# A GENERAL SURVEY OF THE FOSSIL FLORA OF MADHYA PRADESH—A REVIEW*

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ABSTRACT

In the remote past, when our planet, the earth, was young, the conditions prevailing on its surface were quite different than what those are to-day. Under these unfavourable conditions life appeared abiogenetically first, most probably, in water then on land. Plant fossils, both megafossil as well as microfossil assemblages, discovered from the localities situated in Madhya Pradesh only are mentioned here. A brief description of the mega-plant fossils is given under the following heads :

(1) Flora of the Pre-Gondwana period (from the Precambrian to the Lower Carboniferous). The flora mostly consisted of chemical plant fossils—*Fermoria*, *Stromatolites* and some alga of Desycladaceae.

(2) Flora of the Gondwana period (Upper Carboniferous to Lower Cretaceous).

(*a*) *Glossopteris flora*—Main plants of the flora are *Gangamopteris*, *Glossopteris* (Pteridosperms), *Noeggerathiopsis* (Cordaitales), *Schizoneura*, *Phyllotheca* (Pteridophytes).

(*b*) *Dicroidium flora*—consisted of *Dicroidium*, *Pterophyllum*, *Pecopteris*, *Taeniopteris* (mostly Pteridophytic).

(*c*) *Ptilophyllum flora*—was represented by some fern genera (Pteridophytes) and gymnosperms.

(3) Flora of the Post-Gondwana period—was quite different one from the previous floras. With the introduction of angiosperms it advanced to show the characteristics of the modern flora.

The microflora (miospore assemblage) has also been given under the following heads :—

(1) Pre-Gondwana microflora (Precambrian and Cambrian).

(2) Gondwana microflora.

(*a*) Permo-Carboniferous mioflora (Talchir to Raniganj Stage).

(*b*) Triassic mioflora.

(*c*) Jurassic and Lower Cretaceous mioflora.

(3) Post-Gondwana mioflora (Upper Cretaceous and Eocene) Intertrappean.

## INTRODUCTION

Before recording a complete range of fossil flora of Madhya Pradesh, it seems necessary to give a brief account of the birth and history of this part of land through geological times. This will help to understand the evolution of plants through the ages.

The present state of Madhya Pradesh is a part of the Deccan plateau of Indian peninsula. The eastern and southern portion of the peninsula is one of the most ancient land surfaces of the earth. Some of its parts are believed to belong to the primeval crust of our planet, as it first cooled and condensed from a gaseous or liquid mass.

When the earth was young and devoid of life on its surface, great physiographic changes took place. From time to time, molten rocks in the form of lava, volcanic ashes and gases burst through the crust from the interior and gave rise to the primitive landscape. Molten lava flow solidified in thick hard sheets. At places molten rocks solidified in the cracks forming solid walls across the older rocks. The early convulsions of the earth, while she was young, are recorded in the complex folds into which these archaic rocks have

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been thrown. Over large areas the original rocks have been fractured, badly crushed or altered by gigantic earth movements. The action of wind, water and warmth during the period of quiescence brought out vast changes on the earth surface giving rise to rivers, lakes and hillocks. The landscape continually kept changing due to these forces of the Nature.

Long after on this primitive landscape life first originated (when and how?) in water, on which the stratified crust of the earth was laid down. With the march of time the greater part of this crust was worn away and the old surface was again laid bare. Portions of the strata still remain, protected in deep trough like hollows, in the old river basins, the Mahanadi, Godavari and Narbada, and in a number of outlying patches along the east coast from Cuttack to Trichinopoly. These deposits were laid down chiefly in lakes and rivers, and partly also in shallow seas that flooded the land from the north and east. The wealth of evidence these strata contain tells of a long succession of floras and faunas that lived during Palaeozoic era on the vast southern continent of which India once formed an integral part. For temporary incursions of the sea the Deccan plateau has remained a land area, according to our present knowledge, ever since the original crust was formed. Through the vast stretch of time Nature has carved this ancient surface into fantastic shapes.

Very different is the landscape in the central and western parts of the Deccan. This part consists of much younger rocks than the eastern and southern part of the plateau. In most parts newer rocks rest directly upon the eroded surface of the old foundations. After a long period of quiescence the volcanic energy pent up in the interior of the earth is now bursting forth in floods of lava on a scale never witnessed before. This happened most probably at the dawn of Tertiary.

This landscape is made up of long, low, flat-topped hills and spreads over a greater part of the country drained by the Narbada, Tapti and by the upper reaches of the Godavari and Krishna rivers. The same type of scenery extends into Kathiawar and Cutch, and for at least two hundred miles north of Narbada. The flat topped hills at many places present a terraced appearance. These terraces are the exposed surfaces of successive sheets of lava which were poured out at the intervals, during a period that must have extended through many thousands of years, and which on west coast were piled up to a thickness of six to ten thousand feet.

## DESCRIPTION

After this introduction a brief survey of the mega-plant fossils discovered in Madhya Pradesh is given here. The vast period of the floristic evolution on the peninsula, for the sake of convenience, is divided into three major parts :

(1) Flora of the Pre-Gondwana period,
(2) Flora of the Gondwana period,
(3) Flora of the Post-Gondwana period.

The following chart indicates the correlation with the Geological time-scale.

| | | | |
|---|---|---|---|
| Cainozoic | Quaternary | Recent, Pleistocene | |
| | Tertiary | Pliocene | Post-Gondwana 70 M.Yrs. |
| | | Miocene | |
| | | Oligocene | |
| | | Eocene | |
| | | Palaeocene | |

| | | |
|---|---|---|
| Mesozoic | Cretaceous<br>Jurassic<br>Triassic | |
| Palaeozoic | Permian<br>Upper Carboniferous | Gondwana period 205 M Yrs. |
| | Lower Carboniferous<br>Devonian<br>Silurian<br>Ordovician<br>Cambrian | |
| Proterozoic<br>Archaeozoic | Precambrian<br>1500 MYrs. | Pre-Gondwana period |

## 1. Flora of the Pre-Gondwana period

Before describing the Pre-Gondwana flora it seems better to know a little about the Earth-history of this period. The age of the earth has been estimated as about 4.5 billion years (Misra, 1974). According to Cloud (1968) the earth was devoid of atmosphere and magnetic field during its early history. Slowly, in due course, due to various changes—physical, chemical and geological, the primitive atmosphere came into existence, which was altogether different from the one around us. This primordial atmosphere consisted of hydrogen, helium, methane, ammonia, nitrogen and some other gases in minute quantities, but it was completely devoid of oxygen. In such an inhospitable atmosphere, in the early Pre-cambrians, about 3.5 billion years ago, on the surface of this, then young planet, abiogenetic evolution may have started to give rise to Prekaryotic cells which lack nucleus and divide by simple fission (Cloud & Gibor, 1970). This was followed by first oxygen generating photosynthetic cells. It helps us to understand why the primitive organisms were anaerobic forms. With the origin of primitive life, and starting of photosynthetic activities production of free oxygen began. By about 2 billion years ago, advanced oxygen mediating enzymes appeared, and at this stage of the history of the earth, oxygen was diffused into the terrestrial atmosphere, which had a secondary origin, resulting by the volcanic out-gasing from the earth's interior since ages. Later, about 1.5 billion years ago Eukaryotic cells appeared, which contain a nucleus and divide by mitosis. These cells were the precursors for the evolution of higher life forms. In due course the oxygen in the atmosphere was originally put there by plants, as a result the early plants made possible the evolution of the higher plants and animals which require free oxygen for their metabolism (Cloud & Gibor, 1970).

Pre-Gondwana rocks in the peninsular area are represented by the following systems :

| | | | |
|---|---|---|---|
| Purana Group | Vindhyan System | Bhander Series<br>Rewa Series<br>Kaimur Series<br>Semri Series | Precambrian to Ordovician |
| Archean Group | Cuddapah<br>Dharwars<br>Archaean | | |

Fossil record of the Pre-Gondwana period in the Peninsular area including Madhya Pradesh is extremely meagre. Till now no record of land plants is available from the Peninsular area, though in extra-peninsular India a few land plants such as *Rhacopteris*, *Sphenopteridium*, *Sphenopteris*, *Psilophyton?* have been recorded from Silurian and Lower Carboniferous beds.

However, organic life in its primitive form has been discovered in the Cuddapah and Vindhyan rocks (Precambrian to Ordovician) of Central India (Madhya Pradesh). Earlier, these rocks were believed to hold no life.

Some forms of plant life which have been recorded at various localities in Madhya Pradesh are described below :

1. *Chemical plant fossils*—Presence of organic carbon in chemical form is an evidence of the occurrence of primitive plant life. Such occurrences are known as chemical plant fossils.

(*a*) Organic carbon amounting to 12.28 per cent has been found in the carbonaceous shales of the Kaimur Series at Japla—1.2 billion years old, (Ghosh & Bose, 1954).

(*b*) Algal dust has been reported from Lower Vindhyans (Misra & Bhatnagar, 1950).

2. *Algae* (*Cyanophyceae*) *stromatolites*—It is proved beyond doubt that the lithotrophic and filamentous blue-green algae have been the cause of building organo-sedimentary structures that are given a class name of stromatolites. Though stromatolites have now been reported from various Precambrian localities in India, but they are not common in Madhya Pradesh.

The stromatolites have been found to occur in Vindhyan System, which covers a vast territory in Central India (Madhya Pradesh). Recently, Krishna Mohan (1968) has described laminated algal stromatolites, *Collenia* and *Conophyton*, from the Bijawars of the Jog area, Hoshangabad District, Madhya Pradesh (Misra, 1974). The possibility of finding stromatolites in some of the limestone quarry of Rewa town cannot be overlooked.

Raipur limestones of the Chhattisgarh basin also contain a number of stromatolites. Microscopic algal remains are reported from Lilgar, Bhopal (Bhander Series) by Sitholey, Srivastava and Verma (1953).

3. *Fermoria*—Carbonized horny concentric discs have been discovered in the Suket Shales at the base of the Kaimurs near Rampura in Madhya Pradesh (Jones, 1909).

4. *Algae* (*Dasycladaceae*)—Misra (1949) has identified Dasycladaceous material from limestones of Vindhyan system.

5. *Fungal spores*—too have been reported from the Precambrian and the Cambrian rocks in Madhya Pradesh.

No fossil of the higher plant group has yet been discovered in the Pre-Gondwana rocks of Madhya Pradesh, though in other parts of the world very rich flora grew, specially from the Devonian to Carboniferous till the Carboniferous glaciation covered major part of the Gondwanaland. Many plants of this flora, which escaped extinction, reappeared after the glaciation and have been recorded from various parts of the Gondwana continent. Several of these plants attained gigantic size. These tall trees with thick under vegetation were responsible for the coal deposits of that age. Plants of this period mostly belonged to pteridophytes and gymnosperms, besides small plants of the phyllum Thallophyta. Fossil record of bryophytic vegetation is very rare.

## 2. Flora of Gondwana period

Gondwana period begins after the Carboniferous glaciation, from the Upper Carboniferous and extends right up to Upper Cretaceous, for about 205 million years. Three distinct flora are recognizable during this period and all of these are well represented in Madhya Pradesh. There is no clear floral break—(*a*) *Glossopteris* flora, (*b*) *Dicroidium* flora and (*c*) *Ptilophyllum* flora.

(*a*) *Glossopteris* flora : (Palaeozoic—Permo-Carboniferous mainly, and early Triassic)–This flora appeared at the beginning of the Gondwana period in Upper Carboniferous and continued till the end of Panchet (Middle Triassic) when all the main elements of the flora disappeared completely. It was a flora of cold and temperate climate. The main plant after which the flora is named is *Glossopteris*. It is the most dominant genus of the flora. Other important elements of the flora are *Noeggerathiopsis*, *Gangamopteris*, *Vertebraria*, and *Schizoneura*. Most of the elements of this flora are well represented in Madhya Pradesh. The flora attained its maximum development during Raniganj Stage after which there was rapid decline.

*Gangamopteris* is the oldest and an important member of this flora. In its early period (Talchir Stage) it was a dominant genus of the flora. The presence of gymnospermous and pteridophytic spores in the shales immediately above the boulder beds clearly shows that plants of these groups must have been living before the ice age, though no megafossils have yet been traced. *Gangamopteris cyclopteroides* has been recorded from a section in Johilla river near the vlllage Goraia which is situated in the Johilla Coalfield in the South Rewa Gondwana basin. It has also been recorded from Umaria Coalfield, Bukbuki (Chirmiri), Soura nala, Ulsar, Bareri and west of Anukpur. Out of the nineteen known species at least four have been recorded from various localities in Madhya Pradesh.

*Glossopteris* is the most dominant genus of the flora. It has a very wide distribution both in extent and time. In all, there are sixty-one known species, out of which thirty-two have been recorded in India, and thirteen are indigenous. At least nine species are from Madhya Pradesh.

*Noeggerathiopsis* (Cordaitales) is the third important element of this flora. It also has a very wide range.

Other members of this flora recorded from various localities in Madhya Pradesh are listed below. Most of these localities are situated in South Rewa Gondwana basin, such as—Ganjra nalla, Pali-Deogawan beds, Karkati, Goraia, Singrauli Coalfield, Umaria Coalfield, etc.

Gymnosperms (Pteridospermales)—*Gangamopteris cyclopteroides*, *G. cyclopteroides* var. *attenuata*, *G.* cf. *angustifolia*, *G. major*, *Gangamopteris* sp. ; *Glossopteris indica*, *G. communis*, *G. taeniopteroides*, *G. browni*, *G. decipiens*, *G. angustifolia*, *G. damudica*, *G. formosa*, *G. cordata*, *G. retifera*, *G. ampla*, *G. communis* var. *stenoneura*, *Vertebraria indica*, *Rhabdotaenia feddenii*, *Arberia umbellata* and *Dictyopteridium sporiferum*.

Gymnosperms (Cordaitales)—*Noeggerathiopsis hislopi*, *N. indica*, *N. gondwanensis*, *Samaropsis milleri*, *S. johillensis*, *S. ganjrensis*, *S. goraiensis*, *S. surangei*, *Cordaicarpus zeilleri*, *Cornucarpus furcata*, *Alatocarpus indicus*.

Gymnosperms (Coniferales)—*Buriadia heterophylla*, *Paranocladus indica*, *Voltzia heterophylla*.

Gymnosperms (Cycadales)—*Pseudoctenis balli*, *Taeniopteris spathulata*, *Macrotaeniopteris danaeoides*.

Gymnosperm (Bennettitales)—*Pterophyllum* sp. (fore-runner of the future flora).

Pteridophyta (Arthrophyta)—*Schizoneura gondwanensis, Phyllotheca indica, P. griesbachii, P. sahnii, Sphenophyllum speciosum.*

Pteridophyta (Pterophyta)—*Alethopteris lindleyii, A. whitbyense, Sphenopteris hughesii, S. polymorpha, Merianopteris major, Gondwanidium validum.*

Bryophyta—*Capsulites gondwanensis.*

(2) *Dicroidium flora :* (Early Mesozoic—Triassic).

When the humid temperate climate slowly changed to dry and warm one the dominant plant of this flora—*Dicroidium* appeared on the scene. The conditions for *Glossopteris* flora were getting unfavourable, and it was slowly waning and disappearing from the stage, this new flora stepped forward to take its place. Though this new flora was not so rich in number of genera and species as the previous one, but it was hardy enough to face and bear the severe climatic and ecological conditions.

Fossils of this flora also are common in the South Rewa Gondwana basin of Madhya Pradesh. It has been recorded from Parsora, Chicharia, Dhurai (top of the hillock), Janar nala near Harai, Kathai, Bandhogarh, Majketa, Kalwa, Nidpur. It is a Triassic flora and overlaps on one end the *Glossopteris* flora and on the other the *Ptilophyllum* flora of the late Mesozoic . Elements of the flora are :

Gymnosperms (Pteridosperms)—*Dicroidium odontopteroides, D. sahnii, D. hughesii, D.* cf. *feistmantelli,*

Gymnosperms (Cycadophyta)—*Taeniopteris spathulata.*

Gymnosperms (Bennettitales)—*Pterophyllum sahnii.*

Gymnosperms (Coniferales)—*Araucarites parsorensis.*

Gymnospermous wood—*Tikioxylon hughesii, T. spiralli, Dadoxylon chandaensis.*

Pteridophytes—*Parsorophyllum indicum, Marattiopsis* sp., *Pecopteris concinne, Cyclopteris pachyrachis, Sphenopteris rotundifolia, Sphenopteris* sp.

Remnants of the previous flora :

*Glossopteris indica, G. brownii, Vertebraria indica, Noeggerathiopsis hislopi, Samaropsis srivastavae, Schizoneura gondwanensis.*

Flora of the Nidpur beds : Among the Lower Triassic beds of India Nidpur beds are supposed to be the youngest in age. Recently, very interesting assemblage of fossil plants have been discovered (Satsangi, 1964) along the Gopad river near the village Nidpur (24.7° : 81.54°) in Sidhi District, Madhya Pradesh. Fossils are preserved in micaceous carbonaceous shales. So far seven species of *Glossopteris* (*Glossopteris sahnii, G. papillosa, G. nidpurensis,* and four unidentified species), *Noeggerathiopsis* sp., *Rhabdotaenia* sp., *Lepidopteris indica, Dicroidium nidpurensis, D. papillosum, D. gopadensis, Taeniopteris glandulata, Glottolepis rugosa, Conites* sp., *Nidistrobus harrisianus, Nidia ovalis,* and *Satsangia campanulata* are known.

(3) *Ptilophyllum flora :* (Late Mesozoic—Jurassic and Cretaceous).

*Ptilophyllum* flora is again a very rich flora, and reaches its maximum development in Rajmahal and Jabalpur stages, after which it starts disappearing, so much so that Umia Stage presents a very poor flora. However, Umia flora has some plants freshly introduced to it which become the precursors of the modern vegetation.

*Ptilophyllum* is the dominant genus and it appears only when *Glossopteris* flora becomes completely extinct. It is well represented in Jabalpur Stage of Sehora, Chandia, Jabalpur, Bansa in South Rewa Gondwana basin, Madhya Pradesh. The flora is represented by the following members :

Cycadales : *Taeniopteris vittata, Nilssonia princeps.*

Bennettitales : *Ptilophyllum acutifolium, P. distanse, P. cutchense, P. gladiatum, P. institacalum, P. jabalpurense, P. bansaensis, Bucklandia, Otozamites, Dictyozamites.*

Ginkgoales : *Baiera, Ginkgoites feistmantelii.*

Pentoxyleae : *Nipaniophyllum hirsutum.*

Coniferales : *Coniferocaulon rajmahalense, Elatocladus conferta, E. indica, Pityphyllum, Desmiophyllum, Araucarites, Brachyphyllum expansum.*

Pteridosperms : *Cycadopteris pulcherrima, C. brauniana, C. auriculata, C. indica, C. major, Dicroidium odontopteroides.*

Pterophyta : *Coniopteris hymenophylloides, Alethopteris vittata, Phlebopteris, Hausmannia, Cladophlebis indica, Gleichenites gleichenoides, Onychiopsis paradoxus, Weichselia* sp., *Sphenopteris* sp.

3. *Flora of the Post-Gondwana period :* (Upper Cretaceous, Eocene and after).

The fossil flora of the Post-Gondwana period is essentially different from all the pre-existing floras described so far. This is the period when the evolution of the flowering plants took place, and the flora consisted of plants more akin to modern ones. Tall seed ferns and lycopods became extinct, and the flora adapted to the modern conditions evolved.

By this period the Gondwanaland started breaking down into its present components, and Indian peninsula became a separate entity, destined to join the land mass of the North. Due to the shifting of continents, their changed geographical positions and shifting of magnetic poles, each part differed climatically from the other, and in each developed its characteristic flora.

The position and changes in the Southern part of the Indian Peninsula (the Deccan including Madhya Pradesh) has already been discussed. The floral records of the period beginning with Upper Cretaceous are preserved in several set of beds, each between two lava flows or traps. Out of these Inter-trappean beds, the one laid down first has the oldest records, and the bed laid down in the end has latest record which is closely comparable to the present day flora.

The flora of many Inter-trappean beds has been worked out and a long list of the fossil recorded from these beds is now available. Some of the important localities are—Mohgaon Kalan, Sausar, Seoni, Jabalpur, Sagar, Chhindwara, Sitapuri, Takli, Mahurzari, Keria, Sitabaldi, Nawargaon, Ghiar, Samnapur, Parsapani, Bharatwada, Kathotia, Phulphuldol, Barwaha near Indore.

In the Bagh limestones of the Narbada valley, Chiplonkar (1944) found *Dissocladella, Indopolia,* and *Orioporella.* From the Bagh bed of Barwaha near Indore Singh (1950) reported the occurrence of *Neomeris* also in these limestones. A rich algal flora with many new forms from the Barwaha limestones of the Bagh group of Madhya Pradesh has been reported (Upper Cretaceous and Lower Tertiary)—*Dissocladella savitriae* var. *chirakhanensis, Holosporella piae* (Dasycladaceae). Ghosh and Pal (1968) reported a member of Codiaceae *Cayeuxia fructilosa,* incidentally the first record of the genus from Indian formations (Balakrishnan, 1974). Pal (1968) reported two new species of *Cayeuxia—C. minuta* and *C. chirakhanensis.* Red algae *Peyssonnelia antiqus* Johnson is reported from the Bagh beds of Madhya Pradesh (Ghosh & Pal, 1969). Pal (1969) discovered another red algae, *Lithoporella indica,* in the same bed.

A systematic account of the flora recovered so far from the above localities is given below : Locality is given in the beginning in bracket. Thallophyta—

Fungi—(Sausar)—*Perisporiacites varians, Palaeosordaria lagena,* (Mohgaon kalan)—*Shuklania dwivedii, Diplodia rodei, Helminthosporites.*

Algae—Chlorophyceae—(Mohgaon)—*Oedogonites,* Filament cf. *Ulothrix,* (Seoni, Sausar)—Filament cf. *Ulothrix.*

—Charophyta—(Seoni, Sausar)—*Gyrogonites medicaginula*, (Jabalpur, Sagar)—*Chara malcolmsonii*, (Seoni, Sagar)—*Chara sausari*.

Bryophyta—(Mohgaon kalan)—Bryophytic sporogonium, *Shuklanites deccanii*.

Pteridophyta—(Sausar)—*Massulites coelatus*, (Singhpur-Sausar)—*Azolla intertrappea*, (Mohgaon, Sausar)—*Salvinia intertrappea*, *Rodeites dakshinii*, *Rhizomites dakshinii*.

Gymnosperms—

Wood—(Mohgaon kalan)—*Dadoxylon deccani*, *D. resinosum*, (Chhindwara)—*D. shuklai*, *D. eocenum*, *D. chhindwarensis*, *Cupressinoxylon intertrappeum*, (Sitapuri)—*Spiroxylon intertrappeum*.

Cones and seeds—(?)—*Indostrobus bifidolepis*; (Takli)—*Takliostrobus alatus*, *Pityostrobus crassitesta*, (Mohgaon)—*Mohgaonstrobus sahnii*, Ovuliferous scale, (Sausar)—*Sausarospermum fermori*.

Angiosperms—

Monocotyledons—wood-stem and root.

(Mohgaon kalan)—*Palmoxylon kamalam*, *P. hislopi*, *P. solidum*, *P. mohgaonensis*, *P. invaginatum*, *P. dakshinensis*, *P. chhindwarensis*, *P. raoi*, *P. narayani*, *P. maheshwarii*, *P. parthasarthyi*, *P. kraeuselii*, *P. cordatum*, *P. fibrosum*, *Cyclanthodendron* (*Palmoxylon*) *sahnii*, Floral axis of Cyclanthaceae, *Rhizopalmoxylon penchiensis*, *Musocaulon indicum*, *M. cardiosperma*, (Mahurzari)—*Palmoxylon eocenum*, (Keria)—*P. surangei*, (Seoni, Nawargaon)—*P. sclerodermum*, (Jabalpur)—*P.* (*Cocos*) *sundaram*, (Sitapuri, Jabalpur)—*P. edwardsi*, (Nawargaon)—*P. nawargaoensis*, *P. blanfordi*, (Sitabaldi)—*P. liebigianum*.

Leaf—(Mohgaon)—*Palmophyllum dakshinense*, *Nipa hindi*, *Sparganium* also from Sausar, (Takli)—*Nipadites*.

Flower, fruit and seed—(Mohgaon kalan)—*Shuklanthus superbum*, *Viracarpon hexacarpum* (also from Takli), *Palmocarpon compressum*, *P. insigne*, *P. mohgaoense*, *P. sulcatum* *P. indicum*, *P. trigonum*, *Tricoccites trigonum*, Fruiting axis of *Tricoccites*, *Palmostrobus*. (Mahurzari)—*Veracarpon elongatum*, *Amomocarpum sulcatum*, *A. affine*, (Takli)—*Palmocarpon* (*Iriartites*) *takliansis*, *P. bracteatum*, *Patmocarpon* sp.

Dicotyledons—

Leaf—(Mohgaon)—Leaf cf. *Lagerstroemia indica*, *Phyllites mohgaoense*.

Root—(Mohgaon)—*Dicotylerhizos sahnii*, Aerenchymatous roots.

Wood—Family Aceraceae—(Samnapur)—*Aceroxylon tertiarum*.

—Ampelideae—(Mahurzari)—*Leeoxylon multiseriatum*.

—Anacardiaceae—(Keria)—*Anacardioxylon semicarpoides*, (Parsapani)—*Holigarnoxylon parsapanii*.

—Anonaceae—(Parapani)—*Polyalthioxylon parapanii*, (Samnapur)—*Miliusoxylon indicum*.

—Burseraceae—(Keria)—*Boswellioxylon indicum*, (Mahurzari, Mohgaon)—Dicot wood of Burseraceae.

—Bignoniaceae—(Samnapur)—*Dolichandroxylon prathamii*.

—Casuarinaceae—wood of *Casuarina*.

—Combretaceae—(Samnapur)—*Terminalioxylon mandlii*.

—Detiscaceae—(Mohgaon)—*Tetramelioxylon prenudiflora*.

—Euphorbiaceae—(Keria)—*Mallotoxylon keriense*, *Bridelioxylon kraeuselii*, *Paraphyllanthoxylon keriense*, (Bharatwada)—*P. sahnii*.

—Ebenaceae—(Mohgaon)—*Ebenoxylon mohgaoense*.

—Elaeocarpaceae—(Samnapur)—*Deccanoxylon samnapurens*, (Agarwara) *Elaeocarpus oxylon agarwarense*, (Mahurzari)—*E. antiquum*.

—Flacourtiaceae—(Parapani)—*Hydnocarpusoxylon indicum.*
—Guttiferae—(Mahurzari)—Dicot wood of Guttiferae, (Parapani)—*Garcinioxylon mandlii.*
—Icacinaceae—(Samnapur)—*Gomphandroxylon samnapurense,*
—Lauraceae—(Samnapur)—*Machilusoxylon hindusthanensis, Litseoxylon tertiarum.*
—Lecithidaceae—(Mahurzari)—*Barringtonioxylon deccanense,* (Parapani)—*B. parapani.*
—Leguminosae—(Mahurzari)—*Aeschynomene tertiara.*
—Moraceae—(Agarwara)—*Artocarpusoxylon agarwarense.*
—Malvaceae—(Mahurzari)—*Hibiscoxylon indicum.*
—Myrtaceae—(Mohgaon)—*Dryoxylon mohgaoense.*
—Rutaceae—(Paraspani)—*Zanthoxylon eocenum, Feronioxylon ancientum,* Wood of Rutaceae.
—Rhamnaceae—(Mohgaon)—*Rhamnoxylon intertrappea.*
—Sapindaceae—(Keria)—*Sapindoxylon schleicheroides, S. chhindwarensis,* (Pandharakwada)—*S. pandharakwadense.*
—Simarubaceae—(Mohgaon)—*Ailanthoxylon indicum, Simaruboxylon indicum,* (Mahurzari)—*Ailanthoxylon mahurzariense,* (Ghiar)—*Gondwanoxylon ghiarense,* (Kathotia)—*G. kathotiai.*
—Sonneratiaceae—(Mohgaon)—Wood of *Sonneratia,* (Samnapur)—*Dubangoxylon decanii.*
—Tiliaceae—(Mahurzari)—*Grewioxylon mahurzariense, G. intertrappea,*
—Verbenaceae—(Samnapur)—*Vitexoxylon indicum.*
Flowers, fruits and seeds :
(Mohgaon kalan)—*Sahnipushpam glandulosum, S. shuklai, Sahnianthus parijai, S. idinectrianum, Indocarpa intertrappea,* (Mahurzari)—*Enigmocarpon parijai.*

The above list of fossil plants is not up-to-date and in no way exhaustive. Many plants recently discovered, in the absence of literature and authentic record, could not be included in this list.

## MICROFLORA

In the present decade palynology has become very helpful in several fields of pure and applied sciences, side by side the study of pollen and spores has become much advanced. A brief survey of the microflora of the various periods is given here. Microflora reported from various beds situated in Madhya Pradesh only are described here under the following heads :

1. Pre-Gondwana microflora.
2. Gondwana microflora—
   (*a*) Permo-Carboniferous (Talchir to Raniganj stages),
   (*b*) Triassic,
   (*c*) Jurassic and Lower Cretaceous.
3. Post-Gondwana microflora (Upper Cretaceous and Eocene).

### 1. Pre-Gondwana Microflora (Pre-Cambrian and Cambrian) :

Microspores of the vascular plants have been recorded in the Cuddapah sediments of Jonk river section, Raipur District, Madhya Pradesh (Sahni & Shrivastava, 1962). From Vindhyans monolete-microreticulate, punctate spores and trilete-cingulate, monosaccate, disaccate and striate spores have been reported (Bose, 1956 ; Ghosh & Bose, 1954). Carbonised and non-carbonized woods with simple and bordered pits have also been recovered from Vindhyans (Ghosh & Bose, 1950).

2. Gondwana Microflora :

(*a*) *Talchir to Raniganj Stages* (Permo-Carboniferous) :

Plant spores from the Manendragarh Marine bed—The palynological assemblage consists almost entirely of spores which are of terrestrial origin. These are recovered from the blackish shale(with marine fauna). The pollen genera recorded are : *Plicatipollenites, Punctatisporites, Virkkipollenites, Potonieisporites, Parasaccites, Faunipollenites, Vestigisporites* (Lele, 1969).

Megaspores resembling *Duosporites* are found from a typical Talchir siltstone in a section along the banks of Johilla river near village Barachada, south of Birsinghpur, Madhya Pradesh (Lele & Chandra, 1966).

From a bed of Talchir shales exposed in a section in the Johilla river near the village Goraia in South Rewa Gondwana basin a rich assemblage of megafossils and microflora has been obtained (Surange & Lele, 1957 ; Potonie & Lele, 1960). Nineteen genera of microfossil flora have been recognized including seven genera noted above. These are *Leiotrilets, Cyclogranisporites, Lophotriletes, Horriditriletes, Pityosporites, Lunatisporites, Sulcatisporites, Granulatisporites, Vesicaspora, Labiisporites, Cuneatisporites* and *Quadrisporites.*

Coal bearing beds of Umaria, which are younger than marine beds and Talchirs, have yielded some new spore genera, *Crucisaccites monoletus, Stellapollenites, Striatites, Stroter-sporites, Rhizomaspora, Welwitschiapites* (Maithy, 1966).

Goswami (1951) has described some microflora, cuticles, tracheids, monosaccate and disaccate pollen from coal samples collected from Umaria and Johilla coal mines, Dhanpuri coal mines, Korar mines, and from a thin seam exposed in Bandha nala south of Ujheni (24.10° : 80.53°).

Miospore assemblage has been reported from a grey shale collected from the outlying shale dumps of a well sunk in the Gopad river bed about 1½ miles east of Nidpur in Madhya Pradesh. It has the characteristic flora of the Raniganj Stage (Maheshwari, 1966). It comprises of 3 trilete, 5 monosaccate, 13 disaccate and 3 others, 24 genera in all. These are given below in order of their dominance :

| | | | | | |
|---|---|---|---|---|---|
| *Sulcatisporites* | 21.75% | *Densipollenites* | 16.50% | *Faunipollenites* | 16.00% |
| *Lahirites* | 10.50% | *Striatites* | 8.50% | *Vesicaspora* | 6.50% |
| *Striatopodocarpites* | 7.75% | *Cuneatisporites* | 4.00% | *Verticipollenites* | 1.50% |
| *Platysaccus* | 1.50% | *Lunatisporites* | 1.25% | *Hamiapollenites* | 1.25% |
| *Striomonosaccites* | 0.75% | *Rhizomaspora* | 0.75% | *Leiotriletes* | 0.25% |
| *Cyclogranisporites* | 0.50% | *Granulatisporites* | 0.25% | *Limitisporites* | 0.25% |
| *Welwitschiapites* | 0.25% | | | | |

The following were rare and insignificant : *Microbaculispora, Latosporites, Virkkipol-lenites, Parasaccites, Vittatina* and *Hindipollenites.*

Miospore assemblage from the Ganjra nala bed in the South Rewa Gondwana basin has been described by Lele and Maithy (1969) and Saksena (1971) in details. Lele and Maithy have recorded 23 genera and Saksena has reported 35 genera. 12 genera are common in both records, while 11 genera in Lele's paper are such which have not been recorded by Saksena, and 23 genera in Saksena's paper are such which have not been reported by Lele and Maithy.

| Exclusive in Lele and Maithy (1969) | Recorded in both papers | Exclusive in Saksena (1971) |
|---|---|---|
| *Caheniasaccites*<br>*Crucisaccites*<br>*Dentatispora*<br>*Didecitriletes*<br>*Faunipollenites*<br>*Ginkgocycadophytus*<br>*Gondwanapollis*<br>*Pachysaccus*<br>*Rhizomaspora*<br>*Rimospora*<br>*Rugasaccites* | *Illinites*<br>*Lunatisporites*<br>*Parasaccites*<br>*Plicatipollenites*<br>*Potonieisporites*<br>*Punctatisporites*<br>*Stellapollenties*<br>*Striatites*<br>*Vestigisporites*<br>*Virkkipollenites*<br>*Vittatina*<br>*Welwitschiapites* | *Acanthotriletes, Sulcatisporites, Alisporites, Beharisporites, Calamospora, Cuneatisporites, Densosporites, Duosporites, Florinites, Guthorlisporites, Laevigatosporites, Leiotriletes, Lycospora, Marsupipollenites, Microbaculispora, Pityosporites, Primuspollenites, Reticulatisporites, Stroteisporites, Trileites, Triquitrites, Verrucosisporites, Verticipollenites.* |

Thus, a very rich microflora consisting of at least forty-six spore genera and more than eighty species have been recorded from the Ganjra nala beds. In the Palaeozoic Period the miospores are rich in monosaccate forms in Talchirs, Karharbari and Barakars, while disaccate pollen was found in abundance in Barakars and Raniganj. The miospore assemblage from the Ganjra nala beds is more characteristic of Karharbari than of Barakar.

(*b*) *Triassic mioflora*

Trivedi and Misra (1970) have described mioflora from Nidpur, Sidhi District, Madhya Pradesh. The mioflora comprises of : *Acanthotriletes*, *Cuneatisporites*, *Distriomonosaccites*, *Faunipollenites*, *Lunatisporites*, *Lophotriletes*, *Striatopodocarpites*, *Striomonosaccites*, *Striatites*, *Sulcatisporites* and *Verticipollenites.*

(*c*) *Jurassic and Lower Cretaceous mioflora :*

Only Lower Cretaceous spore pollen assemblages have been described from rocks of Jabalpur Series. Mioflora from three localities has been studied—Jabalpur, Sehora and Hathnapur in the Satpura coal basin, Madhya Pradesh. It comprises of 58 genera and 103 species, out of which 23 genera are common in Rajmahal and Jabalpur mioflora. The mioflora characteristic of Jabalpur Stage is given below :

| | | | |
|---|---|---|---|
| *Haradisporites,* | *Stereisporites,* | *Biretisporites,* | *Dictyophyllidites,* |
| *Concavisporites,* | *Todisporties,* | *Leptolepidites,* | *Lophotriletes,* |
| *Coniatisporites,* | *Biformazsporites,* | *Rugulatisporites,* | *Lycopodiacidites,* |
| *Klukisporites,* | *Matonisporites.* | *Lametatriletes,* | *Venustaesporites,* |
| *Boseisporites,* | *Sestrosporites,* | *Murospora,* | *Peregrinisporites,* |
| *Contiguisporites,* | *Densoisporites.* | *Crybelosporites.* | *Leschikisporites,* |
| *Metmonoletes* | *Dettmannites.* | *Rouseisporites.* | *Coptospora.* |
| *Abiespollenites,* | *Monosulcites,* | *Gliscopollis,* | *Reticulatasporites,* |
| *Laevigatosporites* | *Monolites* | *Trilites,* | *Baculopollenites.* |

Thus, the Cretaceous mioflora is totally different from any of the previous miofloral assemblage.

3. Post-Gondwana mioflora. Upper Cretaceous and Eocene (Intertrappeans) :

Not much attention has been paid to the study of mioflora of Post-Gondwana period in Madhya Pradesh. Some work has been done by CHITALEY (1951) on the microflora from the Mohgaon kalan beds. She has not described them individually and classified them into various genera and species, but has classified them according to broad divisions of vascular plants. She adopted the terminology introduced by ERDTMAN (1947).

Spores of Pteridophytes: *Aletes*—with tetrad scar absent.

*Monoletes*—monolete mark.

*Triletes*—with trilete mark. (*a*) Subtriangular spores with convex sides, (*b*) Triangular with rounded angles, (*c*) Spheroidal to elliptical.

Pollen grains of Spermatophytes:

Gymnosperms—*Monosaccites* (one winged)

*Disaccites* (two winged)

Angiosperms—Monocotyledoneae—*Monoporites* (*Graminidites*) *minor*. *Tetrado-monoporites* (*Typhidites*). *Monosulcites* (*Palmidites*) *minima*. *Monosulcites* (*Palmidites*) *media*. *Monosulcites* (*Palmidites*) *spinosa*.

Dicotyledoneae— *Monosulcites*.

*Tricolpites* (*Rhamnacidites*).

*Tricolporites* (*Myrtacidites*).

*Tricolporites* (*Rosacidites*).

*Triorites* (*Betulacidites*).

*Triorites* (*Lythracidites*).

*Porites*.

Angiospermic pollen grains are most dominant in the mioflora. It is closely comparable to the present day mioflora.

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