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# Fungal palynomorphs from southern Red Sea coastal sediments of Saudi Arabia

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## ABSTRACT

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Fungal palynomorphs were recovered from the coastal sediments (Holocene) of a locality west of Abha town on southern Red Sea coast of Saudi Arabia between Jeddah in the north and Jizan in the south. The study reveals the presence of a diverse variety of fungal palynomorphs in these sediments from different environments. These have been identified, described, and illustrated here in this paper. Here we describe 8 new fungal species as well. The new species are: *Dicellaesporites bisariae*, *Dicellaesporites foveolatus*, *Inapertisporites choudharyi*, *Inapertisporites kharei*, *Inapertisporites foveolatus*, *Inapertisporites microverrucatus*, *Monoporisporites rotundus* and *Pluricellaesporites mishrae*. The relationship of fungal palynomorphs with their extant counterparts has been traced, wherever possible. Environmental significance of the assemblage has also been discussed.

**Keywords**: Palynology, Fungal palynomorphs, Non-pollen palynomorphs (NPP), Red Sea coastal sediments, Holocene, Saudi Arabia.

## INTRODUCTION

The Red Sea is a large marine ecosystem where mangroves, sea grasses, coastal vegetation and associated flora, and terrestrial mammals are common around the coastal zones. Wadi Hali is an ephemeral stream, and the present area of study covers the Wadi Hali fan that lies on the Red Sea coast of Saudi Arabia, south of Jeddah and north of Jizan (Figure 1, in Kumar 2023). This is a small region covering an area of around 50 km N-S and 40 km E-W. This area has several distinct environments like aeolian, fluvial, coastal, intertidal, brackish water ponds with mangrove stands and saline lagoons (Figure 2, in Kumar 2023). According to Jado et al. (1990) this area was semiarid having intense rainfall during the humid phases (Late Pliocene to Early Pleistocene and Late Pleistocene to Early Holocene) during its Quaternary history. The description of coastal flora and vegetation of the southern Red Sea coast, geography, climate, and oceanography of the Red Sea was described by Kumar (2020, 2021).

The Red Sea coast of Saudi Arabia is an arid region known as the Tihama (also spelled Tihamah) Plain (Figure 5, in Kumar 2020). Several lagoons and bays, both small and large, meander through this long coastline and at times become saline lakes because they

get disconnected from the sea due to either local tectonics or Quaternary sea-level changes. Mangrove swamps and wadis (dry riverbeds) are scattered all along the coast. This area has several distinct depositional environments like aeolian, fluvial, coastal, intertidal, brackish water ponds with mangrove stands and saline lagoons (Figure 2, in Kumar 2023).

Palynological studies on the Red Sea Holocene sediments and the adjoining coastal regions are very few. The earliest studies were on the Late Pleistocene-Holocene sediments (Bergrenn 1969, Wall & Warren 1969). Similar palynological studies on the Late Quaternary sediments of southern Suez Isthmus (Kholeif, 2004) and recent mangrove sediments along the Red Sea coast of Egypt (Kholeif, 2007) were published. A preliminary palynological study on two offshore Oman samples was reported by Matsuoka et al. (2017). Recent dinoflagellate cysts were described from the Persian Gulf, Gulf of Oman, and northwestern Arabian Sea by Bradford (1975) and Bradford and Wall (1984). Recently, Kumar (2020, 2021, 2023) published a detailed account of palynology of the coastal sediments from various environments of the southern Red Sea coast of Saudi Arabia, in which he described diverse groups of marine and terrestrial palynomorphs including short accounts of the fungal spores, hyphae and fruit bodies. In all the above-mentioned studies, fungal palynomorphs were either not reported or were mentioned only as a minor constituent of the assemblage.

The objective of this study was to identify and illustrate a diverse variety of fungal palynomorphs present in these coastal sediments.

## STUDY AREA

The area under the study covers mainly a mixture of marginal marine and non-marine environments that include upper intertidal and supratidal flats, algal mats and mud flats, scattered patches of mangroves and their muddy environments, sand flats, both rippled and without ripples of the upper intertidal environments. The samples were collected from the mangrove swamp environment and algal mat environment (Figure 2, in Kumar 2023), Middle Holocene palaeochannel section (Figure 1.A), Sabia Island coral reef environment (Figure 3, in Kumar 2023), and intertidal environment (Figures 1.B–G).

## MATERIALS AND METHODS

This study is based on 25 samples collected from five different localities representing five different coastal environments around the Wadi Hali area (18º49' 35.27" N, 41º22'44.23" E) and its surroundings in the southern Red Sea coast of Saudi Arabia. Sample locations and methods used in this study were described in Kumar (2020, 2021). The locations of the outcrop samples WH1 through WH7 from the palaeochannel section are shown in Figure 1. A, and locations of seven surface samples from the intertidal environment are shown in Figures 1. B–G.

## DESCRIPTION OF FUNGAL PALYNOMORPHS

Genus: ***Alleppeysporonites*** Ramanujam & K.P. Rao 1978

**Index Fungorum Registration Identifier:** 21008.

**Type species:** *Alleppeysporonites scabratus* Ramanujam & K.P. Rao 1978.

**Classification:** Fungi Imperfecti, Phragmosporae.

**Remarks:** Ramanujam and Rao (1978) stated that *Alleppeysporonites* shows striking similarity to the dematiaceous fungus *Grallomyces* (Barnett 1956, Ellis 1971, Subramanian, 1971). The appendages of the fossil are similar to the stalked attachment organs of *Grallomyces* conidia. The spore wall in *Grallomyces* is minutely verrucate whereas in the fossil spores it is psilate to scabrate. *Grallomyces* is common in moist tropics.

***Alleppeysporonites elsikii*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 2.2

**Index Fungorum Registration Identifier:** 559420.

**Specimen:** Slide M1c; 160.8 × 16.5.

**Remarks:** Spores multicellate having rectangular cells; size 95 µm; nonaperturate; spore wall thin, psilate; appendages 12–23 µm long.

***Alleppeysporonites* sp.**

Figure 2.1

**Specimen:** Slide AM1c: 137.7 × 3.5.

**Remarks:** Size 108 × 58 µm; multicellate,

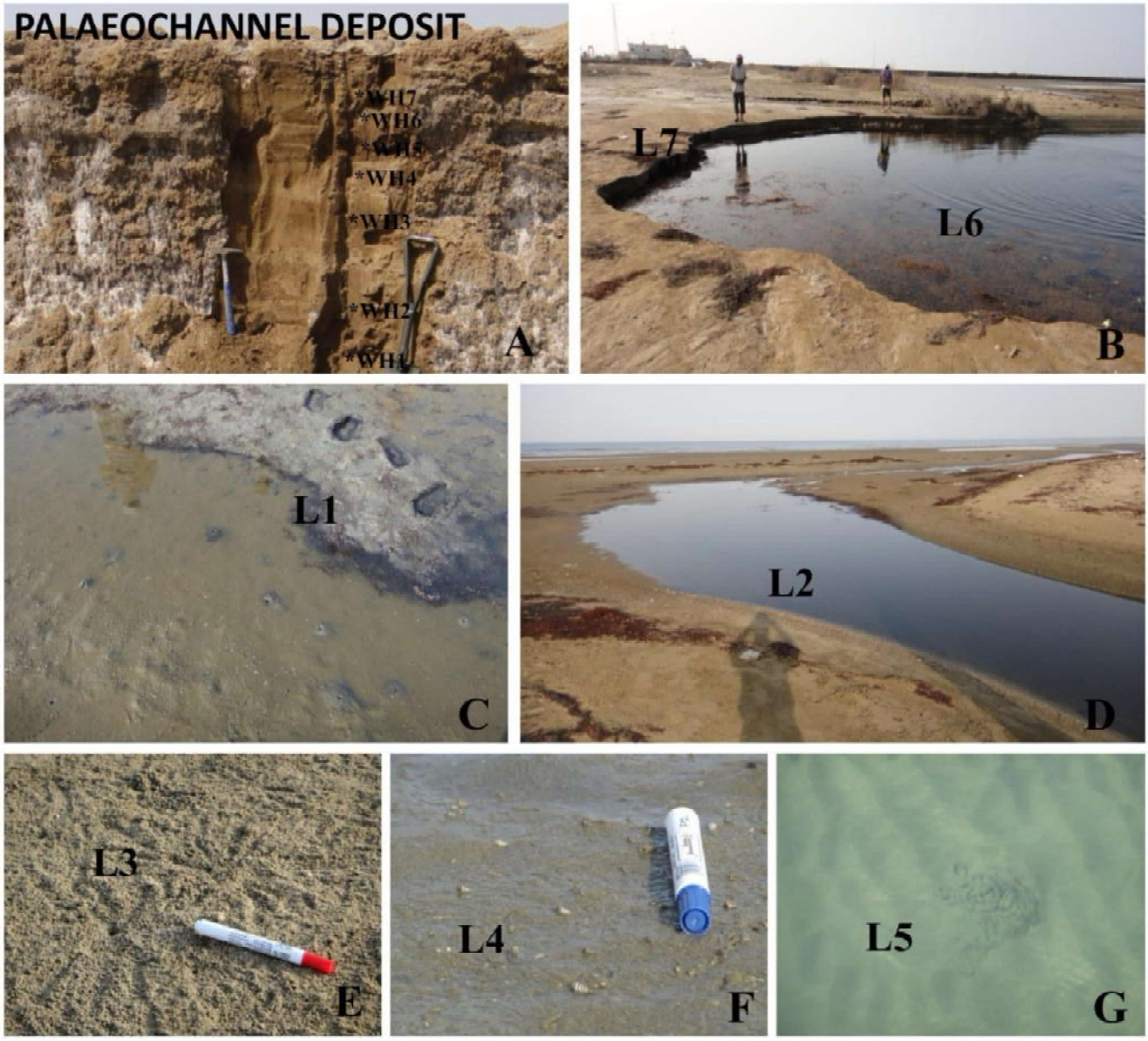


**Figure 1. A.** The locations of seven clay and fine sand samples (WH1 through WH7) from the palaeochannel section. **B–G.** Locality of samples collected from intertidal environment. Four clay to fine sand samples (L1 through L4) are from tidal flats close to the shoreline and two clay samples (L6 and L7) are from a small pond with abundant algae. The sample L5 is subtidal mud collected 100 m away from the coastline under 1.5 m water depth. **B.** (the pond) is farthest, about 150 m from the shoreline; **C, D, E** and **F** get closer to the shoreline in the same order**. G** is located under 1.3 m water depth about 100 m away from the shoreline in the sea (after Kumar 2020). **B.** L6: Mud and fine sand from middle of the pond and L7: Silty to sandy laminated sediment on the edge of the pond. **C.** L1: Black mud from a small pond on the tidal flat. **D.** L2: Tidal channel that connects the pond with sea. **E.** L3: Tidal flat surface full of fecal pellets and bioturbation. **F.** L4: Tidal flat along the shoreline. **G.** L5: Subtidal mud, 100 m from the coast in 1.3 m water depth.

transverse septa 1–3 per branch, cells rectangular, 5–10 × 2–6 µm, nonaperturate; spore wall thin, psilate. The present species differs from *Alleppeysporonites scabratus* Ramanujam & K.P. Rao 1978 in having psilate spore wall and lesser number of cells per branch.

Genus: ***Alternaria*** Nees 1816

**Index Fungorum Registration Identifier:** 25604.

**Type species:** *Alternaria tenuis* Nees 1816.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: *Pleosporomycetidae*, Order: *Pleosporales*, Family: *Pleosporaceae.*

***Alternaria* sp. cf. *A. bellus*** (Anil Chandra et al.) R.K. Saxena et al. 2022

Figure 5.3

**Specimen:** Slide L1c; 137 × 22.5.

**Remarks:** Size 27 × 10 µm.

***Alternaria* sp. 1**

Figure 5.1

**Specimen:** Slide L6c; 159.5 × 17.2.

**Remarks:** Size 89 × 23 µm, main body multicellate, 48 µm long, cells arranged along more than one axes; septa 2.5 to 3 µm thick; appendage unicellate, 41 µm long; spore wall up to 1.5 µm thick, psilate. The present specimen differs from all other species of *Polycellaesporonites* in having broad proximal end and narrow distal end. *Alternaria alternariatus* (Kalgutkar & Sigler) R.K. Saxena et al. 2022 differs in pattern of septation.

***Alternaria* sp. 2**

Figure 5.2

**Specimen:** Slide WH6a; 148.5 × 21.5.

**Remarks:** Capsular-elongated multicellate body; size range 54–58 × 10–12 µm; main body of spore 22–24 × 10–12 µm. Tube like projection hyaline, inaperturate; spore wall up to 1 µm thick, psilate. *Alternaria sirmaurensis* (A. Gupta) R.K. Saxena et al. 2022 can be easily distinguished from the present species by its very short appendage. *A. saxenae* (A. Gupta) R.K. Saxena et al. 2022 and *A. psilatus* (A. Gupta) R.K. Saxena et al. 2022 are conspicuous by their thicker and wider septa.

Genus: ***Asterinites*** Doub. & D. Pons 1973 ex Kalgutkar & Janson. 2000

**Index Fungorum Registration Identifier:** 28610.

**Type species:** *Asterinites colombiensis* Doub. & D. Pons 1973.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: *Dothideomycetidae*, Order: *Asterinales*, Family: *Asterinaceae.*

**Remarks:** Jansonius and Hills (1976, card no. 181) stated that Doubinger and Pons (1973) described two species and until one of these is selected as type species, the genus is not validly published. To validate this genus, Kalgutkar and Jansonius (2000) designated *Asterinites colombiensis* Doub. & D. Pons 1973, p. 234, plate 2, figures 1–6 as lectotype.

***Asterinites tellezii*** Doub. & D. Pons 1973 ex Kalgutkar & Janson. 2000

Figure 2.3

**Index Fungorum Registration Identifier:** 483253.

**Specimen:** Slide AM2d; 163 × 18.2.

**Remarks:** The specimen is 386 × 29.8 µm in size.

Genus: ***Callimothallus*** Dilcher 1965

**Index Fungorum Registration Identifier:** 21042.

**Type species:** *Callimothallus pertusus* Dilcher 1965.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: Incertae sedis, Order: *Microthyriales*. Family: *Microthyriaceae.*

**Remarks:** Jansonius and Hills (1976, card no. 356) validated this genus by selecting *Callimothallus pertusus* Dilcher 1965, p. 13, plate 6, figure 45 as the lectotype. Elsik (1978) pointed out that the porate

condition in *Callimothallus* is required for at least a number of the cells to separate it from *Phragmothyrites* and that if the porate nature is well represented, even fragments of the fructification are recognizable.

***Callimothallus pertusus*** Dilcher 1965

Figure 2.4

**Index Fungorum Registration Identifier:** 560965.

**Specimen:** slide L4b; 161.5 × 4.

**Remarks:** The size of the specimen is 93 × 76 µm.

Genus: ***Cercospora*** Fresen. ex Fuckel. 1863

**Index Fungorum Registration Identifier:** 7545.

**Type species:** *Cercospora apii* Fresen. 1863.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: *Dothideomycetidae*, Order: *Mycosphaerellales*, Family: *Mycosphaerellaceae.*

***Cercospora* sp.**

Figures 2.5–6

**Specimens:** Slide L2a; 136.2 × 8; slide WH3d; 146 × 8.

**Remarks:** The length of the specimens ranges from 110 to 208 and width ranges from 6.5 to 9 µm.

Genus: ***Dicellaesporites*** Elsik 1968

**Index Fungorum Registration Identifier:** 21074.

**Type species:** *Dicellaesporites popovii* Elsik 1968.

**Classification:** Fungi Imperfecti, Didymosporae.

***Dicellaesporites bisariae*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 2.7

**Index Fungorum Registration Identifier:** 559421.

**Holotype:** Figure 2.7, slide WH1a; 147 × 21. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spores oval, dark brown in colour. Size 42 × 30.5 µm. Dicellate, uniseptate, septa 8–11 µm thick. slightly curved. Spore wall psilate, very thick and opaque.

**Comparison:** The present species can be differentiated from other species of *Dicellaesporites* by its exceptionally thick and curved septum and thick spore wall.

**Etymology:** This species is named in honour of B.K. Bisaria, formerly of the Geological Survey of India (N.R.), Lucknow, India.

***Dicellaesporites foveolatus*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 2.8

**Index Fungorum Registration Identifier:** 559422.

**Holotype:** Figure 2.8, slide AM1a; 157 × 12. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spore oval with broadly rounded ends; 46 × 35 µm; dicellate, cells slightly unequal; single septum, 3–4 µm thick; spore wall ca. 1–2 µm thick, foveolate, foveola irregular.

**Comparison:** This species can be distinguished from the other species of this genus by its foveolate spore wall, broadly rounded apices, and thick septum.

**Etymology:** The species is named after its foveolate spore wall.

***Dicellaesporites plicatus*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 2.9

**Index Fungorum Registration Identifier:** 559423.

**Specimen:** Slide WH1d; 158.5 × 8.

**Remarks:** Fungal spore dicellate, cells slightly unequal, oval-elongated with one end broadly rounded and the other end pointed, size 27.8 × 13.5 µm; septum

1–1.5 µm thick; spore wall ca. 1–2 µm thick, irregularly folded with thin and delicate folds.

***Dicellaesporites verrucatus*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 2.10

**Index Fungorum Registration Identifier:** 559424.

**Specimen:** Slide L3c; 135.3 × 18.

**Remarks:** Fungal spore elliptic with both ends narrowly rounded, size 65 × 38 µm; dicellate, cells equal in size; single septum 3 µm thick; spore wall ca. 1–2 µm thick, verrucate, verrucae.

Genus: ***Endochaetophora*** J.F. White & T.N. Taylor 1988

**Index Fungorum Registration Identifier:** 25872.

**Type species:** *Endochaetophora antarctica* J.F. White & T.N. Taylor 1988.

**Classification***:* Phylum: *Mucoromycota*, Subphylum: *Mucoromycotina*, Class: *Endogonomycetes*, Subclass: Incertae sedis, Order: *Endogonales*, Family: *Endogonaceae.*

**cf. *Endochaetophora* sp.**

Figure 2.11

**Specimen:** Slide L2b; 151.5 × 17.5.

**Remarks:** Diameter is 82 µm and length of processes is 30–150 µm.

Genus: ***Exesisporites*** Elsik 1969

**Index Fungorum Registration Identifier:** 21100.

**Type species:** *Exesisporites neogenicus* Elsik 1969.

**Classification:** Fungi Imperfecti, Amerosporae.

**Remarks:** Glass et al. (1986) cited possible affinity of *Exesisporites* to the extant imperfect fungus *Nigrospora*.

***Exesisporites chandrae*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figures 2.12–15

**Index Fungorum Registration Identifier:** 559425.

**Specimen:** Slide M7a; 140.5 × 10.

**Remarks:** Fungal spore spherical to elliptical; size 43–57 × 32–43 µm. Monoporate, pore small, surrounded by 2–4 µm thick margin; pore associated with a prominent fold; spore wall 1–2.5 µm thick, psilate.

***Exesisporites* sp.**

Figure 2.16

**Specimen: S**lide WH3c; 131.5 × 15.

**Remarks:** The specimen is 42.8 µm in diameter. The pore is not surrounded by a thickening.

Genus: ***Hypoxylonites*** Elsik 1990

**Index Fungorum Registration Identifier:** 25556.

**Type species:** *Hypoxylonites brazosensis* Elsik 1990.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Sordariomycetes*, Subclass: *Xylariomycetidae*, Order: *Xylariales*, Family: *Xypoxylaceae.*

→

**Figure 2.** All photographs ×400 unless otherwise mentioned.
**1.** *Alleppeysporonites* sp. Slide AM1c; 137.7 × 3.5. **2.** *Alleppeysporonites elsikii* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, Slide M1c; 160.8 × 16.5. **3.** *Asterinites tellezii* Doub. & D. Pons 1973 ex Kalgutkar & Janson. 2000, Slide AM2d; 163 × 18.2. **4.** *Callimothallus pertusus* Dilcher 1965, Slide L4b; 161.5 × 4. **5–6.** *Cercospora* sp., **5.** Slide L2a; 136.2 × 8; **6.** Slide WH3d; 146 × 8. **7.** *Dicellaesporites bisariae* R.K. Saxena & A. Kumar, sp. nov. Slide WH1a; 147 × 21. **8.** *Dicellaesporites foveolatus* R.K. Saxena & A. Kumar, sp. nov., Slide AM1a; 157 × 12. **9.** *Dicellaesporites plicatus* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, Slide WH1d; 158.5 × 8. **10.** *Dicellaesporites verrucatus* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, Slide L3c; 135.3 × 18. **11.** cf. *Endochaetophora* sp., Slide L2b; 151.5 × 17.5. **12–15.** *Exesisporites chandrae* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, **12.** Slide M7a; 163 × 9.5; **13.** Slide M7a; 140.5 × 10; **14.** Slide M7b; 140.5 × 5; **15.** Slide M2b; 133.5 × 5.3. **16.** *Exesisporites* sp., Slide WH3c; 131.5 × 15. **17–18.** *Tetraploa* sp. 1, **17.** Slide SI2c;129 × 20; **18.** Slide SI2d;142.5 × 18. **19.** *Tetraploa* sp. 2, Slide M7a; 157 × 11. **20.** *Hypoxylonites* sp. 1, Slide WH3c; 140.5 × 11.3.

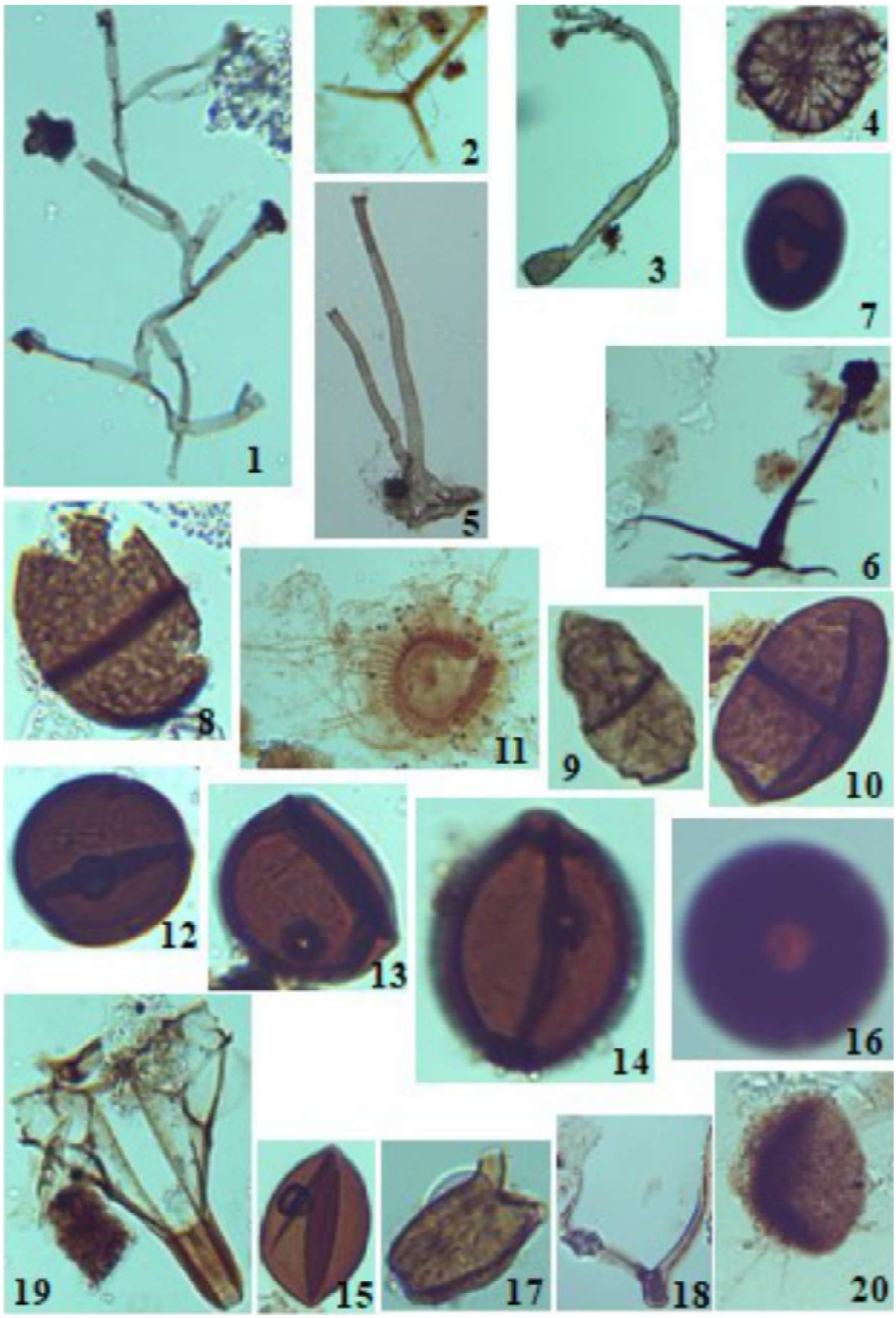


**Figure 2**

**Remarks:** *Hypoxylonites* Elsik 1990 is characterized by one elongate scar or furrow which is straight and parallel to the long axis of the spore. The *Hypoxylonites* morphotype is possibly produced by many living fungi; most are in *Xylariaceae* (*Ascomycota*). The spore type is also produced by a few hyphomycetes. The genus is named after its resemblance to the ascospores of extant *Hypoxylon* (Bull.) Fries.

***Hypoxylonites* sp. 1**

Figure 2.20

**Specimen:** Slide WH3c; 140.5 × 11.3.

**Remarks:** Size of the specimen is 63.6 × 45 µm and hyphae length varies from 20 to 23 µm.

***Hypoxylonites* sp. 2**,

Figure 3.1

**Specimen:** Slide SI1d; 150 × 12.4.

**Remarks:** The specimen is 30.7 µm in diameter.

***Hypoxynonites* sp. 3**

Figure 3.2

**Specimen:** Slide L5d; 148.8 × 8.

**Remarks:** Size of the specimen is 57 × 27 µm.

***Hypoxynonites* sp. 4**

Figure 3.3

**Specimen: S**lide L5c; 128.8 × 16.8.

**Remarks:** This fungal spore is 95 × 30 µm.

Genus: ***Inapertisporites*** Hammen 1954

**Index Fungorum Registration Identifier:** 560987.

**Type Species:** *Inapertisporites variabilis* Hammen 1954.

**Classification:** Fungi Imperfecti, Amerosporae.

***Inapertisporites choudharyi*** R.K. Saxena & A. Kumar, **sp. nov.**

Figures 3.4–5

**Index Fungorum Registration Identifier:** 559426.

**Holotype:** Figure 3.4, slide M6a; 156.5 × 11.2. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spores dark brown in colour, oval-elongated, 74–76 × 60–62 µm. Unicellate, inaperturate, spore wall coarsely reticulate, muri thinner than lumina.

**Comparison:** The present species differs from other species of *Inapertisporites* by its coarse reticulum.

**Etymology:** The species name is in honour of N.K. Choudhary, formerly of Ground Water Department, U.P., Lucknow, India.

***Inapertisporites kharei*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 3.6

**Index Fungorum Registration Identifier:** 559427.

**Holotype:** Figure 3.6, slide L3c; 152 × 2.8. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spore dark brown, circular, 42

→

**Figure 3.** All photographs ×400 unless otherwise mentioned.
**1.** *Hypoxylonites* sp. 2, Slide SI1d; 150 × 12.4. **2.** *Hypoxynonites* sp. 3, Slide L5d; 148.8 × 8. **3.** *Hypoxynonites* sp. 4, Slide L5c; 128.8 × 16.8. **4–5.** *Inapertisporites choudharyi* R.K. Saxena & A. Kumar, sp. nov., **4.** Slide M6a; 156.5 × 11.2; **5.** Slide M6c; 148.6 × 17.2. **6.** *Inapertisporites kharei* R.K. Saxena & A. Kumar, sp. nov., Slide L3c; 152 × 2.8. **7.** *Inapertisporites foveolatus* R.K. Saxena & A. Kumar, sp. nov., Slide L4c; 147.3 × 13.5. **8.** *Inapertisporites kedvesii* Elsik 1968, Slide M1a; 161 × 10.6. **9–13.** *Inapertisporites microverrucatus* R.K. Saxena & A. Kumar, sp. nov. **9.** Slide L2b; 134.5 × 6; **10.** Slide L1c; 144.5 × 14; **11.** Slide L1c; 136.7 × 20.2; **12.** Slide WH7a; 151.5 × 14.3; **13.** Slide WH7c; 146.4 × 8. **14.** *Inapertisporites* sp. 1, Slide L1c; 156 × 11.8. **15.** *Inapertisporites* sp. 2, Slide WH7c; 150.5 × 12. **16.** *Inapertisporites* sp. 3, Slide WH7b; 135 × 15. **17.** Inaperturate elongated fungal spores, Slide M1a; 137 × 2.5. **18–19.** *Laevitubulus laxus* Burgess & Edwards 1991 (Fungal Hypha Type), **18.** Slide SI2d; 162 × 15.5; **19.** Slide L5c; 157 × 14.8. **20.** *Laevitubulus* sp., Slide SI2a; 144.8 × 17.6.

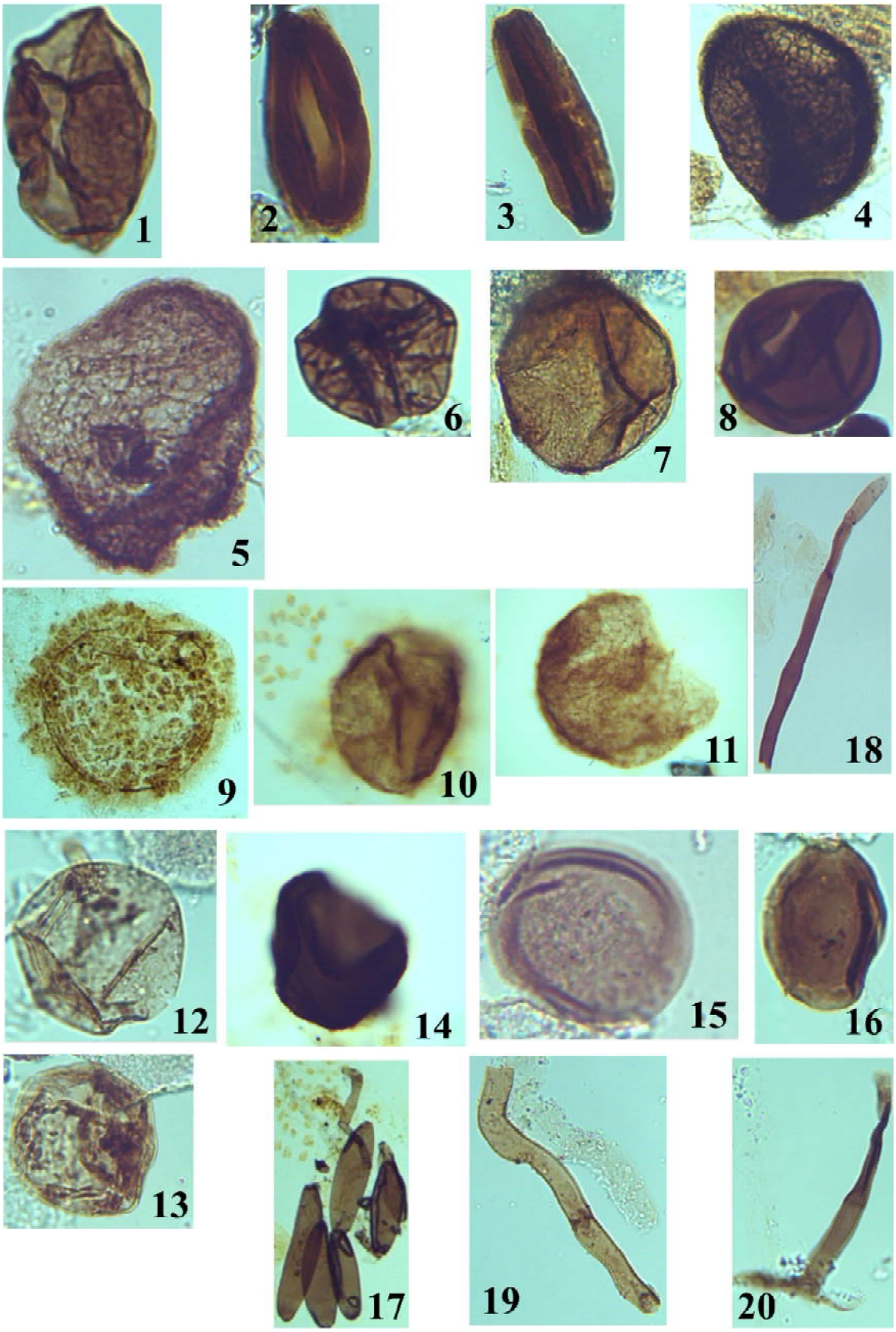


**Figure 3**

μm in diameter, unicellate, inaperturate. Spore wall prominently folded.

**Comparison:** The present species resembles *Inapertisporites kedvesii* Elsik 1968 in having folded spore wall but in the former folds are much more prominent and profuse than the latter.

**Etymology:** The species is named after S.K. Khare, formerly of CMPDI, Coal India Limited, Singrauli, India.

***Inapertisporites foveolatus*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 3.7

**Index Fungorum Registration Identifier:** 559428.

**Holotype:** Figure 3.7, slide L4c; 147.3 × 13.5. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spores oval, unicellate, 71 × 64 μm, inaperurate, nonseptate. spore wall 1 μm thick, foveolate, foveola evenly distributed.

**Comparison:** The present species can be differentiated from the other species of this genus by its foveolate spore wall.

**Etymology:** This species is named after the foveolate spore wall.

***Inapertisporites kedvesii*** Elsik 1968

Figure 3.8

**Index Fungorum Registration Identifier:** 315797.

**Specimen:** slide M1a; 161 × 10.6.

**Remarks:** Size range of the fungal spores is 37–41 × 31.5–39 μm.

***Inapertisporites microverrucatus*** R.K. Saxena & A. Kumar, **sp. nov.**

Figures 3.9–13

**Index Fungorum Registration Identifier:** 559429.

**Holotype:** Figure 3.10, slide L2b; 134.5 × 6. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spores mostly spherical, sometimes oval, size 49–220 × 45–220 μm. Unicellate, Inaperturate, nonseptate. Spore wall up to 4 μm thick, verrucate, verrucae variously shaped, 2–3 μm in diameter.

**Comparison:** The present species can be differentiated from the other species of this genus by its microverrucate spore wall.

**Etymology:** The species name is derived from microverrucate spore wall.

***Inapertisporites* sp. 1**

Figure 3.14

**Specimen:** Slide L1c; 156 × 11.8.

**Remarks:** The specimen is 90 × 83 μm.

***Inapertisporites* sp. 2**

Figure 3.15

**Specimen:** Slide WH7c; 150.5 × 12.

**Remarks:** The specimen is 39 × 33.5 μm.

***Inapertisporites* sp. 3**

Figure 3.16

**Specimen:** Slide WH7b; 135 × 15.

**Remarks:** The specimen is 37.2 × 25.8 μm.

**Inaperturate elongated fungal spores**

Figure 3.17

**Specimen:** Slide M1a; 137 × 2.5.

**Remarks:** The size range of the specimens is 73–111 × 21–27 μm.

Genus: ***Laevitubulus*** Burgess & Edwards 1991

**Index Fungorum Registration Identifier:** 92254.

**Type Species:** *Laevitubulus tenuis* Burgess & Edwards 1991.

**Classification:** Fungi Imperfecti, Mycelia sterilia.

***Laevitubulus laxus*** Burgess & Edwards 1991 (Fungal Hypha Type)

Figures 3.18–19

**Index Fungorum Registration Identifier:** 649135.

**Specimens:** Slide SI2d;162 × 15.5; slide L5c; 157 × 14.8.

**Remarks:** These are fungal hyphae with length ranging from 105 to 166.3 µm and width ranging from 8 to 10 µm.

***Laevitubulus* sp.**

Figures 3.20, 10.1–3

**Specimens:** Slide SI2a;144.8 × 17.6; slide SI2b;134.2 × 15; slide M1a; 135.8 × 16.2; slide M1a; 149 × 4.

**Remarks:** The fungal hyphae range in length from 84 to 200 µm and 4 to 29 µm in width.

Genus: ***Monoporisporites*** Hammen 1954 emend. Kalgutkar & Janson. 2000

**Index Fungorum Registration Identifier:** 21174.

**Type Species:** *Monoporisporites minutus* Hammen 1954.

**Classification:** Fungi Imperfecti, Amerosporae.

***Monoporisporites jansoniusii*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 4.4

**Index Fungorum Registration Identifier:** 559430.

**Specimen:** Slide AM1b; 134.8 × 12.8.

**Remarks:** Fungal spore spherical to elliptical; size 88 × 86 µm; monoporate, pore small, surrounded by 2¬4 µm thick pore margin, pore associated with a prominent fold, spore wall 1¬2.5 µm thick, psilate.

***Monoporisporites pattersonii*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 4.5–7

**Index Fungorum Registration Identifier:** 559431.

**Specimen:** Slide L2c; 167 × 7.

**Remarks:** Fungal spores spherical-subspherical; size 39–46 × 38–44 µm; monoporate, pore circular, 6–9 µm in diameter; spore wall 1–2.5 µm thick, reticulate.

***Monoporisporites valdiyae*** R.K. Saxena & A. Kumar in Manawasinghe et al., in press

Figure 4.8¬9

**Index Fungorum Registration Identifier:** 559432.

**Specimen: S**lide AM2c; 158.5 × 18.

**Remarks:** Fungal spores oval-elliptical; size 39–41 × 28–31 µm; monoporate, pore terminal, 4–7 µm, surrounded by 1.5–2.5 µm thick margin. Spore wall 2–2.5 µm thick, coarsely but faintly reticulate.

***Monoporisporites rotundus*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 4.10

**Index Fungorum Registration Identifier:** 559433.

**Holotype:** Figure 4.10, slide AM1c;123.5 × 5.5. Repository: Carleton Climate and Environment Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spores spherical in shape, 47.4 × 45 µm. Monoporate, pore 9–11 µm in diameter, pore margin not thickened. Spore wall 6–7 µm thick, enveloped by a hyaline covering.

**Comparison:** The present species is conspicuous in having large pore, exceptionally thick spore wall and hyaline outer covering.

**Etymology:** The species name is derived from its spherical shape.

***Monoporisporites* sp. 1**

Figure 4.11

**Specimen:** Slide AM2b;144 × 18.2.

**Remarks:** The specimen is 88 × 69.2 µm in size.

***Monoporisporites* sp. 2**

Figure 4.12

**Specimen:** Slide L5c; 145 × 20.

**Remarks:** The specimen is 48 × 43 µm in size.

Genus: ***Palaeomycites*** Mesch. 1902 emend. Kalgutkar & Janson. 2000

**Index Fungorum Registration Identifier:** 21210.

**Type species:** *Palaeomycites gracilis* (Renault) Mesch. 1898.

**Classification:** Phylum: *Mucoromycota*, Subphylum: *Mucoromycotina*, Class: *Endogonomycetes*, Subclass: Incertae sedis, Order: *Endogonales*, Family: *Endogonaceae.*

***Palaeomycites robustus*** (R.K. Kar) Kalgutkar & Janson. 2000

Figure 4.14–16

**Index Fungorum Registration Identifier:** 483251.

**Specimens:** slide L1c; 139.6 × 13.8; slide L1d; 137 × 7; slide M2a; 160.5 × 7.

**Remarks:** The specimens are of varying size ranging from 38 to 123 µm in length and from 33 to 106 µm in width.

Genus: ***Palaeosclerotium*** Rothwell 1972, p. 2354.

**Index Fungorum Registration Identifier:** 21215.

**Type species:** *Palaeosclerotium pusillum* Rothwell 1972.

**Classification:** *Ascomycota*, *Erysiphales*.

***Palaeosclerotium* sp.**

Figure 4.17

**Specimen:** Slide L3c; 145.5 × 6.5.

**Remarks:** The size of the specimen is 53×46 µm.

Genus: ***Papulosporonites*** Schmied. & A. J. Schwab 1964

**Index Fungorum Registration Identifier:** 21220.

**Type species:** *Papulosporonites sphaeromorphus* Schmied. & A. J. Schwab 1964.

**Classification:** Fungi Imperfecti, Dictyosporae.

***Papulosporonites multicellatus*** (R.K. Saxena & H.P. Singh) Kalgutkar & Janson. 2000

Figures 4.18–19

**Index Fungorum Registration Identifier:** 483504.

**Specimens:** Slide M3b; 132.8 × 4.5; slide M3c; 148 × 18.5.

**Remarks:** The size range of the specimens is 44–59 × 44–53 µm.

Genus: ***Pluricellaesporites*** Hammen 1954

**Index Fungorum Registration Identifier:** 21255.

**Type species:** *Pluricellaesporites typicus* Hammen 1954.

**Classification:** Fungi Imperfecti, Phragmosporae.

***Pluricellaesporites mishrae*** R.K. Saxena & A. Kumar, **sp. nov.**

Figure 4.13

**Index Fungorum Registration Identifier:** 559434.

**Holotype:** Figure 4.13, slide WH1b; 132 × 3. Repository: Carleton Climate and Environment

→

**Figure 4.** All photographs ×400 unless otherwise mentioned.
**1–3.** *Laevitubulus* sp., **1.** Slide SI2b; 134.2 × 15; **2.** Slide M1a; 135.8 × 16.2; **3.** Slide M1a; 149 × 4. **4.** *Monoporisporites jansoniusii* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, Slide AM1b; 134.8 × 12.8. **5–7.** *Monoporisporites pattersonii* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, **5.** Slide L2c; 164.5 × 10; **6.** Slide L2c; 167 × 7; **7.** Slide L1c; 149.5 × 2. **8–9.** *Monoporisporites valdiyae* R.K. Saxena & A. Kumar in Manawasinghe et al., in press, **8.** Slide AM2c; 158.5 × 18; **9.** Slide AM1b; 154 × 16.5. **10.** *Monoporisporites rotundus* R.K. Saxena & A. Kumar, sp. nov., Slide AM1c; 123.5 × 5.5. **11.** *Monoporisporites* sp. 1, Slide AM2b; 144 × 18.2. **12.** *Monoporisporites* sp. 2, Slide L5c; 145 × 20. **13.** *Pluricellaesporites mishrae* R.K. Saxena & A. Kumar, sp. nov., Slide WH1b; 132 × 3. **14–16.** *Palaeomycites robustus* (R.K. Kar) Kalgutkar & Janson. 2000 (*Glomus* Type), **14.** slide L1c; 139.6 × 13.8; **15.** Slide L1d; 137 × 7; **16.** Slide M2a; 160.5 × 7. **17.** *Palaeosclerotium* sp., Slide L3c; 145.5 × 6.5. **18–19.** *Papulosporonites multicellatus* (R.K. Saxena & H.P. Singh) Kalgutkar & Janson. 2000, **18.** Slide M3b; 132.8 × 4.5; **19.** Slide M3c; 148 × 18.5. **20.** *Polyadosporites* sp. 1, Slide M6d; 147.8 × 14.2.

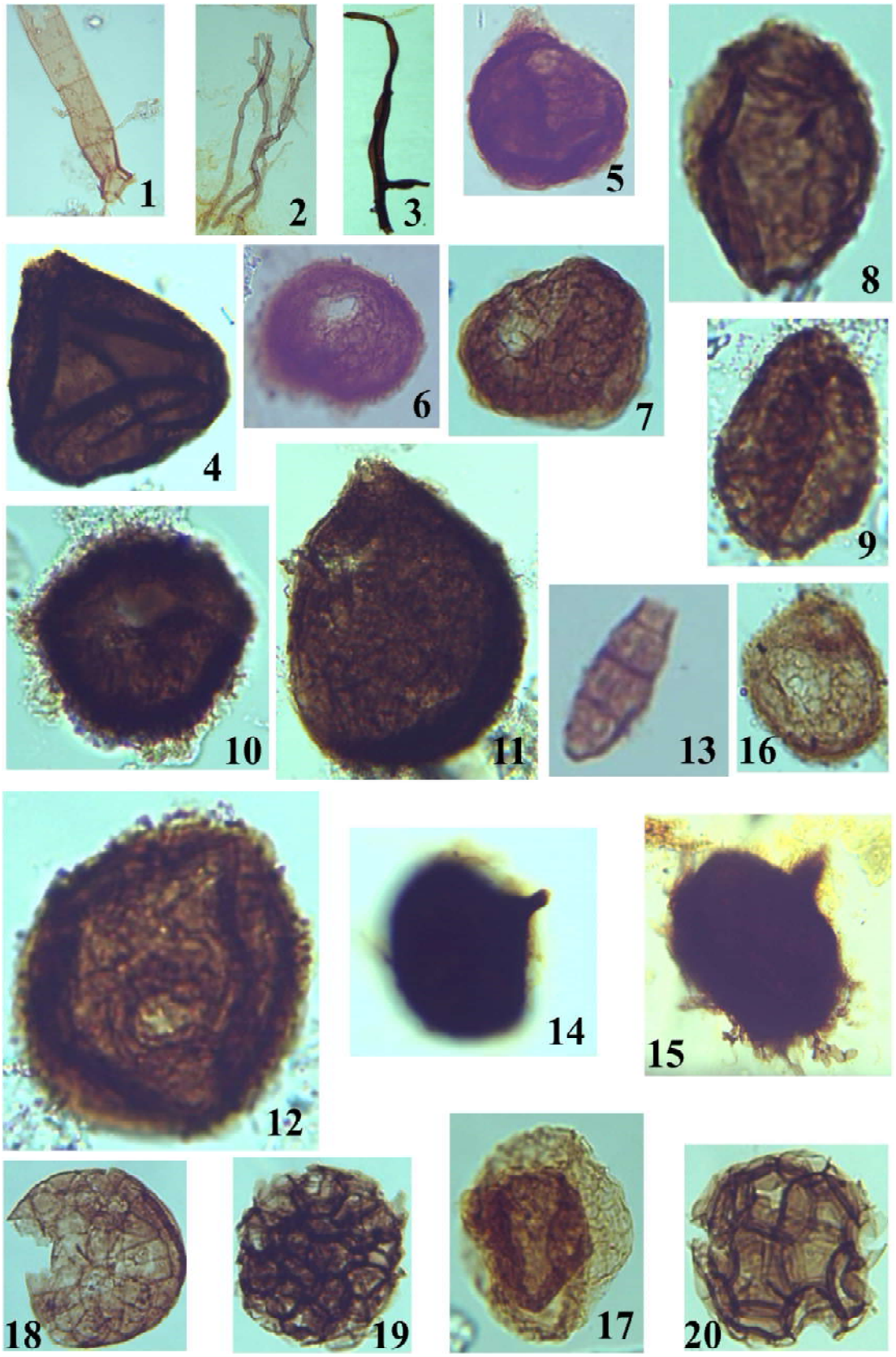


**Figure 4**

Research Group, Department of Earth Sciences, Carleton University, Ottawa, Canada.

**Diagnosis:** Fungal spore elliptical-spindle in shape, wide in the middle and tapering at both ends. Size 26.5 × 10 µm. Monoporate, pore at one end, pore 7 µm wide, not surrounded by thickening. Spore wall 1.5–2 µm thick, psilate.

**Comparison:** This species can be distinguished from the other species of *Pluricellaesporites* by its exceptionally wide pore.

**Etymology:** This species is named in honour of V.P. Mishra, formerly of the Geological Survey of India (N.R.), Lucknow, India.

Genus: ***Polyadosporites*** Hammen 1954

**Index Fungorum Registration Identifier:** 21256.

**Type species:** *Polyadosporites suescae* Hammen 1954.

**Classification:** Fungi Imperfecti, Dictyosporae.

***Polyadosporites* sp. 1**

Figure 4.20

**Specimen:** Slide M6d; 147.8 × 14.2.

**Remarks:** Fungal spore is composed of several cells that are united in irregular manner. Diameter of the specimen is 47.5 µm.

***Polyadosporites* sp. 2**

Figure 5.19

**Specimen:** Slide SI1c;135 × 3.

**Remarks:** This specimen shows several spores tightly bound in a cluster. Its overall size is 30.7 µm.

Genus: ***Scolecosporites*** R.T. Lange & P.H. Sm.

**Index Fungorum Registration Identifier:** 21296.

**Type species:** *Scolecosporites maslinensis* R.T. Lange & P.H. Sm. 1971.

**Classification:** Fungi Imperfecti, Phragmosporae.

***Scolecosporites* sp.**

Figure 5.4

**Specimen:** Slide M5a; 154 × 2.2.

**Remarks:** The size is 99 × 8 µm (variable).

Genus: ***Spinosporonites*** R.K. Saxena & S. Khare 1992

**Index Fungorum Registration Identifier:** 28635.

**Type Species:** *Spinosporonites indicus* R.K. Saxena & S. Khare 1992.

**Classification:** *Ascomycota*, *Microthyriales*.

***Spinosporonites* sp.**

Figure 5.5

**Specimen:** Slide WH2a; 137 × 13.

**Remarks:** The size of the specimen is 42 × 40 µm.

Genus: ***Spirotremesporites*** Dueñas 1979 emend. Elsik 1990

**Index Fungorum Registration Identifier:** 21309.

**Type Species:** *Spirotremesporites simplex* Dueñas 1979.

**Classification:** Fungi Imperfecti, Amerosporae.

***Spirotremesporonites* sp.**

Figure 5.6

**Figure 5.** All photographs ×400 unless otherwise mentioned.
**1.** *Alternaria* sp. 1, Slide L6c; 159.5 × 17.2. **2.** *Alternaria* sp. 2, Slide WH6a; 148.5 × 21.5. **3** *Alternaria* sp. cf. *P bellus* Chandra et al. 1984, Slide L1c; 137 × 22.5. **4.** *Scolecosporites* sp., Slide M5a; 154 × 2.2. **5.** *Spinosporonites* sp., Slide WH2a; 137 × 13. **6.** *Spirotremesporonites* sp., Slide AM2a; 133.4 × 14. **7.** *Staphlosporonites neyveliensis* Ambwani 1983, Slide M5d; 148.5 × 15.5. **8.** *Trichothyrites amorphus* (R.K. Kar & R.K. Saxena) R.K. Saxena & N.K. Misra 1990, Slide WH3b; 137 × 18. **9.** *Trichothyrites setifer* (Cookson) R.K. Saxena & N.K. Misra 1990, Slide L4a; 161 × 20.5. **10.** *Trichothyrites* sp., Slide WH3b; 160 × 5.6. **11–14.** Cluster of fungal hyphae, **11.** Slide L2c; 152.2 × 11.2; **12.** Slide M2c; 143.8 × 15; **13.** Slide M2c; 146.2 × 12.2; **14.** Slide AM1b; 146.2 × 16.5. **15.** Fungal Remain Type 1, Slide L1a; 151.7 × 16. **16.** Fungal Remain Type 2, Slide AM2d; 158 × 4. **17.** Fungal Remain Type 3, Slide L6b; 149.5 × 9. **18.** Fungal Spore Type, Slide L1d; 130.2 × 10.2. **19.** *Polyadosporites* sp. 2, Slide SI1c; 135 × 3. **20.** Sporangiun with spores, Slide L4d; 145 × 10.6.

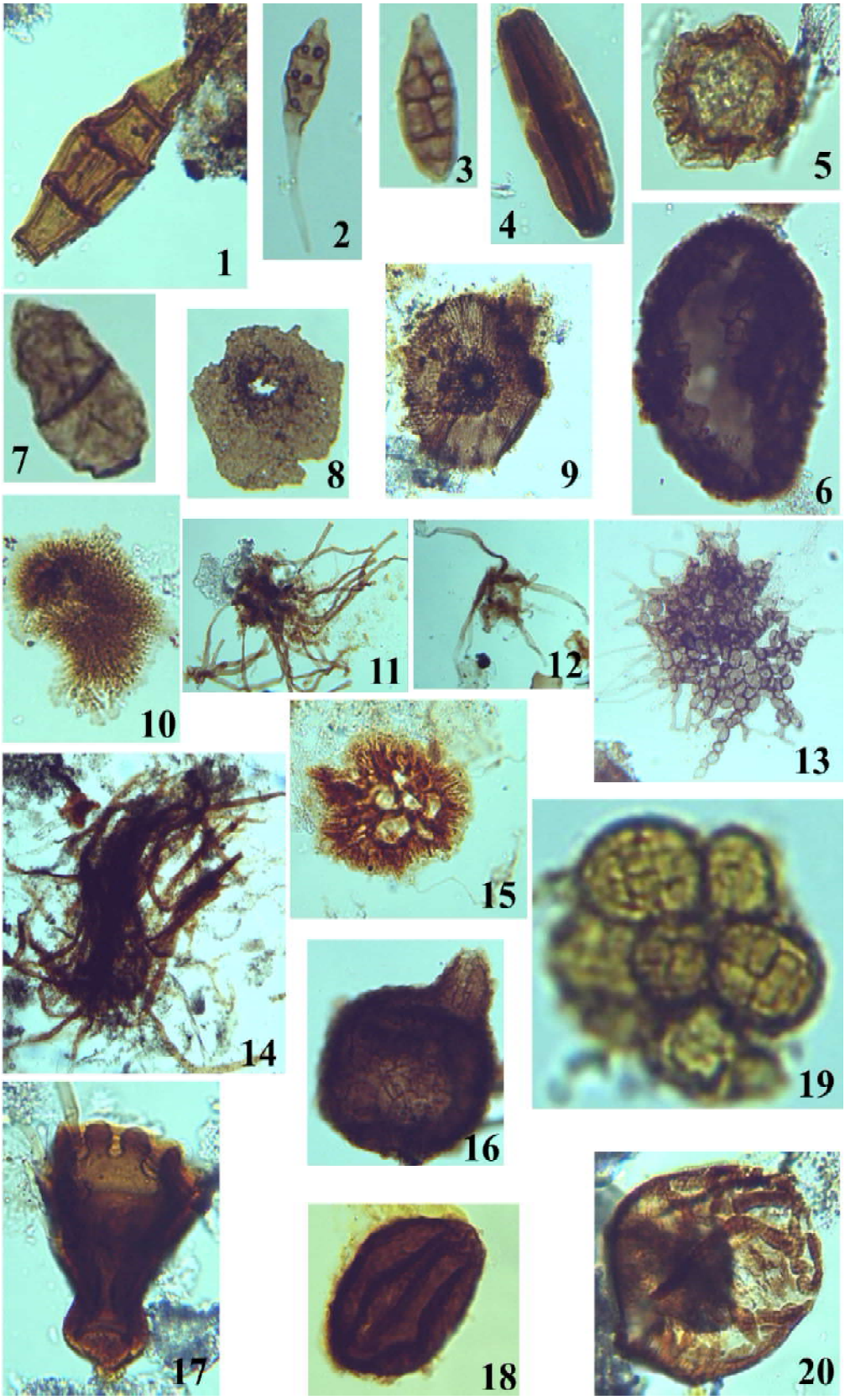


**Figure 5**

**Specimen:** Slide AM2a;133.4 × 14.

**Remarks:** 98.2 × 66.6 µm.

Genus: ***Staphlosporonites*** Sheffy & Dilcher 1971

**Index Fungorum Registration Identifier:** 21316.

**Type Species:** *Staphlosporonites conoideus* Sheffy & Dilcher 1971.

**Classification:** Fungi Imperfecti, Dictyosporae.

***Staphlosporonites neyveliensis*** Ambwani 1983

Figure 5.7

**Specimen:** Slide M5d; 148.5 × 15.5.

**Remarks:** The specimen is 65 × 44 µm.

Genus: ***Tetraploa*** Berk. & Broome 1850

**Index Fungorum Registration Identifier:** 10199.

**Type species:** *Tetraploa aristata* Berk. & Broome 1850.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: *Pleosporomycetidae*, Order: *Pleosporales*, Family: *Tetraplosphaeriaceae.*

***Tetraploa* sp. 1**

Figures 2.17–18

**Specimens:** Slide SI2c; 129 × 20; slide SI2d; 142.5 × 18.

**Remarks:** The body ranges from 27 to 35 µm in length and 18 to 23 µm in width. The length of hyphae ranges from 210 to 280 µm in length and from 9 to 13 µm in width.

***Tetraploa* sp. 2**

Figure 2.19

**Specimen: S**lide M7a; 157 × 11.

**Remarks:** The size of the spore is 142.5 × 135 µm.

Genus: ***Trichothyrites*** Rosend. 1943

**Index Fungorum Registration Identifier:** 21342.

**Type Species:** *Trichothyrites pleistocaenicus* Rosend. 1943.

**Classification:** Phylum: *Ascomycota*, Subphylum: *Pezizomycotina*, Class: *Dothideomycetes*, Subclass: Incertae sedis, Order: *Microthyriales*, Family: *Trichothyriaceae.*

***Trichothyrites amorphus*** (R.K. Kar & R.K. Saxena) R.K. Saxena & N.K. Misra 1990

Figure 5.8

**Index Fungorum Registration Identifier:** 483359.

**Specimen:** slide WH3b; 137 × 18.

**Remarks:** The diameter of the specimen is 45 µm.

***Trichothyrites setifer*** (Cookson) R.K. Saxena & N.K. Misra 1990

Figure 5.9

**Index Fungorum Registration Identifier:** 483358.

**Specimen:** Slide L4a; 161 × 20.5.

**Remarks:** The size of the specimen is 60 × 50 µm.

***Trichothyrites* sp.**

Figure 5.10

**Specimen:** Slide WH3b; 160 × 5.6.

**Remarks:** The fungal thyriothecia is 53 × 38 µm. Ostiole is faintly defined.

**Cluster of fungal hyphae**

Figure 5.11–14

**Specimens:** slide L2c; 152.2 × 11.2; slide M2c; 143.8 × 15; slide M2c; 146.2 × 12.2; slide AM1b;146.2 × 16.5.

**Remarks:** These specimens represent a variety of clusters of fungal hyphae. In most cases (Figures 5.11–12, 14), hyphae are psilate and non-septate whereas in Figure 5.13, they are clearly septate. Hyphae are of varying lengths and their width varies from 1.5 to 5 µm.

**Fungal Remain Type 1**

Figure 5.15

**Specimen:** Slide L1a; 51.7 × 16.

**Remarks:** The size of the specimen is 92 × 75 µm.

**Fungal Remain Type 2**

Figure 5.16

**Specimen:** slide AM2d; 158 × 4.

**Remarks:** This specimen is spherical in shape with a robust, horn-like projection. Size 78.6 × 63.4 µm. Wall reticulate, reticulum irregular, meshes of varying shapes. Reticulate pattern continues also in the horn-like projection.

**Fungal Remain Type** 3

Figure 5.17

**Specimen:** Slide L6b; 149.5 × 9.

**Remarks:** The size of the specimen is 89 × 65 µm.

**Fungal Spore Type**

Figure 5.18

**Specimen:** slide L1d; 130.2 × 10.2.

**Remarks:** This is a large size (84 × 56 µm) spore with three prominent folds parallel to the longer axis and faintly speckled spore wall.

**Sporangiun with spores**

Figure 5.20

**Specimen:** slide L4d; 145 × 10.6.

**Remarks:** Sporangium 72.5 µm in diameter. Wall broken at places. Several multicellate phragmospores can be seen inside the sporangium.

## DISCUSSION

The fungal palynomorph assemblage described here from the southern Red Sea coastal sediments (Holocene) of Saudi Arabia is quite diversified. It is represented by 23 genera and 27 named species. In addition, there are several specimens which could be identified only up to generic level and have been described as sp. 1, sp. 2, etc. The assemblage consists mainly of fungal spores whereas sporocarps are poorly represented by only three genera. The extant relationship of fungal sporocarps, spores, mycelia and other fungal remains is presented in Table 1.

**Table 1.** Extant relationship of fungal sporocarps, spores, mycelia and other fungal remains from southern Red Sea coastal sediments (Holocene) of Saudi Arabia.

| Phylum | Order | Family | Modern genus | Fossil genus | Fossil species |
|---|---|---|---|---|---|
| *Ascomycota* | *Erysiphales* | – | – | *Palaeosclerotium* | *Palaeosclerotium* sp. |
| | *Microthyriales* | *Microthyriaceae* | | *Asterinites* | *Asterinites tellezii* |
| | | | | *Callimothallus* | *Callimothallus pertusus* |
| | | | | *Spinosporonites* | *Spinosporonites* sp. |
| | | | | *Trichothyrites* | *Trichothyrites amorphus* |
| | | | | | *Trichothyrites setifer* |
| | | | | | *Trichothyrites* sp. |
| | *Mycosphaerellales* | *Mycosphaerellaceae* | *Cercospora*. | – | *Cercospora* sp. |
| | *Pleosporales* | *Pleosporaceae* | *Alternaria* | | *Alternaria* sp. 1 |
| | | | | | *Alternaria* sp. 2 |
| | | | | | *Alternaria* sp. cf. *A. bellus* |
| | | *Tetraplosphaeriaceae* | *Tetraploa* | | *Tetraploa* spp. 1 |
| | | | | | *Tetraploa* spp. 2 |
| | – | – | *Nigrospora* | *Exesisporites* | *Exesisporites chandrae* |
| | | | | | *Exesisporites* sp. |
| | *Xylariales* | *Xylariaceae* | *Hypoxylon* | *Hypoxylonites* | *Hypoxylonites* spp. 1–4 |
| | | | | *Spirotremesporites* | *Spirotremesporonites* sp. |
| | *Incertae sedis* | *Incertae sedis* | *Grallomyces* | *Alleppeysporonites* | *Alleppeysporonites elsikii* |
| | | | | | *Alleppeysporonites* sp. |
| *Mucoromycota* | *Endogonales* | *Endogonaceae* | – | *Palaeomycites* | *Palaeomycites robustus* |
| | | | – | *Endochaetophora* | cf. *Endochaetophora* sp. |
| Mycelia Sterilia | – | – | – | *Laevitubulus* | *Laevitubulus laxus* |

**Table 2.** Distribution of fossil fungal taxa in various environments of southern Red Sea coast of Saudi Arabia.

| Taxa | Environments of southern Red Sea coast of Saudi Arabia | | | | |
|---|---|---|---|---|---|
| | Intertidal | Wadi Hali Palaeochannel | Mangrove Swamp | Algal mat | Coral reef |
| *Alleppeysporonites elsikii* | | | F | | |
| *Alleppeysporonites* sp. | | | | F | |
| *Alternaria* sp. 1 | F | | | | |
| *Alternaria* sp. 2 | | F | | | |
| *Alternaria* sp. cf. *A. bellus* | R | | | | |
| *Asterinites tellezii* | | | | F | |
| *Callimothallus pertusus* | F | | | | |
| *Cercospora* sp. | R | R | | | |
| *Dicellaesporites bisariae* | | F | | | |
| *Dicellaesporites foveolatus* | | | | F | |
| *Dicellaesporites plicatus* | | F | | | |
| *Dicellaesporites verrucatus* | F | | | | |
| cf. *Endochaetophora* sp. | R | | | | |
| *Exesisporites chandrae* | | | C | | |
| *Exesisporites* sp. | | R | | | |
| *Hypoxylonites* sp. 1 | | R | | | |
| *Hypoxylonites* sp. 2 | | | | | R |
| *Hypoxynonites* sp. 3 | R | | | | |
| *Hypoxynonites* sp. 4 | R | | | | |
| *Hypoxynonites* sp. 4 | | | F | | |
| *Inapertisporites kharei* | F | | | | |
| *Inapertisporites foveolatus* | F | | | | |
| *Inapertisporites kedvesii* | | | F | | |
| *Inapertisporites microverrucatus* | C | F | | | |
| *Inapertisporites* sp. 1 | R | | | | |
| ?*Inapertisporites* sp. | | R | | | |
| Inaperturate elongated fungal spores | | | C | | |
| *Laevitubulus laxus* | F | | | | R |
| *Laevitubulus* sp. | R | | R | | F |
| *Monoporisporites jansoniusii* | | | | F | |
| *Monoporisporites pattersonii* | F | | | | |
| *Monoporisporites valdiyae* | | | | F | |
| *Monoporisporites rotundus* | | | | F | |
| *Monoporisporites* sp. 1 | | | | R | |
| *Monoporisporites* sp. 2 | R | | | | |
| *Pluricellaesporites mishrae* | | F | | | |
| *Palaeomycites robustus* | F | | R | | |
| *Palaeosclerotium* sp. | R | | | | |
| *Papulosporonites multicellatus* | | | F | | |
| *Polyadosporites* sp. | | | R | | |
| *Scolecosporites* sp. | R | | | | |
| *Spinospororonites* sp. | | R | | | |
| *Spirotremesporonites* sp. | | | | R | |
| *Staphlosporonites neyveliensis* | | R | | | |
| *Tetraploa* sp. 1 | | | | | F |
| *Tetraploa* sp. 2 | | R | | | |
| *Trichothyrites amorphus* | | | | | |
| *Trichothyrites setifer* | F | | | | |
| *Trichothyrites* sp. | | R | | | |
| Cluster of fungal hyphae | C | F | | | |
| Fungal Remain Type | R | | | | |
| Fungal Remain Type | | | | | R |
| Fungal Remain Type | R | | | | |
| Fungal Remain Type | R | | | | |
| To be identified | | | | | R |
| Sporangiun with spores | R | | | | |

**Rare** (R): 1-3 specimens; **Few** (F): 4-6 specimens; **Common** (C): 7 or more specimens.

It has already been stated that the samples were collected from various environments, viz. Intertidal, Mangrove swamps, Palaeochannel, Coral reef and Algal Mat environments. In these marginal environments, there is free mixing of fresh water and therefore many of the fungal palynomorphs were transported from land. Table 2 shows distribution of taxa in various environments along the Red Sea coast of Saudi Arabia.

Conidia of *Tetraploa* are found generally associated with grasses indicating grass supporting environment nearby. Similarly, *Alternaria* spores indicate the presence of herbaceous flora. It is well known that to survive, *Alternaria* needs a moist warm environment. This fungus lives in seeds and seedlings and is spread by spores. *Nigrospora* (being represented by *Exesisporites*) grows in soil, air, and plants as a leaf pathogen. Microthyriaceous ascocarps, viz. *Callimothallus, Spinosporonites* and *Trichothyrites* are also epiphyllous fungi growing on leaves. In general, the assemblage indicates warm and moist conditions in the area.

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