Fungal remains from the Early Palaeogene subsurface sediments of Barakha, Barmer District, western Rajasthan, India

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ABSTRACT

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The present paper deals with fungal remains obtained from the Akli Formation (Late Palaeocene-Early Eocene) encountered in a bore-hole near Barakha Village, Barmer District, Rajasthan. The assemblage, dominated by fungal spores, is represented by 10 genera and 17 species and is characterized by high frequency of *Inapertisporites, Brachysporisporites* and *Hypoxylonites*. Different species of *Hypoxylonites* and *Spirotremesporites* have affinity with modern family Xylariaceae.

Key-words: Fungal remains, Akli Formation, Late Palaeocene-Early Eocene, Barmar, Rajasthan, India.

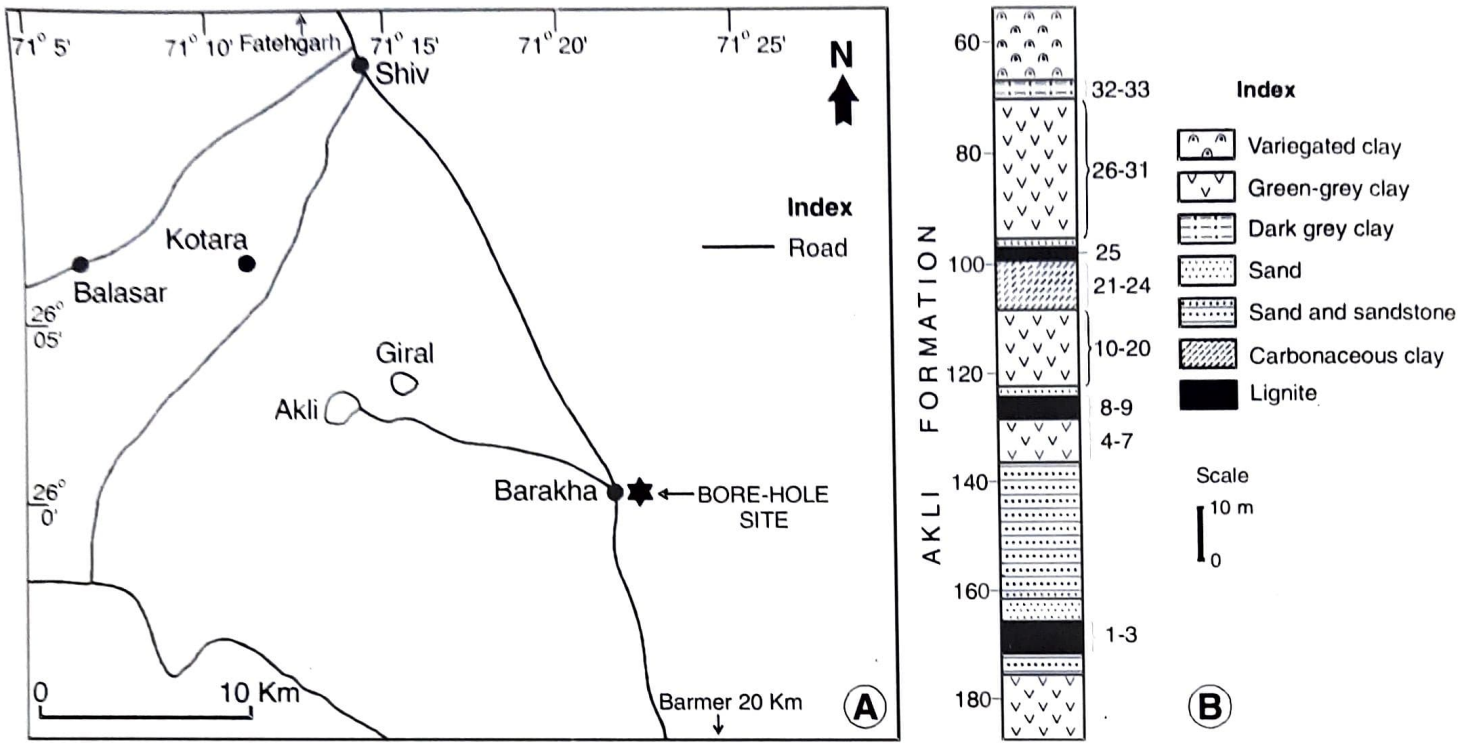
INTRODUCTION

Early Tertiary sediments of Barmer Basin were deposited in a narrow, elongated, roughly N-S trending linear graben (Sisodia & Singh 2000, Roy & Jakhar 2002). The present study was carried out on rock samples of a bore-hole near Barakha Village in Barmer District, Rajasthan. The bore-hole sequence represents Akli and Kapurdi formations but recovery of plant microfossils was limited to the former litho-unit. The Akli Formation is comprised of grey/green clay, carbonaceous clay, sandstone and lignite beds. The assemblage recorded from this formation is dominated by fungal spores and is represented by 10 genera and 17 species. The assemblage is characterized by high frequency of *Inapertisporites, Brachysporisporites* and *Hypoxylonites.*

Palynological studies on the Akli Formation have been carried out by Tripathi et al. (2003, 2009) and Tripathi and Srivastava (2010). These studies were conducted on rock samples collected from open-cast lignite mines near Akli and Giral and variety of palynofossils were recovered. Numerous bones of lower vertebrates, comprising of fish, crocodiles and snakes, have been reported from the Akli Formation (Rana et al. 2005).

MATERIAL AND METHOD

Samples for the present study were collected by one of us (H.S.) from a bore-hole, drilled by Mineral Development Corporation Limited, Rajasthan, located about 3 km north-east of Barakha Village (Lat. 25°67'51"N: Long. 71°21'14"E) in the Barmer District, Rajasthan (Text-figure 1A). Altogether, thirty three samples were macerated, of which 9 samples proved palynologically productive (Text-figure 1B, Table 1). Clay samples were treated with HCl (for 12 hours) followed by HF (for 3-4 days). Lignite samples were treated with HNO_3 (for 3-4 days). The acid treated samples were washed with the help of 500 mesh sieve and then treated with 10-15% potassium hydroxide solution. The slides were prepared in polyvinyl alcohol and mounted in canada balsam. The slides are stored in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.



Text-figure 1. A. Map showing location of the borehole. B. Bore-hole section showing position of samples.

DESCRIPTION OF FUNGAL REMAINS

Genus: *Inapertisporites* van der Hammen 1954

***Inapertisporites giganticus* Song 1985**

Plate 1, figure 1

Description: Spore ovoid, 35x24 µm, inaperturate, spore wall 1.5 µm thick, scabrate, provided with irregular folds.

***Inapertisporites kedvesii* Elsik 1968**

Plate 1, figures 3, 8

Description: Spores subspherical, 25-30x20-28 µm, unicellular, inaperturate, spore wall less than 1 µm thick, psilate, provided with irregular folds.

***Inapertisporites edigeri* Kalgutkar & Jansonius 2000**

Plate 1, figure 7

Description: Spore sub-ovoid, 15x11 µm, unicellular, inaperturate, provided with a longitudinal fold in centre of body, spore wall 1.5 µm thick, psilate.

Genus: *Spirotremesporites* Duenas-Jimenez 1979

***Spirotremesporites eminens* (Rouse & Mustard) Kalgutkar & Jansonius 2000**

Plate 1, figure 2

Description: Spores elliptical, 27-31x8-11 µm, tapering at both the ends, aperturate, aperture in form of thin groove like sulcus extending longitudinally in spiral fashion, spore wall about 1 µm thick, psilate.

Genus: *Brachysporisporites* Lange & Smith 1971

***Brachysporisporites longovatus* Song & Cao 1994**

Plate 1, figure 4

Description: Spores oval, 30x14-36x18 µm, 5-celled, cells separated by very thick septa, basal cell largest, apical cell smallest, spore wall 2 µm thick, psilate.

***Brachysporisporites catinus* (Elsik & Jansonius) Kalgutkar & Jansonius 2000**

Plate 1, figure 11

Description: Spores oval, 25x15-38x21 µm, 4-celled, cells separated by very thick septa, basal cell largest, apical cell smallest, spore wall 2 µm thick, psilate.

***Brachysporisporites pyriformis* Lange & Smith 1971**

Plate 1, figure 13

Description: Spores pyriform, 24 µm long, basal

Table 1. Occurrence of fungal taxa in the samples of bore-hole near Barakha, Village, Barmer District, Rajasthan

Taxa	Sample numbers								
	1	2	3	4	5	6	7	9	13
Brachysporisporites pyriformis	+								
Brachysporisporites catinus			+						
Brachysporisporites longovatus				+	+				
Hypoxylonites sulekii		+			+				
Hypoxylonites vittatoides						+			
Hypoxylonites magnus				+	+				
Hypoxylonites felixii	+		+						
Inapertisporites giganticus				+					
Inapertisporites edigeri						+			
Inapertisporites kedvesii				+			+	+	
Spirotremesporites eminens				+		+			
Pluricellaesporites cf *P. cooksoniae*			+						
Multicellites crassisporus	+								
Reduviasporonites catenulatus		+							
Phragmothyrites edwardsii		+							
Scolicosporites scalaris								+	
Dicellaesporites popovii							+		+
Fungal Spore Type 1	+		+						

cell 15 µm wide, 3-celled, cells separated by thick septa, the septum separating the basal cell almost centrally placed, spore wall 3-4 µm thick, psilate.

Genus: *Hypoxylonites* Elsik 1990

***Hypoxylonites sulekii* Elsik 1990**

Plate 1, figure 6

Description: Spores narrowly elliptical, 18-21x7-10 µm, lateral ends rounded, aseptate, longitudinal furrow wide with rounded ends, extending up to ¾ the length of spore, spore wall 2 µm thick, psilate.

***Hypoxylonites vittatoides* Elsik 1990**

Plate 1, figure 9

Description: Spore oval, 18x12 µm, lateral ends broadly rounded, aseptate, longitudinal furrow schizoid, almost completely traversing the spore, spore wall 1.5 µm thick, psilate.

***Hypoxylonites magnus* Elsik 1990**

Plate 1, figure 14

Description: Spores elliptical, 19-22x10-13 µm, one end broadly rounded, other end obtusely pointed, aseptate, provided with a centrally placed longitudinal furrow extending about two third of the spore length, spore wall 3 µm thick, thicker at lateral ends, psilate.

***Hypoxylonites felixii* Elsik 1990**

Plate 1, figure 18

Description: Spores oval, 20-23x10-14 µm, lateral ends rounded, aseptate, provided with a centrally placed longitudinal furrow covering the full length of the spore, spore wall 2 µm thick, psilate.

Genus: *Dicellaesporites* Elsik 1968

***Dicellaesporites popovii* Elsik 1968**

Plate 1, figure 12

Description: Spore more or less oval, 21x10 µm, dicellate, inaperturate, spore wall 1.5 µm thick, psilate.

Genus: *Pluricellaesporites* van der Hammen 1954

Pluricellaesporites cf *P. cooksoniae* Kalgutkar & Jansonius 2000

Plate 1, figure 15

Description: Spore body elongated, 65 µm, 5-celled, apical end of the spore obtusely pointed, antapical cells gradually tapering, last antapical cell filamentous, slender and tail like, each septum provided with a pore, maximum width of spore 4 µm, spore wall less than 1 µm thick, psilate.

Remarks: Present specimen differs from *Pluricellaesporites cooksoniae* Kalgutkar & Jansonius (2000) in being longer, slender and in having fewer numbers of cells.

Genus: *Scolicosporites* Lange & Smith 1971

Scolicosporites scalaris (Kalgutkar) Kalgutkar & Jansonius 2000

Plate 1, figure 16

Description: Spore body filamentous, 80x10 µm, scalariform, multicellular, 17 cells arranged in a row, spore tapering at both the ends, cells equally spaced with regular transverse septa, each septum provided with wedge-shaped folds and a pore, individual cell wider than long (10x7 µm), spore wall less than 1 µm thick, psilate.

Genus: *Multicellites* Kalgutkar & Jansonius 2000

Multicellites crassisporus (Salard-Cheboldaeff & Locquin) Kalgutkar & Jansonius 2000

Plate 1, figure 17

Description: Phragmospore ovate, 18x10 µm, inaperturate, provided with fissures at the extreme ends, 4-celled, septa porate, thickened around the central perforation, spore wall less than 1 µm thick, psilate.

Remarks: Present specimen is smaller in size than the form described by Salard-Cheboldaeff & Locquin (1980) but is similar in other characters.

Genus: *Reduviasporonites* Wilson 1962

Reduviasporonites catenulatus Wilson 1962

Plate 1, figure 19

Description: Conidia like spores arranged in chain, individual cell 8-11 µm long, 7-9 µm wide, contact area of cells flattened, cell wall less than 1 µm thick, psilate.

Genus: *Phragmothyrites* Edwards 1922

Phragmothyrites edwardsii (Rao) Kalgutkar & Jansonius 2000

Plate 1, figure 20

Description: Ascomata subcircular, 32-43 µm, non-ostiolate, margin uneven, central cells polygonal, outer cells radially elongated, individual cell non-porate.

→

Plate 1

1. *Inapertisporites giganticus* Song 1985; slide no. 14082; Coordinates: 22.7x73.4 (35x24 µm).
2. *Spirotremesporites eminens* (Rouse & Mustard) Kalgutkar & Jansonius 2000; slide no. 14078; Coordinates: 25.6x64.4 (27x8 µm).
3,8. *Inapertisporites kedvesii* Elsik 1968; slide nos. 14072 and 14071; Coordinates: 21.8x74.3 and 26.3x65.4 respectively (25x20 and 24x21 µm respectively).
4. *Brachysporisporites longovatus* Song & Cao 1994; slide no. 14069; Coordinates: 26.5x64.4 (30x14 µm).
5,10. Fungal Spore Type 1; slide nos. 14077 and 14066; Coordinates: 25.6x72.5 and 24.6x773.5 respectively (18x9 and 19x12 µm respectively).
6. *Hypoxylonites sulekii* Elsik 1990; slide no. 14074; Coordinates: 26.7x75.4 (19x7 µm).
7. *Inapertisporites edigeri* Kalgutkar & Jansonius 2000; slide no. 14070; Coordinates: 24.5x77.6 (15x11 µm).
9. *Hypoxylonites vittatoides* Elsik 1990; slide no. 14075; Coordinates: 32.3x66.5 (18x12 µm).
11. *Brachysporisporites catinus* (Elsik & Jansonius) Kalgutkar & Jansonius 2000; slide no. 14081; Coordinates: 25.8x71.7 (25x15 µm).
12. *Dicellaesporites popovii* Elsik 1968; slide no. 14073; Coordinates: 25.7x63.6 (20x10 µm).
13. *Brachysporisporites pyriformis* Lange & Smith 1971; slide no. 14083; Coordinates: 27.4x76.3 (24 µm long, basal cell 15 µm wide).
14. *Hypoxylonites magnus* Elsik 1990; slide no. 14079; Coordinates: 25.3x76.2 (19x10 µm).
15. *Pluricellaesporites* cf *P. cooksoniae* Kalgutkar & Jansonius 2000; slide no. 14067; Coordinates: 33.5x63.5 (65x4 µm).
16. *Scolicosporites scalaris* (Kalgutkar) Kalgutkar & Jansonius 2000; slide no. 14076; Coordinates: 28.5x74.5 (80x10 µm).
17. *Multicellites crassisporus* (Salard-Cheboldaeff & Locquin) Kalgutkar & Jansonius 2000; slide no. 14064; Coordinates: 23.2x77.3 (18x10 µm).
18. *Hypoxylonites felixii* Elsik 1990; slide no. 14080; Coordinates: 29.6x76.4 (20x10 µm).
19. *Reduviasporonites catenulatus* Wilson 1962; slide no. 14065; Coordinates: 27.7x75.6 (Individual cells 8-11x7-9 µm).
20. *Phragmothyrites edwardsii* (Rao) Kalgutkar & Jansonius 2000; slide no. 14068; Coordinates: 24.7x72.6 (35 µm).

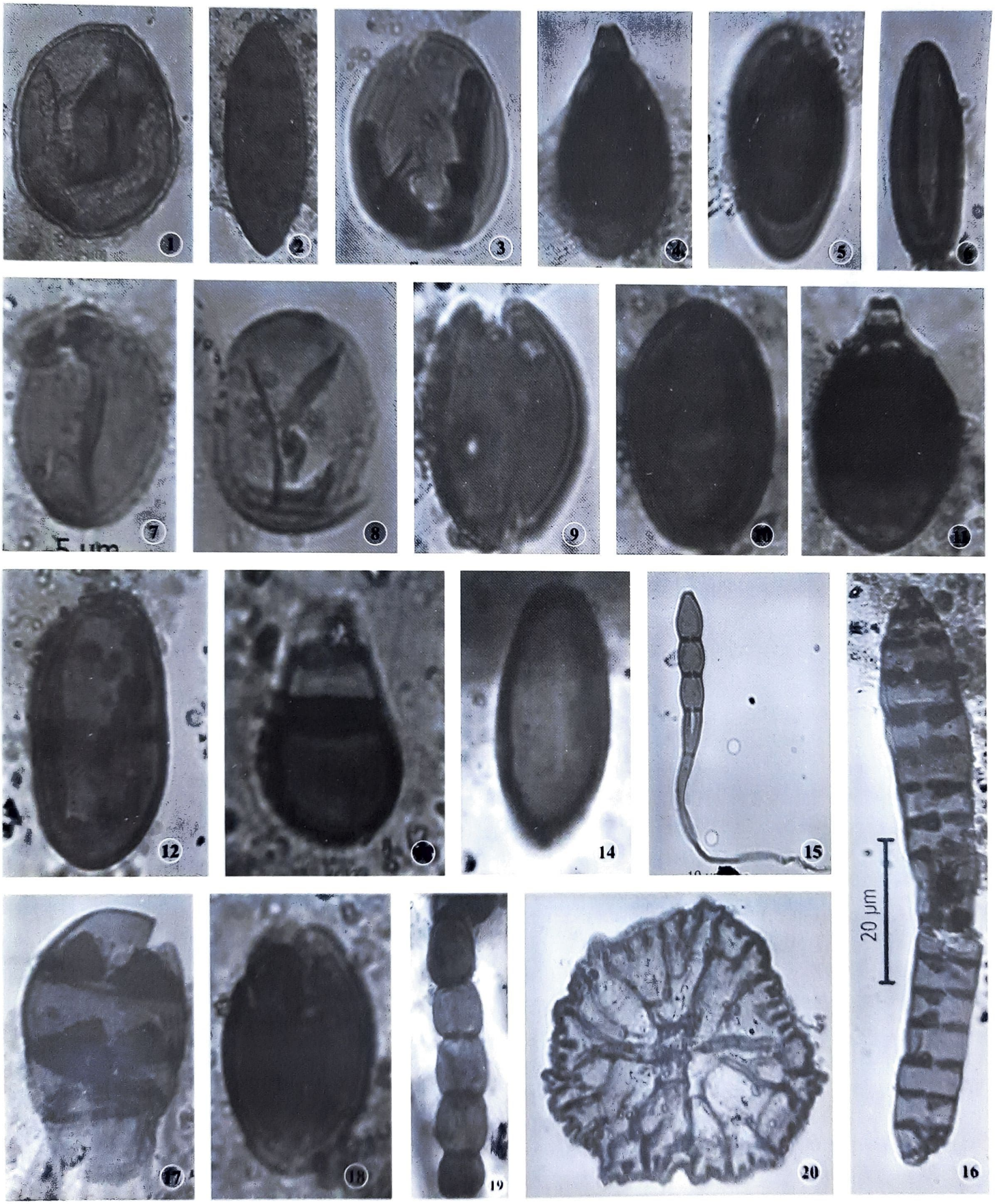


Plate 1

Fungal Spore Type 1

Plate 1, figures 5, 10

Description: Fungal spores oval, 18x9-20x12 µm, lateral ends rounded, provided with a dark central body appressed to the lateral walls, spore wall 1.5-2 µm thick, psilate.

Remarks: The spore is unique in possessing a central body, a character not observed in any other described spore.

DISCUSSION

The present fungal assemblage contains spores having affinity with the family Xylariaceae (*Hypoxylonites* and *Spirotremesporites*). Abundance and diversity of these spores, along with other fungal remains, suggest prevalence of tropical, warm-humid climatic conditions during the deposition of Akli sequence (Elsik 1990). Most of the members of family Xylariaceae grow on rotten wood or are parasites on some angiosperms. Sedimentological and palynological studies indicate that the Akli Formation was deposited under brackish water conditions (Sisodia & Singh 2000, Tripathi et al. 2009).

Fungal remains from Early Palaeogene sediments of western India have been recorded from Barmar, Rajasthan (Jain et al. 1973, Tripathi & Srivastava 2010), Palana, Rajasthan (Sah & Kar 1974), Kutch, Gujarat (Kar & Saxena 1976, 1981, Kar 1978, 1985), Rajpardi lignite, Gujarat (Bhattacharya 1987, Kar & Bhattacharya 1992, Samant & Phadtare 1997), Bhavnagar, Gujarat (Samant 2000), Surat lignite, Gujarat (Samant & Tapaswi 2000) and Cambay Basin (Rawat et al 1977, Koshal & Uniyal 1984). Most of these assemblages are richly represented by different species of *Lacrimasporonites, Monoporisporites, Parmathyrites, Kutchiathyrites, Trichothyrites, Dyadosporites* and *Diporisporites*. These genera are not represented in the present assemblage. However, some fungal forms described earlier from the Akli Formation (*Hypoxylonites, Inapertisporites, Brachysporisporites, Scolicosporites, Phragmothyrites, Multicellites*) by Tripathi and Srivastava (2010) occur in the present assemblage also. Presence of *Hypoxylonites* and *Spirotremesporites*, having affinity with modern family Xylariaceae, is a striking feature of the present assemblage. Different species of these genera are reported to occur in good number from Tertiary sediments of Meghalaya and Tripura, north-eastern India (Nandi et al. 2003).

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REFERENCES

Bhattacharya M. 1987. Fungal remains from the Rajpardi lignite, Broach District, Gujarat. Geophytology 17(1): 120.

Duenas-Jimenez H. 1979. Estudio palinologico de los 35 mts. superiores de la seccion Tarragona, Sabana de Bogata. Caldasia 12: 539-571.

Elsik W. C. 1968. Palynology of a Paleocene Rockdale lignite, Milam County, Texas. I. Morphology and taxonomy. Pollen Spores 10: 263-314.

Elsik W. C. 1990. *Hypoxylonites* and *Spirotremesporites*, form genera for Eocene to Pleistocene fungal spores bearing a single furrow. Palaeontographica Abt. B 216: 137-169.

Jain K. P., Kar, R. K. & Sah S. C. D. 1973. A palynological assemblage from Barmer, Rajasthan. Geophytology 3(2): 150-165.

Kalgutkar R. M. & Jansonius J. 2000. Synopsis of fungal spores, mycelia and fructifications. AASP Contribution Series 39: 1-423.

Kar R. K. 1978. Palynostratigraphy of the Naredi (Lower Eocene) and the Harudi (Middle Eocene) formations in the district of Kutch, India. Palaeobotanist 25: 161-178.

Kar R. K. 1985. The fossil floras of Kachchh -IV. Tertiary palynostratigraphy. Palaeobotanist 34: 1-280.

Kar R. K. & Bhattacharya M. 1992. Palynology of Rajpardi lignite, Cambay Basin and Gujra Dam and Akri lignite, Kutch Basin. Palaeobotanist 39(2): 250-263.

Kar R. K. & Saxena R. K. 1976. Algal and fungal microfossils from Matanomadh Formation (Palaeocene), Kutch, India. Palaeobotanist 23(1): 1-15.

Kar R. K. & Saxena R. K. 1981. Palynological investigation of a bore core near Rataria, southern Kutch, Gujarat. Geophytology 11(2): 103-124.

Koshal V. N. & Uniyal S. N. 1984. Palaeocene-Early Eocene palynofossils in the subsurface of North Cambay Basin, Gujarat (western India). In: Badve R. M. et al. (Editors) - Proceedings of the 10th Indian Colloquium on Micropalaeontology and Stratigraphy. Pune 1982, Maharashtra Association for the Cultivation of Science, Pune: 233-243.

Lange R. T. & Smith P. H. 1971. The Maslin Bay flora, South Australia. 3. Dispersed fungal spores. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte no. 11: 663-681.

Nandi B., Banerjee S. & Sinha A. 2003. Fossil Xylariaceae spores from the Cretaceous and Tertiary sediments of north-eastern India.

Acta Palaeontologica Sinica 42(1): 56-67.

Rana R. S., Kumar K., Singh H. & Rose K. D. 2005. Lower vertebrates from the Late Palaeocene–Earliest Eocene Akli Formation, Giral Lignite Mine, Barmer District, western India. Curr. Sci. 89(9):1606-1613.

Rawat M. S., Mukherjee J. S. & Venkatachala B. S. 1977. Palynology of the Kadi Formation, Cambay Basin, India. In Venkatachala B. S. & Sastri V. V. (Editors) – Proceedings of the 4th Colloquium on Indian Micropalaeontology and Stratigraphy. Dehradun 1974-75, Institute of Petroleum Exploration, Oil & Natural Gas Commission, Dehradun: 179-192.

Roy A. B. & Jakhar S. R. 2002. Geology of Rajasthan (North-west India) Precambrian to Recent. Scientific Publishers (India), Jodhpur, 421 pp.

Sah S. C. D. & Kar R. K. 1974. Palynology of the Tertiary sediments of Palana, Rajasthan. Palaeobotanist 21(2): 163-188.

Salard-Cheboldaeff M. & Locquin M. V. 1980. Champignons présents au Tertiaire le long du littoral de l'Afrique équatoriale. 105e Congrès National des Sociétés savantes, Caen, 1980, Sciences, fascicule 1: 183-195.

Samant B. 2000. Fungal remains from the Bhavnagar lignite, Gujarat, India. Geophytology 28(1-2): 11-18.

Samant B. & Phadtare N. R. 1997. Stratigraphic palynoflora of the Early Eocene Rajpardi lignite, Gujarat and the lower age limit of the Tarkeshwar Formation of South Cambay Basin, India. Palaeontographica Abt. B 245(1-6): 1-108.

Samant B. & Tapaswi P. M. 2000. Fungal remains from the Surat lignite deposits (Early Eocene) of Gujarat, India. Gondwana Geol. Mag. 15(2): 25-30.

Sisodia M. S. & Singh U. K. 2000. Depositional environment and hydrocarbon prospects of Barmer Basin, Rajasthan, India. North American Free Trade Association 51(9): 309-326.

Song Z. 1985. A research on Tertiary palynology from the Qaidam Basin, Qinghai Province. Edited by Research Institute of Exploration and Development, Qinghai Petroleum Administration, [and] Nanjing Institute of Geology and Palaeontology, Academia Sinicia, 297 p. (in Chinese). Petroleum Industry Press.

Song Z. & Cao L. 1994. Late Cretaceous fungal spores from King George Island, Antarctica; Stratigraphy and Palaeontology of Fides Peninsula, King George Island, Antarctica. Monograph 3: 47-49.

Tripathi S. K. M., Kumar M. & Srivastava D. 2009. Palynology of Lower Palaeogene (Thanetian-Ypresian) coastal deposits from Barmer Basin (Akli Formation, Western Rajasthan, India): Palaeoenvironmental and palaeoclimatic implications. Geologica Acta 7(1-2): 147-160.

Tripathi S. K. M., Singh U. K. & Sisodia M. S. 2003. Palynological investigation and environmental interpretation on Akli Formation (Late Palaeocene) from Barmer Basin, western Rajasthan, India. Palaeobotanist 52(1-3): 87-95.

Tripathi S. K. M. & Srivastava D. 2010. Palynological investigations, facies analysis and palaeoenvironmental interpretations from Late Palaeocene to Early Eocene lignites and associated sediments of Barmer, western India. Palaeobotanist 59: 1-32.

Van der Hammen T. 1954. El desarrollo de la flora Colombiana en los periodos geológicos. I. Maestrichtiano hasta Terciario más inferior. Boletín Geológico 2: 49-106.

Wilson L. R. 1962. A Permian fungus spore type from the Flowerpot Formation of Oklahoma. Oklahoma Geology Notes 22: 91-96.