BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY LUCKNOW

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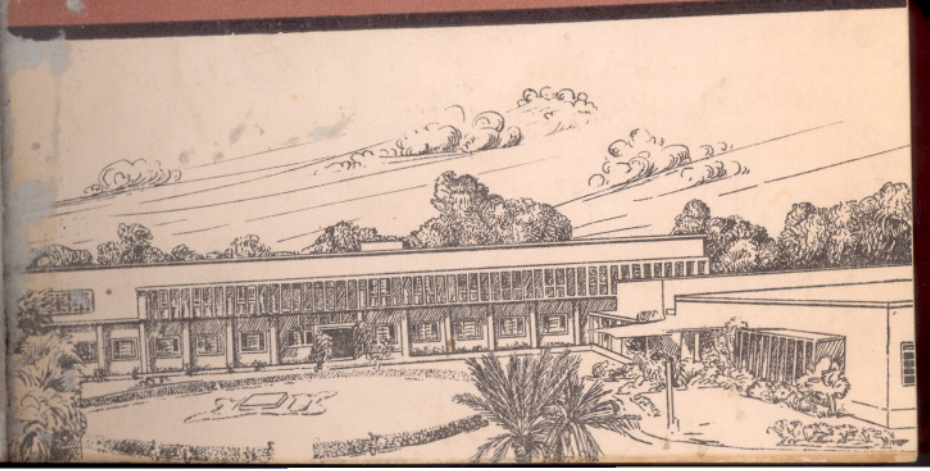

CONTENTS

I. INTRODUCTION

Under the inspiring guidance of Professor Birbal Sahni, F. R. S. a Palaeobotanical Society was founded at Lucknow in May 1946 and registered under the Societies Registration Act (XXI of 1860) in June 1946. By a resolution passed on 10th September 1946 the Governing Body of the Palaeobotanical Society established an Institute of Palaeobotany and appointed Professor Sahni as its first Director in an honorary capacity. Pending the acquisition of a permanent home the work of the Institute was carried on in the Department of Botany at the University of Lucknow.

In September 1948 the Institute received from the Government of Uttar Pradesh the generous gift of an estate comprising a large bungalow on 3½ acres of land at 53 University Road, Lucknow. Soon plans were made for erecting a new modern building for the Institute. On 3rd April 1949 its foundation stone was laid by Pandit Jawaharlal Nehru who, besides being the Prime Minister of India, was at that time also the Minister of Scientific Research and Natural Resources.

Within a week of this ceremony the young Institute suffered an irreparable loss in the sudden and untimely passing away of its Founder Director, Professor Birbal Sahni. The most apt tribute was paid to him when in October 1949 the Governing Body of the Palaeobotanical Society named the Institute after him as the Birbal Sahni Institute of Palaeobotany.

Subsequent to Professor Sahni's sudden passing away, on 11th April 1949 the Governing Body of the Palaeobotanical Society authorised his wife, Mrs. Savitri Sahni, to discharge all the duties of the Director of the Institute in addition to her own duties as the President of the Society. In May 1950 Dr. R. V. Sitholey, Assistant Director was appointed as Officer-in-charge for carrying out the current duties

of the Director under the supervision of the President. In 1951 the United Nations Educational, Scientific and Cultural Organization (UNESCO) included the Institute in its Technical Assistance Programme, under which Professor O. A. Hφeg of the University of Oslo, Norway, served as its Director from October 1951 to the beginning of August 1953. A short time after Professor Hφeg's departure, Dr. K. R. Surange was made the Offlcer-in-charge under the supervision of the President, Governing Body of the Palaeobotanical Society. In October 1959 Mrs. Savitri Sahni, in addition to being the President of the Society also became the President of the Institute and was incharge of the administration. At the same time Dr. Surange was appointed as Director having charge of academic and research activities.

At the end of 1967 it was felt that a stage had come when the Palaeobotanical Society should function purely as a professional scientific body and Institute as a separate institution. A new constitution was framed under which the Birbal Sahni Institute of Palaeobotany was registered as a separate body on 9th July 1969. In November 1969 the Palaebotanial Society transferred and delivered possession of the Institute to this new body whereby the Birbal Sahni Institute of Palaeobotany came under the management of a new Governing Body with Professor T. S. Sadasivan of the University of Madras as its Chairman.

The present report pertains to the year the Institute started as an independent institution and covers its activities from April 1969 to March 1970.

II. RESEARCH

1. PRE-GONDWANA

1.1 Microfossils from Rampura

Leiosphaeridia, *Protoleiosphaeridium*, *Retisphaeridium*, *Tasmanites* and an algal remain *Gloeocapsomorpha* were recorded belonging to the Kaimur Series (Vindhyans) Madhya Pradesh. Age of the Vindhyans has been discussed in the light of these discoveries.

1.2 Devonian spores

A rich assemblage of Acritarchs and spores has been recorded for the first time from palynological samples ranging from Silurian to Devonian deposits.

2. LOWER GONDWANAS

2.1 Glossopteris flora—morphological and stratigraphical studies.

2.1.1 *Mahanadi Valley*

Handappa, Orissa

Some new male and female fructifications referable to the Glossopteridales have been recorded. The male fructifications are *Glossotheca utkalensis* gen. et sp. nov., *Eretmonia utkalensis* sp. nov., *E. hinjridaensis* sp. nov. and *E. karanpurensis* sp. nov. In *Glossotheca* naked sporangia in aggregates are borne on ultimate branchlets and six of the aggregates are carried on a common pedicel attached to the stalk of a fertile leaf. In all the three species of *Eretmonia* the sporangial clusters are only two in number. The female fructification *Lidgettonia indica* carried stalked, naked ovules on the fertile leaf stalk. Morphology of female fructifications *Scutum* and *Cistella* is explained *Scutum* is a compact cone, with ovules carried on a small, thin scale leaves. In *Cistella* the ovules are devoid of scales and they are perhaps embedded on a mulbery like fleshy head of the cone. It is concluded that southern hemisphere Glossopteridales is a group of extinct gymnosperms; although showing remote relationship with Pteridosperms, distinct enough to stand on its own as a separate group. The variety of reproductive organs show that in Glossopteridales we are perhaps dealing with more than one order.

2.1.2 *South Karanpura*

Four species of *Gangamopteris* and some species of *Glossopteris* have been recorded from a shale bed about 70 feet above Argada 'S' Seam. The dominance of *Gangamopteris* indicates the Karharbari age. Twelve species of *Glossopteris*, out of which three are new, have been described

from the shales of Argada Seam, Lower Nakkari Seam and Upper Nakkari Seam. *Glossopteris fusa* sp. nov. is distinguished by the evanescent nature of midrib and closely spaced elongate meshes of equal size. *G. petiolata* sp. nov. is distinguished by a petiolate leaf and closely spaced, more or less straight secondary veins which form narrow palygonal meshes. *G. Karanpurensis* sp. nov. is distinguished by its large size, arched secondary veins which run straight to the margin and form open hexagonal meshes of equal size.

The study of a large number of impressions of *Sphenopteris* fronds from the Barakar stage reveals that *Sphenopteris polymorpha* Feistm., 1881 and *S. hughesi* Arber, 1905 are homonyms. *S. polymorpha* is emended and retained on the basis of nomenclatural priority.

2.1.3 *Rajmahal Hills*

Some megafossils from the Bansloi valley have been recorded from localities mapped by Ball as the Dubrajpurs. The Dubrajpur group had earlier been either included in the Lower Gondwanas or equated with the Mahadevas. Sandstone and shale beds overlying the Lower Gondwana and referred to as the Dubrajpur have yielded plant fossils characteristic of the Rajmahal Intertrappean Series. Hence it has been suggested that the name Dubrajpur be replaced by Intertrappean Rajmahal beds for beds overlying the Lower Gondwana sediments. Beds, hitherto mapped as Dubrajpurs and now shown to contain *Glossopteris* and *Vertebraria* should be included in the Lower Gondwanas.

2.1.4 *Singrauli Coalfied*

A new genus, viz., *Alatocarpus* is instituted to contain certain large platyspermic seeds. The species *Samaropsis johillensis* Saksena, 1955 from the South Rewa basin is also transferred to *Alatocarpus*. The Singrauli material contains *A. indicus* sp. nov. (the type species) some specimens comparable to *A. (Samaropsis) johillensis* (Saksena) comb. nov,, and *Alatocarpus* sp. It is suggested that *Samaropsis pincombei* Walkom, 1928 may also belong to *Alatocarpus*. The occurrence of the seeds and associated plants on the age of the beds is briefly discussed.

2.1.5 *Jharia Coalfield*

The wood genera *Barakaroxylon* Surange and Maithy, 1962 and *Indoxylon* Surange and Maithy, 1963 are merged as the central and the

peripheral secretory canals, which distinguish these two genera, have been found in one and the same specimen. On the basis of priority the genus *Barakaroxylon* has been retained. A new species *Barakaroxylon monocanalosum* has been instituted. It is characterised by the presence of a single, central canal in the pith as opposed to *B. jhariense* which is characterised by a central canal and a number of peripheral canals.

2.1.6 *Giridih Coalfield*

Four new species of fossil plants, viz., *Gangamopteris oblancaolata* sp. nov. *Euryphyllum obovatum* sp. nov., *Dolianitia karharbarensis* sp. nov. *Buriadia florinii* sp. nov. have been recorded from the Karharbari beds of the Giridih Coalfield.

2.2 Sporae Dispersae

2.2.1 *South Karanpura*

A systematic study of two miospore assemblages, one is from the shales associated with the Argada 'S' Seam, and the other is from another shale about 70 feet above the Argada 'S' Seam, indicates that both the assemblages are palynologically more closely related to the Karharbari stage.

2.2.2 *Johilla Coalfield*

A miospore assemblage containing 23 genera and 42 species from the Ganjra Nalla beds is described. The genera *Rugasaccites*, *Pachysaccus*, *Gondwanopollis* and *Rimospora* are newly instituted. The stratigraphical position of the Ganjra Nalla beds is discussed in the light of the plant micro-and macrofossil evidences.

2.2.3 *Daltonganj Coalfield*

On the basis of plant megafossils and the miospores recovered from the coal bearing beds the stratigraphical position of these beds in the Lower Gondwana succession is discussed.

2.2.4 *Jayanti Coalfield*

Miospore assemblages have been recorded for the first time from the matrix of two intercalated Talchir Boulder Beds. *Virkkipolleni es*, *Plicatipollenites*, *Parasaccites*, *Caheniasaccites*, *Vestigisporites*, *Potonieisporites*

and *Limitispo·ites* are predominant. The distribution pattern of the miospores in the two boulder beds has been studied and comparisons made with the known equivalent assemb'ages. The bio-stratigraphical and palaeobotanical significance of the findings have been discussed briefly.

2.2.5 *South Rewa Gondwana basin*

Stratigraphical geology and palaeobotany of the Lower Gondwana sediments exposed at Umaria, Birsinghpur, Pali, Annuppur, Manendragarh and Chirimiri areas is described in detail. The palynological assemblage, besides spores and pollens, includes megaspores and Acritarchs. The spore pollen assemblages have yielded 81 species assignable to 50 genera. Of these 2 genera (*Sakseneasporites* and *Talchiritriletes*) and 41 species are new. The Acritarch assemblage from the Umaria Marine Bed is a significant find and includes, in addition to four known genera, one new genus *Fovrolites* and eight new species. The data collected from both organic and inorganic sediments have been collated both qualitatively and quantitatively. Field observations indicate that the Umaria Marine Bed represents an Upper Talchir transgression while the Mahendragarh Marine Bed represents a Lower Talchir Transgression. The palynological and palaeobotanical evidences confirm the conc'usion already drawn from field evidences that the Talchirs within the South Rewa Gondwana Basin are correlatable and that such correlation can be extended to other Lower Gondwana Basins of Peninsular India.

Biostratigraphical studies clearly indicate that all the Coal Measure strata of the South Rewa Gondwana Basin, earlier assigned to the Barakar Stage, are in fact related to the Karharbari Stage, and have been now so assigned. Thus, it is clear that that the lithological recognition of the Karharbaris or Barakars in the South Rewa Gondwana Basin is not reliable. Palynological evidence, favours the inclusion of the Karharbaris within the Talchir Series.

2.2.6 *Godavari basin*

From the *Sporae dispersae* of some Lower Gondwana coals of Godavari Basin, five new miospore genera bearing hitherto undescribed association of morphographic characters have been instituted. Two of

them, viz., *Godavarisporites*, and *Lobatisporites* are trilete, *Kingiacolpites* is a monolete and *Gondisphaeridium* and *Globulaesphaeridium* are alete genera.

2.2.7 *Lower Gondwana megaspores*

The taxonomy and stratigraphic distribution of dispersed megaspores in the Lower Gondwana Formations (Permian) of India have been worked out. The morphographic delimitation of different genera and species has been based on the extensive and intensive study of megaspores from different basins in India. These data are supplemented by the hitherto known account of megaspores from other Gondwana continents. A large number of specimens have been studied in reflected as well as transmitted light and it has been found necessary to base the taxonomy of the genera on the characters studied by both the methods. For the study under transmitted light many specimens were progressively overmacerated controlling it for careful study at various stages until the inner body was liberated.

It has been found that the nature of exine ornamentation, the nature and extent of trilete ridge in relation to the contact area, and the nature as well as the presence or absence of cushions on the inner body are important characters in taxonomy. On these lines, thirteen genera and forty species have been recognized, out of which six genera and eighteen species are new. The distribution of the genera and species of megaspores in Indian basins and stratigraphic horizons has been given.

2.2.8 *Permo-Triassic boundary in Raniganj Coalfield, W. Bengal*

In Raniganj coalfield sediments of the Raniganj Stage (Permian) appear to be conformably overlain by the Panchet sediments (Triassic). Palynological investigations of a large number of sub-surface and surface samples disclose a sharp change in the spore and pollen assemblages across the Raniganj-Panchet boundary.

The Raniganj assemblage is dominated by striate-bisaccate forms like *Strotersporites*, *Striatopiceites*, *Striatites*, etc. while trilete and monolete types occupy a secondary position. The Panchet assemblage on the other hand is dominated by trilete genera like *Decisporis*, *Divaripunctites*, *Dictyophyllidites*, etc. while striate bisaccates have become rare.

The sharp change seen in the palynological assemblages across Raniganj-Panchet boundary in this area apparently reflects both evolutionary and environmental changes.

2.2.9 *Cycado-Ginkgopsid Pollen*

The Cycado-Ginkgopsid pollen grains are generally monosaccate and monocolpate. They occur in Cycadales, Bennettitales, Pentoxylae, Ginkgoales, Welwitschiales and Gnetales. Development of pollen grains in *Cycas circinalis*, *Ceratozamites*, *Macrozamia*, *Ginkgo* and *Gnetum* has been studied. Some fossil members are known to have produced trilete bearing non-saccate pollen grains.

It has been concluded that there are two different kinds of organization in Cycado-Ginkgopsid pollen grains :—

I Monocolpates (1) Cycadalean type—Circuloid in polar view; with colpus well demarcated or ill defined.

(2) Bennettitalean type—spindloid in polar view with colpus well demarcated or incipient.

II Triletes

There is evidence of progressive reduction in the extent and differentiation of the colpus from primitive to evolved classes of plants.

2.2.10 *Correlation Studies—Sohagpur Coalfield*

This includes a sporological study of 53 bore hole coal samples from Bhaskarpara, Kutkona and Batura blocks of Sohagpur coalfield, M. P., India. The distribution of various palyno-taxa among the samples has suggested the occurrence of eight coal seams distinguished by eight spore assemblages. Miospore Assemblage G is characterised by the dominance of *Brevitriletes* and *Sulcatisporites*. The Assemblage F shows a dominance of *Brevitriletes* closely associated with *Microbaculispora* and *Indotriradites*. The last genus becomes dominant in Assemblage E1 with the former two as subdominants. *Brevitriletes* again ranks highest in Assemblage D and is associated with *Sulcatisporites*. In Assemblage C *Brevitriletes* continues to be dominant but the association is marked by the subdominance of *Horriditriletes* and *Sulcatisporites* while in Assemblage B *Horriditriletes* becomes the most dominant genus and remains associated with *Brevitriletes* and *Sulcatisporites*. Assemblage A is

characterised by the dominance of *Sulcatisporites* in association with *Striatopodocarpites* and *Striatites*.

The sporological succession is marked by three miofloral changes seggregating four groups of assemblages. Chronostratigraphically, Assemblage G belongs to lower Karharbari Stage, Assemblages F-E represent Lower Barakar Stage, Assemblages D-B represent Middle Barakar Stage and Assemblage A represents the Upper Barakar Stage.

2.2.11 *Argada 'S' Seam, S Karanpura*

The miospore assemblage from the coal of Argada 'S' seam, South Karanpura Coalfield has been described and compared with similar mioflоras of the other coalfields of Indian Lower Gondwanas. This miospore assemblage closely resembles the mioflora of the shale associated with Argada 'S' seam. In view of the mioflora from the shale band 70' above the Argada 'S' seam being similar to the mioflora of the Giridih coalfield, the type area for the Karharbari Stage, Argada 'S' seam has been considered older than the Karharbari Stage of Giridih Coalfield. However, in view of striking difference between the mioflora of Argada 'S' seam and that of the Talchir Stage, it is suggested that Argada 'S' seam should be considered as a part of Karharbari Stage and as compared to the Karharbari Stage in the Giridih Coalfield, it should be recognised as Lower Karharbari Stage.

2.2.12 *Palynostratigraphy Studies—Lower Gondwana succession*

A critical analysis of all the available palynological data from coals and shales belonging to various stratigraphical subdivisions of the Lower Gondwana System has revea'ed the occurrence of 12 distinguishable assemblages in succession. In the Talchir stage only one assemblage is known so far, in the Karharbari stage two have been recognised and for the Barakar, Barren Measures and Raniganj stages three assemblages each have been substantiated.

2.3 Petrological studies of Coals

2.3.1 *Coals exposed near Gopalprasad, Talchir Coalfield*

The coal samples collected from the exposed beds of Gopalprasad have been studied since no previous knowledge exists about microstruc-

ture and relevant details of this coal. Coals are typically dull, fine grained and hard in nature. They are constituted by Vitrinite, Exinite, Intertinite macerals and sedimentary mineral matter. Among those Inertinite and mineral grains dominate the coal constitution. Rapid alternating bands of Durite and Carbargillite and increasing high percentage of mineral matter makes the coal more dull and shaly.

Sporological analysis reveals that the coal consist of 20 genera including a number of trilete, monolete, monosaccate and disaccate spores. The miospore assemblage dominates in striated disaccate pollen, e.g., *Faunipollenites*, *Striatopodocarpites*, *Lahirites* and *Striatites*. Trilete miospores are less common, while monosaccates are rare. Non-striated monosaccate genus is *Sulcatisporites*.

Petro-palynologically, compared with the Lower Seam and Upper Seam No. I of Talchir Coalfield and others, the coals are of poor quality. They are probably of Upper Barakar age.

2.3.2 *Genesis of Talchir Coals*

Palyno-petrological studies on the coals of Talchir Coalfield have distinguished three different types of coal formation. Among the three assemblages based on palyno-fossils : Assemblage—A is characterised by the dominance of *Brevitriletes* followed by *Faunipollenites* and *Sulcatisporites;* Assemblage—B contains *Cyclogranisporites* as the most dominant genus, and Assemblage—C is distinguished by sporadic occurrence of *Faunipollenites* closely followed by *Striatopodocarpites* and *Sulcatisporites*. On the basis of the distribution of various macerals among the above coals, likewise, three distinct coal types have been recognised. Coal Type—1 is chiefly a mixed Durain coal and comprises mostly of trimaceral group, Coal Type—2 is a typical fine grained Durain with high incidence of semifusinite while Coal Type—3 is chiefly a shaly Durain containing high amount of mineral matter.

2.3.3 *Microscopic study of Raniganj Coals*

Coal samples from Poniati, Dishergarh, Samla, Narainkuri and Nega seams (top and bottom) from Raniganj Coalfied were examined microscopically to know the physical composition and nature of the coal seams. The study reveals that the coals are banded component

types derived from heterogenous phytoorganic material. Lignogene (Vitrinite) constituents derived from lignified cell walls are conspicuous microcomponents of the coals. Liptogene (Liptinite) constituents derived from pollen and spore coat, plant cuticles and fossil resins form secondary proportions in the coal composition.

2.3.4 *Physical constitution of Indian Lower Gondwana Coal Seams*

The vast majority of Lower Gondwana coal seams investigated reveal microfragmental character of organic matter rich in Durain and Duroclarain types with few thin Vitrain bands. They are characterised by fine state of maceral division with significant proportion of sedimentary mineral matter. Inertinite (Fusinite and Semifusinite) is very predominant in the coal seams forming 50 to 60% of the maceral composition. The distribution pattern of the physical constituents of the coal shows characteristic petrographic assemblages or types indicating many features of economic application. Predominant fusinization of fossil material and finely dispersed clay minerals suggest decay and decomposition of swamps in addition to peatification. The differing degrees of exposure of organic material may be due to lower ground water level than swamps indicating drier conditions during the initial phase of coal formation. Subsequent coalification and regional variation in coal types may be explained on the basis of stratigraphical depth and certain igneous rocks commonly seen in the coal seams.

2.3.5 *Microconstituents of hard coals*

Faced with limitations of existing types of analysis for proper evaluation of coals, in particular Gondwana Coals and to explain much of the complexities or the characteristics of coal types, a new scheme has been formulated. This scheme adopts basic entities of plant material for classification as opposed to units based on technological property.

The woody microconstituents have been generalised into one unit Kuaonas Vitrinite based on overall features. But by careful palaeobotanical analysis this broad unit may be subdivided with many types. At least 6 types have been recognised.

2.4 Palaeozoic from Abroad

2.4.1 *Lukuga Series, Belgian Congo*

A miospore assemblage from a sample from the river Kibamba have been studied. Out of 55 genera recorded, the genus *Cirrabaculisporites* is new. The new species instituted are *Leiotriletes plicatus, L. plicatir diatus, L. magnificus, Punctatisporites foveolatus, Acanthotriletes longispinosus, Cirrabaculisporites praeclarus, C. ramosus, Dentatispora congoensis, Densosporites congoensis, D. angustus, Indotriradites congoensis, Welwitschiapites congoensis, Ginkgocycadophytus africanus* and *Tetraporina superba.*

A quantitative analysis of the miospore assemblage shows the predominance of the genera *Leiotriletes, Punctatisporites* and *Sulcatisporites.*

2.4 2 *Ombela and Lokandu*

Two samples from Assises glaciaires et periglaciaires from Ombela and Lokandu regions were macerated. The miospore assemblages recovered are dominated by monosaccate pollen grains while the bisaccate pollen grains are next in abundance. On this evidence it has been concluded that Ombela and Lokandu assemblages are younger than Elila river beds of Assises glaciaires et periglaciaires but older than Walikale sediments belonging to the Assise des sch stes noirs de Walikale

2.4.3 *Lufupa-Mushyashya confluence*

From Lufupa-Mushyashya confluence spores, pollen, cuticle and seeds have been described. The miospore assemblage consists of 50 genera, out of which two (*Cyclopilisporites* and *Pilasphaeridium*) are new. Out of 107 species recovered following species are new : *Punctatisporites lufupaensis, Horriditriletes concavus, Cyclopilisporites congoensis, Lukugasporites baculatus, Cristatisporites mammillatus, C. coniatus, C. obliquous, Dentatispora superba, Parasaccites fimbriatus, P. tuberculatus, Fimbriaesporites diffusus, Faunipollenites enigmatus, F. circumstriatus, Pilasphaeridium plicatus* and *P. circularis.* A quantitative analysis of the palynological assemblage shows that this too is younger than Assises glaciaires et periglaciaires of Elila river but older than Assise des schistes noirs de Walikale.

3. MESOZOIC

3.1 Triassic

3.1.1 *Parsora flora*

Parsorophyllum, a new genus of fern like frond is recorded from Parsora, in the Madhya Pradesh. The present position of the Parsora flora is briefly reviewed.

3.1.2 *Nidpur—Megafossils*

Megafossils from Nidpur have been worked out in detail. Out of them, six species of *Glossopteris* (*G. senii, G. papillosa, G. nidpurensis, G.* sp. A, *G.* sp. B and *G.* sp. C , *Rhabdotaenia* sp., *Lepidopteris indica, Taeniopteris glandulata, Noeggerathiopsis* sp., *Glottolepis rugosa* and *Conites* sp. are newly recorded.

Among the species of *Glossopteris*, except *G.* sp. C, all the species are based on cuticular structure. All the species of *Glossopteris* described from Nidpur differ from the Palaeozoic species in cuticular structure.

The specimens of *Rhabdotaenia* are rather fragmentary. Their cuticle is somewhat similar to *R. fibrosa* Pant & Verma. Like the latter species they too have fibres between secondary veins. In *Lepidopteris indica* the cuticle on one side is slightly thicker than the other and also the thicker surface has more stomata than the thinner. Subsidiary cells on both the surfaces are 5-7 in number and bear a prominent cutinized lappet. *Taeniopteris glandulata* is characterized in having gland-like bodies between secondary veins. The lateral and end walls of the epidermal cells are sinuous. *Noeggerathiopsis* sp. is preserved only in the form of impressions. In venation pattern it resembles most *N. gondwanensis* Lele & Maithy and *N. densinervis* Maithy.

A large number of tongue-shaped, detached scale-leaves with rugose surface has been described as *Glottolepis rugosa*. Its cuticle is very tough and hypostomatic. The stomata are sparsely distributed and concentrated more towards base. The cuticle more or less resembles some of the species of *Dicroidium* collected from Nidpur.

Conites sp. is an unusually large cone and has been compared with ? *Araucarites sydeneyensis* Walkom.

3.1.3 *Nidpur—Miospores*

The spores and pollen grains recovered from shales have been referred to 22 genera and 40 species. Out of them 4 genera (*Nidipollenites, Satsangisaccites, Weylandites* and *Praecolpites*) and 18 species are new. The mioflora is constituted by two spore genera and 20 pollen genera. Among the latter, both striated saccates and non-saccates are well diversified and also the latter forms are dominant. The miofloral assemblage shows closest relationships with the Upper Permian and Lower Triassic miofloras of India and it is most likely a deposition of younger Lower Triassic age.

3 2. Jurassic—Cretaceous

3.2.1. *Rajmahal flora*

Ptilophyllum amarjolense Bose and *P. sahnii* Gupta and Sharma have been studied in great detail. Cuticular structure and anatomical detail of the rachis and pinna have been described.

Besides the above two species, all the other species of *Ptilophyllum* from the Rajmahal Hill have been re-examined. They have been assigned to *P. acutifolium* Morris, *P. cutchense* Morris, *P. rarinervis* (Feistmental) and *P. tenerrimum* Feistmantel.

The collection includes three species of bennettitalean male fructification *Weltrichia*, viz., *W. singhii* Bose, *W. polyandra* (Ganju) Bose & Sitholey and *W. Santalensis* (Sitholey & Bose) Bose. *W. singhii* consists of about 12 microsporophylls which are united at base, forming a cup-shaped structure. The importance lies in its being found attached to a *Bucklandia*-type stem. *W. polyandra* is based on the specimens originally described as *Ontheanthus polyandra.* It is an unopened flower which very closely resembles the upper (microsporophyllous) part of *Cycadeoidea dactylota* Bose, 1966. Many new specimens of *W. santalensis* have been figured and on their basis a new interpretation regarding the microsporophylls have been given. Also a new restoration of a microsporophyll has been made. The microsporophyll has been depicted as a bilaterally symmetrical structure without any twisting of the distal portion.

3.2.2 *Sehora flora*

From here, *Todites indicus* (Oldham and Morris) *Doratophyllum senii* and *Williamsonia seniana* have been described. All the specimens of *T. indicus* from Sehora are sterile. *D. senii*, in gross features, resembles most of the previously known species uf *Doratophyllum* but it differs from all of them in the nature of subsidiary cells and some of the adjacent cells which are all very thickly cutinized. *W. seniana* has been instituted on eight carbonized specimens. The cuticular structure of its bracts resembles the cuticle of *Ptilophyllum distanse* (Feistm.) Jacob and Jacob, 1954 described from the same locality.

3.2.3 *South Rewa-L. Cretaceous*

Research work on three species, viz., *Gleichenia nordenskiöldii*, *Phlebopteris polypodioides*, and *Weichselia reticutata* has been completed. In *G. nordenskiöldii* the pinnules are attached with a small part of the base near midrib. The base of pinnule is asymmetrical and its lower basal edge overlaps the rachis. In the Indian specimens of *P. polypodioides* the pinnules are relatively narrower than most of the specimens, previously described, from other countries. The upper cuticle of *W. reticulata* consists of polygonal cells whose anticlinal walls are thick and strongly looped. Cells over veins are longer and narrower and their anticlinal walls are moderately undulate to almost straight.

3.2.4 *From Kathiawar - Kutch*

A few specimens of *Cladophlebis* sp. cf. *C. longipennis* Seward have been collected from Darad. All of them are sterile. Two fragmentary microsporophylls have been recorded from Kakadbhit in Kutch as *Weltrichia* sp. In them the preservation is very poor but the sporogenous chambers of the appendages are clearly seen.

3.2.5 *Dalmiapuram Grey Shale zone, South India*

The age of the grey shale horizon of Dalmiapuram, which unconformably underlies the Coral Reef Limestone of the Uttatur Stage, has long been a matter of controversy because of the absence of any definite fossil evidence. Some geologists place it within the Uttatur Stage (Cenomanian) while others have assigned them a Pre-Uttatur

age. Samples collected from this grey shale have yielded a rich palynological assemblage, which include the following significant spore-pollen taxa - *Cicatricosisporites* spp., *Co tignisporites dettmanii*, *Appendicisporites cristatus*, *A. erdtmanii*, *Traingulopsis trilobatus*. Besides spores and pollen the followlng mikroplankton genera have also been recognised-*Gonyaulacysta* sp., *Cyclonephilium distinctum*, *Hystrichosphaeridium* spp., *Oligosphaeridium complex*, *Baltisphaeridium*, *Palaeoperidium* and *Chlamydophorella* sp.

The palynological assemblage ascribes a Lower Cretaceous (Aptian) age for the grey shale zone of Dalmiapuram and hence support a Pre-Uttatur age for the bed. The abundant presence of microplankton remains suggests brackish-water to near-shore environment of deposition.

3.2.6 *Palynological succession through Mesozoic of India*

A critical synthesis of all the palynological data from the Mesozoic rocks of India based upon published information supplemented by original study has revealed the occurrence of miofloras successively dominated by *Decisporis*, *Alisporites* complex, *Classopollis* complex, *Araucariacites* complex, cyatheaceous and schizeaceous spores complex and finally angiospermic pollen grains. In this palynological succession as many as nine spore assemblages have been seggregated as occurring in the Indian sediments. A table incorporating the chronostratigraphic placement of the various miofloras and the salient details of the assemblages have been included.

3.2.7 *Palynologieal subdivision af Gondwana sequence*

All the palynological information regarding Gondwana rocks in India has been synthesized building up the vertical succession of principal spore kinds through the Gondwana Era It has been possible to distinguish 6 miofloras, to being restricted to Permian, one each to Triassic, Liassic and Oolitic together with lower Cretaceous, and the youngest as the basal, non-angiospermous precursor of the Miofloras of middle Cretaceous and younger ages. The 5 maxima of trilete spores separating the miofloras have been shown to be directly succeeding the miofloral changes. Three of these changes tend to

lie along the boundaries between Permian, Triassic, Liassic and Oolitic and are considered to be of greater significance on floristic grounds. It has been concluded that palynologically the Gondwana Era is divssible into 3 rather than 2 divisions.

3.3 Upper Cretaceous

3.3.1 *Therriaghat, Shillong Plateau*

Preliminary investigations on some samples from a greenish calcareous shale member of the Langpar fromation, exposed at the Umsohryngkew river section at Therriaghat have yielded the following microplankton species - *Achomosphaera operculata A. cambra, A. delicata, A robusta, A. volianta, A. globata, A. convexa, Hystriahospaeridium robustum, H. transculentum, H. assamicum, Oligosphaeridium cephalum, Polysphaeridium subtile, Leptodinium ovum, Fromea acambra, Asccodinium* cf. *scabrosum, Baltisphaeridium* sp , *Apteodinium* sp. and *Caningia* sp. The assemblage indicates a brackish water enviroment of deposition. None of the Eocene samples from the Therriaghat section has yielded microplanktons. On the other hand rich assemblages of palynological fossils from the overlying members suggest that sea regressed from this area during the deposition of the overlying members of the Therria Stage.

3.3.2 *Cretaceous - Tertiary boundary in S. Shillong plateau*

Demarcation of the Cretaceous - Tertiary boundary in Assam is an important stratigraphical problem which still awaits solution. Opinion based on field evidences appear to be sharply divided. The present project has been undertaken with the object of finding palynological markers which will help in the delimitation of this boundary. A large number of samples have been collected from a number of measured sections around Thrriaghat, Langpar, Cherra-Shella road, Punktung, etc.

More than 50 samples from both Langpar and Mahadek Formations have been examined. Only one sample has so far yielded palynological fossils. Since the spore-pollen yield from this sample was very low the area was revisited for fresh collections.

4. TERTIARY

4.1 Palaeogene

4.1.1 *Zonation of Cherra formation*

In the South Shillong Plateau, sediments of the Cherra Formation rest on the eroded surface of Langpar Limestone (Danian) and are in turn conformably overlain by the Lakadong Limestone. Three biostratigraphical zones have been established, based on the disposition of the Cherra Sandstone in three altitudinal belts, each characterized by a non-persistent coal seam and on the distribution of stratigraphically reliable palynological marker species.

The lower zone can be distinguished by high frequencies of *Schizosporis crassimurus*, *Retialetes emendatus* and *Polypodiiporites mawkmaensis*, together with a few other forms restricted only to this zone. The middle zone can be recognized by the common occurrence of *Corrugatisporites formosus*, *Sestrosporites dettmanii*, *Foraminisporis medius*, *Monosulcites rarispinosus*, *Monosulcites wodehousei* etc. and low frequencies or ± absence of *Schizosporis crassimurus* and *Polypodiisporites mawkmaensis*. The upper zone is distinct in the absence of palynomorphs characteristic of the lower and middle zones and the common occurrence of *Foveosporites pachyexinous*, *Polycolpites speciosus*, *Engelhardtioidites parvus*, *etc.*

4.1.2 *Laitryngew–Mawkma Coal bearing sandstone.*

Palynological studies of the sedimentary formations of the South Shillong Plateau have shown that the Coal-bearing sandstones may be slightly older than what they were regarded (i. e., Lower Middle Eocene). The dominance of marker species like *Schizosporis crassimurus*, *Polypodiisporites mawkmaensis*, *Retialetes emendatus*, *Nymphaeacidites clarus*, *Polycolpites ornatus*, *Tricolporopollis decoris*, *Lycopodiumsporites palaeocenicus*, *Triorites inferius*, etc. and the absence of Lower Eocene and Upper Cretaceous forms indicate that this sandstone group is equivalent to Cherra Formation and hence Palaeocene in age. The results of heavy mineral studies also seem to confirm to the palynological dating.

The fossils suggest prevalence of tropical climate and a shallow, fresh-water or lagoonal environment of deposition.

4.1.3 *Tura Formation Garo hills*

The Tura Formation is a group of coal bearing sandstones, clays and shales resting ± horizontally over the eroded platform of the Pre-Cambrian basement. They attain a maximum thickness of 600 feet in this area. The uppermost sandstone member of the formation were found to be conformably overlain by about 187 ft. of Siju Limestone.

Palynological studies carried out so far reveal that the Tura Formation contains two distinct palynological zones. The morphological and stratigraphical significance of these zonal assemblages is to be worked out.

4.1.4 *Laki sediments of Kutch*

A number of bore-hole samples from near Jhulrai, Baranda and Panandhro were examined for their palynological fossils. The core samples were supplied by the Directorate of Geology and Mining, Government of Gujarat. All the samples represent the Laki Series and comprise of grey and carbonaceous shales alternating with thin bands of lignite and fine-grained sandstones. The basin of deposition seems to be shallow as the maximum depth of the Laki sediments does not exceed 110 feet.

Most of the samples proved to be rich in palynological fossils. The stratigraphically important elements of the Laki assemblage are - *Osmundacidites, Callialasporites, Podocarpidites, Liliacidites, Palmaepollenites, Meliapollis, Stephanocolpites, Polycolpites, Proteacidites, Barringtonia, Sonneratia, Pellicieria, Rhizophora* etc. Apart from these a number of microplankton genera have also been recorded.

The presence of mangrove elements together with hystrichosphaerids, dinoflagellates and microforaminifera indicate a near-shore, most probably estuarine environment of deposition. The palynological assemblage having mesozoic-elements like *Callialasporites, Podocarpidites* etc. together with dominant *Stephanocolpites, Polycolpites, Liliacidites, Palmaepollenites, Proteacidites* etc. suggest a Palaeocene–Lower Eocene age for the Laki sediments.

4.2 Neogene

4.2.1 *Tertiary sediments of Kerala*

With a view to build the biostratigraphy of the Tertiary sediments of Kerala coast samples were collected from two sections, one near

Quilon and the other at Warkalla. The Quilon section comprises of fossiliferous limestone, carbonaceous clays, sandy clays and sands while the Warkalla section consists of variegated clays and sands, carbonaceous clays, white plastic clays and lignitic bands.

The carbonaceous clay from the mine section near Padappakara, Quilon yielded a rich assemblage of fungal remains. No spores or pollen grains were found. The dominant fungal types are *Parmathyrites indicus, Quilonia typica,* and *Entophylyctis willoughbyi.*

4.2.2 *Palynology of Caddalore Sandstones*

The Neyveli Lignite deposit form an important horizon of the Cuddalore Series. Plant microfossils have, so far, been recovered from the lignite member only. The palynological assemblage comprises of a large number of angiosperms and ferns. Not a single microplankton taxa was found. The palynological fossils indicate a fresh-water environment of deposition and the prevalence of moist subtropical climate.

4.2.3 *Petrology of Neyveli lignite*

General microscopic studies have been made to determine the petrological characters of the lignite. Woody, Peaty and Coaly types of lignite have been distinguished. Vessels, hyphae of fungi and spores have been recognised. From the petrographic analysis the samples investigated appear to consist predominantly of angiospermous woods and tissues suggesting recent deposition. Presence of abundance of fungal remains and resins indicate high decay and destruction of woody constituents.

4.2.4 *Techniques in brown coal studies*

Number of formulations have been made for preparation of lignite. While trying various resins based on Coal preparation technique, apart from Palatal, Araldite, Lekutherm, Degalan, Pleximon resins have been found satisfactory for embedding lignite samples.

4.2.5 *Nomenclatur of Exinite etc.*

Botanical terms have been erroneously coined for microconstituents of hard and brown coals based on technological properties of palaeo-

botanical components. Resin bodies although resemble in micro-structure to sclerotia yet they are two different basic organic units and hence a separation from Sclerotinite has been suggested. Similarly Huminite has been separated from Detrinite due to two different inorganic units.

4.2.6 *Etching technique of Vitrinite*

Etching technique has been evolved to show the latent botanical structure of Vitrinite component and thus to differentiate different organic units of woody component - The etching soiution of Chromic-Su'phuric acid is used (10 c. c. of Conc. Su'. acid + 30 c. c. of saturated Chromic acid).

4.2 7 *Lithotype classification of Brown Coal*

Based on fossils and their derivative assemblage, different layers of brown coals have been recognized, namely xylitic layers, fibrous layers, Exinite or yellow layer, brown layer and black layer.

4.2.8 *Fossil woods from the Middle Tertiary of Eastern India*

Petrified woods were investigated from the Miocene Tipam Sandstone near Hailakandi and Jaipur In Assam and from the Mio-Pliocene of Deomali in NEFA. The woods from Hailakandi, in Cachar district, were found to resemble those of the genera *Gluta - Melanorrhoea, Adenanthera, Swintonia, Antisoptera* and *Diospyros -Maba.*

From Jaipur the fossil woods showed affinities with the modern genera *Shorea, Holigarna, Peltophora, Terminalia Duabanga, Calophyllum, Afzelia-Intsia* and *Gluta - Melanorrhoea.*

The genera reconized in the fossil woods of Deomali are *Sideroxylon, Shorea, Cynometra* and *Terminalia.*

The existence of the above genera during the Miocene-Pliocene of eastern India and their presence in the modern flora of that region suggested that there has been no great change in the vegetation and ecological condition of that area since the Middle Tertiary period.

4.2.9 *Fossil plants of the Siwalik formation*

Siwalik exposures are found all along the southern foot-hills of the Himalayas. In the past petrified woods and leaf impressions had been reported from a number of localities, but they had not been studied systematically. Recently detailed collections have been made at a number of localities. From Nalagarh (Himachal Pradesh) a large collection of fossil woods was made, whose preliminary examination has revealed a preponderance of legumes and dipterocarps. A collection of leaf impressions from Tanakpur (U. P.) shows forms resembling those of *Dillenia, Terminalia, Syzygium, Myristica, Litsea* etc. In another collection of leaf impressions from Bhikna Thoree (Bihar) have been recognized such plants as *Zizyphus jujuba, Bauhinia hookerii* or *Hardwickia binata* and *Cinnamomum tamala.* These studies are indicating that in early Siwalik times rich moist vegetation was growing in Western Himalayas in such localities where conditions are comparatively more arid at the present day. There also seems to be a transition from moisture to aridity as we go up in the Siwalik strata. These indications have stimulated careful and detailed investigation of the Siwalik flora.

4.2.10 *Studies on the petrified woods of the Cuddalore Series*

Detailed studies on the rich collections of fossil woods from the Cuddalore Sandstones of South Arcot district, Tamil Nadu has revealed that besides identifying new forms, it is also important to revise many of the old identifications. In accordance with this latter view five dipterocarpaceous woods, viz., *Dipterocarpoxylon indicum, Shoreoxylon holdeni, Shoreyxylon mortrandrense, Shoreoxylon megaporosum,* and *Anisopteroxylon cuddalorense* have been revised. All these species show close resemblance with the woods of the modern genus *Dryobalanops* which at present is restricted to the Malaysian region (Java and Sumatra). Further, the affinities of *Hopeoxylon indicum, Dipterocarpoxylon cuddalorense, Guttiferoxylon indicum, Celastrinoxylon dakshinense* and *Albizzioxylon sahnii* have also been revised after a critical examination.

Further investigation of the collections have revealed the occurrence of taxa resembling *Diospyros, Chrysophyllum, Adina-Nauclea* and *Shorea.*

The increasing data on the identification of these woods are helping to build up the composition of the rich forests that grew in South India during Miocene - Pliocene epochs.

4.3 General Tertiary

4.3.1 *A comprehensive study of the Tertiary floras of India as known so far.*

The Tertiary floras in India remained practically uninvestigated until the first quarter of the present Century. Lately, however, they have received the attention of a number of workers who have furnished considerable data on this subject. Realizing the importance of a critical consideration of all the significant information in this field, so as to assess the value of our present knowledge and plan future lines of investigation, this study was taken up.

The Tertiary floras of India can conveniently be divided into two groups - Palaeogene and Neogene. Palaeogene floras are found only in the Peninsular India, while Neogene occur in both the Peninsular and extra-Peninsular regions. They are predominantly tropical floras, made up of genera now largely confined to the Old World.

A notable feature of the Indian Palaeogene is the occurrence of a few southern hemisphere taxa which recall the pre-Cenozoic relationships between India and the Gondwana continents to the south.

The London clay flora shows noticeable general resemblance with the Indian Palaeogene. There are also related forms in the Tertiary of northern Africa. It is possible that the Indo-Malayan type of vegetation grew all along the southern shores of the Tethys sea during the early Tertiary period.

From the observations on the vegetation of the Miocene time, it is envisaged that there were large scale migrations and intermingling of floras over Malaysia, India, Arabia, and Eastern Africa during Neogene period. Water seems to have been a major factor in controlling the distribution of plants at low latitudes throughout the Cenozoic era.

It has also been possible to reconstruct the palaeogeography of India during the Early Eocene and Miocene epochs on the joint evidence of plant and animal fossils.

4.4. Tertiaries from Abroad

4.4.1. *Fossil woods from the Tertiary of Burma*

A collection of petrified woods from the Miocene deposits of Burma was worked out. It consists of wood resembling those of the modern genera *Dipterocarpus, Shorea-Pentacme, Sterculia, Gluta-Melanorrhoea, Acacia, Cynometra, Afzelia-Intsia, Cassia,* and *Lagerstroemia.* All these genera are found today growing in the forests of Burma. This fact indicates that there has been little climatic and vegetational change in this area since the Middle Tertiary period. Similar fossil woods are also found in the Miocene beds of Assam and NEFA, showing thereby that during the Neogene period eastern India and northern Burma had the same type of vegetation.

4.4.2 *Tertiary woods from Congo*

A collection of fossil woods from the Miocene of Lake Albert, Congo has been investigated with the help of modern woods of Tropical Africa available in the Royal Museum of Central Africa at Tervuren, Belgium. Some of the fossils have been identified with the genera *Entandrophragma, Dichrostachys, Isoberlinea, Brachystegia, Baphia* and *Newtonia-Albizzia.* Majority of these belong of to Leguminosae It seems that legumes were growing abundantly in Central Africa during the Neogene period. The plants are all typically tropical in nature.

4.4.3. *Fossil woods from the Tertiary of Czechoslovkia*

From a collection of fossil woods from Northern Bohemia, dicotyledonous woods were worked out at the Institute while the conifers were investigated at the National Museum, Praha (Czechoslovakia). The dicot genera identified are *Liriodendron, Cercidiphyllum, Platanus. Carpinus* or *Corylus, Ostryopsis-Corylus* and a number of Lauraceae. These form a significant complement to our knowledge of the Tertiary floras of Czechoslovakia, which were so far studied only on the basis of leaves and fruits. *Platanus* represents an important element from the phytogeographical viewpoint since it occurs fairly abundantly in this flora in the earlier as well as later volcanic phase.

A few fossil woods from the Tertiary of South Bohemia were also brought for investigation from Czechoslovakia. Some of them have been worked out and found to resemble the woods of *Mimusops, Diospyros Maba,* Lauraceae and Coniferae. The study is still in progress

5. QUATERNARY

5. . Palynology

5. 1. *Palynology of wild rices*

In continuation of the work on cereal Vs noncereal pollen particularly their morphology, production and sedimentation, the examination, of *Oryza perennis* and *O. sativa* var. *spontanea* in the field has revealed that they are partly cleistogamous and partly wind pollinated. Per anther production of pollen in these two species is comparatively much smaller than in the other wild grasses. Tho more or less psilate pollen grains range in size between 25 μ - 45 μ and rarely attain the size of 51 μ. In spite of the decidous nature of the spikelets, pollen analysis of the soil samples from the marshes abounding in these wild rices has revealed a very small percentage of grass pollen preserved. The size of the pollen preserved was in the range mentioned above. The abundant occurrence of the wild rices in these marshes is not depicted by the pollen spectrum, and further the occurrence of pollen of the size 51 μ may mislead a pollen analyst. The observations reveI that the usual size criteria distinguishing cereal pollen from the wild grass pollen as enunciated in Europe cannot be applied in India. Possible causes for poor preservations of pollen may be the aerobic nature of the samples examined when the microbial activity should be great and the calcareous and circumneutral nature of samples, both of which are detrimental to the preservation of pollen. The walls of pollen grains, however, did not show any effect of the microbes on them.

5.2. Pollen Analysis

5. 2. 1. *Kumaon Himalaya*

A moss fragment recovered during pollen analytical investigations of Bhim Tal, has heen identified as *Sphagnum papillosum* Lindb. The specimen from the superficial layers may not be older than 1000 years.

There is so far no record of *Sphagnum* from the Kumaon Himalayas, and there are only two species, *S fimbriatum* and *S. squarrosum* known from Himachal Pradesh in the entire Western Himalayas. *S. papillosum* is not known from India so far.

5.2.2. *Nilgiris*

The radiocarbon dates of the Ootacommund pollen profile have now made is possible to date the phases of vegetational development. The initiation of the Shola forest took place about 35,000 year ago, through gradual invasion of the grasslands under a warm and humid climate which was free from frost. The Shola forest comprising *Enonymous, Gordonia* and devoid of Myrtaceae is indicative of low precipitation (60"-80") as obtained today in the eastern part of the Nilgirls. The establishment of the Shola forest took place in stages : by about 24,000 years the shrubby vegetation had been established and by about 15000 years the Shola forest had already been formed. The subsequent phase of disforestation of the Shola forest at Kakathope remains to be dated.

5.2 3. *Himachal Pradesh*

Pretty long pollen profiles at both Khajiar and Rewalsar reveal a succession leading from the oak woods - oak mixed conifer woods to Deodar woods. A short term disturbance in the oak mixed conifer woods at Khajiar is noted around first century A. D. and the final decline of the oak woods and rise of deodar woods is dated by radiocarbon at 700 A. D. but the latter phase at Rewalsar is dated at 540 A. D. The substantial decline of oak woods and their replacement by Pine in the Kashmir Valley earlier estimated at 700 A. D. is corroborated by the finds at Himachal Pradesh.

5 2.4. *Rajasthan*

Pollen diagrams constructed from Sambhar, Didwana, Lunkaransar and Pushkar Lakes both from the Western and Eastern Rajasthan and supported by radiocarbon dates provide history of vegetation and climate during the last 10,000 years. Through a large part of the sequence the non-arboreals are dominant together with *Artemisia* indicating constantly arid climate. At about 3000 B.C. trees and shrub

pollen ratios increase, indicating the extension of the forests, comprising *Prosopis, Acacia, Capparis* and *Anogeissus pendula,* in this open arid and semi-arid Savanaah type of forest but on the whole predominantly dry conditions have prevailed to the present. Evidence of scrub burning in the past has been recorded.

5.2.5. *Assam*

The late Quaternary deposits comprising soft unconsolidated clays, silts and sands at Tockalai, Cinnamara, Assam have revealed the occurrence of moist evergreen forest in the vicinity of Tockalai.

5.2.6. *Bengal*

Pollen analysis of top peat layers and the associated silty and clayey deposits have shown the peat layers to be rich in pollen and spores. The saprophytic fungi identified include *Tetraploa aristata, T. ellissii, Amellophora mussaenda* and *Entophlyctis lobata.* Of these *Tetraploa aristata* is found both in marine water and fresh water streams.

Pollen analysis reveals the occurrence of a fresh water *Heritiera* forest on the ground lying between the drier banks of streams and the central depressions in which the peat was deposited. The peat layer ranges in age from 4075±100 and 2610±100 B.P. Its fresh water nature is further confirmed by the pollen grains of *Potamogeton, Ludwigia* and *Myriophyllum.* Fresh water to slightly brackish conditions are suggested by the presence of diatoms of Pennales which are dominant. The members of Centrales are rare.

Heritiera forest comprised *Heritiera* and *Bruguiera* both dominantly present and *Ceriops.* The other members were poorly present.

Decaying woods of *Heritiera* and *Sonneratia* have been recovered in some sections at greater depths and dated by radiocarbon to 5810±120 B.P. and 5440±115 B.P. respectively.

5.3. Archaeobotany

5.3.1. *Indian cultivated plants—Wheat*

Morphological and statistical evalution of length, breadth, thickness, and I/B, L/T, B/L, T/L and T/B indices of carbonised wheat

grains from Mohenjo-Daro, Navdatoli-Maheshwar and Ter, ranging in age from 2300 B.C. to 200 A.D. and their comparison with the modern wheat grains of *T. sphaerococcum*, *T. compactum* and *T. aestivum* have reaveled that the carbonised grains belong to *T. sphaerococcum* only. The grains are comparatively smaller in the early Historical Period than during the Chalcolithic and the Harappan Periods. The present investigation reveals that this indigenous wheat after domestication was the only wheat cultivated in India for over two thousand years before the Birth of Christ.

5.3.2. *Barley*

Potsherds from Bogor, a neolithic site in Rajasthan have yielded no evidence of ancient plant economy. The carbonised material from Kalibangan comprises abundant naked and hulled forms of six-rowed barley. The grains are much shrunk in size which may be due to poor growth on sandy soils besides the effect of carbonisation. This is the only site of Harappan civilization where sizeable collection of barley has been obtained. It has been scarcely found at the other site. Records are absent from the Chalcolithic and they are rare in the Iron Age. Its history does not find accord with the written evidence as in ancient literature, of which the possibilities of any context with the Harappan culture are not borne out. The Harappans were either pre-Aryans or the tribes contemporary with the Aryans. The plant economy of Banas culture in Rajasthan comprising rice and *Sorghum* is again different from the staple diet of the Aryans Its authorship with the early waves of the Aryans is not borne out by Archaeobotany.

5.3.3. *Rice*

In order to aid specific identification of carbonised rice, L/B×T ratios have been built up of Indian wild rices and of *O. sativa*. These have been found widely different from those of carbonised rice grains owing to considerable shrinkage in size due to carbonisation. The imperfect preservation of morphological details in imprints or carbonised rice has prevented their proper specific identification. Chiefly owing to this it has not been possible to record the various phases of domestication of rice in India. The imprints on pot-sherds provide a better opportunity for such a study if it is proven that the clay or mud used

was picked up from marshes bearing wild rices, the spikelets of which fall off after maturity and get incorporated in the sediments of marsh. Clay-lumps picked up from marshes bearing wild rices showed a small number (about 8-9) of spikelets per lump suggesting that the mixing of spikelets and straw with clay was largely an intentional practice with the ancient Indians.

A few sites have provided enough materials to bring out local changes in food economy. The Chalcolithic site Ahar in Rajasthan reveals rice, the only cereal during 1950 B.C.-1725 B.C. and *Sorghum* introduced about 1725 B.C., became important staple diet of the ancient Aharians. At Navdatoli-Maheshwar-a chalcolithic site in M.P., wheat was the only cereal until rice was introduced in Period II, which gradually grew in importance in 1440 B.C. At Ter in Maharashtra wheat and rice were equally important during 200 B.C.-100 A.D. but from 100 A.D.-250 A.D. wheat predominated. Chickpea (*Cicer arietinum*) introduced during 100 A.D.-250 A.D., became an important article of food economy during 250 A.D:-400 A.D.

5.3.4. *Studies on the charcoal samples from Ter and Inamgaon in Maharashtra*

A few charcoal samples, collected from the archaeological sites near Ter and Inamgaon in Maharashtra, were received for identification. Their detailed anatomical study has shown that the charcoal pieces from Ter show affinities with the modern genera *Acacia, Boswellia Terminalia, Tectona, Sonneratia* and a bamboo. It seems plausible to conclude that the inhabitants of the region around Ter were using the woods of the above genera during the chalcolithic period

5.4. Aeropalynology

5.4.1. *Pollen over Lucknow*

Atmospheric pollen calendar for 1969-70 differs considerably from the one prepared earlier for 1954-55 particularly in regard to the dominance of pollen in the air as shown below :

	1954-55	1969-70
Holoptelea	42.55%	13%
Ailanthus	22.00%	2.40%

Gramineae	9.79%	34.60%
Azadirachta	4.16%	3.60%
Morus	6.15%	0.93%
Myrtaceae	2.20%	13.10%
Chenopod-Amaranth type	3.06%	8.60%

In most cases the period of dissemination of pollen tallies with the flowering season of the species and it has been possible to distinguish three flowering seasons. The maximum grass pollen in the air in 1954–55 was recorded in Oct. - Nov. but in 1969-70 it is observed in March - April. In some genera there is a shift in time in the first appearance of pollen in the air this year as compared to 1954-55.

The annual frequency of fungal spore catch, built up for the first time at Lucknow, is as follows :

Alternaria (35.8 %), *Helminthosporium* (12.8 %), Uredospores of *Puccinia* (12.1 %), *Cladosporium* (5 %) and *Nigrospora* (4.9%), *Cercospora* (3.4 %) and *Chaetomium* (1.04 %), etc. The rest are under 1 %. Spores of *Alternaria, Cladosporium* and Smuts are usually frequent during Feb. - May; *Helminthosporium, Nigrospora, Aspergillus* and *Puccinia* during Sep. - Oct., *Chaetomium* in August, *Cercospora* in Oct. - Nov. and *Curvularia* in Aug. - Sept.

III PAPERS PUBLISHED

Following papers were published by the staff

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IV ABSTRACT OF THESES

Contribution to the Upper Jurassic and Lower Cretaceous Floras of India

M L. Kasat

The thesis is based on the study of some fossil plants from the Upper Jurassic and Lower Cretaceous of India. The fossils have been collected from the Rajmahal Hills (Bihar) ; Sehora and Marpiparia (Madhya Pradesh) Kakadbhit, Ghuneri, Trambau, Khara river etc. (Kutch) and Darad (Kathiwar).

For the description of megafossils the thesis has been divided into four parts. The first part deals with the Filicales, having only two genera, viz. *Todites* Seward (1900) and *Cladophlebis* Brongniart (1849) *Todites* is represented by only one species i. e. *T indicus* (Old. & Morr.) Bose and Sah (1968) and *Cladophlebis* by *C.* sp. cf. *C. longipennis* Seward (1894) and *C. salicifolia* (Morris) n. comb.

In the second part, *Pachypteris indica* (Old. & Morr.) Bose and Roy (1968), a Mesozoic pteridosperm, has been dealt with. In this species some new observations on the venation pattern of the pinnules have been made.

In the third part a new species of *Doratophyllum* Harris (1932) has been described. The new species *D. senii* is based mainly on the cuticular structure.

The fourth part deals with a large number of Bennettitalean fronds and fertile organs. Among the leaves *Ptilophyllum* Morris (1840) and *Dictyozamites* Oldham (1863) have been described. The genus *Ptilophyllum* is represented by 14 species which have been described under impressions, incrustations and petrifactions. Under impressions four species viz. *P. acutifolium* Morris (1840), *P. cutchense* Morris (1840), *P. rarinervis* (Feistm.) n. comb. and *P. tenerrimum* Feistmantel (1877) have been included. All these four species are based on external characters alone. Eight species based on cuticular structure have been described under incrustations. These are *P. oldhamii* Jacob & Jacob (1954), *P. indicum* Jacob & Jacob (1954), *P. horridum* Roy (1963), *P. sakrigaliensis* Sah (1958), *P. distans* (Feistmantel) Jacob & Jacob (1954), *P. institacallum* Bose (1959), *P. jabalpurense* Jacob & Jacob (1954), *P. gladiatum* Bose and Sukh Dev (1958). The remaining species i. e. *P. amarjolense* Bose (1953), *P. sahnii* Gupta & Sharma (1968a) and *P. nipanica* Vishnu-Mittre (1957) are preserved in the form of petrifactions. In these three species, besides the surface characters, the anatomy of the fronds have been studied in detail.

The fertile organs comprise two genera, viz. *Weltrichia* Braun (1847) and *Williamsonia* Carr. (1870). The specimens of *Weltrichia* have been described as *W.* sp. because of the bad preservation. *Williamsonia* is represented by seven species. Out of these two species, viz., *W. senii* n. sp. and *W. sahnii* Gupta (1943) have been described in detail. The former is based on cuticular structure and the latter is based on external characters alone. The remaining five species are imperfectly preserved and hence described as *W.* sp. A, *W.* sp. B, *W.* sp. C. , *W.* type 1 and *W.* type 2

Contribution to the Indian Messozoic Palaeobotany

SHYAM CHANDRA SRIVASVAVA

The present thesis deals with the mega-and microfossils from Nidpur, Gopad valley, Sidhi district, Madhya Pradesh, India. The

fossils are preserved in carbonaceous shales and are preserved in the form of incrustation.

The thesis has been divided into four parts. The first part deals with the introduction, geology of the area, material and methods. In the introductory chapter a brief summary of the geological and palaeobotanical work, so far, done in India has been given. The description of the geology of the Nidpur fossiliferous locality, material and methods is based mainly on own observations.

In the second part the megafossils have been described. They have been classified as follows :—

1. Glossopteridales
2. Corystospermales
3. *Plantae incertae sedis*

The Glossopteridales is represented by six species of *Glossopteris* Sternberg and one species of *Rhabdotaenia* Pant. Out of the species of *Glossopteris*, three are new and are based on cuticular characters. They are *G. nidpurensis*, *G. senii* and *G. papillosa*. The remaining three are based mainly on external characters and their details are not known so well. They are here described as *G.* sp. A, *G* sp. B and *G.* sp. C. Among these the cuticle of *G.* sp. A, is fairly well preserved but the specimen is very incomplete.

The specimen of *Rhabdotaenia* described here are very fragmentary. But some of them have yielded good cuticular preparations. Based on the cuticular structure, these specimens have been described as *Rhabdotaenia* sp.

The Corystospermales includes two genera viz. *Lepidopteris* Schimper and *Dicroidium* Gothan. The former genus has only one species (*L. indica* sp. nov.) while the latter has four species *D. nidpurensis* sp. nov. ; *D. papillosum* sp. nov. , *D. gopadensis* and D. sp. The new species of *Lepidopteris* is based on a single specimen. The species of *Dicroidium* have been instituted after studying the cuticular structure of more than four hundred specimens.

Uuder *Plantae incertae sedis* the following genera have been recorded.

1. *Taeniopteris glandulata* sp. nov. — ? Cycadales
2. *Noeggcrathiopsis* sp. — ? Cordaitales
3. *Conites* sp. — ? Coniferales
4. *Glottolepis rugosa* gen. et. sp. nov. — unknown affinity

Besides the above four genera a few fragmentary specimens have been described as "fragmentary conifer shoots" on cuticular features.

A large number of specimens of *T glandulata* have been collected but unfortunately in none of them the cuticle is well preserved. They have "gland-like bodies" between secondary veins. Specimens of *Noeggerathiopsis* are very fragmentary and have not yielded any cuticle at all. *Conites* sp. is an unusually large cone. *Glottolepis rugosa* gen.et sp. nov. is based on a large number of detached scale-leaves. They are very thick tongue-shaped and have rugose surface.

The third part describes the dispersed spores and pollen grains. They have been referred to 22 genera and 40 species. Out of these, 4 genera (*Nidipollenites, Satsangisaccites, Weylandites* and *Praecolpatites*) and 18 species are new. The mioflora is constituted by two spore genera and 20 pollen genera. Amongst the latter, non-striated saccates are dominant,

In the fourth part the mega-and microfloral assemblages from Nidpur have beed compared with the various assemblages of Triassic age from both southern as well as nothern hemispheres.

On the evidence of mega-and microfossils, the fossiliferous beds at Nidpur are supposed to be of Lower Triassic age and are considered slightly younger in age than the Panchet Stage. The most characteristic feature of the Nidpur flora is the overwhelming dominance of the genus *Dicroidium*.

Stratigraphical and pollen analytical studies of the Interglacical deposits of Nichahom and the adjacent areas in the Kashmir Valley

R. D. Robert

Part I of the Thesis deals with the two of the fundamental problems in Quaternary Palynology; one, the studies of pollen content of moss cushions, surface and sub-surface samples in relation to the composition of the forest; two, the correlation of pollen content with megafossils in the plant bearing lower Karewa sediments. It has been found that high concentrations of pine pollen, insect pollination of several species and the biotic pressure on ground vegetation obtained in the Kashmir Valley vitiate modern pollen spectra through over-and under-representation of pollen grains and the composition of the forest communities is not adequately reflected by them. AP/NAP ratio can hardly be used as a measure for the correct position of forest cover. The differential pollen production, the direction and velocity of upthermic winds, and diseases strongly affect the production and dissemination of pollen grains. The subfossil pollen content shows considerable difference from the composition of forest inferred from leaf impressions chiefly because of local and regional representations of either of the two botanical evidences. It has been suggested that both the pollen content and leaf impressions should be considered together for the reconstruction of past vegetation. A reinvestigation of the megafossils has revealed that the leaf impressions referred to *Odina, Woodfordia, Mallotus* and *Ulmus* are identifiable with leaves of *Holoptelea,Salix, Celtis and Corylus* respectively.

Part II deals with the stratigrapy and pollen analyses of the sediments. The stratigraphical data have largely been borrowed from the Geological Survey of India. The recent discovery by the author of thick deposit of cemented conglomerate and sand overlying the lower lignite towards southeast of the Nichahom plateau has made possible the correlation of Nichahom lignitic deposits with similar deposits at Laredura and the other sites. The lignite in this region has been found to have originated from sedgepeat in situ.

Owing to the meagre data, the palynological correlation of lignitic deposits has not been possible as desired. The pollen stratigrapy at

Nichahom reveals fluctuations in conifer mixed broad-leaved temperate forests with relatively changing proportion of the broad-leaved forest comprised by oaks and *Corylus*. The working Hypothesis of three-fold vegetational sequence has also been critically examined, and the candidate does not regard this division as established. The sequence is referred to I interglacial.

The work has further revealed that quite a few species of eastern Himalaya flourished in the Kashmir Valley during the I Interglacial. Their absence today from the Kashmir Valley must have resulted from the climatic and physiographical changes since the deposition of the Lower Karewas. *Rhus* and *Corylus* were fairly abundant in the Vegetation of the I Interglacial but are infrequent today in the Kashmir Valley and hence the composition of the Interglacial forests was much different from that of comparable forests obtained in the state today.

V FIELD WORK

Karanpura Coalfied

Two members each of the Palaeozoic and Coal departments visited the South Karanpura coalfield under Barakar project scheme. A complete succession was covered in this area for megafossils, microfossils and sedimentary petrological sampling. Outcrops were collected in sequence from traverse in Marmara Nala and Nakkari Nala. The coal samples and megafossils were collected from ten different seams for detail sampling.

A systematic and sequential collection of coal and associated shales, sandstones etc., from measured sections in South Karanpura Coalfield was undertaken in collaboration with N. C. D. C. Samples were collected from Argada Sector, Gidi Sector (A. B. C.) Urimari Block, Marmara Nala and Nakkari Nala. 209 samples for palynological investigation were collected from the coalfield.

Vindhyans and Mahanadi Valley

Collected several samples of Vindhyan formations at and around Mahiar in Madhya Pradesh. A large collection of *Glossopteris, Sphenopteris, Schizoneura Raniganjia* and several *Glossopteris* scale leaves were

collected from a thick bed of hard, compact, buff colour clayey shales exposed in a road cutting and Hinjrida Ghati near Handappa in the Dhenkanal district of Orissa.

Raniganj Coalfield

Several good specimens of *Sphenopteris*, *Alethopteris*, *Sphenophyllum*, *Phyllotheca* and a rarely known genus *Stellotheca* were collected.

Panchet of Raniganj & Deobar

Near "Neel" factory species of *Schizoneura*, *Glossopteris* and *Samaropsis* were collected. Besides these a large number of samples were also collected for microfloral study.

Fragmentary specimens of *Schizoneura*, *Glossopteris*, *Noeggerathiopsis* and *Dicroidium* were collected from Deobar area in the Auranga river.

Upper Jurassic of Rajmahal

Collections were made from Amarjola, Chilgojuri, Nipania, Khatangi hill, Kolajora, Kasamau, Sitalpur, Danowara, Pathargama, Sakrigalighat, Bindaban, Mandro, Basgo Bedo and Onthea.

From Pathargama a rich cellection of *Thinnfeldia*-like leaves, along with some fructifications, were made. From Basgo Bedo a very rich collection of *Dictyozamites* was made.

Assam

A systematic and sequential collection of coal and associated shales was made from deep as well as strip mines in Namdang, Baragolai, Ledo and Tipang areas of Upper Assam. About 190 samples have been collected from measured sections and useful geological d ıte about them collected and verified.

Two members of the Oil department visited Assam. The main object of the visit was to have discussions with the Chief Geologist, Oil India Limited, Duliajan, on matters of mutual interest. This visit was also utilized for the selection of palynological oriented surface and subsurface samples from Oil India's collections.

Digboi oilfield was also visited for the collection of surface samples from Girujan Clay Stage. On way back collections were made from the Jowai—Badarpur Road Section. This section exposes rocks ranging from Sylhet Limestone Stage (Middle Eocene) to Boka-Bil Stage (Miocene). Other sections visited were (1) Pynursla-Thanjinag-Punktung Section (2) Cherra-Shella road Section; (3) Therriaghat river Section. All the above three sections were visited for the Cretaceous-Eocene boundary problem.

A party from the Tertiary department and Herbarium went to Assam to collect the Palynological samples from the collieries near Margherita. During this tour they also collected leaf-impressions from the Oligocene of Tikak-parvat Stage, and fossil woods from the Namsang beds near Deomali. Modern plants were also collected from near Deomali for comparative studies

Madhya Pradesh

The N.C.D.C. offered us a full core from a deep boring in Korba Coalfield for palynological investigation. 145 samples were collected from various litho units including those of thin coalseams extending from the Barakar Stage down to the Talchir Boulder Bed. Besides these the C.F.R.I. made 8 overall samples from the coalseams of the same bore core, available to us.

North Western India

In January 1970 two members of the Department of Mesozoic Palaeobotany, two of Tertiary Palaeobotany and one of the Department of Oil Palynology went on a joint excursion to the important Mesozoic and Tertiary sedimentary exposures of Gujarat. Saurashtra and Kutch. The main purpose of this excursion was to make extensive fossil collection from the known localities of this region and to explore as many new fossil localities as possible. Another object was to collect surface samples from well exposed measured sections and road traverses for palynological investigation.

On way to Gujarat, the party collected leaf-impressions from a tufaceous rock which was supposed to be Pliocene in age, but on examination was found to be Recent. A rich collection of Lower Creta-

ceous plant fossils was made from a sandstone member near Himatnagar, a well known Mesozoic locality. Several outcrop samples were collected from Miocene beds exposed near Bhavnagar, Verawal and Bhatia. Near Dwarka there are a number of exposed section of the Dwarka beds. Samples for palynological study were collected from two of the best exposures.

A rich Mesozoic fossil collection was made from the area around Than. A number of megafossils, previously not known from this locality, were collected during the detailed survey of this area.

In Kutch Tertiary fossil woods were collected from a locality a few km. east of Bhuj, and another about 50 km. west of Bhuj. Extensive collections of Mesozoic plants were made from localities near Dasalpur. Palynological samples were collected from a number of sections exposed along Lodai and Lakhpat roads, which covered almost all the Mesozoic and Tertiary sedimentary deposits of Kutch.

Gajarat and Rajasthan

Visited Than and adjacent localities in Gujarat where drilling operations through the Laki rediments were in progress. The object of the visit was to collect core samples from 12 bore-holes that were drilled by the Directorate of Geology and Mining, Government of Gujarat. Collected surface sample from the Mesozoic and Lower Tertiary sediments for palynological study from Barmer, Kalyatji, Rampur and Jaisalmer in Rajasthan. More than 200 samples from 5 mesaured sections were collected.

Bombay and Cuttack

The field work was carried out at Bombay in collaboration with the Tata Institute of Fundamental Research to collect data for investigations under the collaborative research project between the department of Quaternary Palaeobotany and department of Geophysics of Tata Institute.

Studies of river terraces and stone tools along the Vaitarna and Dehisar Rivers were carried out. Evidences of two terraces and a few flakes were obtained. Besides the studies of mangrove vegetation,

extensive borings and diggings were carried out at Manori Island, Aksa, Borivilli, Erangal, Bassein-Naigaon and Madh-Bandholi areas and samples collected for pollen analysis and radio-carbon dating.

At Cuttack spikelets of wild rices were collected from the Central Rice Research Institute as well as these and marsh samples were collected from the swamps bearing wild rices for investigation.

Himachal Pradesh

Pollen analytical materials and samples for radiacarbon dating were collected from Khajiar and Rewalsar. Stratigraphy of these swamps was also carried out.

Rajasthan, Haryana & Punjab

A large number of surface samples were collected from these States for pollen analysis and comparison with the present day plant communities.

VI. TRAINING PROVIDED TO OUTSIDERS

Training was provided in techniques and research to the following persons :

Mr. A. A. Moiz, Lecturer in Geology, Osmania University. Coals of Godavari Valley. (For Ph. D. thesis).

Mr. Ram Chandra, Research Scholar, Geology Department Banaras Hindu University. Coals of Wardha Valley (For Ph. D. thesis).

Mr. M. Z. Patel, Research Scholar, Institute of Sciences, Nagpur. Techniques and consultation of literature.

VII. TECHNICAL ASSISTANCE TO OUTSIDERS

Age determination of samples $K_1 - K_{20}$ from Congo.	Director Musee' Royal De l' Centrale, Tervuren, Belgium.
Age determination of samples KA_1 and LA_1 from Assam.	Director, Geological Survey of India, Assam Circle, Shillong.

40 thin sections of hard rock samples.	Department of Geology, Delhi University.
For pollen analysis, Archaeological samples from Malwan.	Professor Allchin, Cambridge.
Samples for identification.	Professor Gaur, Department of Archaeology, Aligarh Muslim University.
Samples for identification.	Prof. S. B. Deo, Department of Archaeology, Nagpur University.
For pollen analysis, samples from Mangalore.	Dr. Nicholson.
For pollen analysis. samples from Kutch and Nal lakes.	Mr. S. K. Gupta, Tata Institute of Fundamental Research, Bombay.
For identification of charcoal samples from various archaeological sites.	Tata Institute of Fundamental Research, Bombay.
Advice on specific identification by pollen. 4 samples of polliniferous material of *Solanum* spp. from field and herbarium.	Mr. M. K. Vaid, Forest Research Institute Dehradun.
For identification and C 14 dating. A sample of living wood believed to be 5000 years old.	Forest Research Institute, Dehra Dun.

VIII. SPONSORED/COLLABORATIVE RESEARCH

The following research projects have been undertaken by the Department of Coal Palaeobotany with different universities and institions.

1. Palyno-petro-stratigraphical studies of the Lower Gondwana coals and associated deposits with Coal Division of the Geological Survey of India (in collaboration with the Palaeozoic department).

2. Palynology and study of physical constituents of coals with the Central Fuel Research Institute, Jealgora.

3. Palyno-petrology of Wardha Valley coals with Geology Department, Banaras Hindu University.

4. Palynology of Godavari Valley coals with Geology department, Osmania University.

5. Palyno-petrology of Kutch lignites with State Geological Survey of Gujrat.

6. Palyno-petro-stratigraphical studies of Neyveli lignite deposits with Neyveli Lignite Corporation of India.

7. Palaeo-ecology and pollen-spore floras of Upper-Cretaceous (Mancos) coal beds of Utah, U.S.A.with Geology department of Michigan State Univcrsity, U.S.A.

The following research projects have been undertaken by the department of Quaternary Palaeobotany with universities and institutions :

8. History of post glacial vegetation and climate of Rajasthan desert with Centre for Climatic Research, University of Wisconsin, U.S.A. (The scheme ended on 28.2.70).

9. Vegetational history and environmental archaeology of Marwe-Madh in Bombay and Kutch with Tata Institute of Fundamental Research

10. Pollen allergy with Departments of Pharmacology and Tuberculosis of the King George Medical College, Lucknow.

The following research project has been undertaken by the department of Oil Palynology :

11. Palyno-stratigraphical studies of sub-surface and surface samples from Makum-Namdang-Ledo-Jaipur anticlive-Lahorkatiya and Dwarmam areas for age determination, correlation, environmental and Oil migration problems for Oil India Ltd., Duliajan, Assam.

IX. PAPERS AND LECTURES AT SYMPOSIA/CONFERENCES/ MEETINGS ETC.

Papers

Glossopterid fructifications from the Lower Gondwanas of India.	Dr. K. R. Surange	22nd Scientific Meeting Palaeobotanical Society.
Tertiary flora of India and their bearing on the historical geology of the region.	Dr. R. N. Lakhanpal	XI International Botanical Congress Symposium on the Interfaces between Botany & Geology at Seattle, U.S.A.
The elaters in the Anthocerotales.	Dr. D. C. Bharadwaj	Seminar on Morphology Anatomy and Embryology of Land Plants at Delhi University.
The Cycado Ginkgopsid pollen grains.	,,	,,
Palyno-stratigraphy of Lower Gondwana sequence in India.	Dr. D. C. Bharadwaj	Symposium on Gondwana, Geology Department, Aligarh Muslim University.
Weltrichia santalensis and other bennettitalean male fructifications from India.	Dr. M. N. Bose and Dr. R. V. Sitholey	22nd Scientific Meeting Palaeobotanical Society.
Ancient food economy in India with remarks on the Aryan hypothesis.	Dr. Vishnu-Mittre	III International Conference on Asian Archaeology, Colombo, Ceylon.

Botanical material and methods in archaelogy.	Dr. Vishnu-Mittre	IIII International Conference on Asian Archaeology Colombo, Ceylon.
Environmental background to the Neolithic-Chalcolithic complex in N.W. India.	Dr. Vishnu-Mittre	II International Conference on Asian Archaeology.
Palaeobotanical evidence for the history of cultivated plants of India.	Dr. Vishnu-Mittre	Symposium on Crop Plant Evolution, Indian Society of Genetics, I.A.R.I. Delhi.
Palynological interpretation of palaeo-environments.	Dr. S. C. D. Sah & Dr. R. K. Kar	22nd Scientific Meeting, Palaeobotanical Society.
Cretaceous microplanktons from Therriaghat, Shillong Plateau.	Dr. S. C. D. Sah, Dr. R.K. Kar & Dr. R. Y. Singh	22nd Scientific Meeting, Palaeobotanical Society.
Devonian miospores from Czechoslovakia.	Dr. K. M. Lele	22nd Scientific Meeting, Palaeobotanical Society.
Wood anatomy of Ginkgoales.	Dr. Uttam Prakash	Seminar on Morphology. Anatomy and Embryology of Land Plants at Delhi University.
Wood anatomy of Indian Terminalias.	Dr. Uttam Prakash jointly with J. C. Srivastava.	Seminar on Morphology, Anatomy and Embryology of Land Plants at Delhi University.
Degradation of woody tissue and its relation to origin of coal.	Dr. G. K. B. Navale	22nd Scientific Meeting, Palaeobotanical Society.

Palynology of the Jabalpur Series.	Dr. H. P. Singh	22nd Scientific Meeting, Palaeobotanical Society.
Origin of floating islands in the lakes of Khajiar and Rewalsar in Himachal Pradesh.	Dr. G. Singh and C. Sharma	22nd Scientific Meeting, Palaeobotanical Society.
Noeggerathiopsis a Glossopterid or Cordaitalean form ?	Dr. P. K. Maithy	22nd Scientific Meeting, Palaeobotanical Society.
Palynological interpretations of palaeoenvironments with reference to India.	Dr. R. K. Kar	Seminar at the Centre of Advance Study in Geology, Punjab University, Chandigarh.
Pollen analysis of Upper Pleistocene samples from Tochlai, Assam.	Dr. H. P. Gupta	22nd Scientific Meeting, Palaeobotanical Society.
A new species of *Barakaroxylon.*	Dr. S. Kulkarni	22nd Scientific Meeting, Palaeobotanical Society.
Acritaelis from Umaria Marine beds.	Mr. Anil Chandra	22nd Scientific Meeting, Palaeobotanical Society.
Palynology of *Holoptelea.*	Miss Asha Khandelwal	22nd Scientific Meeting, Palaeobotanical Society.

Lectures

Tertiary floras of India.	Dr. R. N. Lakhanpal	Botany Department, Lucknow University.
Lower Gondwana Flora.	Dr. D. C. Bharadwaj	Botany Department, Lucknow University.

Fossil floras of the Upper Gondwana of India with special reference to the Rajmahal hills.	Dr. M. N. Bose	Botany Department, Lucknow, University.
History of cultivated Plants,	Dr. Vishnu-Mittre	Botany Department, Lucknow University.
Plant fossils, kinds preservation and methods of study and dating.	Dr. Vishnu-Mittre	Botany Department, Gauhati University, Gauhati, Assam.
Origin of life and early land plants.	,,	,,
Pro-gymnosperm and Pteridosperms.	,,	,,
Origin and evolutionary history of Cycadophytes.	,,	,,
Origin and evolutionary history of Angiosperms.	,,	,,
Origin and evolutionary history of Conifers.	,,	,,
Palynology.	,,	,,
Ecological and philosophical consideration.	,,	,,
Introduction to Palaeobotany.	Dr. S. C. D. Sah	Geology Department, Delhi University, Delhi.
Important Palaeozoic, Mesozoic and Tertiary fossils.	,,	,,
Important fossil flora of India.	,,	,,

Plant evolution, palaeo-environments and palaeo-geography.	Dr. S. C. D. Sah	Geology Deport. ment, Delhi Univer-sity, Delhi
Palaeobotany as an aid to economic geology.	,,	,,
Introduction to Palaeo-botany.	,,	Department of Geol. and Centre of Ad-vance study in Geo-logy, Punjab Univer-sity, Chandigarh.
Stratigraphy and impor-tant fossil floras of India.	,,	,,
Plant evolution, migra-tion and distribution.	,,	,,
Plants as indications of environments.	,,	,,
Relationship of palaeo-botany to stratigraphy.	,,	,,
Palynology—a new tool in oil exploration.	,,	,,
Role of Palynology In Oil exploration.	,,	Oil India Ltd., Duliajan, Assam.
Plant evolution, palaeo-geography and palaeo-environment.	,,	,,
Palynology as a tool for Economic Geology.	,,	Geology Depart-ment Gauhati University, Gauhati.

Following lectures were delivered at the Birbal Sahni Institute of Palaeobotany by Professor O.A. Hǿeg, Emeritus Professor University of Oslo, Norway.

(a) The Arctic World—its past and present—17th Sir Albert Charles Seward Memorial Lecture.

(b) The Psilophytales—before and after 1960—Part I.

(c) The Psilophytales—before and after 1960—Part II.

(d) The Norwegian flora - facts and problems.

X. DEPUTATION/TRAINING/STUDY ABROAD

Dr. K. R. Surange	*Moscow and Leningrad, U.S.S.R.* to see palaeobotanical work being carried out in Universities and Institution of U.S.S.R., under Indo-Soviet Cultural Exchange Programme (28.3.70-14.5.70).
Dr. R. N. Lakhanpal	*Seatlle, U.S.A.* to attend the XI International Botanical Congress and take part in a symposium "Interfaces between Botany and Geology". (24.8.69-2.9.70).
Dr. Vishnu-Mittre	*Colombo, Ceylon* to attend II International Conference on Asian Archaeology (21.8.69-27.8.69).
Dr. Sukh Dev	*Moscow, Leningrad and Taskhant US.S.R.,* to study Mesozoic floras of Russia, under Indo-Soviet Cultural Exchange programme. (28.3.70-21.6.70).
Dr. N. Awasthi	*Moscow and Leningard, U.S.S.R.*, to study Tertiary floras of Russia, under Indo-Soviet Culture Exchange Programme (28.3.70-14-6.70).

Dr. H. K. Maheshwari	*Columbus, U.S.A.* at Coal Geology Laboratory, U.S. Geological Survey, Ohio State University/United Nations Development Programme/ Palaeozoic Palaeobotany.
Dr. K. P. Jain	*Paris, France* at Laboratoire de Micropalaeontologie/French Government Scholarship/Advance study in microplanktons in oil exploration.

XI. HONOURS & AWARDS

Dr. K. R. Surange	Fellow of the National Institute of of Sciences of India.
Dr. M. N. Bose	Correspondant (Foreign Member) de la Classe des Sciences naturelles de l' Academic royale des Sciences d' Outre-Mer (Belgium).
Mr. M. L. Kasat	Ph. D., Lucknow University, "Contribution to the Upper Jurassic and Lower Cretaceous Floras India".
Mr. Shyam Chandra Srivastava	Ph. D., Lucknow University, "Contributions to the Indian Mesozoic Palaeobotany.
Mrs. R. Robert	Ph. D., Lucknow University "Stratigraphical and pollen analytical studies of the Interglacial deposits of Nichahom and the adjacent areas in the Kashmir Valley".

XII. FOUNDERS DAY

As usual the Founders Day was celebrated on 14th November 1969, the birth-day of Professor Birbal Sahni, F.R.S., the Founder of the Institute.

In the morning wreaths and flowers were placed on the Samadhi of Professor Birbal Shani

At the evening's function Prof. M. B. Lal, Vice-Chancellor, Lucknow University was the Chief Guest. Professor T. S. Sadasivan Chairman, Birbal Sahni Institute of Palaeobotany welcomed Professor M. B. Lal, Professor Hφeg and other guests. After the learned address of the Chief Guest, Professor O. A. Hφeg, Emeritus Professor, University of Oslo, Norway delivered the XVII Sir Albert Charles Seward Memorial Lecture on "The Arctic World—its past and present". Dr. K. R. Surange, Director, Birbal Sahni Institute of Palaeobotany proposed the vote of thanks to the Chief Guest, Professor O. A. Hφeg and other guests.

XIII. REPESENTATION ON COMMITTEES/BOARDS

Dr. K. R. Surange	Member, Executive Committee, World Organization of Palaeobotany.
	Member, International Committee for Palaeobotanical Nomenculure.
	Secretary, Editorial Board "The Palaeobotanist.
	Member, Executive Council, The Palaeobotanical Society.
Dr. R. N. Lakhanpal	Chief Editor, Palaeobotanical Society.
	Member, Executive Council, The, Palaeobotanical Society.

	Member, Editorial Board, Palaeobotanical Society.
Dr. D. C. Bharadwaj	Member, International Commitee on Palynology.
	Secretary, Sub-commission on spores, International Commission on Palaeozoic Microfloras.
	Convener for Permian Stratigraphy in the International Commission on Palaeozoic Microfloras.
	Member, International Sub-commission on Carboniferous stratigraphy of I.U.G.S.
	Secretary, Palaeobotanical Society.
	Member, Editorial Boards, of "Review of Palaeobotany and Palynology", "The Palaeobotanist".
Dr. M. N. Bose	Vice-President, J. Sen Memorial Committee.
	Member, Editorial Board "The Palaeobotanist".
	Member, Executive Council, the Palaeontological Society of India.
	Member, Executive Council, The Palaeobotanical Society.
Dr. Vishnu-Mittre	Member, Indian Radio-carbon Dating Committee, Tata Fundamental Research Institute. Bombay.

	Member, Executive Council, Indian Archaeological Society.
	Member, Executive Council, Quaternary Research Society of India.
	Member, Executive Council, The Palaeobotanical Society.
Dr. S. C. D. Sah	Joint-Secretary, The Palaeobotanical Society.
Dr. G. K. B. Navale	Member, International Committee on Coal Petrology.
	Member, International Coal Nomenclatural Commission.
	Member, International Lignite Nomenclatural Commission.
	Member, International Liginite and Coal Analysis Commission.
	Member, National Committee of Coal Petrology.

XIV. PUBLICATIONS

1. The Journal - **The Palaeobotanist.**

During the year following Numbers of The Palaeobotanist were published.

(a) Numbers 1,2 and 3 of the Volume 17.

(b) Number 1 of Volume 18.

(c) Numbers 2 and 3 of Volume 18 were sent to the press.

Seward Memorial Lecture.

XVI Sir Albert Charles Seward Memorial Lecture on "Role of Palaeobotany in Indian Geology" delivered by Mr. G. C. Chatterjee, Retired Director-General of the Geological Survey of India was printed.

Sale

During 1969-70, an income of Rs. 35,000/- was registered from the sale proceeds of the Institute's publications. This sum includes the following foreign exchange earned through the sale of the publications :

US $	2,645.00
DM	407.88
£	78.06

XV. LIBRARY

Books

Number of Books added during the year.	96
Total number of books as on 31.3.70	2,346

Journals

Number of issues of Journals received during the year	372
Total number of issues of Journals as on 31.3.70	2,790
New Journals subscribed	4

Reprints

Number of reprints recieved during the year	918
Total number of reprints as on 31.3.1970	18,085

Microfilms

Total number of micro-films as on 31.3.1970	153

Exchange

Number of papers purchased for exchange	56
Total number of reprints sent out on exchange	7,434
Number of individuals on exchange	198
Number of Institutions on exchange	52

11 complete sets af reprints of Professor B. Sahni were sent to institutions.

Request for exchange received from the following :

(i) Chef du Department Documentation, Bureau de Recherches Geologique et Miners, Orleans, France.

(li) Instituto de Geologia Applicada, Oviedo, Spain.

(iii) Texas Research Foundation, Texas.

(iv) Library, Institute of Geology, University Strassbourg, France in exchange with their publication "Bull. de service de. la Carte Geol de Alsace et de Lorraine".

(v) Geographical Institute of Bonn University, Germany.

(vi) Natural History Museum Bagdad, Iraq.

A number of research students and scientists from various universities and Institutions, who visited the Institute took opportunity to consult the latest literature in the Library. Books and Journals were loaned to Geological Survey of India, Northern Circle, Botany Departments of Lucknow, Calcutta, Kalyani, Panjab universities and National Botanical Gardens, Lucknow.

New arrivals were displayed in the library on every Monday.

XVI. MUSEUM

Exhibition halls

Total number of specimens displayed in the halls 845

Twenty battery operated hand magnifiers (7 x) were provided for some specimens.

New lables were introduced for many specimens. The lighting arrangements of the geological map in relief were set right.

Fossil store-room

Catalogued specimens as on 31.3.70	34,024
Specimens from foriegn countries as on 31.3.70	544

Number of type and figured specimens as on 31.3.70	902
Number of figured slides as on 31.3.70	4,027
Number of negatives as on 31 3.70	2,878

New additions made during the year. A total number of 1,260 localities have been traversed by the staff.

Palaeozoic specimens	870
Mesozoic specimens	2,123
Tertiary specimens	1,251
Coal samples	971
Oil samples	889
Quaternary samples	328

Thirty six flourescent tubes were fitted in basement store room.
Specimens were presented to the following institutions :

(i) Kalyani University, Kalyani.

(ii) University College of Scier ce Calcutta University, Calcutta.

(iii) Department of Geophysics and Geology, University of Roorkee.

(iv) Director, Geology & Mining, Shillong.

(v) Department of Botany, University of Delhi.

(vi) Department of Botany, University of Burdwan.

XVII. HERBARIUM

Woods

New wood samples added during the year.	364
Total number of wood samples as on 31.3.70	2,187
Total number of wood slides other slides	1,499
Other slide	4,632

Fruits and seeds

New fruit and seed samples added during the year	72
Total number of fruits and seeds as on 31.3.70	618

Herbarium specimens

New herbarium specimens added during the year	—
Total number of herbarium specimens as on 31.3.70	4.557

Pollen slides

New pollen slides added during the year	34
Total number of pollen slides as on 31.3.70	7,540

Exchange

Woods specimens received from

Dr. W.R. Muller-Stoll G.D.R.	4
The Director, Musee' Royal de l' Afrique Centrale	21
The Director, Service Florestal, Sao Paulo, Brazil	30
The Director, Instituto Florestal, Madrid	26

Wood specimens sent to

The Director, Musee' Royal de l' Afrique Centrale, Belgium	77

Wood slides sent

The Forest Research Institute, Dehra Dun	17

General

Herbarium sheets which required poisoning or change were poisoned and replaced. A party collected 205 plant specimens and 5 fruit and seed specimens. Fruits, seed, cones and other plant material which were collected by the staff were received in the herbarium. Correspondence was initiated regarding exchange of fruits and seed with institutions in foreign countries.

XVIII. BUILDING

During the year following constructions were undertaken :

Kitchen for the Visiting Scientists rooms.

Glazing of the veranda on the east side of the administrative building for providing space to the staff.

Construction of a water channel from the tube well.

Distempering of the main hall, Library, Museum and some laboratories was also carried out.

XIX. VISITORS

Distinguished persons

Dr. K. Nakazawam, Kyoto University, Japan.	12.8.1969
Dr. Y. Nogauni, Kyoto University, Japan	17.8.1969
Mr. K. N. Mehta, Oil India Ltd.	13.10.1969
Dr. John C. Brown Issoa Plant Industry Station, Beltsvilla Md.	3.11.1969
Professor and Mrs. Ove Arbo Hǿeg, Oslo Norway	13.11.1969
Dr. N. Mahdi, Director, National History Museum, Baghdad, Iraq	24.2.1969

Educational and other Institutions

Students and teachers of the following institution visited the Museum and the Institute :

Department of Botany, University of Delhi.

Department of Botany, Karnatak University.

Department of Museology, University of Calcutta.

Department of Botany, Ranchi University.

Department of Botany, Arya Vidyapith, Gauhati.

Department of Botany, University of Jodhpur

College of Science, Raipur.

Physics Department, I.I.T., Kanpur.

XX. THE GOVERNING BODY AND THE FINANCE COMMITTEE

The Governing Body

Chairman

Professor T. S. Sadasivan,
Director,
Centre for Advanced Studies in Mycology &
Plant Pathology, University Botany Laboratory,
Madras-5

Members

Mrs. Savitri Sahni,
686, Birbal Sahni Marg,
Lucknow (For her life time).

Dr. R. V. Sitholey,
Assistant Director,
National Botanic Gardens,
Lucknow

Professor S. C. Agarwala,
Head of the Botany Department,
Lucknow University,
Lucknow.

Dr. S. K. Mukherjee,
Director,
Botanical Survey of India,
Calcutta-13

Professor A. G. Jhingran,
Head of the Geology Department,
Delhi University,
Delhi-7.

Mr. M. S. Balasundram,
Director General,
Geological Survey of India,
Calcutta-13

Professor D. D. Pant,
Head of the Botany Department,
Allahabad University
Allahabad

Mr. L. S. Chandrakant,
Joint Educational Adviser to the
Government of India,
Ministry of Education and Youth Services,
New Delhi

Professor A. R. Rao,
No. 2, XI Main Road, IIIrd Block,
East Jayanagar,
Bangalore-11

Professor Sripadrao Kilpady
1-2-8/8, Street No. 1, Himayat Nagar P.O.,
Hyderabad-29

Professor K. R. Surange,
Director,
Birbal Sahni Institute of Palaeobotany,
Lucknow (Member-Secretary)

Mr. R. K. Khare,
Registrar.
Birbal Sahni Institute of Palaeobotany,
Lucknow (Non-Member Assistant Secretary)

Finance Committee

Chairman

Professor T. S. Sadasivan,
Director,
Centre for Advanced Studies in Mycology
& Plant Pathology,
University Botany Laboratory,
Madras-5

Members

Professor S. C. Agarwala,
Head of the Botany Department,
Lucknow University,
Lucknow

Professor K. R. Surange,
Director,
Birbal Sahni Institute of Paiaeobotany,
Lucknow

XXI. THE STAFF

Director

Professor K. R. Surange, M.Sc., PhD. (Lucknow) Ph.D. (Cantab), F.N.A.Sc., F.N.I.

Department of Palaeozoic Palaeobotany

Dr. K. M. Lele, M.Sc., Ph.D.
Dr. P. K. Maithy, M.Sc., Ph.D.
Dr. H. K. Maheshwari, M.Sc., Ph.D.
Dr. Miss Shaila Kulkarni, M.Sc., Ph.D.
Mrs. Rehana Makada, M.Sc.
Mr. Anil Chandra, M.Sc.

Department of Mesozoic Palaeobotany

Dr. M. N. Bose, M. Sc., Ph. D,. Correspondant
del' Arsom, Head

Dr. Sukh Dev, M. Sc. (Hons.) Ph. D. (Lucknow), Ph. D. (Reading).
Dr. M. L. Kasat, M. Sc., Ph. D.
Dr. Shyam Chandra Srivastava, M. Sc., Ph. D.
Miss J. Banerjee, M. Sc (Research Scholar)

Department of Tertiary Palaeobotany

Dr. R. N. Lakhanpal, M.Sc., Ph.D., F.B.S., F.N.A. Sc.
Dr. U. Prakash, M.Sc., Ph.D.
Dr. N. Awasthi, M.Sc., Ph.D.
Miss S. Pant, M.Sc. (Research Scholar)

Department of Coal Palaeobotany

Dr. D. C. Bharadwaj, M. Sc. Ph. D. (Lucknow), Dr. rer. Nat. (Bonn). F. B. S. Head,

Dr. G. K. B. Navale, M. Sc. Ph. D., F. G. S , F G. M. S.

Dr. Haripall Singh M. Sc., Ph. D.

Dr. R. S. Tiwari, M. Sc. Ph. D.

Dr. Suresh Chandra Srivastava, M. Sc., Ph. D.

Mr. Anand Prakash, M. Sc.

Mr. Pramod Kumar M. Sc.

Mr. B. K. Misra, M. Sc. (Research Scholar)

Department of Quaternary Palaeobotany

Dr. Vishnu-Mittre, M. Sc., Ph. D. (Lucknow), Ph. D. (Cantab) Head,

Dr. Gurdip Singh, M. Sc. Ph. D. (Lucknow), Ph, D. (Belfast).

Dr. H. P. Gupta, M. Sc., Ph. D.

Dr. (Mrs.) R. Robert, M. Sc., Ph. D.

Mr. R. D. Joshi, M. Sc.

Mrs. Chhaya Sharma, M. Sc.

Miss Asha Khandelwal, M. Sc. (Research Scholar)

Project on History of Post-glacial Vegetation and Climate of the Rajasthan Desert (Upto 28.2.70).

Miss S. Chopra, M. Sc.

Mr. A. B. Singh, M. Sc.

Miss Sushma Pant, M. Sc.

Miss M. Choudhry, B. Sc., J. T. A.

Department of Oil Palynology

Dr. S. C. D. Sah, M. Sc., Ph. D. Head

Dr. K. P. Jain. M. Sc., Ph. D.

Dr. R. K. Kar, M. Sc., Ph. D.

Mr. R. Y. Singh, M Sc.

Administration

Mr. R. K. Khare (Registrar)

Mr. V. P. Gulati (Deputy Registrar.

Mr. S. D. Mehtani (Office Assistant)
Mr. S. K. Suri (Stenographer)
Mr. S. P. Chadha (P. A. to Director).
Mr. H. S. Srivastava) U. D. C.)
Mr. Bhagwan Singh (U. D. C.).
Mrs. P. K. Srivastava (Receptionist)
Mr. Ramesh Chandra (L. D. C.)

Accounts

Mr. Ghanshyam Singh (Accounts Officer).
Mr. S. B. Verma (Accountant)
Mr. T. N. Shukla (U. D. C)
Mr. B. K. Jain (U. D. C.)
Mr. I. J. Mehra (L. D. C.)
Mr. N. N. Joshi (L. D. C.)

Publication

Mr. N. N. Moitra (Publication Incharge)

Library

Mr. J. N. Nigam (Library Assistant)

Museum

Mr. T. S. Mohan Shanker (Museum Assistant)
Mr. N. C. Saxena (Junior Museum Assistant)

Harbarium

Mr. G. P. Srivastava (Herbarium Incharge)
Mr. J. C, Srivastava (Herbarium Assistant)
Miss Shikha Bose (Herbarium Assistant)

Laboratory Services

Mr. R. C. Gupta (Junior Technical Assistant)
Mr. N. K. Khasnavis (Laboratory Assistant)

Photography & Drawing

Mr. M. N. Takru (Artist)
Mr. B. N. Bose (Photographer)

Head	Actual Expenditure (Rupees in lakhs appx.
27.1. Plan	
(i) *Recurring*	
Pay of Establishment	0.002
D. P. of Establishment	0.001
Allowances & Honoraria	0.001
Contingencies	0.212
Total ...	0.216
(ii) *Capital*	
Apparatus & Equipment	0.641
Service Ancillary to research	0.113
Building & Grounds	0.076
Furniture & others requirements	0.080
Total ..	0.910
Grand Total ...	1.126
27.2. Non-plan	
Recurring	
Pay of Officers	1.942
D. P. of Officers	0.046
Pay of Establishment	1.461
D. P. of Establishment	0.161
Allowances & Honoraria	1.348
Provident Fund Contribution	0.343
Contingencies	1.138
Maintenance	0.054
Chemical and apparatus	0.109
Total ...	6.607