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Palynofloral investigation of Akli Formation (Palaeocene) of Giral Lignite Mine, Barmer District, Rajasthan, India

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ABSTRACT

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Palynological analysis of lignite and associated sediments, including fragmentary amber pieces, from a sediment profile recently exposed at northern part of Giral Lignite Mine yielded palynoassemblage of pollen, spores and fungal remains. The dominant elements are angiospermous pollen belonging to the families Arecaceae, Annonaceae, Onagraceae Ctenolophonaceae and Bombacaceae, followed by pteridophytic spores having close affinity with Dicksoniaceae, Schizaeaceae, Pteridaceae, Matoniaceae and Lycopodiaceae. Based on palynofossils, it can be inferred that the area supported dense tropical evergreen to semi-evergreen low land forest. Pteridophytic spores show sub-aquatic to swampy conditions and fungal remains indicate prevalence of warm-humid climate. Presence of a good amount of Arecaceae pollen and a few dinoflagellate cysts also suggests that site was close to coast.

Key-words: Palynoflora. Akli Formation, Palaeocene-Early Eocene, Giral Lignite Mine, Barmer District, Rajasthan.

INTRODUCTION

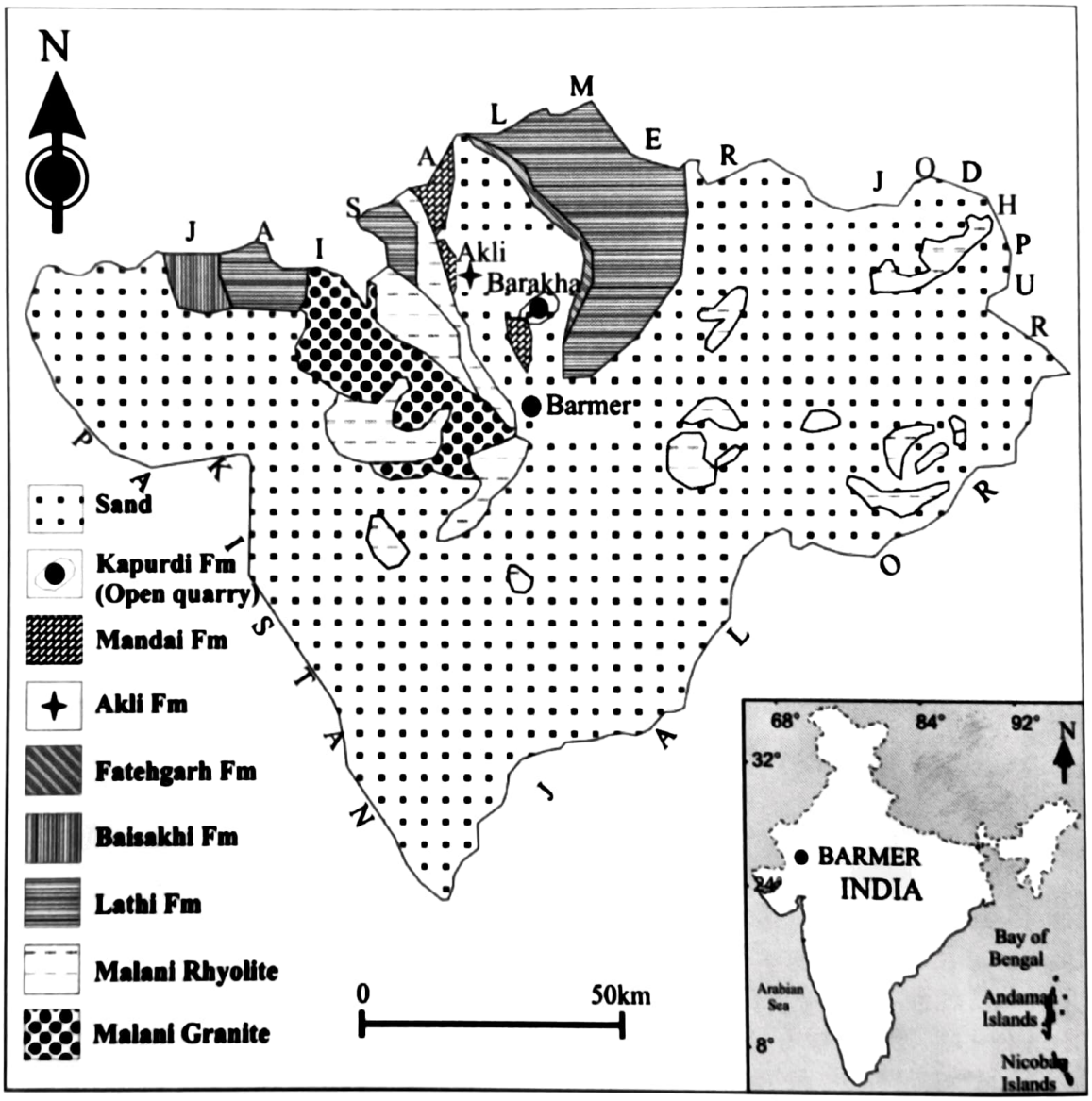
Palynofossils from the Late Palaeocene-Early Eocene sediments of Rajasthan have been recorded by Bose (1952), Jain et al. (1973), Naskar and Baksi (1978), Tripathi (1994, 1995, 1997), Tripathi et al. (2003, 2009), Tripathi and Srivastava (2010), Singh and Tripathi (2010) and Singh and Mahesh (2015). Geology of Barmer district has been published by Sisodia and Singh (2000). Faunal studies by Sahni et al. (2004) and Rana et al. (2005, 2006) indicate Late Palaeocene-Early Eocene age for the Akli Formation and Early Eocene age for the Kapurdi Formation. The present paper attempts to record the palynoflora from the newly exposed section of Akli Formation and to interpret the depositional environment and age of this sedimentary succession.

MATERIAL AND METHODS

Samples were collected from a newly exposed section at the northern part of Giral Lignite Mine. This site (Lat. 26°25'07"N, Long. 71°09'47"E) is about 40 km NNW of Barmer city and 14 km NW from Barakha village. This sediment profile is exposed at the side of Barmer-Fatehgarh road at Giral-Thumbli area (Text figure 1) and is capped by alluvial and fluvial sand and sand dune. The Akli Formation unconformably overlies the Fatehgarh Formation and is underlain by the Mandai Formation (Table 1). 34 samples and 15 pieces of amber were collected from 34 m thick exposed section of the mine for palynological analysis (Text figure 2). For

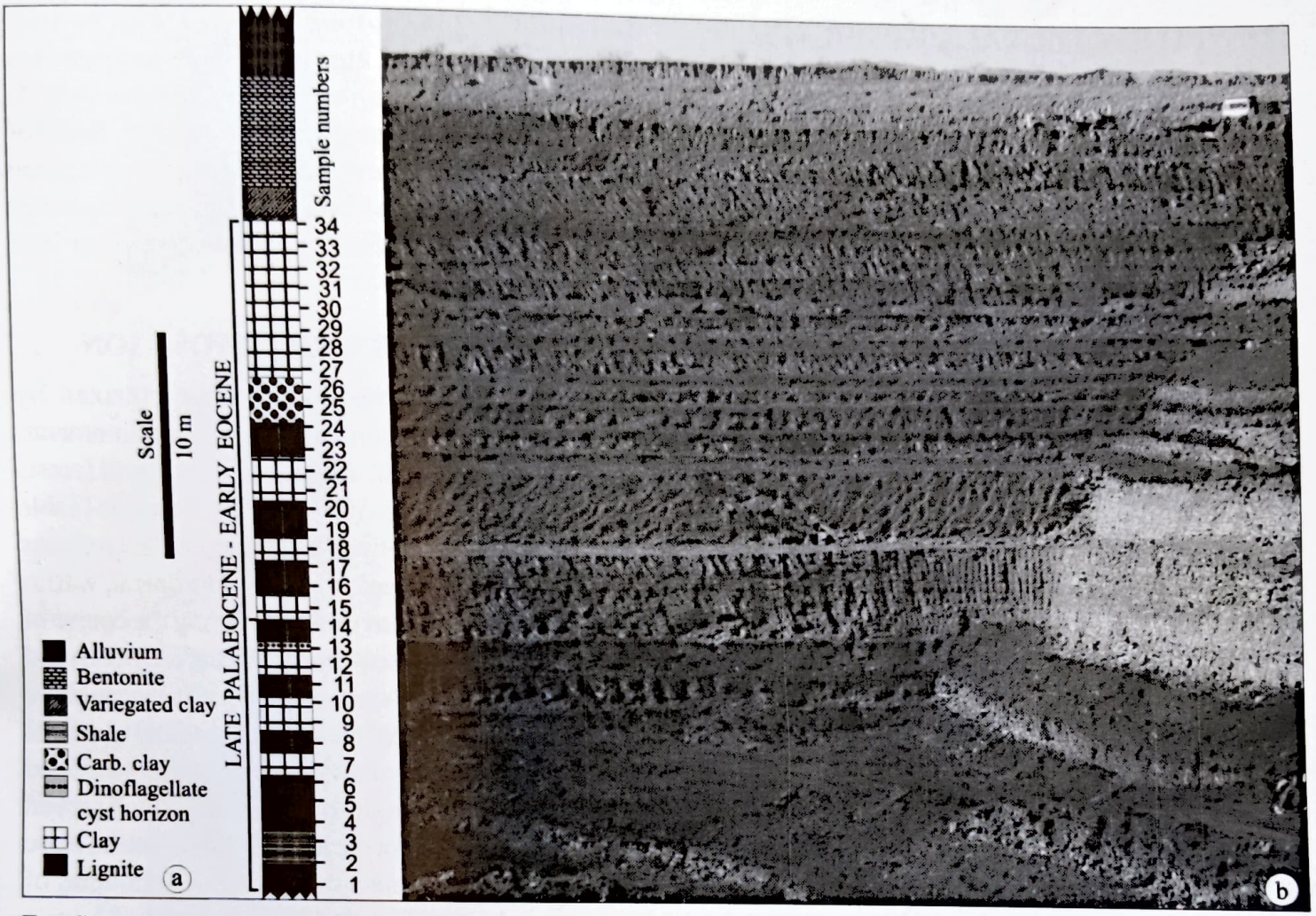
Table 1. Generalized Tertiary stratigraphic succession of the Barmer basin.

Stratigraphic units	Lithology	Age
Kapurdi Formation (30m)	Yellowish-white shale like clay bed with Gypsum bands	Lower Eocene
Mandai Formation (100m)	Conglomerate, dirty white sandstone, ferruginous sandstone and quartzitic sandstone	Palaeocene to Lower Eocene
Akli Formation (265m)	Grey and reddish bentonite, greenish grey clay with or without Lignite intercalated with siliceous earth and gypsum.	Palaeocene
Fatehgarh Formation (70m)	Siltstone, ferruginous siltstone with sub-bentonite, flaggy, kankery sandstone, phosphatic sandstone, pebbly and gritty sandstone and conglomerate	? Upper Cretaceous to Palaeocene



Text-figure 1. Location of Giral Lignite Mine (Akli Formation), Barmer District, Rajasthan (After Rana et al. 2005).

extraction of palynofossils from rock samples, standard maceration technique was followed. However, amber pieces were dissolved in toluene to recover microbiota. The dissolved mixture was sieved through 500 mesh sieve, washed with toluene and then dehydrated with glacial acetic acid and centrifuged. The residue was acetolysed. This mixture was centrifuged to remove supernatant acetolysed mixture and the residue was sieved and washed with distilled water. The slides are prepared with polyvinyl alcohol and mounted using canada balsam. The slides were studied under Leica DM 3000 microscope. The dissolved amber pieces exhibit spores, pollen and fragmented woody materials as well fragmentary body parts of the insects.



Text-figure 2. a. Vertical stratigraphic column of the mine face from where samples were collected. **b.** Newly exposed section in the northern part of Giral Lignite Mine (Akli Formation), Barmer District, Rajasthan.

Frequency of each palynotaxa was determined by counting about 150 palynofossils per sample. Frequency and distribution of recovered palynomorphs were utilized to understand floral composition, its spatial variation and environmental conditions. The studied slides are stored in the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Table 2. Botanical affinities and present day distribution of families represented in the palynoflora.

Families	Palynotaxa	Present day distribution
Dicksoniaceae	*Dictyophyllidites kyrtomatus*	Tropical-subtropical, subaquatic to swampy
Schizaeaceae	*Lygodiumsporites lakiensis*	Tropical-subtropical, climbing fern
Lycopodiaceae	*Lycopodiumsporites specious*	Cosmopolitan
Pteridaceae	*Pteridacidites* sp.	Tropical-subtropical
Arecaceae	*Neocouperipollis kutchensis, Acanthotricolpites karii, Spinizonocolpites echinatus, Spinizonocolpites adamantus, Spinizonocolpites baculatus, Spinizonocolpites prominatus, Kapurdipollenites clavatus, Proxapertites hammenii, Arecipites bellus, Monocolpopollenites kutchensis, Albertipollenites crassireticulatus*	Tropical-subtropical
Annonaceae	*Matanomadhiasulcites maximus, Polybrevicolporites cephalus*	Tropical
Fungi	*Brachysporisporites tenuis, Callimothallus pertusus, Multicelliasporites confusus*	Tropical humid

PALYNOFLORAL ASSEMBLAGE

Pteridophytic spores: *Dictyophyllidites kyrtomatus* Kar & Kumar 1986, *Lycopodiumsporites specious* Dutta & Sah 1970, *Lygodiumsporites lakiensis* Sah & Kar 1969 and *Pteridacidites* sp.

Angiospermous pollen: *Acanthotricolpites karii* Saxena & Khare 2004, *Albertipollenites crassireticulatus* (Dutta & Sah 1970) Mandal & Rao 2001, *Arecipites bellus* Sah & Kar 1970, *Kapurdipollenites clavatus* Tripathi 2010, *Longapertites discordis* Frederiksen,1994, *Matanomadhiasulcites maximus* (Saxena 1979) Kar 1985, *Monocolpopollenites kutchensis* (Venkatachala & Kar 1969) Saxena & Trivedi 2009, *Neocouperipollis kutchensis* (Venkatachala & Kar 1969) Kar & Kumar 1986; *Polybrevicolporites cephalus* Venkatachala & Kar 1969, *Proxapertites hammenii* Venkatachala & Rawat 1972, *Spinizonocolpites adamantus* Frederiksen 1994, *S. baculatus* Muller 1968, *S. echinatus* Muller 1968, *S. prominatus* (McIntyre 1965) Stovar & Evans 1973.

Dinoflagellate cysts: *Polysphaeridium congregatum* (Stover 1977) Bujak et al. 1980 and *Spiniferites ovatus* Matsuoka 1983.

Fungi: *Brachysporisporites tenuis* Kumar 1990, *Callimothallus pertusus* Dilcher 1965, *Multicellites confusus* (Chandra et al. 1984) Kalgutkar & Jansonius 2000.

The palynoassemblage is dominated by angiospermous pollen, particularly those having affinity with modern plants presently confined to tropical to subtropical areas. These are: *Acanthotricolpites karii, Albertipollenites crassireticulatus, Arecipites bellus, Kapurdipollenites clavatus, Matanomadhiasulcites maximus, Monocolpopollenites kutchensis, Neocouperipollis kutchensis, Proxapertites hammenii, Spinizonocolpitse adamantus, S. baculatus, S. echinatus* and *S. prominatus*. Some of the constituents of the pteridophytic assemblage are *Dictyophyllidites kyrtomatus, Lygodiumsporites lakiensis, Lycopodiumsporites speciosus* and *Pteridacidites* sp.

ENVIRONMENT OF DEPOSITION

The palynoassemblage is characterized by vegetation thriving in coastal, mangrove environments. Evergreen trees of both tropical to sub-tropical forests also occur with thick fern vegetation along side (Table 2). Recorded pteridophytic spores and fungal remains also suggest that the region witnessed tropical, warm-humid climate with heavy rain fall during the course of deposition. Rich representation of Arecaceae pollen and few dinoflagellate cysts indicate existence of near-shore environment and exhibit mixing of marine and terrestrial elements. The habitat of palynoflora suggests lowland vegetation of dense angiosperm forests which served as the source material for the formation of lignite in close proximity to the palaeo-shore line. Abundance of biodegraded terrestrial and high amount of humic organic matter show anoxic conditions throughout the mine sequence. The overall floral composition indicates presence of low land angiosperm vegetation in the lower part of the succession and abundance of family Arecaceae in a middle part. The upper part is mostly dominated by pteridophytic and angiospermous plants. Arecaceae (55%), Lycopodiaceae (15%), Matoniaceae (10%), Annonaceae (8%), unidentified (7%), and fungal bodies (5%) are represented in the sedimentary sequences. Flora extracted from amber

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Plate 1

1. *Dictyophyllidites kyrtomatus* Kar & Kumar, BSIP Slide No. 15563. **2-3.** *Lygodiumsporites lakiensis* Sah & Kar, BSIP Slide Nos. 15558, 15561. **4.** *Lycopodiumsporites specious* Dutta & Sah, BSIP Slide No. 15559. **5.** *Pteridacidites* sp., BSIP Slide No. 15561. **6-7.** *Spinizonocolpites echinatus* Muller, BSIP Slide Nos. 15559, 15560. **8.** *Spinizonocolpites adamantus* Frederiksen, BSIP Slide No. 15558. **9.** *Spinizonocolpites baculatus* Muller, BSIP Slide No. 15558, 10. *Spinizonocolpites prominatus* (McIntyre) Stovar & Evans, BSIP Slide No. 15562. **11.** *Neocouperipollis kutchensis* (Venkatachala & Kar) Kar & Kumar, BSIP Slide No. 15558. **12.** *Acanthotricolpites karii* Kar & Bhattacharya, BSIP Slide No. 15563. **13.** *Kapurdipollenites clavatus* Tripathi & Srivastava, BSIP Slide No. 15562. **14.** *Proxapertites hammenii* Venkatachala & Rawat, BSIP Slide No. 15563. **15.** *Arecipites bellus* Sah & Kar, BSIP Slide No. 15563. **16.** *Monocolpopollenites kutchensis* (Venkatachala & Kar) Saxena & Trivedi, BSIP Slide No. 15562. **17.** *Albertipollenites crassireticulatus* (Dutta & Sah) Mandal & Rao, BSIP Slide No. 15561. **18.** *Matanomadhiasulcites maximus* (Saxena) Kar, BSIP Slide No. 15558. **19.** *Polybrevicolporites cephalus* Venkatachala & Kar, BSIP Slide No. 15562. **20.** *Brachysporisporites tenuis* Kumar, BSIP Slide No. 15562.

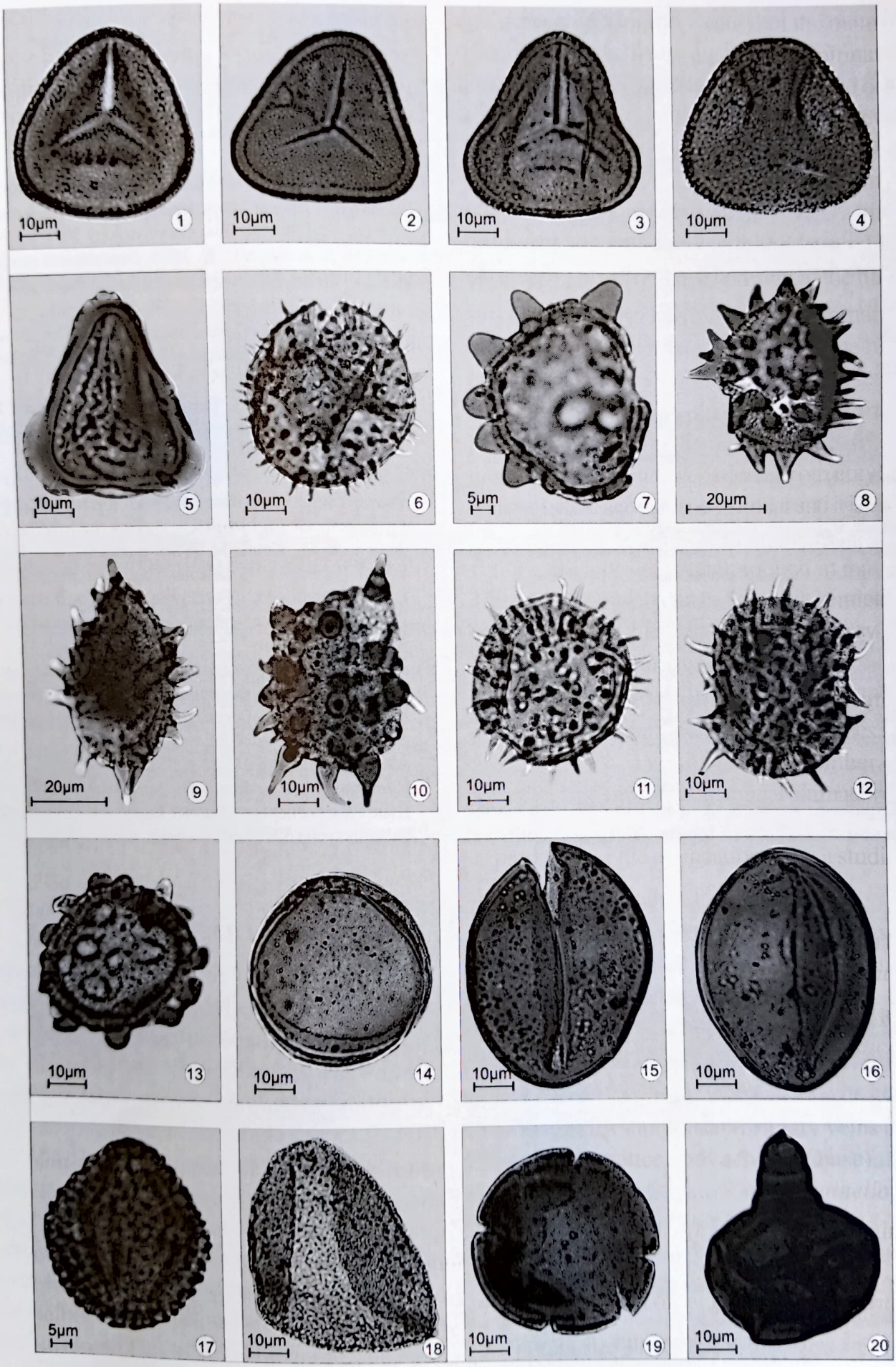
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Plate 1

also shows more or less same composition pattern, e.g. Arecaceae (53%), Lycopodiaceae (12%), Matoniaceae (8%), Annonaceae (6%), unidentified (12%) and fungal bodies (9%).

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