

Fungal remains from the Neyveli Formation of Tiruchirapalli District, Tamil Nadu, India

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Fungal remains recovered from the Neyveli Formation of Jayamkondacholapuram Well-12 in Tiruchirapalli District, Tamil Nadu are described. The assemblage consists of thirteen genera and twentyfive species, including three genera and seven species of epiphyllous microthyriaceous fungi and ten genera and eighteen species of fungal spores. Of these, two genera and six species are new. The important taxa are : *Inapertisporites*, *Multicellaesporites*, *Diporicellaesporites*, *Phragmothyrites*, *Pluricellaesporites* etc.

Key - words - Fungal remains, Tertiary, Neyveli Formation, Tiruchirapalli District, Tamil Nadu, India.

INTRODUCTION

The term Neyveli Formation was proposed by Siddhanta (1986) after the Neyveli Mines in South Arcot District, Tamil Nadu, where the upper part of the Formation is well exposed in open pit sections. It consists of semiconsolidated sandstone and clay beds with occasional limestone intercalations, carbonaceous clay and lignite. This formation, particularly the lignite bed, is rich in spores, pollen and fungal remains. The fungal remains have been recorded by Ramanujam (1963), Ramanujam and Ramachar (1963, 1980), Reddy *et al.* (1982), Ambwani (1983), Siddhanta (1986) and Sarma and Reddy (1988) from the material collected from the Neyveli Lignite Mines in South Arcot District, Tamil Nadu.

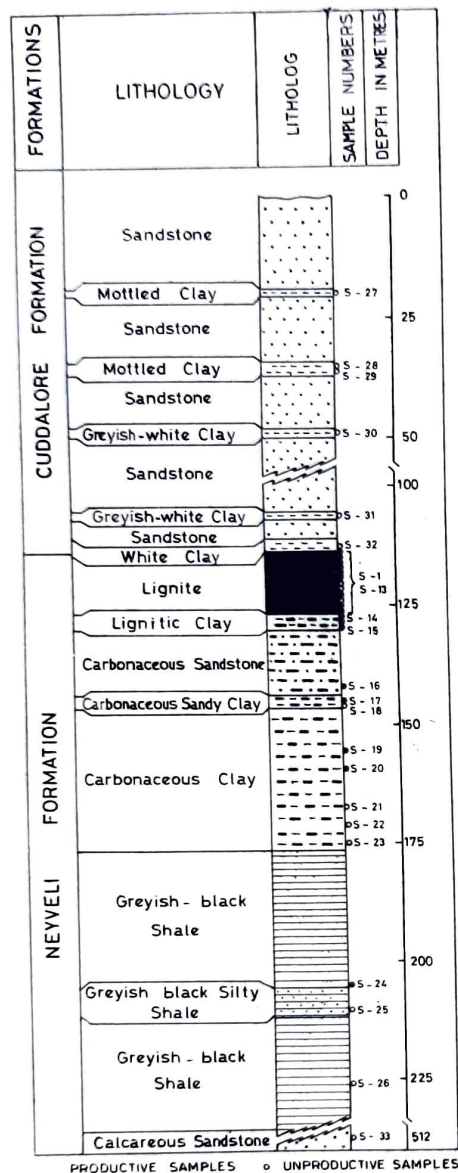
The present assemblage of fungal remains has been recovered from the samples collected from a borehole (Lat. 11°11' 27" N; Long. 79° 24' 02" E) in Jayamkondacholapuram (JC-12), about 45 km south of Neyveli, Tiruchirapalli District, Tamil Nadu. The Neyveli Formation, in this borehole, comprises a variety of sandstones, shales and clays with lignite bed at the top. In all, 32 samples were collected (Text-fig. 1). Unused material, slides and negatives are permanently stored at the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

CHECK-LIST OF FUNGAL REMAINS

* *Appendicisporonites typicus* gen. et sp. nov. (Pl. 1, fig. 1)

- * *Appendicisporonites* sp. (Pl. 1, fig. 12)
- * *Diporicellaesporites multicellatus* sp. nov. (Pl. 1, fig. 3)
- * *Diporicellaesporites* sp. (Pl. 1, fig. 6)
- * *Frasnacritetrus indicus* sp. nov. (Pl. 1, fig. 17)
- * *Frasnacritetrus* sp. (Pl. 1, fig. 11)
- * *Fusiformisporites* sp. (Pl. 1, fig. 8)
- * *Hypoxylonites* sp. (Pl. 1, figs 2,14)
- Inapertisporites dilcheri* Chandra *et al.* 1984
- I. kedvesii* Elsik 1968 (Pl. 1, fig. 15)
- I. subovoideus* Sheffy & Dilcher 1971 (Pl. 1, fig. 7)
- I. udarii* Gupta 1985
- Kutchiathyrites eccentricus* Kar 1979
- * *Kutchiathyrites* sp. (Pl. 1, fig. 4)
- * *Lacrimasporonites* sp. (Pl. 1, fig. 13)
- Multicellaesporites elsikii* Kar & Saxena 1976
- * *Multicellaesporites* sp. 1 (Pl. 1, fig. 9)
- * *Multicellaesporites* sp. 2 (Pl. 1, fig. 10)
- Phragmothyrites assamicus* (Kar *et al.* 1972) Saxena *et al.* 1984
- P. eocaenica* Edwards 1922 emend. Kar & Saxena 1976
- P. pertusus* Dilcher 1965
- * *P. serratus* sp. nov. (Pl. 1, fig. 5)
- * *Pluricellaesporites tamilensis* sp. nov. (Pl. 1, fig. 16)
- * *Spinisporonites indicus* gen. et sp. nov. (Pl. 1, figs 18-19)
- Trichothyrites setiferus* (Cookson 1947) Saxena & Misra 1990

The taxa marked with an asterisk (*) are described or commented upon. Plate and figure numbers given in the above list in parentheses refer to illustrations of the present paper.



Text-fig. 1

DESCRIPTION

Genus - *Multicellaesporites* Elsik 1968 emend. Sheffy & Dilcher 1971

Multicellaesporites sp. 1
Pl. 1, fig. 9

Description - Spore elliptical with round ends; size $88 \times 28 \mu\text{m}$; octacellate; septa distinct, $1.5\text{--}2 \mu\text{m}$ thick; wall $1.5 \mu\text{m}$ thick, psilate.

Comparison - *Multicellaesporites nortonii* Elsik (1968) differs from the present species by its smaller size ($39 \times 15 \mu\text{m}$), fusiform shape and pentacellate structure. From

amongst the species described by Sheffy and Dilcher (1971), *Multicellaesporites irregularis* has thirteen, irregular, oblong cells; *M. elongatus* has elongated shape, tapering terminal cell and a flat base; and *M. grandiusculus* is smaller and pentacellate. *Multicellaesporites elsikii* Kar & Saxena (1976) is tetra- to hexacellate.

Multicellaesporites sp. 2
Pl. 1, fig. 10

Description - Spore fusiform with acute ends; size $66 \times 23 \mu\text{m}$; octacellate; septa distinct, $2 \mu\text{m}$ thick; wall $1.5 \mu\text{m}$ thick, psilate.

Comparison - *Multicellaesporites nortonii* Elsik (1968) resembles the present species in having fusiform shape but differs by its smaller size ($39 \times 15 \mu\text{m}$) and pentacellate condition. *Multicellaesporites fusiformis* Sheffy & Dilcher (1971) is distinguished by its smaller size and tetracellate structure.

Genus - *Fusiformisporites* Rouse 1962 emend. Elsik 1968

Fusiformisporites sp.
Pl. 1, fig. 8

Description - Spores fusiform with pointed ends; size $103\text{--}110 \times 35\text{--}38 \mu\text{m}$; inaperturate; dicellate; septum $3\text{--}4 \mu\text{m}$ thick, each cell having longitudinal ribs; wall $1 \mu\text{m}$ thick, psilate.

Comparison - This species differs from *Fusiformisporites crabbii* Rouse (1962) by its shape, and nature of septa and ribs. *Fusiformisporites marii*, *F. pseudocrabbii* and *Fusiformisporites* sp. (Elsik, 1968, pl. 2, figs 10-11, 13-14) are distinguished by their smaller size.

Genus - *Hypoxylonites* Elsik 1990

Hypoxylonites sp.
Pl. 1, figs 2, 14

Description - Spores elongated elliptical with round ends; size range $36\text{--}38 \times 7\text{--}8 \mu\text{m}$; wall $1 \mu\text{m}$ thick, psilate. A slit-like furrow, parallel to the spore axis, present.

Remarks - Elsik (1990) described forty species of *Hypoxylonites* but none of them is comparable to the present species.

Genus - *Lacrimasporonites* Clarke 1965 emend. Elsik 1968

Lacrimasporonites sp.
Pl. 1, fig. 13

Description - Spores oval; size $34\text{--}39 \times 27\text{--}30 \mu\text{m}$; monoporate, pore apical; wall $1 \mu\text{m}$ thick, psilate; presence of a transverse fold imparts appearance of a septum.

Comparison - *Lacrimasporonites levis* Clarke (1965), *L. westii* and *L. stoughii* (Elsik, 1968, pl. 2, figs 20-21) are smaller in size.

Genus - *Diporicellaesporites* Elsik 1968

Diporicellaesporites multicellatus sp. nov.
Pl. 1, fig. 3

Holotype - Pl. 1, fig. 3, size 144 x 32 μm , slide no. BSIP 10380, coordinates 40.5 x 93.8.

Type Horizon - Neyveli Formation (*Trilatiporites selligii* Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 124.0 m from the surface), Tiruchirapalli District, Tamil Nadu, India.

Diagnosis - Spores elliptical to elongated, tapering towards the ends; size range 79-144 x 21-32 μm ; octacellate to dodecacellate, middle cells rectangular whereas terminal cells elongated; septa distinct, 2-4 μm thick, diporate, pores terminal, distinct, 4.5-5.5 μm in diameter; wall 1-1.5 μm thick, psilate to faintly punctate.

Comparison - The present species has close similarity with *D. pluricellus* Kar & Saxena (1976) in size and number of cells but differs in having narrow, elongated terminal cells. *Diporicellaesporites stacyi* Elsik (1968) and *D. acuminatus*, *D. purearensis* and *D. tetralocularis* (Sheffy & Dilcher, 1971) are distinguished by their smaller size.

Diporicellaesporites sp.
Pl. 1, fig. 6

Description - Spore elongated; size 63 x 21 μm ; tetracellate, terminal cells smaller than the middle ones; septum between two bigger cells 4 μm thick, other septa less than 1 μm thick; diporate, pores terminal, distinct, ca. 4 μm in diameter; wall 1.5 μm thick, psilate.

Comparison - The present species differs from *D. stacyi* Elsik (1968) in having cells larger and unequal in size. *Diporicellaesporites acuminatus*, *D. tetralocularis* and *D. purearensis*, described by Sheffy and Dilcher (1971), are distinguished by their smaller size. *Diporicellaesporites pluricellus* Kar & Saxena (1976) is distinguished by having 7-11 cells. *Diporicellaesporites multicellatus* sp. nov. differs in having 8 to 12 cells and equally thick septa.

Genus - *Pluricellaesporites* van der Hammen 1954

Pluricellaesporites tamilensis sp. nov.
Pl. 1, fig. 16

Holotype - Pl. 1, fig. 16, size 89 x 43 μm , slide no. BSIP 10380, coordinates 25.8 x 109.3.

Type Horizon - Neyveli Formation (*Trilatiporites*

selligii Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 124.0 m from the surface), Tiruchirapalli District, Tamil Nadu, India.

Diagnosis - Spores oval to elongated, non-apertural end broadly rounded; size range 76-97 x 29-44 μm ; multicellular, six to nine celled; septa 1.5-2.5 μm thick; monoporate, pore distinct, terminally placed, 3 μm in diameter; wall up to 1 μm thick, psilate.

Comparison - The present species differs from *P. hillsii* Elsik (1968) by its larger size. *Pluricellaesporites* sp. (Kar *et al.*, 1972) differs in being narrower and longer (100 x 12 μm). All the species of *Pluricellaesporites* described by Sheffy and Dilcher (1971) are distinguished by their smaller size.

Genus - *Kutchiathyrites* Kar 1979

Kutchiathyrites sp.
Pl. 1, fig. 4

Description - Microthyriaceous ascostromata semilunar in shape, eccentrically developed; size 74 x 65 μm ; hyphae radially diverging; cells squarish to rectangular, imparting pseudoparenchymatous appearance; radial hyphae not prominent.

Comparison - The present species is similar to *K. eccentricus* Kar (1979) but can be distinguished by less prominent radial and transverse hyphae.

Genus - *Phragmothyrites* Edwards 1922 emend. Kar & Saxena 1976

Phragmothyrites serratus sp. nov.
Pl. 1, fig. 5

Holotype - Pl. 1, fig. 5, size 72 x 68 μm , slide no. BSIP 10379, coordinates 45.3 x 108.3

Type Horizon - Neyveli Formation (*Triangulorites bellus* Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 128.0 m from the surface), Tiruchirapalli District, Tamil Nadu, India.

Diagnosis - Ascostromata circular to subcircular, nonostiolate; size 45-73 x 42-72 μm ; hyphae radiating, septate, interconnected, forming ill-developed pseudoparenchymatous tissue; cells polygonal, squarish to rectangular, sometimes central cells possessing single pore; marginal cells serrated and partially divided longitudinally into two or three incomplete divisions, imparting a serrated outline.

Comparison - The present species can be distinguished from *P. assamicus* (Kar *et al.*, 1972) Saxena *et al.* (1984) by

its serrated margin and incomplete division of peripheral cells. *Phragmothyrites eocaenica* Edwards (1922) emend. Kar & Saxena (1976) and *P. pertusus* Dilcher (1965) are distinguished from the present species by their well-developed pseudoparenchymatous cells and smooth margin.

Remarks - *Phragmothyrites* sp. cf. *P. eocaenica* (Venkatachala & Kar, 1969, pl. 1, figs. 1, 3) and *Phragmothyrites* sp. (Venkatachala & Rawat, 1972, pl. 5, fig. 17) are similar to the present species.

Genus - Spinosporonites gen. nov.

Type species - Spinosporonites indicus sp. nov.

Diagnosis - Spores circular to subcircular; inaperturate; multicellular, each cell giving rise to a robustly built spine.

Comparison - *Phragmothyrites* Edwards (1922) emend. Kar & Saxena (1976) differs from the present genus by its radiating hyphae and absence of spines.

Spinosporonites indicus sp. nov.

Pl. 1, figs. 18-19

Holotype - Pl. 1 fig. 18, size 42 x 39 μm (excluding spines), slide no. 10381, coordinates 59.0 x 94.4.

Type Horizon - Neyveli Formation (*Trilatiporites selligii* Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 124.0 m from the surface), Tiruchirapalli District, Tamil Nadu, India.

Diagnosis - Spores subcircular; size 42-46 x 38-40 μm (excluding spines); inaperturate; multicellular, each cell giving rise to a robustly built spine; spines 7-9 μm long, up to 3 μm wide at the base and pointed at the tip.

Genus - Appendicisporonites gen. nov.

Type species - Appendicisporonites typicus sp. nov.

Diagnosis - Spores subcircular; inaperturate; multicellular, each cell possessing a long process; processes septate or nonseptate, with pointed or blunt tips; wall psilate.

Comparison - *Phragmothyrites* Edwards (1922) emend. Kar & Saxena (1976) is distinguished from the present genus by its well developed pseudoparenchymatous cells and in the absence of processes.

Appendicisporonites typicus sp. nov.

Pl. 1, fig. 1

Holotype - Pl. 1, fig. 1, size 46 x 38 μm (excluding appendages), slide no. BSIP 10386, coordinates 52.2 x 102.4.

Type Horizon - Neyveli Formation (*Triangulorites bellus* Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 128.0 m from the surface), Tiruchirapalli District, Tamil Nadu, India.

Diagnosis - Spores subcircular; size 44-47 x 36-39 μm (excluding appendages); inaperturate; multicellular, each cell possessing a long process; processes nonseptate, 43-45 μm long and 5-6 μm wide with pointed tip, psilate.

Appendicisporonites sp.

Pl. 1, fig. 12

PLATE 1

(All photomicrographs are magnified ca. x 750, unless mentioned otherwise. Coordinates of specimens refer to the stage of Leitz Diaplan Microscope no. 512834/074490.

1. *Appendicisporonites typicus* gen. et sp. nov.; Slide no. BSIP 10386, coordinates 52.2 x 102.4.

2. 14. *Hypoxylonites* sp.; Slide no. BSIP 10381, coordinates 57.6 x 94.5, Slide no. BSIP 10380, coordinates 49.6 x 93.8.

3. *Diporicellaesporites multicellatus* sp. nov.; Slide no. BSIP 10380, coordinates 40.5 x 93.8.

4. *Kutchiathyrites* sp.; Slide no. BSIP 10382, coordinates 57.3 x 106.0.

5. *Phragmothyrites serratus* sp. nov.; Slide no. BSIP 10379, coordinates 45.3 x 108.3.

6. *Diporicellaesporites* sp.; slide no. BSIP 10381, coordinates 69.2 x 93.2.

7. *Inapertisporites subovoideus* Sheffy & Dilcher; Slide no. BSIP 10382, coordinates 54.6 x 112.2.

8. *Fusiformisporites* sp.; Slide no. BSIP 10384, coordinates 40.2 x 107.9.

9. *Multicellaesporites* sp. 1; Slide no. BSIP 10381, coordinates 30.1 x 100.0

10. *Multicellaesporites* sp. 2; Slide no. BSIP 10381, coordinates 53.8 x 110.3.

11. *Frasnacritetrus* sp.; Slide no. BSIP 9945, coordinates 40.6 x 102.2.

12. *Appendicisporonites* sp.; Slide no. BSIP 10382, coordinates 41.4 x 101.9.

13. *Lacrimasporonites* sp.; Slide no. BSIP 10393, coordinates 35.4 x 105.3.

14. *Inapertisporites kedvesii* Elsik; Slide no. BSIP 10382, coordinates 42.9 x 94.6.

15. *Pluricellaesporites tamilensis* sp. nov.; Slide no. BSIP 10380, coordinates 25.8 x 109.3.

16. *Frasnacritetrus indicus* sp. nov.; Slide no. BSIP 10390, coordinates 54.9 x 96.7.

17-18. *Spinosporonites indicus* sp. nov.; Slide no. BSIP 10381, coordinates 59.0 x 94.4 and 57.3 x 102.4.



PLATE 1

Description - Spore subcircular; size 52 x 34 μm (excluding appendages); inaperturate; multicellular, each cell gives rise to a long process; processes septate, 20-33 μm long and 4 μm wide with blunt tip, psilate.

Comparison - The present species can be distinguished from *Appendicisporonites typicus* sp. nov. by its septate

Genus - *Frasnacritetrus* Taugourdeau 1968 emend. Saxena & Sarkar 1986

Frasnacritetrus indicus sp. nov.

Pl. 1, fig. 17

Holotype - Pl. 1, fig. 17, size 27 x 16 μm (excluding appendages), slide no. BSIP 10390, coordinates 54.9 x 96.7.

Type Horizon - Neyveli Formation (*Triangulorites bellus* Cenozoone).

Type Locality - Jayamkondacholapuram Well - 12 (depth 128.0 m from the surface), Tiruchirapalli, District, Tamil Nadu, India.

Diagnosis - Fungal conidia with four processes. Main body rectangular to oval, 23-28 x 13-17 μm , multicellular, being divided by longitudinal and transverse ridges/furrows, spore wall up to 1 μm thick, conate, conii uniformly distributed. Processes septate, 35-117 μm long and 3-4.5 μm wide, number of septa in each process 2 to 5, psilate.

Comparison - The present species is distinguished from *F. taugourdeau* and *F. conatus* (Saxena & Sarkar, 1986) by its septate processes and multicellular conidia body. *Frasnacritetrus* spp. 1, 2 and 5 (Saxena & Sarkar, 1986) are distinguished in having three nonseptate processes. Moreover, *Frasnacritetrus* spp. 1 and 5 have unicellular body. *Frasnacritetrus* sp. 3 (Saxena & Sarkar, 1986) differs from the present species by its longitudinally septate, granulate conidia body and septate basal part of the processes.

Frasnacritetrus sp.

Pl. 1, fig. 11

Description - Conidia with four processes; body subrectangular, 22 x 17 μm , longitudinally septate; wall 1 μm thick, conate, conii uniformly distributed; processes 55 μm long, 3 μm wide, tubular, uniformly thick, nonseptate.

Comparison - The present specimen is closely comparable to *Frasnacritetrus* sp. 3 (Saxena & Sarkar, 1986) in its longitudinally septate body but the latter is distinguished by its processes, being septate at the basal part, and granulate conidia body. It can be differentiated from *Frasnacritetrus indicus* sp. nov. which has multicellular body and septate processes.

DISCUSSION

The present fungal remains from the Neyveli Formation include spores and epiphyllous microthyriaceous fungi. They are assigned to 13 genera and 25 species, including two new genera and six new species. Of these, three genera and seven species are of fungal fruiting bodies belonging to Microthyriaceae and 10 genera and 18 species of fungal spores belonging to Ascomycetes, Basidiomycetes and Deuteromycetes.

The fungal remains constitute 11 per cent of the total assemblage and commonly occur throughout the sequence. Fungal spores are dominant in the lignite whereas *Frasnacritetrus* is restricted to the middle part of the sequence, underlying the lignite. Epiphyllous microthyriaceous fungi is common in the lower part of the sequence.

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