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FUNGAL REMAINS FROM THE NEOGENE SEDIMENTS OF MAHUADANR VALLEY, LATEHAR DISTRICT, JHARKHAND, INDIA AND THEIR PALAEOCLIMATIC SIGNIFICANCE

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ABSTRACT

Fungal remains are recorded from the Neogene fossiliferous beds exposed along the Rampur Nala and Birha River in the vicinity of Mahuadanr locality in Latehar District, Jharkhand, and their significance in understanding the palaeoenvironment discussed. The the exposed section is mainly constituted of pyroclastic rocks, conglomerates, sandstones and organic-rich shales. However, the lower part of the shales has yielded a very rich fungal assemblage with 22 well established forms, and 10 other types of spores and fruiting bodies of uncertain affinities very frequent in the sediments. The assemblageg suggests that the region experienced a humid climate during the course of sediment accumulation with a thick vegetation providing suitable substrates for the growth and proliferation of fungi.

Keywords: Tertiary, Fungal remains, Depositional Environment, Mahuadanr, Jharkhand

INTRODUCTION

The study of fossil fungal remains retrieved in the sedimentary deposits provides significant proxy records for palaeoenvironmental reconstruction, along with pollen/ spores and megafloral remains. The role of fungal remains/ spores in stratigraphy was dealt with by Graham (1962) and Elsik (1974). However, their utility in palynostratigraphy of the deposits is rather uncertain; as most of the fungal spores exhibit a wider distribution (Tiffney and Barghoorn, 1974; Pirozynski, 1978). For instance, the fossils belonging to Microthyriales have been recorded from the early Tertiary to Recent times (Elsik, 1968). Hence, it may not be reasonable to consider them as potential stratigraphic markers. On the other hand, their occurrence in relative frequencis and diversity in sedimentary deposits has relevance in deciphering the sequential changes in palaeovenvironment and palaeohabitat (Van Geel, 1978; Lange, 1978).

In India, there is considerable information on Tertiary fossil fungal remains from various regions such as Himachal Pradesh (Saxena *et al.,* 1984; Sarkar and Singh, 1988), Gujarat (Kar and Saxena, 1976, 1981; Kar, 1985; Rawat *et al.,*1977; Koshal and Uniyal, 1984; Bhattacharya, 1987), Rajasthan (Sah and Kar, 1974), Kerala (Rao and Ramanujam, 1976; Patil & Ramanujam, 1988), Madhya Pradesh (Trivedi and Verma, 1973; Barlinge and Paradkar, 1982), Neyveli in Tamil Nadu (Venkatachala and Rawat, 1972) and northeastern region (Kar *et al.,* 1972; Saluja *et al.,*1972; Jain and Dutta, 1978; Mehrotra, 1983;).There are also records from the Quaternary deposits of Gujarat (Sharma, 1976), Tripura (Prasad and Ramesh, 1983; Prasad, 1986) and Tamil Nadu (Rao and Menon, 1970).

These studies provide insights into palaeoclimatic trends in different sedimentary basins during the Tertiary and help to ascertain the relationships wtih host plants on which the fungi lived. Fossil fungi have substantiated paleoenvirontmental inferences based on pollen and mega fossil records in various basins. In the absence of pollen and mega fossil records, they have supplemented the palaeo climatic reconstruction. Until now there have been no such studies from Jharkhand, where the organic-rich, fossil-bearing horizons seem likely to contain fossil fungi. In view of this, a preliminary investigation has been executed while examining the megafloral remains from the Tertiary fossiliferous bed of Mahuadanr locality of Jharkhand.

Mahuadanr the locality of investigation (84° 06′ 40″ E, 23° 23′15″ N) lies 116 km south of Daltenganj and about 4 km northeast of Rajdanda townships in the Chhotanagpur Plateau region of Latehar District, Jharkhand (Fig.1).

GEOLOGY OF THE AREA

The state of Jharkhand, is structurally divided into the Gangetic Plain and the Chhtanagpur Plateau. The Chotanagpur Plateau is a part of the Indian peninsular shield- and can be divided into seven domains. The present area of investigation is in the Chhtanagpur granite gneiss terraen (Roy Chowdhury, 1974). The geology of this area has been described by Puri and Mishra (1982), who have assigned an age of late Tertiary (Neogene) to this section.

The Deccan Trap rocks extend into the southwestern corner of the Palamau District and cover the high plateau around Mahuadanr and Netarhat, the top portion of which is now usually weathered and altered to laterite and bauxite.

The sedimentary formations in the area form an outlier within the Pre-Cambrian Chhtanagpur Granite gnesis country. Pyroclastic sediments, conglomerates, sandstones and shales are exposed along the Birha River and its tributaries between Rajdanda and Mahaudanr villages. (Fig. 2)

The exposed stratigraphic sequence proposed by Puri and Mishra (1982) is shown in Fig. 3.

Towards the northwestern and southwestern extremities of the sedimentary outlier, a small outcrop of pumiceous rhyodacite is exposed in Jhumari-Mahua Nala. In the southwestern side of the area, the pyroclastics are unconformably overlain by conglomerates, sandstones or shales. In the northwestern part of the area, the pyroclastic rocks (volcanic sandstones) are exposed along the Birha river downstream from road bridge near Rajdanda and is overlain

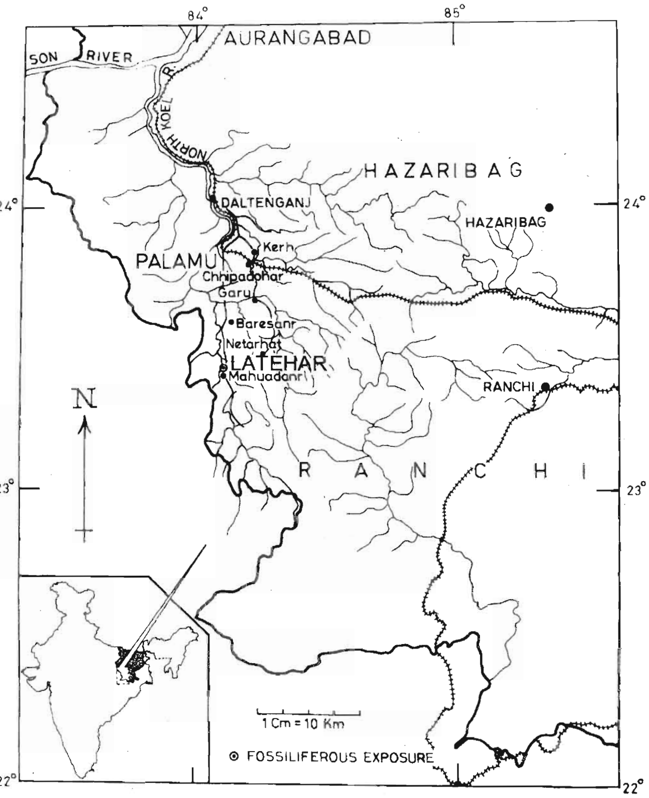

Fig. 1. Map showing investigation site Mahuadanr in Latehar District, Jharkhand.

by sandstones. Here the volcanic bed is massive in appearance and contains angular fragments of gneisses, amphibolites, felspar in a medium–grained matrix. The top 15 cm of these sediments have rounded pellet-like bodies embedded in the rock matrix (Puri and Mishra, 1982).

The conglomerate unit is exposed only towards the south of the outlier. In the southwestern extremity, it is 1m thick reaching 2m in the southeastern extremity. In the Birha River and the Rampur Nala, it overlies the granite-gneiss and in Jhumari Nala it overlies the pyroclastics and is overlain by sandstones. It contains 8-12 cm, rounded to subrounded fragments of granite-gneiss, and may have interbedded shales and sandstones in the Rampur Nala and the Birha River. Based on fossil fishes and birds, Puri and Mishra (1982) suggested late Tertiary (Neogene) age to this section, indicating a freshwater ponding depositional environment.

MATERIAL AND METHOD

Samples were collected from the 14.2 m thick section exposed along Rampur Nala in Mahuadanr Valley. Prior to the collection of samples, the exposed surface was scrapped up to 1 foot in order to remove the weathered and oxidized material. The section consists of pyroclastic rocks, conglomerates, sandstones and organic-rich shales. 10 samples were collected for fungal and pollen studies from this section.

After washing, the samples were treated with 40% HF for 2-3 days to dissolve silicates. Thereafter, the material was washed thoroughly with water followed by treatment with 10% HCL to remove carbonates. The residues were treated with 10% KOH solution in order to deflocculate spores and to dissolve humus. Finally, the material was washed thoroughly with water to remove alkali. The slides were prepared in polyvinyl for microscopic examination.

DESCRIPTION OF FUNGAL REMAINS

Twenty two well-established fossil fungal forms and 10 other tentatively identified fungal remains in the form of thallus, spores, fruiting bodies and vegetative parts have been recorded (Plates I&II). The morphological details of the retrieved fungal taxa/remains and their affinities with modern counterparts are given as below:

1. ***Microthyriacites* sp.** (Pl. I, fig. 1) - Fruiting body is about 70 μm in diameter; ostiole obscure and surrounded by radiating rows of indistinct elongated cells. Body shows slightly wavy margin.
   Comments - The recovered fungal body very closely resembles with the modern family Microthyriaceae. However, due to some vague cellular structures it could not be assigned exactly to the extant taxon. Hence, it is put in an artificial genus, *Microthyriacities*. Such types of fungal forms have also been recovered by several workers from the Miocene of Quilon, Kerala (Jain and Gupta, 1970) and from the Holocene peat of Tripura (Prasad, 1986).
2. ***Microthyrium* sp.** (Pl. I, fig. 2) - Fruiting body is 80 μm in diameter with distinct margin, ostiole wide and prominent. The wall of the fruiting body possesses radiating rows of sub-quadrangular cells, which are narrower near the centre and become wider towards the periphery.

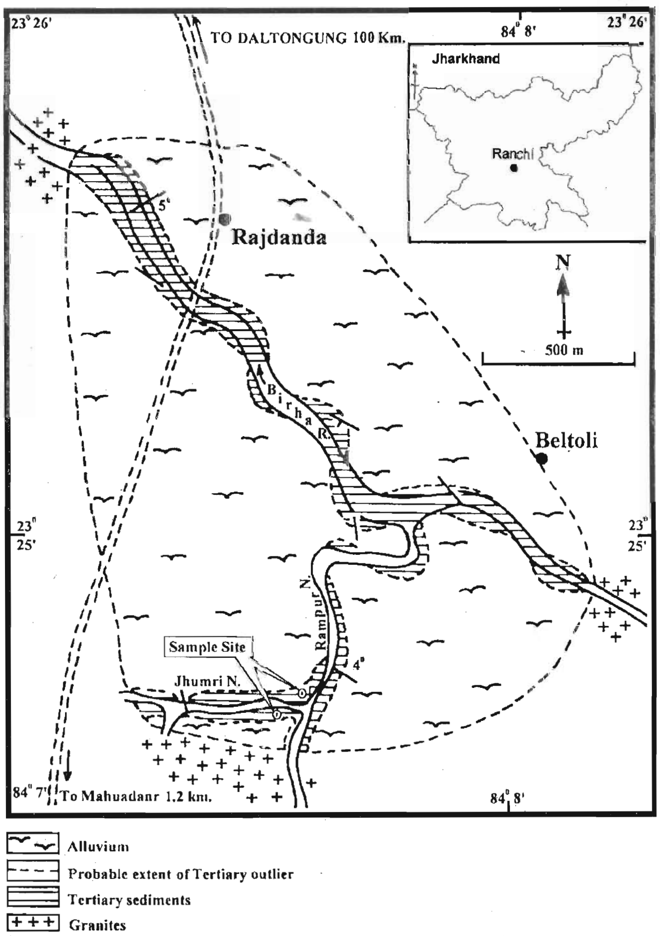

Fig. 2. Detailed geological map of the Mahuadanr area.

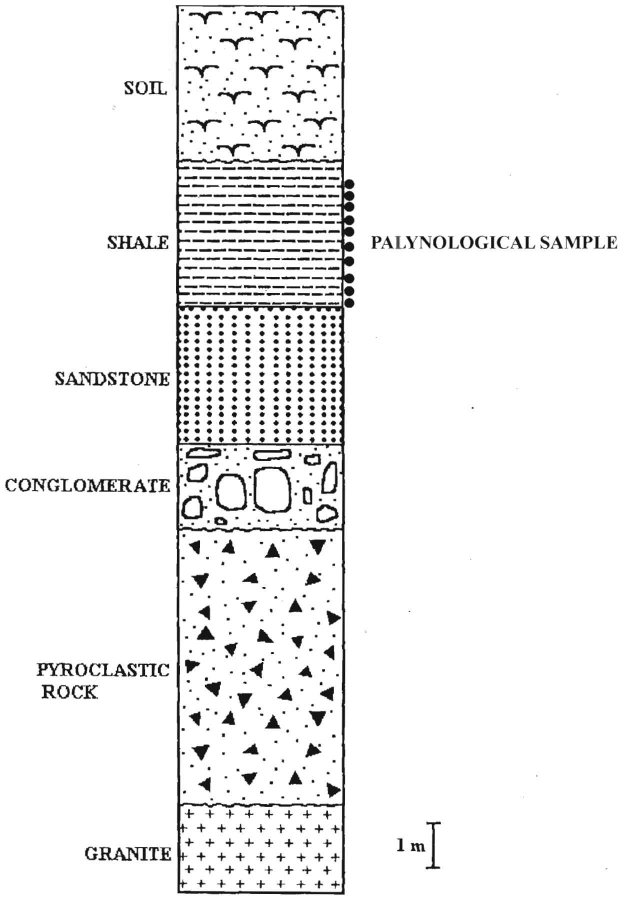

Fig. 3. Lithostratigraphy of investigated section in the Mahuadanr area (after Puri and Mishra, 1982).

Comments - Van Geel (1978) reported the fruiting body of Microthyriaceae in the Holocene peat sample of the Netherlands. Similar fruiting bodies have also been recovered from different geological strata such as the Holocene of Tripura (Prasad, 1986) and Miocene-Pliocene of Cuddalore (Jacob and Jacob, 1950) belonging to *Microthyrium* and Microthyriaceae groups, respectively.

3. **Fruiting body of *Trichothyrites*** (Pl. I, figs. 3,5) - Fruiting body is 53 μm in diameter with a conspicuous darker body constituted of thickened cells. The ostiole is provided with a rim of thick-walled cells. The rest of body has elongated cells arranged in radiating rows, which gradually get widened towards the margin.
Comments - The members of the family Trichothyriaceae are common tropical hyperparasite on other epiphyllous ascomycetes. This type of fruiting body has also been described from the Holocene of Tripura (Prasad, 1986).

4. **Fruiting body of *Microthyrium* Type** (Pl. I, figs. 4) - Fruiting body measuring 60 μm in diameter is spheroidal and with radiating rows of sub-quadrangular cells. Cells are smaller towards the central part and gradually become broader toward the peripheral region. ostiole is very distinct and wide with dark outline.
Comments - The fruiting body exhibits its close affinities with those of extant *Microthyrium*. However, the cells are comparatively much wider than in the *Microthyrium* sp. described earlier. Hence, the present form is designated as *Microthyrium* Type.

5. ***Phragmothyrites*** (Pl. I, fig. 6) - Fungal fruiting body is radial, circular, non-ostiolate and measures about 55 μm in diameter. The wall of fructification contains elongated files of cells. The cells towards central part are smaller as compared to those of the peripheral region.
Comments - The fruiting body is large and shows some resemblance with those of Microthyriaceae. However, it has been assigned to an artificial form genus *Phragmothyrites,* to which it exhibits some resemblance in morphological characters. It has been recorded from lower Eocene of Kutch (Venkatachala, Kar and Raza, 1969), lower Miocene of Quilon, Kerala (Jain and Gupta, 1970) and Holocene deposits in Tripura (Prasad, 1986).

6. **Fungal fruiting body Type-I** (Pl. I, fig.7) - fungal body is multicellular and irregular in shape, measuring 60 x 50 μm in dimension. Cells are small without a definite outline.
Comments - Owing to much obscured features, it could not be possible to trace out the affinities of this fungal fruiting body to any modern taxonomic group. Hence, it has been termed the Fungal fruiting body Type-I.

7. ***Spinosporonites*** (Pl. I, fig. 8) - Spore is multicellular, inaperturate, sub-circular with diameter of 40 μm (excluding spines). Each cell gives rise to a robustly built 6-7 μm long spine. Spines are up to 3 μm long with wide base and acute tip.
Comments - It resembles *Spinosporonites indicus* recorded from the Neyveli Formation of Tiruchirapalli, Tamil Nadu (Saxena and Khare, 1992).

8. ***Diporisporites*** (Pl. I, fig. 9) - Fungal spore is 6-celled, 32 μm long and 20 μm wide in dimension. Terminal cells are bilobed, porate and fusiform with dark thickening. Pores are about 5 μm wide. Spore splits at each end.
Comments - It shows resemblance with the *Diporisporites* described by Elsik (1968) from Rockdale Lignite, Milam County, Texas.

9. **Fungal spore Type-II** (Pl. I, fig. 10) - Bicelled sickle-shaped spore measures 36 x 10 μm in size, slightly constricted at middle and gradually tapering on either sides; septum with a thick pore at the centre. Spore is provided with longitudinal germ slit all along the length.
Comments - Affinities of this fungal spore could not be ascertained to any extant genus or species.

10. ***Nigrospora*** (Pl. I, fig. 11) - Unicellular dark hyaline spheroidal spore, about 26 μm in diameter, papillate type, slightly pointed, protruding on either sides.
Comments - It is abundantly found in sediments and is a common pathogen of grasses.

11. ***Multicellaesporites*** (Pl. I, fig. 12) - Multicellular, inaperturate fungal spore (6-7-celled), fusiform, uniseriate, 37 μm long with maximum width of 10 μm, sides tapering up to 4 μm, light brown, cells on either ends smaller and pointed. Central cells are larger, almost rectangular conspicuous with triangular 2.5 μm high septal folds and a pore at centre. Spore wall is 1.5 μm thick and psilate.
Comments-Multicellaesporites spore was described from Miocene of Tonakkal area, Kerela (Verma and Patil, 1985), Quaternary sediments of Arabian sea (Chandra, Saxena and Setty, 1984) and Holocene deposits of Tripura (Prasad and Ramesh, 1983).

12. ***Meliola* sp.** (Pl. I, fig. 13) - Spore barrel-shaped, measuring 32 x 18 μm in diameter, 5-celled, central cells are rectangular; basal and terminal cells dome-shaped, septa 2 μm thick,

spore wall 1.5-2 µm thick, psilate.

Comments - Modern forms of genus *Meliola* are widely described in humid tropics and are obligate or obligophagous parasite on green plants (Hansford, 1961). These spores found in low frequencies and are recovered from the Miocene bed of the Tonakkal area, Kerala (Verma and Patil, 1985), from the Holocene deposits of Tripura (Prasad, 1986; Prasad and Ramesh, 1983) and Calcutta, West Bengal (Banerjee and Sen, 1988). However, the fossil record of this extant genus extends up to Eocene in U.S.A. (Dilcher, 1965).

13. ***Alternaria* sp.** (Pl. II, figs. 1,4) - Conidia multicellular with both transverse and longitudinal septa, much variable in size and shape, obclavate to elliptical or ovoid, 75-80µm long and 10-25µm broad at its widest with an apical appendage.

Comments - It has been reported from the Quaternary of Malvan, Surat District, Gujarat (Sharma, 1976) and Pykara, Ootacamund, Tamil Nadu (Rao and Menon, 1970).

14. Fungal spore Type-III (Pl. II, fig. 2) - Fungal spore dark, measuring 82 µm long with maximum width of 49 µm, but 46 µm wide at the centre due to constriction, surface provided with ward-like structures with blunt ends, two thick bands are visible on the surface.

Comments - Unidentified fungal spore type.

15. Cleistothecium Type (Pl. II, fig. 3) - It is globular and completely closed cleistothecium-containing ascocarps. Fruiting body is provided with some hyaline septate appendages dark in colour.

Comments - It shows close similarities with the cleistothecium of *Ascomycotina*.

16. ***Diporicellaesporites*** (Pl. II, fig. 5) - Spore large, 5-celled, 110 µm x, 55 µm in dimension, 3-septate, septa dark and conspicuous, tetracillate, psilate and one slit-like aperture present on either end, aperture chambers are slightly off-set from outline of inner chamber; septa prominent.

Comments-It shows resemblance with the *Diporicellaesporites* recorded from the Rockdale Lignite, Milam County, Texas (Elsik, 1968).

17. ***Helminthosporium*** (Pl. II, fig. 6) - Conidia 11-celled, thick walled, 100 µm long and 15 µm wide, cylindrical or ellipsoidal, often curved a little, gradually narrowing at both ends, brown, thick walled with 8-10 transverse septa; septum between cells thick with single perforation.

Comments - It is a common pathogen of grasses and frequently occurs in the fossiliferous horizon of the investigated site. The spores have been recovered from the Quaternary deposits of Malvan, Surat District, Gujarat (Sharma, 1976) and Pykara, Ootacamund, Tamil Nadu (Rao and Menon, 1970).

18. Fungal spore Type-IV (Pl. II, fig. 7) - Fungal spore multicellular, 41 µm long and 25 µm wide; spore with two prominent longitudinal septa.

Comments - The identity of this fungal spore could not be traced to any extant and form genera, hence it has been designated as Fungal spore Type-IV.

19. ***Multicellaesporites elsikii*** (Pl. II, fig. 8) - Fungal spore 5-celled, elliptical, 15 x 8 µm in size, generally inaperturate, septa clear, individual cells same of size.

Comments - It resembles *Multicellaesporites elsikii* described by Kar and Saxena (1976) from the Palaeocene of Kutch, Gujarat.

20. Fungal spore Type-V (Pl. II, fig. 9) - Spore is club-shaped, 10-celled, septa thick, size 50 x 10 µm at border area and 50 x 7 µm in tapering area. Basal cells are tapering into a tail-shaped structure. Apical portion is comparatively much broader.

Comments - Fungal spore could not be assigned to any extant and form genus because of insufficient distinguishing features.

21. ***Tetraploa*** (Pl. II, fig. 10) - Conidia quadriserrate, oblong, generally with four setose and septate appendages, size of body ranging from 20 to 40µm in length and, 15 to 30µm in width, setae 20-40µm long and 3-5µm broad.

Comments - This has been reported from the Quaternary of Malvan, Surat, Gujarat (Sharma 1976), Miocene beds of Quilon, Kerala (Rao and Ramanujam, 1975), Palaeocene-Eocene of the Cauvery Basin, Tamil Nadu (Venkatachala and Rawat, 1972).

22. ***Monoporisporites koenigii*** (Pl. II, fig. 11) - Spore oval to subspherical, pear-shaped, 2 µm x15 µm in dimension, psilate, monoporate; spore darkly pigmented; apical pore bulges out slightly; septa with four perforations.

Comments - It resembles *Monoporisporites koenigii* (Elsik, 1968) from the Rockdale Lignite, Texas.

23. ***Dicellaesporites* sp.** (Pl. II, fig. 12) - Fungal spore 2-celled, oval in shape, measuring 33 x 23 µm in size, capsular, inaperturate; wall 0.5 µm thick, psilate; septum 1 µm thick appearing to be two layered.

Comments - It shows resemblance with *Dicellaesporites* sp. (Elsik, 1968) from the Rockdale Lignite, Texas.

24. ***Staphlosporonites*** (Pl. II, fig. 13) - Ten-celled, oval fungal spore, dark walled, 28 x 19 µm in dimension, septa thick and placed parallel to a median longitudinal groove.

Comments - Sheffy and Dilcher (1971) recovered similar type of fungal spores from the Eocene of Tennessee, U.S.A. and named them as *Staphlosporonites*. These have also been described from East African Lake (Wolf, 1967).

25. ***Curvularia*** (Pl. II, fig. 14) - Conidia 3-5 celled, dark brown colour, 40µm long and 10 µm broad, thick walled, somewhat fusiform, curved or bent with one or two enlarged cells in the centre.

EXPLANATION OF PLATE I

(All figures x 750)

1. ***Microthyriacites*** sp.
2. ***Microthyrium*** sp. - fruiting body

3&5. ***Trichothyrites***- fruiting body

4. ***Microthyrium*** Type -fruiting body
6. ***Phragmothyrites***- fruiting body
7. Fungal fruiting body Type-I
8. ***Spinosporonites***
9. ***Diporisporites***
10. Fungal spore Type-II
11. ***Nigrospora***
12. ***Multicellaesporites***
13. ***Meliola*** sp.

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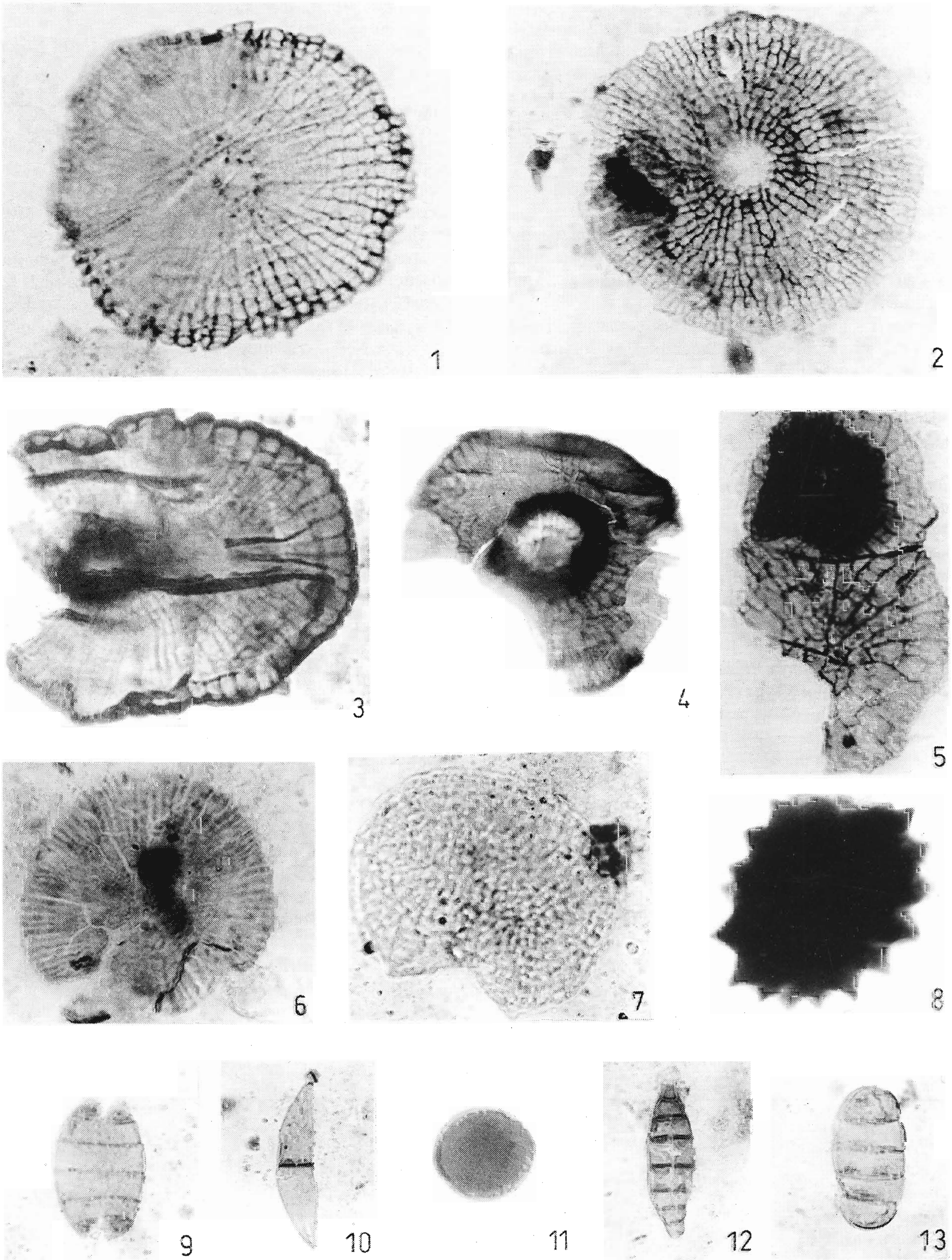
Plate I



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Comments - It is a common pathogen of grasses and has been recorded abundantly from the fossiliferous horizon of the investigated site. It has been reported from the Quaternary deposits of Malvan, Surat, Gujarat (Sharma, 1976) and Pykara, Ootacamund, Tamil Nadu (Rao and Menon, 1970).

26. Ascospore (Pl. II, fig. 15) - Spore unicellular, ovoid, measuring 8 x 5 µm in size and psilate.
Comments - It closely resembles ascospore of *Ascomycotina*.

27. Fungal spore Type-VI (Pl. II, fig. 16) - Spore multicellular, triseriate, cells arranged in a thick ring-like, dark hyaline structure, with broad and hollow central part; size 25 µm in circumference.
Comments - Fungal spore could not be assigned to any extant and form genus because of insufficient distinguishing features.

28. *Didymoporisporonites normalis* (Pl. II, fig. 17) - Spore 2-celled, measuring 25 x 13 µm in dimension, slight constriction at the middle, psilate, opaque septum, wall 0.5-1.0 µm thick, pore present at one end.
Comments - It resembles *Didymoporisporonites normalis* of Sheffy and Dilcher (1971).

29. *Diplodia* Type (Pl. II, fig. 18) - Fungal spore bicelled, cell open on either poles, septa prominent with a single pore, thickened at middle; size of spore 22 x 10 µm, maximum width of single cell *ca.* 12 µm.
Comments - This type of spore has also been recorded from the Quaternary beds Kumaun and Tertiary deposits of Chindwara, Madhya Pradesh (Mahabale, 1969).

30. *Dictyosporium* spore Type (Pl. II, fig. 19) - Spores elliptical, olive-brown, multicellate, psilate with the horizontal as well as vertical septa, size 22 x 14 µm; septum is 2µm thick, spore wall 1.5 µm thick,
Comments - Spores of this type were described under the name of *Dictyosporium* spore Type-I from the Miocene of the Tonakkal area, Kerala (Verma and Patil, 1985).

31. *Cookeina* sp. (Pl. II, fig. 20) - Bicelled fungal spore, golden yellow in colour, fusiform with longitudinal striations, size 18 x 10µm.
Comments - Spore shows much resemblance with modern *Cookenia* as recorded from the Lake Tanganyika sediments (Wolf and Cavaliere, 1966). Similar type of spores has also been recorded from the Neogene sediments of Quilon and Warkalli, Kerala (Ramanujum and Rao, 1978) and Holocene of Tripura (Prasad, 1986).

32. Fungal spore Type-VII (Pl. II, fig. 21) - Fungal spores eight-celled (28 x 22 µm), broad, dark septate and septa without definite outline.
Comments - Due to much obscured features, it could not be identified.

PALAEOCLIMATIC INFERENCES

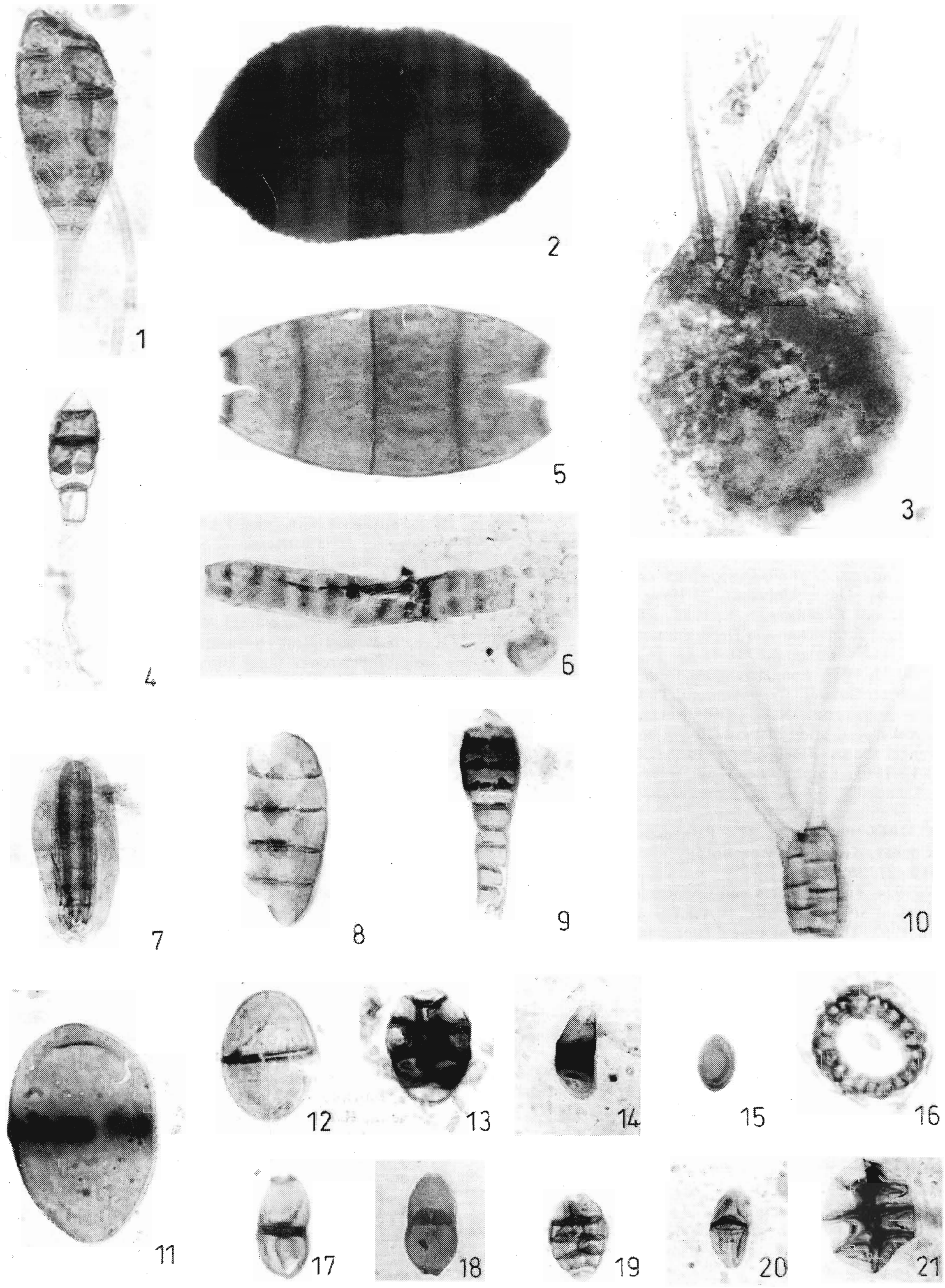
The fungal spores are not taken as stratigraphic markers, as they have a wider range of occurrence in terms of geological time scale. However, their presence in the fossiliferous beds furnishes very significant and reliable database in order to understand the depositional environment of sediments as well as to substantiate the palaeoclimatic inferences drawn mainly on the basis of the megafossils recovered from the sediments. Sometimes in the absence of the megafloral remains in the horizons owing to poor preservation, they can be solely used to supplement the depositional environment. During the course of investigation of megafloral remains mainly leaf impressions from the Neogene fossiliferous beds exposed along Rampur Nala in the vicinity of Mahuadanr Valley in Latehar District, Jharkhand, we have come across a large number of fungal remains in the form of unicellular to multicellular structures of different shapes and sizes in variable frequencies in the sediments. The lower part of the exposed section, mainly constituted of pyroclastic rocks, conglomerates, sandstones and organic-rich shales, has yielded a very rich fungal assemblage comprising 22 well-established forms such as *Tetraploa*, *Curvularia*, *Diplodia*, *Nigrospora*, *Cookeina*, *Alternaria*, *Helminthosporium*, *Meliola*, *Multicellaesporites elsikii*, *Trichothyrites*, *Microthyrium*, *Microthyrites* sp., *Monoporisporites koenigii*, *Phragmothyrites*, *Dictyosporum*, *Didymosporisporonites*, *Dicellaesporites*, *Staphlosporonites*, *Diporisporites*, *Diporicellaesporites* and *Spinosporites* and 10 other fungal remains in the form of spores and fruiting bodies of uncertain affinities. The preponderant record of parasitic fungi such as *Tetraploa*, *Helminthosporium*, *Nigrospora*, *Diplodia*, etc., the common pathogens of cereals and grasses, along with saprophytic fungi viz., *Curvularia*, *Alternaria*, *Cookeina* and *Dictyosporium* reflects the presence of luxuriant herbaceous vegetation with plenty of wood logs, litters and other decaying organic remains on the ground floor, which provided suitable substrates for the proliferation and dissemination of all these fungi during the course of sediment accumulation in the basin. The rich diversity of the fungal remains in the sedimentary deposits is indicative of prevalence of a humid climate in the region. Interestingly,

EXPLANATION OF PLATE II

(All figures x 750 otherwise stated)

1&4. ***Alternaria*** sp.
2. Fungal spore Type-III
3. ***Cleistothecium*** Type
5. ***Diporicellaesporites***
6. ***Helminthosporium*** X500
7. Fungal spore Type IV
8. ***Multicellaesporites elsikii***
9. Fungal spore Type-V
10. ***Tetraploa***
11. ***Monoporisporites koenigii***
12. ***Dicellaesporites*** sp.
13. ***Staphlosporonites***
14. ***Curvularia***
15. ***Ascospore***
16. Fungal spore Type-VI
17. ***Didymoporisporonites normalis***
18. ***Diplodia*** Type
19. ***Dictyosporium*** spore Type
20. ***Cookeina*** sp.
21. Fungal spore Type-VII

Plate II



the frequent retrieval of multiple forms of the epiphyllous fungi such as *Microthyrium*, *Microthyrium* sp., *Microthyrites*, *Phragmothyrites*, *Trichothyrites*, etc. together with *Meliola* also strongly provides authentic evidence for the equivalent climate as they require an environment of high humidity coupled with high temperature for their optimal growth. The recovery of a large numbers of well-preserved fossil leaf impressions (Singh and Prasad, 2007) belonging to tropical evergreen and deciduous elements from the same fossiliferous beds also corroborates the prevailing humid climate in the region during the Neogene. Howevere, the record of fishes from the same beds (Puri and Mishra, 1982) suggests that the sedimentation in the basin occurred in a ponding environment.

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