A FURTHER RECORD OF MICROTHYRIACEOUS FUNGI FROM THE NEOGENE DEPOSITS OF KERALA IN SOUTH INDIA

K. P. RAO* AND C. G. K. RAMANUJAM**

**N. B. Science College, Hyderabad*

***Osmania University, Hyderabad.*

ABSTRACT

The paper deals with some new records of microthyriaceous fungi from the Miocene deposits of Quilon and Warkalli beds of the Kerala State in South India. The new taxa recorded are *Notothyrites echinatus* sp. nov., *Callimothallus dilcherii* sp. nov., *Microthallites cooksonii* sp. nov., *Paramicrothallites edvensis* sp. nov., *Asterothyrites keralensis* sp. nov., and *Microthyriella diporatus* sp. nov.

INTRODUCTION

Fruit bodies or ascomata referable to the microthyriaceous complex although known from as early as the Upper Cretaceous strata of South India (BANERJEE & MISRA, 1968) are commonly encountered, however, in the Indian Tertiary deposits ranging from the Paleocene to Mio-Pliocene horizons (JACOB & JACOB, 1950; CHITALEY, 1957; RAO, 1958; RAMANUJAM, 1963 a, 1963 b; VENKATACHALA & KAR, 1969; JAIN & GUPTA, 1970; KAR, SINGH & SAH, 1972; RAMANUJAM & RAO, 1973). JAIN (1974) recently provided a brief but useful review of the diverse remains of fossil fungi recorded from various geological horizons of India. The present contribution deals with some new records of the microthyriaceous fruit bodies from the Neogene deposits of Kerala along the west coast of South India.

The Kerala Tertiaries resting unconformably over the archaean gneissis complex are divisible into the lower marine Quilon beds and the upper continental Warkalli beds. The calcareous and carbonaceous clays of the Quilon beds and the lignite in Warkalli beds have yielded a number of beautifully preserved thyriothecia along with an extremely rich assemblage of the pteridophytic spores and angiospermic pollen grains.

SYSTEMATIC DESCRIPTION

Family—Microthyriaceae

Sub-Family—Microthyreae

Genus—**Notothyrites** Cookson, 1947

Notothyrites denticulatus Ramanujam & Rao, 1973 (Pl. 1, Figs. 1, 2)

Comments—Fruit bodies of this type are quite common in the Warkalli lignites. The figured specimen differs from the fruit bodies described earlier in its larger size (95 μ), some what irregularly outlined ostiole and a greater number of denticular or coni-like processes protruding into the ostiolar opening.

N. echinatus sp. nov. (Pl. 1, Figs. 3, 4)

Diagnosis—Ascomata flattened, dimidiate, rounded, margin even and firm; 90-115 μ in diam; ostiolate, ostiole centric, 11-14 μ in diam; elevated on a thick border of 4-5 layers of thick-walled cells, inner layer of ostiole border with 15-22 prominent spinous processes, spines 5-8 μ long, 2.0-2.5 μ broad at the base. Rest of fruit body with radially aligned squarish to rectangular cells, 3.0-3.5 × 2.5-4.5 μ in size, radial walls of these cells thickened.

Comments—Fruit bodies of this type have been recovered from the Warkalli lignite. *Notothyrites echinatus* sp. nov. differs from other known species in the possession of prominent spinous processes projecting into the ostiole. *N. setiferous* Ramanujam & Rao (1973) recorded from the Warkalli lignites is characterised by short denticular to conate processes.

Holotype—Pl. 1, Fig. 3. Slide W. L. S.—64. Co-ordinates: 14.0 × 86.4, Size: 98 μ.

Locality and Age—Lignite from Warkalli; Upper Miocene.

N. padappakarensis Jain & Gupta, 1970. (Pl. 1, Fig, 5)

Comments—Ascomata of this type recorded originally from the Padappakkara clays of Quilon beds are frequently encountered in the Warkalli lignites too. But they differ from the Quilon specimen in their smaller size and more robust papillate protuberances from the border of ostiole.

Genus—**Callimothallus** Dilcher, 1965

Callimothallus dilcherii sp. nov. (Pl. 2, Fig. 13).

Diagnosis—Free mycelium lacking; ascomata flattened, ±circular, margin irregular, 75—120 μ in diam., non-ostiolate, cells forming the ascomata radiating from angular central cell, cells near central region 5-6 angled and those towards periphery rectangular, 4-5 μ wide and 4-7.5 μ long, marginal cells bottle shaped (phialides) with a distinctly constricted neck and porate, pores one per cell, located terminally, 1.5-2.5 μ wide, radial and tangential walls of cells thickened.

Comments—This characteristic fruit body has been recorded from the Edvai lignite. In view of the possession of pores in certain cells, the fruit body is included under the genus *Callimothallus* Dilcher (1965). *C. pertusus* recorded from the Eocene deposits of Western Tennessee, U.S.A. (Dilcher, 1965) and from the Warkalli lignites (Miocene) of South India (Ramanujam & Rao, 1973) is characterized by a proximally located pore in each cell of the stromata. *C. assamicus* reported from the Tura Formation (Eocene) of Garo hills, Assam (Kar, Singh & Sah, 1972) has pores confined to the central cells of the fruit body only. *C. dilcherii* sp. nov. while resembling *C. quilonensis* Jain & Gupta (1970) described from the Quilon beds at Padappakkara in possessing peripheral porate cells, is distinguishable in its peculiar bottle-shaped peripheral cells. The specific name is in honour of Dr. D. L. Dilcher.

Holotype—Pl. 2, Fig. 13. Slide. Edv. L-6. Co-ordinates: 11.8 × 89.6, Size: 84 μ.

Locality and Age—Edvai, Quilon Formation (Miocene)

Genus—**Microthallites** Dilcher, 1965

Microthallites cooksonii sp. nov. (Pl. 1, Fig. 10)

Diagnosis—Free mycelium absent. Ascomata ±rounded, flattened, up to 90.0 μ in diam. non-ostiolate, 2-5 wedge-shaped cells at the centre, ascomata with simple or forked radial rows of cells, 2.5—4.0 μ broad and 3.5-6.0 μ long, radial walls of cells prominently thickened and appearing as straight reinforcements, tangential walls very thin.

Comments—Ascomata of this type are very commonly encountered in certain samples of the Warkalli lignite and are generally found perched on some unidentified angiosperm leaf cuticles. Cookson (1947) established the genus *Microthyriacites* (Microthyriaceae incertae sedis) for fungal forms for which neither the presence nor the absence of free hyphae could be definitely ascertained. Dilcher (1965) established the genus *Microthallites* for forms which definitely lack free mycelium but cannot be precisely compared with any modern or fossil taxon. The present species can be differentiated from *Microthallites lutosus* Dilcher (1965) in its prominently thickened radial walls and possession of a group of 2-5 wedge-shaped central cells. The species has been named in honour of Dr. (Mrs.) Isabel Cookson.

Holotype—Pl. 1, Fig. 10. Slide W. L. S. S_1-29. Co-ordinates: 12.8×77.1; Size: 37.5 μ.

Locality and Age—Lignite from Warkalli; Upper Miocene.

Genus—**Paramicrothallites** Jain and Gupta, 1970

Paramicrothallites edvensis sp. nov. (Pl. 1, Fig. 7)

Diagnosis—Free mycelium lacking. Ascomata flattened, ±circular, margin firm and even, 50-85 μ in diam., ostiolate, ostiole with no specialised border, rounded to slightly irregular, 7.5—9.0 μ in diam., cells of ascomata radiately arranged, 3.0—4.5 μ wide, squarish to rectangular near central region, elongated, 6.0—9.0 μ long and thin-walled near margin, margin mostly crenate with local thickenings.

Comments—Fruit bodies of this type are fairly common in the Edvai lignite of Quilon Formation. Jain and Gupta (1970) instituted the genus *Paramicrothallites* to separate ostiolate forms from non-ostiolate forms included under the form—genus *Microthallites* of Dilcher (1965). *Paramicrothallites spinulatus* (Dilcher) Jain & Gupta (1970) is characterised by the possession of small spines on the margin of the fruit body. *P. menonii* Jain & Gupta (1970) recorded from the Quilon beds near Padappakkara has smooth margin. *P. edvensis* sp. nov. is distinguishable in its crenate margin.

Holotype—Pl. 1, Fig. 7. Slide Edv. L-11. Co-ordinates: 12.0×90.8, Size: 67 μ.

Locality and Age—Edvai, Quilon Formation (Miocene)

Sub-family—Asterineae

Genus—**Asterothyrites** Cookson, 1947

Asterothyrites keralensis sp. nov.

Diagnosis—Ascomata rounded, dimidiate, margin even to crenate, firm, 58-85 μ in diam. Ostiolate, ostiole centric, round, 7-9 μ in diam., with a prominent border of 2-3

layers of thick-walled dark brown cells. Hyphopodiate free mycelial shreds near ostiole border, rest of ascomata with strictly radiately arranged, squarish to rectangular 2.0-4.0 μ wide cells; outer walls of marginal cells thickened. Ascospores unknown.

Comments—Fruit bodies of this type are very common in certain samples of Warkalli lignites and show a wide range of variation in their size. One of the constant characters is the presence of hyphopodiate mycelial shreds in the vicinity of the ostiole border. No definite organic connection of these hyphal branches and the border cells of the ostiole could however, be established. *A. sinuatus* and *A. delicatissimus* described from Australia (Cookson, 1947) are non-ostiolate.

Holotype—Pl. 2, Fig. 12. Slide W. L. $S._1$—91. Co-ordinates: 16.8×84.5; Size: 62.5 μ.

Locality and Age—Lignite from Warkalli (U. Miocene).

Sub-Family—Trichopelteae

Genus—**Trichopeltinites** Cookson, 1947

Trichopeltinites fusilis Dilcher, 1965 (Pl. 2, Fig. 14)

Description—Stroma linear, ribbon-like with irregularly lobed margins, linear diam. up to 108 μ, one layered, hyphae dichotomising repeatedly, cells 2.5-4.0×5.0-10.0 μ with fairly thick radial walls, free hyphae lacking.

Comments—Stroma of *Trichopeltinites fusilis* are encountered only occasionally and in none of them fertile regions were found.

Locality and Age—Lignite from Warkalli (Upper Miocene).

Trichopeltinites sp. (Pl. 2, Fig. 16)

Description—Free mycelium lacking, stroma flattened, deep brown in color, ribbon shaped, mostly with even margins, variable in size, 60-175 μ; cells forming the pseudoparenchymatous structure becoming increasingly longer towards periphery, 2.5-3.5× 4.0-10.0 μ, radiately arranged, radial walls of cells distinctly thicker than the tangential walls. Fertile regions not found.

Comments—*Trichopeltinites* sp. differs from *T. fusilis* (Dilcher, 1965) in its larger and robust size, ± regular form with prominently thick-walled cells.

Location—Pl. 2, Fig. 16. Slide W. L. $S._1$—8. Co-ordinates: 19.4×87.1, Size: 153 μ.

Family —Micropeltaceae

Sub-family —Haplopeltoideae

Genus —**Microthyriella** Höhnel, 1909

Microthyriella diporatus sp. nov. (Pl. 2, Fig. 15)

Diagnosis—Free mycelium lacking. Ascomata flattened, irregular in shape, highly variable in size ranging between 50-150 μ; cells of the ascomata 5.0-10.0 μ in diam., penta to hexagonal, irregularly arranged and porate, pores mostly two per cell, 2.5-3.5 μ wide, circular and randomly disposed.

Comments—Fruit bodies of this type are fairly common and exhibit a wide variation in their shape and size. Since no other dehiscence mechanism was observed in any of the fruit bodies examined, the pores in the cells can be supposed to function as secondary ostioles helping in the release of spores (DILCHER, 1965). *M. fungosa* from the Eocene of Tennessee U.S.A. (DILCHER, 1965) is distinguishable in the possession of only one pore per cell.

Holotype—Pl. 2, Fig. 15. Slide W. L. S.-32. Co-ordinates: 22.7 × 71.7, Size: 88 μ.

Locality and Age—Lignite from Warkalli (Upper Miocene).

Genus—**Haplopeltis** Theissen, 1914

Haplopeltis mucoris Dilcher, 1965 (Pl. 1, Fig. 6)

Description—Ascomata flattened but elevated in the centre; ± rounded, margin somewhat uneven and firm; 150 μ in diam., ostiolate, ostiole centric, round 16 μ in diam., surrounded by a ring of small cells 2-3 μ wide, cells forming the rest of the ascomata angular, 2.5-3.5 μ wide, irregularly arranged. Free mycelium and spores unknown.

Comments—Fruit bodies of this type are fairly common. In their characteristic irregular arrangement of cells and in the possession of an ostiole surrounded by a ring of small cells, the fruit bodies recovered from Warkalli lignites resemble those reported from Eocene deposits of Tennessee, U.S.A., and hence included under *Haplopeltis mucoris* (DILCHER, 1965), but the Warkalli specimens differ in their slightly larger size.

Microthyriaceae Incertae sedis (Pl. 2, Figs. 8, 9)

Description—Free mycelium absent. Ascomata flattened but conspicuously elevated in the centre as a mound, shape somewhat irregularly rounded, margin firm, 61.0 μ diam. ostiolate, ostiole eccentric, 10-12 μ in diam., surrounded by 2 or 3 rings of thick-walled angular cells, usually 3-5 μ wide. Cells of the rest of ascomata 4.0-7.0 μ in diam., angular, irregularly aligned. Tangential walls of peripheral cells thickened.

Comments—Fruit bodies of this type found only occasionally in the Warkalli lignite, although generally comparable with *Haplopeltis*, are distinguishable in the possession of 2 or 3 rings of thick walled cells around the ostiole. In *Haplopeltis*, the genus described above, the ostiole is surrounded by a single ring of small cells.

DISCUSSION

The microthyriaceous fungi described in the present contribution include the species of *Notothyrites*, *Asterothorites*, *Callimothallus*, *Microthallites*, *Paramicrothallites*, *Haplopeltis*, and *Trichopeltinites*. The list of all the validly published microthyriaceous fungi till to date from the Tertiary horizons of India is given below.

A critical perusal of this list indicates in no uncertain manner the richness of these fungi, both qualitatively and quantitatively from the Neogene strata of India. The microthyriaceous epiphyllous fungi generally abound in tropical humid climates and it is known that their growth and spread is conditioned more by rainfall and humidity than by temperature. The common occurrence of myriad kinds of these fungi in the Neogene deposits of India clearly indicates warm humid climate with plenty of rainfall during this period. In this connection it is significant to note that a recent palynological investigation of the Kerala Tertiaries by one of us (K. P. RAO, 1974) has distinctly indicated a tropical humid climate with plenty of precipitation during the Neogene of Kerala.

Genera and Species	Age	Locality	Authors
Callimothallus assamicus	Eocene	Tura Formation, Assam	Kar, Singh & Sah, 1972
C. sp. cf. *pertusus*	Eocene	,,	,,
Parmathyrites turaensis	Eocene	,,	,,
Phragmothyrites (*Microthyriacites*) *edwardsii* (Rao)	Eocene	Tura Formation, Assam	Kar, Singh & Sah, 1972
P. sp. cf. *P. eocaenicus*	Eocene	,,	,,
Microthyriacites sahnii	Eocene	Palana lignite, Bikaner	Rao, 1958
M. cooksonii	Eocene	Palana lignite, Bikaner	Rao, 1958
Pseudosphaerialites senii	Eocene	Laki sediments, Kutch	Venkatachala & Kar, 1969
Sphaerialites ovatus	Eocene	,,	,,
Callimothallus quilonensis	Miocene	Padappakkara clays, Kerala	Jain & Gupta, 1970
C. pertusus	Miocene	Warkalli lignite, Kerala	Ramanujam & Rao, 1973
C. raoi	Miocene	,,	,,
C. dilcherii sp. nov.	Miocene	Edvai lignite, Kerala	,,
Notothyrites padappakarensis	Miocene	Padappakkara clays; Warkalli lignite, Kerala.	Jain & Gupta, 1970
N. setiferus	Miocene	Warkalli lignite, Kerala	Ramanujam & Rao, 1973
N. denticulatus	Miocene	,,	,,
N. echinatus sp. nov.	Miocene	,,	,,
Paramicrothallites menonii	Miocene	Padappakkara clays, Kerala	Jain & Gupta, 1970
P. edvensis sp. nov.	Miocene	Edvai lignite, Kerala	,,
Microthyriacites edwardsii	Miocene	Warkalli, lignites, Kerala	Rao, 1958
M. cooksonii	Miocene	South Arcot lignite, Madras	Rao, 1958
Phragmothyrites sp cf. *P. eocaenica* Edwards.	Miocene	Padappakkara clays, Kerala	Jain & Gupta, 1970
Parmathyrites indicus	Miocene	,,	,,
Asterina eocaenica	Miocene	Warkalli lignite, Kerala	Ramanujam & Rao, 1973
Asterothyrites sp.	Miocene	,,	,,
Asterothyrites keralensis sp. nov.	Miocene	,,	,,
Euthyrites keralensis	Miocene	,,	Ramanujam & Rao, 1973
Plochmopeltinites cooksonii	Miocene	,,	,,
Microthallites cooksonii sp. nov.	Miocene	,,	,,
Trichopeltinites fusilis	Miocene	,,	,,
Haplopeltis mucoris	Miocene	,,	,,
Microthyriella diporatus sp. nov.	Miocene	,,	,,
Microthyriaceae Incertae sedis	Miocene	,,	,,

The stratigraphic potential of the microthyriaceous fungi is known very little till to-date. While it is premature to comment upon the stratigraphic utility of these fungi, it may be significant to note that genera like *Euthyrites*, *Plochmopeltinites* and *Asterothyrites*, have been recorded so far only from the Neogene deposits.

REFERENCES

BANERJEE, D & MISRA, C. M. (1968). Cretaceous microflora from South India. *Mem. geol. Soc. India.* **2:** 99-104.

CHITALEY, S. D. (1957). Further report on the fossil microflora from the Mohgaonkalan beds of Madhya Pradesh, India. *Proc. nat. Inst. Sci.* **23:** 69-79.

COOKSON, I. C. (1947). Fossil Fungi from the Tertiary deposits in the southern hemisphere. Part I. *Proc. Linn. Soc. New South Wales*, **72** (3-4): 207-214.

DILCHER, D. L. (1965). Epiphyllous fungi from Eocene deposits in Western Tennessee, U.S.A., *Palaeontographica.* **116 B:** 1-54.

JACOB, K. & JACOB, C. (1950). Cuticles from the Tertiary lignites of Cuddalore, South Arcot, India. *Proc. VIIth Int. bot. Congr. Stockholm*: 572.

JAIN, K. P. (1974). Fossil Fungi in *Aspects and Appraisal of Indain Palaeobotany*, ed. Surange, *et. al.* p. 38, Birbal Sahni Institute of Palaeobotany, Lucknow.

JAIN, K. P. & GUPTA, R. C. (1970). Some fungal remains from the Tertiaries of Kerala Coast. *Palaeobotanist.* **18:** 117-122.

KAR, R. K., SINGH, R. Y., & SAH, S. C. D. (1972). On some algal and fungal remains from Tura Formation of Garo Hills, Assam. *Palaeobotanist.* **19:** 146-154.

RAMANUJAM, C. G. K. (1963a). Thyriothecia of Asterineae from the South Arcot lignite, Madras *Curr. Sci.* **32:** 327-328.

RAMANUJAM, C. G. K. (1963b). On two new species of fossil fungi from South Arcot ligntie *Proc. 50th Sci. Congress.* **3:** 396.

RAMANUJAM, C. G. K. & PURNACHANDRA RAO, K. (1973). On some microthyriaceous fungi from a Tertiary lignite of South India. *Palaeobotanist.* **20:** 203-209.

RAO, A. R. (1958). Fungal remains from Tertiary deposits of India. *Palaeobotanist.* **7:** 43-46.

RAO, K. P. (1974). Palynology of the Tertiary sediments of the Kerala State, South India. *Ph.D. Thesis* Osmania University, Hyderabad.

VENKATACHALA, B. S. & KAR, R. K. (1969). Palynology of the Laki sediments in Kutch—2. Epiphyllous fungal remains from the bore-hole No. 14. *Palaeobotanist.* **17:** 179-183.

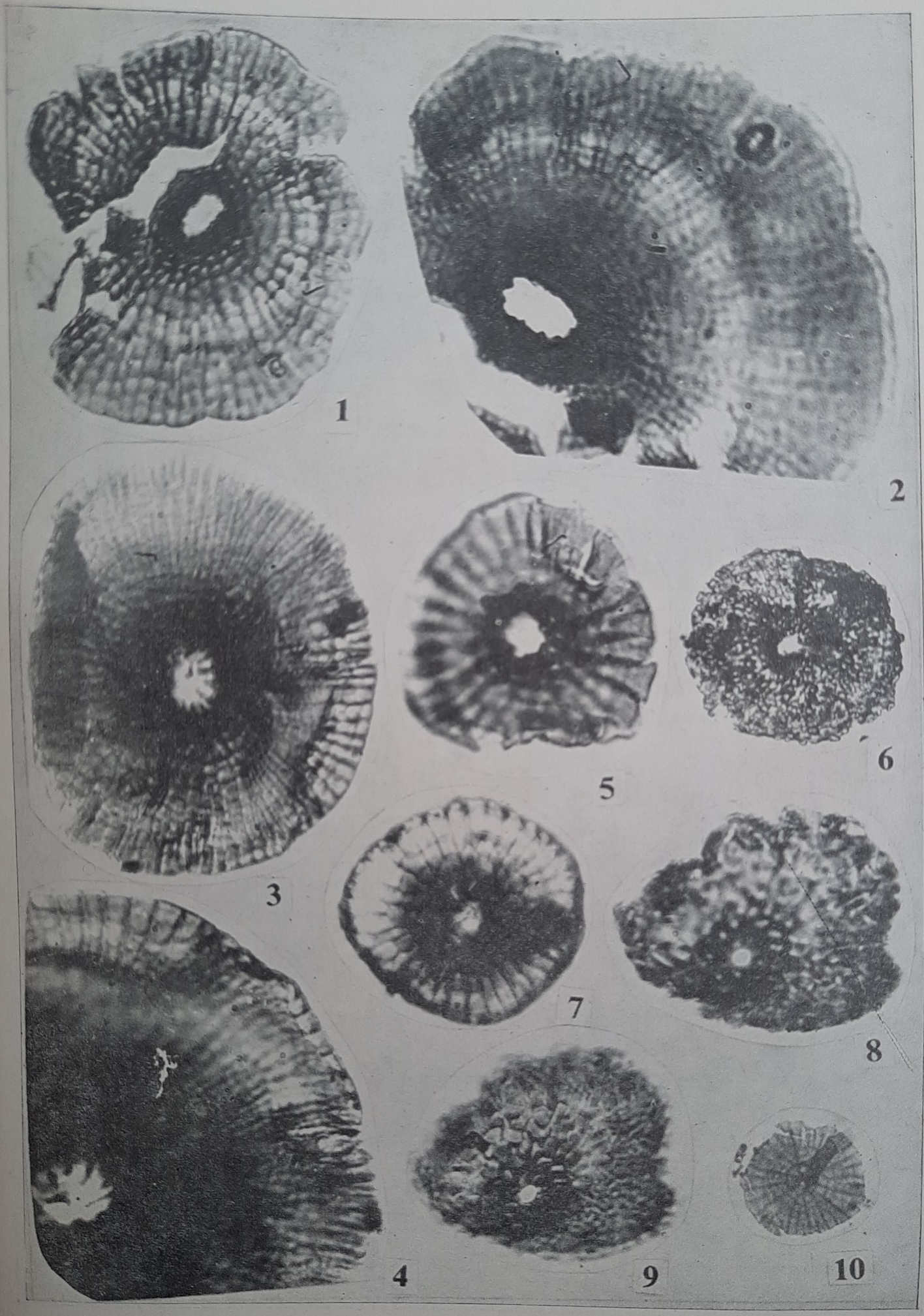
EXPLANATION OF PLATES

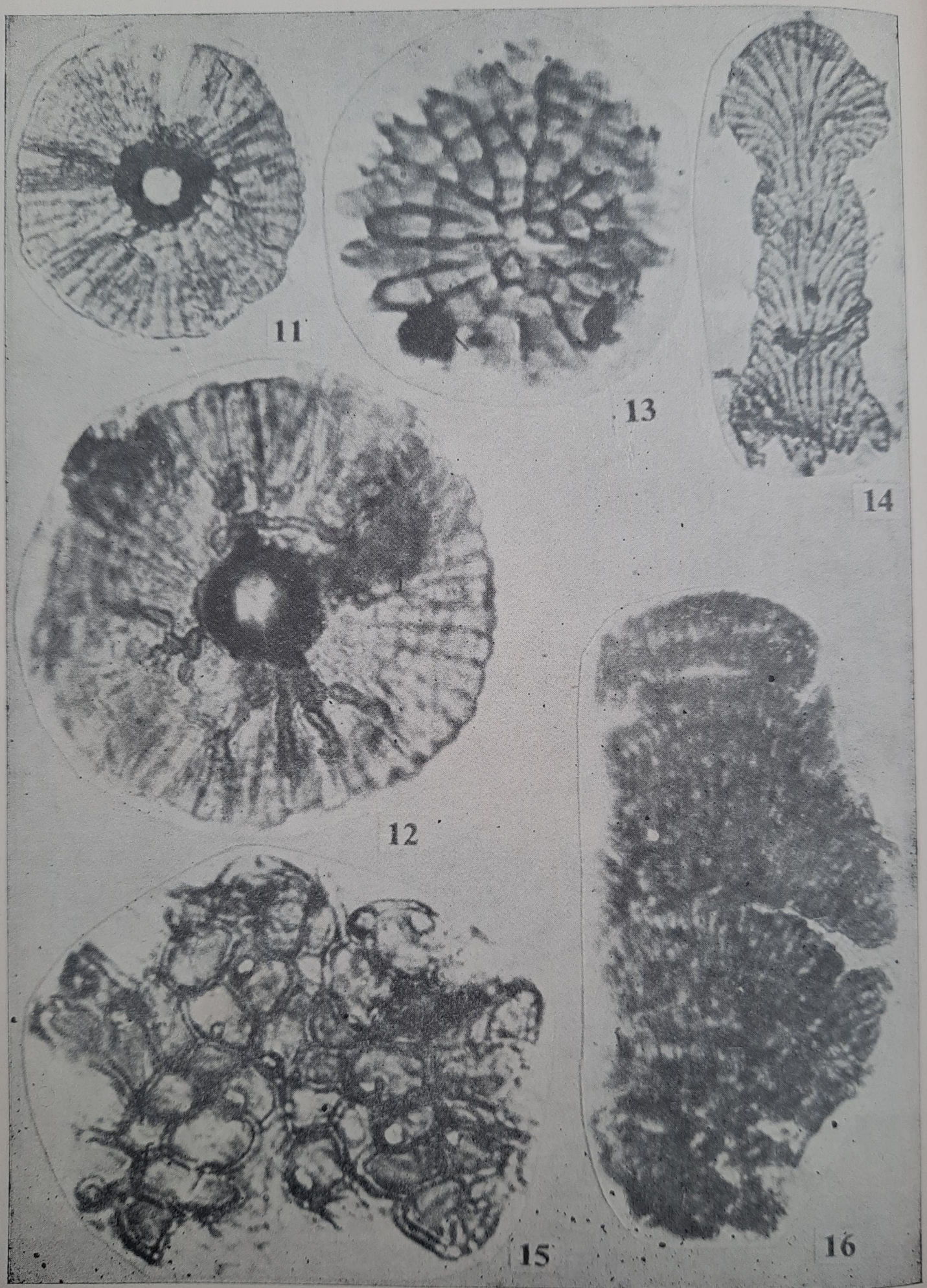
PLATE 1

1. *Notothyrites denticulatus*, entire ascomata ×600.
2. *N. denticulatus*, part of the fruit body magnified. Note the coni-like processes projecting into the ostiole. ×900.
3. *N. echinatus* sp. nov. (holotype) ×600.
4. *N. echinatus*, part of the fruit body magnified to show the spinous processes ×900.
5. *N. padappakarensis*, Note the robust papillate protuberances ×600.
6. *Haplopeltis mucoris.* ×250.
7. *Paramicrothallites edvensis* sp. nov. (holotype) Note the crenate margin. ×600.
8. 9. Microthyriaceae Incertae sedis. ×700.
10. *Microthallites cooksonii* sp. nov. ×600.

PLATE 2

11. *Asterothyrites keralensis* (paratype) ×700.
12. *A. keralensis* sp. nov. (holotype) ×1000.
13. *Callimothallus dilcherii* sp. nov. (holotype) ×700.
14 *Trichopeltinites fusilis.* ×600.
15. *Microthyriella diporatus* sp. nov. (holotype) ×700.
16.. *Trichopeltinites* sp. ×700.


1
2
3
5
6
7
8
4
9
10



Rao *et al.*—Plate 2