

PROFESSOR BIRBAL SAHNI BIRTH CENTENARY CELEBRATIONS--A REPORT

Professor Birbal Sahni, one of the foremost scientists of the country, was the first Indian to have taken to palaeobotany as his research interest. Born on 14 November 1891, Birbal Sahni had his palaeobotanical orientation in the laboratory of Professor Sir Albert Charles Seward at Cambridge. He revived the study of fossil plants from India, and put palaeobotanical researches on an organized basis in the country. The Birbal Sahni Institute of Palaeobotany—the academic successor, proudly celebrates the birth centenary of this great man. A large number of programmes has been chalked out for the occasion by a National Organizing Committee.

The Birth Centenary Celebrations commenced in the forenoon of 14 November 1991 with *Pushpanjali* at the Samadhi of Birbal Sahni, followed by planting of a sapling of the Scholars' tree (*Alstonia scholaris*) in the campus of the Birbal Sahni Institute. This was followed by unveiling of a tablet commemorating the foundation of the Institute of Palaeobotany in the Department of Botany, University of Lucknow by Professor T.S. Sadasivan.

Early in the afternoon, an exhibition on 'Birbal Sahni, and Past of the Green World' was inaugurated by the eminent scientist Dr. A. P. Mitra, in the Regional Science Centre, Lucknow.

The Centenary Celebrations were formally inaugurated by Professor S.Z. Qasim, Member of the Planning Commission. His Excellency Sri B. Satyanarayan Reddy, Governor of Uttar Pradesh was the Chief Guest. Professor T. S. Sadasivan, one of the oldest students of Birbal Sahni, delivered a memorial lecture on "Professor Birbal Sahni's contribution to Indian Botany and its impact on the scientific scenario". Tributes to Birbal Sahni were paid by Dr. A.P. Mitra, President of National Academy of Sciences, and Dr. B.P. Radhakrishna, Editor of the Geological Society of India. Dr. Harsh K. Gupta, Advisor, Department of Science and Technology, released the Birbal Sahni Memorial Volume on the "Indian Gondwana" published by the Geological Society of India.

On 15 November 1991, in the forenoon, a Group Discussion on "Relevance of Palaeobotany in modern context" was held. Sri C.P. Vohra, Director-General of the Geological Survey of India presided over the discussion which was moderated by Professor H.Y. Mohan Ram. In the afternoon, Professor David Leonard Dilcher, University of Florida, delivered 21st Professor Birbal Sahni Memorial Lecture on "The importance of plant/animal interactions in the origin and subsequent evolution of flowering plants". Sri C. P. Vohra released two special publications, one of "Extinct plants, evolution and earth's history" published by the Current Science Association, and the other "Catalogue of plant fossils from India" published in 11 fascicules by the Birbal Sahni Institute of Palaeobotany.

The scientific programmes that took place during the following week included (i) Symposium on "Evolutionary Plant Biology, 16-17 November 1991, inaugurated by Professor Alfred Traverse of the Pennsylvania State University; (ii) Symposium on "Four Decades of Indian Palaeobotany, 18-19 November 1991, inaugurated by Professor G. G. K. Ramanujam of Osmania University, Hyderabad; and (iii) Birbal Sahni Birth Centenary Palaeobotanical Conference, 20-22 November 1991, inaugurated by Professor D. L. Dilcher. Details of these are given later in the text.

During the week four special lectures were also delivered. These were (i) 36th Sir A. C. Seward Memorial Lecture—"History of International co-operation in Palynology" by Professor James E. Canright of Arizona State University which was presided by Professor R. N. Kapil; (ii) 37th Sir A. C. Seward Memorial Lecture—"Links with the past in the plant world: cuticles as recorders of diversity, kerogen formation and palaeoatmospheric CO₂ level" by Professor Henk Visscher of University of Utrecht which was presided by Dr. B. D. Sharma; (iii) The Palaeobotanical Society International Medal Award Lecture for 1989—"The early history of land plants revisited" by Professor Harlan P. Banks of Cornell University (read by Pro-

fessor Alfred Traverse); and (iv) The Palaeobotanical Society International Medal Award Lecture for 1991 "Sporopollenin and chitin—non-biodegradable plastics' trace major biochemical events of the geological past" by Professor Alfred Traverse of the Pennsylvania State University, U.S.A.

Group Discussion—Relevance of Palaeobotany in Modern Context

Presiding over the discussion, Sri C.P. Vohra, Director-General of the Geological Survey of India highlighted the usefulness of palaeobotanical researches in search for coal and hydrocarbons, palaeogeographical modelling and configuration of the continents including plate boundaries. Earlier, introducing the theme, B. S. Venkatachala said that palaeobotany has entered an interpretative phase, wherein increased emphasis is being laid on synergy. Relevant data from the study of modern plants, geochemistry, etc. are being usefully employed to make the Science more useful.

Initiating the discussion, David Dilcher pointed out that science is expensive and that palaeobotany thus must demonstrate its potential by outlining benefits that accrue through the study of fossil plants. Palaeobotany has tremendous potentials for new discoveries but happenstances need be avoided. Researches only on major themes need be taken up. A close link should be maintained with molecular biologists and use of latest technology can and should be made. R.N. Kapil laid emphasis on increased use of latest technology such as the SEM, TEM, Fluorescence Microscopy, Spectrophotometry, etc.

C. G. K. Ramanujam exhorted the palaeobotanists to avoid a defeatist view and to be more articulate and create a rapport between the laboratory, the classroom and the lay public. B. D. Sharma wanted percolation of knowledge about usefulness of plant fossils down to the masses. Henk Vischer suggested that a concerted effort be made to train young girls and boys in modern botany and give them a detailed insight into geology and chemistry to enable them undertake palaeobotanical research in a comprehensive mode. Alfred Traverse suggested that besides convincing the powers, that be, of the usefulness of palaeobotany, a Media Blitz and displays of exhibits on the lines of Missouri Botanical Gardens will be

great propoganda tools to popularize palaeobotany. M. Bonardi laid emphasis on collaborative researches. Other active participants included K. P. Jain, H. K. Maheshwari, A. Sedowska, H. P. Singh and R. S. Tiwari.

The general opinion that evolved through this group discussion, that was moderated by Professor H. Y. Mohan Ram, was that palaeobotany continues to remain relevant. Most participants wanted to widen its horizons, to make it more purposeful.

Symposium on Evolutionary Plant Biology

The symposium was jointly convened by B. S. Venkatachala and David L. Dilcher. Out of 29 confirmations for oral presentations, 23 were finally made.

Introducing the theme, B. S. Venkatachala said that in whatever manner life originated, once it began there was no discontinuity. There was evidence not only of physical evolution but evolution of the consciousness also. D. S. Bhakuni was of the view that all non-biological processes that produce organic compounds occurring in any environment in space and time are involved in prebiotic organic synthesis. T. V. Desikachary felt that all records of the occurrence of heterocysts in the Precambrian need more proof. Two phyletic lines, the homocystous and the heterocystous, can be deciphered. According to B. S. Mehrotra, the origin of Fungi was shrouded in mystery, and it is not possible to state for sure the ancestral types that gave rise to this group. C.V. Subramanian spoke on the role of internal factors on fungal behaviour and fungal evolution.

Tracing the evolution of the cormophytic plant body in lower vascular plants, B.K. Nayar pointed out that the axis/stem is not the product of shoot apical meristem, and that all vasculature is developed from tissue derived from leaf meristem. Stele is a product of conjoined leaf vasculatures. According to C. G. K. Ramanujam the lycopods declined drastically after Late Carboniferous, and since then constitute a blind alley in the evolution of vascular plants. Analysing the cytogenetic and genetic conspectus of the evolutionary biology Pteridophytes, S. C. Verma found some support to the model based on polyploidy and "gene silencing" during genome evolution in ferns.

P.D. Dogra presented a study of comparative embryogeny on *Ginkgo*, cycads and conifers which has led to the recognition of some evolutionary tendencies of the primitive basal plan which gave rise to different types of embryogenesis. Hari K. Maheshwari and A.K. Srivastava presented evidence for two basic patterns in leaves, fertile organs, and pollen suggesting evolution of the glossopterid group of plants along two lines. According to G.S. Paliwal, the intimate relation between the sieve elements and certain parenchymatous cells might have contributed to the success of seed plants in evolution.

The reproductive biology of angiosperms, so believes David Dilcher, is derived from an ancestral complex that predates their origin. The angiosperms never stopped evolving and diversifying aspects of their reproductive biology at various times and at various rates. The evolutionary modifications in the flowers/flower parts are, in the opinion of R. R. Rao, fundamentally guided by the mode of pollination and pollination mechanism, a fact that proves polyphyletic nature of angiosperms.

D. Padmanabhan was of the opinion that the basic leaf form in the palms is the palmate form from which the costapalmate forms appear to have evolved which subsequently gave rise to the pinnate forms. H. Y. Mohan Ram and Anita Sehgal deciphered the unique nature of the species of the family Podostemaceae. S. Mahadevan was of the opinion that the parasitic plant *Cuscuta* lost its roots, expanded leaves, cotyledons and cambium probably due to an aberrant abscisic acid metabolism.

T. N. Ananthakrishna believes that the role of primary and secondary metabolites in the chemical ecology of the insects enables identification of the relevant pathways responsible for resistance mechanisms of plants as well as factors in insects overcoming plant resistance.

Symposium on Four Decades of Indian Palaeobotany

The symposium was organized by the Birbal Sahni Institute of Palaeobotany. Of the 33 invited papers, 27 were presented and discussed. Introducing the theme, B. S. Venkatachala said that the post-Sahni Era witnessed diversification of plant fossil studies and accumulation of stupendous data. There is a need to unify, update and revise the generated database so as to renew the

state of the art. The data generated from the terminal Precambrian in the Indian subcontinent should be tagged to establish stratigraphic biochronology. Areas in the outer and inner sedimentary belts of Lesser Himalaya, different regions of Vindhyan Basin in central India and Bhima, Kaladgi, Kurnool basins of south India which are known for their complete succession of Precambrian-cambrian rocks should be explored. Problems like prokaryote-eukaryote transition, metaphyte/metazoan evolution, possibility of recent contaminations in older sediments should be tackled through a multidisciplinary approach.

He queried: What was the Gondwana Vegetation like during the initial glacial period? Did the Gondwana Flora evolve from earlier plant communities that survived in protected niches during glaciation or did it evolve from plants that migrated to Gondwana Supercontinent from other phytochorias after glaciation? These need answers. Studies on dispersed cuticles should be used for stratigraphical correlation at levels where spores/pollen are not known. An attempt should be made to identify consistent characters in spore/pollen to reduce taxonomic anomaly. How does "mixed" vegetation of pericratonic marine sequences of Kashmir reflect upon the relative position of the different land masses, land connections or otherwise? Probability of parallel evolution of these plants should be examined afresh. The concept, limit and extension of Indian Gondwana demands an in-depth research and an answer is likely to come. Whether the Ptilophyllum Flora is an endemic Gondwana flora or did it occupy much of the Eurasian landmass needs to be explained. It is necessary to study the cause of the extinction of some Mesozoic floral elements and their evolutionary ramifications.

He emphasized that it is essential to strengthen and widen the scope of early angiosperm fossil studies by adopting high resolution study of character assessment of dispersed pollen grains so as to trace the antiquity, relationship and evolutionary aspects of the early angiosperms in time and space. This study would also necessitate to develop information on the possible favoured regimes, environments and climates in which the early angiosperms appeared, flourished, diversified and rose to the position of dominance. The Deccan Trap Episode should be understood in the light of K/T transition. The available

Palaeogene palaeobotanical and palynological data need to be re-examined in depth in global perspective in order to understand the possible migratory pathways particularly keeping in view the geographic locale of the Indian subcontinent. Evolution of the Neogene floras has been largely influenced by the orogeny of the Himalaya and other orogenic belts in the country. The influence of Sino-Japanese and Indo-Malayan floras and their contribution to the development of Neogene floras pose several questions. The problems associated with regionalism, endemism and migration/extinction of floras in response to physical and climatic factors need to be worked out in depth so as to unravel the history of the modern flora of India. Study of palaeoclimate and phytogeography of the Quaternary Period involves an interdisciplinary approach. Investigations on Quaternary deposits in parts of the Himalaya, the arid zone of Rajasthan and some parts of western India should be intensified. Phytogeographic and palaeoclimatic models based on plant megafossils, palynofossils and tree-ring analysis need to be designed to unravel the record of the last 40,000 years. Additional data should be generated in coming years to understand the glacial/interglacial phases of recent past and their probable link with the past climate. Chronological history of interaction between Man and Biosphere can be built through archeobotanical studies.

Emphasizing studies on the biodiagenesis of lignites, he opined that they will help in deciphering coalification trends, genesis, palaeoenvironmental condition and economic suitability of a deposit. Besides dispersed organic matter (D.O.M.) studies on oil source rocks enhance our understanding regarding the evolution of source material under various processes of degradation. Palynofossils and other vegetal remains of the past help interpret ancient environmental condition favourable for organic matter accumulations and their conversion to fossil fuels by transformation and subsequent thermal alteration. Recent researches have also shown that phytoplankton and other benthonic calcareous algae constitute potent reservoir for hydrocarbon formation. Biozonation, correlation and dating of sedimentary formations on the basis of dinoflagellate cysts, nannoplankton are emerging as useful tools in identifying promising hydrocarbon rich sediments.

According to Mukund Sharma, Manoj Shukla and B. S. Venkatachala the attainment of multicellularity by the metaphyte and metazoan fossils from the Precambrian rocks of India was a major step in the evolution of life. They pointed out that knowledge of fluctuations in sea level and isotopic and chemical composition of sea water prior to 600 Ma may help to solve the riddle of origin of multicellularity, antiquity and evolution of metaphytes and metazoans. Based on collective data from different basins, Shaila Chandra recognized five major vegetational changes in the Permian Gondwana with the remarks that very little is known from the Early Palaeozoic flora of India during the Siluro-Devonian Period. Analysing the Gondwana flora of India, A.K. Srivastava observed that fossil plants of *Schizoneura*, *Phyllothea*, etc. constitute a minor part of the assemblages though they are well represented in the contemporaneous floral provinces of the northern hemisphere. Usha Bajpai outlined the morphological trends in the Gondwana plants observing wide diversities in the morphology of pteridophytic megaspores and reproductive organs of gymnosperms. Whether these morphotrends were ecologically or genetically controlled need to be understood squarely in order to understand evolution of new types. Presenting an account of the Gondwana flora as related to provincialism, Hari K. Maheshwari pointed out distinct provincialism in the Barakar Formation of Early Permian age. Presence of Ginkgopsid leaves in the northern part of the Rajmahal Basin and elements of Cathaysian affinity in the Mamal Formation of the Kashmir Basin were cited as a few of the examples for his inferences.

Vijaya and R.S. Tiwari dealt with the morpho-evolutionary biohorizon-stratigraphy of the fossil saccate pollen with the help of cladograms and stratograms through the Gondwana sequence. They brought to light major extinction of monosaccate pollen at the Lower Permian—Upper Permian boundary and that of the striate disaccates in the basal Triassic. A comprehensive account of Permian palynological assemblages identifying various stratigraphical units in the Godavari Graben was presented by Suresh C. Srivastava. Based on 19 marker assemblage zones of spore-pollen species through the Gondwana sequence (Early Permian-Early Cretaceous) R. S. Tiwari and Archana Tripathi outlined a species based palynostratigraphy.

tigraphical scheme.

Shyam C. Srivastava and S. R. Manik discussed palaeobotanical evidences in favour of gradual changes in the composition of Permian-Early Triassic-Late Triassic floras. Tracing out the geological history, Jayasri Banerji summed up the life and time of *Williamsonia*. A synthesis of available data on the reproductive biologies of Mesozoic plants in India was presented by Sukh-Dev.

M. B. Bande opined that the Palaeogene flora of peninsular India can be considered to be the ancestral flora for the present day peninsular vegetation. Glimpses of the origin, development and radiation of Neogene flora of peninsular India were given by J. S. Guleria. He pointed out that large scale migrations and admixture of floras were due to establishment of land connections by Early Miocene. Through the changing patterns of vegetation in the Neogene Siwalik succession of extrapeninsular India, N. Awasthi identified elements of tropical/subtropical, wet evergreen forests to deciduous type. He also examined the data in the light of the rise of Himalaya. Adducing palaeobotanical evidence for the rise of Himalaya, H. P. Singh presented several vegetational patterns ranging from Late Palaeocene to Middle Pleistocene. He also discussed the cult-historical data which shows that the Himalayan range continued to rise even after the advent of man. Stratigraphical implications of Tertiary palynological succession in north-eastern and western India were discussed by R. K. Kar. Presenting a paper on the palynology, palaeoecology, correlation and age of Neyveli lignites and associated sediments, R. K. Saxena resolved the controversial age of the Neyveli Formation by providing a convincing evidence in favour of Palaeocene-Eocene age.

H. P. Gupta presented an account of changing patterns of vegetation in the intermontane Kashmir Basin since 4 Ma through palynological studies by reconstructing a complete profile of vegetation. A palynological assay on palaeoclimatic oscillations since last deglaciation in western Himalaya by Chhaya Sharma embodied palaeovegetational and palaeoclimatic patterns. The data threw light on the origin and development of 'floating Islands'. Dealing with palynological history of the Holocene mangrove vegetation, Asha Khandelwal evaluated the causes of mangrove deterioration in time and space and opined for greening the

coastline. R. R. Yadav informed that a major break through in getting 745 years long chronology of *Cedrus deodara* has been achieved in Uttarkashi.

K. S. Saraswat presented a comprehensive account of archaeological plant remains in ancient cultural and socio-economical dynamics of the Indian subcontinent and brought to light the facts on the past plant economy and usage of medicinal plants. Highlighting the role of benthonic calcareous algae, A. Rajanikanth presented an ecological perspective of the rock building calcareous Cretaceous-Tertiary algae from India.

The role of fossil dinoflagellates in Indian biostratigraphy was discussed by K. P. Jain, R. Garg and Khawaja-Ateequzaman. They stressed the need for having integrated studies between phytoplanktons and relevant palaeontological disciplines. Anil Chandra spoke on the significance of fossil diatoms in biostratigraphical, palaeoecological and palaeo-oceanographical interpretations.

Dealing with the genesis of Indian Tertiary coals and lignites, B. K. Misra observed that structural disturbances and igneous activity have caused abrupt rise in the prevailing geothermal gradient all along the north and north-eastern boundary of the Indian plate and affected increase in the rank of coal deposits. Tectonically quieter area of western and southern India have lignite deposits of almost equivalent age. Anand-Prakash classified the Himalayan coals according to the guidelines suggested by ASTM system and also dealt with their nature, formation, composition and rank indicating the role of intense tectonic activity on the diagenesis of organic matter.

Birbal Sahni Birth Centenary Palaeobotanical Conference

The conference was jointly convened by Palaeobotanical Society and the Birbal Sahni Institute of Palaeobotany. In all 163 abstracts of research papers from India and overseas were received out of which 122 were presented in the conference.

The conference was inaugurated by Professor David L. Dilcher. Introducing the theme, B. S. Venkatachala briefly touched upon the recent achievements made in various fields of palaeobotany and emphasized the need to adopt multidisciplinary approach for unravelling the hidden myste-

ries of this science. He observed that preliminary palaeobiological evidences available from the Archaean sediments of Dharwar Craton indicate presence of anaerobic chemoheterotrophic signature in 2.6 Ga old sediments. The association of probable sulphate reducing bacteria with pyrite is suggestive of presence of eubacteria and traces back anaerobic chemoautotrophic activity to 2.6 Ga. Presence of columnar stromatolites and structurally mineralized filamentous microfossils in the cherts interbedded with BIF in 2.6 Ga old Dharwar sediments provide presumptive evidence of filamentous photoautotrophs. Subjects to the authenticity and reproducibility of the persisting reports of possible metazoan activity prior to 800 Ma from Vindhyan sediments, a possibility exists that metazoan activity had started much earlier than accepted so far.

The assessment of available floristic and lithostratigraphic evidences indicates that the Gondwana sedimentation commenced in the early stage of Permian and continued up to Triassic. The Jurassic sediments were not deposited in the intracratonic basins. The Rajmahal flora is now considered to be of Early Cretaceous age. The paralic sediments of east coast are now considered Neocomian-Aptian in age, contrary to the earlier Jurassic assignment based on megafossil evidences. Thus, the first marine influence now dates back to Late Hauterivian-Barremian time in Cauvery Basin. The palynodata assemblage indicates Maastrichtian age for 4 widely separated and distinct geological settings (Padwar, Naksal, Narsapur subsurface section & Tiruchirapalli). This documents near synchronicity of flows over extensive areas and cosmopolitan nature of terminal Cretaceous biotas of Indian peninsular region.

The extinction pattern at the terminal Eocene in India indicates northward migration of India after Cretaceous-Palaeocene. The change in the latitudinal position and resulting variations in climate may have been responsible for such extinctions in India.

The extra peninsular Palaeozoic-Mesozoic plant bearing horizons, need special attention. The re-assessment of stratigraphic position and taxonomic status of this biota may provide key for correlation, palaeogeography and conclusions on the hypothesis of continental drift.

The source for hydrocarbon is vegetal

debris and consequently study of the organic matter contained in the sediments and level of the thermal transformation indicate hydro-carbon source rock potential of the sediments.

A study in detail is to be promoted for the levels of biological diversity and factors controlling it in view of the their wide application in drawing time scale boundaries and modelling for future changes. Further it is stated that much finer resolutions are envisaged in biostratigraphy and taxonomy by developing quantitative biostratigraphy and studies of ultra structures of fossils when the wider use of computers and electronic microscopes have already been implemented for purposeful studies. Such new methodology and technology are bringing revolutionary changes to the traditional concepts.

Apart from various palaeobotanical and geological aspects, discussions were held on some other areas of study, such as, recognition of major nectar and pollen sources for honey bees and the significance of pollen in allergy. Population magnitude could be assessed through phytoplankton in industrial effluent. Weathering of stones by Lichens was an interesting observation.

Based on organic-walled microfossils Late Proterozoic (possibly Early Vendian) age was deduced for the Infra-Krol Formation in Himachal Lesser Himalaya. Interesting blue-green algal fossils were recorded from the Fawn Limestone Formation of Vindhyan Basin. Attempts have been made to summarise the Precambrian and Lower Cambrian stromatolites of the Lesser Himalaya of India, concluding possible links between the evolution of the metaphytes and metazoans and the decline of the stromatolites across the P/C boundary in the Indian subcontinent.

A new fern-like foliage from the Early Permian of Hura Coal-field was reported, the affinities of the fossil are yet uncertain. The record of vertically preserved *Vertebraria* in the Upper Permian of Ib-River provided new evidence in support of its being a root system. The association of blattoid insects with the Gondwana flora in South America (Late Carboniferous) and India (Early Permian) has been used for palaeoecological and palaeoclimatological interpretations. Palynological study of Permian sediments in Talcher coalfield resulted into recognition of three assemblage zones, namely within

Upper Talchir, Lower and Upper Barakar Formation. In Godavari Graben eight palynoassemblages were recognised in the succession from Karharbari to Kamthi formations. Spores, pollen and acritarchs were reported from faunal coal-balls occurring in the Bomte member of the Garu Formation, West Siang District, Arunachal Pradesh, suggesting marine influence during Early Permian. Late Early Triassic age has been assigned to Nidpur beds in the Singrauli coalfield, on palynological evidence. *Glossopteris*-like leaves recorded from Triassic of Sydney and Clarence Moreton basins of eastern Australia suggested surviving remnants of the *Glossopteris* flora. The Mamal Formation, uppermost unit of the Punjal Group in Kashmir, was redefined and a new stratotype proposed.

On the basis of an objective evaluation of the Bathonian through Albian microfossil/faunistic data, generated from Indian sedimentary sequences in the recent years, it was concluded that as yet it has provided limited degree of calcareous nannoplankton and epistominid foraminifers hold excellent promise, particularly so in the ammonoid devoid intervals.

On the basis of marker dinoflagellate cyst taxa late Hauterivian-Barremian age was derived for a subsurface sequence drilled in Palar Basin. Based on the same parameter the occurrence of marine Palaeocene sediments in Kutch Basin was established; *per contra* non-existence of Palaeocene, Lower Eocene and early Middle Eocene was advocated on critical field observations coupled with re-evaluation of published larger and planktonic foraminifera. Shallow marine environment with existence of tidal flat has been indicated during the deposition of Subathu Formation (Eocene) around Garkhal area, Himachal Pradesh.

Report of reworked Late Devonian to Early Carboniferous spores and pollen from basal Dharamsala sediments in Jawalamukhi Well-B, Himachal Pradesh, was an interesting find and has great palaeogeographic significance.

Latest Maastrichtian calcareous nannoplankton *Micula murus* zone was recognised in Um Sohregkew River Section, Meghalaya; dinoflagellate evidence from the same samples supported the age conclusions. High resolution biostratigraphy has been attempted to demarcate the K/T boundary in this section. Late middle Eocene (Barto-

nian) calcareous nannoplankton were reported from Kutch Basin, assignable to NP17 and a part of NP16 zones. In a subsurface sequence off Senegal coast, west Africa, the K/T boundary was palynologically delineated at 958 m depth marked by disappearance of Maastrichtian marker spore-pollen taxa and appearance of a fern spike. Such a major floral change was attributed to possible influence of the K/T event.

Late Cretaceous-Palaeocene age has been assigned to Deccan Intertrappean beds on palynological grounds. The occurrence of palynofossils in association with dinosaurian remains and fresh-water Maastrichtian ostracods helped in precise estimation of age of the Deccan volcanism and placement of K/T boundary.

Discovery of *Podocarpus* and *Mesua* leaves from Makum coalfield, and a number of tropical evergreen elements from the Tipam sandstone, in Assam and Nagaland indicated tropical climate with excessive humid condition during Oligocene-Miocene times in north-eastern India. A middle Miocene phytogeographical link between India and Africa was suggested on the basis of occurrence of *Julbernardia* in India. Fossil records of *Calophyllum*, *Gluta* and *Cinnamomum* from Varkali beds confirmed tropical climate with prevalence of excessive humid conditions during Middle Miocene in Western Ghats; the sediments were deposited in near-shore environment. Restricted distribution of spores, pollen and dinoflagellates in different members of Bhuban Formation in Cachar Basin indicated a potential for identifying these sediments in subsurface sequences and their further correlation in the basin. Through palynological analysis of Bhuban sediments exposed in Mizoram a tropical to subtropical, warm, humid climate, during its deposition, was suggested.

Origin, environment and geology of Holocene Japanese coastal Lagoon lakes were discussed with the remark that these are comparable with the lakes in Himalayas. Investigations that tried to correlate geological, lithological, climatological, palaeobotanical, mineralogical, etc. parameters, to build up the different environments of the Lagoon of Venice (Italy) and the northern Adriatic sea during the Late Quaternary were discussed.

A palynological interpretation on mangrove development in Chilka lake was attempted. Results of palynofossils and

palynodebris in Kerala mud-banks was presented. The palynological study of a marine core off Karwar near the estuary of the Kalinadi River revealed major vegetational change at circa 3500 year B. P. in the Late Holocene evolution of the vegetation covering the Western Ghats in north Kanara. Through palynological analysis of a profile from Rambha, Chilka lake, Orissa, degradation of mangrove during Late Holocene (3,700 year B. P.) could be indicated in three different phases. Dendroclimatic studies through tree-ring analysis of dry temperate forest sites at Uttarkashi and Kinnaur, North-West Himalaya, proved useful in reconstructing the past lake level changes in relation to precipitation changes in the region.

Organic petrological investigations of Karewa peat/lignite from Kashmir Valley indicate that it was dominantly composed of organic matter derived from land and plants deposited under shallow fresh water environment. Reflectance study of Pathakhera coals of Satpura Basin suggested its high volatile bituminous nature. The coal at PK-II incline seems to have been the results of a dyke, present in the area. The analysis of organic matter facies and maturation data of outcrop samples from Gondwana formation of South Rewa Basin, indicated that they are good source beds and have potential to generate hydrocarbons.

The discovery of high amount of total liptinite macerals in Early Permian (Barakar) coals significantly suggest definite difference in the depositional setting (back water and lacustrine swamp in fluvial regime) and floral communities of Early and Late Permian coal seams in the Son-Mahanadi Basin. The hydrocarbon prospect in Moran oilfield, Upper Assam was discussed indicating that the oil and gas are produced from Barail Group only but there is every possibility of the presence of hydrocarbon in pre-Barail sandstone reservoirs.

Discovery of seeds and fruits from Shikapur in Rann of Kutch was a new find of bread wheat in the food economy of Harappans and most of the other species examined suggest arid conditions prevailing in the region during the Harappan time (circa 2500 to 2200 years B. P.). The paper on "women and tree motif" dealt with tree motifs depicted in various ancient temples of the country. The mythic stories connected with the motifs were discussed and the

plants identified. In another presentation "Handedness in nature" was explained showing possible reasons for the preponderance of right handed DNA over left handed ones.

Past of the Green World—A tribute To Birbal Sahni

An exhibition was organised by National Council of Science Museums and Birbal Sahni Institute of Palaeobotany at the Science Centre Lucknow. Professor A. P. Mitra, F. R. S. inaugurated the exhibition. The object of the exhibition has been to create general awareness about the science of palaeobotany in order to disseminate the vast reservoir of knowledge accumulated in the past to the common man and specially to the young. The exhibition has been divided into two sections. One section displays the life and work of Professor Birbal Sahni. Here a room with the original belongings of Professor Sahni has been recreated.

The second section displays the origin and evaluation of plant life in seventeen panels. The panels exhibit origin and evolution of plant life, early land plants, coal forming vegetation, naked seeded plants, angiosperms (flowering plants); diversification; Himalayan orogeny, coastal vegetation, desertification; coal, oil, petroleum palaeobotany, fossil dating of rocks, Kaalchakra (geological clock) and other aspects of palaeobotany.

Publications released during the celebrations

Indian Gondwana—Memoir 21—Edited by B. S. Venkatachala & H. K. Maheshwari; published by Geological Society of India, Bangalore.

Extinct Plants, Evolution and Earth's History—Edited by B. S. Venkatachala, C. V. Subramanian & S. Ramaseshan—Published by the Current Science Association, Indian Academy of Sciences, Bangalore.

Birbal Sahni : Link with the Past & Birbal Sahni Institute of Palaeobotany

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& Information Directorate
(CSIR), New Delhi.

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A Catalogue of fossil plants from India

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Part - 3 A. *Palaeozoic & Mesozoic Spores & Pollen*—Suresh C. Srivastava.
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Part - 4 *Cenozoic (Tertiary) Megafossils*—Rashmi Srivastava.

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Part - 11 *Archaeobotany*—Chanchala.

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