

# Palynological record from Chhasra Formation (Early Miocene), Eastern Kutch, Gujarat

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## ABSTRACT

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A moderately diverse palynoflora consisting of angiospermous pollen and pteridophytic spores has been recorded from poorly known Chhasra Formation (Early Miocene) exposed in a section near Palasawa in eastern Kutch, Gujarat, western India. Dinoflagellate cysts are absent in the section, whereas the fresh water *Centropyxis*, a testate amoeba, is recorded. Among the important genera recovered are: *Hammenisporis*, *Khariasporites*, *Acanthotricolpites*, *Spinizonocolpites*, *Spinomonocolpites*, *Retitrescolpites*, *Meliapollis*, *Ctenolophonidites*, *Palaeomalvaceapollis*, *Graminidites* and *Ericipites*. Preliminary qualitative and quantitative assessment reveals the dominance of angiospermous pollen grains over pteridophytic spores, and an overall warm and humid coastal climate with tropical rain forest in a lowland coastal setting. Ongoing work in this newly identified section may reveal greater insights into diversity and significance of the Chhasra palynoflora.

**Key-words**—Palynology, Palaeoecology, Neogene (Early Miocene), Palasawa, Eastern Kutch.

गुजरात में पूर्वी कच्छ के छसरा शैलसमूह (प्रारंभिक मध्यनूतन) से प्राप्त परागाणविक अभिलेख

पूनम वर्मा, निवेदिता मंडल, एम.आर. राव, महेश जी. ठक्कर एवं सुनील बाजपेई

## सारांश

पश्चिमी भारत में गुजरात के पूर्वी कच्छ के पलसावा के निकट खंड में अनावरित अल्प विख्यात छसरा शैलसमूह (प्रारंभिक मध्यनूतन) से आवृतबीजीय पराग व टेरिडोफाइट बीजाणुओं से युक्त नियंत्रित भिन्न परागाणुवनस्पतिजात अभिलिखित की गई है। खंड में घूर्णीकशाभ पुटियां नहीं हैं, जबकि अलवण जल एक वसीयती अमीबा, *सेन्ट्रोपिक्सिस* अभिलिखित किया गया है। प्राप्त महत्वपूर्ण वंश - *हम्मेनीस्पोरिस*, *खरियास्पोराइटिज़*, *एकेन्थोड्राईकोल्पाइटिज़*, *स्पाइनोमोनोकोल्पाइटिज़*, *स्पाइनोमोनोकोल्पाइटिज़*, *रेटिट्रेस्कोल्पाइटिज़*, *मेलियापोल्लिस*, *टीनोलोफोनिडाइटिज़*, *पैलियोमालवेसीपोल्लिस*, *ग्रामिनिडाइटिज़* एवं *एरिसिपोइटिज़* हैं। प्रारंभिक गुणात्मक एवं मात्रात्मक मूल्यांकन टेरिडोफाइट बीजाणुओं पर आवृतबीजीय पराग कणों की प्रभुत्वता तथा निचलीभूमि तटीय जमाव में उष्णकटिबंधीय वर्षा वन सहित तट के समग्र कोष्ण एवं आर्द्र जलवायु का खुलासा करते हैं। इस नवीन अभिनिर्धारित खंड में चल रहा कार्य छसरा परागाणुवनस्पतिजात की विविधता एवं सार्थकता में बृहत् अंतर्दृष्टि का खुलासा कर सकता है।

**संकेत-शब्द**—परागाणुविज्ञान, पुरापास्थितिकी, नियोजन (प्रारंभिक मध्यनूतन), पलसावा, पूर्वी कच्छ।

## INTRODUCTION

THE sedimentary basin of Kutch includes the entire district of Kutch in the Gujarat State of western India. The exposed Tertiary sequence in Kutch comprises mostly shallow marine shelf sediments in the peripheral and intervening structural lows bordering the Mesozoic uplift areas (Biswas, 1992). Considerable amount of palynological data has been documented from the Palaeogene sediments by Mathur (1963, 1966); Venkatachala and Kar (1969); Sah and Kar (1969, 1970); Saxena (1978, 1979) and Kar (1978, 1979, 1985). In contrast, palynological investigations of the well developed Neogene sequences are meagre, with a few notable exceptions by particularly Mathur and Mathur (1969), Kar (1985) and Mandal (2010). The present communication, based on preliminary field work conducted recently by two of us (SB & MGT), reports a moderately diverse palyno-assembly from the Chhasra Formation exposed at a locality (23°28'33.58" N: 70°58'40.83"E) about 6 km east of the village Palasawa in eastern Kutch, Gujarat, western India (Fig. 1). The Chhasra Formation is exposed as patchy outcrops in the low plains between Mesozoic highlands. The productive lithology is a 10 cm thick bed of grey shales that forms part of an approximately 1.2 m thick section consisting mainly of ferruginous sandstones and conglomerates. In a close by locality, these conglomerates have yielded terrestrial and aquatic vertebrates, including mammals that are currently under study. Fossil wood belonging to the families Lythraceae (*Lagerstroemia*), Fabaceae (*Bauhinia*) and Ebenaceae (*Diospyros*) also occur in abundance around this locality (personal communication from Dr. R.C. Mehrotra, BSIP).

## MATERIAL AND METHODS

Three samples of grey shales from the Palasawa section (Early Miocene) in eastern Kutch were collected and processed for the recovery of palynomorphs. All the three samples were found productive. For the recovery of palynomorphs, samples were treated with HCl, HF and HNO<sub>3</sub> followed by 10% solution of KOH. The material was finally washed with water through a sieve of 500 meshes. The residue was mixed with polyvinyl solution and was spread uniformly over a cover glass with the help of a glass rod. The cover glass was dried naturally in room temperature and mounted in canada balsam. A Nikon Eclipse 90i microscope was used for the study and photomicrography. The slides are housed in the Repository of Museum of Birbal Sahni Institute of Palaeobotany, Lucknow, India.

## PALYNOFLORAL ANALYSIS

A moderately diverse palynoassembly (Pl. 1) has been recorded from the Chhasra Formation (Early Miocene) exposed near Palasawa Village, eastern Kutch. The recorded

palynoflora consists of 26 genera and 30 species belonging to pteridophytic spores (5 genera and 6 species) and angiosperm pollen grains (18 genera and 21 species), reworked Cretaceous pollen (1 species), fungal spore (1 species) and testate amoeba cyst (1 species). Quantitatively, the assemblage is dominated by angiospermous pollen (~85%), followed by pteridophytic spores (~15%). Among the angiospermous pollen, monocots (essentially palm pollen) account for 53% whereas dicot pollen forms 32% of the total palyno-assembly. The recorded palynotaxa are listed as follows:

### Pteridophytic spores

*Lygodiumsporites lakiensis* Sah & Kar, 1969  
*Todisporites major* Couper, 1953  
*Khariasporites densus* Kar, 1985  
*K. granulates* Kar, 1985  
*Osmundacidites* sp.  
*Hammenisporis* sp.

### Angiospermous pollen grains

*Proxapertites operculatus* van der Hammen, 1956  
*Spinomonocolpites achinatus* Singh & Misra, 1991  
*Acanthotricolpites bulbospinosus* (Kar, 1985) emend. Singh & Misra, 1991  
*A. kutchensis* (Venkatachala & Kar) Singh & Misra, 1991  
*A. intermedius* Singh & Misra, 1991  
*Spinizonocolpites prominatus* (McIntyre, 1965) Stover & Evans, 1973  
*Dorreenipites distinctus* Navale & Misra, 1979  
*Lakiapollis ovatus* Venkatachala & Kar, 1969  
*Tribrevicolporites eocenicus* Kar, 1985  
*Albertipollenites* sp.  
*Dermatobrevicolporites dermatus* Kar, 1985  
*Tripilaorites triangulus* (Sah & Kar) Kar, 1985  
*Retitrescolpites* sp.  
*Rhoipites* sp.  
*Meliapollis navalei* Sah & Kar, 1974  
*Meliapollis* sp.  
*Ctenolophonidites* sp.  
*Palaeomalvaceaeapollis paucispinosus* Kar, 1985  
*Polyadopollenites* sp.  
*Graminidites* sp.  
*Ericipites* sp.

### Fungal spore

*Glomus* sp.

### Reworked Upper Cretaceous taxa

*Mulleripollis bolpurensis* Baksi & Deb, 1976

### Testate Amoeba

*Centropyxis* sp.



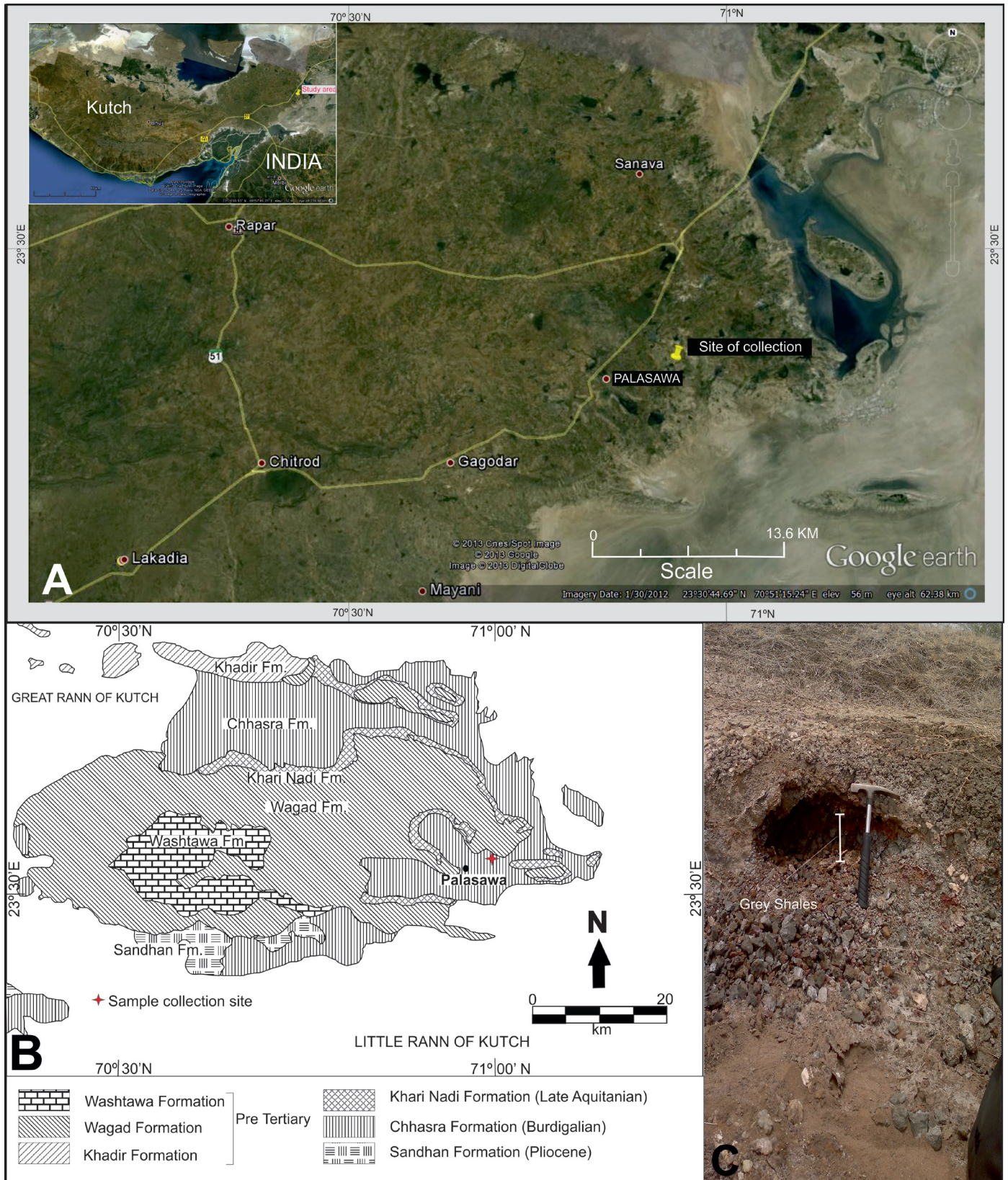


Fig 1—(A) Satellite imagery of Eastern Kutch, (B) Geological map of study area, (C) Field photograph.

## DISCUSSION

The palynoflora recovered (5 genera and 6 species of pteridophytic spores and 18 genera and 21 species of angiosperm pollen grains) has affinities with 15 extant families, of which 5 families are tropical to subtropical; 2 are tropical; 2 tropical rain forest; 1 tropical to temperate and 5 cosmopolitan (Table 1) in distribution. Palms referable to the family Arecaceae are dominant in the assemblage, and are predominantly pantropical, restricted to evergreen and semi-evergreen forests. The assemblage is dominated by angiospermous pollen grains (~85%) followed by pteridophytic spores (~15%).

The presence of *Lygodiumsporites*, *Todisporites*, *Osmundacidites*, *Khariasporites* and *Hammenisporis* is indicative of fresh water swamp and pond conditions. Coastal elements belonging to *Spinizonocolpites* and *Spinomonocolpites* show a strong affinity with *Nypa fruticans*. Similarly, the genus *Acanthotricolpites*, also related to *Nypa* (Venkatachala *et al.*, 1996), is profusely represented. The genus *Nypa*, represented by the extant species *N. fruticans*, is a mangrove palm growing in tidal mud flats fringing the tidal reaches of large fresh water rivers (Morley, 2000). Thus, the occurrence of mangrove (*Spinizonocolpites*, *Acanthotricolpites* and *Spinomonocolpites*) and back-mangrove (*Palaeomalvaceaeapollis* and *Meliapollis*) taxa indicates marginal brackish water conditions. On the basis of morphological characters, *Proxapertites* has been interpreted to represent the family Araceae (Zetter *et al.*, 2001; Hesse & Zetter, 2007). The tropical rain forest elements belonging to Bombacaceae, Oleaceae and Ctenolophonaceae are also present in the assemblage. Overall, the assemblage indicates

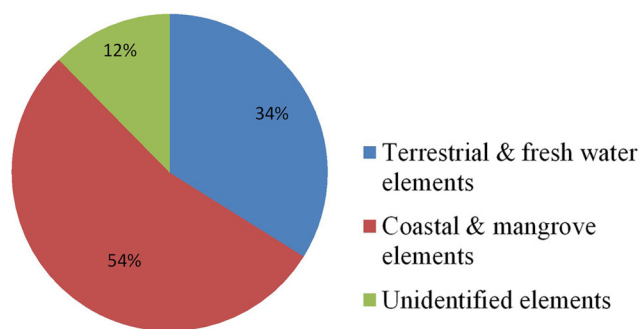


Fig. 2—Palaeoecological analysis of recovered palynomorphs from Palasawa section, Eastern Kutch, Gujarat.

warm and humid coastal climate with tropical rain forest in the vicinity of the site of deposition. *Centropyxis*, a testate amoeba cyst, is also recorded in good number, indicating freshwater influence. From a palaeoecological prospective, the coastal and mangrove elements (54%) dominate over terrestrial and fresh water palynomorphs (34%) (Fig. 2). Based on the total palynoassemblage, the deposition of Palasawa sediments appears to have taken place in a lowland coastal setting where inland, coastal, mangrove and fresh water elements have been deposited.

The Chhasra Formation was originally described as Vinjhan Shale (Biswas & Raju, 1971, 1973) from the western Kutch Mainland, where it is much better developed compared to the eastern part of the Kutch Basin. The Chhasra Formation is dated as Early Miocene (Burdigalian) based on the Miogypsinidae Assemblage described from the western Kutch Mainland (Biswas, 1992). The record of *Spinizonocol-*

## PLATE 1

(The bar in figures is equal to 10 µm)



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|--|--|
| 1-3. <i>Acanthotricolpites bulbospinosus</i> (Kar) emend. Singh & Misra, 1991, BSIP Slide Nos. 14918, E 38/4; 14919, N 46; G 69/3. | 15. <i>Retitrescolpites</i> sp., BSIP Slide No. 14927, J 52/1.                             |
| 4-5. <i>A. kutchensis</i> (Venkatachala & Kar), Singh & Misra, 1991, BSIP Slide Nos. 14920, H 42/3; 14921, R 60/2.                 | 16. <i>Rhoipites</i> sp., BSIP Slide No. 14928, G 60/4.                                    |
| 6. <i>A. intermedius</i> Singh & Misra, 1991, BSIP Slide No. 14919, W 52/3.  | 17. <i>Meliapollis</i> sp., BSIP Slide No. 14925, F 45.                                    |
| 7. <i>Spinomonocolpites achinatus</i> , Singh & Misra, 1991, BSIP Slide No. 14919, O 54/2.   | 18. <i>Ericipites</i> sp., BSIP Slide No. 14923, E 57/4.                                   |
| 8. <i>Spinizonocolpites prominatus</i> (McIntyre, 1965) Stover & Evans, 1973, BSIP Slide No. 14924, R 63.                          | 19. <i>Mulleripollis bolpurensis</i> Baksi & Deb, 1976, BSIP Slide No. 14929, S 50/2.      |
| 9. <i>Proxapertites operculatus</i> van der Hammen, 1956, BSIP Slide No. 14925, H 40/2.  | 20. <i>Lakiapollis ovatus</i> Venkatachala & Kar, 1969, BSIP Slide No. 14931, K 47/3.      |
| 10. <i>Dorreenipites distinctus</i> Navale & Misra 1979, BSIP Slide No. 14919, K 41/4.   | 21. <i>Palaeomalvaceaeapollis paucispinosus</i> Kar, 1985, BSIP Slide No. 14923, J 38/2.   |
| 11. <i>Tripilaorites triangulus</i> (Sah & Kar) Kar, 1985, BSIP Slide No. 14921, F 57/4.   | 22-23. <i>Graminidites</i> sp., BSIP Slide Nos. 14927, D 62/1; 14925, G 57/3.              |
| 12. <i>Dermatobrevicolporites dermatus</i> Kar, 1985, BSIP Slide No. 14926, P 66/4.  | 24-25. <i>Khariasporites densus</i> Kar, 1985, BSIP Slide Nos. 14918, D 63/2; 14926, U 47. |
| 13. <i>Tribrevicolporites eocenicus</i> Kar, 1985, BSIP Slide No. 14919, H 47.   | 26. <i>K. granulates</i> , Kar, 1985, BSIP Slide No. 14926, J 53/3.                        |
| 14. <i>Meliapollis</i> sp., BSIP Slide No. 14923, H 61/4.  | 27. <i>Lygodiumsporites lakiensis</i> Sah & Kar, 1969, BSIP Slide No. 14924, R 57/1.       |
|  | 28. <i>Todisporites major</i> Couper, 1953, BSIP Slide No. 14932, S 48.                    |
|  | 29. Inaperturate pollen, BSIP Slide No. 14933, J 56/1.                                     |
|  | 30. <i>Osmundacidites</i> sp., BSIP Slide No. 14932, R 51/4.                               |
|  | 31. <i>Centropyxis</i> sp., BSIP Slide No. 14918, H 45.                                    |
|  | 32. <i>Glomus</i> sp., BSIP Slide No. 14927, D 64/2.                                       |



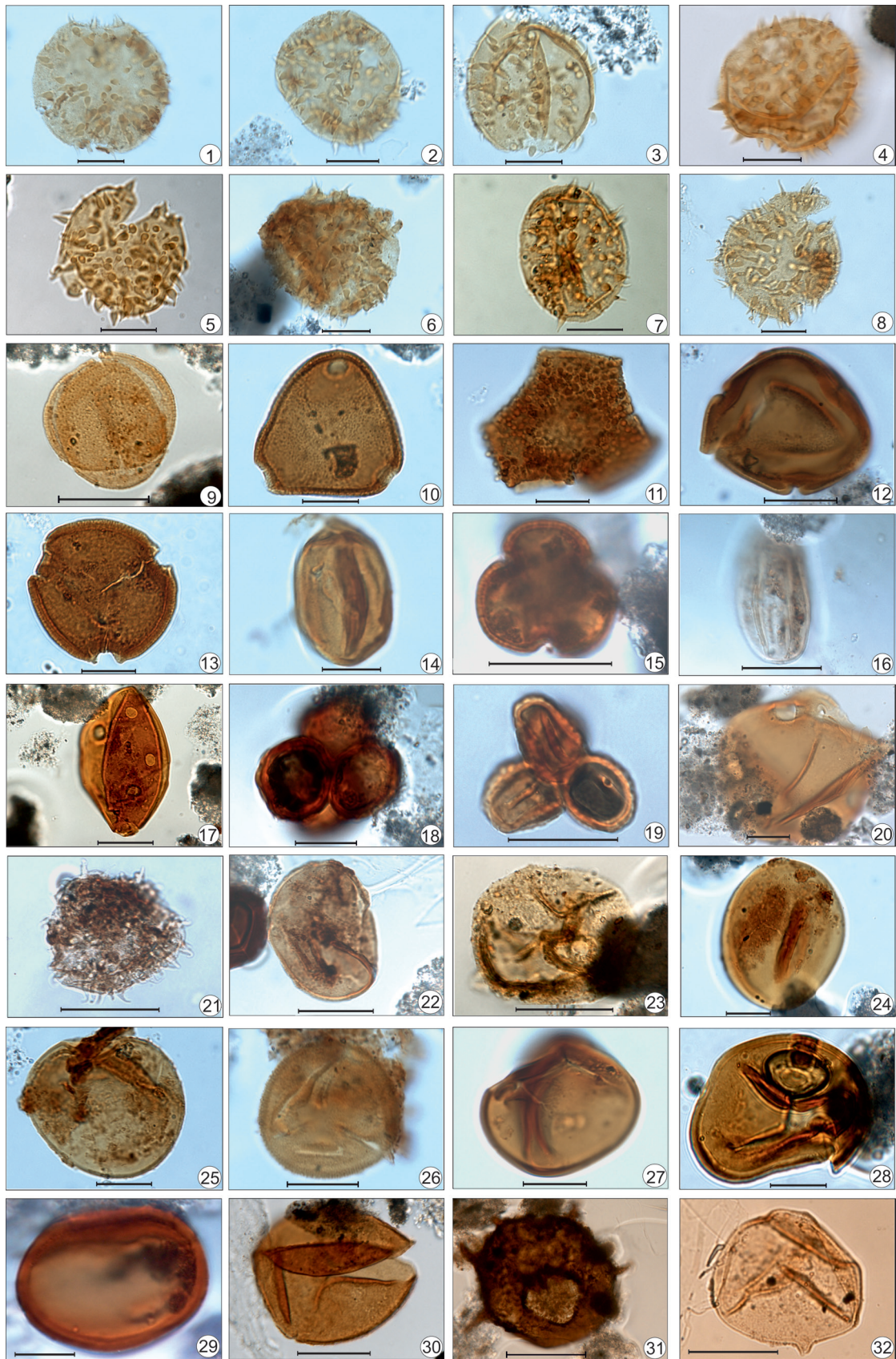


PLATE 1

Family	Palynotaxa	Present Day Distribution
Schizaeaceae	<i>Lygodiumsporites lakiensis</i> ( <i>Lygodium</i> )	Tropical-Subtropical
Osmundaceae	<i>Todisporites major</i> <i>Osmundacidites</i> sp. ( <i>Osmunda</i> )	Cosmopolitan
Parkeriaceae	<i>Hammenisporis</i> sp. ( <i>Ceratopteris thalictroides</i> )	Tropical-Subtropical (water-fern)
Araceae	<i>Proxapertites operculatus</i>	Tropical
Arecaceae	<i>Spinomonocolpites achinatus</i> ( <i>Nypa</i> ) <i>Acanthotricolpites bulbospinosus</i> ( <i>Nypa</i> ) <i>A. kutchensis</i> <i>A. intermedius</i> <i>Spinizonocolpites prominatus</i> ( <i>Nypa fruticans</i> ) <i>Dorreenipites distinctus</i>	Tropical
Bombacaceae	<i>Lakiapollis ovatus</i> ( <i>Durio</i> )	Tropical rain forest
Anacardiaceae	<i>Rhoipites</i> sp.	Tropical to Subtropical
Oleaceae	<i>Retitrescolpites</i> sp.	Tropical rain forest
Meliaceae	<i>Meliapollis navalei</i> <i>Meliapollis</i> sp.	Tropical-Subtropical
Mimosaceae	<i>Polyadopollenites</i> sp. ( <i>Acacia</i> )	Cosmopolitan
Ctenolophonaceae	<i>Ctenolophonidites</i> sp. ( <i>Ctenolophon</i> )	Tropical
Malvaceae	<i>Palaeomalvaceapollis paucispinosus</i>	Tropical to temperate
Ericaceae	<i>Ericipites</i> sp. ( <i>Erica</i> )	Cosmopolitan
Poaceae	<i>Graminidites</i> sp.	Cosmopolitan
Centropyxidae	<i>Centropyxis</i> (testate amoeba)	Cosmopolitan

Table 1—Palynotaxa from Chhasra Formation (early Miocene) and their present day distribution.

*pites*, *Spinomonocolpites*, *Acanthotricolpites* and members of Bombacaceae in the present assemblage is reminiscent of the Palaeogene palynoassemblages of Kutch and other areas, indicating somewhat similar climatic conditions during the early Miocene. Many of the forms are brackish water in nature, suggesting that the coastal lowland vegetation may not have changed significantly until the late Early Miocene (Burdigalian) when the Chhasra Formation was deposited. Besides, some of the taxa in the present assemblage, especially *Hammenisporis*, *Khariasporites*, *Polyadopollenites*, *Palaeomalvaceapollis*, *Ericipites* and *Graminidites* are of Early Miocene affinity, and somewhat comparable to Early Miocene assemblages recorded from the Khari Nadi and Chhasra formations of western Kutch (Kar, 1985; Mandal, 2010, respectively); Kerala Basin (Rao & Rajendran, 1996) and from the subsurface sediments of West Bengal (Mandal & Vijaya, 2004). However, since this investigation is based on preliminary sampling, the above interpretations are essentially tentative and would need confirmation from additional work.

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