SOME FUNGAL REMAINS FROM THE TERTIARIES OF KERALA COAST

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ABSTRACT

The present paper incorporates some fungal remains recovered from the carbonaceous clay, Padappakara, Quilon, Western Ghat, India. The main constituents of the present fungal assemblage are microthyriaceous and Chytridialean remains, described under different taxa. The epiphyllous microthyriaceous fruiting bodies are viz. *Parmathyrites* gen. nov., *Paramicrothallites* gen. nov., *Notothyrites* Cookson, *Callimothallus* Dilcher and *Phragmothyrites* Edward whereas *Entophlyctis willoughbyi* Bradley embraces the Chytrid-sporangia. Apart from these a few other types of fungal bodies, viz. *Diploneurospora tewarii* gen. et sp. nov., *Quilonia typica* gen. et sp. nov. and *Microthyriacites* Cookson have also been reported.

INTRODUCTION

OUR knowledge of Indian fossil fungi is very meagre. A summary of the previous work done has been published by Rao (1959). Not much has been added to its literature within the last ten years except the contribution of Ramanujam (1963) and Venkatachala & Kar (1969). The former has described some well preserved thyrothecia of Asterineae from the South Arcot lignite, Madras; whereas the latter have reported epiphyllous fungi from Laki sediments of Kutch.

The material for the present investigation was collected by one of us (K. P. JAIN) from a clay mine section near Kanjantharia House, Padappakara (11 km. north-east of Quilon). It is located at the bank of Kanjrikuttu Kayal, South of 3rd mile stone of Kuthira Mumampu and P.W.D. on the bus road. Padappakara area is located on the eastern side of Ashtamundi lake (76°38′20″N. Lat.; 8°58′40″W. long.). The complete section has been analysed by usual acid and alkali method for palyno-stratigraphic studies but none other than carbonaceous clay yielded the organic remains and that too only fungal remains. The 3′ thick carbonaceous clay band is over and underlain by grey clay.

The samples contain a good amount of sulphates and marcasite which might have prevented other less resistant organic matters to be preserved.

The fossil fungi described in the present paper are classified according to the system proposed by Bessey (1950).

SYSTEMATIC DESCRIPTION

Class — Ascomyceteae
Order — Hemisphaeriales
Family — Microthyriaceae

Young forms (Germlings) of Microthyriaceous fungi Dilcher (1965)

Pl. 1, Figs. 6-9

1959 — *Stigmocyst* Rao, pl. 1, figs. 5-6.

Remarks — Recently Bradley (1967) has described some fossil chytrids from the Eocene of Green River formation. He includes all the previous records of Microthyriaceous germlings of Dilcher (*l.c.*) under *Entophlyctis willoughbyi*. The present work represents the occurrence of both the forms described by Dilcher (*l.c.*) and Bradley (*l.c.*) along with several well developed mature microthyriaceous fruit bodies.

The chytrid sporangia at maturity are mainly characterized by germ-pore or exit pore and deep segmentation constricted into a number of separate sectors whereas these features are not observed in the microthyriaceous germlings, the mature forms of which are quite large with radially arranged cells. Further, the occurrence of microthyriaceous germlings is also supported by the presence of their mature fruit bodies. In view of these facts it is proposed here to describe the present specimens as young forms (germlings) of Microthyriaceous fungi and maintain *Entophlyctis willoughbyi* Bradley separately as a chytrid group.

Genus — *Parmathyrites* gen. nov.

Type Species — *Parmathyrites indicus* gen. et sp. nov.; Pl. 1, Fig. 1.

Generic Diagnosis — Ascomata flattened, non-ostiolate; ± circular, one layered thick; hyphae radially arranged, interconnected, forming pseudo-parenchymatous non-porate cells. Outer peripheral cells prominent with thickened radial walls, spines peripheral, spine sheath present or absent, Ascospore unknown.

Description — Ascomata dark brown in colour, sub-circular to circular in shape, 80-200 μ in diameter, solitary. Each peripheral cell developing into a long-spine like process. Spines unequal, 20-50 μ long wall thick, radially fused at base forming continuous peripheral sheath around ascomata. Later, fused radial walls again separate from each other converging into a pointed apex forming a median wall throughout free spine portion.

Comparison — *Parmathyrites* gen nov. is comparable only with two genera, viz. *Phragmothyrites* Edwards (1922) and *Microthyriacites* Cookson (1947) in having non-ostiolate and non-porate nature of the pseudoparenchyma formed by radially arranged interconnected hyphae. But it differs mainly in having peripheral sheath of spines around the fruit body.

Parmathyrites indicus sp. nov.

Pl. 1, Figs. 1-2

Diagnosis — Ascomata flattened, circular, 180-190 μ in diameter, solitary, one layered thick, radiating hyphae connected throughout whole length, central portion not well preserved, ascomata non-ostiolate. Central cells squarish, marginal rectangular. Cell walls thin, each peripheral cell develops into a long spine like process. Spines about seventy in number around periphery, unequal in size, 20-50 μ long, pointed at the apex broader at base, walls thick, fused radially at the base, free on the upper side. Ascospore unknown.

Holotype — Pl. 1, Fig. 1; Slide No. 3845/1.

Type Locality — Padappakara, Quilon, Western Ghat, South India.

Horizon — Miocene.

Comparison — From the perusal of the vast palynological literature it seems that there are no comparable forms except the one reported by Tilgner (1954, p. 41, fig. 1) from the Tertiary Brown Coals of Germany. The specimen can easily be differentiated from the Brown Coal microthyriaceous fruit body (TILGNER, *l.c.*) in having larger, closely arranged, pointed spines and in its bigger body size.

Parmathyrites sp.

1954 — Fruit bodies in Brown Coal, Tilgner, p. 40; Fig. 1.

Description — Ascomata flattened, circular, 80 μ in diameter, solitary, one layered thick, having radiating hyphae connected throughout their whole length, non-ostiolate, central cell squarish, cell walls thin, each peripheral cell developed into a long spine like process. Spine unequal, apex blunt, wall thick at the base and fused radially.

Locality — Brown Coal, Banersberg, Rhon mountains, Germany.

Horizon — Tertiary.

Other known species of the genus:

Parmathyrites (al. *Microthyriacites*) *cooksonii* (RAO, 1959), P. 45; Pl. 1, Figs. 7-9 comb. nov.

Type Locality — Palana and South Arcot.

Horizon — Eocene and Miocene respectively.

Genus — ***Notothyrites*** Cookson. 1947

Notothyrites padappakarensis sp. nov.

Pl. 1, Figs. 13-14

1954 — Fruit bodies in Brown Coals, Tilgner, p. 40, fig. 3.

Diagnosis — Ascomata, flattened, sub-circular, ostiolate, outline sinuous, 40-100 μ in diameter, solitary, radiating hyphae interconnected; cells 2·5×4 μ in size, elongated towards periphery; wall thin, tangential walls of peripheral cells strongly thickened and entire. Ostiole well defined, 7-10 μ in diameter, distinctly elevated, centric to slight eccentric, bordered by two to four layers of dark brown, thick walled, papillate cells; degree of raised papillate surface variable, 1·5-2·5 μ high. Hyphae absent. Ascospore unknown.

Holotype — Pl. 1, Fig. 14; Slide No. 3450/1.

Type Locality — Padappakara, Quilon, Western Ghats, South India.

Horizon — Miocene.

Comparison — The present specimen closely compares with *N. airensis* Cookson

(1947) but differs mainly in its smaller size, conical form and the degree of prominence of ostiole border. *N. setiferous* Cookson (1947) and *N. neyvelii* Ramanujam (1963) can be differentiated in having short, non-septate, blunt setae in some ostiole border cells.

Genus — *Paramicrothallites* gen. nov.

Type Species — *Paramicrothallites* (*Microthallites*) *spinulatus* (Dilcher) comb. nov. (PL. 12, FIG. 92).

Diagnosis — Stroma radiate, more or less rounded, ostiolate, ostiole not surrounded by specialized cells, free hyphae absent.

Paramicrothallites menonii sp. nov.

Pl. 1, Fig. 10

Diagnosis — Ascomata flattened, circular, ostiolate, 40-60 µ in diameter, solitary, margin entire; hyphae radially arranged, inter-connected, forming pseudoparenchymatous cells; central cells squarish, marginal rectangular, walls thin. Ostiole well defined, 8-10 µ in diameter, centrally placed, not unsurrounded by any specialized cell, margin lobed. This simple ostiole is formed probably due to dissolution of the central cells of the ascomata. Free hyphae are either truly lacking or not preserved. Ascospore unknown.

Holotype — Pl. 1, Fig. 10; Slide No. 3847/9.

Type Locality — Padappakara, Quilon, Western Ghats, South India.

Horizon — Miocene.

Comparison — *Paramicrothallites menonii* sp. nov. closely resembles with *Paramicrothallites spinulatus* (Dilcher) comb. nov. in its shape, size range, radiating nature and surrounded ostiole by specialized cells. *P. menonii* sp. nov. can, however, be distinguished from *P. spinulatus* (*l.c.*) in the absence of two layered stroma with basal echinations on the margins.

Remarks — Dilcher (*l.c.*) instituted a new artificial genus *Microthallites* with two new species, viz. *M. lutosus* non-ostiolate and *M. spinulatus* ostiolate. In view of the present studies it seems quite important, at least in case of fossil forms to consider the presence or absence of ostiole as a generic character (*see* TABLE 1) to classify the dispersed microthyriaceous ascomata or thyrothecia. Cain (1961), Holm (1958) and Rai *et al.* (in press) are also of the opinion that the ostiole character is important in the classification of ascomycetes at the generic level. It is, therefore, suggested here to maintain *Microthallites* Dilcher (*l.c.*) only for non-ostiolate forms. The ostiolate species *M. spinulatus* Dilcher (l.c.) has been transferred to the new genus *Paramicrothallites* as its genotype.

TABLE 1

(Classification of fossil microthyriaceous fungi)

Fossil microthyriaceous fungi

- Radiate forms
- Young forms (germlings) not having complete radiate nature.

- Ostiolate
  - Ostiole surrounded by thick walled specialized cells.
    1. *Notothyrites* Cookson (1947)
    2. *Sphaerialites* Venkatachala & Kar (1969)
  - Ostiole not surrounded by thick walled specialized cells.
    1. *Paramicrothallites* gen. nov.
- non-ostiolate
  - Ascomata cells porate
    1. *Callimothallus* Dilcher (1965)
    2. *Pseudosphaerialites* Venkatachala & Kar (1969)
  - Ascomata cells non-porate.
    1. *Phragmothyrites* Edwards (1922)
    2. *Microthallites* Dilcher (1965)
    3. *Parmathyrites* gen. nov.

Derivation of Specific Name — It has been given after Prof. K. K. Menon, Department of Geology, University of Kerala, Trivendrum.

Genus — *Callimothallus* Dilcher (1965)

Callimothallus quilonensis sp. nov.

Pl. 1, Figs. 15-16

Diagnosis — Ascomata flattened, sub-circular to circular, non-ostiolate, 35-65 μ in diameter, solitary, margin entire to crenate. Centre cell triangular from which radiating rows of cells extend outward, cells more elongated towards the periphery, peripherial cells porate, pore single, slightly elevated, 1-3 μ wide, placed apically. Cell wall thick. Hyphae absent. Ascospore unknown.

Holotype — Pl. 1, Fig. 15; Slide No. 3846/7.

Type Locality — Padappakara, Quilon, Western Ghat, South India.

Horizon — Miocene.

Comparison — *Callimothallus quilonensis* sp. nov. closely resembles with *Callimothallus pertusus* Dilcher (1965) in its shape, radiate nature and porate stroma but the former can be distinguished from latter in having only porate peripheral cells.

Genus — *Phragmothyrites* Edwards, 1922

Phragmothyrites sp. cf. *P. eocaenica* Edwards (1922)

Pl. 1, Figs. 12

Description — Ascomata flattened, circular, non-ostiolate, 70-80 μ in diameter, one layered thick, margin entire or slightly crenate, radiating hyphae interconnected, forming pseudoparenchymatous tissue; central cells small, thick and dark coloured, outer cells squarish to rectangular, thin walled. Subtending layer prominent having thick radial cell walls. Ascospore unknown.

Order — Sphaeriales.
Family — Melanosporaceae.

Genus — *Diploneurospora* gen. nov.

Type Species — *Diploneurospora tewarii* gen. et sp. nov., Pl. 1, Fig. 21.

Generic Diagnosis — Ascospore two celled, uniseriate, elliptical, margin uneven, cells unequal; upper cell prominent, dark brown in colour, thick walled, wall sculptured with longitudinal ribs. Lower cell hyaline, appendage like, small in size, rib sculpture faint.

Diploneurospora tewarii gen. et sp. nov.

Pl. 1, Fig. 21

Diagnosis — Ascospores two celled, uniseriate, cells unequal in size, length ratio nearly 3:1, both ends acute, two cells attached at broader bases along one side. Larger cell dark brown in colour, elliptical 50×16 μ in size, exine 0·7 μ thick, sculptured, ribs prominent on one side, extending upto margins on the other side, leaving central portion free, ribs longitudinal, discontinuous, 8-10 in number, branched. Smaller cell hyaline, tail like, 10×15 μ in size. Exine thin, ribs very faint, 4-5 in number.

Derivation of Generic and Specific Names — In comparison with the single celled ascospore of extant genus *Neurospora*, the present two celled fossil ascospore similar to *Neurospora* has been given the name *Diploneurospora*. The specific name has been given after Dr. J. P. Tewari, Department of Botany, Lucknow University, who helped us in identifying the fossil specimen.

Class — Phycomyceteae
Order — Chytridiales
Family — Phlyctidiaceae

Genus — *Entophlyctis* Fischer, 1892

Entophlyctis willoughbyi Bradley (1967)

Pl. 1, Figs. 3-5

Fungal spores, cf. *Desmidiophaera*, Pl. 9, Figs. 126-127; in Martin & Rouse, 1966.

Remarks — Out of the list of synonomy made by Bradley (1967, p. 579) only *Phycopeltis* sp. Köck (1939, Pl. 3, Figs. 1-6) shows closest resemblance with *E. willoughbyi* in having deep segmentation, exit pore and germ tube; otherwise, all other forms represent the young forms (germlings) of microthyriaceous fungi.

Incertae sedis

Genus — *Quilonia* gen. nov.

Type species — *Quilonia typica* gen. et sp. nov., Pl. 1, Fig. 19.

Generic Diagnosis — Body multicellular, filamentous. Exine thick, margin undulated. Apical and basal portions narrow, central wide. Basal stalk prominent with one or two rectangular thick walled cells; apical cell mostly incomplete, curved, central portion broad, elongate with irregular shaped furrow like suture, inside the filament at different places occur small 1 to 4 circular, ostiolate bodies.

Quilonia typica gen. et sp. nov.

Pl. 1, Figs. 17-20

Diagnosis — Body multicellular, filamentous measuring 175-215 $\mu \times 10$-25 μ in size. Basal stalk distinct, with one or two rectangular cells, 8-10 μ in size with unevenly thickened walls. Apical portion curved and incompletely preserved, central portion broad, elongate. Exine 1·5-2·5 μ thick, at places dense due to accumulation of upper lose covering. Furrow prominent, 40-67·5$\mu \times$2-2·5 μ in size. Some small, circular, 8-10 μ in size bodies occur throughout the filament.

Holotype — Pl. 1, Fig. 19; Slide No. 3845/5.

Type Locality — Quilon, Padappakara, Western Ghat, India.

Horizon — Miocene.

Comparison — *Quilonia typica* gen. et sp. nov. approaches nearest to the extant genus *Annellophora* (Hughes) Ellis.

Genus — *Microthyriacites* Cookson, 1947

Microthyriacites sp.

Pl. 1, Fig. 11

Description — Ascomata flattened, more or less circular, 60-80 μ in diameter, one layered thick with irregular margins. Ascomata consisting radiating rows of cells, cells range from 1·5-5$\mu \times$2-6 μ in size, central cells thick walled, 4-6 μ in diameter, forming a cover or lid over the area of immature stroma, probably forming ostiole later on. Cell wall mostly thin, in some cells radially thick. Ascospore unknown.

Remarks — These ascomata are rare in the assemblage and it is not clear whether they represent mature ascomata or they are the developmental stages of a large species such as *M. grandis* Cookson (1947).

Fungal spore Type 1

Pl. 1, Fig. 22

Description — Phragmospore four celled, broadly elliptic in shape, measuring 40$\times$25 μ in size. End cells slightly flattened, thin walled; central two cells dark in colour, thick walled, with rectangular lumen.

Remarks — Similar phragmospores were also recorded by Rao (1958) from Warkalli lignites. These phragmospores are rare in the present assemblage. Due to the absence of any kind of definite fructifications it is difficult to compare them with living genera and to determine their true relationship.

Fungal spore Type 2

Pl. 1, Figs. 23-24

Description — Teliospores globose to ovoid, dark brown in colour, 25-35 μ in size, small pore in centre, trilete mark faint, arms short. Exine 2-4 μ thick, smooth.

Remarks — These spores are fairly common in the present assemblage. It closely resembles with living *Uromyces Clignyi* Pat. and Harriot (1900, in Hennen, 1965) in its shape, size and a faint trilete mark.

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EXPLANATION OF PLATE 1

(*All microphotographs* × 500 *except where stated otherwise*)

1. *Parmathyrites indicus* gen. et sp. nov.; Slide No. 3845/1; × 300.
2. A portion of the same magnified; × 500

3-4. *Entophlyctis willoughbyi* Bradley (1967); Slide Nos. 3845/3 & 3845/2 respectively.

5. *E. willoughbyi* Bradley (1967); Slide No. 3847/12; × 1000.

6-9. Young forms (germlings) of Microthyriaceous fungi Dilcher (1965); Slide Nos. 3841/4, 3843/1, 3848/4 and 3848/7 respectively.

10. *Paramicrothallites menonii* sp. nov.; Slide No. 3847/9.

11. *Microthyriacites* sp. Cookson (1947); Slide No. 3847/8.

12. *Phragmothyrites* sp. cf. *P. eocaenica* Edwards (1922); Slide No. 3841/3.

13-14. *Notothyrites padappakarensis* sp. nov.; Slide Nos. 3848/2 & 3850/1 respectively.

15-16. *Callimothallus quilonensis* sp. nov.; Slide Nos. 3846/7 & 3846/6 respectively.

17-18. *Quilonia typica* gen. et sp. nov. Slide Nos. 3848/6 & 3842/1 respectively; × 250.

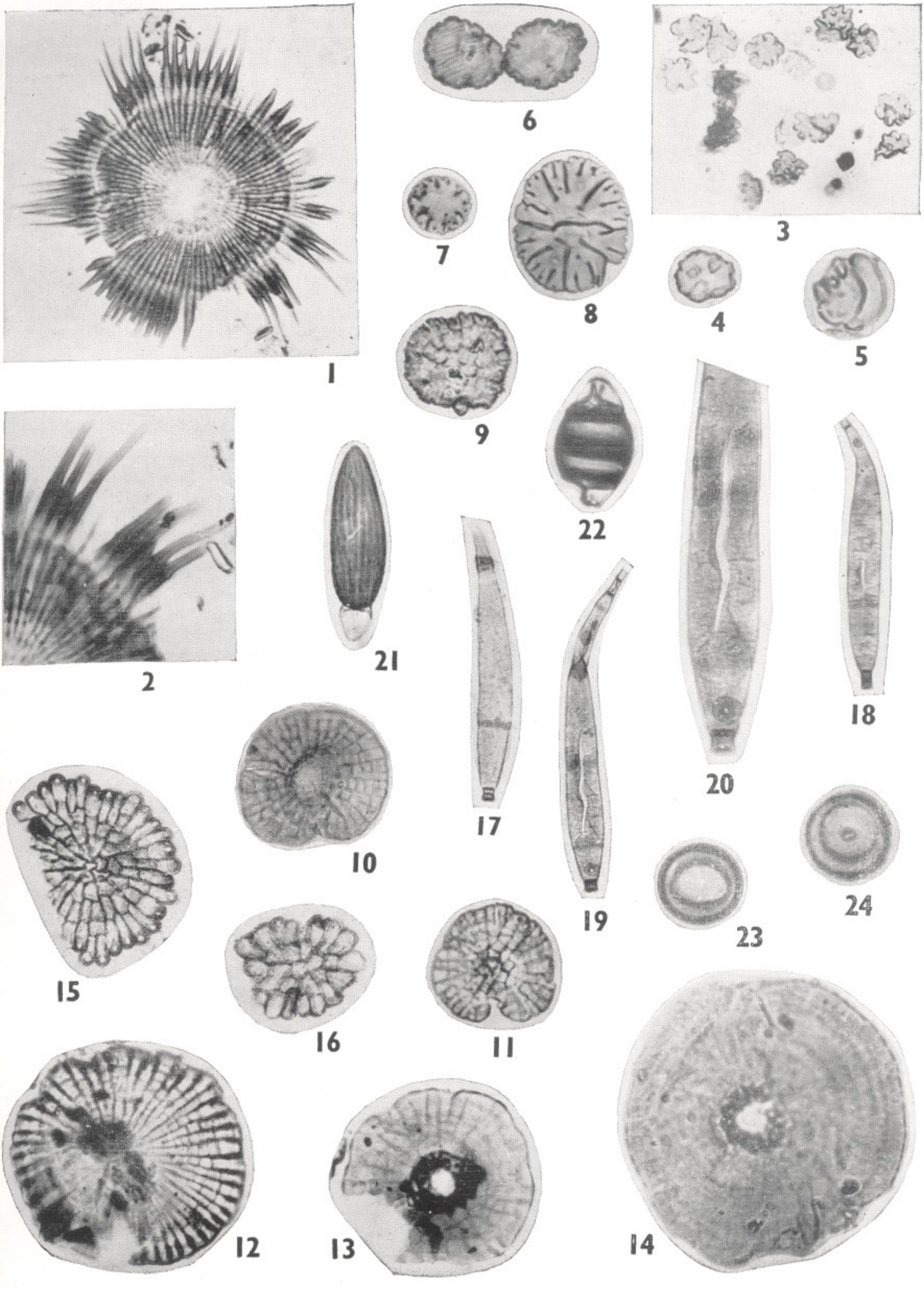
19. *Quilonia typica* gen. et sp. nov.,; Slide No. 3845/5; × 250.

20. Same magnified; × 500.

21. *Diploneurospora tewarii* gen. et sp. nov.; Slide No. 3851/2.

22. *Fungal spore* type-1; Slide No. 3848/1.

23-24. *Fungal spore* type-2; Slide Nos. 3844/1 & 3848/5.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