Plant microfossils from the lignite deposit (Eocene) of Barsinghsar in Bikaner District, Rajasthan, India

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Plant microfossils from the Eocene lignite sample collected from Barsinghsar near Bikaner, Rajasthan have been described in this paper. The plant microfossils include algal filaments and nets, fungal hyphae and spores, bryophytic thalli and capsules (?), pteridophytic cuticles and spores, cuticles of gymnosperms and various kinds of pollen grains, and cuticles and peculiar fructifications (?) of angiosperms. Palaeoecological conditions during sedimentation of Eocene lignite in Rajasthan have also been discussed.

Key-words—Plant microfossils, Lignite, Barsinghsar, Rajasthan, Eocene, India.

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सारॉंश

भारत के राजस्थान के बीकानेर जिले के बरसिंहसर स्थान के लगुडांगार (लिग्नाइट) निक्षेप (इओसीन युगीन) से प्राप्त सूक्ष्म पादपाश्मों का विवेचन

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इस शोध–पत्र में राजस्थान के बीकानेर जिले के निकट बरसिंहसर नामक स्थान से एकत्र किये गये इओसीन युगीन लगुडांगार (लिग्नाइट) प्रादर्शों से प्राप्त सूक्ष्म पादपाश्मों का वर्णन किया गया है। सूक्ष्म पादपाश्मों के अन्तर्गत् शैवालीय तन्तु एवं जाल, कवकीय तन्तु एवं बीजाणु, ब्रायोफाइटी थैलाई, सम्पुट (?), टेरिडोफिटिक उपचर्म तथा बीजाणु, अनावृतबीजी उपचर्म तथा विभिन्न प्रकार के परागकण एवं आवृतबीजी पौधों के उपचर्म तथा विशिष्ट फलन (?) आते हैं। राजस्थान में इओसीन लिग्नाइट के अवसादीकरण के दौरान की पुरापर्यावरणीय परिस्थितियों की भी चर्चा इस शोध–पत्र में की गयी है।

EOCENE Lignite deposits are exposed at several places in western Rajasthan, e.g., Palana, Barsinghsar, Giral, etc. either in subsurface (6 to 30 m below ground level) or in open mines. Harsh and Sharma (1992) studied a carbonised wood from Palana (Bikaner) and identified its inorganic and organic constituents. Rao and Vimal (1950, 1952) and Sah and Kar (1974) described pollen and spores from Palana lignite. The plant microfossils studied here were recovered from a lignite sample from Barsinghsar, about 6 km west of Palana, in Bikaner District Rajasthan (Text-figure 1). These microfossils include algal filaments, fungal hyphae, sporangia, spores, cuticles, pollen grains as well as peculiar kind of seeds and fructifications. Approximately 45 m thick lignite at 20-30 m below ground level occurs at Barsinghsar as shown in the geological section (Text-figure 2). The lignite samples were macerated by using HNO_3 and plant microfossils recovered were mounted in glycerine jelly.

DESCRIPTION AND DISCUSSION

Algae—Filaments length 400 to 3230 μm,

PLATE 1 ⟶

1. An irregular net of algal filaments resembling *Hydrodictyon* (?). x 120.
2. A regular net of algal filaments. x 120.
3. Host cuticle with fungal spores. x 60.
4. Same enlarged. Each large spore bears a small bulbous stalk. x 240.
5. An intact sporangium full of spores. x 120.
6. Burst sporangium liberating spores. x 120.
7. Same enlarged. x 400.

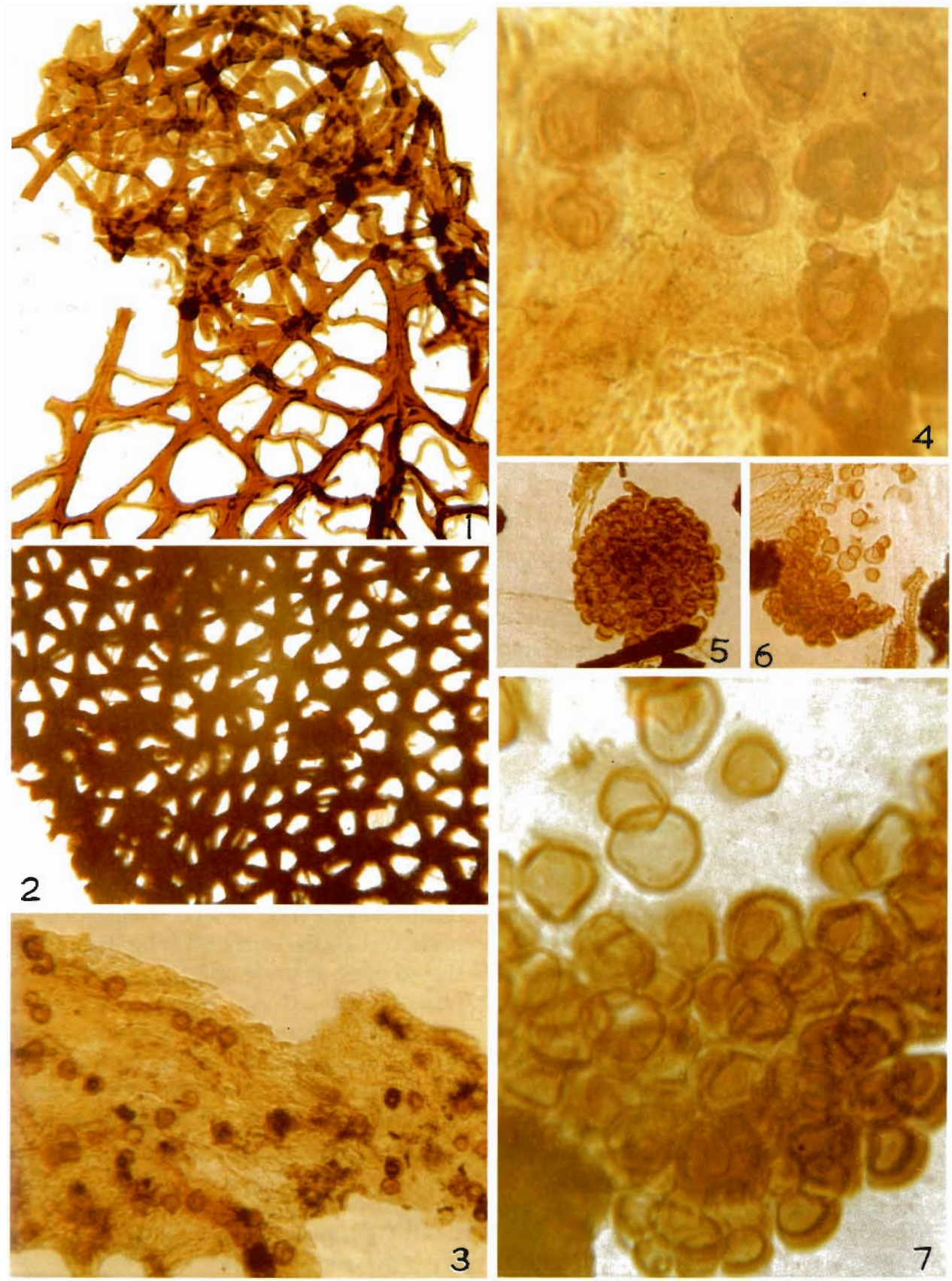
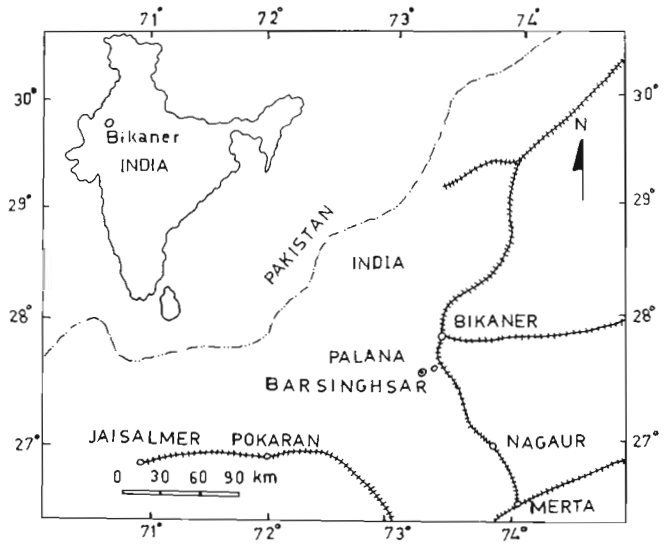
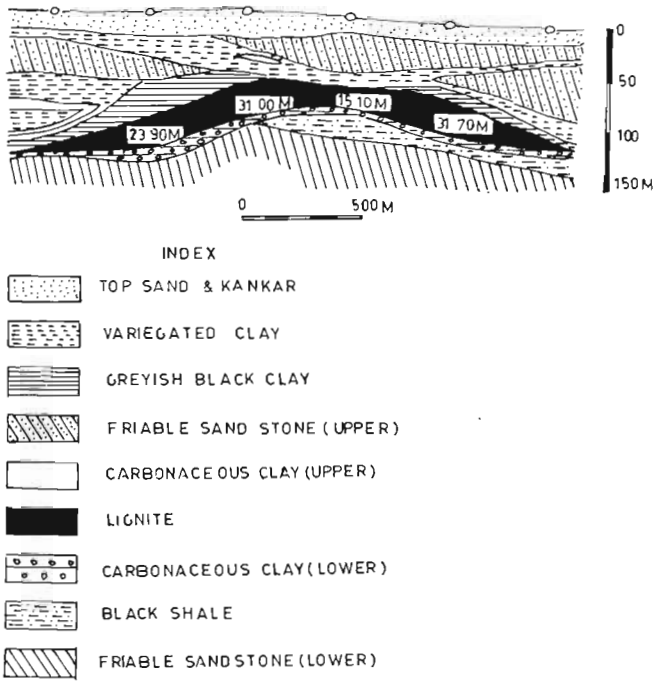


PLATE 1



Text-figure 1—Location map of Barsinghsar lignite area, Bikaner District, Rajasthan, India.



Text-figure 2—Geological cross section along line of drill holes in Barsinghsar lignite deposit, Bikaner (based on the information provided by D.M.G.).

thickness 45-100 μm, mostly unbranched and septate. Regular nets (Pl. 1, fig. 2) occur frequently in the material, 170 x 100 to 1120 x 840 μm in size, made of interconnected filaments, surrounding several points. Around each point there are 5-7 inverted triangle-like cavities. Thickness of filaments and the size of inverted triangular cavities are variable. In irregular nets (Pl. 1, fig. 1) filaments of variable thickness and the cavities formed differ in shape and size. These nets may be closely compared with modern green algae *Hydrodictyon* (Bold *et al.*, 1987, figs 420D, G).

Fungi—Various kinds of fungal bodies and spores isolated as well as attached to the host cuticle are found. The individual spores are either unicellular or multicellular. The former are small, circular and double-walled resembling uredospores of *Puccinia* or some rust. Fruiting bodies resembling *Phragmothyrites* Edwards (Jain & Gupta, 1970, Pl.1, fig. 12) have also been observed. They are circular, 100-108 μm in diameter with successive rings and radiating hyphae (Pl. 2, fig. 3) giving appearance as that of pseudoparenchymatous tissue. The central cells are small and dark while the outer cells are rectangular and thin-walled.

Uniseriate multicellular spores are either spindle-shaped (Pl. 2, fig. 1) or rod-shaped (Pl. 2, fig. 2). The former are 300-340 x 50-60 μm and resemble the genus *Alternaria* (Bold *et al.*, 1987) but the cells are without vertical septae. The spore has a small distinct stalk (Pl.2, fig. 1) and spindle shaped body is made of 8-12 cells arranged in a linear fashion. At each transverse septum, two valve like structures of unknown nature are present. The rod-shaped spores measure 150-160 x 25-30 μm and resemble *Helminthosporium* (see Alexopoulos & Mims, 1979). Sporangia globose

PLATE 2 →

1. A spindle-shaped fungal spore. x 400.
2. A rod-shaped fungal spore. x 400.
3. *Phragmothyrites* sp.; A fungal fruiting body made of radiating pseudoparenchyma. x 400.
4. Cuticle resembling *Hausmannia*. Reticulate venation with squarish aerioles. x 120.
5. A peculiar structure with rings of tubercles at the apex. x 120.
6. Angiospermous cuticle with scattered stomata. x 120.
7. Same cuticle with thick-walled cells. x 120.
8. A tricolporate angiosperm pollen grain. x 400.

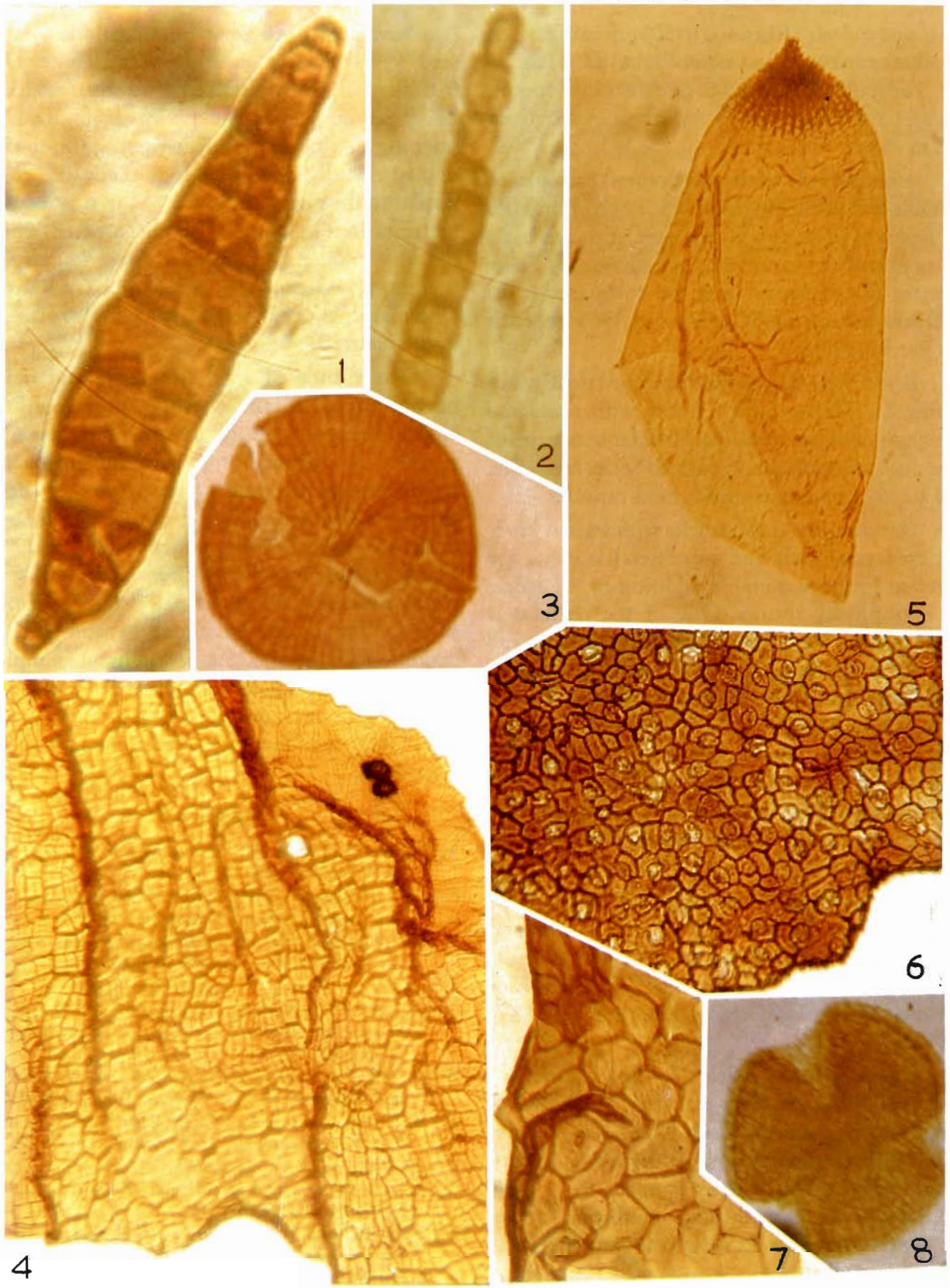


PLATE 2

in shape and vary from 400 to 500 μm in diameter; wall membranous and non-cellular (Pl. 1, figs 5-7). The sporangia are full of double walled spores. Spores are homosporous and range in size from 20 to 25 μm in diameter.

A number of cuticles have superficially placed double walled chlamydospores or zygospores (Pl. 1, figs 3, 4), 25-40 μm in diameter, and each bears a small bulbous base, 8-12 μm in diameter. These spores (Zygospores) may be compared with *Glomus fasciculatum* (Gerdemann, 1965; Schenck & Perez, 1987).

Bryophytes—Bilobed and unilobed thalli measuring 2.2 x 2.5 to 6.7 x 8.5 mm with scales and rhizoids have been isolated. Cellular structures of the thalli are not visible. Elongated bodies measuring 10 x 2 to 15 x 3 mm resemble moss capsules.

Pteridophytes— Leaf cuticles with various kinds of epidermal cells and superficial stomata are present in the material in addition to the trilete pteridophytic spores. One of the cuticles is multiveined; lateral veins arise at right angles and form more or less squarish aerioles (Pl. 2, fig. 4). This cuticle resembles *Hausmannia* Dunker (Bose & Sah, 1967; pl. 6, figs 3, 7), a fossil frond of Dipteridaceae (Bower, 1926). A pteridophytic spore with distinct triradiate mark is identified as *Dandotiaspora* sp. (Sah *et al.*, 1971) measuring 98 x 104 μm with pad like structures at the ends of triradiate rays.

Gymnosperms—The cuticles recovered by maceration have thick-walled epidermal cells and scattered or regularly arranged haplochelic stomata. On the basis of these characters they resemble conifers and cycads (Greguss, 1968; Stockey & Ko, 1986).

Angiosperms—Cuticles, pollen grains and peculiar kinds of seeds and fructifications of angiosperms have also been found. The cuticles have thin or thick-walled epidermal cells with scattered or regularly placed stomata (Pl. 2, figs 6, 7). Subsidiary cells are distinct or indistinct. Pollen grains recovered are either tricolporate (Pl. 2, fig. 8) or hexacolpate.

A number of peculiar fructifications (?) and seeds (?) have been isolated from the lignite. The fructifications are oval, stalked structures measuring 840 x 504 to 1200 x 588 μm with mouth-like opening at one end and distinct stalk at the opposite end. The mouth has teeth-like cells similar to the peristome of a moss. In majority of fructifications 1-5 carpel like bodies are seen, while in others numerous spores and spore tetrads are present. Oval seeds (?) 950 x 260 to 1120 x 370 μm with markings of converging rays are also present in the material.

Occurrence of algal filaments and nets, bryophytic thalli and capsules, pteridophytic cuticles and spores and gymnospermous remnants suggests the presence of aquatic and subaquatic conditions at the time of deposition of these sediments. Eocene woods of *Araucarioxylon* (Harsh & Sharma, 1988), *Lagerstroemioxylon* (Guleria, 1990; Harsh & Sharma, 1995), *Terminalioxylon* and *Anogeissusoxylon* (Harsh *et al.*, 1992), etc. from Bikaner favour the existence of non-marine conditions in the area. Studies on lignite samples collected from Giral, Barmer District also indicate the existence of plant microfossils which favour fresh water sedimentation of Eocene lignites in Rajasthan.

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