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Epiphyllous fungi from the Gondwana

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Epiphyllous fungi belonging to Ascomycetes and Deuteromycetes are recorded. Microthyriaceous germlings have been found on the lower cuticle of a *Glossopteris* species from the basal Barakar sediments of Saharjuri Outlier. Microthyriaceous stromata have been found on the lower cuticle of *Thinnfeldia indica* Feistmantel and a leaf apparently of *Ctenozamites* type, both from Early Cretaceous of Cauvery Basin. Mycelia sterilia have also been recorded on the lower cuticle of *Thinnfeldia indica*. On the basis of the occurrences of Microthyriaceae, a tropical to subtropical climate is deduced for the Early Cretaceous Period of India.

Key-words—Fungi, Epiphyllous, Ascomycetes, Deuteromycetes, Gondwana (India).

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सारांश

गोंडवाना से अधिपर्णी कवक

ऊषा बाजपेयी एवं हरिकृष्ण माहेश्वरी

ऐस्कोमाइसिटीज़ एवं ड्यूटेरोमाइसिटीज़ नामक वर्गों से सम्बद्ध अधिपर्णी कवक अभिलिखित किये गये हैं। सहरजुरी पुरान्तःशायी के आधारी बराकार अवसादों से उपलब्ध एक ग्लॉसॉप्टेरिस जाति के निचले उपचर्म से माइक्रोथाइरियेसीय नूतनोद्भिद् प्राप्त हुए हैं। **थिन्नफ़ेल्डिआ इन्डिका** फ़ाइस्टमॅन्टेल तथा **टीनोज़माइटिस**-प्ररूप की एक पत्ती के अधरि उपचर्म से माइक्रोथाइरियेसीय अवर्णिकायें प्राप्त हुई हैं, ये दोनों ही प्रारम्भिक कावेरी द्रोणी से एकत्रित किये गये थे। **थिन्नफ़ेल्डिआ इन्डिका** के अधरि उपचर्म से बन्ध्य कवकजाल भी अभिलिखित किये गये हैं। माइक्रोथाइरियेसी की उपस्थिति के आधार पर भारत के प्रारम्भिक क्रीटेशी कल्प हेतु उष्णकटिबन्धीय से उपोष्णकटिबन्धीय जलवायु प्रस्तावित की गई है।

THE fungi have a long history and are known from Precambrian to present day, but it is one group of organisms that is comparatively little known in fossil condition. Much of knowledge about fossil fungi is derived from palynological preparations. Reports of occurrence of bacteria, fungi or other microbes on the fossil leaf cuticles are scarce, mostly having been reported on the Tertiary leaves.

In India, fungi are known mostly from the post-Gondwana sediments (Venkatachala & Kar, 1969; Jain & Gupta, 1971, and others) except for some stray reports of fungal spores in petrological sections of Permian coal. Banerji and Misra (1968) have reported a microthyriaceous fungus in the subsurface Upper Cretaceous sediments of southern India. Recently microthyriaceous stromata have also been recorded from the basal Cretaceous sediments (Pant, Srivastava & Pant, 1983; Bose & Banerji, 1984). Here we record some more epiphyllous fungi that were observed after processing carbonified leaves for recovery of cuticles. These belong to the Microthyriaceae and Fungi Imperfecti. We have not

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gone into detailed taxonomy as information available is too little for any meaningful identification.

Two types of microthyriaceous stromata, one type of microthyriaceous germlings, and some hyphae of uncertain affinity have been illustrated. The fungi have been found in two horizons, viz., (i) on dispersed cuticle of a *Glossopteris* species from the shale of basal Barakar Formation, Chitra Patrika Mine, Early Permian, Saharjuri Outlier, Deogarh Coalfield, Bihar and (ii) cuticles of *Thinnfeldia indica* and *?Ctenozamites* from a tube well near Naicolam, Sivaganga Formation, Early Cretaceous, Tiruchirapalli District, Tamil Nadu.

DESCRIPTION

Ascomycetes

The Microthyriaceae, which are epiphyllous fungi, are characterised by strongly flattened, somewhat rounded, shield-shaped ascocarp or ascostroma with a centrum. The stromata vary in size. The margin of the stromata may be entire to fimbriate. The cells of the stromata usually have an ostiole through which the ascospores may be released. In some cases the ostiole is absent (Stevens, 1925). Vegetative mycelium is not known in few genera. All but a few are leaf parasites. They are largely tropical but a number of genera occur in temperate zones, too (Bessey, 1950; Alexopolous & Mims, 1979).

Type-1 (Pl. 1, fig. 1)—? Germlings, 36-248 μm in diameter, discoid, flattened. Margin entire. Cells not decipherable individually, only radiating undulations seen. Ostiole not seen.

These structures are found on the cuticle of a *Glossopteris* leaf from the Lower Permian of Chitra Mine area, Deogarh Coalfield (Bajpai, 1988).

Type-2 (Pl. 1, fig. 2)—Stromata 44-268 μm in diameter, more or less circular, margin fimbriate. Stromata consist of radiating rows of cells. Cells 4-6 μm wide and 4-8 μm long. This fungus has been found on the lower cuticle of *Thinnfeldia indica* (Maheshwari, 1986).

Single-celled ascospores, young stages of stroma and mature stromata are seen on the cuticle. However, the pore or ostiole is not seen on the cross wall of the cells. It is presumed that the stromata lack ostioles.

Type-3 (Pl. 1, fig. 3)—Stromata 200-350 μm in diameter, discoid, strongly flattened. Margin fimbriate to entire at places. Cells are more or less rectangular, compactly arranged, 4-6 μm wide and 3-5 μm in length. Ostiole not seen. Developmental stages are not seen though a number of stromata has been observed on the lower cuticle of a leaf apparently similar to that of *Ctenozamites*. These stromata resemble the one figured by Bose and Banerji (1984, pl. 48, fig. 3).

DEUTEROMYCETES

The Deuteromycetes or Fungi Imperfecti include those fungi which apparently lack a sexual phase. These fungi only have septate hyphae and reproduce by means of conidia. The fungi of this group are known from Devonian to the present time (Dilcher, 1965).

One type each of sclerotia and branched hyphae have been observed on the leaf of *Thinnfeldia indica* Feistmantel. These sclerotia and hyphae belong to Mycelia Sterilia as defined in Bernett's (1960) key to the genera of Fungi Imperfecti.

Type-4 (Pl. 1, fig. 4)—The fossil sclerotia are dark and seem to be thickened somatic structures of interwoven mycelial threads, with long and septate hyphae formed under unfavourable conditions.

The sclerotia measure 80-150 μm in diameter. Hyphal cells are 3-5 μm wide and 20-40 μm long. Branching of hyphae is not seen but in living fungi branched septate hyphae are produced under favourable conditions. The sclerotia may be compared with those of modern *Papulaspora* Preuss.

Type-5 (Pl. 1, figs 5, 6)—The septate branched hyphae are without asexual fruiting bodies and spores. Hyphae are straight or curved, branched oppositely to subopposite or alternately. Hyphal cells are 8-12 μm wide and 16-60 μm long. The mycelium resembles that of modern *Rhizoctonia* DC.

REMARKS

The fungi grow on living and dead plants under favourable conditions and in the presence of required enzymes. They play an important role in the biodegradation of plant litter due to their ability to utilize cellulose. The enzymes produced by fungal hyphae digest the tissue, partially degrading the tissues and thus providing material for further fungal growth. After decomposition by fungi, the resulting organic matter is attacked by bacteria (Venkatachala, 1981, 1984). The bacteria that are involved to any significant extent in decomposition of plant litter belong to the order Pseudomonadales, Eubacteriales, Actinomycetales and Myxobacteriales. The fungi and bacteria undoubtedly control early stages of diagenesis of the organic matter (Teichmüller & Teichmüller, 1967). Not much, however, is known concerning their occurrence and distribution on fossil plant material.

In the Gondwana, bacterial degradation of organic matter has been illustrated by Bajpai and

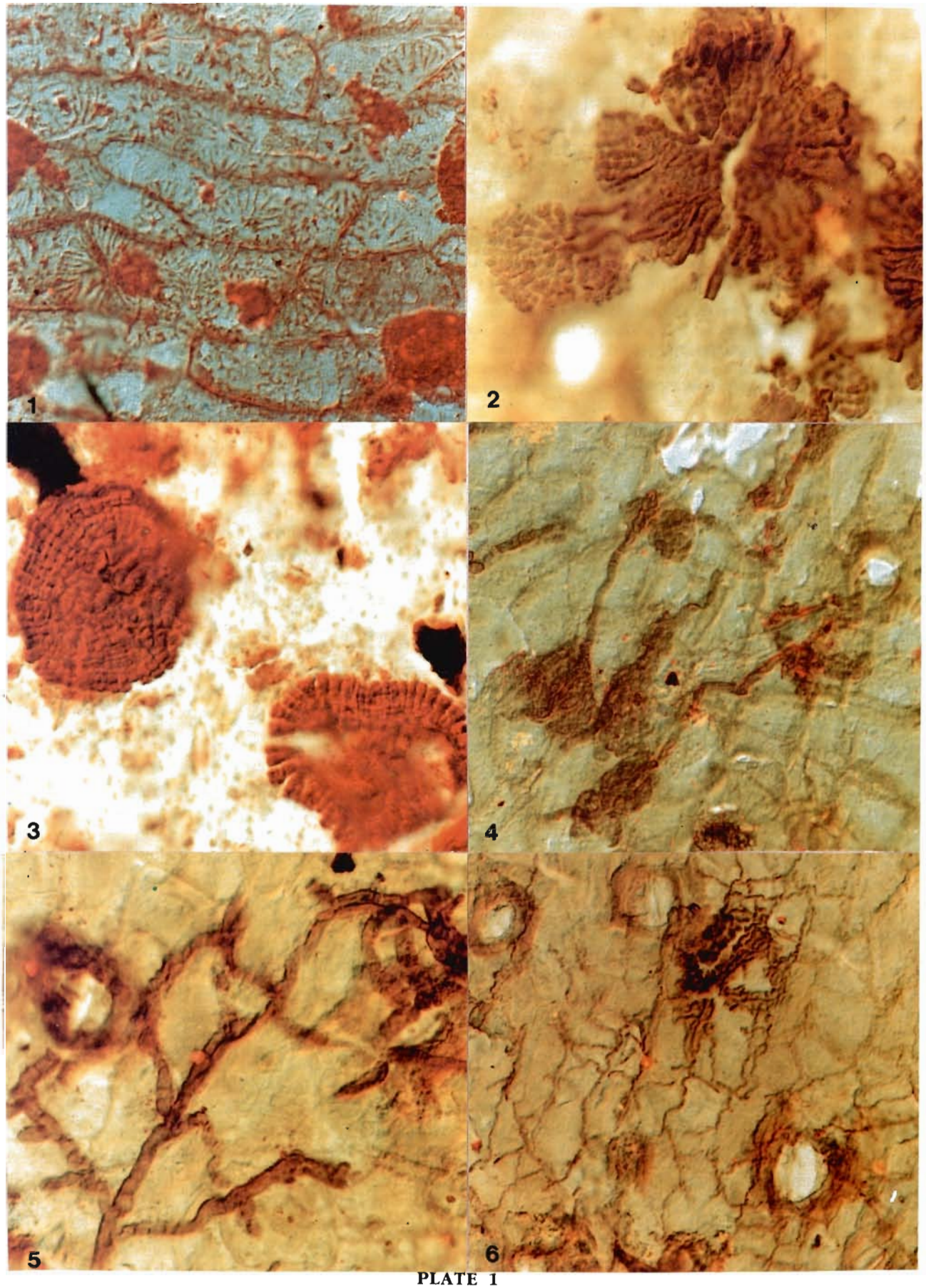

PLATE 1

Maheshwari (1986) on megaspores from the Permian of Zaire. Fungal hyphae are also present on these megaspores. Presently we record fungal infestation on Gondwana leaves. However, it is yet not clear if these fungi grew on the living plant or on the leaves in the litter. As the cuticle on which such microbiota grew is not sufficiently well-preserved, often the lateral walls are lost, it is presumed that the fungus played a role in degradation of the epidermis. Modern microthyriaceae are generally parasitic. fungi imperfecti occur everywhere, producing conidia as readily on decaying plant organs as on living ones (Wolf & Wolf, 1947).

The fossil and extant forms of Microthyriaceae infest both angiosperms and gymnosperms (Dilcher, 1965) but were not known from sediments older than Early Cretaceous. Present report takes back the ancestry of this family possibly to Early Permian. The occurrence of Microthyriaceae in the Bansa, Trambau and Naicolam beds shows that a tropical to subtropical climate prevailed when the Lower Cretaceous sediments of India were being deposited.

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PLATE 1

1 Microthyriaceous germlings on the cuticle of a *Glossopteris* leaf. x *ca* 400.

2. Radiate, circular stromata with fimbriate margin on the cuticle of *Thinnfeldia indica.* x *ca* 400.

3. Discoid stromata, without an ostiole on the cuticle of *?Ctenozamites* sp. x *ca* 400.

4. Sclerotia with long septate hyphae on the cuticle of *Thinnfeldia indica.* x *ca* 250.

5,6. Fungal hyphae on *Thinnfeldia indica.* x *ca* 400, *ca* 250.