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Research Article

FACULTATIVE FUNGAL REMAINS FROM MIOCENE LIGNITE COAL OF NEYVELI TAMILNADU INDIA

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ABSTRACT
The present investigation comprises of 16 genera and 18 species of fossil fungal elements showing affinities with Hyphomycetes, Ascomyceta (Mycrothyriaceae) and Basidiomycetes families, are recovered from the brown coal of Neyveli lignite mine-I,Tamil Nadu, India. In the assemblage 15 new genera and 17 new species have been assigned where Hyphomycetes represents 8 genera and 10 species ,the Ascomycetes includes 7 genera and 7 species while Basidiomyctes represent 1genus and 1 species; in the total fungal population the Microthyriaceae represents 2 genera and 2 species. The above assemblage comprising Hyphomycetes , Ascomycetes, Basidiomycetes together with endomycorhiza and microthyriaceous elements indicates warm and humid tropical climate prevailed around Neyveli area.

***Key Word**: Fungal remains, Lignite, Miocene, Neyveli , Tamil Nadu, India*

INTRODUCTION
Many coenocytic hyphae with fungal affinities have been discovered from different stratigraphic horizons (Palaeozoic and Mesozoic sediments): Kidston and Harvey,et. al. (1969); Wagnerand Taylor, (1981); Krassilov (1981); Stubblefield et.al.(1985); Taylor and White, (1989); White and Taylor (1988,1989); Remy et al., (1994). A large number of fossil fungal spores, filaments, fruiting bodies and mycorrhiza have been recovered from the Palaeozoic to Cenozoic sediments by Dilcher (1965), Elsik (1968), Kalgutkar and Jansonius (2001); Tiffney and Barghoorn (1974) and Pirozinski (1978). Schopf, (1968) recorded fungal bodies from the Precambrian age (Bitter Spring Formation, Australia), Elsik (1968) reported Early Eocene endophytic fungal forms while Sherwood-Pyke and Grey (1985) recovered the first terrestrial fungi from the late Silurian rocks of Sweeden, shows affinity with Ascomycetes. Kidston and Lang(1921)reported fungal entities from the Rhyne Chert (Devonian age) of England. The late Permian fungi from the Carboniferous period was established by Stubblefield et al., (1985).Taylor & White (1989) reported the Triassic endogenous fungi from Antarctica. However, the fossil taxa of Ascomycetes group became well established by Late Cretaceous and Tertiary age.The Early Cretaceous records of fossil fungi from India were made from the Rajmahal Intertrappean beds by Tripathi (2001).Later,Kar etal.(2003) reported fungal megafossil (*Lithopolyporales zeerabadensis*)from the Lameta Formatiom (Maastrichtian) of Madhya Pradesh, subsiquently in.(2004) they .made an observation on *Protocolletotrichum*, a plant pathogen from the Deccan Intertrappean beds of India. Recovery of epiphyllous and mycorrhizal fungi from the dinosaurian coprolites (Maastrichtian age), Maharashtra State was also brought forward by Sharma et al., (2005). These workers pointed out the antiquity of various fungal groups during the geological past.

As regards the recovery of fungal bodies from the Indian lignites (Tertiary age), Rao (1958) for the first time discovered a few microthyriaceous fungi from the Upper Tertiary of South India. Later Ramanujam (1963, 1963a); Thiergart and Frantz (1963) recovered well preserved fungal bodies belonging to Asterinae and Microthyriaceae. Venkatachala and Kar (1969);Jain and Gupta (1970) reported epiphyllous microthyriaceous fungi from the early Tertiary of Kutch and Late Tertiary of Kerala state respectively. Ramanujam and Rao(1973) published occurrence of *Notothyrites* and *Plachmopeltinites* from Kerala basin. In the preceding years, Reddy and Ramanujam (1982), Ambwani (1983) worked out some fungal remains from the Neyveli Lignite mine, Tamil Nadu, India. Rao (2003) reported *Kalviwadithyrites*, a new

microthyriaceous thalloid fungus from Sindhudurg Formation, Maharashtra, India. Reports on fungal remains of Lower Tertiary of Haryana State with special reference to Noto*thyrites, Phragmothyrites, Asterothyrites, Parmathyrites,* and *Microthyriacites,* was discussed by Gupta (1992, 1994).The present investigation of fungal spores and associated fruiting bodies are recorded from the Neyveli Lignite Mine-I,Tamil Nadu, India. In the present work, a number of fungal spores, fruiting bodies representing Hyphomycetes, Ascomycetes and Basidiomycetes groups are described in detail.

Stratigraphy

The Neyveli deposits are developed in the northeastern part of South Arcot basin (Ariyalur-Pondicherry sub-basin) aligned in a NE-SW direction (latitude 11˚15′-11˚40′N; longitude 79˚25′-79˚40′E) in Tamil Nadu state (Figure 1).The Neyveli field with an expance of more deposits of than 480 km² with its apex towards the northeast shows quality and low ash contents of lignite. Available records have suggested Eocene–Miocene-Pliocene age for these deposits. The Precambrian (schists and gnesses) succeed by fossiliferous limestone, calcarious sandstone and marlstone, Upper Cretaceous in age, whereas the Cuddalore Formation (Miocene-Pliocene) tops the sequence.

General geological succession in and around Neyveli Lignite field, South India (after Subramanian, 1969)

Table: 1

Age		Formation lithology
TERTIARY	Recent	Soil, alluvium, laterite and kankar
	Late Miocene Cuddalore,	Argillaceous sandstone, Lignite bearing sandstone, grits sands, clays and pebble
	---------- Probable unconformity ----------	
	Eocene	Black clay, shale black clay, shales, grey coloured limestones with fossils
Y ---------- U n c o n f o r m i t y ----------		
Mesozoic (Cretaceous)	Ariyalur	Shale, limestones , siliceous limestones marls etc.
----------U n c o n f o r m i t y ----------		
Cambrian (Archaean)		Intrusive Dolerites, ,quartz veins, granitois gneisses

Figure 1:
A. Shwing the location of the Neyveli Lignite Mine-1
B. Litholog shwing the different sediments at Neyveli mine-1.

The subsurface lignite in upper part of Cuddalore Formation lies as one major seam in the Neyveli field at depths varying between 45and150m below ground level and varies between less than 6 and 27m within

the field. There is no depositional disturbance either in the same or in its associated sediments. The lignite seam is uniform, non-banded nature (Balasunder, 1968; Subramanian, 1969; Gowrisankaran et al., 1987; Banerji, 1988 and Singh et al., 1992. It is massive and compact when fresh with dark brown to black in colour of granular to fibrous texture (Figure 2).The total lignite bearing areas is divided in to mine-I (towards North), mine-II (towards south of mine-I) whereas the proposed mine-III is further south of mine-II. However, the exact knowledge about the flora, stratigraphic position, genesis (Swamp-type) and palaeodepositional environment of lignite field is still incomplete.

MATERIAL AND METHODS

The fungal bodies described here were recovered from the lignite coal seam of mine-I, Neyveli Lignite Mine, Tamil Nadu (Figs.1&2).The total 15 samples were collected from15m.thick seam-I exposed in the eastern part of the mine and processed. For the purpose samples, were treated with conc. HNO3 and then with KOH(1%) to remove the debris. Some of the lignite samples were directly processed to obtain thin microtome sections to know the presence of fungal bodies in situ (as mentioned in the text).

FUNGAL TAXA

The genera and species in the assemblage recovered from the lignite samples, are mentioned below**.**

***Dwayabeejaesporonites* gen. nov.**
Dwayabeejaesporonite undulatus sp. nov.
***Edmundmasonaesporites* gen. nov.**
Edmundmasonaesporites globulatus sp. nov.
***Nigrosporites* gen.nov.**
Nigrosporites neyveliensis sp. nov.
***Phialophoronites* gen. nov.**
Phialophoronites magnus sp. nov.
***Dictiyosporiuminites* gen. nov.**
Dictyosporiuminites intermedium sp. nov.
***Memnonillasporonites* gen. nov.**
Memnonillasporonites stellatus sp .nov.
***Pluricellaesporites* gen.nov.**
Pluricellaesporites semcircularis sp.nov**.**
***Multicellaesporites** Sheffy & Dilcher,* 1971
Multicellaesporites serpentinus sp.nov.
M. pulvinus sp.nov.
M. squamotus sp.nov.
***Cladosporiumsporinites* gen. nov.**
Cladosporiumsporinites cylindricus sp .nov.
***Guignardiacarpites* gen. nov.**
Guignardiacarpites sphaerioides sp .nov.
***Xylariasporites* gen. nov.**
Xylariasporites lanceolatus sp. nov
Rhytidhysteriumites gen.nov.
Rhytidhyteriumites lunatum sp.nov.
***Mycosphaerellascoidetes* gen.nov.**
Mycosphaerellascoidetes radiatus sp. nov
Phragmothyrites gen. Nov.
Phragmothyrites polypetaloides sp.nov.
Meliastroma Ratan kar etal., 2010
Meliastroma tlangsamensis Ratan kar et al., 2010

***Aeciosporonites* gen. nov.**
Aeciosporonites peridionum sp.nov.
Description Of Taxa
Family*: Hyphomycetaceae,* Subramanian, 1971.
Genus: *Dwayabeejaesporonites* gen. nov.
Type Species: *Dwayabeejaesporonite undulatus* sp. nov.
Derivation of name: After extant genus *Dwayabeeja* Subramanian,1971; the specific name is assigned after its undulate nature.
Generic Diagnosis: Conidiophores with 14-15cells arranged acropital order, thick walled, enclosed in an undulating conidiophores wall; conidiophores up to 200 µm size , apical cell mostly smaller; scoliospores range 12-25 x 25-32µm.
Dwaybeejaesporonites undulatus sp. nov.
(Fig **2**, 1)
Holotype:Figure **2**.1; size 200µm; slide no.LU. D/19 (sectional view in lignite block) **Locality**: Neyveli Lignite.Mine-I, Tamil Nadu, India.
Digonosis: Conidiophore bearing scoliospores 14-15 cells, brown in colour, slightly curved, cells arranged in linear fashion; conidiophore wall undulate; size ranges up to 200µm; scoliospores arrangement acropital (small cell at the apex),barrel shaped ; measuring 12-15X25-32µm, translucent.
Remarks: Fungal body is comparable to extant genus *Dwayabeeja* of Hyphomycetes group (Subramanian, 1971); conidiophores with barrel shape scoliospores, arranged in acropital fashion.
Genus: *Edmundmasonaesporites* gen.nov.
Type species: *Edmundmasonaesporites globulatus* sp.nov.
(Figure **2**; 2)
Derivation of name*: Edmundmasonia* (derived from Subramanian,1971); the specific name denotes globular apical cell.
Generic Diagnosis: Spore multicelled, septate, dark in colour; 5 celled, apical cell enlarged, globular,vacuolated; spores 100-120x18-30µm, apical cell large measures 33µm, basal one 18 µm; spore wall laevigate.
Edmendmosonaesporites globulatus sp .nov.
(Figure **2**,2)
Holotype:Figure **2**, 2;Size120x30µm;slide no. LU D/2;Co-ordinates (P3/2).
Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Spores multicelled,4-5-celled, constriction present between two cells; apical cell enlarged,colour dark brown;globular,cells vacuolated, tapering at the base; size100-120x18-30 µm; spore wall laevigate.
Remarks:The present fossil spore shows resemblance with the extant genus *Edmundmasonia* described by Subramaniam,1971under Hyphomycetes.
Genus: *Nigrosporites***,** gen.nov.
Type Species: *Nigrosporites neyveliensis* sp.nov.
(Figure **2**,3)
Derivation of name: After the genus *Nigrospora*, of Hyphomycetes, (Subramanian, 1971).
GenericDiagonosis: Dispersed conidia oval / lanceolate somewhat flattened, large absolutely opaque, colour black , spore wall hyaline; size ranges 35-45µmx 25-30µm.
Nigrosporites neyveliensis sp. nov.
(Figure **2**,3)
Holotype: Pl. I,Figure 3; size 45 x 30µm; slide no.LU- D/1, Co-ordinates (P1/6) .
Type Locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Spores (Conidia), dispersed solitarily, shape oval / lanceolate, somewhat bilaterally flattened, biconvex; large, dark black in colour, opaque; spore wall hyaline; size ranges 35-45 x 25-30µm.

Remarks: The present species resembles *Nigrospora* (Hyphomycetes), Subramanian, 1971 for being black, opaque and lanceolate in shape.

Genus *: Phialophoronites* gen.nov.

Type Species: *Phialophoronites magnus* sp.nov.

(Figure **2**, 4)

Derivation of name: The generic name is based after the extant fungal genus *Phialophore* as mentioned by Subrahmanian, 1971; its large size denotes the specific name.

Generic Diagnosis: Phialophores in a vesicle (head-like structure), generally solitary, colour light brown;circular to subcircular shape; size 600-700X 350-400µm;30-40 microspores per phialophore; size of the microspores 40-80µm,spore exine laevigate.

Phialophoronites magnus sp. nov.

(Figure **2**, 4)

Holotype:Figure **2**,4; size 700 x 400 µm; slide no. LU- D/3;Co-ordinates (K8/2).

Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: *Phialophore* large, globular, brownish in colour;size 600-700x 300-400µm; microspores 18-25µm per *phialophore*; 30-40 microspores present, spore size ranges 40-80µm; exine laevigate.

Remarks: Similar spore bearing bodies *of* P*hialophore* belonging to Hyphomycetes are known to occur generally on humic matters (Subramanian, 1971), described here **for** the first time from the Neyveli lignite**.**

Genus: *Dictiyosporiuminites* gen.nov.

Type Species: *Dictyosporiuminites intermedium* sp.nov.

(Figure **2**, 5)

Derivation of name: After the extant genus *Dictyosporium* (Hyphomycetes) Subrahmanian, 1971.

Generic Diagnosis:Conidiophore compact in sporodochium-like structure,clustured dark in colour; size mediumly large, 400-450 x 125-150 µm; conidia produced singly, acrogenous; branches multiseptate, 5-8 septa observed; 4-5 branches present.

Dictyosporiuminites intermedium sp. nov.

(Figure **2**, 5)

Holotype:Figure **2**,5; size 450x150µm; slide no.LU-D/3, Co-ordinates (B9/3)

Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Conidiophore compact encompassed as sporodochium–like structure; cluster, dark coloured, conidiophores branches multicellular and multiseptate;5-8 septa in each conidiophore; size 400-450 x 125-150 µm, each cell measures 25 x 50–20 x 40 µm, basal attachment not discernible.

Remarks: *Dictyosporiminites intermedium* can be compared with the extant Hyphomycetes genus *Dictyosporium* (Subramanian,1971)in having sporodochium-like structure with multiseptate conidiophores (united together).These fungal bodies generally grow on dead stems of herbaceaous plants *(Alexopaulos*,1996*)*.

Genus: *Memnonillasporonites* gen. nov.

Type species: *Memnonillasporonites stellatus sp. nov*

(Figure **2**, 6)

Derivation of name: After the genus *Memnonilla* of Aspergillaceae (Subramanian, 1971); the specific name signifies to stellate nature of conidiophore.

Generic Diagnosis: Conidiophore, thick, dark brown-blackish in colour;conidia attached in straight line, 8-9 conidia in a conidiophore; constriction between two disk-like conidia present; exine stellate, lateral walls thick; size 600-620 x 100-125µm; each conidium measures 40 x 120-60 x 120 µm.

Memnonillasporonites stellatus sp. nov.

(Figure **2**, 6)

Holotype:Figure **2**,6; size 600x100µm; slide no.LU-D/8 (Co-ordinates-(R20/3).

Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Conidiophore thick, dark brown to blackish in colour, 8-9 conidia present, stellete, disk-ike conidia attached in straight pile; constriction present between two conidia; size of conidiophore 600-620x100-125µm; conidia 40x120-60x120µm; apical conidium with 2-3 small papilla.
Remarks: The present fossil specimen resembles to extant genus *Memnonilla* of Aspergillaceae showing presence of disc-like conidia in a chain as mentioned by Subramanian (1971).The specific name denotes the stellate nature of conidiophore exine. Recovery of the present form makes the first record from the Neyveli lignite.
Genus: *Pluricellaesporites* (Elsik) Sheffy & Dilcher, 1971.
Type species: *Pluricellaesporites ellipticus* Sheffy & Dilcher**,** 1971.
(Figure **2,** 7)
Description: Spores uniseriate, monoporate, dark brown in colour, 4-10 celled,septate semicircular in shape, shallow constriction between cells, cells rectangular to somewhat triangular in shape;size varies 40-100x15-20µm;each cell 30x10-10x 15µm; conidium seen oozing out from the apical cell.
Pluricellaesporites semcircularis sp.nov**.**
(Figure **2**, 7)
Holotype: Figure **2,**7; size 100x30µm; slide no.LU-D/13, Co-ordinates (K3/3).
Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Spores uniseriate, monoporate, dark brown in colour, 4-10 celled; size ranges 40-100 x 15-30µm;semicircular in shape; shallow constriction present between two cells; cells variously shaped; size 40-100x15-30µm, each cells measure-10x15-30x10-µm; aperture present in apical cell; conidium oozing out from the apical cell .
Remarks: The present fungal body referable to *Puricellaesporites* Sheffy & Dilcher (1971) rarely present in the assemblage, it is comparable to *P. ovatus*, Sheffy& Dilcher (1971); *P .hilsii* Elsik (1968); *Pluricellaesporites sp.* Kar et.al.(1972) and *P.curvulatus* Ambwani (1983). However, the present species differs from the above mentioned species in having constriction between two cells and laevigate exine.
Genus*: Multicellaesporites* Sheffy & Dilcher, 1971
Type Species*: Multicellaesporites elongatus***,** Sheffy & Dilcher, 1971.
Multicellaesporites serpentines sp nov.
(Figure **2** 8)
Description: Fungal spores inaperturate, uniseriate, multicelled, septate; colour dark brown; 650 µm long and 25µm broad; septa thin, vacuolated, apical cell round, basal and apical cells distinct, measuring 100x20 µm.
Holotype: Figure **2**,8; size 650 x 25µm; slide no.LU-D/13; Co-ordinates (D2/4)
Type locality: Neyveli Lignite, Mine-I, Tamil Nadu, India**.**
Diagnosis: Fungal spores inaperturate, uniseriate, undulated, cells vacuolated, snake-like shape; 650x25µm basal and apical cells distinct , larger up to 100x20 µm.
Remarks: Spores septate ,vacuoles present throughout the body; apical and basal cells larger,snake-like shape marks the distinction of the present species of *Multicellaesporites* known so far.
Multicellaesporites pulvinus *sp. nov.*
(Figure **2**,9)
Holotype:Figure **2**,9; size 100 x 15µm; slide no. LU-D/15, Co-ordinates (Q1/3).
Type locality*:* Neyveli Lignite, Mine-I, Tamil Nadu, India.
Diagnosis: Fungal spores inaperturate, uniseriate, brown in colour, elongated, swollen at middle part; 8celled;size ranges 100-110 x 10-15 µm; middle 3 cells large and swollen (14x10-17x10µm) septate, septa thin; apical two end cells elongated without triangular projections but seen well developed in the middle cells.
Remarks: The present specimen is comparable to *Multicellaesporites* sp. Kar& Saxena, 1976. *M. ovatus* Sheffy & Dilcher,1971; Saxena & Khare, 1992 but it differs from the above mentioned species in having

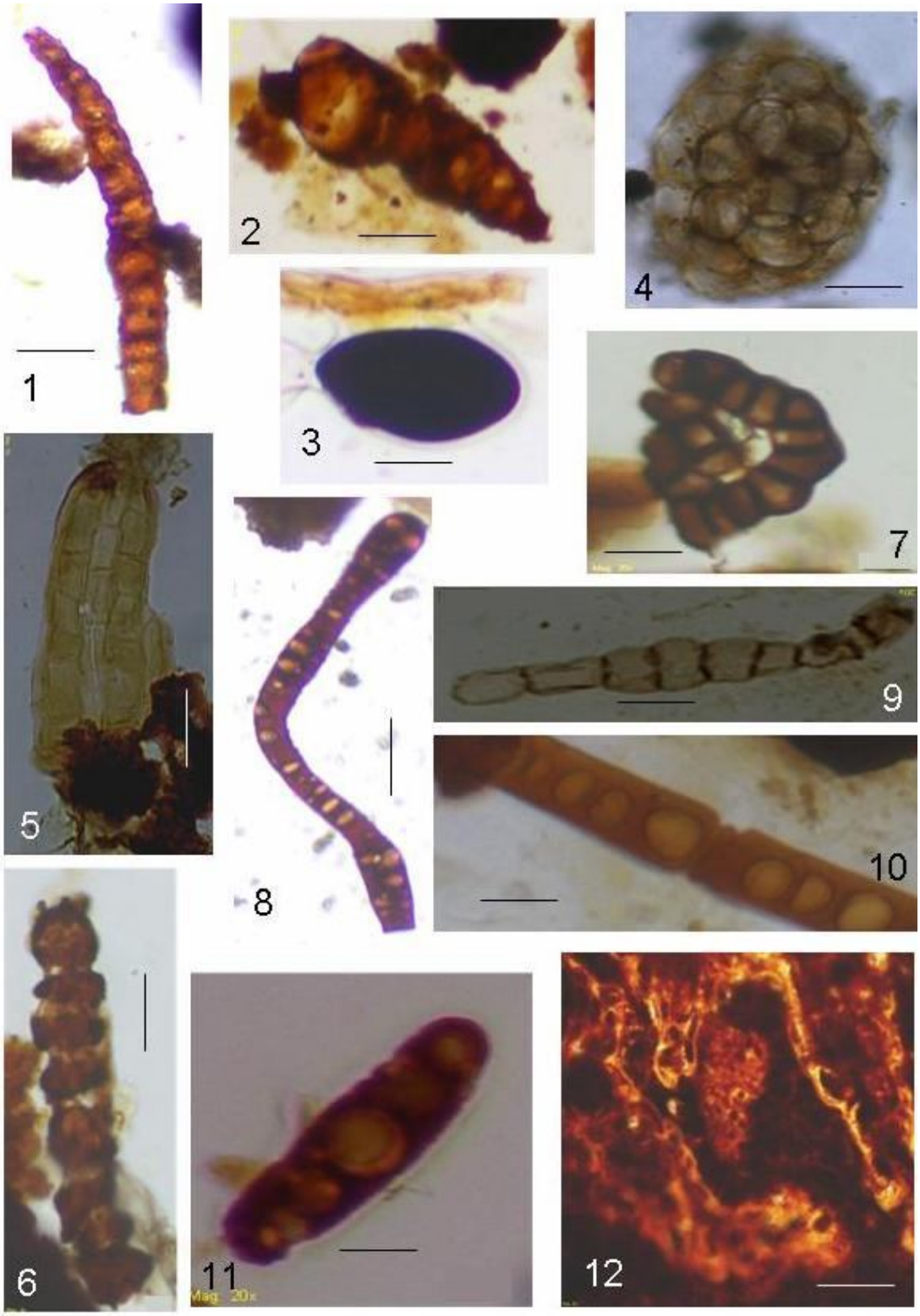

Figure 2: Facultative Fungal Remains From Miocene Coal Of Neyveli Lignite Mine,Tamil Nadu, India

middle three cells swollen with triangular projections and end cells without triangular projections, cylindrical, larger than the rest.

Multicellaesporites squamotus sp. nov.

(Figure **2**, 10)

Holotype:Figure **2**,10 ; size 280 x 80µm; slide no.LU-D/18; Co-ordinates (R1/3).

Type Locality: Neyveli Lignite, Mine-I Tamil Nadu, India.

Diagnosis: fungal spores filamentous, inaperturate, uniseriate, multicelled, colour brown; deep constriction with a ring-like girdle, each cell with globular to subglobose conidia, 8-10 light colour conidia present; size of the spores 240-280 x 50-80µm; girdle (20µm) thick and smooth.

Remarks: The present species differs from the earlier known species of *Multicellaesporites* in having septate long conidia, dark brown; presence of ring-like girdle is an important feature.

Phylum: Ascomycota Alexopaulos et al., 1966.

Family: Ascomycetaceae

Genus*: Cladosporiumsporinites* gen. nov.

Type Species: *Cladosporiumsporinites cylindricus* sp.nov.

(Figure **2,** 11)

Derivation of name: After the extant genus *Cladosporium*, the specific name signifies cylindrical shape.

Generic Diagnosis: Conidia cylindrical, oblong, rounded at both the ends, 3-4 septate, fuliginous (dark soot colour); size80-100x15-30µm; septa slightly constricted.

Cladosporiumsporites cylindricus sp. nov.

(Figure **2**11)

HolotypeFigure **2**, 11; size100x-30 µm; slide no.LU-D/3;Co-ordinates (L3/2).

Type Locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Conidia cylindrical shape, generally oblong, rounded at both the ends; basal cell slightly bigger in size, 3-4 septate, fuliginous (dark soot colour; size generally 80-100 x 15-30 µm; constriction seen at the septa; middle cells broader than basal and apical cells.

Remarks: These conidia are born on the apical part of the conidiophores; but are found detached in dispersed condition, resemble to extant taxon *Cladosporium* (grows on leaves of *Dianthus barbatus* and other Caryophyllaceae plants). The other species, *Cladosporium* are selective to the host eg:*C. calotropis* (on *Calotropis procera*) and *C. variable* (on leaves of spinach) (Alexopaulos, et al., 1996).

Genus: *Guignardiacarpites* gen.nov.

Type Species: *Guignardiacarpites sphaeroides* sp.nov.

(Figure **2**, 12)

Derivation of name: After extant genus *Guignardia* of Botryosphaeriaceae (Alexopaulos *et al.,* 1996); the specific name refers to its spherical shape.

Generic Diagnosis: Apothecium circular (sectional view of lignite block); conidia single celled, brownish in colour;pycnidia numerous,oval to circular shape; size 600 x 700µm;picnidium measures30µm;ectal excipulum thick single cell layer, hypothecium tectate and thick.

Guignardiacarpites sphaeroides sp.nov.

(Figure **2**, 12)

Holotype:Figure **2**,12; size 600x700µm; slide no.LU–D/19 (sectional view of lignite block).

Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Apothecium spherical , stalk attached to matrix (as seen in sectional view), pycnidia numerous, circular, single celled; yellow to light brown in coluur; size of apothecium 0.6x0.7mm;pycnidia measure30µm; ectal excipulum thick,cellular details not clear ; hypothecium tectate; hymenium cells partly visible.

Remarks: The present fungal fruiting body resembles the characters as exhibited by apothecia of *Guignardia* of Ascomycota group. The generic name derived after *Guignardia,* Erikson & Hawksworth,

1992 (in Alexopaulos,1996); the above fossil apothecium has been recorded for the first time from the Neyveli lignite.

Family: Xylariaceae Anisworth *et al.*, 1973.

Genus: *Xylariasporites* gen.nov.

(Figure **3**, 13)

Generic Diagnosis: Ascospore hyaline brown in colour one celled, dark colour with slit-like germ pore; size ranges 60-70x30-40µm(generally60-x40µm);spores lanceolate, acute , pointed at the poles; germ pore up to 2 µm wide.

Type species: *Xylariasporites lanceolate* sp.nov.

Derivation of name- *Xylaria (*Xylariaceae); lanceolatus (lens-like shape).

Xylariasporites lanceolatus sp.nov.

(Figure **3**.13)

Holotype: Figure **3**,13; size 60x 40 µm; slide no. LU-D/6, Co-ordinates (K7/4).

Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Aeciospore hyaline brown, one celled, dark brown in colour germ pore slit-like; size ranges 60-70 x 30-40 µm(usually 60x40µm);spores lanceolate biconvex, tapering at the poles; aperture fine, 2µm wide.

Remarks: The species belongs to family Xylariaceae of Ascomycetes group; the present spore having one cell with fine germ pore, shows affinity with *Xylaria* spores (as mentioned by Ainsworth et al., 1973).

Genus: *Rhytidhysteriumites* gen. nov.

Type Species*: Rhytidhysteriumites lunatum* sp. nov.

(Figure **3**, 14)

Derivation of name: Based on the extant genus *Rhytidhysterium* (after Ainsworth et al., 1973);the specific name denotes apothecium lunar shape.

Generic Diagnosis: Apothecium in sectional view, tapering ends, parathesoidal hyphae form apothecium);asci distributed throughout stroma; size of ascus 400x40µm;asci 20-25x8-10;µm;3-4ascospores in each ascus; paraphyses many, circular in cross section.

Rhytidhysteriumites lunatum sp. nov.

(Figure 3, 14)

Holotype:Figure **3**,14; size 400x40µm; slide no.LU-D/29 (sectional view in lignite block).

Type Locality: Neyveli Lignite Mine-I, Tamil Nadu, India.

Diagnosis: Apothecium lunate in sectional view (in Lignite block); hyphae forming apothecium contain cylindrical asci; matrix of pseudoparenchymatous.Size 400x 40µm, tapering at both ends; asci measure 20-25x8-10µm;3-4 ascospore in each ascus , dark brown in colour; size of ascospores circular 5-8 µm.

Remarks: The apothecium containing asci shows resemblance with the extant genus *Rytdihysterium* as described by Anisworth et al., 1973.

Genus: *Mycosphaerellascoidetes* gen. nov.

Type species: *Mycosphaerellascoidetes radiatus* sp. nov.

(Fig**3**, 15)

Derivation of name: After the extant genus *Mycosphaerella*, Alexopaulos, et al, 1996; the specific name refers to radiating asci in the ascocarp.

Generic Diagnosis: Stromatic ascocarp with asci; apothecium cushion shaped (in cross section entrapped in lignite block); colour dark brown to black;cylindrical, asci radiate in apothecium, asci protected by paraphyses cylindrical in shape;size of apothecium 160x120µm; size of asci 15-20x20-30µm;3-4 ascospores present in each ascus.

Mycosphaeriellascoidetes radiatus sp. nov.

(Figure **3**, 15)

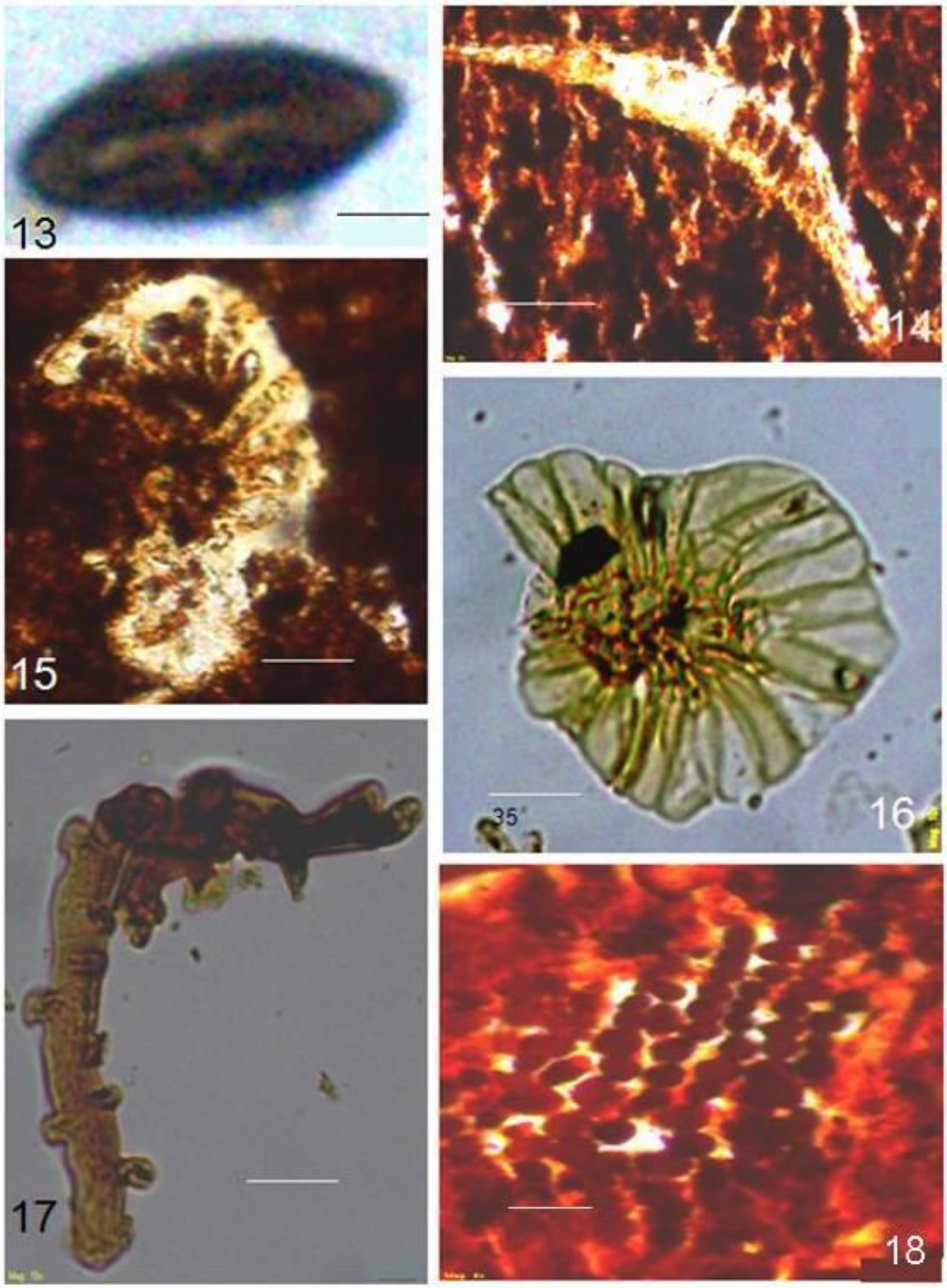

Figure3: Facultative Fungal Remains from Miocene Coal Of Neyveli Lignite Mine Tamil Nadu India

Holotype:Figure **3**,15; size 160 x 120 µm; slide no. LU- D/11 (sectional view).
Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Apothecium inoperculate, cushion-like, dark brown in colour; asci and parphyses radiating; apothecium oval in cross section (sectional view in a lignite block) ;160x120µm;size of ascospores 15-20 x 20-30µm, 3-4 in each ascus; asci enclosed in a pseudoparenchymatous tissue; paraphyses translucent.
Remarks: The present fungal apothecial body forms a new record from the Neyveli lignite coal that closely resembles to the apothecium of *Mycosphaerella* of the family Dothidaceae (Bessey, 1950).
Genus: *Phragmothyrites* Edwards, emend. Kar & Saxena, 1976.
Type species: *Phragmothyrites eocenica*, Kar & Saxena, 1976; plate 3,Figure 20
Generic Diagnosis: Ascostromata thalloid, subcircular-circular,no free hyphae observed,non-ostiolate, hyphae radially arranged interconnected;pseudoparenchya one cell thick; pores generally present.
Ph*ragmothyrites polypetaloides* sp.nov.
(Figure **3**, 16)
Holotype: Figure **3**,16; size200x150 µm; slide no.LU-D/8, Co-ordinates (H3/3)
Type locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Ascostoroma circular to subcircular, non-ostiolate; colour brown;size 200x150µm, parenchyma divisible in two zones (outer zone with elongated thin cells while inner zone with thick walled polygonal cells);outer zone petaloid,size of the cells varies from 50x10-55x20µm; four to five basal cells protruded .
Remarks: The present species can be distinguished from *P.assamicus* Kar et.al. (1972), Saxena et al., (1984). *P. serratus* Saxena & Khare (1992) and *Phragmothyrites* sp. cf *eocenica* Gupta (1994) in having bigger size and petal-like arrangement of the longer cells while the inner cells are more or less rectangular.
Genus: ***Meliostroma*** Ratan Kar et al., 2010.
Type Species*: Meliostroma tlangsamensis* Ratan Kar et al., 2010 (Pl. II, Figs.10&11)
Meliostroma tlangsamensis Ratan Kar et al., 2010.
(Figure **3**,17)
Description: Fungal spores with hyphae; size 180-200 µm long and 20-30 µm wide, globular to capitates, hyphopodia one celled, bottle shaped, mucronate; stroma cylindrical, finely reticulate.
Holotype:Figure **3**,17; size200x30µm; slide no.LU-D/18.Co-ordinates (K8/2).
Type Locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagnosis: Fungal hypha multicelled, spores globular to capitate; size of hypha 180-200 µm long and 20 µm wide; hyphopodia generally one celled, rarely two cells can be seen; mucronate to bottle shape; apical two spores elongated.
Remarks: Specimen somewhat resembles that illustrated by Dilcher (1965); Ramanujam and Rao (1978); both types have longer capitate hyphopodia than the present specimen. However, the present specimen closely resembles to *Meliostroma tlangsamensis* accept slight variation in size.
Order: Uredinales Alexopaulos et al., 1996.
Family: Basidiomycetes
Genus: *Aeciosporonites* gen.nov.
Type species: *Aeciosporonites peridionum* sp.nov.
Derivation of name: After the *Aeceiospore* enclosed in peridium (Alexopaulos *et al., 1996*); the specific name is based on the nature of peridium.
Generic Diagnosis: *Aeciospre* chains enclosed in a peridium with chains of aeciospores (sectional view); size of the peridium 500x 550µm; each chain consist of 8-14 aeciospore, blackish in colour,oval to circular in shape (20-30µm); exine finely verrucose.
Aeciosporonites peridionum sp. nov.
(Figure **3**, 18)

Holotype Fig3,18;size500 x 550µm;slide no.LU-D/20 (sectional view) .
Type Locality: Neyveli Lignite Mine-I, Tamil Nadu, India.
Diagonosis: Peridium seen in cross section of lignite block; size 500-550 µm, chains of the aeciospores present, each chain consists of 8-14 aeciospores; blackish in colour, oval to circular in shape, exine finely verrucose; size varies from 20-30 µm; peridium wall thick ,opaque and brittle, cells indistinct.
Remarks: Similar spores enclosed in a peridium with long chains generally are recorded in rust family. The present fossil specimen has been recorded in situ entrapped in the lignite (sectional view).The peridium containing chains of spores comparable to aeciospores are found in the extant family Basidiomycetes of Uredinales group (Alexopaulus *et al*, 1996).

DISCUSSION

Many fungi are parasites on living plants and derive food material for their necessary growth but confer no benefit in return. For some fungi this association is obligatory, they may exist outside their host in some dormant form such as spores but their growth under natural conditions is confined to their appropriate host(s).Other fungi have ability to parasitise plants given suitable conditions but otherwise live as saprophytes. Apart from the infection occurring through wounds, a number of fungi use the natural openings in the plant surface (eg. stomata, lenticels and hydathodes). According to Pole-Evans,1907; Von Ramm,1962;Clements,1935 entry through stomata is a very common feature. Pristou and Gallegly, 1954 confirmed that some fungi which do not make use of the wounds or natural openings but penetrate the unbroken plant surface in particular to cuticle. Fungal relationship can be observed in different manners; some fungi develop mainly on the surface of the plant and colonize little in the internal tissue (epidermis) eg. *Erysiph* spp.
Majority of the Hyphomycetes attack the plants and cause the disease of facultative type,consistently produce spots on the plant foliage (e.g: *Alternaria, Bipolaris, Drechelera, Cercospora Cercosporella, Cladosporium* and *Fusicloium etc.)*. The species of *Cladosporium* persists, mainly on the angiosperm leaves several months the leaf-fall but the genera *Epicoccum* and *Alternaria* are rather more effective on litters (Sui,1951;Park,1982 and Godfrey,1983).The taxa *Bipolaris* and *Drechelera* are serious pathogens on grasses and other graminaceous plants all over the world. There are a few pathogens which cause wilt of trees (eg:wilt of oak trees by *Chalara quercina*).It is unique that all the vascular plant pathogens genera produce phialospores. Many Hyphomycetes have rather specific host range, sometimes limited to genus level only; the genus *Cercospora* is an example (Chupp,1954).In case of smut fungi the host specific specialization are interdependent and mutually complemetary The host specificity of the fungi is based on its taxonomic value and occure only on certain plant species (Fischer,1953).
The Ascomycopsida and Basidiomycopsida fungi are the most effective of all the decomposer organisms involved in breaking down cellulose and lignin.Therefore, in dispesable part of every ecosystem. Many species of club fungi especially those in the order Uridnales. Ustilaginales, Exobasidales and Tulasnellales are wide spread plant pathogens, collectively they attack almost every family of vascular plants and thus have far reaching ecological effect (Lorenz and Pearson,1995).On the other hand Nidularales are found in deserts on the prairies and in forests. However, in the forests they are found attached to the fallen branches of the trees where it is slightly sunny and dry while in the prairies they are found in rotting depressions. In general Basidiomycopsida like Ascomycopsida favour much drier climate and individual species tend to be very widely distributed in the given area (Carroll, 1998; Patrini, 1992).
In the present investigation efforts have been made to correlate the present fossil fungal spores/bodies to their extant counterparts as these fungi could be employed to their specific ecological destinations and host specificity as well.Association of microthyriaceous fungi on the other hand indicates that during Miocene time the Neyveli region was enjoying the tropical and humid climate resulting luxuriant vegetation in the area.

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REFERENCES
Ainsworth GC, Sparrow SK and Sussman AS (1973). The fungi an advance treatise. *Academic Press, New York* **IVA** 144.
Alexopaulos CJ, Mims CW and Blackwell M (1996). Introduction Mycology. *JohnWiley& Sons Inc. Toranto, New–York, Singapur* 1-869.
Ambwani K (1983). Fungal remains from Neyveli Lignites, South India. *Palaeobotanist* **31** (2)148-153.
Balasunder NK (1968). Tertiary deposits of Neyveli lignite field. In: *Cretaceous-Tertiary formation of South India. Geological Society of India Memoir* **2** 256-262.
Banerji RK(1988). Biostratigraphic approach to Palaeocene problem with special reference to the Cauvery basin.In;H.K.Maheshwari(editor).Procedings of the Symposium: Palaeocene of India-limits and subdivisions. Indian *Assocociation of.Palynostratigraphers Lucknow. Pubication* **4**1-17.
Bessey EA (1950). Morphology and taxonomy of fungi. *Blackiston Company.Philadelphia.*
Carroll GC (1988). Fungal endophytes in stems and leaves from latent pathogen to mutualistic symbiont. *Ecology* **69** 2-9.
Chupp C (1954). A monograph of the Fungus Genus *Cercospora*" Ithaka, New York, 667.
Clements H .F. 1935**:** Morphology and physiology of some lenticels of *Pyrus malus*. *Botanical Gazett* **97** 101-107.
Deb U, Bakshi SK and Ghosh AK (1973). On the age of Neyveli Lignite -a palynological approach. *Quarterly Journal Geologigal Mineral Metallurgical Society of India* **45**(1) 23-38.
Dilcher DL (1965). Epiphyllous fungi from Eocene deposits in western Tennessee,U.S.A. *Palaeontographica* **16 B** 1-54.
Elsik WC (1968). Palynology of Palaeocene rockdale Lignite Milam Country, Taxas-I: Morphology and taxonomy. *Pollen et Spores* **10** (2) 263-314.
Erickson OE and Hawkworth DL (1993). Outline of Ascomycetes. *Systematic Ascomycetes* **13** 51-257.
Fischer GW (1953). Manual of the North American smut fungi' Ronald Press, New York.
Godfrey E.S. 1983: Growth of two terrestrial microfungi on submerged older leaves. *Transactions of British Mycological Society London* **81** 418-421.
Gowrisankaran S, Sethi PP, Hariharan R and Agarwal KP (1987). Lignite deposits of India-their occurrences, depositional features and characterstics-In R.M. Singh (editor),*Procedings Seminar on Coal Recource of India (1986) Varanas* **48** 1-553.
Gupta A (1992). Algal/fungal spores from Subathu Formation, Himachal Pradesh. *Journal of Indian Botanical Society* **71** 27.
Gupta A (1994). Fungal fruiting bodies from Lower Tertiary sediments of Sirmaur District, Himachal Pradesh, *Indian Botanical Journal of Linnaean Society* **15** 247-257.
Jain KP and Gupta RC (1970). Some fungal remains from the Tertiaries of Kerala coast. *Palaeobotanist.* **18** 177-182.
Harvey R Lyson AG and Lewis PN (1969). A fossil fungus from Rhynie Chert. *Transactions British Mycological Society* London **53** 155-157.
Kalgutkar RM and Jansonius J (2001). Synopsis of fungal spores, mycelia and fructifications. *American Association of Stratigraphers and Palaeobotanists Contribution Series* **39** 1-423.

Kar RK, Mandaokar BD and Ratan Kar (2005). Mycorrhizal fossil fungi from the Miocene sediments of Mizoram, northeast, India. *Current Science* **89** 256-259.
Kar RK SharmaN Agarwal A and Ratan Kar (2003). Occurrence of fossil wood rotters (Polyporales) from the Lameta Formation (Maastrichtian) India *Current Science* **85** 37-40.
Kar RK, Sharma N and Verma UK (2004). Plant pathogen *Protocolletotrichum* from a Deccan Intertrappean bed (Maastrichtian),India.Cretaceous Research **25** 945-950.
Kar R K Singh RY and Sah SCD (1972). On some algal and fungal remains from Tura Formation of Garo Hills, Assam. *Palaeobotanist* **19** 146-154.
Kar R K and Saxena RK (1976). Algal and fungal microfossils from Matanomadh Formation (Palaeocene), Kutch, India. *Palaeobotanist* **26** 1-15.
Kidston R and Lang WH (1921). On the old sandstone plants showing structure from Rynie Chert Bed Aberedeenshire.Part V- The thallophyte occurring in the peat bed; the succession of plants through a vertical section of the bed and condition of accumulation and preservation of the deposit.Transactions of *theRoyalSociety London ,Edinbergh* **52** 335-250.
Krassilov V (1981). *Orestovia an*d the origin of vascular plants. *Lethaia* **14** 235-250.
Park D (1982) Phyllopane fungi, tolerence of hyphal tips to drying.*Transactions of the British Mycological Society* **69** 225-231.
Patrini O (1992). Fungal endophytes of tree leaves in microbial Ecology of leaves (eds:J. H. Andrews and Hirano*) Springer-Verlag, New-York*. 179-197.
Pirozinski KA (1978). Fungal spores through the ages-a mycologist's view. *Procedings of theIV. International. Palynolynological Conference, Lucknow* **1** 327-330.
Pole-Evans IB (1907). The cereal rusts-1 development of their U*ridomycelia*. *Annals of the Botany, London* .**21** 441-446.
Pristou R and Gallegly ME (1954). Leaf penetration by *Phytophthora infestans*. *Phytopathology* **44** 81-86.
Ramanujam CGK (1963). Thyrothecia of Asterinae from the South Arcot Lignite, Madras. *Current Science* **32** 327-328.
Ramanujam CGK (1963a). On two new species of fungi from the South Arcot lignite. *Procedings of the 50th Indian Science Congress* **3** 396.
Ramanujam CGK (1966). Palynology of the Miocene lignite from South Arcot District, Madras, India. *Pollen et Spores* **8**(1)149-203.
Ramanujam CGK and Rao KP (1978). A palynological approach to study the Warkalli deposits of Kerala in South India. *Palaeobotanist* **4** 57-59.
Ramanujam CGK RamkrishnaH and Mallesham C (1986). Palynoassemblage of the subsurface Miocene sediments of the east coast of southern India. Its floristics and environmental significance. *Proceding Special, Indian Geophytological Conference Poona* 13 - 117**.**
Rao A (1958). Fungal remains from Tertiary deposits of India. *Palaeobotanist* 7, 43-46**.**
Rao MR (2003). *Kalviwadithyrites*,a new fungal fruiting body from Sindhudurg Formation (Miocene) of Maharashtra, India. *Palaeobotanist* **52**(1)17-119.
Ratan Kar, Mandaokar BD and Kar RK (2010). Fungal taxa from the Miocene of Mizoram, northeast India. *Review. Palaeobotany Palynology* **58** 240-249.
Reddy PR, Ramanujam CGK and Srisalam K (1982). Fungal fructifications from Neyveli Lignite, Tamil Nadu-their stratigraphic and palaeoclimatic significance. *Records Geological Survey of India* **114** 112-122.
Remy W, Taylor TN and Haas H (1994). Early Devinian Fungi:A Blastocaladalean fungus with sexual reproduction. *American Journal of Botany* **81** 690-772.
Saxena RK and Khare S (1992). Fungal remains from the Neyveli Formation of Tiruchirapalli District, Tamil Nadu, India. *Geophytology* **21** 37-43.

Siddhanta BK (1986). The age of Neyveli lignite with reference to stratigraphy and palynology. *Indian Minerals* **40** (3) 61-82.
Schopf JW (1968). Microflora of Bitter Springs Formatiom, Late Precambrian, Central Australia. *Journal of Palaeontologgy* **42** 651-688.
Sharma N, Kar RK and Agarwal A (2005). Fungi in dinosaurian (Isisaurus) coprolites from the Lameta Formation (Maastrichtian) its reflection on food habit and environment. *Micropalaeontology* **51** 73-82
SheffyMV and Dilcher D (1971). Morphology and taxonomy of fungal spores. *Palaeontographica* **133B** 34-51.
Sherwood-Pyke MA and Grey J (1985). Silurian fungal remains: probable records of the class Ascomycetes. *Lethaia* **18** 1-20.
Singh A, Misra BK, Singh BD and Navale GKB (1992). The Neyveli deposits (Cauvery Basin), India: Organic composition, age and depositional patterns. *International Journal of Coal Geology* **21** 45-97.
Siu RGH (1951). Microbial decomposition of cellulose. *Reinhold, New-York* 73.
Stubblefield S, Taylor TN and Miller CE (1985). Studies in Palaeozoic fungi, IV: wall structure of fossil endogenaceous clamydospores. *Mycologia* **77** 88-96.
Subramanian CV (1971). An account of Indian species Hyphomycetes (except Cercosporae) *Indian. Council of Research New-Delhi.*1-930.
Subramanian V (1969). Geology and ground water aspects of the Neyveli Lignite Field, South Arcot Dictrict, Madras State. *Memoir.Geoogical Survey of India* **94** 1-298
Taylor TN and Taylor EI (1993). The biology and evolution of fossil plants. *Englewood Cliff, New Jersey* 1-982.
Taylor TN and White JF (1989). Triassic fungi with suggested affinities to endogenous (Zygomycotina). *Review Palaeobotany Palynology* **61** 53-61.
Thiergart F and Frantz U (1963). Some spore and pollen grains from the Tertiary brown coal of Neyveli. *Palaeobotanist* **11** 43-45.
Tiffney BH and Barghoorn EH (1974). The fossil record of fungi, In: *Occasional papers of the Farlow Herbarium of Cryptogam Botany* Rollins, edited by RC, Roby, K **7** 1-42.
Tripathi A (2001). Fungal remains from Early Cretaceous Intertrappean beds of Rajmahal Formation in Rajmahal Basin, India. *Creteceous Research* **22** 565-574.
Venkatachala BS and Kar RK (1969). Palynology of the Tertiary Sediments of Kutch-1 Spores and pollen from bore-hole no. 14. *Palaeobotanist* **17**(2) 157-178.
VonRamm C (1962). Histological study of infection by *Alternaria, longipes* on tobacco. *Phytopathology* **45** 391-398.
White JF and Taylor T N (1988). Trassic fungus from Antarctica with possible ascomycetous affinities. *Ammerican Journal of Botany* **75** 1495-1500.
White J and Taylor TN (1989). A trichomycete-like fossil from Triassic of Antarctica. *Mycologia* **81** 643-646.