

## FUNGAL REMAINS FROM NEYVELI LIGNITE, SOUTH INDIA

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### ABSTRACT

The fungal remains recovered from Neyveli Lignite, South India include a few fungal spores as well as fruiting bodies belonging to Myxomycetes, Chytridiales, Deuteromycetes, Microthyriaceae and Ascomycetes. Attempts have been made to trace out their affinities with the present forms. The forms which are not assignable to any modern forms are kept under the artificial classification.

*Key-words* — Fungal remains, Myxomycetes, Chytridiales, Deuteromycetes, Microthyriaceae, Ascomycetes, Neyveli Lignite, South India.

### सारांश

दक्षिण भारत के निवेली लुगुडांगार से कवकीय अवशेष — कृष्ण अम्ब्वानी

दक्षिण भारत के निवेली लुगुडांगार से उपलब्ध कवकीय अवशेषों में मिक्सोमाइसिटीज, काइट्रिडिअल्स, ड्यूटेरो-माइसिटीज, माइक्रोथारिडिअल्स एवं एस्कोमाइसिटीज से सम्बद्ध कुछ कवकीय बीजाणु तथा फलन-कार्य उपलब्ध हुई हैं। वर्तमान प्रारूपों से इनकी सजातीयतायें खोजने के प्रयास किये गये हैं। जिन प्रारूपों को वर्तमान प्रारूपों से नामनीय नहीं किया जा सका, उन्हें कृत्रिम वर्गीकरण के अन्तर्गत रखा गया है।

### INTRODUCTION

**W**ORK on the microflora of Neyveli Lignite was carried out by Navale (1961), Thiergart and Frantz (1962), and Ramanujam (1963a, 1963b). Later on Ramanujam (1966) gave a detailed illustrated account of the Neyveli Lignite pollen and spore assemblage belonging to pteridophytes, gymnosperms and angiosperms. Besides, Deb (1972) and Navale and Misra (1979) described the pollen grains of angiospermous plants from the Neyveli Lignite. In 1981, Ambwani *et al.* also reported the occurrence of pollen of *Ctenolophonidites* and later from the same beds Bande and Ambwani (1982) reported the presence of *Sclerosperma*-like pollen grains belonging to Palmae.

The present paper is based on the studies of the fungal remains from the Neyveli Lignite, South India and some noteworthy fungal forms belonging to Myxomycetes, Chytridiales, Deuteromycetes, Microthyriaceae as well as Ascomycetes have been

described here. Besides, a few more fungal spores have been described under artificial classification.

Regarding the age of the Neyveli deposits it is believed as Upper Miocene or Pliocene (Krishnan, 1968; Lakhnupal, 1970; Ramanujam, 1966; Navale, 1973). However, Deb (1973) and Venkatachala (1973) on the basis of palynological studies of the Cauvery Basin suggested that the lower age limit of the lignite may even extend up to Eocene.

### SYSTEMATIC DESCRIPTION

*Genus* — *Dicellaesporites* Sheffy & Dilcher, 1971

*Dicellaesporites campanulatus* sp. nov.

Pl. 1, fig. 1

*Diagnosis* — Inaperturate fungal spore bodies, two cells, uniseriate, dark brown to blackish in colour, size  $\pm 80 \mu\text{m}$ , shape ovate. Upper cell campanulate while basal cell round, two cells separated by a very

thick septum about 12  $\mu\text{m}$  thick. Exine thin and smooth.

*Description* — The inaperturate fungal spores are two-celled and uniseriate in structure, size ranges up to 80  $\mu\text{m}$  and the shape is ovate. The upper cell is campanulate in appearance while the basal cell is round. Two cells are separated by a very thick septum about 12  $\mu\text{m}$  in thickness. Exine is thin and laevigate.

*Comparison* — The present species resembles *Dicellaesporites elongatus* Ramanujam (1978) which bears a thick septum but the spore size is small and the shape is elongated. Further, it is bigger in size as well as the upper cell is campanulate in shape, hence the specific name *D. campanulatus* sp. nov. has been assigned.

*Holotype* — Pl. 1, fig. 1; size 80  $\mu\text{m}$ .

*Locality* — Neyveli Lignite, South India.

*Dicellaesporites disphaericus* Sheffy & Dilcher, 1971

Pl. 1, fig. 2

*Remarks* — Inaperturate fungal spore body, two cells, uniseriate, brown in colour, size about 16  $\mu\text{m}$ , individual spore  $\pm 8$   $\mu\text{m}$  in size; exine slightly thicker  $\pm 2$   $\mu\text{m}$ , laevigate, septum disc-shaped.

The present fossil spore is more or less identical in characters to *D. disphaericus* described by Sheffy and Dilcher (1971).

*Multicellaesporites* (Elsik) Sheffy & Dilcher, 1971

*Multicellaesporites curvatus* sp. nov.

Pl. 1, figs 3, 4

*Diagnosis* — Spores uniseriate, dark brown; 9-10 cells unite forming a curved filament, cells separated by septa, constriction present at the junction of two cells; size 100  $\mu\text{m}$ . Each cell inaperturate circular, subcircular to ovate; measuring  $\pm 12$   $\mu\text{m}$  in size. Exine thick  $\pm 2$   $\mu\text{m}$ , laevigate.

*Description* — Fungal spores uniseriate, dark brown in colour about 9-10 cells unite to form a filament; filament curved in shape. Cells separated by septa; constriction present at the junction of two cells. Size of the filament  $\pm 100$   $\mu\text{m}$ . Individual spores inaperturate; circular, subcircular to ovate

in shape measuring  $\pm 12$   $\mu\text{m}$  in size. Exine 2  $\mu\text{m}$ , thick and laevigate.

*Remarks* — As far as the author is aware, the present species is different from all those similar fossil species of *Multicellaesporites* earlier described by Elsik (1968), Sheffy and Dilcher (1971) as well as Ramanujam (1978) in its curved nature and bigger size. The specific name of the present species has been suggested on the basis of the curved nature of the filament.

*Holotype* — Pl. 1, fig. 3; size 100  $\mu\text{m}$ .

*Locality* — Neyveli Lignite, South India.

*Multicellaesporites elsikii* Kar & Saxena, 1974

Pl. 1, fig. 5

*Description* — Spores generally pentacellate, more or less elliptical in shape. Size  $\pm 60$   $\mu\text{m}$  and septate, septa thin and clear. Individual cells more or less of same size measuring 12-16  $\mu\text{m}$ . Spore wall up to 1  $\mu\text{m}$  thick and psilate.

*Remarks* — Spores are similar to those described by Kar and Saxena (1976) from the Matanomadh Formation (Kachchh) but differs only in having the apical cell slightly elongated.

*Multicellaesporites* sp.

Pl. 1, fig. 6

*Description* — Spores uniseriately arranged, brown in colour. Four individual cells unite to form a filamentous structure. Filament curved at the upper part, cells separated by thin septa; spores more or less round in shape measuring 10-12  $\mu\text{m}$  in size; inaperturate. Exine thin  $\pm 1$   $\mu\text{m}$  thick and laevigate.

*Remarks* — The present specimen resembles the fungal spore of the extant genus *Curvularia* described by Chhaya Sharma (1974) from the Quaternary deposits of Malvan, Gujarat.

*Staphlosporonites* Sheffy & Dilcher, 1971

*Staphlosporonites neyvelienseis* sp. nov.

Pl. 1, fig. 7

*Diagnosis* — About 17 fungal cells aggregate in an oblong structure measuring

$\pm 105 \times 60 \mu\text{m}$  in size; 2-3 cells wide tapering to a single cell thick. Each cell psilate ranging up to  $20 \mu\text{m}$  in size. Exine thin and smooth.

*Description* — The fungal body consisting of about 17 fungal cells arranged in an oblong structure; brown in colour measuring about  $105 \times 60 \mu\text{m}$  in size. The fungal body is 2-3 cells wide and the whole mass tapering to a single cell thickness. Each cell is psilate measuring up to  $20 \mu\text{m}$  in size. Exine of the spore is thin and smooth.

*Comparison* — The present species resembles *Staphlosporonites allomorphus* Sheffy & Dilcher (1971) in general appearance but differs in having more number of cells and larger size. It also resembles the spore type illustrated by Graham (1962) as *Alternaria* but differs in having larger number of cells and considerably bigger size.

*Holotype* — Pl. 1, fig. 7; size  $105 \times 60 \mu\text{m}$ .

*Locality* — Neyveli Lignite, South India.

*Staphlosporonites tristriatus* Sheffy & Dilcher, 1971

Pl. 1, fig. 8

*Remarks* — Spore body of about 8 cells, arranged in an ovate structure measuring about  $60 \mu\text{m}$  in size; 2 to 3 cells wide, psilate, dark brown in colour septa opaque, varying in thickness and continuous with wall. Individual spore  $14-16 \mu\text{m}$  in size.

*Parmathyrites* Jain & Gupta, 1970

*Parmathyrites* sp. Kar *et al.*, 1972

Pl. 1, fig. 9

*Description* — Ascostroma flattened, circular in shape, non-osteolate, about  $65 \mu\text{m}$  in diameter and solitary. The whole body is single cell thick, hyphae radially arranged and interconnected throughout their length. Central cell more or less triangular surrounded by single row of thick-walled polygonal cells. Peripheral cells more elongated towards margin and provided with numerous glandular structures. Tangential wall of the marginal cells is extended in the form of long spines. Spines unequal acute up to  $30 \mu\text{m}$  long.

*Remarks* — The present specimen closely resembles *Parmathyrites* sp. described by

Kar *et al.* (1972) in all respects except smaller in size and having shorter spines.

Fungal remain cf. *Stemonitis*

Pl. 1, figs 10, 11

*Description* — The entire body is attached on a higher plant cell. The fungal body is divisible into a short stalk at the base and capillitial network composed of fibrous mass. The size of the body is about  $160 \times 40 \mu\text{m}$ . Within the network columella runs vertically. The capillitial fibres anastomose forming a loose network; these fibres do not unite along the margin and hence forming an open type of net work. Columella not clearly seen. A few spores appear to be trapped in the capillitial net work. The spores are round to oval in shape, brown in colour and measure  $6-8 \mu\text{m}$  in size. They are nonaperturate. The exine of the spore is laevigate and thin.

*Remarks* — Two specimens were observed in the slide with one partially preserved showing the capillitial threads only. The present fungal body resembles closely with the extant genus *Stemonitis*, a member of Myxomycetes in its structure having stalk, columella and capillitial threads. It was also compared with other members of the family as: *Physarum*, *Arcyria* and *Dictydium* but differs from all of them in having different nature of fruiting body.

Fungal remain cf. *Perithecium* of Ascomycetes

Pl. 1, figs 12-14

*Description* — A mature fungal fruiting body/ascocarp resembling *Perithecium* of Ascomycetes is round in shape and dark brown in colour. The size of the fungal body is about  $200 \mu\text{m}$  in diameter. The whole fungal body appears to be a pseudo-parenchymatous mass comprising of interwoven fungal hyphae which profusely anastomose themselves. The ascocarp shows a small circular opening probably an osteole from where a few ascospores appear to come out. The ascospores are brown in colour, oval in shape and measure about  $6-8 \mu\text{m}$  in size. The exine of the spore is smooth and thin. The asci are not seen within the ascocarp wall.

*Remarks* — Similar fungal ascocarps are found in the family Ascomycetaceae. There are five types of ascocarps known according to the way they bear their asci: (i) those which bear naked asci without any fruiting body, (ii) those which produce their asci inside a completely closed ascocarp called a Cleistothecium, (iii) those whose ascocarp is more or less closed but at maturity is provided with a pore through which the ascospores escape, is known as Perithecium, (iv) those which produce their asci in an open ascocarp is called as Apothecium, and (v) those which form their asci directly in a cavity (locule) within the stroma (Alexopoulos, 1962). In addition various modified forms may also occur.

The present fossil specimen very well agrees with the third type of ascocarp which shows the presence of a small aperture (Pl. 1, figs 13, 14).

Fungal remain cf. Spore of *Coprinus*

Pl. 1, fig. 15

*Description* — Fungal spore is large in size about 80  $\mu\text{m}$ , black in colour, ovate in shape and has an apical large aperture. Exine thick, dark black and smooth. A short coenocytic hypha appears to come out from the spore.

*Remarks* — Similar fungal spores are found in the Subclass Holobasidiomycetes of the Class Basidiomycetes. Such type of basidiospores are usually met within *Coprinus* Gaumann (1952, p. 262).

Fungal remain cf. *Helminthosporium*

Pl. 1, fig. 16

*Description* — Fungal spores 4-septate consisting of 5 cells. The basal cell is smaller while the two middle cells are largest in size. The size of the spore is about 70  $\mu\text{m}$ . The individual cells range from 5 to 15  $\mu\text{m}$  in size. Exine thick, brown in colour,  $\pm 1.5\text{--}2\ \mu\text{m}$  and smooth. Distinct pores are at different levels immediately above or below the septa.

*Remarks* — The present spore type resembles the conidiospore of the genus *Helminthosporium*, a member of Hyphomycetes (Subrahmanian, 1971) which has been classified under Deuteromycetes by Alexopoulos (1962).

Fungal remain — Type 1

Pl. 1, fig. 17

*Description* — Fungal remain containing 4 dark coloured cleistothecia arranged in a linear fashion. The cleistothecia are oval to round in shape, black in colour with smooth wall and vary from  $30 \times 24$  to  $36 \times 24\ \mu\text{m}$ .

*Remarks* — Such type of cleistothecia are generally met within Ascomycetaceous type of fungi.

Fungal remain — Type 2

Pl. 1, fig. 18

*Description* — Fungal sporangium is attached on the epidermal cell of a higher plant. The sporangium is a spherical body enclosing only a single large sporogenous mass in it. Size of the sporangium is about 80  $\mu\text{m}$  and the sporangial wall is thin bearing fine spines. The sporogenous mass is dark in colour, oval in shape and about 60  $\mu\text{m}$  in size. The exine is smooth.

*Remarks* — Similar structures belonging to the Chytridiales Group of fungi (Alexopoulos, 1962) are observed growing on the epidermis of higher plants. Further, the sporangia reported by Johnson (1974, pl. 20, fig. 223) and Dayal and Thakurji (1968, pl. 22, fig. 28) are the supporting evidence for the present fossil fungal remain.

Fungal/algal remain — Type 3

Pl. 1, fig. 19

*Description* — Fungal/algal hyphae/filaments uniseriate, two hyphae/filaments appear conjugating each other by means of an ovoid to circular outgrowths. One of the outgrowths forms a small unicellular hypha.

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## EXPLANATION OF PLATE

(All photomicrographs.  $\times 500$  except when mentioned)

1. *Dicellaesporites campanulatus* sp. nov., slide no. 6559.
2. *D. disphaericus*, slide no. 6560.
- 3, 4. *Multicellaesporites curvatus* sp. nov., slide nos. 6561-62.
5. *M. elsikii*, slide no. 6563.
6. *Multicellaesporites* sp., slide no. 6564.
7. *Staphlosporonites neyveliensis* sp. nov., slide no. 6565.
8. *S. tristriatus*, slide no. 6566.
9. *Parmathyrites* sp., slide no. 6567.
10. Fungal remain cf. *Stemonitis*, slide no. 6568.
11. Fungal remain cf. *Stemonitis*.  $\times 1000$ , slide no. 6568.
- 12, 13. Fungal remain cf. Perithecium of Ascomycetes.  $\times 250$ , slide no. 6569.
14. Fungal remain cf. Perithecium of Ascomycetes (osteolar portion).  $\times 1000$ , slide no. 6570.
15. Fungal remain cf. *Coprinus*, slide no. 6571.
16. Fungal remain cf. *Helminthosporium*, slide no. 6572.
17. Fungal remain-Type 1, slide no. 6573.
18. Fungal remain-Type 2, slide no. 6574.
19. Fungal remain-Type 3, slide no. 6575.



PLATE I