonisporites* sp., *E. erlansonii*, *Minerisporites mirabilis*, *Paxitriletes fairlightensis, P. institus, P. Maheshwarii*; pollen grains of *Cycadopites grandis, Araucariacites australis, Alisporites grandis, Podocarpidites magnus*, etc. Some



Charcoalified fossil wood remains: A) uniseriate bordered pits, B-C) irregularly arranged and enlarged bordered pits and rupturing of walls, D) remains of vascular bundles

dinoflagellate cysts and colonies of *Botryococcus braunii* algae are also recorded from these sections. The recorded palynofloral assemblages indicate their deposition along the estuarine swamps. Comparison with similar palynotaxa especially megaspores from other Gondwana palynoflora of India, Australia and Argentina suggests Aptian-Albian age.

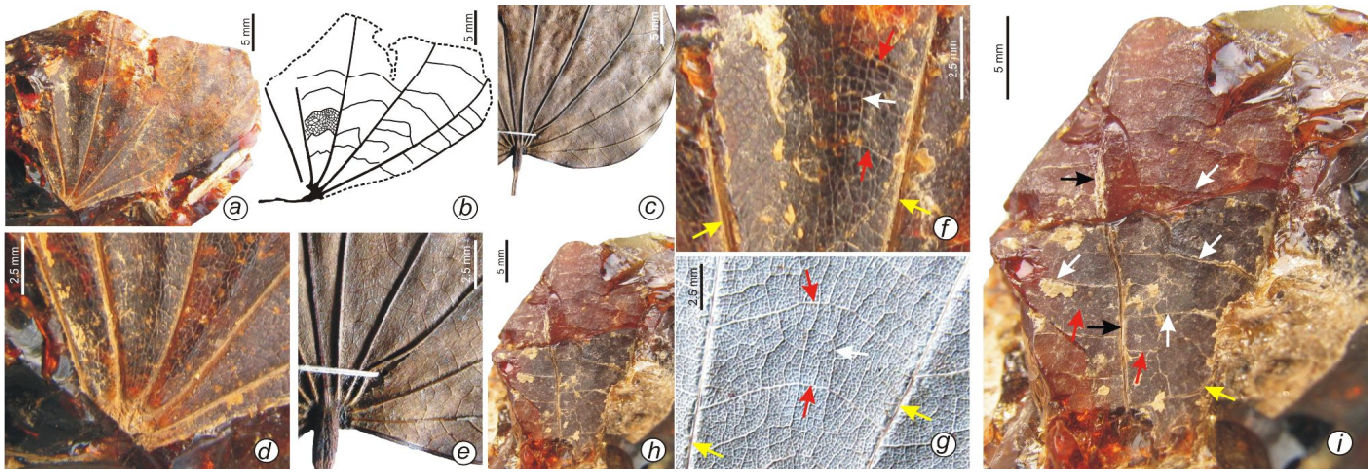
Microscopic charcoal and other sedimentary organic matter have been recorded from the sediments exposed along the Khari Nadi near Bhuj. These charcoalified plant microfossils remains exhibit least to severe morphological alterations and change in colour from pale yellow to brown, dark brown and black. Record of charcoal at this locality can be regarded as direct evidence of wildfire on the vegetation existed during the Early Cretaceous. Botanical affinity of charcoalified and non-charcoalified fragments suggests their derivation from the vegetation constituted mainly by the woody gymnosperms.

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

Two fossil leaves preserved in the amber collected from the Thingdawl Hmar Veng quarry, Mizoram have been studied in detail. The amber belongs to the Upper Bhuban Unit of the Bhuban Formation of Surma Group, and is of an Early to Middle Miocene age. One of the leaves is identified as *Bauhinia* of the family Fabaceae, while the other belongs to the family Anacardiaceae. This is the first report of the occurrence of fossil leaves in amber from northeast India. Their presence suggests evergreen forests in the region during the depositional period. The geochemistry of amber indicates that the studied fossil was exuded from Dipterocarpaceae.



Bauhinia kachchhensis Lakhanpal & Guleria

a) A fossil leaf showing venation pattern, b) Text figure of the fossil leaf, c) A modern leaf of *Bauhinia* showing similar venation, d) Showing base of the fossil leaf, e) Modern leaf of *Bauhinia* showing similar base as in the fossil, f) A part of the fossil showing detailed venation (yellow arrows indicating primary veins, red arrows indicating percurrent secondaries and white arrow indicating tertiary vein), g) A part of the modern leaf showing similar venation (yellow arrows indicating primary veins, red arrows indicating percurrent secondaries and white arrow indicating tertiary vein).

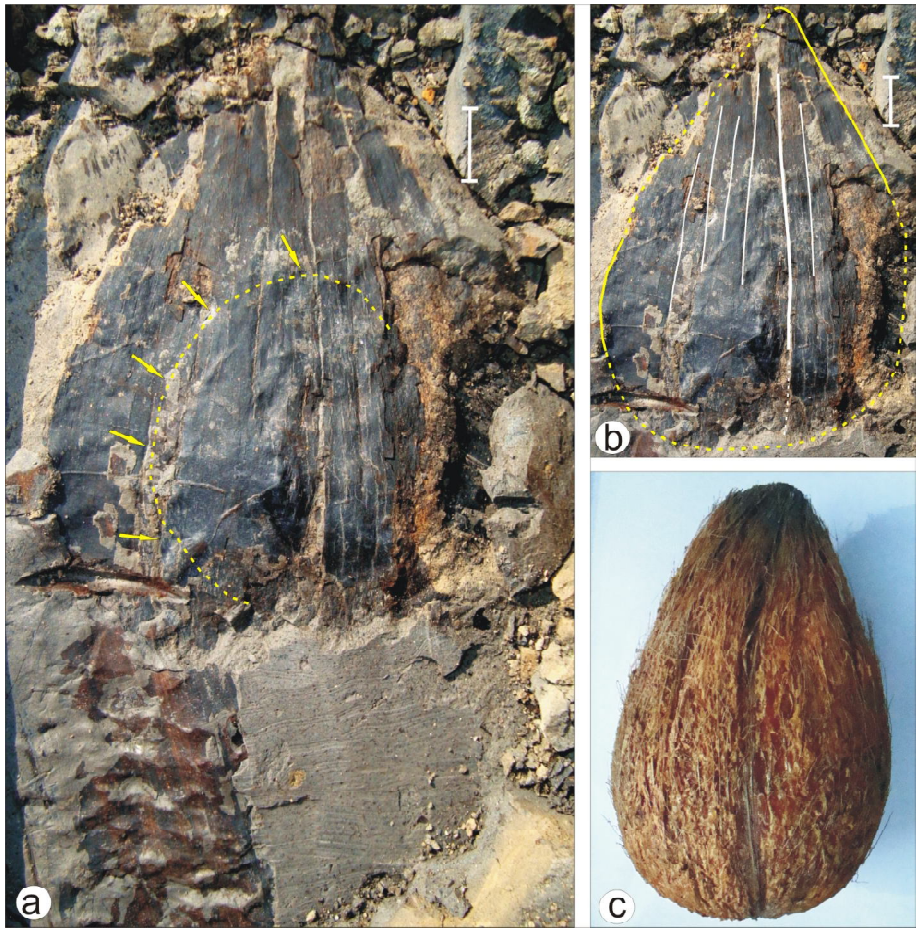
Dicotylophyllum sp.

h) A fossil leaf in natural light, i) The fossil showing detailed venation pattern (black arrows for primary veins, white arrows for secondary veins, red arrows for intersecondary veins and yellow arrow for eucamptodromous venation).

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

A fossil fruit collected from the Early Eocene sediments of the Tarkeshwar lignite mine of Surat district, Gujarat has been investigated in detail (with Hukam Singh). It belongs to *Cocos* (*Cocos nucifera* L.) of the Arecaceae. This species is a ubiquitous sight in all tropical and subtropical regions 23° N and S of the equator and thrives under warm and humid conditions, but tolerates short periods of temperature below 21° C (70° F). It is a life-supporting species in fragile island and coastal ecosystems and has an unparalleled impact on the history of human dispersal in the tropics. It provides almost all the necessities of life in the low islands of the Pacific and is named as the tree of life. The history of dispersal and cultivation of *Cocos* is fundamentally interwined with human history in the tropics. Fossil data from the Palaeocene also supports the long-term presence of coconuts (or coconut-like species) in both the Indian and Pacific basins.



Fossil fruit *Cocos* (a & b) from the Tarkeshwar lignite mine, and modern fruit (c) (Scale bar=1cm)

The *Cocos* occurrence indicates coastal conditions in the region (Cambay Basin) during the depositional period in contrast to arid to semi-arid climate prevailing there at present. The present fossil, along with the previously published palynoassemblages from the Tarkeshwar mine, supports the equatorial position of the Indian subcontinent at the time of deposition, i.e. during the Early Eocene.

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

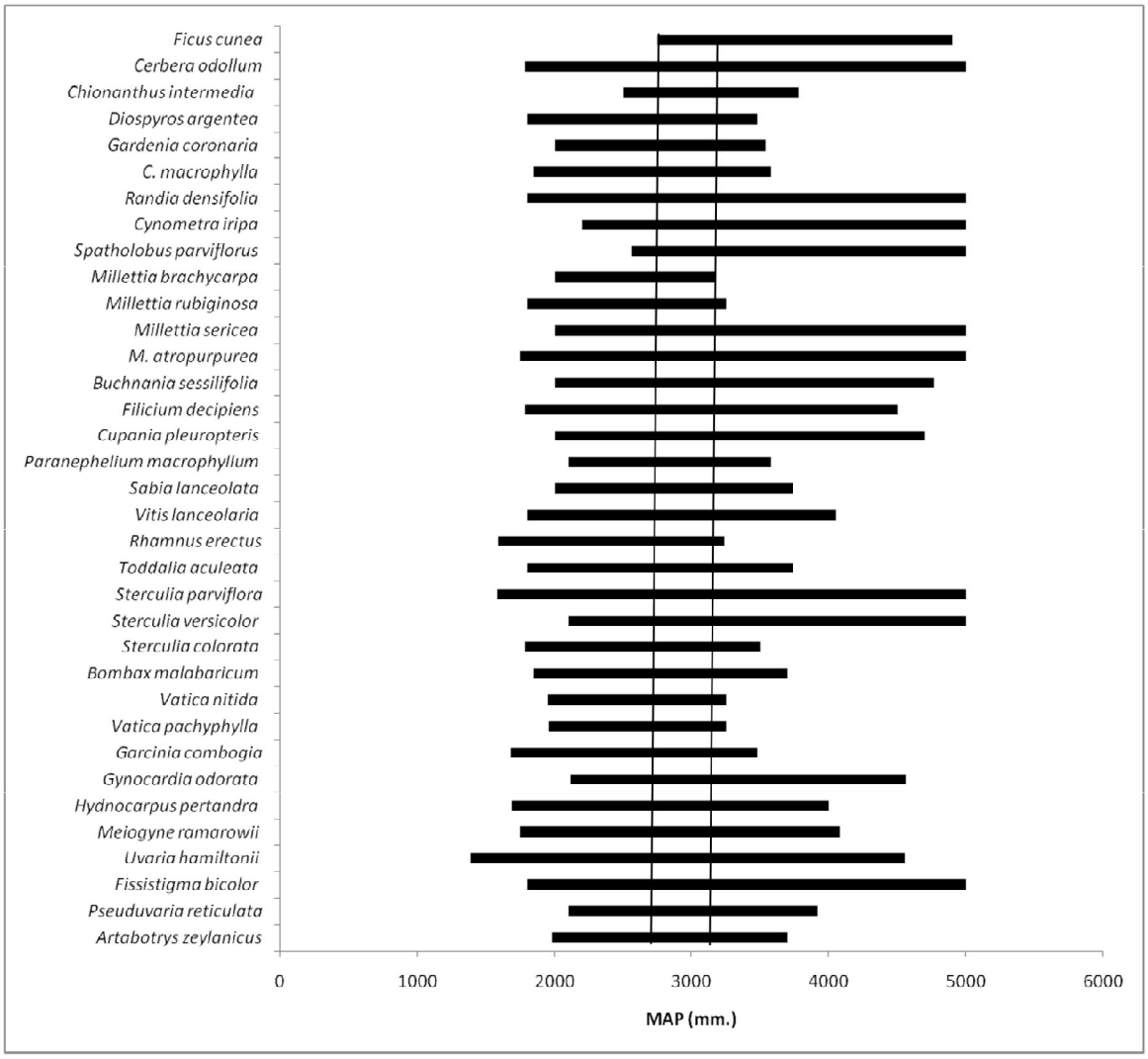
Investigator: Mahesh Prasad

The morphotaxonomical study on the fossil plant from Middle Siwalik sediments of Oodlabari area, West Bengal revealed the occurrence of 35 species of 18 angiospermous families. Of these, 23 species have been recorded as new to the fossil flora of Siwalik Group. The remaining 12 species are already reported from different Siwalik localities of India and Nepal. The family Fabaceae (Legume family, represented by 11 species) is the most dominant family in the studied Siwalik fossil assemblage, followed by Annonaceae (9 species), Flacourtiaceae (8 species), and Dipterocarpaceae (7 species). The evergreen elements (52%) dominate the fossil flora of Siwalik in Oodlabari area during Miocene in contrast to mixed deciduous elements at present. Only about 26% taxa of the total assemblage are found to grow presently in the Himalayan foot hills and the remaining 74% taxa are locally extinct; suggesting changes in the climatic conditions.

On the basis of NLRs approach, the followings reconstructed climatic estimates (Co-existence intervals) for different climatic parameters are obtained:

MAT (Mean Annual Temperature)	:	22°-26.5°C
CMT (Mean Annual Temperature of Coldest Month)	:	17.8°-20°C
WMT (Mean Annual Temperature of Warmest Month)	:	25°-30°C
MAP (Mean Annual Precipitation)	:	2650-3200 mm

Thus, it may suggest that fossil flora recovered from the Middle Siwalik of West Bengal coexist in such climatic ranges during sedimentation. Additionally, a field work has been undertaken at the Siwalik of Nainital and Champawat districts of Uttarakhand, and collected a variety of plant fossils (petrified woods, leaf & fruit impressions) and palynological samples.

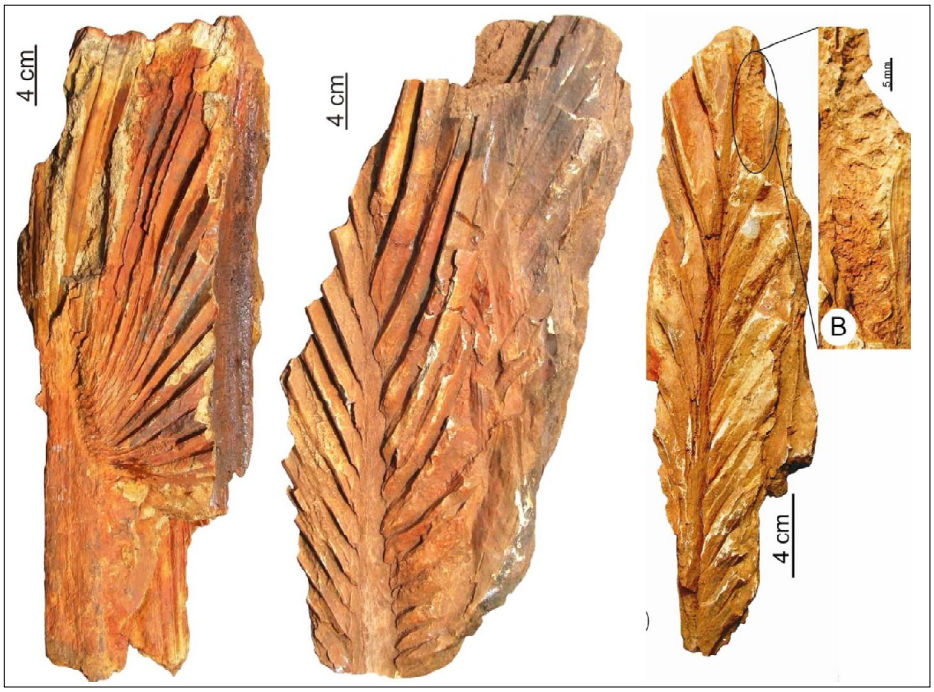


Coexistence intervals of climatic parameter: MAP of all the 35 taxa recorded from Oodlabari area, Darjeeling district (▬ indicate the intervals of coexistence) and vertical lines indicating the common range of MAP

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

Investigator: Rashmi Srivastava

An extensive collections of fossil plant remains have been made from number of Deccan Intertrappean localities of Madhya Pradesh and Maharashtra, namely Dhangaon, (Mandla district), Salaiya, Devrikhurd, Umaria, Samnapur and Ghughua Fossil Park (Dindori district), Ghansaur and Paddikona (Seoni district), Bhutera (Chhindwara district), Mahurzari (Nagpur district), and Nawargaon (Wardha district). A number of fruits



Fossil palm leaves (*Sabalites dindoriensis*) from Dindori district (MP)

collected from a new locality– Dhangaon (MP) have been studied. They are tentatively identified as monocot fruits showing resemblance with arecoid palms. Photo-documentation, observation and identification are under progress. A number of dicotyledonous woods have also been studied from the locality, and the detail studies are under progress. They are identified with the families Malvaceae, Burseraceae, Sapindaceae and Myrtaceae. It has been observed that a number of genera belonging to these families have overlapping xylotomical characters. In addition, a manuscript dealing with palm leaves from Dindori district (MP) has been revised.

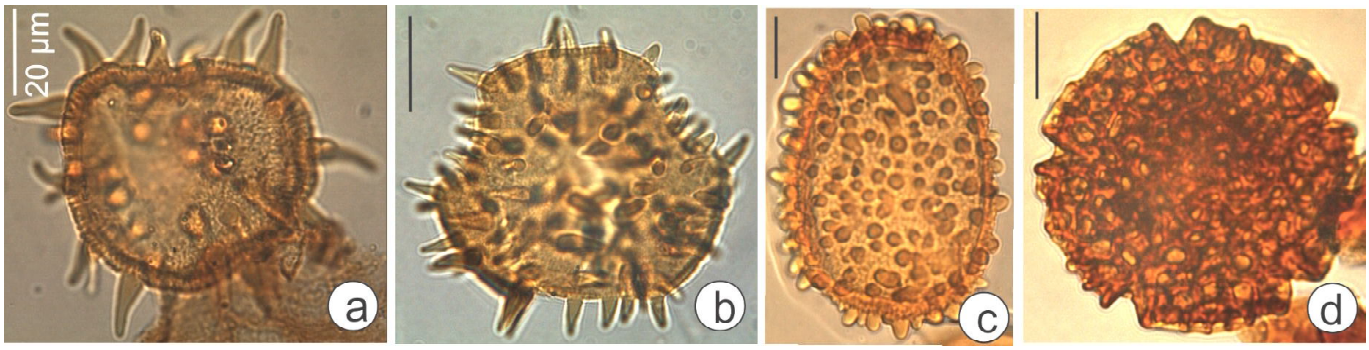
Terminal Cretaceous-Neogene Miofloristics Group

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

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

The palynological assemblage recovered from Panandhro lignite mine succession (Kachchh Basin) yielded variety of dinoflagellate cysts, algal and fungal spores, pteridophytic spores and angiosperm pollen. The lower part of the lignitic succession revealed the presence of spore-pollen only, dominated by *Neocouperipollis* spp., *Acanthotricolpites* spp., *Dandotiaspora dilata, D. telonata*, *Matanomadhiasulcites maximus, Proxapertites operculatus, Tripilaorites* spp., *Kielmeyerpollenites* spp., *Sastriipollenites trilobatus,* etc. This assemblage suggests a Late Palaeocene age for the lower part of the succession. *Apectodinium homomorphum* recorded in the middle part of succession with rich spore-pollen, viz. *Retipollenites confusus, Dipterocarpuspollenites retipilatus, Triangulorites bellus*; indicating a latest Thanetian to early Ypresian age. *Homotryblium tasmaniense, H. tenuspinosum, H. floripes, H. abbreviatum, Glaphyrocysta exuberans* and *Muratodinium fimbriatum* indicates an age not younger than middle Lutetian for the upper part of the succession. Significantly, the appearance of *Apectodinium homomorphum* possibly indicates the presence of the Thanetian-Ypresian boundary, whereas the appearance of *Homotryblium floripes* may point to the Ypresian-Lutetian boundary in the studied interval. It is inferred that the lower part of the succession was deposited in a coastal-swampy environment, the middle part in a marine coastal set up and the upper part under shallow marine inner shelf conditions.

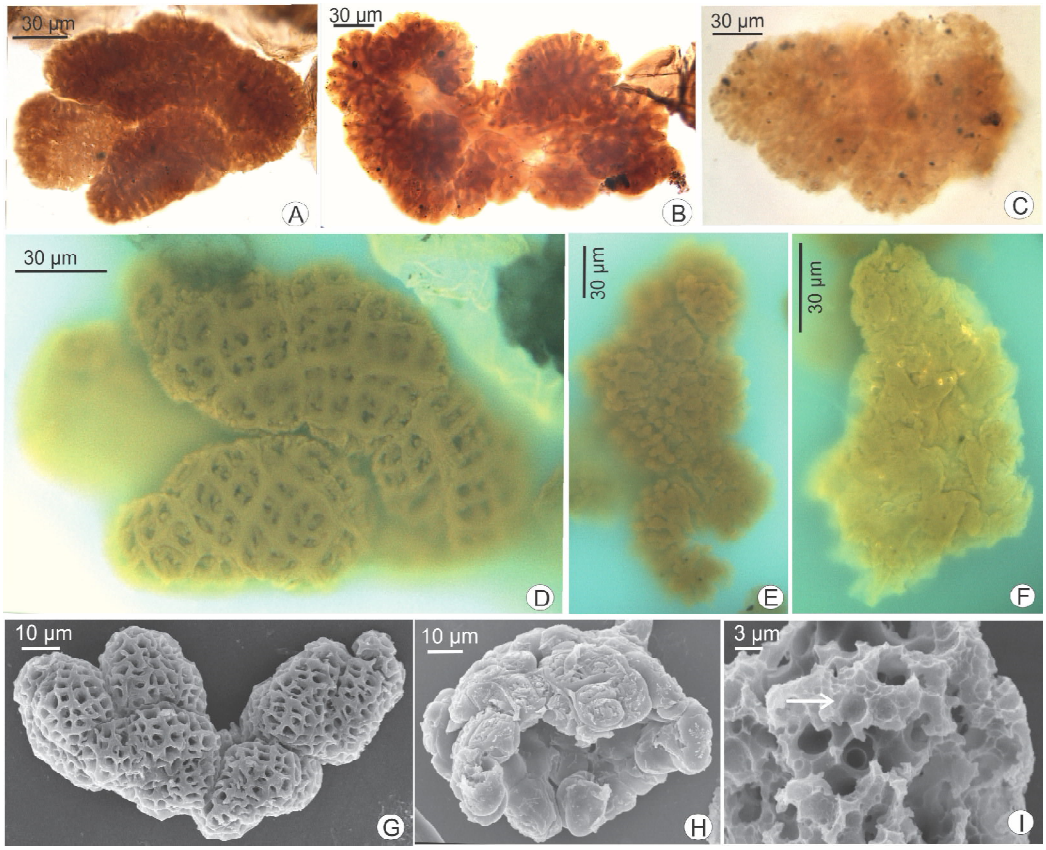
Palynostratigraphic analyses of mine pit sections of the Akli Formation exposed at Giral in Barmer Basin (Rajasthan) have been undertaken to determine, i) age of the sequences, ii) stratigraphic distribution of the palaynotaxa in the vertical horizons, iii) vegetation existed during deposition of various sequences, iv) depositional environments of various facies types. The palynofloral assemblage recorded from various lithotypes of the section show domination of several dinoflagellate cysts of *Damassadinium californicum, Fibrocysta axialis, Spinidinium* sp., species of *Apectodinium* including *A. augustum, Adnatosphaeridium multispinosum*, *Muratodinium fimbriatum*, *Areoligera senonensis*, *Cordosphaeridium fibrospinosum*, *Wetzeliella* complex



Pollen grains from Giral : a) *Spinizonocolpites* sp., b) *Acanthotricolpites bulbospinosus,* c) *Kapurdipollenites gemmatus,* d) *Duplibaculatipollenites pentacolpites* (bar size 20 µm)

at the lower and middle part of the section, while upper part is represented by spores of *Dictyophyllidites kyrtomatus*, *Dandotiaspora telonata*, and pollen grains of *Matanomadhiasulcites matanomadhensis, Proxapertites operculatus*, *P. crassimurus*, *Spinizonocolpites echinatus*, *S. baculatus*, *Palmidites plicatus, Arecipites bellus, Monosulcites borassioides, Kapurdipollenites gemmatus*, *K. ovatus, Duplibaculatipollenites pentacolporatus*, *Acanthotricolpites bulbospinosus*, etc. These assembalge exibit their deposition along the coast during Late Palaeocene to Early Eocene.

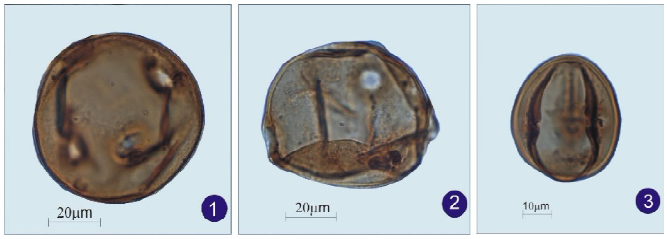
A colonial algae *Botryococcus braunii* is recorded abundantly in the lignite bearing successions of Gurha (Rajasthan) and Surkha (Gujarat) mines. The cosmopolitan green algae flourishes mostly in the open



Fossil *Botryococcus braunii* from lignite bearing sequences of western India:
A, B) Adhesion of various individual colonies, C) Biodegraded colonies, D) Well preserved colonies showing compound cups and rods, E, F) Biodegraded and amorphous stages, G) Detailed structures of cups and rods, H) Arrangement of individual colonies in thimble shape and I) Bioderaded phase showing holes in cups. (Photos A-C under light microscopic, D-F under UV fluorescence light, G-I under scanning electron microscope)

lacustrine environments and also occurs in brackish to saline waters. The light, fluorescence and scanning electron microscopic images of its various forms display aggregates of irregular small sub-colonies comprising small cells and cups arranged in different patterns in thimbles. The morphological and taphonomic characteristics of the algae indicate its autochthonous origin and in situ burial conditions. Its structural details and transformation to amorphous stages, preservation potential in various lithotypes and depositional environment in these two Early Eocene lignite bearing areas are explained (with Anumeha Shukla & R.C. Mehrotra). The occurrence of abundant *Botryococcus* fossils is helpful in recognizing oileferous organic deposits in the sedimentary horizons of western India.

Palynofloral assemblage recovered from the Valia lignite mine (Cambay Basin) is marked with dominance of angiospermic pollen and fungal remains. Algal cysts and pteridophytic spores are also present in high frequency (in few samples). Palynofloras (*Lygodiumsporites, Biretisporites, Todisporites, Dandotiaspora, Polypodiaceaesporites, Arecipites, Palmaepollenites, Longapertites, Spinizonocolpites, Proxapertites, Acanthotricolpites, Margocolporites* & *Ctenolophonidites*) indicate tropical-subtropical



Pollen grains from Valia lignite mine
1) *Lakiapollis ovatus,* 2) *Retibrevicolporites matanomadhensis*, 3) *Barringtopollenites retipilatus*.

palaeoenvironment with tropical humid climate at the time of sedimentary deposition. Arecaceous pollen grains suggest proximity of the near shore environment. The fresh-water swamp and water-edge elements were brought to the sight of deposition by the river channels. Thick vegetation, chiefly constituted by the plants of family Meliaceae, was mainly contributed to the lignite formation. The present floral assemblage clearly indicates Early Eocene age for the studied Valia lignite, and is closely comparable with that recorded from Vastan and Tarkeshwar mines of Cambay Basin (Gujarat) and Barmer and Bikaner basins of Rajasthan. The Early Eocene palynoflora of Kachchh Basin is also similar to the present assemblage. Many pollen taxa of the families Meliaceae, Bombacaceae and Liliaceae are of common occurrence in palynofloral assemblages of both the areas.

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

The assemblages recovered from the Deccan Intertrappean sediments of Anjar, Lakshmipar, Dayapar and Kora of Kachchh district (Gujarat) include *Mulleripollis bolpurensis*, *Ariadnaesporites intermedius*, *Triporoletes reticulatus*, *Gabonisporites vigourouxii*, *Azolla cretacea*, and *Aquillapollenites bengalensis*; indicating a Maastrichtian age for these beds. As earlier recorded species characteristic to the Palaeogene from the section along railway line cutting (near Anjar) are absent from other localities. The assemblages recorded are diverse and represented by all the groups of plants and are typically associated with the pollen of *Nypa (Spinizonocolpites),* a mangrove palm; indicating marine influence of deposition. Fungal associations are also throughout the assemblage. The assemblage recovered from the Laxmipar Intertrappean bed is associated with reworked Jurassic palynomorphs.

Samples from the Naskal have yielded diatoms affiliated to the freshwater genera, viz. *Aulacoseira*, *Ctenophora*, *Tabularia*, *Pinnularia*, *Navicula* and *Nietzsche*. Detail morphological observations of the above diatoms taxa have been done (jointly with AK Ghosh & Arindam Chakraborty). These Maastrichtian fresh water diatoms reflect evolutionary shift of the habitat from saline to the freshwater environment. The rich assemblage recorded reiterates the earliest records and diversification of freshwater diatoms in Indian subcontinent during the deposition of Deccan Intertrappean beds. The Naskal assemblage also contains pollen of grasses which are studied (jointly with Vandana Prasad).

An appraisal of the literature of fossil described from Deccan Intertrappean beds provide evidences of marine influence during the deposition of many of the beds as evidenced by plant indicators. Many of fossil remains were convincingly linked to climate indicators, viz. *Rhizophora* and *Sonneratia* (typical mangrove trees represented by wood), *Barringtonia* (a backwater mangrove tree represented by woods), *Nypa* (only typical mangrove palm

represented by fruits, root, leaves & pollen), *Cocos* (a coastal palm, represented by fruit, wood & pollen), *Acrostichum* (only mangrove fern represented by roots, stem, petiole & paraphyses), and marine red algae (*Peyssonnelia* & *Distichoplax)*. An evaluation of fossils of plant affinities recorded so far from different Intertrappean beds provide a sound evidence of the marine transgression along Narmada-Tapi rifts. This palaeobotanical interpretation corroborates with the finding based on the marine fauna (foraminifera) of the Jhilmili Intertrappean bed of Madhya Pradesh.

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

Investigator: B.D. Mandaokar

Palynological assemblage recovered from the Maharanicherra Road cutting section, south Amarpur district has been assigned to an Early Miocene age, based on the co-occurrence of key markers, such as *Trisyncolpites ramanujamii, Spinizonocolpites echinatus, Malvacearumpollis bakonyensis, Retitrescolpites typicus, Compositoipollenites mammilatus* and *Polyadopollenites indicus*. The terrestrial palynoassemblages have been recovered from the sediments of Bhuban Formation, which were deposited in a marginal marine environment under terrestrial influence as indicated by the presence of very rare dinoflagellate test linings and significant amounts of cuticular material. The presence of *Spinizonocolpites* suggests a shoreline inhabited by mangroves. The occurrence of mangrove taxon– *Malvacearumpollis,* which today belongs to a coastal marsh vegetational community, supports the presence of tidal swamps in the vicinity of the area of deposition. High altitude taxa and sudden increase of Pinaceae (*Pinuspollenites, Piceaepollenites* & *Abiespollenites*) which indicate climate tends to be cooler and drier, but also the existence of mountaining habitats in the periphery of the basin. The diversity of the angiosperm palynoflora, which forms the bulk of the assemblage, is thought to be indicative of a dense lowland vegetation cover. The recovery of fungal remains in great diversity suggests that the region enjoyed a tropical warm and humid climatic condition during the course of deposition.

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 (Late Eocene) exposed in Dilni River section off Tura-Dalu Road section, West Garo Hills district. The assemblage is represented by algae, fungi, pteridophytic spores, gymnospermous and angiospermous pollen grains, beside reworked Permian palynofossils. The assemblage is dominated by dinoflagellate cysts and angiospermous pollen grains. Presence of gymnospermous pollen– *Pinuspollenites* suggests that the topographically elevated areas were not far away from the basin of sedimentation and they have been transported from these uplands in the north. The recorded palynoassemblage indicates that the area enjoyed moist, warm, humid, tropical to subtropical climate. *Tricolporopollis* (Bombacaceae), *Lanagiopollis, Densiverrupollenites, Pellicieroipollis* (Alangiaceae) are tropical rain forest elements, which indicate that the area enjoyed heavy precipitation during Late Eocene time. Presence of fern spores in fair amount along with occurrence of fungal remains is suggestive of warm humid climate. Presence of dinoflagellate cysts along with the pollen of family Arecaceae suggests that the deposition of these sediments took place under shallow or marginal marine coastal environment. The coast might have been bordered by mangroves (*Nypa-Spinizonocolpites*) and other coastal elements. The reworked Permian palynofossils in the assemblage indicates that the sedimentary material for the Rewak Formation was derived from pre-existing Permian sediments. The source area could be isolated Permian outcrops exposed at Singrimari, N-W of the studied area. The recovered palynoassemblage is quite similar to Kopili assemblage, thus assigning to Late Eocene age.

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

Marine Micropalaeontology Group

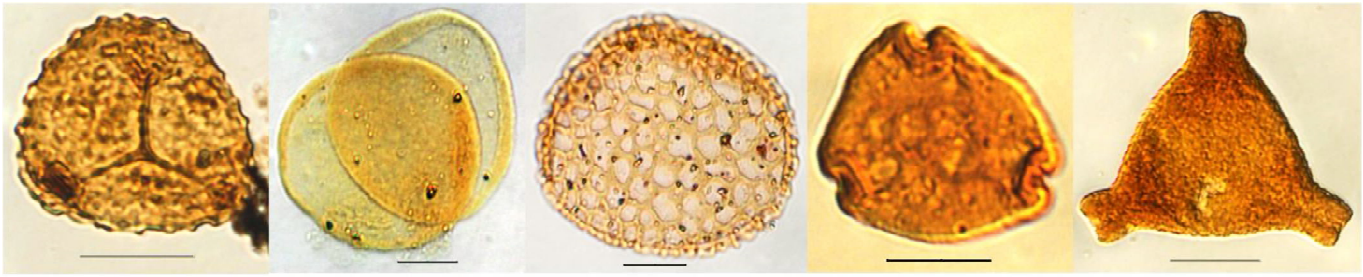
Project- 6.1: Study of Late Cretaceous-Early Palaeogene successions of South Shillong Plateau: Implications for climate and relative sea level changes

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

Within the dinocyst age constrains and carbon isotopic stratigraphic framework, continental palynomorphs from Palaeocene-Eocene succession of Jathang, East Khasi Hills have been studied. The study shows a distinct vegetational turnover from palm dominated rain forest during the pre-CIE to highly diversified dicotyledonous megathermal rain forest during the 'body' of the CIE and post-CIE interval. The nearest living relatives of fossil palynomorphs in the study corresponding to the palynomorphs belonging to tropical rain forest of southern Western Ghats, tropical rain forests of SE Asia, rain forest of western Madagascar as well as evergreen vegetation of Africa suggest a Gondwana origin for Palaeocene-Eocene vegetation of the Indian subcontinent, and migration of megathermal plants to SE Asia, subsequent to the India-Asia collision.

Geochemical variation in elemental abundance and their ratios, CIA, chondrite and UCC normalized rare earth elements (REE) patterns of 30 samples of Jathang succession show that the average abundance of Si, Ba, Th, Zr, La in the pre-PETM part of the section is relatively high compared to the upper part. Similarly, the average Fe, Mn, Co, Cr abundance is more in post-PETM part of the sediment profile. The total REE content in the pre-PETM part is significantly high than the post-PETM part. ~2-fold increase in LREE, greater negative Eu anomaly and overall more fractioned REE pattern are also the characteristics of the pre-PETM part of the profile. The significantly high CIA values throughout the profile suggest that the sediments have experienced advance stage of chemical weathering, however it is maximum around sample no. JTS-14. The geochemical evidences suggest that there is a gradual transition in conditions particularly from sample no. JTS-8 to JTS-15, which, more or less, corroborates with the biotic and isotopic study.

Quantitative palynological study of Ranikor Barsora, shallow marine stratigraphic section from East Khasi Hills has been undertaken to detect the palynofloral turnover across the Palaeocene-Eocene boundary interval. Significant pollen and spore counts from 65 samples are studied stratigraphically and statistically for analyzing the change in palynoflora and palaeoecological conditions across the P/E boundary interval. The record shows a low diversity Late Palaeocene flora followed by a significant increase in pollen diversity during the Early Eocene. Trend observed in the palynomorph diversity is gradual and shows a recurrent pattern suggesting pattern in the palynological cycles. The study of palynocycles and their possible relation with the palaeoecological conditions prevailing during Late Palaeocene-Early Eocene time is still under progress. In addition, nannofossil study has been performed on samples from Siju-Rewak Road section, West Garo Hills. Out of 50 samples, only one sample is productive for nannofossils. The assemblage indicates Late Eocene (Priabonian) age for the Rewak Formation. Presence of coccosphere in good number indicates calm depositional environment.



Lycopodiumsporites palaeocenicus | *Proxapertites assamica* | *Proxapertites emendatus* | *Cricotriporites vimalii* | *Triangulorites bellus*

Palynofloras from Ranikor Barsora section, Meghalaya

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

Investigators: Jyotsana Rai & Abha Singh

The Gangeshwar dome is comparatively smaller and less studied structure in Kachchh Basin. Attempts have been made to systematically measure and date the shales by presence of calcareous nannofossils in between datable marker ammonites containing hard bands. Huge successions of Chari and Katrol formations are exposed in this dome ranging in age from Callovian to Kimmeridgian. These rocks, comprising of alternations of shales, limestones and sandstones, are rich in body and trace fossils. Total 45 samples have been collected from these formations, out of which only 7 samples yielded nannofossils. Two samples (GD 14 & 15) below the Dhosa Oolite (Chari Formation) are poorly productive, and 16 nannofossils species are recorded from these samples. The assemblage suggests Callovian age for this part with reworked early-middle Jurassic nannofossils. Five samples (GD 27-30 & 34) belongs to the Katrol Formation are good in productivity and the recorded assemblage suggests Oxfordian-Upper Kimmeridgian age.

The Ler section is situated about 12 km SE of Bhuj. The outcrop is lying in a dry small river bed close to village of Ler. The section (ca. 46 m thick) consists mainly of bioturbated, shaly, silty, argillaceous to fine sandy silt containing claret coloured ferruginous concretions at several levels. Abundant trace fossils are present and a prominent 5-20 cm thick, bioclastic, calcareous sandstone is present which contains bored pebbles and cobbles of mudstones. The sediment package can be subdivided into a number of several meters thick coarsening upward cycles, terminated by bioclastic calcareous sandstone beds. The Callovian strata are rich and datable both on calcareous nannofossils and ammonites. The Chari Formation is topped by Oxfordian age Dhosa Oolite Member of ca. 1 m thickness and is conglomeratic. This is a highly condensed unit and has been formed due to sediment starvation. Dhosa Oolite being hard unit is devoid of nannofossils. The Chari Member contains nannofossil assemblage of 40 species. In addition, a field work has been undertaken around Kachchh Mainland, and covered Ler, Jhura Dome, Nirona Section, Nihwara Nadi section (=Jawahar Nagar Section) areas representing Chari and Katrol formations.

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

Investigators: Samir Sarkar (till 30.04.2014) **& V.V. Kapur**

The project has been merged with the Project- 13.1 with prior approval of the Research Advisory Council of the Institute.

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

A field work has been undertaken at the Neogene of Ritchie's Archipelago, South Andaman and Hut Bay (Little Andaman) of Andaman and Nicobar Group of Islands and collected samples for the study of calcareous algae, benthic foraminifera and diatoms in addition to other microfossils (radiolaria & planktic foraminifera). Rhodoliths formed by Sporolithoid, Mastophoroid and Melobesioid non-geniculate coralline red algae have been identified in thin section analysis of the samples from late Middle Miocene (Long Formation) of Hut Bay exposed near Butler Bay. In addition, some geniculate coralline forms assignable to the genera *Amphiroa* and *Corallina* and halimedacean green algae also have been identified. The same samples also yielded benthic foraminifera, viz. *Nummulites, Amphistegina, Lepidocyclina*, mililoids and texularids as well as some planktic foraminiferal linings.

Samples those yielded diatoms from Burdigalian-Langhian age of Kalapathar Section, Havelock Island have been precisely dated as NN 4 - NN 5 Zone, also yielded marker radiolarians– *Calocycletta costata-Stichocorys wolfii* (RN 4 Zone). Benthic/ planktic ratio and C/P ratio have been deduced that indicate the evidence of sea level fluctuations. Interpretation has been made

on palaeoenvironmental conditions. From the Late Miocene of Neil East Coast Section (Sitapur locality) of Neil Island, a rich assemblage of well-preserved diatoms has been recovered. The assemblage is dominated by *Azpeitia nodulifer* and *Coscinodiscus radiatus*. Other significant diatoms in the assemblage are represented by *Actinoptychus splendens, Asteromphalus humboldtii, Biddulphia pulchella, Coscinodiscus antique, Diploneis crabro, Endictya oceanic, Grammatophora oceanica, Hemidiscus cuneiformis, Navicula spectabilis, Paralia sulcata, Rhaphoneis amphiceros, Stephanogonia actinoptychus, Thalassiosira lineate*, etc. Besides, Late Pliocene-Pleistocene outcrop (Neil west Coast Formation) of Neil Island has yielded Coralline algae (*Lithoporella, Amphiroa* & *Corallina*), benthic foraminifera, linings of planktic foraminifera, coral fragments and echinoid spines in thin sections.

Project- 6.5: Phytoplankton and geochemical proxies to decipher palaeoclimatic fluctuations from Kerala-Konkan Coast and Arabian Sea

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

Diatoms study has been conducted in the down-core sediments from Cherai beach, Vembanad wetland. Based on the ratio of freshwater and marine diatoms, changing periods of freshwater discharge and marine incursion in the estuary has been deciphered. Four different zones of the diatom assemblages are inferred in the 20 cm core. From the base, Zone-1 shows dominance of marine diatoms over the freshwater diatoms; indicating prevalence of marine influence at the time of deposition. It is also supported by the presence of silicoflagellates in this zone. In the Zone-2, the marine and freshwater diatoms proportions are nearly equal, however the dominance of brackish diatom (*Nitzschia panduriformis*) indicates enhanced freshwater influence due to high monsoonal climatic conditions. The Zone-3 is marked by the increase in freshwater diatoms represented by *Navicula* spp., *Nitzschia* spp., *Pleurosigma*, *Gyrosigma*, *Surirella*, *Achnanthes*, *Amphora* spp.; indicating lowered water level in the estuary. The Zone-4 shows considerably higher diversity of freshwater, and low marine diatoms which indicates further shallowing of the estuary probably due to anthropogenic activities prevailing in the region. The study provides evidence of changes in the runoff due to monsoonal fluctuations and marine incursion from the sea. Along with the diatoms, palynofacies and dinoflagellate cysts studies are also carried, and it is found that *Bitectatodinium spongium* showed dominance over other dinocysts and its prevalence indicated warm and humid climate during the deposition of these sediments.

Rare earth element (REE) abundance patterns in the coastal wetland sediment provide insight into the REE cycle and its influence in the biological processes. The REE of the Vembanad coastal wetland shows that LREEs are the most abundant fraction in the sediments, followed by MREE and HREE for all the stations. REE records showed spatial heterogeneity due to the influence of the physico-chemical conditions along the wetland. The high values observed along the northern and southern stations might be due to the increased source materials by riverine input, which is supported by the textural parameters. Lower total REE values are observed in two of the southern stations (Murinpuzha & Thannermukkam). The REE ratios and enrichment factor values suggest that the abundance is in the order of MREE>LREE>HREE. Positive Eu anomaly is linked to the REE deposition by the weathering of REE-rich weathered lateritic and charnockitic source rocks. The chemistry of the Vembanad wetland is distinct with no significant variation in the oxidation condition indicated by Ce anomaly. It is suggested that the weathering and source materials of the REE, textural parameters and the biochemical processes leads to the REE variation in this coastal wetland environment. Additionally, the geochemical analyses of sediment core samples from three stations in the Vembanad wetland system are also carried out to study the variation of major, minor and trace/REE and to interpret the provenance and environmental variation during the Holocene period.

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

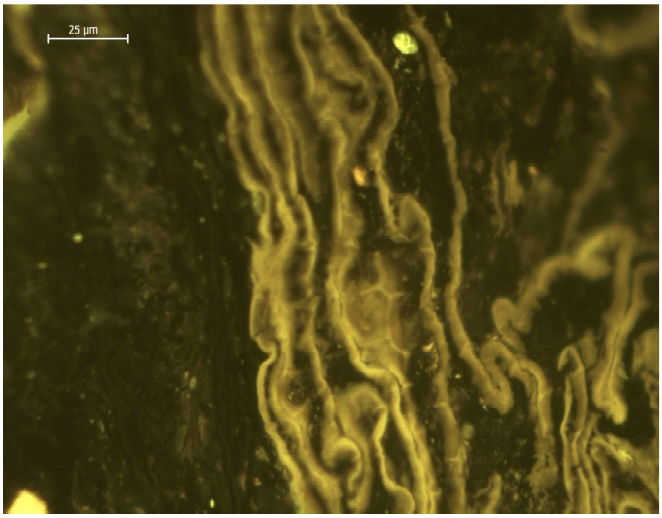
A detailed coal petrographic, i.e. maceral constitution and vitrinite reflectance ($R_{o\ mean}$ %) study of the topmost I and its underlying II and III seams encountered in bore-hole AK-8, representing Ashtona area in Yeotmal District of Wardha Valley Coalfield, has been carried out. The investigations have indicated that the coal seams, in general are mostly represented by vitric (vitrinite rich) and fusic types of coal. Both thick- and thin-walled microspores have been witnessed frequently, mostly in linearly arranged rows as well as randomly distributed in the vitrinitic groundmass. Similarly, large sized megaspores with ornamentation patterns are also noticed, but their frequency is quite low. Cutinites with serrated margins and the sporangial remains, at times containing spores, have also been observed during the maceral study. Clay and carbonate minerals, besides framboidal pyrites have been commonly noticed.

The vitrinite reflectance study indicated that coals representing I and II seams have depicted very low reflectance values (0.37-0.48%, which suggests that these coals have attained sub-bituminous B and high volatile bituminous C stage of rank. The coal of the III seam is however, shaly in nature. These coals have experienced wet moor with intermittent moderate to high floods with occasional exposure to alternating oxic and anoxic moor conditions. In addition, a manuscript on the petrographic analysis of sub-surface coal seams from Koyagudem area (Godavari Valley) has been finalized.

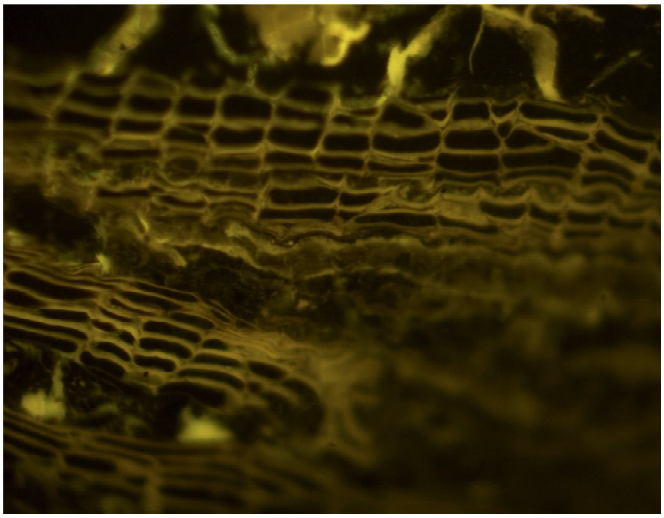
Project- 7.2: Organic matter characterization of western Indian lignites through petrological studies

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

The Eocene lignites from 3 working seams of the Khadsaliya new mine (Bhavnagar district, Gujarat) are found to be rich in huminite group of macerals (51-67%) followed by liptinite (9-24%) and inertinite (5-15%) groups. The huminite is chiefly represented by telohuminite (mainly ulminite) and detrohuminite (densinite + attrinite). The liptinites are chiefly constituted by liptodetrinite and resinite, besides sporinite, cutinite, suberinite, etc. Funginite, semifusinite/fusinite and inertodetrinite represent the inertinite group in the lignites. The associated



Cutinite in Khadsaliya lignite



Suberinite in Khadsaliya lignite

mineral matter is mainly represented by argillaceous and pyrite. The high gelification (GI) and tissue preservation (TPI) indices indicate that lignites have formed in back barrier conditions of deposition. The ground water (GWI) and vegetation (VI) indices suggest that the peat precursor has been subjected to intermittent flooding of the mire, as the maceral data show a shift from mesotrophic to rheotrophic conditions.

The huminite reflectance values ($R_{r\,mean}$ 0.30-0.38%) indicate that studied lignites are less mature and have reached up to lignitic stage (low rank B) of coalification. The hydrogen index (HI) values of lignites vary between 23 and 477 mgHC/g TOC. The T_{max} values of the lignites range between 377 and 432°C. HI *vs* T_{max} along with S_2 *vs* TOC (total organic carbon), and HI *vs* OI (oxygen index) plots of the samples indicate that the organic matter is a mix of Type III/Type II kerogen. Low T_{max} value (average 418°C) suggests immature nature of the lignite deposits. The high TOC (16-54%) along with the Type III/Type II kerogen, as determined by Rock-Eval pyrolysis, indicates the ability of lignites to generate oil and gaseous hydrocarbons upon maturation.

The organic petrographical, geochemical, palynological and palynofacies data of Early Eocene lignites and associated shales from Matasukh mine (Nagaur Basin, Rajasthan) have been finalized and documented to understand the floral composition, depositional conditions, and the hydrocarbon source potential. Petrography of the lignites from two working seams has revealed the evident dominance of huminite (av. 60%) over the liptinite (23%) and inertinite (9%) macerals, along with low amount of mineral matters (8%). The dominance of detrohuminite (attrinite + densinite) suggests that the organic matter has undergone higher degree of degradation; as is also indicated by the frequent occurrence of funginite (2-8%). Low TPI and high GI values indicate limno-telmatic condition of the palaeomire during the deposition of the lignite forming peat. The huminite reflectance values ($R_{r\,mean}$ 0.26%) indicate lignitic stage/rank. Low T_{max} value (av. 401°C) suggests immature nature of the lignite deposits.

Palynofloral assemblage, constituted by angiosperm pollen, pteridophytic spores, and fungal remains, suggests the existence of evergreen forest vegetation in the vicinity of the depositional site. The degradation products of oleanane and 23-norlupane in the sediment extracts also suggest that the angiosperm dominant higher plants served as the source for peat-forming biomass. The high carbon preference index and terrigenous/aquatic ratio values indicate the large input of terrigenous higher plant material. The samples yielded rich organic constituents with the dominance of amorphous organic matter (AOM) and sub-dominance of phytoclasts. The reducing conditions in the depositional site are evident by the presence of framboidal pyrite in lignites. The lignites/shales are characterized by the mix of type II and III kerogen (AOM+phytoclast/liptodetrinite, and as determined by Rock-Eval pyrolysis). The types of kerogen and high TOC content (up to 59.48%) indicate the potential of lignite-bearing sequence of Matasukh to produce oil/gaseous hydrocarbons.

Project- 7.3: Organic petrographical and geochemical characterization of Tertiary lignite bearing sequences of south India

Investigators: R.P. Mathews & B.D. Singh

A field work has been done (by RPM) on the outcrops of Warkallai Formation and Sindhudurg Formation in the Sindhudurg and Ratnagiri districts (Maharashtra). The highly carbonaceous sediments of Warkallai are found to be very less in huminite macerals, which are mainly represented by degraded/partly degraded ulminite, textinite and corpohuminite. Liptinites are mainly consisting of sporinite, resinite and cutinite. Funginite of inertinite group is also present. High content of mineral matter is mainly represented by siderite and pyrite (massive & cell-fillings). Rock-Eval pyrolysis and palynofacies analyses have also been done on Warkallai samples. The TOC content ranges from 0.8-6.72 wt.% with an average value of 3.45 wt.%; indicating that the Warkallai samples consist of 'good to excellent' source rock potential and the organic matter was deposited in reducing condition. Hydrogen index (HI) of the samples varies from 16-106 mg HC/g TOC. A general increase in HI can be seen from top to bottom of the section. The T_{max} values range from 367° C to 416° C. this shows that the samples constitute immature organic matter. HI *vs*. OI, HI *vs*. T_{max} and S2 *vs*. TOC cross plots indicate that the studied sequence contains Type III (gas prone) kerogen.

The overall composition of the palynofacies components shows the clear-cut dominance of phytoclasts (brown), incorporates well-preserved cuticles, fungal hyphae, cork tissues, membranes, etc. (type III kerogen).

Sub-dominance of amorphous organic matter (AOM) is observed with minor content of palynomorphs. The extrapolation of frequencies of phytoclasts, AOM and palynomorphs in the Tyson's APP diagram represents I, II and IV fields indicating a marginal dysoxic-anoxic basin condition for the deposition of organic matter. In addition, the rocks from Ratnagiri are characterized by mineral matter (siderite & pyrite) is more than 90% of the composition. Huminite group is found in sparse and represented mainly by textinite, corpohuminite and ulminite (minor) macerals. Liptinites are represented mainly by cell-filled resinite, cutinite and minor sporinite macerals. Funginite is also present in studied samples.

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

Palynological examination of 30 surface soil and mud samples has been performed in order to establish modern pollen/vegetation relationship from Son wetland situated in Karimganj district (Assam). The recovered palynodata reflect the mixed deciduous forest comprising of *Salmalia*, *Emblica, Bauhinia, Terminalia, Lagerstroemia*, *Barringtonia*, Sapotaceae, Meliaceae and Anacardiaceae under warm and humid climate in response to rainfall variations in the region. High monsoonal activity in and around the region is inferred by the presence of *Syzygium-Duabanga-Schima*-Moraceace assemblage in the sediments. The marshy and aquatic taxa (Cyperaceae, Polygonaceae, *Nymphoides* & *Myriophyllum*) are strongly suggestive of the perennial water-logged condition in the area. Striking signal of winter dryness is well-viewed in the palynoassemblage especially observed through Chenopodiaceae, *Xanthium* and *Artemisia*. The regular presence of pollen grains of conifer and other broad leaved taxa including *Pinus*, *Quercus*, *Alnus*, *Carpinus* and *Betula* are suggestive of high wind activity from the higher altitude. Anthropogenic activity is in continuous pace as reflected by the higher frequencies of Cereal pollen along with moderate values of Solanaceae, Caryophyllaceae and Brassicaceae. Different morphotypes of phytolith (blocky, tabular, globular, elongated, bulliform, rondel, perforated plate, etc.) have also been studied on surface soil in order to support modern palynological data of Chaurbazar area, Karimganj district.

Palyno-chronological records have demonstrated four distinct phases of vegetation succession, contemporary climate and human occupation in Karimganj

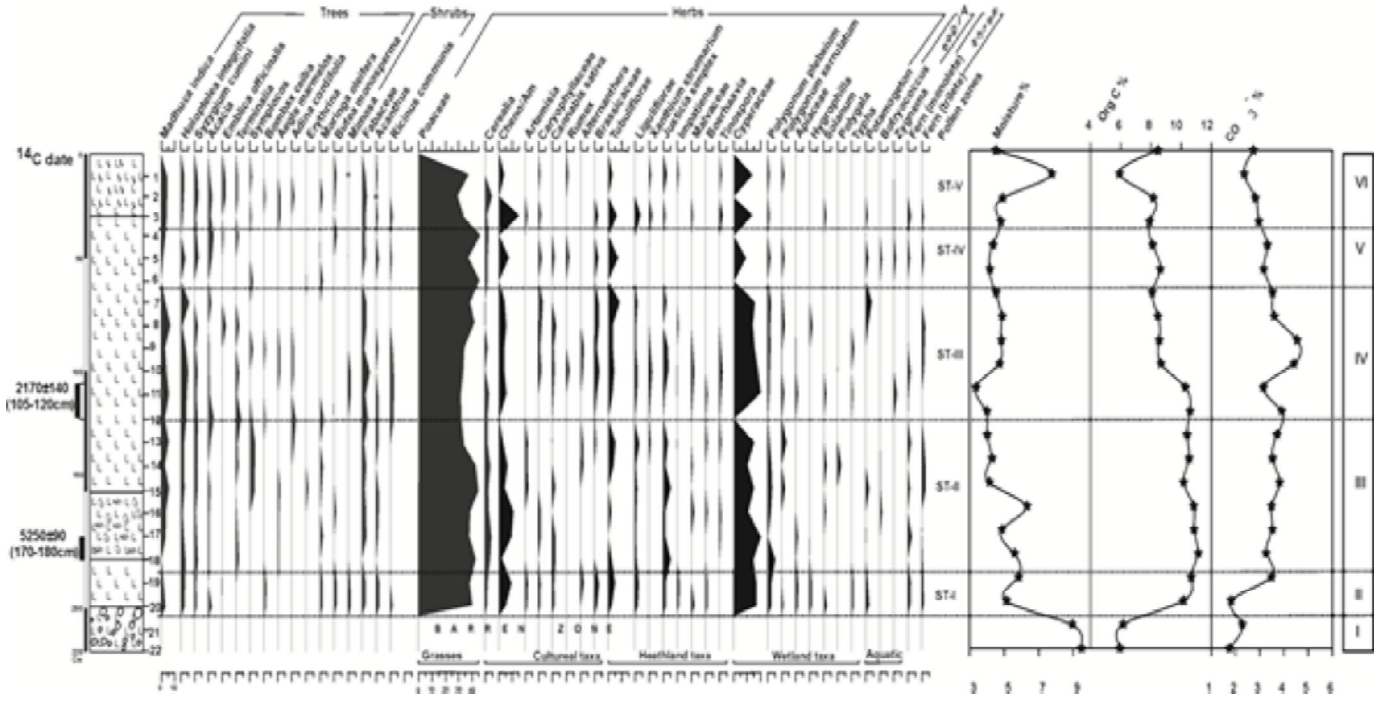
A view of Son wetland, Karimganj district (Assam)

district situated at Indo-Bangladesh border for the last 5,000 yrs BP (covering the Mid-Holocene). A warm and relatively more humid climate prevailed between 2,460 and 310 cal BP as reflected by the increased frequencies of arboreal (*Terminalia, Lagerstroemia*, *Duabanga*, Anacardiaceae Sapotaceae, etc) and marshy taxa (Cyperaceae, Polygonaceae and Onagraceae). From 310 cal BP to present, the region experienced a warm and relatively dry climate as a consequence of anthropogenic activities along with reduction in monsoon precipitation. A 100 cm deep sedimentary sequence is also processed for pollen, spore and phytolith observation in order to deduce palaeoecological conditions from the Chatla wetland situated in Cachar district of Assam. In addition, an extensive field work has been undertaken (by SKB) in Golaghat (Kajiranga wetland), Dibrugarh (Merbeel swamp), Dilli/Jeypore RFs and Hailakandi districts of Assam.

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

Investigators: M.S. Chauhan & Kamlesh Kumar

Pollen, organic/inorganic carbon ratio and moisture content analyses of 2.2m deep sediment profile from Simariya Tal, Chhindwara District has brought out the vegetation shifts and concurrent climatic events in the region of southern Madhya Pradesh since the last 7,467 cal yr BP. Between 7,467 and 6,482 cal yr BP the region witnessed a warm and dry climate region, based on the sediment texture. The presence of gravels suggests that the sediments were accumulated under a pluvial environment. Around 6,482 to 5,742 cal yr BP, the region supported open mixed tropical deciduous forests, with scanty trees under a warm and less-humid climate attributed to reduced monsoon precipitation. The retrieval of aquatic elements signals the existence of the lake. The recovery of Cerealia and ruderal plants denotes that the region was under agricultural practice. Around 5,742 to 2,565 cal yr BP, the open mixed forests were succeeded by diversified tropical deciduous forests with expansion of the earlier existing trees and invasion of *Adina cardifolia*, *Erythrina*, *Aeglemarmelos* and *Symplocos,* depicting a warm and humid climate owing to active SW monsoon. This is also validated by the increased organic carbon content in the sediments. The congenial climatic conditions also favoured the escalation of agrarian practice. The lake assumed a wider expanse, which is indicated by the frequent presence of aquatic plants. The record of molluscan shells implies that the sediments were accumulated in a ponding environment.



Pollen diagram and Loss on Ignition curve of Simaria Tal profile

The mixed deciduous forests became much varied and dense around 2,565 to 1,250 cal yr BP as evidenced from increased frequency of the prominent forest ingredients, viz. *Madhuca indica*, *Holoptelea integrifolia*, *Syzygiumcumini*, *Terminalia*, etc. Further expansion of the lake is indicated by the frequent encounter of *Potamogeton* and *Typha* as well as the freshwater algae. The vegetation mosaic reflects that the region witnessed a warm and very-humid climatic condition. The depletion in the forest ingredients around 1,250 to 675 cal yr BP denotes that mixed deciduous forests turned sparse with sparingly distributed few trees as a consequence of a warm and less-humid climate in response to weak SW monsoon. Since 675 cal yr BP onwards, the recuperation of the mixed deciduous forest is inferred by the improvement in most of the forest associates. This proliferation of the forests signifies the prevalence of a warm and humid climate again due to active SW monsoon.

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

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

A manuscript entitled 'Holocene vegetation and climate change in Central Ganga Plain, based on pollen records from Chaudhary-ka-Tal, Raebareli district, Uttar Pradesh has been revised (with Anupam Sharma). The pollen, sediment texture and organic/ inorganic carbon analyses of the sediment profile has provided significant insights into the vegetation shift and climate change in the Central Ganga Plain since early Holocene. The pollen composition analysed from 10 surface samples of Sevan Tal (Raebareli district) reflects the dominance of non-arboreals (herbs) and low frequencies of the arboreals (trees & shrubs). This irregular display of most of the trees could be ascribed to low pollen productivity since majority of them are entomophilous. The prevalence of grasses, Cheno/Am, Tubuliflorae, *Polygonum*, etc. corresponds with their presence in the ground flora. The encounter of Cerealia, *Brassica*, *Cannabis sativa*, etc. envisages the proximity of agricultural land. Based on the changing pattern of prominent arboreals and non-arboreals in pollen assemblage throughout a 2.0 m thick sediment profile from Kikar Tal, the whole pollen sequence has been divided into the four distinct pollen zones in terms of vegetation and their corresponding climatic conditions during the Late Quaternary Period.

The results on vegetation, climate change and human habitation since last Glacial Maximum in Central Ganga Plain, deduced by multiproxy records from Lashoda Tal, Raebareli district, have brought out that around 21,723 to 18,782 cal yr BP vast stretches of open grasslands with scanty trees of *Holoptelea integrifolia* only occurred in the region under a cool and dry climate. Between 18,782 and 12,530 cal yr BP, open grassland continued, with few more trees portraying the amelioration of climate. Around 12,530 to 6,270 cal yr BP, much expansion of the forest groves interspersed with grassland were established with the onset of a warm and humid climate. The first encounter of cereal pollen around 10,000 cal yr BP elucidates the inception of agrarian practice. Around 6,270 to 2,150 cal yr BP, the further increase in the frequencies and number of trees deciphers that forest groves attained maximum diversification in response to a warm and relatively more-humid. The consistently increasing trend of Cerealia as well as other concomitant cropland weeds reflects the escalation in agrarian practice. From 2,150 cal yr BP to Present the diminishing trend of arboreals infers the existence of grasslands with scanty trees under a warm and dry conditions. A manuscript based on modern pollen rain assemblage of Lashoda Tal has been finalized.

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

Thirty-seven surface sediment grab samples from 5 km river channel (land to sea) have been collected from northern part of Krishna delta. Physico-chemical characteristics (salinity, sediment texture, metal-elemental concentration) and palynology are carried out on these samples. Results reveal a transitional shift in characteristic fresh water to marine palynomorphs from land to sea. A ratio of marine versus terrestrial palynomorphs and arboreal versus non-arboreal forms is calculated in the given situation of tidal amplitude and the distance from the present day shoreline in the study area. Indicator palynomorphs and the magnitude of marine ratio are

Palynological study of sediments from Nawabganj Bird Sanctuary

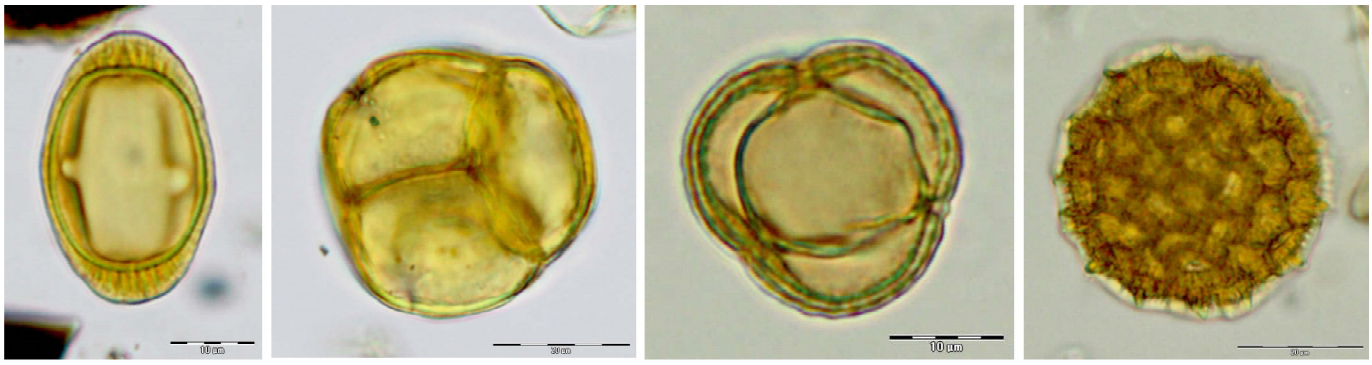
estimated under present situation as modern analogue. This modern analogue is likely to help in studying the magnitude of tidal influx in core samples from the adjoining areas.

Two cores one each from Kanuru and Machilipatnam areas have also been studied from the north-eastern part of present day Krishna River delta. The net rate of sedimentation increased drastically between 3 and 4 ka, which was perhaps controlled tectonically in both the core sediments. The vertical stack of sediment deposited since ~6 ka in the study area is present at different depths from the ground surface. Palynological results reveal mangrove/ estuarine ecosystem since 6-3 ka in the region; indicating palaeoshoreline about 8-10 km inland from the present shoreline. Shoreline ingression is observed since the last 0.5-0.6 ka in Kanuru area, which indicates the subsidence in the area favouring ingression of sea water particularly in between the palaeo sand ridges formed in the region. The changes in relative sea level and tectonic activity in relation to climate since ~6 ka are inferred from the study of sedimentology and palynology in these two cores. Additionally, an exhaustive survey of Nawabganj Bird Sanctuary has been carried out (by AF & SKS) within 15 km range. Two trench samples (of 2.2 m & 1.4 m sedimentary profiles) and 32 surface sediment samples are collected from near to present day lake periphery. The study aims to gather history and origin of lake and climatic changes during Holocene in the gangetic plain.

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

Investigator: S.K. Basumatary

The surface samples (40) from Garobada area of West Garo Hills have been studied. The palynodata displayed the tropical deciduous forest composed of *Terminalia*, *Dillenia*, *Lagerstroemia* and *Semecarpus*. The abundance of aquatic and marshy taxa, namely *Nymphoides*, Onagraceae and Polygonaceae are suggestive of the perennial water logged condition in the region. The recovery of *Melastoma* pollen along with cerealia and *Brassica* indicates the forest deterioration and human activity in the region. Besides, a comparison of the palynodata of surface samples from butterfly mud puddling locations in Ultapani reserve forest of Assam and forest surface samples from the immediate vicinity reflects roughly the same in types and frequency of the modern pollen. The pollen recovered from both the sites indicate the vegetation in the region as primarily an evergreen forest composed of *Elaeocarpus*, *Litsea*, *Dillenia* and *Syzygium*.



Lagerstroemia *Rhododendron* *Xanthium* *Polygonum*

Major palynotaxa recovered from Majuli Island

Endangered wetland in Majuli Island, Assam

View of Bat colony inside Pipulbari Cave, Meghalaya

Palynological study on bat guano from Pipulbari Cave has been conducted. The palynodata displayed the tropical deciduous forest consisting of *Salmalia*, *Syzygium*, *Dillenia* and Combretaceae, which closely resembles with the present vegetation in the region. The bat guano deposit in the cave can be considered as a reliable source of palynodata, which can be used as a counterpart of surface soil palynodata in and around the region. In addition, a 1.0 m sedimentary soil profile from Kathali beel of West Garo Hills has been studied and signifies the existence of tropical deciduous forest composed of *Lagerstroemia*, Anacardiaceae, *Schima* and *Salmalia* admixture with evergreen taxa *Mesua*, *Symplocos* and *Elaeocarus* under warm and humid climatic condition. The evergreen elements along with *Impatiens* are strongly indicative of the monsoonal activity in the region. 15 honey samples has also been pollen analysed and studied from the area. A field work has also been conducted in Garo Hills and Chakrachila wildlife sanctuary and collected polliniferous samples, surface, cave, and sedimentary soil samples.

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

Investigator: Shilpa Pandey

In order to comprehend the relationship between modern pollen deposits and their source plants, 22 surface sediment samples have been collected from the Lothian Island and palynologically analyzed. A total of 18 pollen taxa are found amongst which 14 pollen taxa are existing in the local vegetation. A modern pollen database suggests that mangrove pollen averaged about 70% of the total pollen. *Rhizophora* is over-represented in the pollen spectra in comparison to their abundance in the local vegetation, while *Aegialitis rotundifolia* is under-

Rhizophora mucronata

Sonneratia sp.

Avicennia sp.

Acanthus ilicifolius

represented. Other non-mangrove pollen are poorly represented by their pollen in the sediments. The results of the study have implications for interpreting the fossil pollen data in the study region, particularly in the Sundarbans and Ganges-Brahmaputra Delta, where modern pollen studies are still sparse.

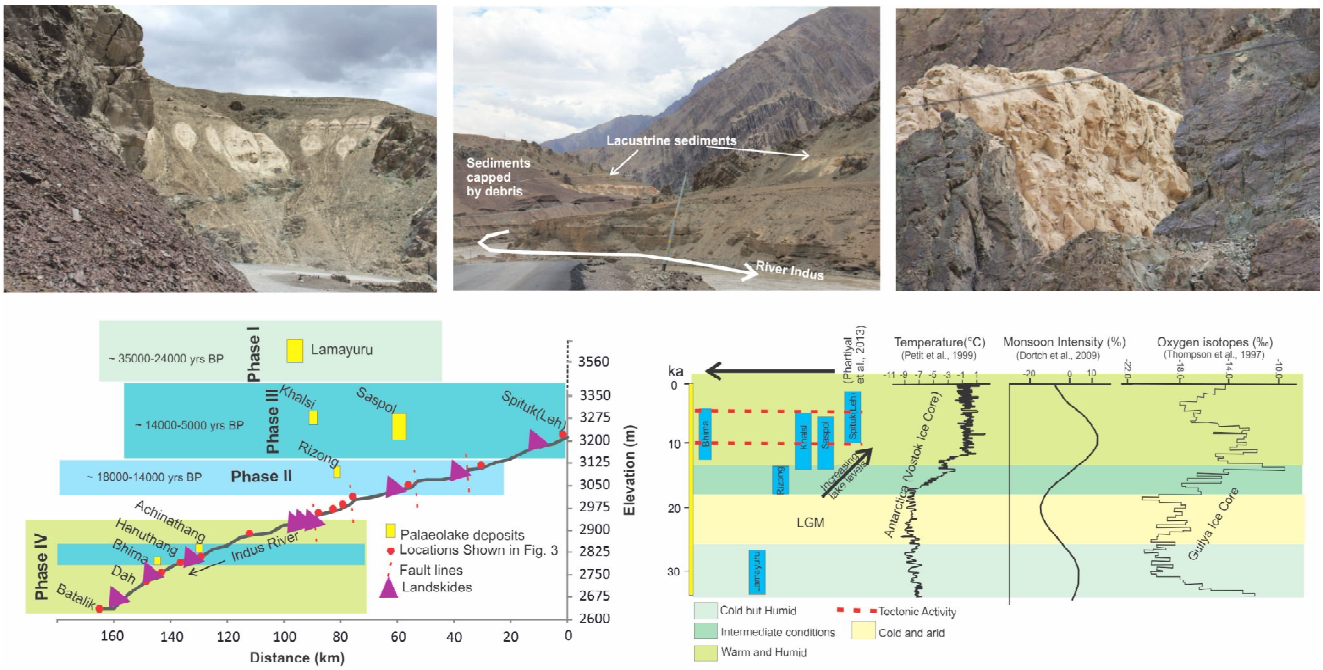
Pollen analysed a 1.7 m deep sediment profile from western part of Sundarbans. The entire profile is mainly composed of silt and clay. Mangrove, dominated by *Aegialitis*, *Excoecaria*, *Ceriops* and *Kandelia*, characterizes the study area. The overall frequency of occurrence reveals that genera like *Sonneratia* and *Rhizophora* dominate the assemblages throughout the core. Other mangrove taxa such as *Acanthus, Avicennia, Excoecaria, Bruguiera, Xylocarpus, Heritiera, Aegialitis* and *Phoenix paludosa* are abundant in restricted stratigraphic sequences. Thus, pollen analytical results of the profile are throughout marked by the dominance of mangrove and their associates pollen. Interpretation of the results is under progress and palynological data has to be fit within the chronological time frame when the ^{14}C dates of the profile will be available. In addition, 10 spider webs collected from Kaikhali and Jharkhali, South 24 Parganas Division (WB) are 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

A transact between Nimo and Batalik along the Indus River in Ladakh region has been studied to consider the geomorphological landform evolution during the Quaternary based on the distribution of the sediments along the valley. Mass movements, catastrophic land sliding and tectonic activity transported material from steep slopes to valley bottoms which were responsible for forming lakes (preserved as thick piles of fine sediment), while the outburst floods redistributed sediment down valley. Three phases of lake formation are recorded in the 136 km stretch– ~35,000 to 26,000 BP (Lamayuru palaeolake), 17,000 to 13,000 BP (Rizong palaeolake) occupying 35 km of the valley length, and 14,000 to 5,000 BP (Khalsi-Saspol palaeolake) 55 km in length and having the highest lake levels. The lake formation is attributed to deglaciation after the last glacial maximum and Holocene warming. Tectonic activities (seismites) are concentrated only at 10 and 6 ka. In addition, grain size analysis, TOC and mineral magnetic proxies of four palaeolake sections (Saspol: 25 m thick, Khalsi: 27 m, Bhima: 10 m & Achinathang: 10 m) along the Lower Indus (between Nimo & Batalik) are also being studied for palaeoclimate studies. Samples for OSL and AMS chronologies of these sections are also processed.

Samples of two glacial lakes from the Khardungla (5,602 m), one of the highest pass of the world that separates the Indus Valley and Shyok Valley, have been analysed for multi-proxy studies using textural, sedimentological, mineral magnetic, geochemical, biotic (palynofacies and diatoms) and isotopic data. The existence of a 185 km valley lake 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 the result of 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. In spite being washed away by the combined effects of active tectonics and intense erosion, the buff colored clay-silt-sand lacustrine facies is well-preserved at few places and is also exposed almost continuously on both banks of the rivers indicative of the existence and extent of this lost lake.



Palaeolake sequences along the River Indus; Longitudinal profile of the Indus Valley with different climatic phases; Comparison of the distribution of palaeolake deposits in the Indus Valley to the temperature, monsoon intensity and Guliya Ice core dataset, and showing the major climatic and tectonic events in the past 35 ka

The geochemical including isotope data generated on the Indus, Shyok Rivers, their tributaries and other first order and hot spring in collaboration with CIMFR (Dhanbad) and PRL (Ahmedabad) is under process of investigation. Additionally, a field work has been conducted (by BP & DN) in regions along the Spiti Valley which preserves the vestiges of once existing lake system. Main types of sediment those are present in the valley (fluvial terraces, lacustrine sediments, glacial & landslides deposits) are observed and mapped. The Quaternary landform features are physically examined through ground check and photographed. The dry beds of the glacial lakes are dug up making a pit for continuous sample collection. An only 50 cm core is also retrieved from the lake. Palaeolake deposits have been recorded. Samples have also been collected for diatom and thecamoebian studies. The localities– Dhankar Lake 1 (altitude 4,148 m), Dhankar Lake 2 (4,162 m) and Schiling Lake (3,647 m) in Upper Spiti Valley; and Nako Lake (3,634 m), Shalkhal (3,116 m) and Reti (3,228 m) in Lower Spiti Valley are under study.

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

Investigator: P.S. Ranhotra

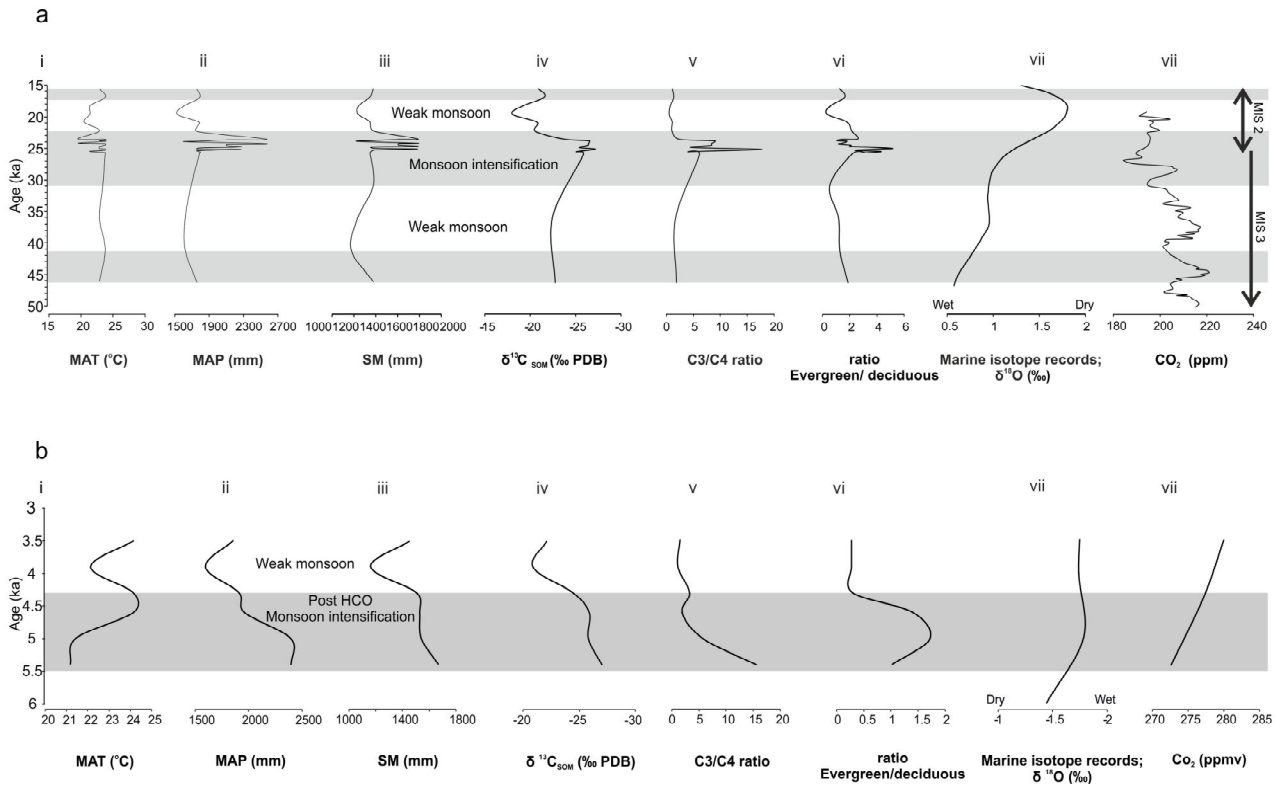
Palynological analysis of the subsurface sediments from the Gangotri and Dokriani glaciated valleys (Garhwal) is in continuation for the vegetational and climatic reconstructions. A 125 cm deep sedimentary profile (KHR-BUG) of the Dokriani Valley consists of dark peat and peaty clay. The peat samples have been radiocarbon dated at three depths and the dates recovered are around 7,090 ±200 Ca yr BC at depth 110-115 cm, 5,390 ±90 Ca yr BC at depth 75-80, and 2,310 ±130 Ca yr BC at depth 54-56 cm from the surface. This shows that the profile covers almost entire Holocene time. A 235 cm deep profile from Tapovan palaeolake (Gangotri Valley) has been OSL dated (at PRL Ahmadabad) at three depths and dates produced shows inversion, viz. 756 ±92 yr BP at depth 230 cm, 1,808 ±133 yrs BP at depth 130 cm, and 960 ±74 yrs BP at depth 70 cm from the surface and covers the late Holocene part. However, based on sedimentology three lacustrine phases have been identified within the sequence that can be related to GLOF episodes. An attempt has been made to generalize the extent of the Gangotri glacier during Holocene, based on the previous reconstructions with more addition of radiocarbon dates available from the palaeoclimatic studies carried out from various geomorphic features at different altitudes within the valley. A manuscript on the aspect has been finalized.

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

Investigator: Ruby Ghosh

Pollen, phytoliths and $\delta^{13}C$ signatures of soil organic matter from two fluvial sedimentary sequences of the Darjeeling foothill region, eastern Himalayas have been used to portray palaeoclimatic oscillations and their impact on regional plant communities over the last ~50 ka. Quantitative palaeoclimate estimation using coexistence approach on pollen data and other proxies indicate significant oscillations in precipitation during the late part of MIS 3 (46.4-25.9 ka), early and middle part of MIS 2 (25.9-15.6 ka), and 5.4 to 3.5 ka. A comparison between monsoonal rainfall, MAT and palaeoatmospheric CO_2 with floral dynamics since last ~50 ka indicates that these fluctuations in plant succession were mainly driven by monsoonal variations. Additionally, surface soil samples collected along a tropical to temperate (138-3,566 m) elevational gradient of the Darjeeling Himalayas have also been done with chemical analysis for both pollen and non-pollen palynomorphs (NPP) to explore the modern vegetation-climate relationship in this part of the Himalayas.

Phytolith formation in plants is commonly thought to be influenced by variations in temperature, precipitation and other environmental factors. The objective of this study is to test how variations in different climatic and edaphic factors, i.e. temperature, rainfall, actual evapotranspiration (AET), potential evapotranspiration (PET), moisture index (MI) and soil pH along a tropical–temperate elevation gradient (150-2,456 m a.s.l.) in the Darjeeling Himalayas would influence the variability and plasticity of formation and frequencies of phytoliths in



Climatic scenario of the Darjeeling foothill region

(a) Between ~50 and 15 ka: Variations of (i) MAT, (ii) MAP and (iii) SM, and (iv) $\delta^{13}C$ records with their effect on (v) C3 and C4 plant diversity, and (vi) evergreen to deciduous plant ratio (present study) and their correlation with global (vii) MIS data (SPECMAP data; Imbrie & McIntyre, 2006), (vii) pCO_2 concentration (Ahn & Brook, 2008).

(b) Between ~ 5.5 and 3.5 ka: Variations of (i) MAT, (ii) MAP and (iii) SM, and (iv) $\delta^{13}C$ records with their effect on (v) C3 and C4 plant diversity, and (vi) evergreen to deciduous plant ratio (present study) and their correlation with (vii) MIS data (SPECMAP data; Imbrie & McIntyre, 2006) (vii) pCO_2 concentration (Indermühle et al., 1998).

Shades distinguish comparatively stronger monsoon over the last ~50 ka. Three major phases i.e., between 46.4 and 41.2 ka, 31 and 22.3 ka and 5.4 to 4.3 ka of monsoon intensification have been observed.

Thysanolaena maxima. Among the 16 phytolith types, frequency, diversity and morphometric sensitivity of some consistently occurring morphs, viz. stomate, cuneiform bulliform, three-lobates and bilobates have been studied in detail to trace their sensitivity to changing environmental factors along the studied elevation gradient in Darjeeling. The study demonstrates that the diversity and morphometric attributes of *T. maxima* phytoliths are plastic in their response to different environmental factors.

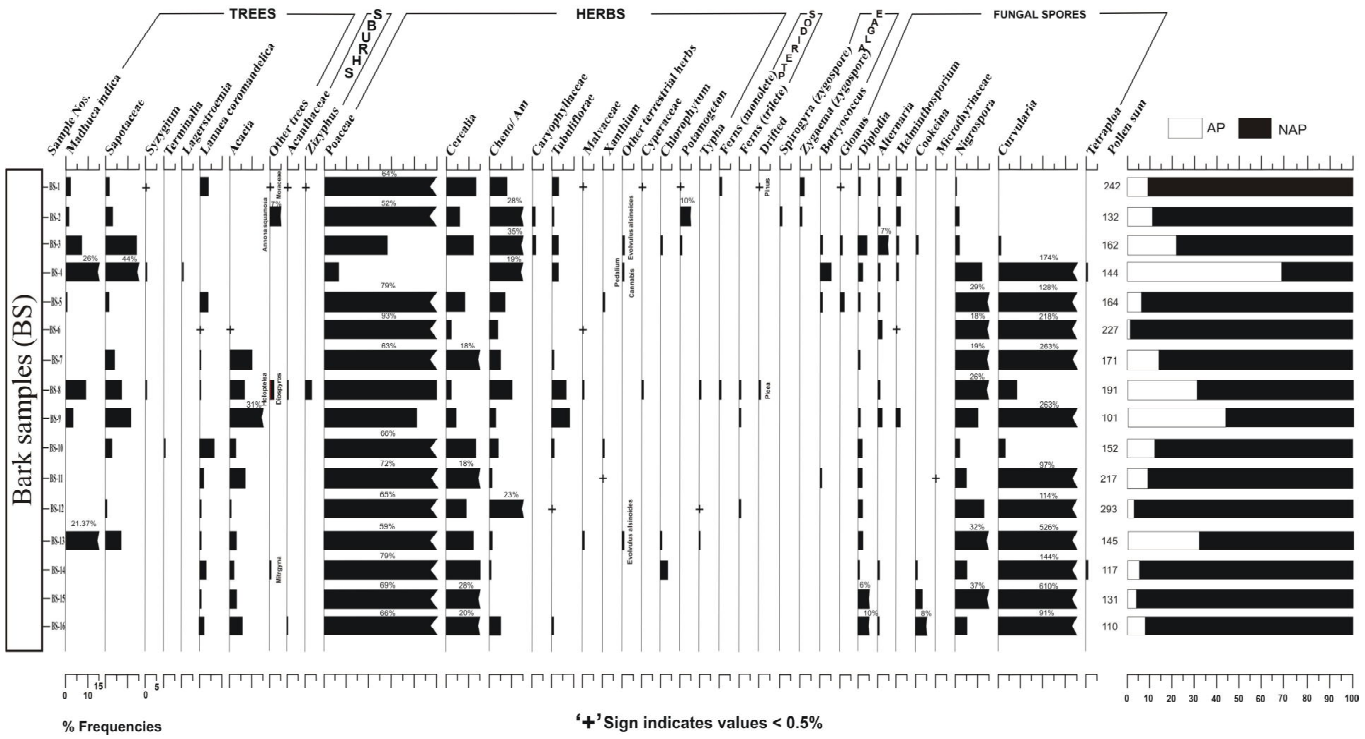
Project- 8.10: Quaternary vegetation and climate change in north and northwestern regions of Chhattisgarh

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

Pollen analysis of 16 modern tree bark samples from Manendragarh Forest Range of Koriya district has revealed the dominance of non-arboreals (herbs) over the arboreals (trees & shrubs). The trees, among the arboreals, constitute an average of 17.23% pollen in the total pollen rain, whereas the average contribution of shrubs is only 0.33%. The non-arboreals have an average of 82.44% pollen in the total pollen rain. Pollen analysis of 12 surface samples from Chhuhi Lake area of the district has also been completed, which showed the dominance of non-arboreal taxa (av. 60.07%) and low representation of arboreal taxa (av. 39.89%).

The field work in Korba district has been undertaken and collected 5 sediment profiles/cores for pollen analysis. Besides, 142 surface samples are also picked up from different forest stands to understand pollen deposition pattern in the region In addition, 16 modern tree bark samples and 5 spider web samples are also collected. Pollen analysis of spider web samples from Bhulsidih area has been accomplished. It demonstrates the complete dominance of non-arboreals (av. 92.37%) over the arboreal taxa (av. 7.62%).

POLLEN SPECTRA OF TREE BARK SAMPLES FROM MANENDRAGARH FOREST RANGE, KORIYA DISTRICT, C.G.



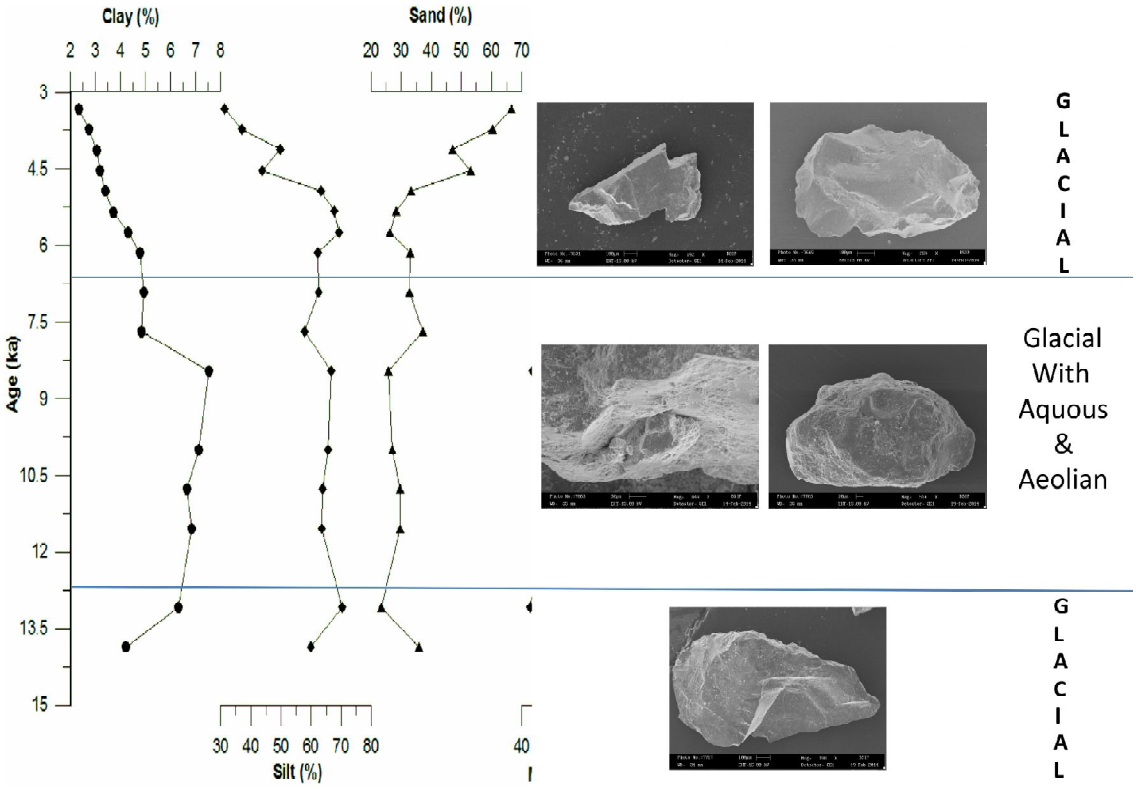
Polar Research Group

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

Palynological studies on surface samples of the Ny-Alesund region, Svalbard are being continued to develop the modern analogues for interpreting the vegetational changes of the past vis-à-vis the climatic oscillations. In spite of the poor yield of palynomorphs, even in the surface sediments, an attempt has been made to understand the relationship between the modern pollen assemblages and the vegetation from which they are derived. Most of the pollen is from the surrounding non-arboreal herbaceous taxa with very few representatives of extra-local elements. 30 samples from a 1.5 m trial-trench have been taken up for further studies. Marine signatures are present in the lower part of the trench in the form of shell fragments and the upper part is terrestrial with a peat band separating the two. Samples are being chemically processed for the release of palynomorphs to check the potentiality for qualitative and quantitative studies.

The four fresh water lake sediment cores from Schirmacher Oasis, East Antarctica have been identified in which one sediment core from Proglacial Lake (P11), two from Land locked lakes (L-49/27 & L-51), and one from Epishelf Lake has been used. These cores were collected during the 32nd Indian Scientific Antarctic Expedition. The selective core samples are used for sedimentological and geochemical analyses. Ten radiocarbon dates have been obtained, out of 12 sediment samples. These dating belong to 3 sediment cores from Schirmacher Oasis. The extrapolation has been done based on the dates and age-depth model has been calculated and prepared in graphical presentation. The dataset on different proxies (grain size distribution, biogenic silica & total organic carbon) have been plotted against the ages. 50 sediment samples have been analyzed for the biogenic silica concentration. Biogenic Silica (BSi) was measured by wet alkaline extraction method, whereas dissolved silica in diluted samples was measured using molybdate blue spectrophotometric method.



Sand, silt and clay % along with quartz microtexture SEM photos from P-11 lake in Schirmacher Oasis

Project- 9.2: Study of Quaternary climatic conditions of the Polar Regions using integrated multi-proxy data

Investigator: Vartika Singh

The dinoflagellate cysts– *Bitectatodinium, Operculodinium*, and thecamoebians like *Arcella* and *Difflugia* have been recorded in significant numbers from the fjord sediments of Arctic. This is providing some initial data important to understand the impact of warming induced melt water flow on the productivity of the fjord. The relative abundance of thecamoebians and dinoflagellate cysts is being studied and is providing signature of melt water influence in the inner part of Kongsfjorden. The anthropogenic carbon particles are also being studied and documented from the fjord sediments. The study of lake surface sediments reveals fairly good amount of diatom frustules over other organic content. The sub-surface sediments however, have considerably low diatom frustule concentration. This inference is being assessed and searched in the light of productivity as a causal factor. The Luminescence dating of trench sediments is being carried out (at PRL, Ahmedabad) for the reconstruction of climate and sea level changes.

The study of Antarctic marine diatoms is being supplemented by geochemical data on the presence and amount of organic and inorganic fractions of carbon to further our understanding of the global carbon budget.

Dendrochronology Group

Project- 10.1: High-resolution palaeoclimatology of western Himalaya

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

Standardized Precipitation Index (SPI), a drought index, has been reconstructed using tree-ring width chronologies of Himalayan cedar (*Cedrus deodara*) prepared from two ecologically homogeneous settings in Kumaun region, extending 7-month SPI of May (SPI7-May) back to 1720 CE. The calibration model capturing 60% of variance in the observed SPI series (1902-1967) is the strongest so far from the Indian region. The SPI reconstruction revealed high year-to-year variability with 1816 (SPI -1.92) and 1737 (SPI +2.33) the driest and the wettest years, respectively. The five year mean of reconstructed SPI revealed multiyear droughts in 1920-1924, 1782-1786, 1812-1816, 1744-1748, 1964-1968 , and pluvial in 1911-1915, 1723-1727, 1788-1792, 1758-1762 and 1733-1737. The SPI7-May was found to be significantly correlated with wheat-barley productivity data of Almora in Kumaun, close to tree ring sampling sites.

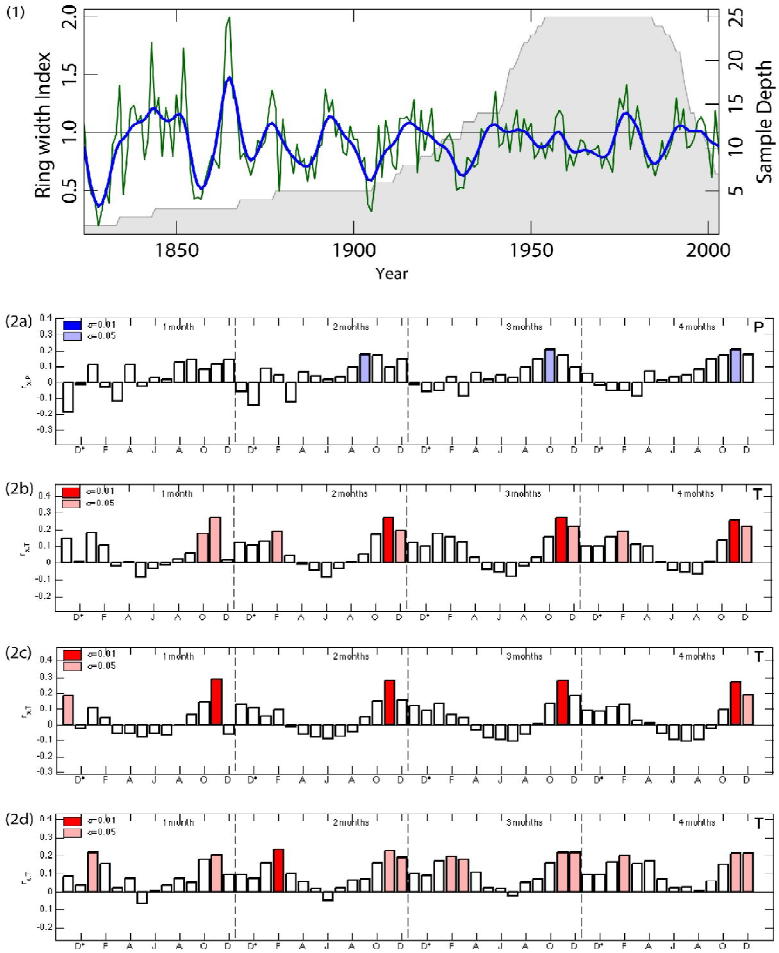
The tree-ring samples have been collected (by KGM) from climate sensitive and open forests sites for long term climate reconstruction in Kinnaur, Himachal Pradesh. 10 samples of *Pinus wallichiana* and 22 samples of *Cedrus deodara* are collected from areas around Purbani and Rarang. Extensive survey of adjoining areas is done to select old trees for sampling.

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

Total 504 tree-ring core samples of four conifer taxa, viz. *Abies densa, Larix griffithiana, Juniperus indica* and *Tsuga dumosa*, and one broad-leaved taxa (*Betula utilis*) have been collected from the north Sikkim. In addition to this, 10 scrub samples of *Juniperus squamata* are also collected. All tree core samples have been mounted in wooden block for further analysis. Total 149 tree-ring samples of *Abies densa* collected from three localities are cross-dated.

Tree-ring analysis of *Toona ciliata* Roem. (Toon) from the subtropical wet hill forests of Kalimpong, Eastern Himalaya has been conducted. Based on this study, 180 years long tree-ring width chronology (spanning A.D. 1824-2003) is prepared and its relationship with regional climatic parameters is established. Besides, tree-ring samples of *Cedrus deodara* collected from Himachal Pradesh, Western Himalaya is also cross-dated and measured. Three chronologies are prepared ranging from 334 to 614 years.



(1) Tree–ring chronology of *Toona ciliata* extending from AD 1824 to 2003 along with number of core samples used to develop tree–ring chronology. The thick line represents the smoothing spline with a 50% frequency cut off of 10 years. (2a-2d) Seasonal correlation results summary of seasonal climatic signals in tree–ring data of *Toona ciliata*. Correlation of tree-ring variable with monthly, 2–months, 3–months and 4–months: (2a) precipitation, (2b) mean temperature, (2c) maximum temperature, and (2d) minimum temperature for ending months from November preceding the growth year through December of the growth year. Monte-Carlo-derived significance of correlation (Meko et al. 2011) is shown in colors on left top corner of each figure for levels 0.01 and 0.05

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

The palaeoethnobotanical investigation of carbonized seeds and fruits has been carried out from the cultural horizons of Chalcolithic, Northern Black Polished Ware, Sunga and Kushan Periods at archaeological site Maner (25º 38´ 33" N: 85º 52´ 15" E), District Patna in middle Ganga Plain, just opposite to site Chirand in District Saran (Bihar). The material from ancient Maner is collected in collaboration with ASI, Patna Circle. Field crop remains and their associates recovered from the site belong to Cereals (*Oryza sativa*: cultivated rice, *Hordeum vulgare*: barley), minor crop (*Coix lacryma jobi*: Job's tears) silicified, millet (*Echinochloa crus-galli*: sawan), legumes/pulses (*Vigna* sp.: black/green gram, *Lens culinaris*: lentil), fibre-crop (*Salmalia malbaricum*: silk-cotton), weeds and wild taxa (*Andropogon* sp.: blue stem grass, *Argemone Mexicana*: Mexican thistle, Cheno-Ams, *Cleome* sp.: spider weed, *Commelina* sp.: day flower faint, *Desmodium gangeticum*: tickclover,

Carbonised remains from Early Historic Rajdhani : a) *Oryza sativa* (cultivated rice), b) *Oryza rufipogon* (wild rice), c) *Hordeum vulgare* (barley), d) *Lens culinaris* (lentil), e) *Lathyrus sativus* (grass pea), f) *Vigna* sp. (cotyledons), g) *Vigan radiata* (green gram), h) *Vigna mungo* (black gram), i) *Pisum arvense* (field pea), j) *Macrotyloma uniflorum* (horse gram), k) *Vicia sativa* (common vetch), i) *Vicia hirsuta* (tiny vetch), m) *Paspalum* sp. (kodo-millet), n) *Rumex* sp. (dock), o) *Andropogon* sp. (blue stem grass), p) *Setaria* sp., q) *Coix* seeds (job's tear), r) *Ziziphus mauritiana* (cultivated uujube)

Eleusine sp.: goosegrass, *Fimbristylis* sp.: fimbristylis sedge, *Indigofera hirsute*: hairy indigo, *Medicago* sp.: blue alfalfa, *Polygonum barbatum*: knotweed, smart-weed, *Rumex* sp.: labbibi, *Solanum* sp.: nightshade, *Trianthema triquetra*: red spinach, *Vicia sativa*: common vetch, and *Ziziphus* sp.: Jujube). Additionally, botanical remains have been retrieved from soil samples, collected by the team from Dept. of Ancient Indian History & Archaeology, LU from ancient site at Biland Khera, District Hardoi (UP) in middle Ganga plain.

Archaeobotanical samples from a early Historic site– Rajdhani in Maharajganj district (UP), datable to 800-200 BC have been analysed. The finds include the remains of *Oryza sativa* (rice), *Hordeum vulgare* (hulled barley), *Lens culinaris* (lentil), *Lathyrus sativus* (grass pea), *Vigna radiata* (green gram), *Vigna mungo* (black gram), *Macrotyloma uniflorum* (horse gram) and *Pisum arvense* (field pea). Associated with these crop remains as an admixture, the remains of *Oryza rufipogon*, *Vicia sativa*, *Vicia hirsuta*, *Paspalum* sp., *Rumex* sp., *Andropogon* sp., *Setaria* sp., *Coix* sp. and *Ziziphus mauritiana* as weeds and other wild taxa have also been recorded. Besides, samples collected from Kotada-Badli, a Late Mature Harappan site in District Kachchh (Gujarat), dated to 2200-1900 BC, have been analyzed. The studies carried out brought to light the dominance of small-grained millets (*Setaria* sp., *Setaria italica* & *Panicum* sp.) in comparison to large-grained cereal (*Hordeum vulgare*); suggesting human adaptation in response to weak SW monsoon. Also participated in the excavations and collected botanical remains from Chandravati site in District Sirohi (Rajasthan).

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 111 samples have been processed for benzene, 147 samples counted in the Ultra Low Background Liquid scintillation Counter, and the calibrated ages calculated for them. These included sediment samples, such as charcoal and wood samples from archaeological sites, lake shores, etc. and also the standard and background samples. Calibrations are carried out using new standard. The dated samples included samples belonging to the Late Quaternary period under consultancy, for Institute projects, and also for collaborative work. The required chemicals, component are procured, glass components fabricated in the laboratory and using them, another benzene preparation system is assembled and improved which is under testing now.

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 & M.C. Manoj

Contemporary science is being transformed increasingly from qualitative mode to quantitative mode and by integrating data from several allied disciplines for a comprehensive understanding of the subject. Therefore, it is important to develop laboratories for sophisticated analytical instrumentation within the institute, so that the dependency on outside agencies is minimized and higher goals may be achieved. In view of the development (procurement & establishment) of standard laboratories, several instruments, such as ICP-MS, IRMS, GCMS and TL/OSL reader have already been procured in the first phase. Along with procurement of these instruments, specifications have been drawn for the new lab setup to host these instruments as well as preparation of samples for measurement/analysis. Since sample preparation is the most important and critical step in any analytical laboratory, adequate measures have been taken including setting up a Class 1000X CLEAN LAB. In order to maintain temperature and continuous positive pressure in the laboratory, air handling units and other lab related accessories, which will be required later at the time of running the instruments, have also been procured.

Important steps taken are– i) finalization of specifications for clean rooms (partitioning, flooring, ceiling & air handling unit) to establish TL/OSL and geochemistry laboratories, and a global tender has been floated for the same, ii) evaluation of technical bid related with clean rooms, followed by preparation of comparative chart and opening of the financial bid. The purchase order has since been placed with the L1 firm, and iii) preparation and evaluation of specifications for oven, fume hood, air handling unit, block hot plate, acid distillation unit, disc mill, furniture, gas cylinders, chemicals, milli-Q water plant, etc. (the delivery of items is in progress).

The laboratory establishment is a continuous process wherein commissioning and installation of already procured items go hand in hand with the procurement process for the next batch of instruments. In this regard, procurement of several more equipments (XRD, FE-SEM & Particle Size Analyzer) and some other units of TL/OSL laboratory has been undertaken with the following steps– i) preparation of specifications for XRD, FE-SEM and particle size analyzer in consultation with the user community, and ii) open tenders are floated for the same and evaluation of technical and financial bid is done. The committee negotiated the price with the firms which quoted the lowest rate (L1) and recommended that the procurement of these instruments from the respective L1 firms may be initiated. Following the approval, purchase orders for the equipment have been issued and LCs are also opened. Currently, the fabrication work of the laboratory is going on in full swing and is expected to be completed soon. Once it is done, the installation of already procured equipments will be initiated and after calibration and standardization of the machines, routine analyses will be started. The TL/OSL reader has been already installed temporarily and the bench marking/ reproducing the results is in progress.

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 Ladakh Himalaya (north-western India) contains deep valleys and high peak mountain ranges. The origin and evolution of these long and wide ranges of mountains is linked to the convergence of the active continental collision during the Cenozoic era. However, there are certain problems that are not yet resolved particularly the timing of the collision, material supplied in the collision zone, processes occurred during this time, etc. Therefore, the aim is to address these issues using palynology, palaeobotany, palaeontology, geochemistry including isotopes systematic techniques. Integration of micropalaeontological and palynological/palaeobotanical data will help to determine the age and environments of deposition of the various pre- and post-collision sedimentary units in the Indus-Suture Zone, and understanding the implications of this data for the collision history. The study of vertical and lateral distribution pattern of pollen/spore/dinoflagellate cyst, dispersed organic matter content (in a sedimentological framework) should be used for characterization of sub-environments and lateral facies variation. Palaeoclimatic and palaeobiogeographic interpretations will also be made on the basis of mega- flora and fauna. Characterization of rocks using geochemical and isotopes will ascertain the provenance and environmental condition prevailing during its formation.

A variety of samples have been collected from the Indus Tsangpo Suture Zone (ITSZ) for palaeobotanical, paleontological and geochemical studies in Kargil, Taruche-Saspoche, Nimu-Chilling, Hemis, and Upshi-Lato areas. Thin sections are prepared for the samples collected from Nimu-Chilling area, which yielded a rich assemblage of foraminifers. The samples from Tauche-Saspoche area have been processed separately for palynomorphs and slides are prepared for the productive samples. Samples from Kargil area are also macerated for the recovery of microfaunal elements and few productive horizons have been demarcated. Samples from the Kargil area are processed separately. The samples for geochemical including isotopic studies will be taken up once the facility is established in the institute.

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

Stromatolites recorded from the carbonate units of the Semri Group have been photo-documented and details have been finalized for the atlas. Diversity of stromatolites of the Bhander Group is being processed for recording the details.

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

Investigators: K. J. Singh & Anju Saxena

Nine species of the genus *Glossopteris* viz., *G. asansolensis, G bunburyana, G. danae, G. manjuiae, G. schopjii, G.schimperi, G ednae, G. kusumiae* and *G. raylei* reported from the Barakar Formation of Churulia area, Raniganj Coalfield have been reinvestigated and compiled for the monographic work. These species have

not been included in the existing monograph of *Glossopteris*. The database of these species incorporating all the morphological details, their stratigraphical occurrences, localities, synonymy, text figures, photographs and reconstructions, etc. has also been prepared. Some of the old literature describing and documenting *Glossopteris* species has been consulted.

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

Investigators: Neeru Prakash & Neelam

For the preparation of catalogue, relevant literatures of Indian researchers have been consulted and taxonomically documented indicating author's name, year of publication, locality, age and abstracts. Besides, generic diagnosis of taxa and description with its classification and text figures or photographs are been included.

Project- 14.4: An annotated bibliography on Indian Gondwana palynology

Investigators: Neerja Jha & Neha Aggarwal

Palynological literature has been collected on Indian Gondwana. Their abstracts have been added or noted. Editing and abbreviation of abstracts in order to bring out the matter in a concise form have been completed and finalized.

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

Investigator: Rashmi Srivastava

Sorting and preparation of references and generic/ specific details of the megafossils genera described from 2006 onwards are being continued. Further work is in progress.

Project- 14.6: Calcareous nannofossil records from India

Investigators: Jyotsana Rai & Abha Singh

Line drawings of various nannofossil taxa belonging to several Jurassic, Cretaceous and Tertiary nannofossil families are under preparation. List of nannofossil species 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 labeled 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

Pollen morphometric examination of 81 plant species belonging to 64 genera under 38 families from different reserve forests of Assam has been performed. Formulation of phenological table, photo-documentation and comparative interpretation is under progress. Fresh polliniferous material (flower/ stamen) of some important constituents (arboreals & non-arboreals) of tropical deciduous forest of Brahmaputra and Barak valley is collected during field visit to Assam.

Work other than Institute Projects

A field work has been carried out (with Vu Anh Thu of Vietnam) in part of the Vindhyan Supergroup exposed in Chitrakut district, Uttar Pradesh, and collected sets of systematic samples from different lithological units of the Semri Group for the palaeobiological studies.

Mukund Sharma

Two types of fossil demosponge have been identified among the earlier recovery of the biota (pollen grains of angiosperms & lower invertebrates) both in thin sections and macerated residue of the laminated chert from Tertiary sequence of Gujarat. They are closely resembled with the extant forms– *Sycon* and *Leucosolenia* of Scypha, usually found in shallow marine water.

Sunil Bajpai, R.S. Singh & Rupendra Babu

A manuscript entitled 'Morphologically complex organic-walled microfossils (OWM) from the Late Palaeoproterozoic-Early Mesoproterozoic Chitrakut Formation, Vindhyan Supergroup, Central India and their implications on the antiquity of eukaryotes' has been finalized.

V.K. Singh & Mukund Sharma

A review paper entitled 'Advent and decline of the genus *Glossopteris* Brongniart in the Talcher Coalfield, Mahanadi Basin, Odisha, India' has been finalized. It deals with the distribution of the genus *Glossopteris* and its fructifications in different formations of the Talcher Coalfield. The study shows how this taxon appeared in the earliest Permian Talchir Formation and evolved and diversified through the Karharbari, Barakar, and lower Kamthi formations, and ultimately vanished in the Early Triassic upper Kamthi Formation. Barren Measures Formation is devoid of any mega plant fossil. The study also shows that the lower Kamthi Formation of the coalfield has the maximum diversity of *Glossopteris* (47 species) among all the known localities of this formation exposed in Indian Gondwana. Very low diversity of *Glossopteris* in the upper Kamthi Formation of Talcher Basin demonstrates that this palaeogeographic area would have experienced more arid conditions in Early-Middle Triassic period as compared to the mellowing climatic conditions prevailing during the same time period in the Panchet Formation (= upper Kamthi Formation) of other areas of Son-Mahanadi and Damodar basins.

K.J. Singh & Anju Saxena

Plant megafossils recorded from the Kamthi Formation of India have been assessed. The formation is mainly exposed in the Mahanadi, Godavari and Wardha basins and has been critically analysed on the basis of its megafloral and palynological contents, and the lithological aspects by earlier workers who variously assigned its age as Late Permian, Early and Late Triassic. An endeavour has been made to compile all the known plant fossil records from the Kamthi Formation for better understanding of its floral and biostratigraphical significance. Known records of the plant megafossils from the formation reveal dominance of the *Glossopteris* flora and paucity of the *Dicroidium* floral elements; suggesting a transition between Late Permian and Early Triassic.

Rajni Tewari, Arun Joshi & Deepa Agnihotri

Twenty-five samples have been analyzed (with Ram Awatar & Shreerup Goswami) from bore-hole SGT-4, drilled in Ghunghuti area in the western part of Sohagpur Coalfield, District Shahdol (MP). Spores and pollen grains have been recovered from eight samples. On the basis of quantitative and qualitative analyses of the samples, two palynoassemblage zones have been identified in ascending order. Palynoassemblage-I (at 242.70 -203.25 m depth) reveals the dominance of the palynoflora– *Scheuringipollenites* and *Faunipollenites*, and Palynoassemblage-II (at 154.05-19.25 m depth) contains striate disaccate pollen grains– *Faunipollenites* and *Striatopodocarpites* in prominence; suggesting a Late Permian age of the strata. Of the two palynoassemblages, the second one corresponds to Raniganj Formation and is equivalent to Middle Pali Member of the Pali Formation, while the underlying first palynoassemblage is equivalent to the lower Barakar Formation.

Diverse and well-preserved palynomorphs have been recovered from the ammonoid *Cylolobus walkeri* bearing youngest bed (0.45 m) of the Gungri Formation, Spiti Valley. The palynofossils reveal the dominance of striate bisaccate pollen grains along with *Lunatisporites pellucidus* and *Gondisporites raniganjensis*; suggesting a Late Permian age of the strata. However, the assemblage also shows FAD (First Appearance Datum) of certain key Early Triassic palynotaxa like– *Kraeuselisporites cuspidus, Lundbladispora obsolete, Osmundacidites senectus, Alisporites asansoliensis, Infernopollenites pseudoclaustratus, Falcisporites australis, Goubinispora indica, Satsangisaccites*

nidpurensis, Chordasporites australiensis, etc.; suggesting latest Permian age (Dorashamian Stage) for the Ghungri Formation. The presence of Dorashamian palynomorphs along with some Early Triassic palynomorphs recorded from the Lingti Road Section clearly suggest that there was continuous deposition of Permian and Triassic sediments at PTB in the classical locality of Spiti Valley. The study is further supported by the conodont records reported by earlier workers.

Rajni Tewari & Saurabh Gautam

The palynocomposition of the bore-hole NP-50 from Nand Besur Coalfield, Nagpur district, Maharashtra is compared with the previously known palynoassemblages from the Early Triassic sediments of Damodar, Godavari, Rajmahal, Satpura, Son-Mahanadi and several other Indian Gondwana basins. The data on the aspect has been finalized. Besides, one manuscript on the Late Permian palynoassemblage from Chalburdi area, Chandrapur district has also been documented.

Srikanta Murthy & O.S. Sarate

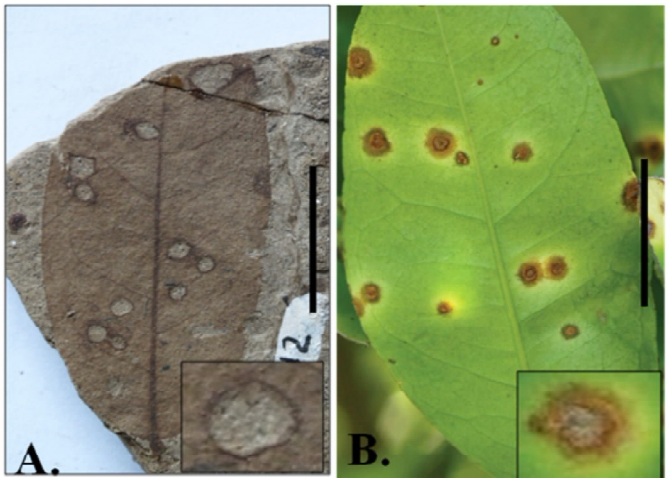
Fossil woods collected from the Tipam Group (Late Miocene) of Laljuri situated near Kumarghat in the Unakoti district have been studied. They are identified as *Kayea* (Calophyllaceae), *Dipterocarpus* and *Shorea* (Dipterocarpaceae), and *Cynometra* and *Millettia* (Fabaceae). Their occurrence in the flora indicated tropical warm and humid condition in Tripura during the period of deposition. Almost all the fossils in the present assemblage were diffused porous. This indicated tropical conditions with little seasonality in the region in that period. A manuscript based on this study is prepared and finalized.

R.C. Mehrotra, Gaurav Srivastava, Nivedita Mehrotra & S.K. Shah

The finding of the genus *Annona* is significant because it serves as 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, reported on the basis of pollen from Kachchh. The Vastan occurrences represent a continuous record from the Indian latest Cretaceous, through the Palaeocene, based on multiple vegetative entities. The well-preserved fruit is morphologically similar to *Annona palustris* L. 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 and then onto India, as it is recorded from the sedimentary beds associated with the Deccan volcanics. Another angiosperm family– Dipterocarpaceae is also found in Vastan with a similar phytogeographic distribution.

Mahesh Prasad, Hukam Singh & S.K. Singh

The presence of gall-like lesion marks in the fossil leaves of *Citrus aurantium* Linn. has been reported from Late Tertiary sequence of Mahuandar Valley (Jharkhand State). Generally, the gall lesions are rounded, oval to circular in shape and 1-2 mm in diameter, however there are some irregular shaped lesions (more than 3 mm in diameter). They occur mostly near the midrib, in between the margin and in lower as well as in upper portion of



Leaf galls on the tropical fossil leaf from Mahuadanr Valley: A) Fossil leaf of *Citrus* sp. showing orientation, distribution and features of galls, B) Modern comparable leaf showing similar details as fossil

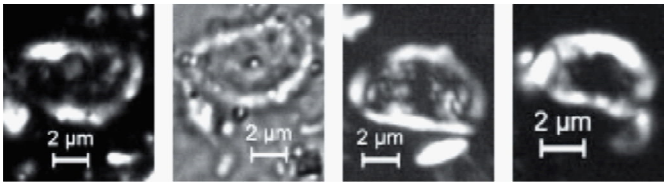
leaves. The lesions are open and hollow and are surrounded by thick border giving ring effect. The fossil lesions have been compared with the similar infected modern leaves and appear to be similar with the most common gall of *Citrus aurantium*, caused by bacteria– *Xanthomonas citri*.

Mahesh Prasad, S.K. Singh & S.K. Saini

Quaternary sediments of Allahband and Trangdi Bet areas (Great Rann of Kachchh) show co-occurrence of nannofossils from several ages (Jurassic-Quaternary). The assemblage is highly diverse and well-preserved. The nannofossil cocktail assemblage is dominated by Late Cretaceous reworked taxa, followed by Tertiary, few Quaternary and very few Jurassic taxa. No elements indicating K/Pg and LPTM boundary in Kachchh Basin was encountered. The periodic sea transgression by tides, flash floods, active tectonics along fault plains and neo-tectonics could be reasons for this unique mixed nannofossil assemblage in the area. It appears that the provenance of Pliensbachian age marine sediments lies

near Allahbund close to Indo-Pakistan border as reworked Pliensbachian (*Mitrolithus lenticularis*) nannotaxa is found in the assemblage.

The Late Cretaceous Infratrappean sedimentary sequences of peninsular India along Narmada-Son lineament exposed in Bagh area have been investigated for nannofossils. Samples from the Bariya Nala section have revealed two nannofossil productive levels. Sample NS-6 representing the top of the Nimar Sandstone is overlain by a highly bioturbated horizon and a mega ripple horizon, and the sample NS-7 represents the base of the overlying ammonite-yielding unit (Nodular Limestone). NS-6 has yielded 41 nannofossil species, and NS-7 has



Nephrolithus frequens- a cold water Late campanain-Maastrichtian nannotaxa from Chakrud section, Zeerabad, central India

yielded 32 species. The Nimar Sandstone-Nodular Limestone boundary in the Bariya Nala section is here considered to correspond to the Turonian/Coniacian boundary based on the nannofossil evidence. This inference is supported by the presence of hard ground in the section. In addition, samples from the Chakrud section near Zeerabad area have yielded a moderately diversified nannofossil assemblage. Occurrence of cosmopolitan markers– *Ceratolithoides self trailiae, Eiffellithus eximius, E. parallelus, Lithraphidites prequadratus, Marthasterites furcatus, Marthasterites simplex, Microrhabdulus undosus, Nephrolithus frequens, Petrarhabdus copulates* and *Uniplanarius sissinghi* clearly indicates late Early Campanian age.

Jyotsana Rai

Pollen-spores, diatoms and fresh water sponge spicules have been studied in 12 samples collected from Karewa Formation of Kashmir. Abundance of benthic diatom and pollen-spores have been recorded and the climatic fluctuations have been inferred during the first interglacial period of the Quaternary period.

Anjum Farooqui, S.K. Shukla & Rajni Tewari

Chemical analysis followed by pollen and spore studies have been performed on yellow rain samples procured from three different localities of Lucknow district, Uttar Pradesh. A manuscript on the aspect has been finalized.

S.K. Bera & Swati Tripathi

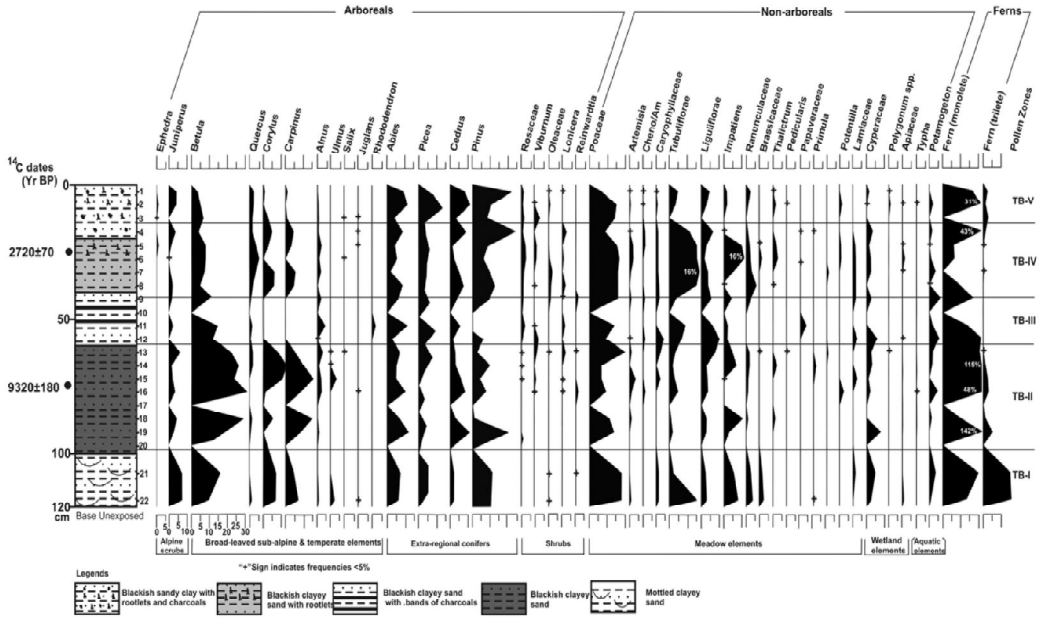
An analysis of remanent magnetism and radiocarbon ages in the dry lacustrine/ sediment fills of the Schirmacher Oasis (East Antarctica) has been conducted to reconstruct past climatic condition. The data traces 6 phases of climatic fluctuation between 13 and 3 ka, (Phases 1, 3 & 5 represent cold periods while Phases 2, 4, and 6 represent warm periods). Holocene Optima (Phase 4) and Mid Holocene Hypsithermal (Phase 6) are distinguished by decreased values of concentrations dependent parameters. Besides, a multi proxy investigation has also been carried out in lacustrine sediment core of Larseman Hills to reconstruct past climatic condition. The core contains valuable information on Holocene climatic conditions from 8.3-1 ka BP. Three distinct climatic regimes, i.e. Phase I, II and III are established by mineral magnetic and textural studies.

Binita Phartiyal

A three day field work has been conducted for collection of samples from an exposed river cut section developed over the Loni River near Gosai Ganj (UP). This work is conducted in relation to the further enhancement in the TL/OSL facility.

Anupam Sharma

A 1.2 m deep sediment profile from Tundabhuj Lake in Parvati Valley (Himachal Pradesh) has been studied for pollen, sediment texture, moisture, organic/inorganic carbon content and geochemical analyses. The result shows that between 15,260 and 13,280 cal yr BP a warm and moderately humid climate was prevailed. An increase in organic carbon and CIA (chemical index of alteration) values suggests moderate degree of chemical weathering. Around 13,280 to 7,340 cal yr BP, the substantial expansion of alpine-scrub vegetation is witnessed. The climate turned cold and dry around 7,340 to 5,030 cal yr BP as deduced by the abrupt reduction in the alpine-scrubs and meadow constituents. A gradual decrease in CIA and organic carbon values also support cold condition. Between 5,030 and 2,000 cal yr BP, the region experienced a warm and humid climate again as evidenced from moderate expansion of alpine-scrubs and conifers. An increasing CIA values, organic carbon and concentration of immobile elements reaffirm better climatic condition. From 2,000 cal yr BP onwards,



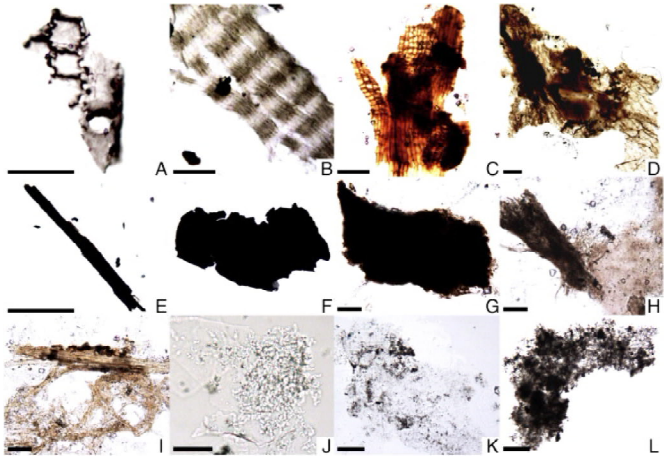
Pollen diagram from Tundabhuj Lake

deterioration in climate is demonstrated by the depletion in *Betula* and broad-leaved associates and increase in dry elements (*Juniperus* & *Ephedra*) Significant decrease in CIA, organic carbon and immobile elements substantiate deterioration in climate.

M.S. Chauhan, Anupam Sharma & Kamlesh Kumar

The dispersed organic matter content has been studied for the very first time from the Guryul ravine section of Kashmir, providing important evidence of anoxia and volcanism. A manuscript based on the aspect has been finalized. The section had been a major contender for the Permian-Triassic boundary Global Stratotype Section before the GSSP Meishan section of China, as it represents a complete sequence of Palaeozoic-Mesozoic transition, witnessing the biggest mass extinction in the evolutionary history of the earth.

Vartika Singh



Representative examples of dispersed organic matter from the Permian-Triassic transition (Zewan and Khunamuh Formations), Guryul Ravine Section: A) plant cuticle, B-C) structured woody tissue, D) plant cuticle showing partial degradation into gelified amorphous material, E-F) opaque (black) organic matter of terrestrial origin, G) partially oxidised brown organic matter, H) degraded brown organic tissue with amorphous light brown gelified matter, I) degraded brown organic tissue with fungal infestation, J) amorphous bacterial matter, K) transparent to translucent granular organic matter, L) mixed gelified and granular organic matter. [Scale bars: 20 μm]

A ~150 years mean summer temperature variations have been developed from north Sikkim using ring-width chronology of *Larix griffithiana*. The reconstruction showed mean summer temperature is warming since 1930s. The period 1996-2005 is the warmest in the past ~150 years in Sikkim Himalaya.

R.R. Yadav & K.G. Misra

345 years previous years October to current years June (OJ) Satluj river flow reconstruction has been developed using *Cedrus deodara* ring-width chronologies from Satluj river basin. The reconstruction is consistent with the decreasing trend in winter precipitation in western Himalaya. The reconstructed river flow data showed high annual to decadal scale variations.

K.G. Misra

A subsurface sedimentary profile from Tibetan region has been palynologically analyzed (with Prof. Cheng Sen Li at the Institute of Botany, CAS, Beijing, China under CAS-TWAS Post Doctoral Fellowship) with

an objective to reconstruct the high resolution Late Holocene climate and monsoonal variations of the region. The study shows warm-wet climate of higher magnitude than present from ~1,600 to 760 yrs BP (~400-1,240 AD) with Alpine Meadow biome. From 760 yrs BP (~1,240 AD) biome changed to Alpine Steppe with cold-dry climate than present. The cold-dry phase peaked around 1,500 to 1,800 AD (Little Ice Age). Decadal warm phases are noticed around 1,375 and 1,640 AD.

P.S. Ranhotra

A pilot field trip has been undertaken for documentation of rock art in Sonbhadra (UP). A multidisciplinary national workshop on rock art is also organized; supported by IGNCA, New Delhi. Another project for field trip is also prepared and submitted to IGNCA. In addition, dating work (on samples from Harappan archaeological site Khirsara, Kachchh; sediments from Lamahatta, Darjeeling; sediment cores from Pednapatnam coast, lower Krishna river deltaic plain; and associated charcoal with Cist burial from Lippa) was carried out in collaboration wih BSIP and outside (HNB Garhwal University) workers in different areas.

C.M. Nautiyal

Pond sediments from Perunkulam pond in south-eastern Tamil Nadu have been collected by making 2 m trench. 10 samples for OSL dating and 20 samples for geochemistry, pollen and diatom analyses are collected. 5 samples have been dated using OSL from PRL. Geochemical analyses are being carried out with the collaboration with NGRI.

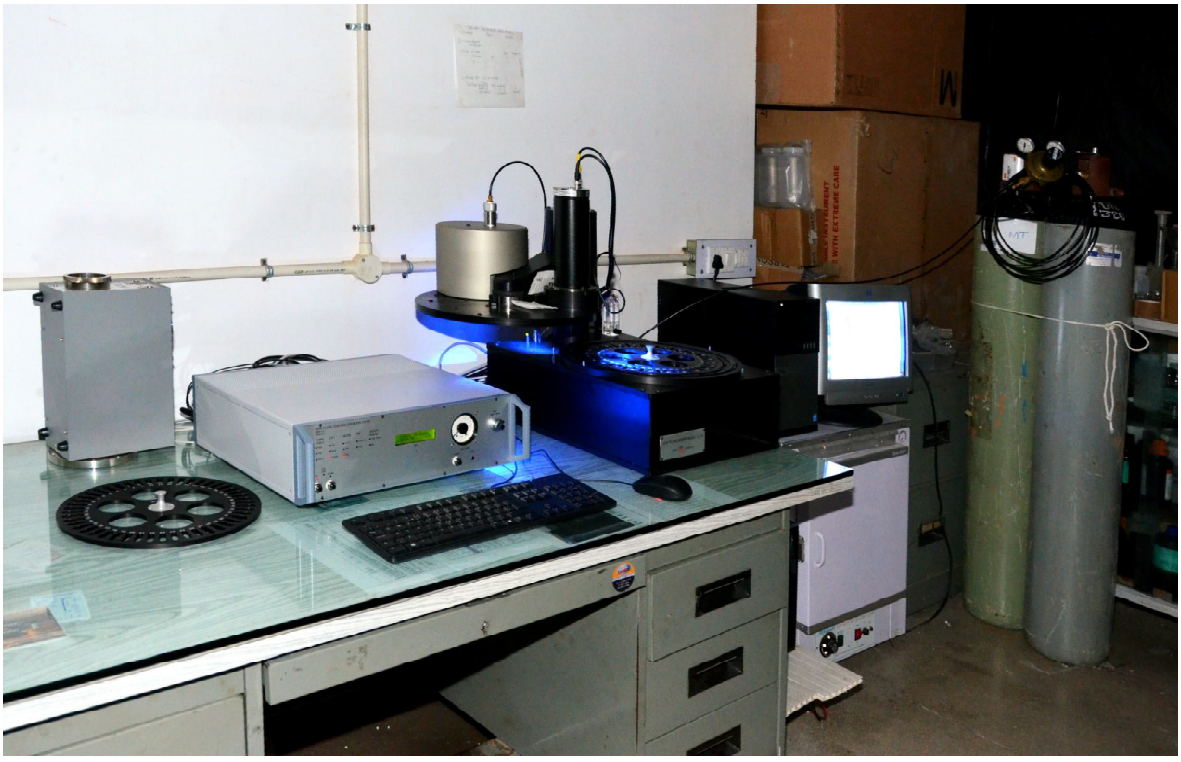
P. Morthekai

Samples that have been collected from the higher Himalaya in collaboration with PRL and Garhwal University are prepared for OSL dating and geochemical analysis. The OSL dating is done on the samples as well as the XRF of lake samples is also done. The documentation work is under progress.

S.N. Ali

A fieldwork has been carried out as part of the IGCP-608 programme, in the Late Cretaceous sedimentary sequences of peninsular India (Madhya Pradesh & Gujarat States) and samples are collected for palaeontological studies. Study of the palaeontological component is in progress.

V.V. Kapur



Newly installed Automated TL/IRSL/Blue OSL System (Model Risø TL/OSL-DA-20C/D), useful for dating Quaternary sediments (glacial, fluvial, aeolian and lacustrine) and archaeological artefacts

Collaborative Work

A project on the Early Carboniferous (Tournaisian) plants from Syringothyris Limestone at Margan Top area in Anantnag district (Kashmir) has recently been started. The stratigraphy, sedimentology and floristics of one of the best plant fossil localities in the Pir Panjal Range, near Margan Top have been documented for the first time in detail. In the preliminary studies, some of the fine-grained deposits have yielded fossil floras dominated by *Sublepidodendron*. The other genera identified are– *Nothorhacopteris, Triphyllopteris, Flabellofolium*, *Noeggerathiopsis*, etc.

K.J. Singh & Anju Saxena
[**& G.M. Bhat & A.M. Dar** (Jammu University)
& Chris Cleal (National Museum of Wales, Cardiff, UK)]

A sediment profile from Nikahari Tal (lake), located north of Ropan Chhapra village in Deoria district (UP), Ganga Plain has been analysed for its pollen assemblage. Total 26 samples are analysed from this profile. The study is in under progress.

Anju Saxena
[**& D.S. Singh** (Lucknow University, Lucknow)]

Investigations have been carried out on plant fossil impressions from Raniganj Formation of Raniganj Coalfield, Damodar Basin, under IGCP Project 'Amalgamation and breakup of Pangea: The type example of the supercontinental cycle'. Four *Glossopteris* species (*G. communis, G. indica, G. stenoneura* & *G. syaldiensis*) are identified. These leaves are common in the Lower Gondwana sediments of different basins of India. *G. syaldiensis* and *G. stenoneura* are endemic to India, whereas *G. communis* has been recorded from Early Permian of South Africa and Brazil, South America. *G. indica* is more commonly distributed and has been recorded from Early Permian of Antarctica, South Africa, Brazil and Argentina, South America, and Late Permian of South Africa.

Recovery of palynomorphs from the rock samples revealed the dominance of striate bisaccate forms, mainly *Striatopodocarpites* in association with *Faunipollenites, Rhizomaspora, Crescentipollenites* and sporadic occurrence of *Parasaccites, Plicatipollenites* and *Potonieisporites*. The palynoflora compares well with known Upper Permian palynofloras of different Indian Gondwana basins, like those recorded from Bijori Formation of Satpura Basin, Raniganj Formation of Damodar Basin, Pali Formation of South Rewa Gondwana Basin, and Kamthi Formation of Mahanadi and Godavari basins.

Rajni Tewari
[under **IGCP Project- 597** (GSI, Kolkata)]

A field work has been carried out under the project 'Biostratigraphic and palaeoclimatic investigations of the Mesozoic sequences of Jaisalmer Basin, Rajasthan' to search and collect plant megafossils and sedimentary samples. Wood fossils are collected from Tamirarai temple, while for the first time plant fossils are collected from Bhadesar and Kuldhar areas. Their identification and photo-documentation is being carried out. Preliminary data from Lathi Formation showed very rare presence of calcareous nannofossils.

Jyotsana Rai, Neeru Prakash & Neelam
[under **MoU with GSI** (Western Region)]

Palynology of Permo-Triassic boundary in Australasia and elsewhere— compilation and finalization of palynological and dispersed organic matter studies carried out on Permian-Triassic sequence in WYB-12 samples from Wybung area of eastern Australia is in progress.

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

The dark bodies recovered inside the Late Permian pollen grains have been documented. One paper entitled 'Unusual spheroidal inclusions in Late Permian gymnosperm pollen grains from southern India revisited:

evidence of a fungal nature' has been finalized.

Neha Aggarwal & Neerja Jha
[**& Michael Krings** (Richard-Wagner-Straße, Munich, Germany) **& T.N. Taylor** (University of Kansas, USA)]

Fossil leaves of *Lagerstroemia* (Lythraceae) have been described from the Siwalik deposits (Middle Miocene) of Kathgodam, Uttarakhand. The fossil records of the Lythraceae indicate its worldwide distribution in the Cenozoic. The family had its widest distribution during the Miocene, but became less widespread during the Pliocene, followed by range expansion during the Quaternary. The present leaf fossil, along with the previous fossil records of *Lagerstroemia*, indicates that the genus followed the same pattern of expansion and retraction as the entire family Lythraceae; suggesting that both the genus and the family adapted in similar ways. The fossil plant assemblage from the Lower Siwalik deposits indicates warm and humid climate with plenty of rainfall in the region during the depositional period.

R.C. Mehrotra & Anumeha Shukla
[**& Rajan Gaur** (Panjab University, Chandigarh)]

The work has been initiated under the National Science Foundation of USA on 'Earth life transitions programme: Stratigraphic refinement, systematic and biogeographic relationships of the Late Cretaceous-Paleocene Deccan biota of India' to examine the anatomical study of woods from Deccan beds. The collaborators have visited BSIP in December 2014 and studied the type slides to sort out the anatomical characteristics of the woods. The specimens housed in the museum are important for understanding of the systematic and biogeographic affinities of vegetation that populated India during the Maastrichtian-Danian, well before direct contact with Europe and Asia. Type slides of petrified woods of the Deccan Intertrappean localities are re-photographed and descriptive data to be made for online website (insidewood.lib.ncsu.edu.)

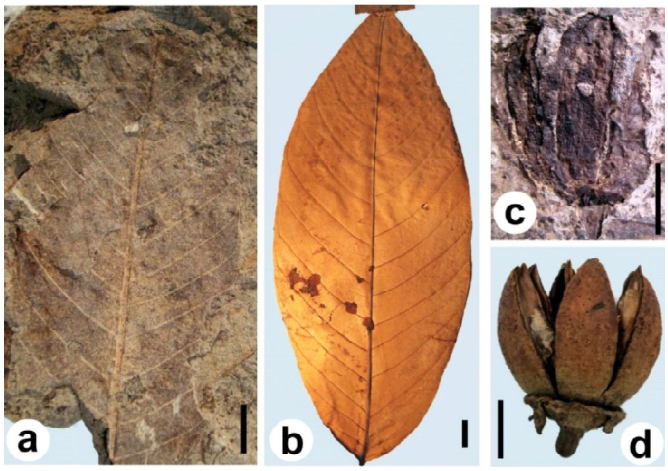
The type materials of fruits and seeds of the Deccan cherts, palms and other monocot specimens have been examined. Enigmatic circular or spherical vessels composed of few elements connected in a sphere or ring-like structure are observed in the type specimen of *Amooroxylon deccanensis* Bande & Prakash. In the recent flora, circular vessels have been found mainly in association with branching nodes, axillary buds, wound callus, pathogens, and they have been artificially induced by auxin. The presence of circular vessels in this fossil trunk showing no signs of branching or trauma makes this record unusual. A manuscript on the aspect has been finalized.

Rashmi Srivastava
[**& E. Wheeler, Steve Manchester & Selena Smith** (USA) **& Pieter Baas** (Netherlands)]

Few leaves collected from the Nagri Formation of Siwalik group have been observed. Amongst them, one is identified as *Terminalia* (Combretaceae).

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

A diverse assemblage of plant macrofossils (leaf/fruit impressions, seeds, fruits & wood fragments) and the associated representative palynofloral elements (mangrove rooting structures, spore & pollen grains) have been documented from Early Eocene beds of the Cambay Shale Formation exposed in Vastan lignite mine in Surat district (Gujarat). The leaves are represented by *Calophyllum eocenicum* sp. nov., *Gardenia vastanica* sp. nov., *Anthocephalus vastanicus* sp. nov., *Melanorrhoea eocenica* sp. nov., along with some known fossil leaves. A single fossil fruit has been attributed to *Lagerstroemia* cf. *L. patelii*. The woods are represented by *Pterospermoxylon suratensis* sp. nov., *P. kutchensis*, *Ebenoxylon cambayense* sp. nov., and *Schleicheroxylon bharuchense*. The palynological assemblage (pollen grains & spores) includes three new species– *Notothyrites undulatus* sp. nov., *Callimothallus semicircularis* sp. nov., and *Carallioipollenites integerrrimoides* sp. nov. along with other associated



Fossil leaf and fruit of a moist deciduous taxa, *Lagerstroemia flosreginae* Retzius from early Eocene of Cambay Shale Formation: a) Fossil leaf showing shape, size and venation pattern, b) Modern leaf showing similarity with the fossil leaves, c) Fossil fruit, d) Modern fruit showing similar shape, size and other morphological features. (scale bars equal 10 mm)

forms. Habitat and distribution of modern taxa comparable with the fossil assemblage from Vastan suggest a terrestrial lowland environment. The macrofossil taxa are indicative of mesophytic, mixed forest growing under tropical to subtropical climate with sufficient humidity. The occurrence of dipterocarp elements suggests the presence of a tropical rain forest in the vicinity of area.

Mahesh Prasad, Hukam Singh & S.K. Singh
[**& Kishor Kumar** (WIHG, Dehradun)]

A field work has been conducted in lignite-bearing areas of the Cambay Basin to collect the samples (lignite, carbonaceous shale, grey shale, green shale, clay, mud stone, etc.) for palynological studies. The leaf, wood, fruit and seed samples are also collected along with a large amount of amber samples from the Vastan, Tarkeshwar and Valia mines in Surat district of Gujarat.

Hukam Singh
[**& David Grimaldi & Colleagues** (from USA & Germany)]

The Early Palaeogene period witnessed distribution of tropical plants in the higher mid-latitudinal regions, providing evidence of the geographical extension of moist, very warm climates, particularly during periods of extreme global warmth such as the Palaeocene/Eocene Thermal Maximum (PETM). In this light, it is planned to compare tropical pollen records of India with the warm Eocene fossil pollen records of Central Europe to assess the extent of tropical character in high latitudinal regions as a result of early Palaeogene global warming. In this regard, field work has been carried out at three localities of Germany– Eckfeld Maar Lake deposits-Middle Eocene, Neuwied Basin; Late Eocene fluviatile succession; and Antweiler-Eocene (brown coal deposit). Studies on fossil pollen from the Eckfeld Maar Lake deposits show distinct 'tropical characters'. Pollen belonging to tropical families, like Anacardiaceae, Sapotaceae, Bombacaceae, Meliaceae, etc. are well-represented. A further study is under progress.

A coexistence approach has been applied on the Nearest Living Relatives (NLRs) of 60 fossil pollen species recorded at different stratigraphic levels in Paleocene-Eocene succession from Jathang, East Khasi Hills (Meghalaya). Seven quantitative climatic parameters are determined for the fossil palynomorphs. The coexistence intervals of each climatic parameter of NLRs corresponding to the specific fossil taxon are plotted against the stratigraphic column. The study shows warm and wet climate with fluctuating rainfall, 731-3151 mm, 24-26° C temperatures, and 5-6 dry month seasonality during the pre-PETM. Excessive warm and wet climate of 26-27° C mean annual temperature and 1215-3151 mm mean annual rainfall condition with 2-3 months of dry period have been reconstructed for the PETM and post-PETM events.

Vandana Prasad
[**& Torsten Utescher** (Bonn University, Germany)]

A multi-proxy study involving palynology, phytoliths, sedimentology, clay mineralogy, carbon isotopes and magnetic mineralogy has been carried out on Wadhwana Lake sediments from sub-humid zone of mainland Gujarat to determine the mid-Holocene climatic fluctuations, and its possible impact on the Harappan culture. The 1.03 m sediment profile shows five palaeoclimatic phases. The study reveals high lake stand during Phase I (~7,500-5,560 cal yr BP) under a considerable cool and moist climatic conditions. Low lake level and dry climate have been documented during Phase II (5,560- ~4,255 cal yr BP). Phase III shows a gradual strengthening of SW monsoon after ~3,500 cal yr BP. Phase IV shows a short pulse of dry climatic conditions (~3,238 to ~2,709 cal yr BP) followed by somewhat similar to present day climate for Phase V. The study concludes that onset of dry climate after 5,500 cal yr BP is a regionally spread synchronous event that has been documented in several lake records of western India. It is surmised that the urbanization in Harappan civilization in NW India was coincident with the initial phase of declining rainfall of mid-Holocene. The emergence of cultural complexity of Harappan civilization should be seen as an initial adaptation to earliest phase of environmental deterioration and its subsequent decline is probably linked with the changing seasonality pattern and excessive dry climate of later phase (~4,200-4,255 cal yr BP) of mid-Holocene.

Vandana Prasad, Anjum Farooqui, Anupam Sharma, Binita Phartiyal & Abha Singh [& Supriya Chakraborty (IITM, Pune), **Subhash Bhandari** (Kutch University, Bhuj) **& Rachna Raj** (MS University, Vadodara)]

A multi-proxy study on the sediments from lower Narmada valley, western India records large flooding events and high sediment influx linked to southwest monsoon variations during Late Holocene. On the basis of proxy data and chronology of preserved sediments, three major environmental perturbations at 1,809, 1,487, and 1,187 cal BP have been identified that corroborate well with the regional fluctuations in southwest monsoon variability. A phase of dominant marine influence (between 2,185 & 1,809 cal BP) is inferred based on the presence of marine palynomorphs, mangrove pollen, and amorphous organic matter (AOM), and is coincident with the phase of weak monsoon in the region. A transition from marine

marsh environment to a phase of high fluvial influx is occurred around 1,809 cal BP. The fluvial influence is inferred based on the replacement of AOM with structured OM, presence of fresh water algae, decrease in the d13C values and dominance of kaolinite clay. The fluvial regime stabilized between 1,487 and 1,187 cal BP as recorded in the overbank sediments, palynomorphs, and geochemical indices, and sedimentation occurred under a highly oxidizing and high energy condition with long distance transport of sediments. The later incision of the sediment sequence, which post-dates 1,187 cal BP, can be attributed to enhanced precipitation. The response of the lower Narmada Valley to short term southwest monsoon fluctuations is manifest in the shifting deposition environments and a major role of terrestrial sediment influx variability is surmised, leading to relative sea level variations in this part of the Indian subcontinent. A temporal and process-based interplay between flooding periods and sediment discharge in river systems and tidal conditions is suggested for the tropical estuarine environments.

Vandana Prasad & Anupam Sharma
[& Alpa Sridhar, D. Balaji, D.M. Maurya, L.S. Chamyal (MS University, Vadodara), **Amzad Laskar** (PRL, Ahmedabad) **& Jayant Tripathi** (JNU, New Delhi)]

For the compilation of an edited volume of book on different aspects of Palaeobotany and its allied disciplines, the invitation letters have been sent to the contributors (in abroad) for sending the manuscripts of the research articles on their topic of choice and expertise. In response, letters of consent have been received from some of the contributors. The book will include articles/research papers contributed by authors from India and abroad.

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

Work on the study of sediment cores (Site 1404 and 1405) of Oligocene-Miocene transition for Post Cruise Research of IODP Expedition 342 is being finalized. Microscopic study and photomicrography have been done. Finalization of manuscript is in progress.

A.K. Ghosh & Arindam Chakraborty
[& Shipboard as well as shore based Scientists (of IODP Expedition 342)]

Diatoms from the Vasishthi River Estuary, Maharashtra have been studied in numerical abundance with different physico-chemical and heavy metal assessment. In the estuary, heavy metals (Cr, Mn, Co, Ni, Cu & Zn) in the upper reaches and suspect anthropogenic sources are identified. The study indicated differential diatoms assemblage in the estuarine complex as far as 20 km inland. The assemblage distribution indicates that different watershed characteristics, runoff conditions, effluents supply and anthropogenic activities have led to varying proportions of diatom assemblage (at generic & species level). The study shows profuse abundance of freshwater and marine forms with occurrences of silicoflagellates and radiolarians; supporting strong marine influence in the estuary. The presence of toxic diatoms namely *Synedra ulna*, *Gomphonema parvulum* also supports to estuarine health conditions alongwith bio-accumulating oyster species indicating influence of heavy metal toxicity in the estuary. The present study offers significant clues to the dynamics of the complex anthropogenic activities in the Vasishthi River estuary, which have detrimental effects on biodiversity of the estuarine and mangrove ecosystems.

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

The study of diatoms is being carried from the Lake Loktak samples to evaluate the influence of Indian monsoon variability in northeast India. The samples have been processed for diatoms and initial study is carried to characterize the siliceous microfossils. It is found that the assemblage is dominated by *Eunotia* species (*E. camelus*, *E. flexuosa*, *E. pectinalis*, etc.), followed by *Synedra ulna*, *Nitzschia* sp., *Gomphonema parvulum*, *G. accuminatum* and occasional occurrences of *Achnanthidium minutissima*, *Pinnularia gibba*, *Hantzschia amphioxys*, *Craticula cuspidate*, *Caloneis bacillum*. The study is under progress.

Biswajeet Thakur, C.M. Nautiyal, Swati Tripathi, S.K. Basumatary & Ruby Ghosh
[**& Supriyo Das** (Presidency College, Kolkata)]

Organic geochemical data have been generated for characterization of the lignite-bearing Eocene sequences from Rajasthan (Matasukh mine, Nagaur district; and Gurha mine, Bikaner district) and Gujarat (Khadsaliya mine, Bhavnagar district) States. The sequences have been analyzed to assess its hydrocarbon-generating potential and to reconstruct the palaeovegetation and palaeoenvironment. Based on rock-eval data, supported with maceral composition and rank data, the kerogen is classified as mixed type II/type III with potential to generate both oil and gas on maturation. The normal alkanes, obtained through GCMS, display a bimodal distribution, suggesting two different organic matter inputs (microbes & higher plants) for Rajasthan lignites.

Alpana Singh, B.D. Singh & R.P. Mathews
[**& Suryendu Dutta** (IIT Bombay, Mumbai)]

Hydrocarbon generation potential, methane sorption capacity, maturity and petrographic composition of coals and shaly coals from Ib-River Coalfield have been determined. Rock eval pyrolysis and total organic carbon analyses indicate that all the samples have excellent TOC content and hydrocarbon generation potential. The thermogenic gas generation is occurring to some degree in almost all sample intervals. It is found that the organic matter abundance is the significant factor in gas sorption capacity of studied samples.

B.D. Singh
[**& A.K. Varma & Associates** (ISM, Dhanbad)]

A palynological study has been carried out in a 1.5 m deep core from Vellayani Lake, Western Ghats. The manuscript has been finalized and revised.

Anjum Farooqui
[**& Hema Achyuthan** (Chennai)]

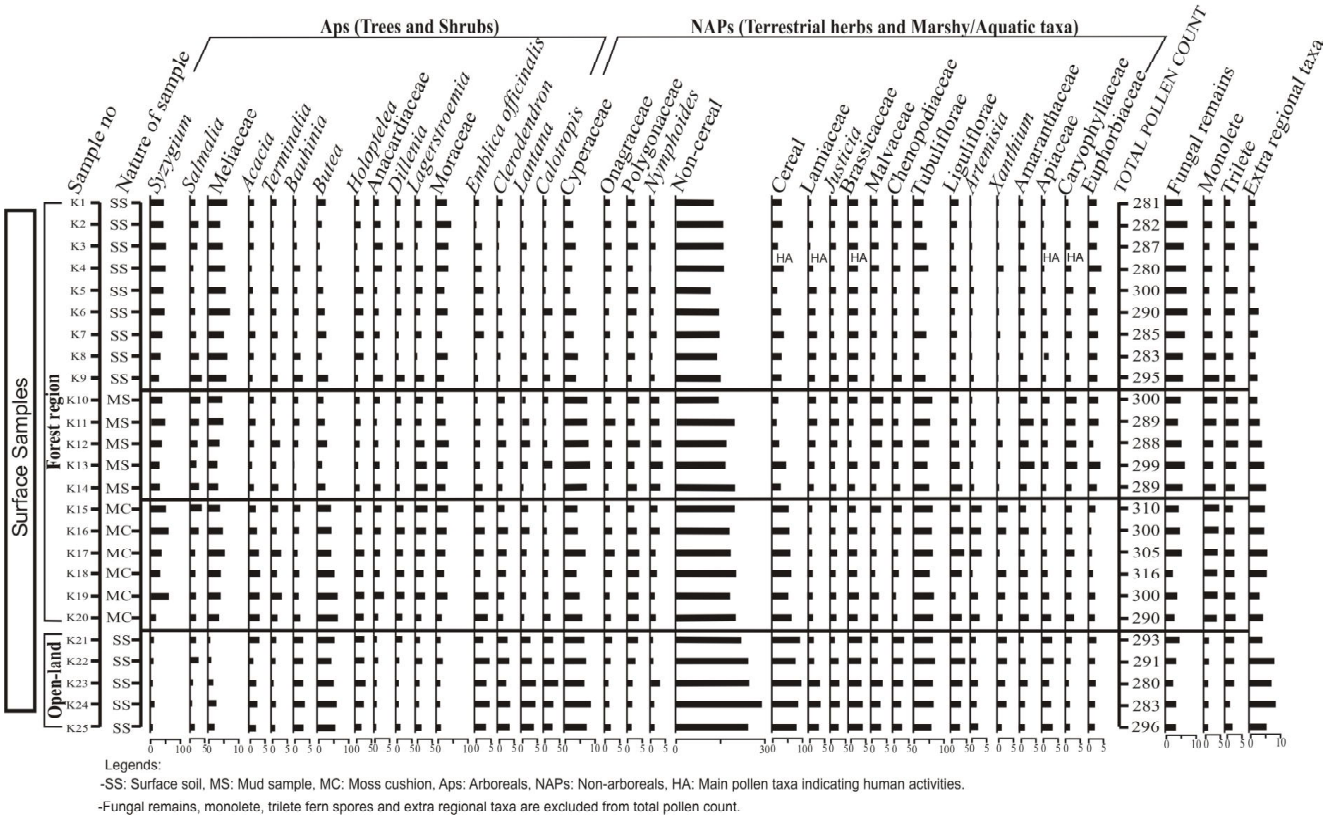
A 200 cm peat bog profile from Koti-Knasar village, Himachal Pradesh comprising 41 soil samples have been palynologically studied. Palyno-chronological records have demonstrated five distinct phases (K-1 to K-V) of vegetation succession and contemporary climate for the last 16,000 yrs.

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

Palynological assessment has been performed on a 40 m deep sedimentary sequence cored from Paravur palaeodelta in central Kerala (SW coast of India). The record shows that *Rhizophora* is the dominant core mangrove taxa. In the sediments from 4 to 7 m, *Sonneratia* is also encountered. The *Rhizophora-Sonneratia* transition from early-middle Holocene to late Holocene is considered to be the most distinctive feature of mangrove response.

Swati Tripathi & S.K. Bera
[**& A.C. Narayana** (University of Hyderabad)]

The dataset of 25 surface pollen samples has been established from the Kukrail conserve forest, Lucknow (part of central Ganga Plain) to display the modern pollen and vegetation relationship. A manuscript on the aspect has been finalized.



Pollen spectra from surface samples of Kukrail RF., Lucknow (APs/NAPs values in forested SS, MS, MC and open-land SS are 39/61, 35/65, 42/58 and 28/72, respectively)

Swati Tripathi, S. K. Basumatary & S. K. Bera
[**& Ajay Arya** (Lucknow University, Lucknow)]

The pollen analysed data from Shuanghaizi Lake, southwestern China have been finalized. Around 11,200 to 11,000 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, with the expansion of broad-leaved elements; deciphering 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** (Institute of Botany, Beijing, China)]

Pollen analysis of 26 surface samples has been carried out from Dunagiri and Bagini Glacier, Garhwal Himalaya. The pollen assemblage reveals dominance of arboreals and reduced numbers of non-arboreals. Conifers as *Pinus*, *Cedrus*, *Abies* and *Picea* are recovered 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)]

The pollen study from Saurashtra coast, Gujarat revealed that the coast experienced relatively wet climatic conditions with simultaneous occurrence of marginally high sea-level between 4,710 and 2,825 cal yr BP. Subsequently, a gradual onset of aridity and lowering of the sea-level is observed between 2,825 and 1,835 cal yr BP, and further a slight decrease in aridity is observed after 1,835 cal yr BP. The present day coastal configuration was probably achieved after around 1,500 cal yr BP. In addition, palynological investigation of a 3.3 m deep sediment profile collected from Lake near Central Himalaya is under progress.

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

Palynological investigation of a 17.5 m thick sediment profile collected from Kolleru Lake, located between the Godavari and Krishna basins of Andhra Pradesh has been carried out to understand the evolution of Kolleru Lake during Holocene. Finalization of data is under progress.

Shilpa Pandey
[**& K. Nageswara Rao** (Andhra University, Visakhapatnam)]

Seven fossil leaves with cuticle described here have been collected from the lower, middle and upper strata of Siwalik (Middle Miocene-Lower Pleistocene) sediments of Arunachal Pradesh. A detailed comparison of the cuticular analysis of the fossils and their living relatives indicate that these fossil species belong to *Dysoxylum raptiensis, Macaranga* cf. *denticulata, Calophyllum suraikholensis, Combretum prechinense* sp. nov., *Actinodaphne palaeoangustifolia, Shorea siwalika* and *Dipterocarpus koilabasensis*. This is the first time Cenozoic fossil leaves of the above genera are described using the micromorphology of their epidermis.The present day distribution of the modern equivalent taxa of the fossils, structural features and the micro-morphological features of the fossil leaves together with epiphyllous fungal remains collectively indicate the prevalence of a warm humid tropical climate in this area during Siwalik sedimentation. The cuticular micro-morphological features help to confirm the identification of their leaf compressions to the species level and are clearly indicative of mesophytic ecological conditions that reflect a tropical climate with high precipitation.

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

Revision and additional analyses have been carried out for the manuscript entitled 'Spring temperatures in the far-western Nepal Himalaya since A.D. 1640 reconstructed from *Picea smithiana* tree-ring widths'.

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

A chronology of 357 years i.e., AD 1657-2013 has been prepared based on 89 tree-ring core samples of *Tsuga dumosa* from Api Nampa Conservation Area, western Nepal Himalaya. We observed significant negative correlation with March-May temperature and positive correlation with March-May precipitation. Based on these observations, reconstructions of temperature and precipitation since AD 1702 are made.

S.K. Shah [**& D.R. Bhuju, S. Bhandari** (TU-CDES, Nepal), **N.P. Gaire** (NAST, Nepal) **& U. Thapa** (University of Minnesota, USA]

The Study of anthropogenic carbon particles and other organic contents has been initiated and is being carried out. A manuscript based on this study is under preparation.

Vartika Singh [& Neelu Singh (NCAOR, Goa]

Palaeoatmospheric CO_2 reconstruction during Pliocene-Pleistocene Transition has been worked out using stomata of *Typha orientalis* as a proxy. Study shows that the maxima of atmospheric CO_2 (~534 ppmv) at ca. 2.65 Ma. This CO_2 spike indicates a transient warm interglacial phase within the intensification of northern hemisphere glaciation during PPT, also recorded from the same Shanxi province of China and northeast Russian Arctic based on other proxies.

P.S. Ranhotra [& Yu-Fei Wang & team
(Institute of Botany, Beijing, China)]

A sediment profile is collected from Panduk region of Mid Ajay River valley about 2.5 km away from present day river channel. About 68 sediment samples have been collected of 16.14 m deep profile. These samples are macerated and processed for palynological studies. Further examination of these samples is being carried out for pollen and spore occurrences throughout the profile.

Nivedita Mehrotra [& Sujay Bandhopadhyay
(University of Burdwan, Burdwan)]

Surface soil samples and moss cushions collected from Khaptad National Park, western Nepal have been processed for pollen analysis. Eleven soil samples and 11 moss cushions are macerated and prepared for palynological studies to understand the modern climate and modern vegetation relationship in western Nepal Himalaya.

Nivedita Mehrotra & S.K. Shah [& D.R. Bhuju (TU-CDES, Nepal), **N.P. Gaire** (NAST, Nepal) **& U. Thapa**
(University of Minnesota, USA]

Memorandum of Understanding between BSIP and GSI (Western Region, Jaipur)
for generating palaeobiological data from Jaisalmer sedimentary basin ranging in age from Jurassic to Cretaceous

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 microfacies analyses of Meghalaya (NE India) and Andaman-Nicobar carbonate sediments pertaining to the Palaeogene and Neogene, respectively have been carried out with special emphasis on calcareous algae and benthic foraminifera. Thin sections of carbonate sediments are extensively studied to make comparative accounts of the Palaeogene and Neogene fossil assemblages. Facies gradients and algal-foraminiferal abundance are evaluated to understand the palaeoecological parameters governing the depositional environments. Conceptual palaeoenvironmental models are prepared to envisage the bathymetric zonations of the coralline algae and benthic foraminifera. Overall shallow bathymetry was inferred for the Palaeogene sediments ranging from 10 to 40 m. The Neogene assemblages, however pointed towards deeper bathymetry (~60 m). Studies on relative abundance of various assemblages led to critical information regarding the nutrient levels, i.e. meso-oligotrophic regime in case of Palaeogene sediments, whereas greater shifts towards eutrophy but largely a mesotrophic regime has been envisaged in case of the Neogene. Larger benthic foraminifera of the Palaeogene sediments of Meghalaya are compared to their West Tethyan counterparts in pertinence to case studies involving the onset of Larger Foraminiferal Turnover (LFT) in the East Tethys. The entire work has been compiled in the form of a Ph.D. thesis and submitted to Andhra University, Visakhapatnam, and has been awarded to Suman Sarkar.

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

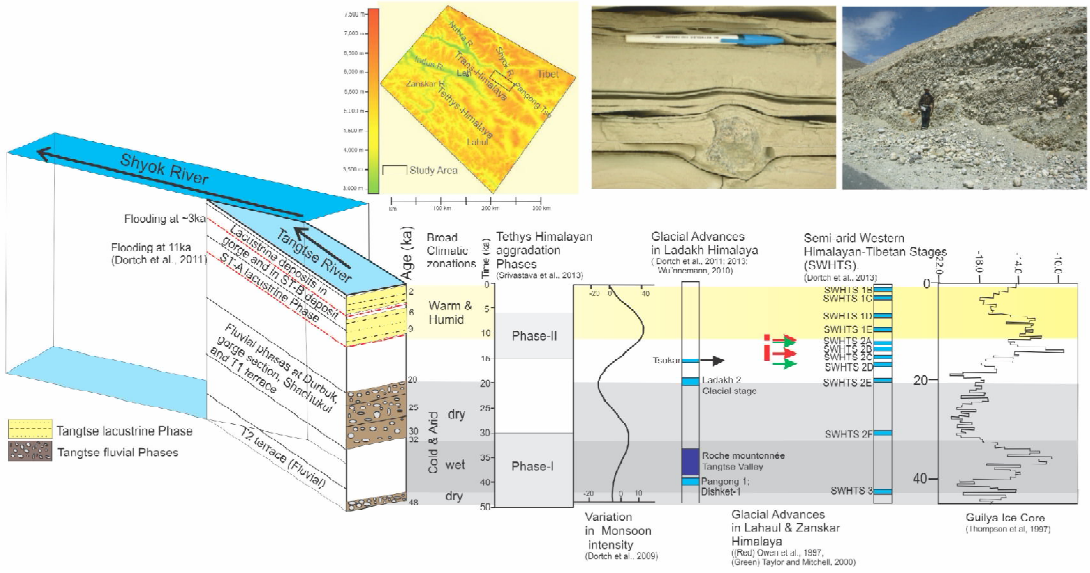
Investigators: R.R. Yadav, B. Sekar & A.K. Yadava

The project completion report has been finalized, based on the study of tree ring chronologies from various sites in Kinnaur region, Himachal Pradesh.

3. **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 (till 28.03.2015)

The Tangtse Valley in Trans-Himalaya records changing depositional regimes since 48 ka. Varied sedimentary architecture with fluvial episodes, lacustrine pulses, flood events, colluvial and aeolian records and the



Schematic block model of the sedimentation versus chronology of the Tangtse Valley, and its comparison with published records along with photographs of the lacustrine and fluvial facies

U-shaped valley itself is a result of past glacial activity. The valley is located east of Pangong Tso/Bangong Co, one of the biggest lakes in Tibet and has served as spillway, flooding the entire Tangtse Valley, resulting in impoundment of lower reaches and forming lakes. Today Pangong Tso consists of five basins separated by shallow sills and is fed by snow melt, a result of westerly precipitation. During high stands the lake drains into River Shyok, through Tangtse River Valley. Several sediment sections dated with ^{14}C and OSL methods show evidences of a sixth basin of Pangong Tso towards west, occupying the present day Tangtse Valley between 9 and 5 ka coinciding with periods of high lake levels in Tibet, China and intensified monsoon periods over the Indian subcontinent. This lacustrine environment is intermittently replaced by a fluvial regime around 48 ka and 30-21 ka with comparatively arid conditions and dry phases, and flooding is recorded at ~3 ka. The above views have been documented and finalized. In addition, the palaeoclimatic data is also being analyzed of the Shachukul section of the Tangtse valley. The chronology samples have sent to Gliwice, Poland. Meanwhile TOC and mineral magnetic, grain size, sub-fossil data, has been worked upon.

4. **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 & Surabhi Garg (till 12.09.2014) [**& D.K. Pandey**, Jaipur]

The project has been completed and compilation of the report is under progress. Two manuscripts, one on the integrated nannofossil-dinocyst-ammonoid biostratigraphy from the Wagad Uplift, and another on gymnosperm fossil woods from Gangta Bet (eastern Kachchh) have been finalized. In addition, a field work has been undertaken around Kachchh Mainland, and covered Trambau River section in Wagad (Oxfordian-Kimmeridgian), Gangta Bet, Cheriya Bet, and Kakindia Bet (Patcham, Chari & Katrol formations).

5. **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

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.

6. **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

Palynological studies of a 90 cm trench from the outwash plain of Hamtah Glacier have been finalized to reconstruct the vegetational scenario in the study area and depict the concurrent climatic fluctuations since Middle Holocene till recent. Throughout the sequence an overall dominance of arboreal pollen is observed over the non-arboreal pollen. For a better understanding of pollen-vegetation relationship as well as vegetational succession with the climate, six pollen zones have been recognized in this pollen sequence from bottom to top. These palynozones are demarcated on the basis of AP/NAP ratio, with respective increase or decrease in the percentage of arboreal/non-arboreal pollen.

Further studies are being done on a 130 cm trench dug on the outwash plain of the nearby Chhatru Glacier. On the basis of palynological analysis, six pollen zones have been demarcated in this sequence from bottom to top. Though there is an overall dominance of arboreal pollen in all the samples, a changing frequency of AP/NAP ratio is observed in the respective palynozones. Moreover, there are some further striking minor phases in between the pollen zones which are showing a sudden increase and decrease in the AP/NAP trend. Additionally, geochemical and mineral magnetic data have been generated from two profiles, one each from the Hamtah (Lahaul-Spiti) and Chorabari (Kedarnath) glaciers.

7. **Project— Linking vadose zone microbial ecology and geochemistry in sediments core from alluvial Mahi River, western India** (Sponsored by DST, New Delhi, No. SR/S4/ES-565/2011)

   Investigators: Anupam Sharma (Co-PI) **& Shazi Farooqui**

The project is basically meant for investigating the geochemical and microbial interaction in transformation of sediments into soil profile, because it has significant implications in terms of carbon sequestration, nutrient

mobility, maintenance of earth surface temperature and so on. Since microbial life is very sensitive to environmental conditions, it was noticed in earlier studies that exposed section samples do not represent the actual community prevailing in the subsurface (vadose zone), hence it has been decided to drill and collect sediment cores and preserve them under sub-zero degree Celsius temperature conditions. In order to collect diverse samples representing the ambient conditions, sites affected by anthropogenic activities and one at the margin of land-sea junction is selected after the reconnaissance survey carried out in the region. Ones the sites are selected, drilling has been done at the respective sites and sediment cores are retrieved. Subsequently, prior to sub-sampling of the sediment cores, physical characteristics were noted down. The cores are divided into two parts and one will be used for microbial study and the other one will be utilized for geochemical studies at MS University of Baroda and BSIP, respectively.

8. **Project— Extending the dating range of luminescence dating technique using feldspars** (Sponsored by DST, New Delhi, No. SR/FTP/ES-56/2011)

Investigator: P. Morthekai

The samples were collected from Dhansi Formation, Narmada Valley near Hoshangabad, MP to validate the luminescence signals which can be used to date older materials. These samples have been processed in PRL and measured for palaeodose there itself. Promising luminescence signals are studied to date samples beyond 0.78 Ma old. A research article on the aspect has been finalized. Measurements are underway to answer the reviewer's comment.

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

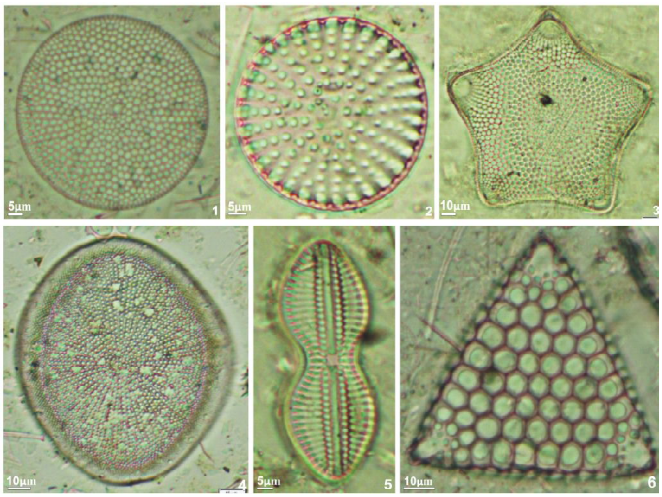
Investigators: Nivedita Mehrotra & A. Bhattacharyya

An 89 cm deep sediment profile from PT Tso Lake in Tawang, Arunachal Pradesh has been studied and fossil palynomorphs are identified and counted in 30 samples. Further analysis and comparison with environmental geomagnetic and carbon isotope data shall be carried out. Palynological studies are also carried out on 8 surface sediment samples collected from Tawang district. Compilation of Ph.D. thesis is carried out and is in the final phase of completion. In addition, surface sediment samples and moss cushion samples from a transect in Sikkim between Lachen and Zemu glacier have been studied for palynological analysis. The palynological data is compared with modern climate data and further statistical analysis is carried out. Analysis of palynological data of a 127 cm long profile from Yabuk, near Zemu Glacier in Sikkim is also completed. A manuscript is under preparation based on palynological analysis of the modern and fossil sediment data and environmental geomagnetic data of the profile sediments.

10. **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

A field work has been undertaken in South Andaman and Little Andaman Islands for collection of samples from measured outcrops. From the Cave Point Section of Neil Island, 85 species of diatoms have been identified. Five biozones have been identified with the help of CONISS cluster analysis according to the dominance of diatom assemblages. To ascertain high resolution biozones, SHEBI analysis is carried out, that envisages 7 diatom assemblage zones. The studied outcrop is characterized by the presence of Late Miocene marker radiolarian– *Didyomocyrtis penultima*. Principal component analysis (PCA) is carried out using SPSS 16.0 for factor analysis. The benthic and planktonic ratio as well as C:P (Centric *vs.* Pennate) ratio of the diatoms show evidence of sea level fluctuations during that period.



Late Miocene diatoms from Neil Island: 1) *Azpeitia nodulifera,* 2) *Stictodiscus nankoorensis,* 3) *Trigonium arcticum,* 4) *Actinocyclus ellipticus* var. *javanica,* 5) *Diploneis crabro,* 6) *Triceratium favus*

The overall analysis indicates a strong monsoonal system, however there are evidences of intermittent weaker monsoonal activity. The upwelling taxon– *Thalassionema nitzschioides* confirms the strong monsoonal activity during Late Miocene in the study area. Sediment grain size analysis has been performed using a CILAS Laser Particle Size Analyzer 1190. Grain-size statistics are calculated with the software GRADISTAT version 8.0. Minor variations have been observed on the sediment grain size analysis. Throughout the outcrop silt is dominated with 40.30-91.10% in comparison to sand and clay. The sand content does not exceed 57.2%. The fine sand being the coarsest grain-size fraction occurs in the sediments. The mean grain size values range between 4.11 and 7.37µm and thus, are classified as very coarse silt to fine silt. Besides, from the same outcrop a Pacific radiolaria (*Acrobotrys disolenia*) has been recorded for the first time from the Northern Indian Ocean (Late Miocene of Andaman and Nicobar Islands).

11. **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

Palynological study of the organic-walled dinoflagellate cysts have been undertaken to fill the knowledge gap of cysts diversity and spatial distribution from the Bay of Bengal. In addition to the previous study from the northern Bay of Bengal, 60 surface samples are collected in 8 transects perpendicular to the coast covering a depth of 25 to 2,500 m (latitude 14º32.833- 19º 45.150 & longitude 80º56.389- 86º37.169) from the western Bay of Bengal during the cruise Sagar Kanya 308. Though the cyst assemblage consist of autotrophic gonyalaucoides in high diversity, but heterotrohic protoperidinioid group are also observed. Cyst abundances are observed higher in comparison to the northern Bay of Bengal site. Morphological variability in the protoperidinioid cyst is observed for the first time from Bay of Bengal. Evaluation of environmental significance on the spatial distribution of individual species and sensitivity of specific cyst proxies has been used to infer palaeoclimatic, palaeoecological and palaeomonsoonal changes. Samples processing has been carried out for calcareous nannofossils and detailed study is under progress.

12. **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, Mayank Shekhar, Jooly Jaiswal (till 30.04.2014) **& Ipshita Roy**

A field work has been carried at Dokriani Glacier valley and Nachiketa Tal area, Uttarkashi (Uttarakhand) for collection of palynological and tree-ring samples. The palynological processing of the surface samples has been completed and the pollen analysis of the few samples from different altitudinal gradient shows positive relationship between the altitudinal distribution of vegetation and their pollen dispersal especially for tree taxa. The tree-ring samples collected from three different sites around the Dokriani valley has been mounted and processed for the dendrochronological studies. The initial tree ring chronology of the *Abies* sp. growing at higher altitudes within the Dokriani glacier valley dates back to ~300 years. The cross dating of the skeleton plots is in continuation.

13. **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 (till 26.09.2014) **& Uttam Pandey**

A field trip has been undertaken in two forest divisions (Lidder Forest & Sindh Forest) of Kashmir Valley. Total 644 tree core samples of 4 conifer taxa viz., *Abies pindrow* (Fir), *Cedrus deodara* (Deodar), *Picea smithiana* (Spruce) and *Pinus wallichiana* (Blue pine) and one broad-leaved taxa viz., *Betula utilis* (Birch) have been collected. All the samples are mounted in the wooden block for further analysis. A review of literature has been carried out to understand the previous tree-ring based studies from Kashmir valley and adjoining region. It is assessed that very sparse records from some sites based on limited number of samples exist.

Tree-ring samples of *Cedrus deodara* (93 cores from 45 trees) collected from Pahalgam locality have been processed and cross-dated. A chronology of 375 years i.e., AD 1640-2014 is prepared based on 79 accurately dated samples. The chronology is correlated with available climate data of Srinagar meteorological station. We observed negative correlation with May-June temperature and positive correlation with April-May-June

precipitation. Based on these observations, reconstructions of both temperature (May-June) and precipitation (April-May-June) since AD 1770 have been made.

14. **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 total of 28 taxa have been recovered from the surface sediment samples from the two South Andaman mangrove forests. Of these, 9 taxa are core mangrove species and 6 taxa corresponded to the mangrove associates. The pollen spectra revealed that the majority of pollen are from mangrove vegetation which reflected the existing local and nearby vegetation. Among core mangroves, *Rhizophora mucronata, Sonneratia apetala, Aegiceras corniculatum, Heritiera fomes* and *Avicennia marina* are represented in higher frequencies. On the other hand, other taxa of the same group are occurred in appreciable proportion. The consistent recovery of fresh water taxa and ferns depict the prevalence of moist and shady conditions with abundant rainfall. Further, palynological investigation of profile samples collected from Wandoor and Chidiyatapu are in progress.

15. **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)

Investigators: Pawan Govil & Syed Azharuddin

The collected sediment core samples (during 243rd cruise of ORV Sagar Kanya) have been sub-sampled at 2 cm interval. The planktonic foraminiferal assemblages, isotopic signature and geochemical proxies will be used from these three Gravity sediment cores. Total 250 samples have been processed according to foraminiferal analysis methodology from the sediment cores SK-240/485 and GC/SK-240/496. Dried fraction is sieved through 250,150 and 63 µm sieves, and each fraction is stored in separate 5 ml storage vials. Each dried fraction has been weighed. Picking of planktonic foraminifera is in the progress from processed sediment samples. Besides, 5 sediment samples from Core SK-240/485 have been sent for the radiocarbon dating.

16. **Project—Biozonation of the Marwar Supergroup around Jodhpur area western Rajasthan, India** (CSIR sponsored, No. 09/528/(0019)/ 2013/ EMR-I)

Investigator: Shamim Ahmad

Marwar Supergroup in western Rajasthan is the perfect destination for palaeontologist to explore the Precambrian life. A Number of trace fossils have been recorded from the Nagaur Sandstone which include horizontal to 3D complex burrows along with the miscellaneous trace, trail and scratch marks made by arthropods. They all embrace to the signatures which positively support the hierarchy of evolutionary trend as it demonstrates from simple burrow to complex life forms. Stratigraphically, *T. Pedum* is found mostly in the siliciclastic facies of the Nagaur Sandstone which is underlain by Bilara Group (carbonate unit). The status of Pc-C boundary in the Marwar Supergroup is still unresolved and major area of study. A manuscript has been prepared on the present investigation. Report of the project is being finalized.

17. **Project— Developing snowfall reconstruction for the Lahul-Spiti region and its association with glacier dynamics** (Sponsored by DST, New Delhi, No. SR/DGH-76/2013)

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

The basic aim of project is to develop long-term snow fall records and glacier fluctuations over the Lahul-Spiti region, western Himalaya using tree ring data as a proxy records. The project staff has been appointed and basic training for dendrochronological analyses has been given.

18. **Project— Studies on the late Quaternary vegetation and climate change in Jammu and Kashmir, India on the basis of pollen proxy records** (Sponsored by DST, New Delhi, No. SR/FTP/ES-81/2013, dated 20.01.2014)

Investigator: M.F. Quamar

A field excursion to Jammu and adjoining districts of J&K has been undertaken, and collected 4 sediment profiles for pollen analysis. Besides, 170 surface samples are also picked up from different forest stands to understand pollen deposition pattern in the region. Maceration of core samples and surface samples are in progress.

19. **Project— Palaeofloristics of Lower Gondwana sediments of India and Brazil with special reference to palaeowild fire and its palaeoecological, palaeoclimatological and biostratigraphical significance** (Sponsored by DST, New Delhi, w.e.f. 01.04.2014)

Investigators: Rajni Tewari & Deepa Agnihotri

Prof. Andre Jasper (Centro Universitário Univates, Lajeado), Prof. Átila Augusto Stock Da Rosa (Universidade Federal de Santa Maria, Santa Maria) and Prof. Etiene Fabbrin Pires (Universidade Federal do Tocantins, Porto Nacional) of Brazil visited the Institute as a part of the project. Besides, coal and shale samples have been selected from the Early Permian Barakar Formation of Dhanpuri Open Cast Mine (Sohagpur Coalfield), and Late Permian Pali Formation (Johilla Coalfield), of the South Rewa Gondwana Basin for the macroscopic charcoal studies. Samples collected from the Nishatbagh (Early Permian) and Zewan (Late Permian) formations, and from Barakar Formation of Manuguru and Goutham Khani collieries (Kothagudem Area, Godavari Graben) are examined under the low power binoculers for presence of charcoal for palaeofire studies. The rock samples containing the charcoal fragments have been sorted for further processing.

A field excursion has been undertaken to Rio Bonito Formation of Quiteria and Curva do Belvedere outcrops, Encruzilhada do Sul, and Mata sandstone of Caturrita/ Santa Maria (Early Triassic) Formation of Afloramento outcrop (fossil wood locality), Saõ Pedro do Sul, RS. Rock sample have been collected from different horizons of Quiteria outcrop for the macroscopic charcoal and megaspore studies. Besides, the specimens preserved in repository of Department of Botany and Palaeobotany, UNIVATES are also examined. The morphological features of plant fossils namely *Lycopodites riograndosulensis*, *Brasiliodendron pedroanuu*, *Corichous quiteriensis, Glossopteris* sp., fern (unidentified), *Sphenopteris* sp. reported from the Rio Bonito Formation (Early Permian) of Quiteria and Curva do Belvedere outcrops, Faxinal Mine, Butia and Morro do Papaléo, Mariana Pimentel, Parana Basin are studied in detail. Additionally, the specimens of *Tietea* sp., *Psaronius* sp., *Grammatopteris* sp. and *Dernbachia* sp. (Filicales) reported from Motuca Formation (Late Permian) of Parnaiba Basin are examined. The fossil specimens of *Brasilodendon pedroanum*, *Asterotheca* sp., *Rhodeopteridium* sp., *Botrychiopsis valida*, *Glossopteris occidentalis*, *Gangamopteris obovata* var. *major, Kawizophyllum* sp., *Arberia minasica*, *Coricladus quiterensis* and *Samaropsis gigas* from the Rio Bonito Formation of Parana Basin, housed at Department of Palaeontology and Stratigraphy, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre have also been examined. Samples collected for macroscopic charcoal studies are being processed.

Exposure of Rio Bonito Formation in Quiteria outcrop, Encruzilhada do Sul, RS, Brazil

20. **Project— Paleogene vertebrate fauna from the lignite associated sedimentary sequences of western India: Investigations of evolutionary and biogeographic aspects** (Sponsored by DST, New Delhi, No. SR/FTP/ES-49/2012, implemented during 2014-15)

Investigator: V.V. Kapur

Palaeontological investigations are underway in the Early Paleogene lignite associated sedimentary sequences of Rajasthan and Gujarat. A few field excursions have also been carried out in the above regions for sample collection and recovery of vertebrates (including mammals). The recovered faunal assemblage is currently under study. A new perissodactyl mammal has been identified to the species level.

21. **Project— Vegetation succession and climate oscillation since late Quaternary from northern Assam, northeast India: A multiproxy analysis** (Sponsored by DST, New Delhi, No. SB/EMEQ-225/2014, w.e.f. 24.07.2014)

Investigator: S.K. Basumatary

One project assistant has been appointed in October 2014. The basic training has been imparted to him. Various literatures have been consulted in relation to the study area. A field trip in different areas such as Kaziranga, Majuli, North Lakhimpur and neighboring areas has been undertaken to collect polliniferous materials, surface and sedimentary soil profile. In addition, 15 wood fossils are

also collected. The total of 30 reference slides of major tree taxa has been made which will be helpful for proper identification of sub fossils pollen in the sediments of the region. The 20 surface samples collected from Majuli Island have been pollen analysed and the palynological investigation of samples is in progress. The preliminary observation of palynoassemblage is suggestive of the tropical openland vegetation in the region.

22. **Project— Characterization of glacial lake deposits of the Ladakh, NW Trans Himalaya: Implications on landscape evolution and palaeoclimate** (Sponsored by DST, New Delhi, No. (No. SR/DGH-69/13, w.e.f. 22.11.2014)

Investigators: Binita Phartiyal & Priyanka Joshi

Literature survey and satellite data is being processed.

23. **Project— Chronology and climate implications of late Quaternary glaciations in the upper Dhauliganga and Alaknanda valleys, central Himalayas, India** (Sponsored by DST, New Delhi, No. SR/FTP/ES-23/2013, w.e.f. August 2014)

Investigator: S. Nawaz Ali

The samples from the study area, collected earlier in collaboration with PRL and Garhwal University, have been processed and analysed.

24. **Project— Palaeoclimate and lake history of Tapovan, Gangotri glacier valley, Garhwal Himalaya** (Sponsored by DST, New Delhi, No. SR/DGH-56/2013)

Investigators: P.S. Ranhotra & Amalava Bhattacharyya

Grant under this project has been received in December 2014. Literature survey on the theme has been initiated.

25. **Project— Analysis of Holocene climate variability using multi-proxy data around Chorabari Glacier (Kedarnath), western Himalaya, India** (CSIR-UGC NET Fellowship, UGC Grant No. F. 2-24/2014(SA-1)

Investigators: Kriti Mishra & Ratan Kar

Thirty surface samples collected in a linear transect of which 10 each have been collected across the outwash plain of the Chaurabari Glacier, and two levels of kame-terraces are studied in order to understand the relationship between modern pollen rain and contemporary vegetation patterns in the region. Pollen assemblages of samples from the outwash plain of Chaurabari Glacier reflect an overall dominance of arboreal pollen over non-arboreal pollen. Amongst conifers, the prominent taxon having highest frequency is *Pinus* (31-54%). Other taxa, such as *Abies* (0.4-2%) and *Picea* (0.2-2%) are also recorded in low values. The broad-leaved elements such as *Quercus* (1-9%), *Alnus* (5-13%) and *Ulmus* (1-4%) are well represented having good frequencies. Other than these, *Betula* (0.2-3%) and *Corylus* (0.6-1%) are also present having low values. Identification of non-arboreals is up to family level and is represented by the members of Lamiaceae, Convolvulaceae, Ranunculaceae, Rosaceae, Brassicaceae, Poaceae, Papaveraceae, Polygonaceae, Combretaceae, Rutaceae, Euphorbiaceae and Solanaceae along with other steppe elements including *Artemisia*, Asteraceae and Chenopodiaceae/Amaranthaceae. Local taxa such as ferns are represented in fair amounts (1-5%) along with fungal and algal spores. The palynological data generated from the surface samples of Chaurabari Glacier consistently show that the pollen rain is not compatible to the actual floristics of the area.

26. **Project— Multiproxy palaeoclimatic studies of Quaternary lake sediments from southern Madhya Pradesh, India** (Sponsored by DST, New Delhi, No. SR/FTP/ES-16/2014, w.e.f. 27.02.2015)

Investigator: Kamlesh Kumar

Literature survey on the theme has been initiated.

27. **Project— Mangrove dynamics and relative sea level changes during late Quaternary in Godavari delta** (Sponsored by DST, New Delhi, No. SR/FTP/ES-84/2014, w.e.f. 17.03.2015)

Investigator: Jyoti Srivastava

The proposed study will be available for use in constructing palaeoclimate, palaeoenvironment and palaeo sea levels, and its use in hydrocarbon industry. The fundamental aspects of mangrove vegetational record in the past will also serve as a basis for application in geomorphological changes and in evaluation studies of specific geoecological systems (with regard to their sensitivity, vulnerability and potentials) and the impact of climatic changes on them.

Research Papers Published

In SCI Journals

Aggarwal N, Krings M, Jha N & Taylor TN 2015. Unusual spheroidal inclusions in Late Permian gymnosperm pollen grains from southern India revisited: Evidence of a fungal nature. *Grana*, http://dx.doi.org/10.1080/00173134.2015.1007080.

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Poster session during Conferences on Quaternary Climate Change (left) and on Gondwana Evolution (right) organised during December 2014 and February 2015, respectively

Deputation to Conferences/Seminars/Workshops

Abroad

C.M. Nautiyal participated in the *IX International Public Forum Dialogue on Atomic Energy, LLC, Security* held at Moscow, Russia during April 09-11, 2014.

Anupam Sharma participated in the *33rd VM Goldschmidt International Conference (Goldschmidt-2014)* held at Sacramento (California), USA during June 08-13, 2014.

C.M. Nautiyal participated in the *VI International Forum ATOMEXPO 2014* held at Moscow, Russia during June 09-11, 2014.

Anjum Farooqui participated in the *3rd International Conference on Biodiversity and Sustainable Energy Development (Biodiversity-2014)* held at Valencia, Spain during June 23-27, 2014.

P. Morthekai participated in the *14th International Conference on Luminescence and ESR Dating* held at McGill University, Quebec (Montreal), Canada during July 07-11, 2014.

R.C. Mehrotra participated in the *International Conference on Plant Culture and Environment* held at Jinan, China during August 19-22, 2014.

M.C. Manoj participated in *XXXIII SCAR Open Science Conference-2014* held at Auckland, New Zealand in August 2014.

Sunil Bajpai, Jyotsana Rai & Neeru Prakash participated in the *2nd International Conference of IGCP-608: Symposium on Land Ocean Linkages and Biotic Evolution during the Cretaceous: Contribution from Asia and western Pacific* held at Waseda University of Tokyo, Japan during September 04-10, 2014.

JR and NP also participated in the post-symposium field excursion and visited Cretaceous forearc basin's siliciclastic successions along the Pacific Coast, central Japan: Choshi, Nakaminato and Futaba Groups along with geosites, geoparks and museums. Besides, Iwaki coal and fossil museum are also visited. Many kinds of Mesozoic and Cenozoic fossils have been sophisticatedly exhibited. Some Cretaceous huge ammonite, dinosaur, pterosaurid, turtle, pliosaurid and shark teeth as well as Cenozoic mammals, whales, elephants and fin footed penguins are displayed. Coal mine is very well-excavated and exhibited, showing history and development of excavation of coal deposits in mines. The main building of Iwaki Ammonite Centre is founded over inclined bedding surface to observe ammonite shell bed and associated fossils. Here large sized ammonites are quite apparently visible.

Rajni Tewari participated in the *2014 Annual Convention of the International Association for Gondwana Research & 11th International Conference on Gondwana to Asia* held at China University of Geosciences, Beijing during September 19-24, 2014.

C.M. Nautiyal participated in the *Atomex Asia 2014* held at Ho Chi Minh, Vietnam during November 19-20, 2014.

P.S. Ranhotra participated in the *IGBP-PAGES Land Cover 6K Launching Workshop* held at LOCEAN, University Pierre et Marie Curie, Paris, France during February 18-20, 2015.

R.R. Yadav participated in the *4th Asian Dendrochronological Association Conference on Climate Change and Tree-ring* held at Kathmandu, Nepal during March 09-12, 2015.

In India

Ruby Ghosh, Anju Saxena & Shailesh Agrawal participated in the *Brainstorming Session on Paleoclimate Records from Ganga Plain* held at Wadia Institute of Himalayan Geology, Dehradun during April 03-04, 2014.

Ruby Ghosh participated in the *Workshop on Hands-on Training on Palaeobotanical and Palynological Techniques* held at University of Calcutta, Kolkata during April 21-28, 2014.

Shilpa Pandey & Swati Tripathi participated in the *National Hindi Science Symposium on Climate Change, Monsoon Variability and Prediction: Scientific Approach* held at Indian Institute of Tropical Meteorology, Pune during July 30-31, 2014.

C.M. Nautiyal participated in the *Rashtriya Hindi Vigyan Sammelan* held at AB Vajpayee Hindi Vishvavidyalay, Bhopal during August 01-02, 2014.

Vandana Prasad participated in the *Workshop on Molecular Phylogenetics-2014* held at the Centre for Ecological Sciences, IISC, Bangalore during August 01-05, 2014.

A. Rajanikanth participated in the *7th International Conference on Geoscience Education* held at University of Hyderabad, Hyderabad during September 05-09, 2014.

Rajni Tewari, Anupam Sharma, Binita Phartiyal, Ratan Kar, Pawan Govil, Biswajeet Thakur, P.S. Ranhotra, Anjali Trivedi, Shailesh Agrawal, S.N. Ali, Nivedita Mehrotra, A.K. Yadava & Kriti Mishra participated in the Expert Meet and *Conference on Climate Change and Environmental Sustainability: Geological records from Poles to Tropics* held at Centre of Advanced study in Geology, University of Lucknow, Lucknow during September 09-10, 2014.

B.D. Singh participated in the *66th ICCP (International Committee for Coal and Organic Petrology) Annual Meeting & International Symposium on Application of Organic Petrography for Power and Steel Industries– our preparedness for facing the challenges in coming decades* held at Science City, Kolkata during September 20-25, 2014.

Anupam Sharma participated in the *Inorganic Mass Spectrometry Meeting-2014 (IOMS)* held at Hotel Rajsthali, Jaipur during September 24-26, 2014.

R.P. Mathews & V.P. Singh participated in the *ICCP International Symposium on Application of Organic Petrography for Power and Steel Industries– our preparedness for facing the challenges in coming decades* held at Science City, Kolkata on September 25, 2014.

Chanchala Srivastava participated in the *Joint Annual Conference of IAS, ISPQS and IHCS* held at Deccan College Post-Graduate and Research Institute, Pune during October 06-09, 2014.

Arindam Chakraborty participated in the *Indo-European Workshop III: Coastal Zone Management and its impact on Society* held at Abad Turtle Beach Resort, Kerala during October 06-09, 2014.

Vandana Prasad participated in the *INQUA-HABCOM Workshop on Palaeoanthropological Perspectives on Plant Communities in South Asia* held at French Institute of Pondicherry, Pondicherry during October 27-November 02, 2014.

P.S. Ranhotra participated in the *National Conference on Himalayan Glaciology*, organized by SERB-DST New Delhi and SCSTE Shimla and held at Shimla during October 30-31, 2014.

Neelam participated in the *National Conference on Desert Sciences– Opportunities and Challenges* in 84th Annual Session of the National Academy of Science held at Jai Narain Vyas University, Jodhpur during November 04-06, 2014.

M.F. Quamar & Shreya Misra participated in the *National Conference on Sedimentation and Stratigraphy* and *XXXI Convention of Indian Association of Sedimentologists* held at the Department of Geology, Savitribai Phule Pune University, Pune during November 12-14, 2014.

M.F. Quamar & Chinnappa Chopparapu participated in the *Tropical Ecology Congress-2014: Tropical Ecosystems in a Changing World* held at the School of Environmental Sciences, JNU, New Delhi during December 10-12, 2014.

Scientists & Research Scholars working on Quaternary aspects participated in the *National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges* held at BSIP, Lucknow during December 15-16, 2014.

R.R. Yadav & K.G. Misra participated in the *5th National Conference on Climate Change* organized by Indian Climate Research Network (ICRN) held at Indian Institute of Technology, Delhi during December 19-20, 2014.

Vandana Prasad participated in the *Seminar on Reconciliation of Marine and Terrestrial Records of Summer Monsoon Variability during the Holocene* held at National Institute of Oceanography, Goa during December 19-21, 2014.

Scientists & Research Scholars working on Gondwana aspects participated in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution* held at BSIP, Lucknow during February 19-20, 2015.

Ruby Ghosh, Swati Tripathi & M.F. Quamar participated in the *5th International Conference on Plants and Environmental Pollution (ICPEP-5)* held at National Botanical Research Institute, Lucknow during February 24-27, 2015.

A.K. Ghosh, Ratan Kar & Arindam Chakraborty participated in the *National Seminar on Contemporary Progress in Plant Sciences* held at Centre of Advanced Study (UGC) Department of Botany, University of Burdwan, Burdwan during March 20-21, 2015.

Training/Study Visits

Abroad

P.S. Ranhotra visited Institute of Botany, Chinese Academy of Sciences, Beijing (China) under CAS-TWAS post-Doctoral Fellowship for one year (August 26, 2013-August 25, 2014) to carryout research work on 'High resolution climatic studies during Late Quaternary from Tibetan Plateau: A multi proxy approach'.

Vandana Prasad visited the Steinmann Institute, Bonn University, Germany under Bilateral Exchange of Scientist Programme of Academies of Sciences of India (INSA) and Germany (DFG) during September 01-30, 2014.

Binita Phartiyal visited the Institute of Tibetan Plateau Research (ITP), Beijing under Bilateral Exchange of Scientist Programme of Academies of Sciences of India (INSA) and Chinese (CAS) during October 09- November 10, 2014.

R.R. Yadav visited the University of Erlangen, Nurenberg under Bilateral Exchange of Scientist Programme of Academies of Sciences of India (INSA) and Germany (DFG) during November 03-December 02, 2014.

Rajni Tewari & Deepa Agnihotri visited Germany and Brazil in connection with DST sponsored project on palaeofloristics of Lower Gondwana sediments of India and Brazil with special reference to palaeowild fire. They visited following institutions and universities– i) Museum of Mineralogy & Geology, and Department of Geochronology, Senckenberg Natural History Collections, Dresden; ii) Senckenberg Natural History Museum, Frankfurt Main (Germany); iii) Department of Botany and Palaeobotany, and iv) Natural History Museum Botany & Palaeobotany Section, Centro Universitário UNIVATES, Lajeado, Rio Grando do Sul; v) Museum of Palaeontology, and vi) Department of Palaeontology & Stratigraphy, Institute of Geosciences, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Rio Grando do Sul (Brazil).

In India

S. Nawaz Ali visited PRL, Ahmedabad for sample analysis during March 10-May 05, 2014 and again during June 20-July 20, 2014.

P. Morthekai visited PRL, Ahmedabad four times for sample analysis during March 18-April 10, 2014; May 25-June 28, 2014; October 25-November 09, 2014; and January 22-February 04, 2015.

Anupam Sharma visited (~2 weeks) School of Environmental Sciences, JNU, New Delhi for mineralogical and geochemical analyses of samples. The data on some of the samples is recently received and some are under process of analysis.

Shamim Ahmad attended the National Field Workshop in Ladakh Region to understand the tectono-sedimentary frame work of the Ladakh fore arc basin, organised by the Palaeontological Society of India during July 28-August 04, 2014.

Dhirendra Sharma & Sumit Bisht attended the Workshop on Informatics: National Seminar– E-Content 2014 held at hotel Golden Tulip, Lucknow on September 16, 2014.

Neerja Jha attended the Subject Expert Committee Meeting for evaluation of project proposals under Women Scientist Scheme of DST held at NGRI, Hyderabad during October 29-30, 2014.

Debarati Nag visited PRL, Ahmedabad for carrying out OSL dating of the samples during October 27-Decmeber 20, 2014.

Pawan Govil & P. Morthekai attended the training programme for Radiological Safety Officer (RSO) Level I training '90sr beta source in the OSL lab as per the AERB regulations' hosted by Indian Association for Radiation Protection in collaboration with Radiological Physics and Advisory Division (PRAD) at BARC, Mumbai during December 01-09, 2014.

Y.P. Singh attended the Conference & Workshop on Biotechnology Trends and Innovation held at M.G. Institute of Management and Technology, Banthara, Lucknow during March 21-22, 2015.

Uttam Pandey attended the Winter School of Quaternary Geology and Paleoenvironment held at Deccan Collage, Pune during December 08-14, 2014.

Uttam Pandey attended the Training program 'Role of Remote Sensing and Geographical Information System (GIS) in Natural Resources Management' at Remote Sensing Application Centre, Lucknow during March 23-27, 2015.

Workshop on Phylogenetic Biology

Across the world, there is a growing interest in biology that is often focused on the areas of biodiversity and genomics. These areas have important applied aspects, and receive much attention in India, where increasing numbers of bright, young biologists are making their mark in rapidly developing fields such as biotechnology and, to a lesser extent, in systematics. However, an important component that is important for both areas, phylogenetics (establishing and understanding the relationships between species) is largely missing from this trend. The need for such 'tree-thinking' in biology is widely recognized and its absence may be compared to an absence of statistics in modern biology.

Phylogenetics is essential for interpreting large amounts of information from different species, such as found in worldwide databases of biodiversity (e.g., GBIF) and DNA sequences (e.g., GenBank). It is critical, for instance, for understanding the exceptionally rich and diversified flora and fauna of India. Millions of years ago, India broke away from Africa, and later became connected to Asia. Because of this, India's biodiversity can only be understood in relation to organisms from regions such as Africa, Eurasia, China and Malaya. Phylogenetic methods are pivotal for a good understanding of the past and, therefore, planning for the future and conservation of biodiversity. However, the paucity of expertise makes this a difficult task at present. The problem is due not to a lack of awareness of the importance of phylogenetics, but rather to limited exposure to the concepts and methods used in this area of biology.

Keeping in background, a three days training programme on *Principles and Practice of Phylogenetic Analysis* making use of different software was conducted by Prof. R. Geeta, Department of Botany, University of Delhi at BSIP during March 02-04, 2015. The workshop was aimed to familiarize participants with the theory and practice of phylogenetics. It commenced with a series of lectures by Prof. Geeta that explained the way to conduct phylogenetic analysis, and described Maximum Parsimony, Neighbour-Joining, Maximum Likelihood and Maximum Posterior Probability methods. In addition, she also provided considerable information on phylogenetic trees and tree thinking, how to build, read and interpret the tree topology, and use trees for character and molecular evolution.

Prof. Geeta also trained the participants for use of software such as PAUP, MESQUITE and MEGA6 conducting basic exercises on how to create a data matrix in fossil studies, followed by their application for various phylogenetic methods. The training programme concluded on a high note, where the participants clearly acquired considerable experience on phylogenetic procedures and their applications in fossil studies. The workshop was coordinated by Dr. Vandana Prasad.

Lectures Delivered

Status of Knowledge on Vindhyan Supergroup: Unsolved Problems at Regional IGC Cell, Geological Survey of India, Lucknow (May 22, 2014). – delivered by Mukund Sharma

Origin of Life: Evidences from India – Possibilities of Science Film Making at the Regional Science City, Lucknow (February 04, 2015). – delivered by Mukund Sharma

Importance of Science for Youth at the Christian College, Lucknow (February 28, 2015). – delivered by Mukund Sharma

Palaeofloristics of Weller and Lashly Formations, Allan Hills, central Transantarctic Mountains, South Victoria Land, Antarctica: Gondwanan Correlation with special reference to India and Implications in Palaeoecology and Phytogeography (Invited lecture) in Expert Meet and Conference on Climate Change and Environmental Sustainability, at CAS in Geology, University of Lucknow, Lucknow (September 9, 2014). – delivered by Rajni Tewari

Story of Chalk: Indian Case Studies (to M.Sc. students) at the Department of Geology, University of Rajasthan, Jaipur (January 02, 2015). – delivered by Jyotsana Rai

Mangroves: Indicators of Tectonic Activity at Indian Institute of Sciences, Bangalore (November 2014). – delivered by Anjum Farooqui

Floral Diversity after the end Permian Mass Extinction Event (Lead Lecture) in the National Seminar on Contemporary Progress in Plant Sciences at Department of Botany, University of Burdwan (March 21, 2015). – delivered by A. K. Ghosh

The Evolving Perception about Nuclear Energy in India in the IX International Public forum Dialogue on Atomic Energy, LLC, Security at Moscow (April 11, 2014). – delivered by C.M. Nautiyal

Hindi mein Vigyan Lekhan in the Rashtriya Hindi Vigyan Sammelan at AB Vajpayee Hindi Vishvavidyalay, Bhopal (August 01, 2014). – delivered by C.M. Nautiyal

Four Lectures (and 2 sessions) during the District Science Club's Science Journalism Workshops (September 6-8, 2014). – delivered by C.M. Nautiyal

What, Why and How of Radiocarbon Dating and *Applications of Radiocarbon Dating for studies in History & Archaeology* at the Department of Ancient History, Archaeology & Culture, Gorakhpur University (September 13, 2014). – delivered by C.M. Nautiyal

Radiocarbon Dating and *Applications* at CSIR-National Metallurgical Laboratory, Jamshedpur (October 13-14, 2014). – delivered by C.M. Nautiyal

Quality Science Education: Ensuring a Sustainable Future for all on World Science Day at Regional Science City, Lucknow (November 10, 2014). – delivered by C.M. Nautiyal

How old is old: An Introduction to Dating at Sagar Institute of Management and Technology, Barabanki (November 11, 2014). – delivered by C.M. Nautiyal

Scientific Temperament during ICSE science book launch at Hotel Lineage (November 15, 2014). – delivered by C.M. Nautiyal

Nuclear Energy: Some Myths & Reality in Atomex Asia-2014 at Ho Chi Minh, Vietnam (November 20, 2014). – delivered by C.M. Nautiyal

Scientific Dating of Rock Art in National Multidisciplinary Orientation Workshop on Rock Art (by IGNCA & BSIP) at BSIP (December 12, 2014). – delivered by C.M. Nautiyal

Holistic Education in Workshop on Competence Building & Decision Making by Mahila Vidyalaya Degree College, and University of Lucknow (December 13, 2014). – delivered by C.M. Nautiyal

Four lectures in a programme by MASTEC (under NCSTC, DST scheme) on various aspects of science communication at Manipur University, Imphal (January 10-14, 2015). – delivered by C.M. Nautiyal

Two sessions on *Dating Techniques* in second level Indo-Swiss Capacity Building Workshop at Jawaharlal Nehru University, New Delhi (January 28, 2015). – delivered by C.M. Nautiyal

Science in Nation building at HAL School, Lucknow (February 28, 2015). – delivered by C.M. Nautiyal

Simplified Presentation of Science: Dilution without Distortion in a Vigyan Prasar programme at Institute of Professional Studies, Allahabad University (March 05, 2015). – delivered by C.M. Nautiyal

Plant Fossil History through Time at Christian College, Lucknow (November 01, 2014). – delivered by Annamraju Rajanikanth

Mid-Holocene Climate and Cultural Responses: A case study from Western India in the mini Seminar on Reconciliation of Marine and Terrestrial Records of Summer Monsoon Variability during the Holocene, on the occasion of 80th Anniversary General Meeting of INSA, jointly organized by NIO, Goa University, and NCAOR at Goa (December 19-21, 2014). – delivered by Vandana Prasad

Ladakh– A Witness of Environmental Variations during Late Quaternary (Invited talk) at Geological Survey of India, Lucknow (June 06, 2014). – delivered by Binita Phartiyal

Quaternary Geomorphic Evolution and Climate during Quaternary in Trans Himalayan Region (Invited talk) at the Institute of Tibetan Plateau Research (ITP), CAS, Beijing, China (October 14, 2014). – delivered by Binita Phartiyal

On Archaeobotanical Aspects (to PGDA students of 1st semester) at Institute of Archaeology, Red Fort, Delhi (January 9-11, 2015). – delivered by A.K. Pokharia

Reconstruction of the Quaternary Climate History: Clues from Pollen and Phytolith Records in Brainstorming Session on Paleoclimate Records from Ganga Plain at WIHG Dehradun (April 3-4, 2014). – delivered by Ruby Ghosh

Phytolith Extraction, Study and Application in Workshop Hands-on Training on Palaeobotanical and Palynological Techniques at Department of Botany, University of Calcutta, Kolkata (April 3-4, 2014). – delivered by Ruby Ghosh (as Resource Person)

Reconstruction of the Quaternary Climate History: Clues from Pollen and Phytolith Records in Brainstorming Session on Paleoclimate Records from Ganga Plain at WIHG Dehradun (April 3-4, 2014). – delivered by Anju Saxena

The Big Realm of Minute Nannofossils (to M.Sc. students) at the Department of Geology, University of Rajasthan, Jaipur (January 01, 2015). – delivered by Abha Singh

Introduction to Palaeobotany at Navyug Mahila Mahavidyalaya, Lucknow (November 14, 2014). – delivered by Jyoti Srivastava

Latest Trends in Isotope Geochemistry of Lake Deposits in Brainstorming Session on Paleoclimate Records from Ganga Plain at WIHG Dehradun (April 3-4, 2014). – delivered by Shailesh Agrawal

Impact Factor vs Impact in Seminar on Educated India-Capable India: Quality Education for all at Lucknow University, Lucknow (17 November 17, 2014). – delivered by Y.P. Singh

Conservation of Geo-heritage Sites of India with special reference to Andaman & Nicobar Islands at Indo-European Workshop III: Coastal Zone Management and its impact on Society, Abad Turtle Beach Resort, Kerala (October 6, 2014). – delivered by Arindam Chakraborty

Lectures by Visiting Scientists

New Insight into Cenomanian Biostratigraphy in Bohemian Cretaceous Basin (Czech Republic) based on Palynomorphs, Foraminifers, Calcareous Nannofossils and Macrofauna – delivered by Dr. Marcela Svobodova, Institute of Geology, Prague, Czech Republic (May 02, 2014).

Elements of Paleomagnetism: Uses in Palaeosciences – delivered by Prof. J.G. Meert, Department of Geological Sciences, University of Florida, USA (November 14, 2014).

Earth's Atmosphere and Climate Change Signals – delivered by Dr. Geetha Ramkumar, Space Physics Laboratory, Vikram Sarabhai Space Centre, Indian Space Research Organization, Trivandrum, Kerala (December 01, 2014).

New Discoveries of the Ediacaran Biota from the Yangtze Gorges, China: A– Wonderful Life, B– Ediacaran Biota – delivered by Prof. Sun Weiguo, Honorary Director, Museum of Nanjing Institute of Geology and Palaeontology, Nanjing, China (December 03, 2014).

Recent Discoveries of the Ediacaran Fossils from Bhima Basin, South India – delivered by Prof. Sun

Weiguo, Honorary Director, Museum of Nanjing Institute of Geology and Palaeontology, Nanjing, China (December 04, 2014).

Evolution of Wood Anatomical Diversity and its Significance in Plant Systematics and Global Change Research – delivered by Prof Pieter Baas, Director of the Rijksherbarium Leiden (National Herbarium of The Netherlands) (December 22, 2014).

Palaeobotanical Investigations of Biogeographic History – delivered by Prof. Steve Manchester, Curator of Palaeobotany, Florida Museum of Natural History, Adjunct Professor, Department of Biology, University of Florida, Gainesville (December 23, 2014).

Fossil Wood: Recognizing Changes through Time – delivered by Prof. Elisabeth Wheeler, Professor Emeritus of the Department of Forest Biomaterials, N.C. State University & Associate of the North Carolina Museum of Natural Sciences (December 23, 2014).

A New Approach to Understanding the Fossil Record of Monocot Flowering Plants–delivered by Dr. Selena Y. Smith, Assistant Professor, Earth and Environmental Sciences and Program in the Environment (December 24, 2014).

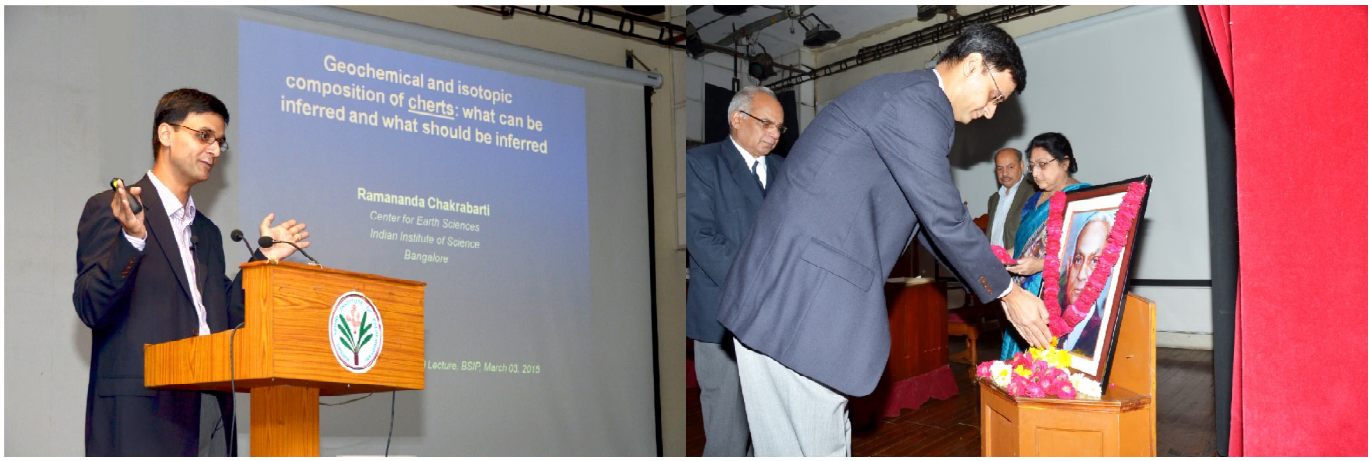
Fossil Insects – delivered by Prof. David A. Grimaldi, American Museum of Natural History, New York, USA (January 08, 2015).

Paleolimnological Walk through Holocene Period to understand Water Quantity and Quality on Boreal Lakes in northwest Ontario. – delivered by Dr. Moumita Karmakar, Department of Biology, Queen's University, Kingston, Ontario, Canada (January 23, 2015).

Global Warming from a Palaeontologist's Perspective – delivered by Dr. Martin Pickford, Honorary Affiliate at the National Museum of Natural History, Paris at Sorbonne Universités, Paris, France (March 27, 2015).

Indian Proterozoic Sequences: A Window into the Foundation of Biotic Evolution (4th Dr. B.S. Venkatachala Memorial Lecture) – delivered by Dr. V.S. Kale, Adjunct Professor, Department of Earth Sciences, IIT Bombay, Mumbai (January 02, 2015).

Geobotany and Biogeochemical Prospecting (1st Dr. K.R. Surange Memorial Lecture) – delivered by Prof. M.N.V. Prasad, Department of Plant Sciences, University of Hyderabad, Hyderabad (February 06, 2015).



Geochemical and Isotopic Composition of Cherts: What can be Inferred and What should be Inferred? (1st Dr. M.N. Bose Memorial Lecture) – delivered by Dr Ramananda Chakrabarti, Centre for Earth Sciences, Indian Institute of Science, Bangalore (March 03, 2015).

Healthy Practices in Finance and Administration and on *Water Harvesting* (Vigilance Week Lecture) – delivered by Shri Mahendra Modi, IPS, Additional Director General, UP (October 30, 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:

Shramjeevi College, Jaipur

University of Pune, Pune

Sri Krishna Kshetra Upadesasales Samithy, Poonithura, Ernakulam

Dept. of Earth Science, IIT Kanpur

Geological Survey of India, Kolkata

Geological Survey of India, Cochin

DSB Campus, Uttarakhand

University of Madras, Chennai

Deccan College of PG Research Institute, Pune

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 researchers of following organizations/ universities:

Kothiwal Dental College and Research Centre, Moradabad (UP)

Sardar Patel P.G. Institute of Dental and Medical Sciences, Lucknow

CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow

Lucknow University, Lucknow

Uday Pratap Autonomous College,Varanasi (UP)

Amity University, Lucknow

Babasaheb Bhimrao Ambedkar University, Lucknow

Babu Banarsi Das University, BBD City, Lucknow

Integral University, Lucknow

Chandra Dental College and Hospital, Barabanki (UP)

Rameshwaram Institute of Technology and Management, Lucknow

Central Institute for Plastic Engineering and Technology, Lucknow

KGMC Medical University, Lucknow

Agra College, Agra (UP)

Career Post Graduate College of Dental Sciences & Hospital, Lucknow

Pranveer Singh Institute of Technology, Kanpur (UP)

D.J. College of Dental Sciences & Research, Ghaziabad (UP)

Christ Church College, Kanpur (UP)

Consultancy services have been provided to Oil India Limited, Jodhpur (Rajasthan) on biostratigraphical studies of sub-surface samples of well Punam-1 (drilled in Bikaner-Nagaur Basin) of NELP VI Block RJ-ONN-2004/2 (under OIL-BSIP contract no. 6108088). The sedimentary successions encountered in the well between 90-1260 m intervals have been studied for palynological constituents of the samples to interpret age and palaeoenvironment, besides demarcation of unconformities/hiatuses. Study was conducted on 50 cutting samples available for biostratigraphic interpretations. – by Sunil Bajpai, Rahul Garg, Mukund Sharma, Madhav Kumar, Jyotsana Rai, Vandana Prasad, Veeru K. Singh, Abha Singh & Neha Aggarwal

Consultancy services have been provided to Geological Survey of India, Jaipur (Rajasthan) on palynological studies of 30 soil samples from 4 bore-holes. – by S.K. Bera, S.K. Basumatary, Anjali Trivedi & Swati Tripathi

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

Rendered palynological training including chemical processing of samples followed by pollen analytical techniques as a part of PhD Thesis for Ms. Seikuti Nohro, Pondicherry University. – by S.K. Bera

Provided scientific assistance in measurements of vitrinite reflectance and observation under fluorescent light on the carbonaceous shale/shale samples of Raniganj Coalfield to Mr. Bodhisatwa Hazra, Ph.D. student of Indian School of Mines University, Dhanbad (in December 2014). – by B.D. Singh & V.P. Singh

Provided scientific assistance in measurements of vitrinite reflectance and observation under fluorescent light on coal samples of Damodar Basin to Ms. Satabdi Mishra, Ph.D. student, and Mr. Sanki Biswal, M.Tech. student of Indian School of Mines University, Dhanbad (in March 2015). – by B.D. Singh & V.P. Singh

Rendered summer training on palaeoethnobotanical investigations to Ms. Shubhangi Srivastava, BA (Hons.) student of Department of Anthropology, JNU New Delhi (in May-June 2014). – by Chanchala Srivastava

Rendered training on Archaeobotany to Dr. Sandhya Misra, post-Doc. Fellow at Archaeology Division, IIT, Gandhinagar (in July 2014). – by Chanchala Srivastava

Imparted palynological training to two Ph.D. students– Ms. Priyanka Raja from Anna University (Chennai), and Ms. Silpa from JNCAR (Bangalore). – by Anjum Farooqui

Imparted palynological training to Mr. Vivek, Geologist from Geological Survey of India, Cochin. – by Anjum Farooqui

Mentored a student– Mr. G. Sandeep (on Summer Intern Fellowship under the combined scheme of three National Science Academies) from the University of Pondicherry (May 01-June 30, 2014). – by C.M. Nautiyal

Reviewed a book on Technology in Hindi for Hindi Sansthan, Lucknow. – by C.M. Nautiyal

Rendered technical supports to Indian Institute of Technology, Kanpur for their newly established OSL Dating Laboratory (on 09.01.2015 & 13.03.2015). – by P. Morthekai

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 & November 2014). – by V.P. Singh

Post-conference field excursion of Conference on Quaternary Climate Change: Experts and participants at Hulaskhera Archaeological Site (Tehsil Mohanlalganj), Lucknow

Post-conference field excursion of International Conference on Gondwana Evolution: Exposure of Parsora Formation (Late Triassic) in Dhaurai Hill near Birsinghpur-Pali (South Rewa Basin), central India

Recognition

Sunil Bajpai

Chairperson, Session-4: *Biodiversity during Gondwana Period* in International Conference on current perspective and emerging issues in Gondwana evolution, BSIP Lucknow, February 2015.

Neerja Jha

Co-Chairperson, Session-4: *Biodiversity during Gondwana Period* in International Conference on current perspective and emerging issues in Gondwana evolution, BSIP Lucknow, February 2015.

R.C. Mehrotra & Jyotsana Rai

Awarded jointly "Scientific Output Medal–2014" of BSIP for the best piece of research work done amongst Scientists- E, F and G during the preceding two years (2012 & 2013).

Jyotsana Rai

Chairperson of part Session 4: *Biotic evolution: Asian and Western Pacific fauna and flora II – Microflora* in 2nd IGCP 608 Symposium– Land-Ocean linkages and biotic evolution during the Cretaceous: Contributions from Asia and Western Pacific, Waseda, Japan, September 2014.

Mukund Sharma, Neha Aggarwal, V.K. Singh, Rahul Garg, Madhav Kumar, Jyotsana Rai, Vandana Prasad & Abha Singh

Received "First Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

Mukund Sharma, Bandana Dimri, Madhav Kumar & Ram Awatar

Received "Third Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

K.J. Singh

Co-Chairperson, Session-1: *Gondwana assembly and fragmentation* in International Conference on current perspective and emerging issues in Gondwana evolution, BSIP Lucknow, February 2015.

Rajni Tewari

Chairperson, *2014 Convention and 11th International Conference on Gondwana to Asia*, China University of Geosciences Beijing, China, September 2014.

Co-Chairperson, Session 2: *Gondwana climate, sedimentation patterns and palaeoenvironments* in International Conference on current perspective and emerging issues in Gondwana evolution, BSIP Lucknow, February 2015.

Rajni Tewari & Saurabh Gautam

Received "Second Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

Rajni Tewari & Deepa Agnihotri

Received "Consolation Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

B.D. Singh, Alpana Singh, Anju Saxena, Neerja Jha & R.P. Mathews

Received "Consolation Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

A. Rajanikanth & C. Chinnappa

Received "Consolation Prize for the Best Poster Presentation" of the paper displayed in the *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution,* BSIP Lucknow, February 2015.

O.S. Sarate

Felicitated by the Director, Institute of Science, Nagpur (Maharashtra) for significant research work which has lead to the discovery of over 3,000 MT of coal reserves in Andhra Pradesh.

Felicitated by the Principal Dr. D.K. Burghate, Shivaji Science College, Nagpur for significant research contributions.

Rashmi Srivastava

Established the collaborative research programme with National Science Foundation of USA with Prof. Steve Manchester, Prof. E. Wheeler, Dr. Selena Smith of USA, and Prof. Pieter Baas of Netherlands.

Anjum Farooqui & Anupam Sharma

Awarded jointly "Team Medal–2014" for excelling to inculcate team spirit and collaborative integrated work within the Institute or in collaboration with other institution during the preceding two years (2012 & 2013).

Anjum Farooqui, Jyoti Srivastava & Ranjana

Received "Paper of the Month Award– May-June 2014" of BSIP for the paper entitled 'Palynological record of tropical rain forest vegetation and sea level fluctuations since 140 ka from sediment core, south-eastern Arabian Sea' published in *P3,* volume 411.

A.K. Ghosh

Nominated and Elected Member of the National Academy of Sciences, India.

A.K. Ghosh, Reshmi Chatterjee & Ratan Kar

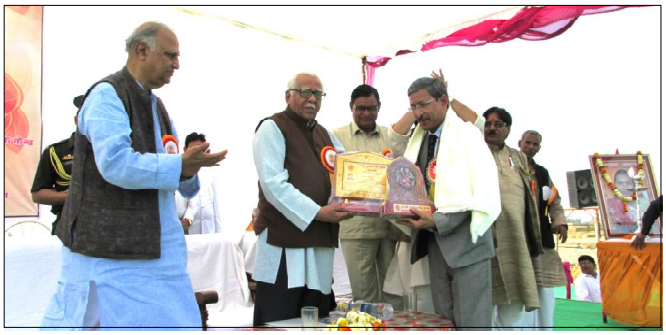
Received "Paper of the Month Award– November 2014" of BSIP for the paper entitled 'Dwarfism and Lilliput effect: A case study on the *Glossopteris* from the late Permian and early Triassic of India' published in *Current Science*, volume 107(10).

C.M. Nautiyal

Chaired a Session of National Conference on *Hindi mein Vigyan Lekhan* held at AB Vajpayee Hindi Vishvavidyalay, Bhopal in August 2014.

Chaired a Session in the Valedictory Session of the INSPIRE programme at Sagar Institute of Technology and Management on November 11, 2014.

Received "Prabhashree Samman" from Prabhashree Samiti, Devgarh, Sonbhadra, presented by the Hon. Governor of Uttar Pradesh (on March 13, 2015)



C.M. Nautiyal, T.K. Mandal, V.K. Singh, R.C. Mishra, D.K. Pal & J. Baskaran

Awarded jointly "External Budgetary Resource Medal–2014" for obtaining external budgetary resources for the Institute (through consultancy services on C14 Dating) during the preceding two years (2012 & 2013).

Vandana Prasad

Nominated as 'guide' for Summer Research Fellowship Programme (Inspire/Kvyp)-2014, jointly sponsored by the three National Science Academies of the country.

Selected as 'resource person' for *Use of Phytoliths in Archeological studies* in INQUA-HABCOM Workshop on Palaeoanthropological perspectives on plant communities in south Asia, jointly organized by the Sharma Centre for Heritage Education and French Institute of Pondicherry and hosted at French Institute of Pondicherry (October 27-November 02, 2014.

Vandana Prasad & Gaurav Srivastava

Awarded jointly "Diamond Jubilee Medal-2014" of BSIP for publishing the papers in high quality refereed journals during the preceding two years (2012 & 2013).

Binita Phartiyal, Anupam Sharma, Randheer Singh & Debarati Nag

Received "Third Prize for the Best Poster Presentation" for the paper displayed in the *National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges,* BSIP Lucknow, February 2015.

Puline K. Sabina

Awarded "Post-doctoral Fellowship" to carry our research under Prof. Mary E.C. Bernardes-de-Oliveira at the Sedimentary and Environmental Geology Department, Geosciences Institute, University of Sao Paulo, Brazil.

S.K. Shah

Received "Paper of the Month Award– December 2014" of BSIP for the paper entitled 'Spring temperatures in the far-western Nepal Himalaya since AD 1640 reconstructed from *Picea smithiana* tree-ring widths' published in *Climate Dynamics*, doi:10.1007/s00382-014-2457-1.

Anjali Trivedi

Received "Best Poster Presentation Award" for the paper displayed in the *Expert Meeting & Conference on Climate Change and Environmental Sustainability: Records from Poles to Tropics*, CAS in Geology, University of Lucknow, September 2014.

M.F. Quamar & S.K. Bera

Received "Paper of the Month Award– April 2014" of BSIP for the paper entitled 'Surface pollen and its relationship with modern vegetation in tropical deciduous forests of southwestern Madhya Pradesh, India: A review' published in *Palynology*, volume 38(1).

Swati Tripathi, S.K. Basumatary, S.K. Bera & C.M. Nautiyal

Received "Paper of the Month Award– September-October 2014" of BSIP for the paper entitled 'Late Pleistocene palaeoclimate based on vegetation of the Eastern Himalayan foothills in the Indo-Burma Range, India' published in *Palynology*, doi: http://dx.doi.org/10.1080/01916122.2014.945665.

Swati Tripathi & Shilpa Pandey

Received "Best Poster Presentation Awards" for the papers displayed in the *National Hindi Science Symposium,* IITM Pune, July 2014.

Shilpa Pandey

Awarded "Junior Scientist Award-2014" by the National Environment Science Academy, New Delhi in November 2014.

M.C. Manoj

Selected as 'SCAR Fellow' in Scientific Committee on Antarctic Research (SCAR) Fellowship award-2014 to carry out research work at Kochi University, Japan on organic geochemistry studies in Southern Ocean sediment cores to study the paleoclimatic variation during the Quaternary.

Selected to participate as a 'Sedimentologist' in the International Ocean Discovery Program (IODP) Expedition in *JOIDES Resolution* from Singapore to Colombo to carry out research in the Bay of Bengal (January-March 2015).

Co-Chair, Session *Southern Ocean Paleoceanography and Paleoclimatic Modelling* in the XXXIII SCAR Open Science Conference-2014, Auckland, New Zealand, August 2014.

Nivedita Mehrotra, A. Bhattacharyya & S.K. Shah

Received "Paper of the Month Award– July-August 2014" of BSIP for the paper entitled 'Analysis of vegetation and climate change during Late Pleistocene from Ziro Valley, Arunachal Pradesh, Eastern Himalaya region' published in *Quaternary Science Reviews*, volume 101.

Rameshwar Prasad

Awarded "Efficient Administrative Staff Medal–2014" for discharging services with utmost promptness and efficiency during the preceding two years (2012-2013).

Ajay K. Srivastava & Ram Dheeraj

Awarded jointly "BSIP Employee Medal–2014" for working diligently and efficiently with extra efforts in discharging the duties of the Technical staff (Group I & II).

Dr. S.K. Wadhawan, Director General, GSI interacting on exhibits in BSIP Museum

Representation in Committees/Boards

Sunil Bajpai

- Member, Editorial Board, *Journal of the Geological Society of India* (for Fast Track Articles).
- *Member, Editorial Board,* Current Science.
- *Chief Editor,* The Palaeobotanist.
- Member, CSIR Research Committee on Earth and Atmospheric Sciences (2011-2014).
- Co-Convener, Organizing Committee, 2nd Symposium International Geoscience Programe Project (IGCP-608), Tokyo, Japan (September 2014).
- Convener, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).
- Chairperson, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

R.R. Yadav

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

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).
- Co-Chairperson, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).
- Examiner, M.Sc. (Botany), Semester II Practical, Lucknow University.

M.S. Chauhan

- Councillor, The Palaeobotanical Society, Lucknow.
- Organizing Secretary, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

Mahesh Prasad

- Treasurer, The Palaeobotanical Society, Lucknow.
- Member, Editorial Board, *Geophytology*.

Jyotsana Rai

- Member, Executive Council, Palaeontological Society of India, Lucknow.

Mukund Sharma

- President, The Society of Earth Scientists, Lucknow.
- Voting Member, ICS, Sub-commission on Cryogenian Stratigraphy (2012-17)
- Corresponding Member, ICS, Sub-commission on Ediacaran (2012-17)
- Member, IGCP -587 (2011-14)
- Member, Research Development and Coordination Cell, BSIP.
- Joint Secretary, Executive Council, The Palaeontological Society of India, Lucknow (2013-14).
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).
- Examiner, M. Tech. (Petroleum Geoscience), BHU, Varanasi

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.
- Councillor, The Palaeobotanical Society, Lucknow.
- Member, Working Committee, 66th Annual Meeting and Symposium of International Committee for Coal and Organic Petrology (ICCP-2014), Kolkata.

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, Organizing Committee, 66th Annual Meeting and Symposium of International Committee for Coal and Organic Petrology (ICCP-2014), Kolkata.
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

R.S. Singh

- Secretary, The Palaeobotanical Society, Lucknow.
- Member, Editorial Board, *Geophytology*.

Chanchala Srivastava

- Executive Member, Indian Society for Prehistoric and Quaternary Studies, Pune.
- Councillor, The Palaeobotanical Society, Lucknow.
- **Member, Organizing** Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

Rashmi Srivastava

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

Rajni Tewari

- Editor, *The Palaeobotanist*.
- Member, Executive Council, The Palaeontological Society of India, Lucknow.
- Member, National Working Group for IGCP Project-597.
- Organizing Secretary, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).
- Member, Scientific Programme and post-Conference Field Committees, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

Anjum Farooqui

- Member, International Geological Correlation Programme (IGCP-495).
- Member, International Council for Biodeterioration of Cultural Properties, Lucknow
- Member, International Society of Applied Geochemists, Hyderabad
- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

A.K. Ghosh

- Councillor, The Palaeobotanical Society, Lucknow.
- Vice-President, Boys' Anglo Bengali Inter College, Lucknow.
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).
- Organizing Secretary, post-Conference Field, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

B.D. Mandaokar

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

C.M. Nautiyal

- Coordinator, Rock Art Documentation Committee for Uttar Pradesh (by Indira Gandhi National Centre for the Arts, New Delhi).
- Member of Selection Panel for Awards, Hindi Sansthan, Lucknow.
- Member, Local Advisory Committee, Regional Science City, Lucknow.
- Member, Organizing Committee, Science Expo (RSC-L).
- Advisor, Coordination Committee, National Children's Science Congress, UP.
- *Bahya Antarangi*, Vigyan Parishad, Allahabad
- Vice-Chairperson and Patron, Bhartiya Bhasha Pratishthapan Rashtriya Parishad (BBPRP), UP.
- Coordinator, Multidisciplinary Orientation Workshop on Rock Art, BSIP (December 11, 2014).
- Member, Screening Committee, National Science Film Festival-2015 (by Vigyan Prasar, Noida).
- Member, Jury, National Science Film Festival-2015 (by Vigyan Prasar, Noida).
- Part of Organizing Committee, *Bhasha Sangoshthi* under the joint auspices of BBPRP and RSC-L (March 22, 2014).

Neeru Prakash

- Editor, *Geophytology*.

- Assistant Transparency Officer, BSIP.
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

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.
- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

Anupam Sharma

- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).
- Convener, post-Conference Field Trip, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).
- Examiner, Ph.D. Thesis, School of Environmental Sciences, JNU, New Delhi.
- Examiner, Ph.D. Thesis, Department of Environmental Sciences, Bundelkhand University, Jhansi (UP).
- External Examiner for upgradation from JRF to SRF, School of Environmental Sciences, JNU, New Delhi.

Ratan Kar

- Member, Terrestrial Working Group, International Arctic Science Committee.
- Assistant Editor, *The Palaeobotanist*.
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

Anju Saxena

- Co-Editor, Editorial Board of an open access journal *Earth Science India*.
- Member, Research Development and Coordination Cell, BSIP.
- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).
- Member, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

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).
- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

Swati Tripathi

- Member, Editorial Board, Journal of Plant Science and Research.
- Member, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

Jyoti Srivastava

- Jury Member, Model Display Event in the National Geography Olympiad and Geofest International-2014, City Montessori School, Lucknow.

S.K. Bera, Binita Phartiyal, A.K. Pokharia, Pawan Govil, S.K. Basumatary, S.K. Shah, P.S. Ranhotra, K.G. Mishra, Anjali Trivedi, Ruby Ghosh, Shilpa Pandey, Kamlesh Kumar, P. Morthekai, Shailesh Agrawal, S.N. Ali, M.F. Quamar & S.K. Shukla

- Members, Organizing Committee, National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges (BSIP, December 2014).

K.J. Singh, A. Rajanikanth, S.S.K. Pillai, Deepa Agnihotri, Neha Aggarwal & Neelam

- Members, Organizing Committee, International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution (BSIP, February 2015).

P.S. Katiyar

- Chairman, Selection Committee, for the position of Project Staff, CDRI New Campus, Lucknow (July 03, 2014).
- Chairman, Selection Committee, for the position of Project Staff, CDRI New Campus, Lucknow (September 18, 2014).

Ph.D. Programmes

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
Mayank Shekhar	Botany	July 2014 Awarded	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
Prabha Sharma	Geology	December2014 Awarded	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
Suman Sarkar	Botany	December2014 Awarded	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
Anjana Vyas	Geology	August 2008 Submitted	Vikram University, Ujjain	Dr. BD Singh (BSIP) Prof. KN Singh	Petrological evaluation of coals from parts of Bisrampur Coalfield, Son Valley, Chhattisgarh
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
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
Meenakshi Hira	Environ-mental Sciences	July 2012 Continuing	Central Univ. of Himachal Pradesh, Dharamshala & JNU, New Delhi	Dr. Anupam Sharma (BSIP) Dr. Anurag Linda & Dr. Sudesh Yadav	Metal characterization of Computers and Mobile phone e-waste and its impact on different soil types
Vikram Partap Singh	Geology	September 2012 Continuing	Banaras Hindu University, Varanasi	Dr. BD Singh (BSIP) Prof. MP Singh	Petrological and Geochemical characterizations of lignite deposits of Saurashtra Basin (Gujarat), India: Implications to economic potential and depositional setting
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
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
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
Saurabh Gautam	Botany	February 2013 Continuing	Ravenshaw University, Cuttack	Dr. Rajni Tewari (BSIP) Dr. Shreerup Goswami	Palynostratigraphy of Gondwana sediments in Sohagpur Coalfield, South Rewa Basin, Madhya Pradesh, India
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, 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

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
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
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
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
Surabhi Garg	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Jyotsana Rai (BSIP) Prof. AK Jaitely	Integrated nannofossil-ammonite biostratigraphy of Wagad, Kachchh: palaeonvironmental and palaeobiogeographic implications
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
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
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
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
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
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
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
Tarasha Chitkara	Geology	July 2014 Continuing	Kurusketra University, Kurukshetra	Dr. Anupam Sharma (BSIP) Dr. Om Prakash Thakur	Quaternary palaeoclimatic studies using multi-proxy approach around Kurukshetra, Haryana, India,
Nanda Kishore Sahoo	Geology	November 2014 Continuing	Indian School of Mines, Dhanbad	Dr. Sunil Bajpai Dr. Jyotsana Rai (BSIP) Dr. AK Bhaumik	Late Neogene biostratigraphy and climatic changes at Andaman Sea: Planktic foraminiferal and nannoplankton study
Uttam Pandey	Geology	November 2014 Continuing	University of Lucknow, Lucknow	Dr. SK Shah (BSIP) Supervisor (assigned after pre Ph.D. course)	Dendroclimatology of northeastern region of Kashmir Valley

Units

Publication

Journal— *The Palaeobotanist*

This year two issues of BSIP's flagship journal *The Palaeobotanist* were published. The first 63(1)

incorporated 9 research papers and 3 reports. The second 63(2) contained 5 research papers. The abstracts of all the research papers were also published in Hindi.

Annual Report

Bilingual Annual Report of the Institute was published in English and Hindi containing pertinent information

related to research work carried out under different projects during the period April 01, 2013 to March 31, 2014. Besides, research papers published, conference participation, training/deputation, awards/honours, Foundation/Founders' Day celebrations, reports of different units, annual accounts and related aspects with relevant photographs and graphics were included.

Abstract Volume & Field Guide

An abstract volume containing thematic abstracts for *National Conference on Quaternary Climate Change: New Approaches and Emerging Challenges* held during December 15-16, 2014 was published. A field-guide folder for the said conference was also published.

Another abstract volume for *International Conference on Current Perspectives and Emerging Issues in Gondwana Evolution* held during February 19-20, 2015 was published. Both these conferences were hosted at BSIP. A comprehensive field-guide book for the post-International Conference field trip was also published.

Souvenir

A Souvenir volume was published on the occasion of the National Conference on *Quaternary Climate Change* held during December 2014.

Miscellaneous

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

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 2014-15	Total
Books in English	78	6,250
Journals (bound volumes)	246	16,897
Reprints	1	40,100
Reference Books	3	351
Books in Hindi	67	597
Ph.D. Thesis	-	103
Reports	-	46
Maps & Atlases	-	61
Microfilm/ Fisches	-	294
Compact Disk	-	74

(Working hours 09:30–18.00 Monday-Friday)

Currently the library is receiving 172 journals (103 through subscription and 69 through exchange). There are 172 registered card holders using the library facilities.

e-Journals

Web based access of the journals is available over the Institutes' 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 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 enjoyed the exhibition and selected 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*, Prof. Sahni's work, Annual Reports, and 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 out side 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*	35
Journals received from different institutions on exchange basis	69

Training

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

The following Institutions availed the Library facilities: Department of Geology, Anna University, (Chennai), Department of Botany, Allahabad University (Allahabad), Department of Geography, University of Burdwan (WB), Archaeological Science Centre, IIT Gandhinagar (Gujarat), and Department of Botany, Lucknow University (Lucknow).

Museum

Museum plays a vital role in popularizing and dissemination of the palaeontological knowledge amongst scholars and the students within the country and abroad. Institute's museum continued to remain an attraction and a large number of visiters viewed museum all through the year. Research materials (plant fossils & rock/sediment samples) were collected from 286 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 33 research papers were submitted by the scientists in the repository during this period. Besides, three sets of plant fossils and slides were gifted to various colleges within the country, and fossil specimens were also presented to the distinguished guests as gifts (Mementos) from time to time.

Museum Holdings

Particulars	Addition during 2014-2015	Total
Type and Figured specimens	176	8,110
Type and figured slides	278	14,709
CDs	30	95

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

Project	Specimens (Megafossils)	Samples
Project– 1	6	1100
Project– 2	255	38
Project– 4	143	143
Project– 5	2	17
Project– 6	225	231
Project– 7	-	55
Project– 8	79	798
Project– 10	-	15
Project– 11	31	11
Project– 13	10	251

Samples deposited under Sponsored/ Collaborative Projects:

DST Project No. SB/S4/ES-621/2012	26
DST Project No. DST/CCP/PP-2011/G	35
DST Project No. SR/DGH/44/2012	174
DST Project No. SR/FTP/ES-49/2012	3
DST Project No. SR/S4/ES-521/2010 & 6.2	62
DST Project No. SR/FTP/ES-81/2013	278
SB/EMEQ-225/2014	180
IV/BSIP/SA/Collaborative/2014-15/L-1183	9
BSIP/GSI Collaborative Project	73
Collaborative work	82
S&T Visiting Fellowship (for Developing, Non- aligned countries,) under DST	183

Specimens / Slides gifted to:

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

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

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

Institutional Visitors

Department of Botany, Gauhati University, Guwahati (Assam)

Pratibha Shikhsa Niketan High School, Naraini, Dewa, Barabanki (UP)

National Post Graduate College, Rana Pratap Marg, Lucknow

C.L.G. Inter College, Ran Ganj Parwat Pur, Pratapgarh (UP)

St. John's College, Agra (UP)

St. Dawarika Parasd P.G. College, Kotwa Mohamad Pur, Akbarpur, Ambedkar Nagar (UP)

Seth M.R. Jaipuria School, Lucknow

Department of Botany, Kuvempu University, Shankaraghatta, Shimoga (Karnataka)

Students of Lucknow University Lucknow

Delegates of National and International Conference

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 Quick Heal Endpoint Security 6.0 Business has been procured with 150 user license to protect the system from viruses/worms. One colour Laser Printer HP LaserJet Enterprise 500 Color M 551 has been procured for computer section.

Computer 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. Notices are regularly updated in Intranet Website. Wireless Internet Connectivity is running within the campus. In addition, Payroll, Form16 and pension packages are also modified as per the requirements of the Accounts Section. Computer Section is providing help to the scientists in preparing the multimedia presentations, charts, graphs, lithologs and diagrams for their scientific documentation and publications.

Scanning Electron Microscopy

The SEM unit of Institute is dedicated for providing help in research and developments for observing morphological and structural characterization of the scientist's samples in the range of micro/ nano scale. Scientists of various discipline studied their variety of samples for structural analysis and microphotographs were recorded as required. Besides the Institute work, number of research scholars from various organizations utilize our expertise for study their samples. The rendering consultancy is not only provides the source income but also helps to disperse the scientific knowledge/ publicity of the Institute. The Institute is going to install new SEM machine FESEM - 7610F from JEOL India Pvt. Ltd. for the better analysis of the samples, which meet the present requirements of the Institute.

Section Cutting Workshop

About 525 rock/fossil samples were cut in the Institute workshop, and over 2,325 slides were prepared during the year. In addition, about 275 slices were made and polished. A number of scientists and teachers/students visited the workshop. The visitors were given live demonstration of cutting, grinding, polishing and preparation of thin slides of the fossil material.

Distinguished Visitors

Shri Ram Naik, Honourable Governor of Uttar Pradesh

Dr. S.K. Wadhawan, Director General, Geological Survey of India, Kolkata

Shri Harbans Singh, Director General, Geological Survey of India, Kolkata

Dr. H.S. Das, Principal Secretary, DST, Govt. of UP and Director General, UPCST

Dr. S.K. Acharya, Ex-Director General, Geological Survey of India, Kolkata

Shri I.R. Kirmani, Additional Director General, GSI (Western Region), Jaipur

Prof. J.G. Meert, Department of Geological Sciences, University of Florida, USA

Prof. N.J. Butterfield, Department of Earth Sciences, University of Cambridge, UK

Prof. A.K. Singhvi, Physical Research Laboratory, Ahmedabad

Dr. Marcela Svobodova, Institute of Geology, Prague, Czech Republic

Dr. Rajeev Mohan, Director (Offtg.), UP Remote Sensing Agency, Lucknow.

Dr. Geetha Ramkumar, Vikram Sarabhai Space Centre, ISRO, Trivandrum, Kerala

Prof. Sun Weiguo, Museum of Nanjing Institute of Geology & Palaeontology, Nanjing, China

Prof Pieter Baas, National Herbarium Leiden, The Netherlands

Prof. Steve Manchester, Florida Museum of Natural History, Gainesville, USA

Prof. Elisabeth Wheeler, N.C. State University & North Carolina Museum of Natural Sciences, USA

Dr. V.S. Kale, Department of Earth Sciences, IIT Bombay, Mumbai

Prof. David A. Grimaldi, American Museum of Natural History, New York, USA

Prof. M.N.V. Prasad, Department of Plant Sciences, University of Hyderabad, Hyderabad

Dr. Paramjeet Singh, Director, Geological Survey of India, Kolkata

Prof. David L. Dilcher, Indiana Uiversity, Bloomington, USA

Prof. Christopher J. Cleal, Natural History Museum, Wales, UK

Dr. Amita Dubey, Uttar Pradesh Hindi Sansthan, Lucknow

Dr. Martin Pickford, National Museum of Natural History, Sorbonne University, Paris, France

Activities in Official Language

The Institute is constantly striving to attain the set target for official language implementation. The Institute participated in the meeting of *Nagar Rajbhasha Kaaryaanvayan Samiti* during the year 2014-15. The Institute was represented in its meeting in Karyaalaya-3 situated in Indian Institute of Sugarcane Research, Lucknow. Newly constituted committee's first meeting was held on December 03, 2014. 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 Month

Hindi Month (September 01-30, 2014) was celebrated in the Institute. During the Month, 67 staff members participated in a series of competitions including *Spot the Errors, Hindi Typing* (Computer), *Noting* and *Scientific lectures*. *Kavi Sammelan* was also organized on 30th September in which 5 guest-poets, in addition to Institute talents, participated. Prize distribution was held on same day in the main auditorium, in which Hindi books of reputed authors were given away as prizes. The Winners were:

Spot the Errors : I – Dr. Anju Saxena
II – Mr. Rahul Gupta &
Mr. P.K. Mishra
III – Dr. Deepa Agnihotri
Encouragement - Mr. Avinash K. Srivastava, Mr. Avanish Kumar, Dr. Abha Singh &
Mr. Harinam Joshi

Noting : I – Mr. Rahul Gupta
II – Mr. V.K. Nigam
III – Mr. P. K. Mishra
Encouragement- Ms. Kriti Mishra & Mr. Avanish Kumar

Typing : I – Mr. Rahul Gupta
II – Ms. Anupam Jain
III – Mr. Raj Kumar
Encouragement-Mrs. Sudha Kureel

A view of Hindi Month celebrations

Scientific Lecture

Scientific Category: I – Mr. Harinam Joshi & Mr. Arun Joshi
II – Ms. Shreya Mishra

General Category: I – Dr. Neelam
II – Mr. Y.P. Singh
III – Ms. Sandhya Singh

Non-Hindi : I – Mr. J. Baskaran
Encouragement-Mrs. Sunita Khanna

Hindi Workshop

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

Hindi ki Asmita ka Prashna, and *Hindi mein Vijnan Lekhan ke Samasyaen* [by Dr. Amita Dubey, Uttar Pradesh Hindi Sansthan, Lucknow] on June 30, 2014.

Vilambit Chaturthmahakalp se Assom Sankatkaari Aadrabhoomi mein Puravanaspati evam Jalvaayu Parivartan [by Dr. Swati Tripathi, BSIP, Lucknow] on September 01, 2014.

Nawabi Yug ka Lucknow [by Shri Ravi Bhatt] on December 04, 2014.

Sudoor Samvedan: Samaj ke liye [by Dr. Rajiv Mohan, Director, UP Remote Sensing Application Centre, Lucknow] on February 27, 2015.

Miscellaneous

The computers of the Institute with net facility have access to multi-lingual software. The process of making forms bilingual is near completion. Annual Report of the Institute for the year 2013-14 was published in Hindi also. Abstracts of all the research papers in Hindi were also published in the international journal of the Institute *'The Palaeobotanist'*. In adherence to the section 3(3) of the Official Language Act 1963, efforts are continued to improve correspondence in Hindi.

The Quarterly and Half yearly reports to DST and *Nagar Rajbhasha Kaaryaanvayan Samiti,* respectively were prepared and regularly sent. Thus, the Institute continues its efforts towards implementations of the Official Language policy.

A view of prize distribution during Hindi Month

Governing Body

(w.e.f. 11.03.2014 to 10.03.2017)

Chairman
Prof. Deepak Pental
Former VC, University of Delhi
Director (R&A)
Centre for Genetic Manipulation of Crop Plants
University of Delhi, South Campus, Benito Juarez Road
Dhaula Kuan, New Delhi-110 021

Members

Secretary
(or his nominee)
Department of Science and Technology
Technology Bhavan, New Mehrauli Road
New Delhi-110 016

Prof. Talat Ahmad
Vice Chancellor
Jamia Millia Islamia Central University
Jamia Nagar, New Delhi-110 025

Dr. V. Purnachandra Rao
Chief Scientist
CSIR-National Institute of Oceanography
Dona Paula, Goa-403 004

Dr. K.J. Ramesh
Scientist-G
Ministry of Earth Sciences
Prithvi Bhavan, IMD Campus, Lodhi Road
New Delhi-110 003

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

Finance Adviser
(or his/her nominee)
Department of Science and Technology
Technology Bhavan, New Mehrauli Road
New Delhi-110 016

Prof. G.V.R. Prasad
Department of Earth Sciences
University of Delhi
Delhi-110 007

Prof. L.S. Chamyal
Department of Geology
M.S. University
Fatehganj, Vadodara-390 002

Director General
(Ex-Officio Member)
Geological Survey of India
27, Jawaharlal Nehru Road
Kolkata-700 016

Director
(Ex-Officio Member)
Botanical Survey of India
CGO Complex, 3rd MSO Building, Block F,
DF Block, Sector I, Salt Lake City, Kolkata-700 064

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

Research Advisory Council

(w.e.f. 23.06.2014 to 22.06.2017)

Chairman

Prof. S.K. Tandon
MoES Chair Professor
Department of Earth Science
Indian Institute of Technology, Kanpur-208 016

Member-Convener (Ex-officio)
Director
Birbal Sahni Institute of Palaeobotany, Lucknow

Members

Prof. R. Geeta
Department of Botany
University of Delhi
Delhi-110 007

Prof. G.V.R. Prasad
Department of Earth Sciences
University of Delhi
Delhi-110 007

Dr. V.P. Misra
Ex-Dy. Director General, GSI
4/490, Vivek Khand
Gomti Nagar, Lucknow-226 010

Dr. S.D. Biju
School of Environmental Studies
University of Delhi
Delhi-110 007

Shri S.N. Choudhuri
Director (Geology)
Geological Survey of India
Natural Energy Resources, Mission IIB
Bhu-Bijnan Bhavan, DK-6 Salt Lake
Sector II, Kolkata-700 091

Dr. V. Ravikant
Department of Geology & Geophysics
Indian Institute of Technology
Kharagpur-721 302

Prof. N.N. Dogra
Department of Geology
Kurukshetra University
Kurukshetra-136 119

Dr. Suryendu Dutta
Department of Earth Sciences
Indian Institute of Technology Bombay
Powai, Mumbai-400 076

Shri S.K. Srivastava
Chairman & Managing Director
Corporate Office, Oil India Limited
Plot No. 9, Near Film City, Sector 16A
Noida-201 301

Member (Ex-officio)
Sr. Deputy Director General
In-charge, Northern Region
Geological Survey of India
GSI Complex, Vasundhara
Sector-E, Aliganj, Lucknow-226 020

Finance and Building Committee

(w.e.f. 23.06.2014 to 22.06.2017)

Chairman (Ex-officio)

Prof. Deepak Pental
Chairman, Governing Body
Birbal Sahni Institute of Palaeobotany

Members

Finance Adviser, DST, New Delhi

Shri B.K. Mishra
Finance and Accounts Officer
Indian Institute of Toxicology Research
M.G. Marg, Lucknow-226 001

Shri V.B. Singh
Ex-Chief Engineer (Civil), UPPCL
4/125, Vishal Khand
Gomti Nagar, Lucknow-226 010

Director
Birbal Sahni Institute of Palaeobotany, Lucknow

Non-Member Secretary

Registrar
Birbal Sahni Institute of Palaeobotany, Lucknow

Independence Day (August 15, 2014)

Republic Day (January 26, 2015)

Staff

Director
Prof. Sunil Bajpai

Scientists

Scientist 'G'
Dr. (Mrs) Neerja Jha (w.e.f. 01.07.2014)
Dr. Samir Sarkar (retired w.e.f. 30.04.2014 AN)
Dr. Ram R. Yadav

Scientist 'F'
Dr. Rupendra Babu
Dr. Samir K. Bera
Dr. Mohan S. Chauhan (retired w.e.f. 31.12.2014 AN)
Dr. Madhav Kumar
Dr. Rakesh C. Mehrotra
Dr. Mahesh Prasad
Dr. (Mrs) Jyotsana Rai
Dr. Dinesh C. Saini (w.e.f. 01.07.2014, voluntary retirement w.e.f. 30.11.2014 AN)
Dr. Omprakash S. Sarate (w.e.f. 01.07.2014)
Dr. Mukund Sharma
Dr. (Mrs) Alpana Singh
Dr. Bhagwan D. Singh
Dr. Kamal J. Singh
Dr. Rama S. Singh
Dr. (Mrs) Chanchala Srivastava (w.e.f. 01.07.2014)
Dr. (Mrs) Rashmi Srivastava (w.e.f. 01.07.2014)
Dr. (Mrs) Rajni Tewari

Scientist 'E'
Dr. (Mrs) Anjum Farooqui
Dr. Amit K. Ghosh
Dr. Bhagwan D. Mandaokar
Dr. Kindu L. Meena
Dr. Chandra M. Nautiyal
Dr. (Mrs) Neeru Prakash
Dr. (Mrs) Vandana Prasad
Dr. Annamraju Rajanikanth
Dr. Anupam Sharma
Dr. Gyanendra K. Trivedi

Scientist 'D'
Dr. Ratan Kar
Dr. (Mrs) Binita Phartiyal
Dr. Anil K. Pokharia

Scientist 'C'
Dr. Sadhan K. Basumatary
Dr. (Ms) Ruby Ghosh (w.e.f. 01.01.2015)
Dr. Pawan Govil
Dr. Abhijit Mazumder
Dr. Krishna G. Misra
Dr. Srikanta Murthy
Dr. S. Suresh K. Pillai
Dr. Parminder S. Ranhotra
Dr. (Mrs) K. Pauline Sabina
Dr. (Mrs) Anju Saxena
Dr. Santosh K. Shah
Dr. Hukam Singh
Dr. (Ms) Vartika Singh
Mr. Veeru K. Singh
Dr. Biswajeet Thakur
Dr. (Mrs) Anjali Trivedi (w.e.f. 01.01.2015)
Dr. (Mrs) Poonam Verma (w.e.f. 01.01.2015)

Scientist 'B'
Dr. (Mrs) Neha Aggarwal
Dr. (Mrs) Deepa Agnihotri
Dr. Shailesh Agrawal
Dr. Sheikh N. Ali
Dr. Arif H. Ansari
Dr. Vivesh V. Kapur
Dr. Kamlesh Kumar
Mr. Manoj M.C.
Dr. Runcie P. Mathews
Dr. P. Morthekai
Dr. (Mrs) Neelam
Dr. Santosh K. Pandey
Dr. (Mrs) Shilpa Pandey
Dr. Mohammad F. Quamar
Dr. (Mrs) Anumeha Shukla
Dr. Sunil K. Shukla
Dr. (Mrs) Abha Singh
Dr. Gaurav Srivastava
Dr. (Mrs) Jyoti Srivastava
Dr. (Mrs) Swati Tripathi

Scientist Emeritus
Dr. Rahul Garg
Dr. Mulagalapalli R. Rao

Birbal Sahni Research Associate
Dr. S. Mahesh (tenure completed w.e.f. 27.06.2014 AN)

(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 (resigned w.e.f. 21.06.2014 AN)
Mr. Arun Joshi
Mr. Harinam Joshi
Ms. Shreya Mishra
Ms. Priyanka Monga
Ms. Debrati Nag
Ms. Ranjana
Mr. D.S. Seetharam (resigned w.e.f. 23.06.2014)
Mr. Vikram P. Singh

Technical Personnel

Technical Officer 'D'
Mr. P.S. Katiyar
Mrs. Sunita Khanna
Mrs. Kavita Kumar (w.e.f. 01.04.2014)
Mr. T.K. Mandal
Mr. Prem Prakash (retired w.e.f. 31.12.2014 AN)
Mr. V.K. Singh
Mr. Avinesh K. Srivastava (w.e.f. 01.04.2014)

Technical Officer 'C'
Mr. Madhukar Arvind
Mrs. Reeta Banerjee
Dr. Subodh Kumar
Mr. R.L. Mehra
Mr. R.C. Mishra
Mr. Pradeep Mohan
Mr. V.K. Nigam
Mr. Chandra Pal
Mr. Keshav Ram (retired w.e.f. 31.10.2014 AN)
Mr. V.P. Singh
Mr. Y.P. Singh

Technical Officer 'A'
Mr. S.R. Ali
Mr. D.S. Bisht
Mr. D.K. Pal
Mr. Dhirendra Sharma
Dr. S.K. Singh
Dr. S.M. Vethanayagam

Technical Assistant 'E'
Mr. Chandra Bali
Mr. Sumit Bisht
Dr. Nilay Govind (w.e.f. 01.04.2014)
Mr. Avanish Kumar (w.e.f. 01.04.2014)
Mr. M.S. Rana (w.e.f. 01.04.2014)
Mr. Subhas C. Singh
Mr. Ajay K. Srivastava (w.e.f. 01.04.2014)
Mr. C.L. Verma

Technical Assistant 'D'
Mr. Pawan Kumar
Mr. Om Prakash
Ms. Kirti Singh

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

Administrative Personnel

Accounts Officer: Mr. N.B. Tewari

Private Secretary
Mrs. M. Jagath Janani

Section Officer
Mrs. Ruchita Bose
Mr. Hari Lal
Mrs. Swapna Mazumdar
Mrs. Pennamma Thomas
Stenographer: Mr. Murukan Pillai

Assistant
Mr. Mishri Lal
Mr. S.S. Panwar
Mr. Rameshwar Prasad (Officiating)
Mr. Gopal Singh
Mr. K.P. Singh
Mr. Avinash K. Srivastava
Mrs. Renu Srivastava
Mr. Koshy Thomas
Mr. N.Unnikannan

Hindi Translator: Mr. Ashok K. Sharma

Upper Division Clerk
Ms. Chitra Chatterjee
Mrs. Sudha Kureel
Ms. Manisha Tharu

Lower Division Clerk
Mr. Rahul Gupta
Ms. Anupam Jain

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

Mr. R.K. Mishra
Mr. Mahesh Nayar
Mr. Manoj Singh

Driver
Mr. Nafis Ahmed ('IV')
Mr. D.K. Mishra ('IV')
Mr. M.M. Mishra ('IV)
Mr. V.P. Singh ('IV')
Mr. P.K. Mishra ('III', w.e.f. 13.01.2015)

Multi Tasking Staff
MTS: Mr. K.C. Chandola

MTS 'II'
Mr. K.K. Bajpai
Mr. Prem Chandra (retired w.e.f. 28.02.2015AN)
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
Ms. Bhawana Bajpai
Mrs. Beena
Mr. V.S. Gaikwad
Mr. Hari Kishan
Mr. Deepak Kumar
Mr. Inder Kumar
Mr. Raj Kumar
Mr. Ramesh Kumar
Mr. Shailesh Kumar
Mr. Suneet Kumar
Mr. Haradhan Mahanti
Ms. Nandani
Mr. Kailash Nath
Mr. Mathura Prasad
Mr. Ram Chander
Mrs. Ram Kali
Mr. Ram Kewal
Mr. Ravi Shankar
Mr. Ankit P. Singh
Ms. Sandhya Singh

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

Sponsored Project Personnel
Mr. Mayank Shekhar, RA
Ms. Nivedita Mehrotra, SRF
Mr. Suman Sarkar, SRF
Mr. Shamim Ahmad, SRF
Ms. Ruchika Bajpai, JRF
Mr. Arindam Chakraborty, JRF
Ms. Surabhi Garg, JRF (tenure completed w.e.f. 12.09.2014)
Ms. Jooly Jaiswal, JRF (resigned w.e.f. 30.04.2014 AN)
Mr. Deepanshu Jayaswal, JRF (resigned w.e.f. 26.09.2014 AN)
Ms. Kriti Mishra, JRF
Mr. Premraj Uddandam, JRF
Mr. Randheer Singh, JRF (tenure completed w.e.f. 28.03.2015)
Mr. Akhilesh K. Yadava, JRF (tenure completed w.e.f. 30.06.2014)
Mr. Syed Azharuddin, JRF
Mr. Saurabh Gautam, JRF
Mr. Raja Ram Verma, Project Assistant (resigned w.e.f. 06.02.2015)
Mr. Saheb Lal Yadav, Field Assistant (tenure completed w.e.f. 30.06.2014)

Retired Staff


Mr. Keshav Ram


Dr. Samir Sarkar


Dr. M.S. Chauhan


Dr. D.C. Saini


Mr. Prem Chandra


Mr. Prem Prkash

Appointments

Dr. Ram Shukla, Registrar w.e.f. 01.01.2015.
Dr. B. Sekar, Consultant w.e.f. 22.07.2014.
Mr. Prem Praksh, Consultant w.e.f. 01.01.2015.

Sponsored Project Personnel

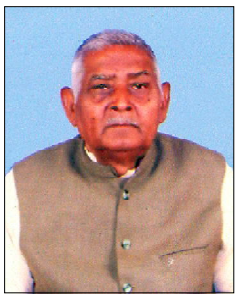
Dr. Shambhu Kumar, Young Scientist (DST Project) w.e.f. 03.07.2014.
Mr. Akhilesh Kumar Yadava, Research Associate w.e.f. 03.02.2015.
Ms. Ipshita Roy, Junior Research Fellow w.e.f. 15.09.2014.
Mr. Nand Kishore Sahoo, UGC-Junior Research Fellow w.e.f. 28.10.2014.
Mr. Uttam Pandey, Junior Research Fellow w.e.f. 03.11.2014.
Ms. Priyanka Joshi, Junior Research Fellow w.e.f. 27.01.2015.
Mr. Vikram Singh, Junior Research Fellow w.e.f. 06.02.2015.
Mr. Ashish Kumar Pal, Junior Research Fellow w.e.f. 13.03.2015.
Ms. Shazi Farooqui, Project Assistant w.e.f. 01.09.2014.
Mr. Saheb Lal Yadav, Project Assistant w.e.f. 03.02.2015.
Mr. Raja Ram Verma, Field Assistant w.e.f. 06.02.2015.

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.

Obituary

Dr. (Mrs.) Archana Tripathi
Ex-Scientist 'G'
passed away on 11.06.2014



Shri Chhange Lal
Ex-Attendant
passed away on 30.06.2014

From the Archives

Prof. Birbal Sahni, FRS delivering speech on the occasion of Foundation Stone laying ceremony

AUDITOR'S 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-2015 and also the Income and Expenditure account and Receipt & 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 misstatement. 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 2015;

b) In the case of the Income and Expenditures 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, 2015

ANNEXURE - 'A'

(Annexed to and forming part of the Audit Report for the year ended 31.03.2015)
BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, 53 UNIVERSITY ROAD, LUCKNOW
AUDIT OBSERVATIONS F.Y.2014-15

<table>
<tr><th>Sl. No.</th><th>Particulars</th><th>Action Taken</th></tr>
<tr><td>1.</td><td>ACCOUNTS: Single entry system was prevalent till 2012, in current year double entry system have been adopted throughout the year as per cash system of accounting but still it needs improvement in some areas. Further, the Institute has also implemented computerised accounting from FY 2012-13 onwards.</td><td>Improvement in some areas i.e. the double entry system is also required to be implemented in other Sections/Units of the administration with the guidance/supervision of the Chartered Accountant, action for which is in process.</td></tr>
<tr><td>2.</td><td>Advances unsettled and pending for recovery/ adjustment as on 31.03.2015 (₹ 12,48,47,158.89) under different heads out of amount advanced upto 14-15, are to be properly taken care at Institute level for early adjustment thereof. Details of which are available in annexed schedule of unsettled advances.</td><td>Out of the unsettled advance, adjustments have been made as per detail below :
<table>
<tr><th>Detail/purpose of Advance</th><th>Amount</th><th>Adjustment</th><th>Balance/ outstanding/ Remarks</th></tr>
<tr><td>Advance to the members of staff for official duty/purpose</td><td>₹15,49,600/-</td><td>₹13,72,176/-</td><td>Adjustment of outstanding advance of ₹ 1,77,424/- is in process</td></tr>
<tr><td>Advance to members of staff for House Building, Conveyance and festivals</td><td>₹40,77,521/-</td><td colspan="2">Recovery is being made from the monthly salary of the members of staff regularly</td></tr>
<tr><td>Advance to Parties by means of letter of credit for purchase of equipments</td><td>₹9,79,94,240/-</td><td colspan="2">Most of the equipments against the advance paid by means of letters of credit are received and installation of the same are in progress. On receipt of satisfactory installation and bills, adjustments will be made for settlement of the advance.</td></tr>
</table></td></tr>
<tr><td>3.</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>Claim for reimbursement of tuition fee is required to be submitted in prescribed form either with fee receipts or certificate from the Principal as per rules on the subject and as such payment is made on submission of fee receipts without duly filled-in certificate from the School.</td></tr>
<tr><td>4.</td><td>TDS amounting to Rs. 50,78,171.00 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.</td><td>All incomes are exempt from Income tax with effect from the financial year 2013-2014 as per Notification of Central Board of Direct Taxes, Govt. of India. Requests of the Institute for refund of TDS deducted are pending with the authorities and efforts are being made to get the refund.</td></tr>
</table>

<table>
<tr><th>Sl. No.</th><th>Particulars</th><th>Action Taken</th></tr>
<tr><td></td><td>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>2014-15</td><td>1,76,942.00</td><td>-</td><td>4,45,207.00</td><td>6,22,149.00</td></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>16,50,602.00</td><td>46,827.00</td><td>33,80,742.00</td><td>50,78,171.00</td></tr>
</table></td><td></td></tr>
<tr><td>5.</td><td>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.</td><td>Efforts are being made for preparation of Assets Registers as required by the Auditors and will be shown to the next Audit.</td></tr>
<tr><td>6.</td><td>In schedule of Assets created during the financial Year 2014-2015 figures reported under the head Assets created upto 2013-2014 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.</td><td>Assets created during the year are reported before depreciation to tally the total amount, whereas assets value as at close of the year is mentioned after the depreciation.</td></tr>
<tr><td></td><td>STORES, WORKS & BUILDING: 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 year could not be reconciled with Current FAR due to lack of proper information.</td><td>Efforts are being made for preparation of Assets Registers as required by the Auditors and will be shown to the next Audit.</td></tr>
<tr><td>7</td><td>Proper records/ Stock Register is to be maintained in every department for items issued to them from stores.</td><td>Noted</td></tr>
</table>

(N B Tewari)
Accounts Officer

(Ram Shukla)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)

Birbal Sahni Institute of Palaeobotany, Lucknow

Balance Sheet as at March 31, 2015

(Amount - Rs.)

CORPUS/CAPITAL FUND AND LIABILITIES	Schedule	Current Year	Previous Year
CORPUS/CAPITAL FUND	1	207,331,084.72	168,225,772.24
RESERVES ANS SURPLUS	2	33,210,903.00	33,210,903.00
EARMARKED/ENDOWMENT FUNDS	3	302,959,341.98	258,014,208.49
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	18,060,814.64	5,787,756.64
TOTAL		**561,562,144.34**	**465,238,640.37**
ASSETS			
FIXED ASSETS	8	93,519,397.54	101,084,811.67
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	9	302,959,341.98	258,014,208.49
INVESTMENTS-OTHERS	10	23,187,598.00	22,063,744.00
CURRENT ASSETS,LOANS,ADVANCES ETC.	11	141,895,806.82	84,075,876.21
MISCELLANDEOUS EXPENDITURE			
(to the extent not written off or adjusted)			
TOTAL		**561,562,144.34**	**465,238,640.37**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

For **Khanna Thaker & Company**
Chartered Accountants

CA. Abhinav Khanna
(Partner)

(N B Tewari)
Accounts Officer

(Ram Shukla)
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, 2015

Fig. in Rupees

INCOME	Schedule	Current Year	Previous Year
Income from Sales/Services	12	1,088,937.00	892,668.00
Grants/subsidies (OB, Deposit A/C and Transfer from Cap. Fund)	13	276,770,000.00	264,825,000.00
fees/Subscriptions	14	-	-
Income from Investments (Income on Invest. From earmarked/endow. Funds transferred to Funds)	15	1,123,854.00	3,063,365.00
Income from Royalty, Publication etc.	16	435,364.00	122,700.00
Interest Earned	17	6,352,695.81	3,518,963.02
Other Income/Adjustments	18	2,044,594.00	1,095,433.00
Increase/(decrease)in stock of Finished goods and works-in-progress	19	-	-
TOTAL(A)		**287,815,444.81**	**273,518,129.02**
EXPENDITURE			
Establishment Expenses	20	189,703,311.00	171,663,177.00
Other Administrative Expenses etc.	21	39,700,098.20	42,821,062.80
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end-corresponding to Schedule 8)		13,862,953.13	14,128,086.43
TOTAL (B)		**243,266,362.33**	**228,612,326.23**
Balance being excess of Income over Expenditure**(A-B)**		44,549,082.48	44,905,802.79
Transfer to Special Reserve (Specify each)		6,000,000.00	13,100,000.00
Transfer to/from General Reserve to Pension Fund		-	
BALANCE BEING SURPLUS/DEFICIT CARRIED TO CORPUS/CAPITAL FUND		**38,549,082.48**	**31,805,802.79**
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 Tewari)
Accounts Officer

(Ram Shukla)
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, 2015

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)	189,703,311.00	171,663,177.00
b) Bank Balances	5,777,387.32	22,287,901.00	b) Administrative Expenses(Corresponding to Schedule 21)	39,700,098.20	42,821,062.80
i) In current accounts					
ii) In deposit accounts					
iii) Endowment deposits					
iv) Salary Account					
II. Grants Received					
a) From Government of India	214,603,000.00	181,225,000.00	**II) Payments made against funds for various projects**	12,159,790.00	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.	62,167,000.00	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/Endowment funds		
b) Own Funds (Utilized)			b) Out of Own Funds (Investments-Others)		
IV. Interest Received			**IV. Expenditure on Fixed Assets & Capital Work-in-Progress**		
a) On Bank deposits	5,344,125.81	2,432,424.02	a) Purchase of Fixed Assets	6,297,539.00	23,867,520.29
b) Loans, Advances etc.	1,008,570.00	1,086,539.00	b) Expenditure on Capital Work-in-Progress		
V. Other Income (specify)			**V. Refund of surplus money/ Loans**		
i) Sale proceeds of Publications	435,364.00	93,411.00			
ii) Miscellaneous Income	2,044,594.00	1,124,722.00	a) To the Government of India		
iii) Sale of Services (Consultancy)	1,088,937.00	892,668.00	b) To the State Government		
iv) Group Insurance			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	12,939,753.00	11,656,440.00
Transfer from Reserve Fund	40,000,000.00	65,000,000.00	ii) Earnest Money Refunded	138,200.00	227,200.00
Net Receipt from Project	24,434,448.00	9,340,509.00	iii) Advances to Parties	75,564,488.39	80,528,265.00
TDS Refund	556,230.00		iv) Pension Fund	6,000,000.00	6,000,000.00
i) Recovery of Advances	41,965,128.39	41,634,540.39	v) Transfer to reserve & surplus	40,000,000.00	60,000,000.00
ii) Earnest Money Deposit	133,400.00	1,021,200.00	**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	16,992,424.93	5,777,387.32
			iv) Endowment deposit account		
			v) TDS on other grant	62,580.00	-
TOTAL	**399,558,184.52**	**409,738,914.41**		**399,558,184.52**	**409,738,914.41**

For **Khanna Thaker & Company**
Chartered Accountants

CA. Abhinav Khanna
(Partner)

(N B Tewari)
Accounts Officer

(Ram Shukla)
Registrar

(Sunil Bajpai)
Director

Staff participating in *Swatchh Bharat Mission*

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