
CHAPTER – II

PREVIOUS WORK

The term 'Gondwana' was first introduced by Medlicott (1872). However, it was officially printed in 1876 by Feistmantel. The Gondwana rocks are characterised by conglomerates, sand stones, shales and coal deposits. The Gondwana period started from the Carboniferous and lasted upto Lower Cretaceous. The period represented distinct floras in Indian sub-continent. The Gondwana period is classified into two divisions by some workers while it was divided into three divisions by others. Surange suggested that each division represent a characteristic flora, therefore, the Gondwana flora consist of (1) Lower Gondwana flora, (2) Middle Gondwana flora, and (3) Upper Gondwana flora.

The Upper Gondwana flora is popularly called as the 'Ptilophyllum flora'. The name is derived from the genus Ptilophyllum which is the Cycadophytic leaf and abundantly found in the Upper Gondwana period. The limits of Upper Gondwana period ranges from Jurassic to Lower Cretaceous. In India the Upper Gondwana flora is found at several places. Important Upper Gondwanadeposits represents Rajmahal hills in Bihar, Jabalpur beds in Madhya Pradesh and Cutch beds in Western parts of India. In addition to these small deposits are found in Gujarat besides these we come across an interesting series of Upper Gondwana deposits found on the East-Coast.

They are in the form of detached outcrops along the coast in the form of thin marine beds. These deposits consist paralic, lagoonal sediments distributed in detached outcrops parallel to the coastline.

The present work deals with a small part of Upper Gondwana flora formed on the East-Coast. The East-Coast sedimentary deposits are distinctly distributed in different river basins. They are - (1) Krishna-Godavari basin which includes a part of Andhra Pradesh. (2) Palar basin which includes a part of Tamil Nadu. (3) Mahanadi basin which includes a part of Athgarh sand stone of Orissa and (4) Cauvery basin which includes the famous Sivaganga formation in Tamil Nadu.

Present work is related with the fossil flora of Trichinopoly region present in the Cauvery basin. Here the Upper Gondwana deposits occur near Uttatur, Terani, Naicolam, Karai, Rayani and Kattipuliyar. In addition to these there are small outcrops which are found in this region. Present chapter deals with the earlier work done on the fossil flora of Upper Gondwana period at the same time more stress will be given on the Megaflora of Cauvery basin.

According to Lele (1962) the Upper Gondwana period is divided into following four divisions - (1) Rajmahal, (2) Kota, (3) Jabalpur, (4) Umia. The earlier contribution of Upper

Gondwana flora of India includes the following work. Feistmantel (1879), Seward and Sahni (1920), Suryanarayana (1954, 1956), Rao (1959), Bose and Jain (1967), Jain (1968), Bose (1974), Bose and Zeba-Bano (1978), Pandya and Patra , Patra (1973) Patra and Patnaik ; Gopal, Jacob and Jacob (1957); Chowdhury (1958); Ayyaswami and Gururaja (1977); Jeyasingh and Sudharsan (1989); Maheshwari (1986); Murthy and Ahmed (1971); Sarma (1958); Bakshi (1968) and Mahabale and Satyanarayana (1977).

The above list includes a brief survey of the earlier work made on Upper Gondwana flora of India. It appears that the Rajmahal, Jabalpur and Cutch floras are studied in more details while the work on East-Coast Upper Gondwana flora is of meagre proportion. The survey of previous work begins with the famous Rajmahal Stage which is developed in the Bihar region. It is mostly Middle to Upper Jurassic in age. Its equivalent deposits in Andhra Pradesh are represented by Gollapalli sand stones present in West Godavari depression.

Rajmahal Stage :

Upper Gondwana rocks representing the Rajmahal Stage are found in Bihar. The Rajmahal hills present in Bihar lies 48 Km N.E. of the Raniganj coal-field. Rajmahal hills show a distinct geology because they are formed of volcanic rocks.

The silicified shales of the Rajmahal represent rich fossil flora dominated by Cycadophytes. They also include conifers, ferns and Cycades. The Rajmahal flora shows plant impressions, compression as well as petrified material. The flora is distinct from Lower and Middle Gondwanas due to presence of large number of ferns and Gymnosperms. The following account represent a brief information about the previous work on this stage. Among the Pteridophytes and Psilophytales are absent in Rajmahal flora. The next important group is the lycopsida it shows following members.

Family - Lycopodiaceae :

Srivastava (1945) reported a vegetative branch under the name Lycopodites gracilis (Oldham and Morris). Seward and Sahni (1920) this plant is compared with living genus Lycopodium on the basis of shape of the leaves and the arrangement. Later on the occurrence of Lycopodium was confirmed when a petrified stem was described by srivastava (1946) as Lycoxylon indicum. Its anatomy shows similar construction as found in living Lycopodium.

Genera : The Sphenopsida which forms another group of Pteridophytes is represented by single family Equisetaceae.

Family - Equisetaceae :

Genus - Equisetites :

Oldham and Morris (1863) described E. rajmahalenses from Rajmahal hills, it shows jointed nature of the stem and arrangement of scale leaves at nodal region. Similar to that of living genus Equisetum. The next group from the ferns and is represented by different families.

Family - Osmundaceae :

It is represented following genera -

Genus : Cladophlebis : Brongniart

A vegetative frond was described by Sahni and Rao (1933) as C. indica from Rajmahal Hills. Another species of the genus was described by Gupta (1956a) as C. sahnii from the same locality.

Genus - Osmundites Unger

It is petrified stem of Osmunda showing a dictyostelic structure. Vishnu Mittre (1956) described the stem as Osmundites sahnii.

Family - Gleicheniaceae :

This family is quite common in the Rajmahal hills. It is characterised by pseudodicotomous branching.

Genus - Gleichenites Goeppart

Seward and Sahni (1920) described a large frond under the name Gleichenites gleichenoides.

Family - Dipteridaceae :

Genus - Hausmania Dunker :

Gupta (1955 b) described H. indica from Rajmahal hills later on Bose and Sah (1968) revised its name as H. crenita.

Family - Matoniaceae :

Genus - Phlebopteris Brongniart

Bose and Sah (1968) described a fragmentary frond from Rajmahal hills.

Unclassified ferns

Genus - Sphaenopteris Brongniart

Following 4 species of the genus are known from Rajmahal hills.

1. Sahni and Rao (1934) described S. rajmahalensis
2. Ganju (1946) described S. khairbaniensis.
3. Bose and Sah (1968) described S. bindrabunensis.
4. Bose and Sah (1968) described S. petagonica.

Genus - Rhizomopteris Schimper

The genus represent a fern rhizome with uncertain affinities following 3 species are known from Rajmahal hills.

1. Ganju (1946) described R. chakshu
2. Gupta (1955) described R. sahni
3. Gupta (1955) described R. rajmahalensis.

Genus - Solanostelopteris Kershaw

The genus represents a petrified stem having Solenostele and 'C' shaped leaf trace. Vishnu-Mittre (1959) described the following two species -

1. S. nipania
2. S. sahnii

Genus - Dictyostelopteris Vishnu-Mittre (1959)

The genus represents dictyostelic stems found at Rajmahal hills following 3 species are known.

1. D. rajmahalensis
2. D. jacobii
3. D. fasciostealeoides.

Gymnosperms

The group is represented by Cycadophytes, Conifers and Ginkgoales. It is the prominent part of the Rajmahal flora representing large number of genera and species. The cycadophytes are divided into 2 orders.

1. Cycadeoidales (Bennettitales)
2. Cycadales.

Order - Cycadeoidales

It includes leaves, stems and reproductive organs. The leaves formed the bulk of the group and represented by following genera :

Genus - Ptilophyllum Morris 1840

The genus represents the characteristic member of the Upper Gondwana flora. Due to its abundant, the Upper Gondwana flora is termed as the Ptilophyllum flora. It is a cycadophytic leaf where rachis is partially covered by the pinna basis on the upper surface. The pinna shows parallel venation. Recently Bose and Kasat (1972) have made a detail survey of the genus in India. They have given morphological as well as cuticular feature of different species. The Rajmahal hills represents following 15 species -

1. P. acutifolium Morris (1840)
2. P. rarinervis (Feist.) Bose and Kasat (1972)
3. P. cutchensis Morris (1840)
4. P. tenerrimum Feistmantel (1879)
5. P. oldhamii Jacob & Jacob (1957)
6. P. indicum Jacob & Jacob (1957)
7. P. horridum Roy
8. P. sakrigaliensis Sah
9. P. institacallum Bose (1974)
10. P. distans (Feist.) Jacob & Jacob (1957)
11. P. jabalpurensis Jacob & Jacob (1957)
12. P. gladiatum Bose and Sukhdev
13. P. sahnii Gupta and Sharma (1968)
14. P. nipanica Vishnu-Mittre (1959)
15. P. amarjolense Bose (1974)

The abundance of Ptilophyllum justifies the presence of Upper Gondwana flora in Rajmahal hills. Rajmahal Stage represent the beginning of the Upper Gondwana period hence it show the occurrence and evolution of the Upper Gondwan flora.

Genus - Pterophyllum Brongniart 1832

It is a pinnate frond and differs from Ptilophyllum in having larger size. It is characterised by long, slender pinnae attached laterally to the rachis. The veins are simple; parallel or rarely branched. From the earlier literature it appears that there was confusion in identification of Pterophyllum. Some authors earlier described Pterophyllum species as the Nilsonia. Oldham and Morris (1863) noted 9 species of Pterophyllum from Rajmahal hills. Later on Feistmantel (1877 b) described from Gollapalli sand stones in Godavari district of Andhra Pradesh a new species P. kingianum. Hence the total number from Rajmahal Stage became 10. Seward (1917), Seward and Sahni (1920), Sahni and Rao (1933) and Sharma (1969) have made more contributions to the knowledge of this genus. Bose (1974) revised the data of Pterophyllum in India and showed that genus Nilsonia is absent and all earlier species of Nilsonia should be transferred to the genus Pterophyllum. Hence Bose and Banerji (1981) revised the account of Cycadophytic leaves in India. Therefore, the

Rajmahal Stage shows the presence of following 8 species -

1. P. distans Morris, (1840)
2. P. rajmahalense Morris, (1840)
3. P. medlicottianum Oldham and Morris, (1863)
4. P. princeps Oldham and Morris, (1863)
5. P. morrisianum Oldham,
6. P. incisum Sahni and Rao, (1933)
7. P. kingianum Feistmantel, (1877 b)
8. P. Guptai Bose and Banerji, (1981)

Genus - Dictyozamites Oldham

This Cycadophytic leaf is distinct from other genera in having reticulate venation and auriculate base of the pinnae by which they are attached to the rachis. Earlier contribution on this genus includes the work of Oldham and Morris (1863) Sahni and Rao (1933), Jacob (1951), Gupta and Sharma (1968). Recently Bose and Zeba-Bano (1978) have given a detailed account of the genus Dictyozamites in India. They have noted the following 5 species from Rajmahal hills.

1. D. indicus Feistmantel, (1877)
2. D. sahnii Gupta and Sharma, (1968)
3. D. hallei Sahni and Rao, (1933)
4. D. feistmantelii Bose and Zeba-Bano, (1978)
5. D. falcatus Morris, Medlicott & Blandford.

Genus - Otozamites Braun 1842

This leaf genus differs from Dictyozamites in having the radiating veins of the pinnules, further the pinnules show more or less auriculate base and almost cover the rachis. Pinnules are triangular or deltoid. According to Bose (1974) the genus is somewhat rare in India. From Rajmahal hills following 2 species are noted. O. gondwanensis Bose and Otozamites sp.

Genus - Anomozamites Schimper 1870

The genus is somewhat similar to Pterophyllum but differs from it in having short and broad pinnae. Bose and Banerji (1981) reported following 3 species from Rajmahal hills -

1. A. creanata (Mc-Clelland) Bose and Banerji, (1981)
2. A. amarjolense Sharma, Surana and Singh.
3. A. fiscus Feistmantel, (1879).

Genus - Bucklandia Presl. 1825

It is a stem and was first described by Oldham and Morris (1863). Feistmantel (1877 a) suggested the relation of Bucklandia stem with Willamsonia. Seward (1917) reported B. indica from Rajmahal Stage. Bose (1953 a) described B. sahnii. Bose (1953 b) described another new species as Bucklandia sp. Sharma described B. guptai. Sharma (1969 b) described B. dichotoma. From this account it appears that 5 species are found in Rajmahal hills.

Fructification :Female flowers :

Genus - Willamsonia Carruthers 1819

The genus represents both male and female flowers of Willamsonia but in India only female flowers have been described by different authors. Following 10 species are found in Rajmahal Stage -

1. W. blanfordii Feistmantel, 1876
2. W. microps Feistmantel, 1877
3. W. indica Seward 1917
4. W. sewardiana Sahni 1932
5. W. harrisiana Sahni 1932
6. W. sahnii Gupta 1943
7. W. guptai Sharma 1968
8. W. amarjolense Sharma
9. W. seniana Bose and Kasat 1969.
10. W. cf. W. scotia Sharma 1970.

Male Flowers :

Genus - Weltrichia Braun 1849

The genus differs from Willamsonia male flowers in having finger like appendages with ray like structures. Following 3 species are found in Rajmahal hills. W. singhii Bose (1967), W. santalensis (Sitholey & Bose) Bose (1967), W. polyandra (Ganju)

Sitholey and Bose (1971).

Bisexual flower :

Genus - Cycadeoidea Buckland 1828.

Only one bisexual flower is known from India. Bose (1966 a) described C. dactylota from Rajmahal Stage.

Genus - Bennetticarpus Harris 1932.

This new genus represents gynaecium of the Bennettitales. Oldham and Morris (1863) described first report of this genus later on Feistmantel (1877 a) described it as Willamsonia gigas.

Genus - Cycadolepis Saporta 1874.

This is a perianth scale, following 2 species are known from Rajmahal hills. C. indica Gupta (1954) and C. oldhamii (Feistmantel) Bose and Jain (1964).

Cycadales

Compared to Bennettitales this order shows the restricted presence in Rajmahal hills and only represented by vegetative organ.

Genus - Taeniopteris Brongniart 1832.

It is a strap shaped leaf with distinct midrib from which simple or forked lateral veins are given out. According to Bose and Banerji (1981) following 3 species are reported from Rajmahal

Stage. T. spatulata Mc-Clenlland, T. oldhamii Bose and Banerji and T. buskoghatensis Bose and Banerji.

Genus - Morrisia Bose 1958.

Recently Bose (1958) instituted this new genus for uni-pinnate leaves with Taeniopteris type of pinnae. According to Bose and Banerji (1981) following 3 species are known from Rajmahal hills. M. mc-clellandi (Oldham and Morris) Bose (1958), M. dentata (Rao and Jacob) Bose and Banerji (1981) and M. rajmahalensis (Feistmantel) Bose and Banerji (1981).

Genus - Cycadites Sternberg 1825.

This genus is somewhat rare in India. The leaves resemble with those of living genus Cycas. According to Bose and Banerji (1981) only one species is known from Rajmahal Stage C. rajmahalensis Oldham.

Coniferales

The Mesozoic period was dominated by cycadophytes as well as conifers. In India Rajmahal stage and Jabalpur Stage shows abundance of coniferous plant remains. Rajmahal Stage shows both vegetative and reproductive organs belonging to different families. The important families found in Rajmahal hills are Araucariaceae, Podocarpaceae and Taxaceae.

Family - Araucariaceae :

It is considered as the most primitive family among conifers. It represents by both vegetative and reproductive organs.

Genus - Brachyphyllum Brongniart 1828

It is vegetative shoot having spirally arranged closely appressed leaves. The leaves are triangular, rhomboidal or conical in shape with thick lamina. Bose and Maheshwari (1974) have noted following 4 species from Rajmahal hills.

1. B. mamillare Brongniart, 1828
2. B. expansum (Sternberg) Seward, 1917
3. B. spiroxylum Bose, 1958
4. B. florinii Vishnu-Mittre, 1959.

Genus - Pagiophyllum Heer 1881.

It is an allied genus where the stem shows more longer leaves than the breadth of leaf cushion. Bose and Maheshwari (1974) noted (1) P. aurucaroides Vishnu-Mittre, (2) P. peregrianum (L. & H.) Sahni from Rajmahal Stage.

Genus - Allocladus Townrow 1967.

Only one species is known from Rajmahal hills viz. A. rajmahalensis Townrow.

Genus - Araucarites Presl 1838

According to Bose and Maheshwari (1974) following 2 species are known (1) A. bindrabunensis V. Mittre, (2) A. nipaniensis Singh.

Genus - Araumyelon Bohra and Sharma.

The root shows distinct fan shaped secondary Xylem. A. pakuraensis is known from Rajmahal hills.

Genus - Araucarioxylon Kraus 1870.

The genus represents secondary Xylem of stem showing picnoxylic wood. Bose and Maheshwari (1974) revised the nomenclature of Araucaric woods in India and found that following 6 species are known in Rajmahal hills.

1. A. agathioides (Krausel and Jain) Bose & Maheshwari 1974.
2. A. rajmahalensis Sahni, 1920.
3. A. amaraparensis (Sah and Jain) Bose and Maheshwari.
4. A. mandroense (Sah and Jain) Bose and Maheshwari.
5. A. brindabunense (Sah and Jain) Bose and Maheshwari.
6. A. santalense (Sah and Jain) Bose and Maheshwari.

Family - Taxaceae :

In the Rajmahal Stage, it shows meagre presence only vegetative organs are known.

Genus - Torreyites Seward 1919.

Ganju (1946) described a vegetative shoot as T.

sitholeyi from Rajmahal hills.

Genus - Taxaceoxylon Krausel and Jain 1964.

Bharadwaj described the first wood of Taxaceae as Taxoxylon rajmahalense. Later on Krausel and Jain (1964) revised the description of Taxinean woods and instituted a new genus Taxaceoxylon. Hence the wood is named Taxaceoxylon rajmahalense.

Family - Podocarpaceae :

This family is quite common in the Rajmahal Stage and is represented by foliage, woods and reproductive organs.

Genus - Elatocladus Halle 1913.

It is sterile shoot having spirally arranged linear to lanceolate leaves. Each leaf shows a distinct midrib. From Rajmahal hills following 3 species are known -

(1) E. conferta (Oldham and Morris) Halle (1913); (2) E. sahnii Vishnu-Mittre, 1959, (3) E. sp. Sahnii 1928.

Genus - Indophyllum V. Mittre (1959).

It represents the vegetative branch and V. Mittre (1959) described following 3 new species - (1) I. sahnii, (2) I. raoii, and (3) I. nipanica.

Genus - Podocarpoxyton Gothan (1905).

Earlier the woods of podocarpaceae were described under the generic name Mesembrioxylon Seward (1919). Recently

Bose and Maheshwari (1974) revised the nomenclature of the woods and transferred them to the Podocarpoxyton. Following 2 species are reported from Rajmahal hills.

1. Podocarpoxyton indium (Bharadwaj, 1953). Bose & Maheshwari, 1974.
2. P. rajmahalense (Jain, 1965) Bose and Maheshwari 1974.

Genus - Circoporoxylon Krausel 1950.

This wood showing simple cross-field pits with circular pit-pore. Krausel and Jain (1964) described C. amarjolense from Rajmahal hills.

Reproductive organs :

Female cone :

Genus - Nipaniostrobus Rao (1943)

Rao (1943) instituted this genus for the female cones. N. sahnii Rao is the only species of this genus known from Rajmahal hills.

Genus - Mehtaia V. Mittre 1959

It is a cone with erect position of ovules. He described following 3 species.

1. M. nipanianesis
2. M. rajmahalensis
3. M. santalensis

Genus - Sitholeya V.Mittre 1959.

This is also a female cone and the genus is characterised by cones with inverted position of ovules. Only one species is known viz. S. rajmahalensis.

Male Cone :

Genus - Podostrobus Rao and Bose, 1971.

It is the male cone and following 2 species are known viz.
(1) P. rajmahalense. V.Mittre (1956) described a male cone as Muscalostrobus sahnii. It is redescribed as (2) P. sahnii (V.Mittre) Rao and Bose, 1971.

Ginkgoales

Genus - Ginkgoites Seward 1919.

The genus represents a cuneate leaf having a distinct venation. Sah and Jain (1964) described G. rajmahalense from Rajmahal Hills.

Pentoxylales

Sahni (1948) discovered a new synthetic and unique group of gymnosperms. Along with other workers he described this group. It includes vegetative as well as reproductive organs.

Stem :

Genus - Pentoxylon Srivastava, .

Srivastava established this genus showing 5 vascular

bundles, he described a new genus P. sahnii.

Genus - Nipanioxylon Srivastava

This genus shows the number of vascular bundles more than 5. He described a new species N. guptai.

Leaves :

Genus - Nipaniophyllum Sahni, 1948.

Earlier leaves were described under the name Taenopteris spathulata. The leaves shows Bennettiales Stonata and diploxylic bundles of Cycadales. Hence Sahni (1948) created a new genus Nipaniophyllum. He described a new species N. raoii.

Female cone :

Genus - Carnoconites Srivastava, 1946.

It is a female cone and represented by following 2 species (1) C. compactum Srivastava, (2) C. laxum Srivastava.

Male cone :

Genus - Sahnia V. Mittre 1953.

It is a male cone and V.Mittre (1953) described S. nipaniensis from the Nipania in Rajmahal Stage.

Pteridosperms

Genus - Thinnfeldia Ettingshausen 1852.

Sah and Sukh-Dev described T. chunkhalensis. Sharma

et. al. (1971) described T. amarjolense, C. Cf. T. lancifolia,
T. sp. Cf. T. feistmantelii, T. sp. A., and T. sp. B.

Genus - Cycadopteris Zigno 1860.

It is also a leaf. Bose (1958 b) described Cycadopteris
sp. from Chunkhal in Rajmahal hills.

Kota Stage :

This stage is named after the village Kota situated on the boundary of Maharashtra and Andhra Pradesh. It is present in the Chandrapur district of Maharashtra and lies on the East bank of Pranhita river. The Kota is associated Maleri Stage and constituted a well known formation called as Kota-Maleri. Rajanikanth and Sukh-Dev (1989) have briefly described its geology and lithology. Along the East-coast the Kota Stage represent detached outcrops intercalated with marine deposits the important beds are Vemavaram beds and Raghavapuram mud stones in Godavari district. The Sriperambudur beds in Tamil Nadu. The previous work includes contribution of Govindan Yadagiri et al., Jain, Rao and Shah, Mahabale, Biradar and Mahabale, Srinivas Rao et. al., Rudra, Vagyani and Deshmukh (1984), Vagyani and Jamane (1986), Vagyani and Mane (1989) etc.

Pteridophyta

Order - Filicales

Family - Osmundaceae

Genus - Cladophlebis Brongniart 1849

Rajanikanth and Sukh-Dev (1989) described C. sp. from Kota in Maharashtra. Sahni and Rao (1933) reported the occurrence of C. indica from Sriperambudur in Tamil Nadu.

Family - Gleicheniaceae

Genus - Gleichenes

Bose et. al. (1982) described following 2 species -

(1) G. nordelskioildii Heer, (2) G. sp.

Unclassified Ferns :

Genus - Sphenopteris Sterbner 1874.

Rajanikanth and Sukh-Dev (1989) described Sphenopteris sp. from Chandrapur district of Maharashtra.

Pteridosperms

Genus - Dicroidium Gothan 1912.

It is an index fossil of Middle Gondwana flora representing the Triassic period. Srivastava (1974) has given the account of Mesozoic Pteridosperms of India. The author suggests that occurrence of Dicroidium in the Jurassic and Cretaceous is doubtful. Jain (1968) described Dicroidium from Vemavaram in

Andhra Pradesh, Bakshi (1968) reported Dicroidium sp. from Raghavpuram in Andhra Pradesh. Rao (1959) described D. feistmantelii from Vemavaram.

All above reports represent a Dicroidium in the Jurassic period particularly in the Kota Stage.

Genus - Thinnfeldia Ettingshausen 1852.

This genus is quite common in the Jurassic period. Feistmantel (1877) described T. subtrigona from Vemavaram.

Cycadophytes

Genus - Ptilophyllum Morris 1840.

Bose and Kasat (1972) has given a brief account of Ptilophyllum in India. Following 3 species are known from Kota Stage of the East-Coast.

1. P. acutifolium Morris,
2. P. cutchense Morris
3. P. rarinervis (Feistmantel) Bose and Kasat.

Genus - Pterophyllum

Bose and Banerji (1981) have given a brief account of Cycadophytic leaves from India, they have noted following 3 species from Kota Stage.

1. P. footeanum Feistmantel from Vemavaram.
2. P. incisum Sahni and Rao from Vemavaram.
3. P. distans Morris from Uppugunduru

Recently Vagyani & Zuting (1986) reported P. distans from Uppugunduru. Further Vagyani (1986) described P. footeanum from the above locality. Vagyani and Mane (1989) reported P. incissum from the same locality.

Genus - Dictyozamites Oldham 1863.

Bose and Zeba-Bano (1978) have given a brief account of Dictyozamites in India, following 2 species are known from Kota Stage.

1. D. feistmantelii Bose & Zeba-Bano from Vemavaram, Raghavpuram and Sriperambudur.
2. D. indicus Feistmantel from Vemavaram.

Genus - Otozamites Braun 1842

Bose (1974) reported following 3 species from Kota Stage.

1. O. vemavaramensis Bose and Jain.
2. O. exhislopii Bose (1974).
3. O. gondwanensis Bose (1974).

All the above species are found at Vemavaram. Recently Vagyani (1986) described O. vemavaranensis from Uppugunduru in Andhra Pradesh.

Genus - Taeniopteris Brongniart 1832.

Bose and Banerji (1981) and Jeyasingh and Sudhersan (1989) described following 3 species are from Kota Stage.

1. T. spathulata Mc-Clenlland.
2. T. haburensis Bose and Banerji.
3. T. buskoghatensis Bose and Banerji.

Genus - Morrisia Bose 1958

It is somewhat rare in the Kota Stage and represented by only one species. M. mc-clenlandi (Oldham and Morris) Bose.

Genus - Anomozamites Schimper 1870.

It is also not common in Kota Stage. bosc et al. (1982) Anomozamites sp. from Andhra Pradesh.

Reproductive Organs :

Genus - Williamsonia Carruthers 1819

Bakshi (1968) described from Raghavapuram in Andhra Pradesh W. blanfordii Feistmantel.

Coniferales

Family - Araucariaceae

Genus - Brachyphyllum Brongniart 1828.

Sahni (1928) noted the occurrence of following 3 species from Kota Stage in the East-Coast.

1. B. feistmantelii (Halle) Sahni
2. B. expansum (Sternberg) Seward
3. B. rhombicum (Feistmantel) Sahni.

Genus - Pagiophyllum Heer 1881.

1. Rajanikanth and Sukh-Dev (1989) described Pagiophyllum sp. A. and Pagiophyllum Sp. B from Kota in Maharashtra.
2. Jain (1968) Pagiophyllum sp. from Vemavaram.
3. Bose and Sukh-Dev (1972) P. marwarensii from Gangapur beds.
4. Bakshi (1968) Pagiophyllum sp. Cf.

Genus - Desmiophyllum Lesquereux 1878

It is a strap shaped leaf. Sahni (1928) described D. indicum from Raghavpuram. Vagyani (1984) described it from Vemavaram in Andhra Pradesh.

Genus - Araucarioxylon Kraus. 1870

Rajanikanth and Sukh-Dev (1989) described following 3 species from Kota Stage.

4. A. santalense (Sah and Jain) Bose & Maheshwari 1974.
2. A. pranhitensis Rajanikanth and Sukh-Dev.
3. A. sp.A.

Recently Jeyasingh and Kumaraswamy (1994) described fourth new species A. mosurensis from a locality near Arakonam belonging to Sriperumbudur beds in Tammil Nadu.

Genus - Dadoxylon Endlicher

Biradar reported 4 species of Dadoxylon from

Kota Stage in Andhra Pradesh. All these woods are described as Dadoxylon sp. from several localities.

Family - Taxaceae

Genus - Torreyites Seward 1919.

Seward and Sahni (1920) described T. constricta from Vemavaram.

Genus - Taxaceoxylon Krausel and Jain 1964.

Rajanikanth and Sukh-Dev (1989) reported following 3 species from Kota in Maharashtra.

1. T. sahani Rajanikanth and Sukh-Dev.
2. T. sp. A.
3. T. sp. B.

Family - Podocarpaceae

Genus - Podocarpoxyton Gothan 1905.

Following 5 species are known from Kota Stage.

1. P. parthaserthyi (Sahni) Bose and Maheshwari 1974 from Tamil Nadu.
2. P. godavarianum (Sahni) Bose and Maheshwari 1974 from Andhra Pradesh.
3. P. tirumangalense (Suryanarayana) Bose and Maheshwari 1974 from Andhra Pradesh.
4. P. krauslii Rajanikanth and suk-Dev 1989 from Maharashtra.

5. P. chandrapurensis Rajanikanth and Sukh-Dev 1989 from Maharashtra.

Genus - Elatocladus Halle 1913.

Sahni (1928) following 3 species are from Kota formation in the East-Coast.

1. E. plana (Feistmantel) Seward 1919.
2. E. jabalpurensis (Feistmantel) Sahni.
3. E. conforta (Oldham and Morris) Halle 1913.

Recently Vagyani and Jamane (1987) described E. plana from Uppugunduru in Andhra Pradesh. Bose et. al. (1982) added 2 new species from Gangapur beds in Andhra Pradesh.

4. E. kingianum Bose, Kutty and Maheshwari.
5. E. sp.

Family - Cupressaceae

Genus - Cupresinoxylon Goppert 1850.

Following 3 species are known from Kota Stage.

1. C. coromandelianum Sahni (1931) from Sriperambudur.
2. C. alterans Sahni 1931 from Raghavpuram.
3. C. kotaense Rajanikanth and Sukh-Dev 1989 Kota.

Ginkgoales

Genus - Ginkoites Seward 1919.

G. crassipes (Feistmantel) Seward is known from Raghavpuram in Andhra Pradesh and Sriperambudur

in Tamil Nadu. Recently Vagyani (1985) reported occurrence of G. crassipes from a new locality Uppugunduru in Andhra Pradesh. Baksi (1968) described G. sp. and G. feistmantelii Bose and Sukh-Dev from Raghavpuram in Andhra Pradesh.

Jabalpur Stage :

It represents a next stage after the Kota Stage. It is found in Madhya Pradesh and shows different composition. The Jabalpur Stage forms two parts, the Upper one is Jabalpur series and Lower one is Ghaugan Stage. Jabalpur Stage shows soft sand stones with traces of lignite and coal beds, but it is rich in Upper Gondwana plant fossils having number of elements. It is characterised by dominance of conifers while Cycadophytes plays second roll in Rajmahal. This picture is exactly opposite. Another distinct feature of Jabalpur flora is moderate presence of Pteridosperms and Pteridophytes.

Pteridophytes

Order - Filicales

Family - Osmundaceae

Genus - Cladophlebis Brongniart

Sahni and Rao (1933) noted that report of Cladophlebis indica (Oldham and Morris) from Jabalpur Stage.

Family - Gleicheniaceae

Genus - Gleichenites Goeppart 1836.

Feistmantel (1882) described G. rewahensis from Bansa in Madhya Pradesh.

Family - Dipteridaceae

Genus - Hausmannia Dunker

Crook Shank (1935) described following 2 species from Madhya Pradesh - (1) H. bulchii Andia, (2) H. dichotoma Dunker.

Family - Dicksoniaceae

Genus - Coniopteris Brongniart 1849

From Jabalpur Stage Bose (1960) described C. hymenophylloides Brongniart.

Unclassified Ferns

Genus - Onychiopsis Yokoyama

Bose and Sukh-Dev (1961) described a fertile species from Bansa and Chandia in Madhya Pradesh under the name O. paradoxus. Bose (1960) reported a sterile specimen from Ghugh hills, Jabalpur, and Sehora in Madhya Pradesh as O. psilotides Stokes and Webb.

Genus - Alethopteris Sternberg

Following 3 species have been described by Feistmantel

(1877-d) from Jabalpur group in Satpuda basin.

- 1. A. medicotti Oldham
- 2. A. lobifolia Schimper
- 3. A. whitbyensis Schimper.

Genus - Sphenopteris Brongniart.

Bose (1960) described Sphenopteris sp. from Jabalpur Stage.

Cycadophyta

Genus - Ptilophyllum Morris 1840.

The genus represents the Upper Gondwana flora due to its abundance. It is dominant in Rajmahal Stage and also shows more frequency in the Jabalpur Stage. According to Bose and Kasat (1972) following 10 species are known in Jabalpur Stage:

- 1. P. acutifolium Morris
- 2. P. cutchense Morris
- 3. P. oldhamii Jacob and Jacob.
- 4. P. jabalpurensis Jacob and Jacob.
- 5. P. distans (Feistmantel) Jacob and Jacob.
- 6. P. horridum Roy
- 7. P. sakrigalensis Sah
- 8. P. institacallum Bose
- 9. P. gladiatum Bose and Sukh-Dev.
- 10. P. indicum Jacob and Jacob.

Genus - Pterophyllum Brongniart 1828.

This genus comparatively shows restricted presence than Ptilophyllum and known by only 2 species from Jabalpur Stage.

(1) P. distans Morris, (2) P. medicottianum Oldham and Morris.

Genus - Dictyozamites Oldham

Bose and Zeba-Bano (1978) following 2 species are reported from Jabalpur Stage. (1) D. indicus Feistmantel and (2) D. feistmantelii Bose and Zeba-Bano.

This indicates that comparing to Rajmahal and Kota of the East-Coast the genus is somewhat rare in the Jabalpur Stage.

Genus - Anomozamites Schimper 1870.

Bose and Banerji (1981) described only one species A. hansapurensis.

Cycadales

Genus - Taeniopteris Brongniart 1832.

According to Bose and Banerji (1981) only one species is found in Jabalpur Stage viz. T. spathulata Mc-Clelland.

Genus - Bucklandia Presl. 1825.

Bose (1958) described Bucklandia sp. from Marhpiaria in Madhya Pradesh.

Coniferales

Jabalpur Stage shows abundance of fossil coniferales the locality like Bansa and Sehora are rich in the fossils of Araucariaceae. The other families are also reported.

Family - Araucariaceae

Vegetative Organs

Genus - Brachyphyllum Brongniart 1828.

This is a sterile shoot having spirally arranged triangular or conical or rhomboidal leaves with thick lamina. The leaves are arranged in compact fashion. Sahni (1928) following 4 species are found in Jabalpur Stage.

1. B. expansum (Sternburg) Sahni.
2. B. feistmantelii (Halle) Sahni.
3. B. rhombicum (Feistmantel) Sahni.
4. B. mamillare Brongniart.

Recently Bose and Maheshwari (1974) described a new species viz. B. sehoraensis from Madhya Pradesh. Hence it appears that 5 species of Brachyphyllum are known from Jabalpur Stage.

Genus - Pagiophyllum Heer 1881.

According to Sahni (1928) following 2 species are known from Sher river and Bansa in Madhya Pradesh.

(1) P. peregrianum (Lindley and Hutton) Sahni. Recently Bose and Sukh-Dev (1972) added 3 new species from Bansa.

1. P. bansanensis
2. P. marwarensis
3. P. rewaensis

They further suggested that P. Cf. peregrianum described by Sahni should be merged with P. marwarensis.

Genus - Araucarites Presl. 1838.

Following 4 species are known from Jabalpur Stage -

1. A. latifolios Feistmantel 1877 c.
2. A. cutchensis Feistmantel 1977 c.
3. A. minutus Bose and Maheshwari 1973.
4. A. sehorensis Bose and Maheshwari 1973.

Genus - Desmiophyllum Lesquereux 1878.

It is a strap shaped leaf where attachment is not clear. Sahni (1928) described D. indicum from Jabalpur Stage.

Family - Podocarpaceae :

Vegetative Organs

Genus - Elatocladus Halle 1913.

According to Sahni (1928) following 4 species are known from Jabalpur Stage.

1. E. conferta Halle.
2. E. plana (Feistmantel) Seward.

3. E. tenerrima (Feistmantel) Sahni
4. E. jabalpurensis (Feistmantel) Seward.

Compared to Rajmahal and Kota Stage no petrified woods have been described from Jabalpur Stage and hence it is devoid of genera like Araucarioxylon and Podocarpoxyton representing the above two major coniferous families.

Reproductive Organ :

Genus - Conites Sternberg 1823.

Sahni (1928) described the C. sp. Cf. Strobilites anceps Berry. It is a female cone reported from Bansa in Jabalpur Stage. The nomenclature and affinities are somewhat unclear.

Genus - Strobilites Lindley and Hutton 1833.

Sahni (1928) described a female cone S. sewardii. The cone is attached with the foliage of E. jabalpurensis it shows sessile ovules in the groups of 2 to 4.

Ginkgoales

Leaves :

Genus - Ginkgoites Seward 1919.

Following 2 species represented the fossil leaves of Ginkgoales. (1) G. lobata Seward and Sahni (1920) and (2) G. feistmantelii Bose and Sukh-Dev (1958).

Genus - Baiera Braun. 1842

Bose (1958) described Baiera sp. from Sher river in Madhya Pradesh.

Genus - Phonicopsis Heer.

Feistmantel (1877) described Phonicopsis sp. from South Rewa basin and Satpuda basin near Jabalpur.

Pteridosperms

Genus - Pachypteris Brongniart 1828.

Bose and Roy (1968) described P. indica from Sher river.

Genus - Cycadopteris Zigno 1860.

Bose and Sukh-Dev (1958) described following 5 species from Jabalpur Stage.

1. C. brauniana Zigno.
2. C. pulcherring Bose and Sukh-Dev
3. C. arauculata Bose and Sukh-Dev.
4. C. indica Bose and Sukh-Dev.
5. C. majus Bose and Sukh-Dev.

The genus represents bipinnate leaves where pinnate shows variation of margins. Cuticular feature of this species differ from each other.

UMIA STAGE

It is found in the Cutch basin and named after a village Umia. The Stage represents the end of Upper Gondwana period. It is characterised by marine deposits. Biswas described

lithological characters of Umia Stage. Accordingly Umia Stage represents the lower formation in Cutch basin. It is followed by Jhuran formation which forms the Upper division. The lithology shows marine shales and sand stones. The rocks are fossiliferous and represent a distinct floral composition. Krishnan (1960) commented that in many respects the Umia flora resembles the Jabalpur flora. The Umia Stage is also represented in Peninsular India at different places. Recently Bose and Banerji (1984) have made extensive floristic studies of fossil flora. The flora represents Gymnosperms, Pteridophytes, Pteridosperms and some unclassified plants.

Pteridophytes

Family - Equisetaceae

Genus - Equisetites Sternberg 1833.

E. rajmahalense Oldham and Morris is fairly common in the Cutch flora it was first reported by Roy (1968). Recently Bose and Banerji (1984) also reported it from several new localities in Cutch. Hence it appears that it is quite common in Cutch and Rajmahal floras.

Genus - Isoetites Munster 1842.

Bose and Roy (1964) described following 2 species from Cutch (1) I. serretifolius and (2) I. indicus. Recently

Bose and Banerji (1984) also reported them from different localities in Cutch.

Genus - Selaginellites Zeiller 1906.

Following 2 species are known from Cutch

(1) Selaginellites sp. and (2) S. gracilis (Oldham and Morris)
Pal.

Family - Osmundaceae

Genus - Todites Seward.

Sukh-Dev noted the occurrence of T. indicus from
Cutch.

Family - Matoniaceae

Genus - Matonidium Schenk

Roy (1968) described N. goepperti (Ettingah) Schenk from
Cutch. zeba-Bano and Bose (1981) described M. singulatum from
Cutch.

Genus - Phlebopteris Brongniart 1836.

Borkar and Chiploker described doubtful specimens
under the name (?) Phlebopteris sp. Recently Banerji (1982)
reported P. minutifolius from Cutch.

Family - Dipteridaceae

Genus - Hausmannia Dunker 1846.

Bose and Banerji (1984) described H. dichotoma Dunker
and Hausmannia sp.

Genus - Coniopteris Brongniart 1849.

Bose and Banerji (1984) described C. Cf. hymenophylloides
(Brongniart) Seward from Cutch.

Family - Gleicheniaceae

Genus - Gleichenites Goeppert 1836

Borker and Chipkonkar described G. nordenskioldi
Heer from Saurashtra.

Family - Weichseliaceae

Genus - Weichselia Stiebler

Sahni (1937) described W. reticulata from Gujarat.

Pteridosperms

Genus - Pachypteris Brongniart 1828.

Bose and Roy (1968) described P. indica. Bose and Banerji
(1984) described P. specifica Feistmantel and P. Cf. elegans
Archangelsky from Cutch.

Genus - Thinnfeldia Ettingshausen.

Recently Maheshwari (1986) reported T. indica Feistmantel
from Tiruchirpalli district in Tamil Nadu.

Cycadophytes

Genus - Ptilophyllum Morris 1840.

Bose and Banerji (1984) described following 9 species
from Cutch.

1. P. acutifolium Morris
2. P. oldhamii Jacob and Jacob.
3. P. indicum Jacob and Jacob.
4. P. distans Jacob and Jacob.

5. P. sakrigaliensis Sah
6. P. horridum Roy
7. P. institacallum Bose
8. C. Cf. amarjolense Bose.
9. P. sp.

Recently Sukh-Dev and Rajanikanth¹⁹⁸⁸ described following 3 species from Trichinapoly district in Tamil Nadu. The locality belong to lower Cretaceous age. (1) P. cutchense Morris, (2) P. acutifolium Morris, and (3) P. Cf. P. rarinervis (Feistmantel) Bose and Kasat.

Genus - Pterophyllum Erongniart 1828.

Bose and Banerji (1981) described P. distans from Cutch.

Genus - Anomozamites Schimper 1870

Bose and Banerji (1984) described following 2 species from Tamil Nadu.

1. A. haburensis, 2. A. sp.

Genus - Otozamites Braun 1843.

Bose and Banerji (1984) described following 3 species from Cutch.

1. O. imbricatus Feistmantel.
2. O. walkmotaensis Bose and Zeba-Bano.
3. O. kachchhensis Bose and Banerji.

Genus - Nilssoniopteris Nathorst, 1909

Bose and Banerji (1984) described following 2 species

(1) N. palluceus, (2) N. variabilis.

Genus - Williamsonia Carruthers 1870.

Feistmantel (1876) described W. blanfordii from Cutch.

Genus - Weltrichia Braun

It is a male flower of Willamsoniaceae and following 2 species are reported from Cutch.

1. W. sp. Sitholey and Bose, 1971.
2. W. harrisina Bose and Banerji 1984.

Coniferals

Family - Podocarpaceae

Genus - Elatocladus Halle 1913.

According to Bose and Banerji (1984) following four species are known from Cutch.

1. E. confertus (Oldham and Morris) Halle.
2. E. Cf. tenerrimus (Feistmantel) Sahni.
3. E. jabalpurensis (Feistmantel) Sahni.
4. E. chawadensis Bose and Banerji.

Borker and Chiplonker described a new species E. longifolium from Saurashtra.

Family - Araucariaceae

Genus - Pagiophyllum Heer.

Bose and Banerji (1984) described following 3 species from Cutch.

1. P. grantii
2. P. chawadensis
3. P. morrisii.

Borker and Chiplonker described P. sp. Cf. divarica ~~Cutn~~ (Bunbury). This makes the number of Pagiophyllum species occurring in the Umia Stage as 4.

Genus - Brachyphyllum Brongniart 1828.

Borkar and Chiplonkar (1971) described P. rgularis from Saurashtra. Recently Bose and Banerji (1984) described following 2 species, (1) B. expansum, and (2) B. royii. This suggests the occurrence of 3 species from Umia Stage.

Genus - Araucarites Presl. 1838.

Following 4 species are known from Cutch.

1. A. cutchensis (Feistmantel) Seward and Sahni 1920.
2. A. minutum Bose and Maheshwari.
3. A. janaianns Bose and Banerji.
4. A. Cf. nipaniensis Singh.

Reproductive Organs :

Genus - Conites Sterberg.

Bose and Banerji (1984) described from Cutch.

1. Conites sp. A.
2. Conites sp. B.

Genus - Strobilites Lindley and Hutton 1833.

Bose and Banerji (1984) described Strobilites Cf.
sewardii Sahni from Cutch.
