PALYNOLOGY OF THE TERTIARY SEDIMENTS IN KUTCH — 2. EPIPHYLLOUS FUNGAL REMAINS FROM THE BORE-HOLE NO. 14

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ABSTRACT

The present paper deals with some epiphyllous fungal remains from the bore-hole no. 14, drilled near Matanamadh, Kutch, Gujarat, India. *Phragmothyrites* sp. *cf. P. eocaenicus* Edwards, *Pseudosphaerialites* gen. nov. and *Sphaerialites* gen. nov. are described.

INTRODUCTION

THE fossil fungi are comparatively less represented and studied in the fossil sediments. Tyler and Barghoorn (1954), recorded some fungal remains from the pre-Cambrian rocks of the Canadian shield. Kidston and Lang (1921) reported fungal objects from the Rhynie Chert Bed (Devonian); while Hollick (1910) described *Pseudopolyporous carbonicus* Hollick from the Carboniferous sediments of W. Virginia. White (1899) described *Excipulites callipterides* White, from the Pennsylvanian of Missouri. Singer and Archanglesky (1958) recorded fungal remains (*Phellinites digiustdi* Singer & Archanglesky) from the Jurassic of Patagonia. Heer (1882) described *Hysterium protogeanum* Heer from the Cretaceous sediments of Greenland. A large number of fungal remains, *i.e.* spores, hyphae, perithecia are known from the Tertiary sediments the world over. The most important group among them are thus fungi with matty perithecia or pseudoperithecia. This group is recorded from the various Tertiary formations of Europe (HARSHBERGER, 1917; EDWARDS, 1922; STEVENS, 1925; POTONIÉ, 1934; POTONIÉ & VENITZ, 1934; THIERGART, 1940; HUNGER, 1953; MAÀCZ & SIMONCISICS, 1956; NEUY-STOLZ, 1958 and RAUKOFP, 1959); America (WILSON & WEBSTER, 1946; MARTIN & ROUSE, 1965), Australia (COOKSON, 1947a, 1947b) and Africa (SAH, 1967).

In the opinion of Graham (1962) the evolution and diversification of fungi is directly related with the evolution and spread of angiosperms. The occurrences of fungal remains in the geological past supports this view. The abundance of epiphyllous, *Hemisphaeriales* and *Pseudosphaeriales* in the Tertiary sediments probably point out the dependence of these forms on broad leaved angiosperms. In the present material the stromatal bodies are frequent while gymnospermous pollen are very rare thereby allowing us to presume that they depended on angiospermous vegetation for its existence.

Genus — *Phragmothyrites* Edwards, 1922

Type Species — *Phragmothyrites eocaenicus* Edwards, 1922.

Phragmothyrites sp. *cf. P. eocaenicus* Edw. 1922

Pl. 1, Figs. 1-5

Description — Perithecium dark brown, subcircular in shape, 60-120 μ. Central part of the perithecium ruptured probably due to hard process of maceration. Hyphae are radially arranged, interconnected forming pseudoparenchymatous tissue throughout the perithecium; cells are ± uniform in size. Squarish to rectangular in shape. Outer layer of the perithecium not thickened and devoid of setae.

Comparison — *Phragmothyrites eocaenicus* Edwards (1922) closely resembles the present specimen in size and disposition of the pseudoparenchymatous cells. The present specimen, however, lacks the central part and so it is only compared with the above mentioned species.

Remarks — The genus *Phragmothyrites* was instituted by Edward (*l.c.*) for fossil forms whose exact position is unknown but very closely related with the genus *Phragmothyrium* of the family Microthyriaceae. The genus *Phragmothyrium* as defined by

Höhnel (1912) includes forms having more than two-celled spores. Edwards could not find the *in situ* spores on the perithecium but on the same preparation he found multicelled spore and presumed it to be the ascospores belonging to *Phragmothyrites eocaenicus* (EDWARDS, 1922, PL. 8, FIG. 7). On the basis of the perithecium alone the identification of the fossil forms is difficult even upto family level but with attached ascospores it is possible to differentiate different types. The ascospores described by Edwards (*l.c.*) were not found attached to the perithecium hence the certainty of the assignment is questionable.

Phragmothyrites and other microthyriaceaeous discs are cosmopolitan in distribution during the Tertiary age (POTONIÉ, 1934; POTONIÉ & VENITZ, 1934; THIERGART, 1940; WILSON & WEBSTER, 1946; COOKSON, 1947a, 1947b; HUNGER, 1953; MAÀCZ & SIMONCSICS, 1956; NEUY-STOLZ, 1958; RAUKOPF, 1959; KEDVES, 1960; GRAHAM, 1962; SAH, 1967).

Cookson (1947a) instituted *Microthyriacites* along with several other genera for the *incertae sedis* Microthyriaceae with radiate and dimidate ascomata without any mycelia or ascospores. Sah (1968) considers this genus synonymous to *Phragmothyrites*. Cookson (1947a) was not sure about the affinity of *Microthyriacites* except that it belongs to the family Microthyriaceae. She, however, did not designate a type species but she described three species *viz. Microthyriacites fimbriatus* (COOKSON, 1947a, PL. 12, FIG. 17), *M. grandis* (COOKSON, 1947a, PL. 14, FIGS. 20-21) and *Microthyriacites* sp. (COOKSON, 1947a, PL. 13, FIGS. 18, 19). *M. grandis* and *Microthyriacites* sp. closely resemble *Phragmothyrites* in shape, size-range and disposition of the pseudoparenchymatous tissue except they are broader. *Microthyriacites fimbriatus* can, however, be readily distinguished from *Phragmothyrites* by its large size (280 μ), central part of the perithecium composed of very dark, strongly built, thick-walled hyphae which radiate from the central group of hexagonal cells. The rest part of the perithecium is light-coloured and composed of rectangular pseudoparenchymatous cells. *Phragmothyrites* in most of the specimens is uniformly dark or darker in the periphery (*see* EDWARDS, 1922, PL. 8, FIGS. 1-4). The genus *Microthyriacites* can be retained to accommodate *M. fimbriatus* type of perithecia by designating *M. fimbriatus* as the type species of the genus.

Genus — *Pseudosphaerialites* gen. nov.

Type Species — *Pseudosphaerialites senii* sp. nov.

Diagnosis — Perithecium dark brown, subcircular - circular in overall shape, mostly one cell thick; middle part of the perithecium darker than adjacent regions; perithecium pseudoparenchymatous, formed by radiating hyphae. Outer cells thickened on periphery, minutely setose; stromatic cavities adjacent to central part possess transparent hypha one in each cell. Asci not seen but seems that one ascus developed in each cavity.

Description — Perithecium mostly dark brown in colour; the central part comprising 4-5 cells, are darker than adjacent parts. Size range of the perithecium 100-140 μ. Hyphae radially arranged, interconnected forming pseudoparenchymatous cells. The cells in middle region are ± square but they are ± rectangular on outside, size range of cells 4×5 μ-10×3 μ. Central part of the perithecium consists of 4-5 cells; darker ± square in size and hypha is not seen on them. The adjacent cells are, however, characterized by the presence of one hypha in each. They are transparent and pressed in the cavity. The outer cells of the perithecium are dark, elongated, thickened and possess minute setae on outer part to provide a serrated overall shape. These cells are generally devoid of hypha in the cavity; but in some specimens some of the cells seem to possess one.

Comparison—Phragmothyrites Edw. (1922) closely resembles the present genus in possessing subcircular overall shape of the perithecium, radially arranged hyphae with interconnections forming pseudoparenchymatous cells and the size range. The present genus can be distinguished by its larger size of the pseudoparenchymatous cells and presence of one hypha in each cavity surrounding the central part of the perithecium. The present genus is also characterized by thickened peripheral cells with minute setae on the other side. *Notothyrites* Cooks. (1947a) is of similar size and pseudoparenchymatous cells but can easily be differentiated by its prominent ostiole bordered by three to five layers of dark-brown, thick-walled cells. *Asterothyrites* Cooks.

(1947a) is amphigenous with fine mycelium and brown hyphae. The ascomata in this genus is scattered, astomate and composed of slender, straight or slightly flexuous radiating hyphae. *Euthythyrites* Cooks. (1947a) is also amphigenous and has ascomata with elliptical, forked or rounded ends. This dehisces by a longitudinal slit along the length of the ascoma. *Microthyriacites* Cooks. (1947a) resembles *Pseudosphaerialites* in the overall shape, size range and pattern of cells but lacks hypha in the stromatic cavity. *Trichopeltinites* Cooks. (1947a) is elongated, leaf-like with many lobes and some branches. *Plochmopeltinites* Cooks. (1947a) is also subcircular and pseudoparenchymatous with sinuous hyphae.

Remarks — The present genus instituted here resembles the extant order *Pseudosphaeriales* in the presence of one hypha in each stromatal cavity; this character is very important in distinguishing this order from the others (BESSEY, 1950). Some species of Hemisphaeriaceae of the order *Hemisphaeriales* also do have such type of stromatal hypha. The order *Pseudosphaeriales* have been regated from the *Sphaeriales*, *Perisporiales* and *Dothideales*. Bessey (*l.c.*) opines that the genetic relationship of the different families belonging to this order is not definitely known; but they are distinguished by the mode of occurrence of the asci from each stromatal cavity. The present specimens do not show any ascospore but the indication of the presence of one hypha in each stromatal cavity in some of the cells allows us to compare with the *Pseudosphaeriales*. So far the general shape and pattern of pseudoparenchymatous cells of the perithecium are concerned the present genus closely resembles the family Microthyriaceae of the order *Hemisphaeriales*. In this family, under the ostiolate cover of the stromata there is a hymenium of vertically standing asci intermingled with conspicuous or sometimes inconspicuous paraphysis-like remnants of the stromatic tissues (BESSEY, 1950)

The genus *Pseudosphaerialites* proposed here can not be linked up with any of the families of the order *Pseudosphaeriales*. In the family Pseudosphaeriaceae (THIESSEN & SYDOW) the perithecium is hemispherical; while in other families i.e., Mycosphaerellaceae, Pleosporaceae, Botryosphaeriaceae the perithecium are not well known.

Extant forms of the genus *Pseudosphaerialites* are mostly tropical and generally parasitic on leaves. The presence of epiphyllous fungi perhaps indicates a humid, tropical climate during the time of deposition.

Pseudosphaerialites senii sp. nov.

Pl. 1, Figs. 6-7

Holotype — Pl. 1, Fig. 6. Size 140×130 μ.

Type Locality — Bore-hole no. 14, Laki Stage (Eocene), Matanamadh, Kutch.

Diagnosis — Perithecium subcircular-circular, 100-140 μ; dark brown in colour, one layered thick in most cases. Central part of perithecium darker than neighbouring regions; in the latter each stromatal cavity possesses one hypha. Hyphae radially arranged, pseudoparenchymatous; outer layer thickened and minutely setose. Asci not seen.

Description — Perithecium is only seen in the present material. They are dark-brown with minutely serrated margin due to setose outer layer. Central part of perithecium comprises 4-5 cells; hyphae not observed; they are darker than rest part except the outer cells. Hyphae radially arranged with interconnections producing pseudoparenchymatous cells. Cells smaller in middle region, but longer at periphery. Cells near the central part possess one hypha in each cavity. Outer cells generally devoid of stromatal hypha though in some cases there seems to be some hyphal outgrowth in these cells. The outer cells dark as or darker than central part of perithecium.

Derivation of name — After late Dr. J. Sen of the Botanical Survey of India whose work on the Tertiary sediments of the Laitryngew coalfield in Assam laid a foundation for Tertiary Palynology in India.

Genus — *Sphaerialites* gen. nov.

Type Species — *Sphaerialites ovatus* sp. nov.

Diagnosis — Perithecium subcircular-circular, dark brown. Central part of perithecium surrounded by at least two-layered thick plate-like structure, rest part one-layered and composed of pseudoparenchymatous cells formed by interconnected hyphae. Mycelium or ascospore not seen.

Description — Perithecium mostly dark brown, plate-like part which surrounds the central part is as a rule darker than rest. Size range of perithecium 60-150 μ, mostly subcircular in shape with slight undulation on margin. Central part of perithecium light brown, comprises 4-5 ± square - hexagonal cells; this area surrounded on all sides ± equally by dark brown circular area. This part two-layered — one ± square - hexagonal in size and the other square - rectangular in size. The remaining part of the perithecium composed of radiating hyphae interconnected with each other to form pseudoparenchymatous cells. Mostly rectangular, peripheral hyphae, however, produce unequally long pseudoparenchymatous cells. No hyphal outgrowth has been observed on the perithecium and ascospore not seen. Hyphae smooth, with setaceous margin.

Comparison — *Asterothyrites* Cooks. closely resembles the present genus in shape, size range and general disposition of the hyphae in producing pseudoparenchymatous cells. The present genus can, however, be distinguished by its plate-like thick two-layered structure surrounding the central part of the perithecium. *Microthyriacites fimbriatus* Cooks. also resembles the present genus in the presence of thickened, dark-coloured area surrounding the central part of the perithecium. The hyphae in *M. fimbriatus* producing pseudoparenchymatous cells also radiate from a central group of hexagonal cells; but this species can easily be differentiated by its very thick hyphae and small size of the cells in the inner as well as in the outer part of the perithecium. *Pseudosphaerialites* is characterized by one-layered thick perithecium which is minutely setose at the periphery and some of the cells into middle region of the perithecium producing one hypha in each stromatal cavity. *Phragmothyrites* Edw. is uniformly thick and the pseudoparenchymatous cells are also ± of same size. *Notothyrites* Cooks. resembles *Sphaerialites* in possessing well marked ostiole bordered by thick-walled three-five layers of dark-brown cells. In *Notothyrites*, the radiating hyphae produce small sized pseudoparenchymatous cells and the thickened area around the ostiole is also proportionately smaller than the present genus. *Plochmopellinites* Cooks. has sinuous hyphae with out distinct pseudoparenchymatous cells.

Sphaerialites ovatus sp. nov.

Pl. 1, Figs. 9-11

Holotype — Pl. 1, Fig. 11. Size 110 μ.

Type Locality — Bore-hole no. 14, Laki Stage (Eocene), Matanamadh, Kutch.

Diagnosis — Perithecium dark-brown, subcircular - circular, size range 60-150 μ. Central part of perithecium surrounded by a thick, at least two-layered, well defined, rounded area. Remaining part of perithecium one-layered and comprises square to ± hexagonal pseudoparenchymatous cells produced by the radiating interconnected hyphae.

Description — Plate like part of perithecium surrounding the central part is darker than the rest. It is circular, consists of two-layered square - hexagonal cells. Central part lighter, and comprises 4-5 ± hexagonal cells. Outer part of perithecium made of radiating hyphae which regularly interconnect each other to form ± rectangular pseudoparenchymatous cells; they may be, however, unequally broad at ends. Outer margin of perithecium slightly undulated but without any marginal thickening. Stromatal cavities do not possess hyphal outgrowth. Setae and ascospores not recorded in the specimens studied here.

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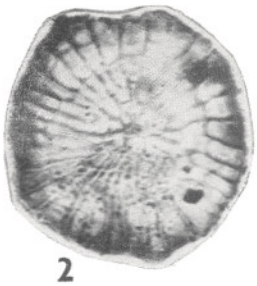

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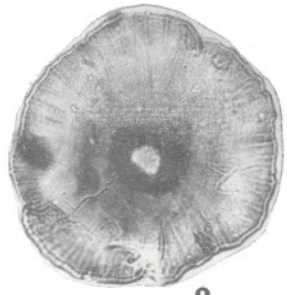

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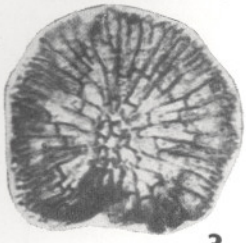

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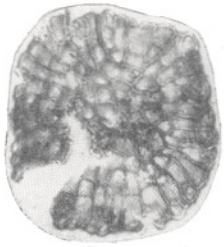

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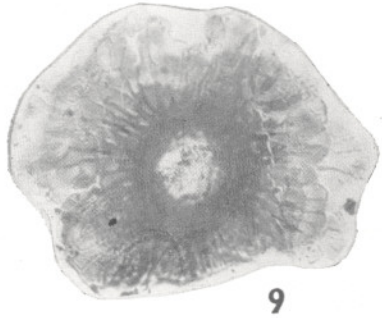

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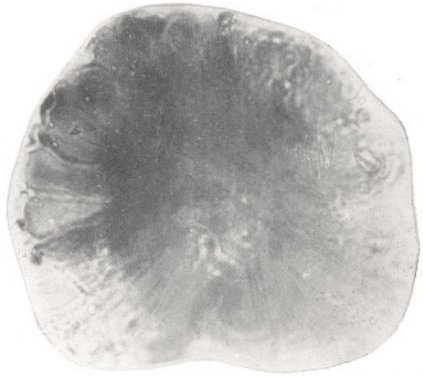

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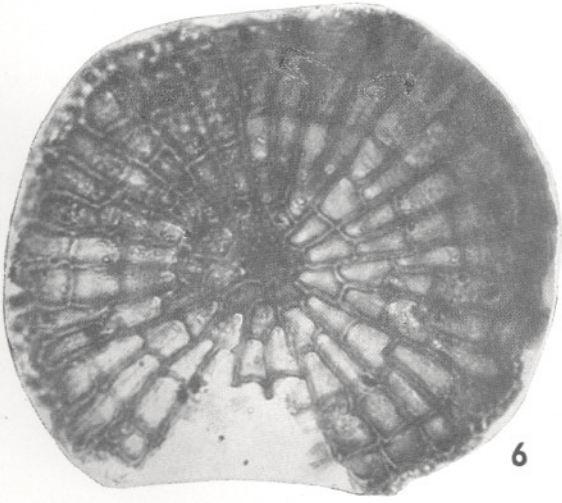

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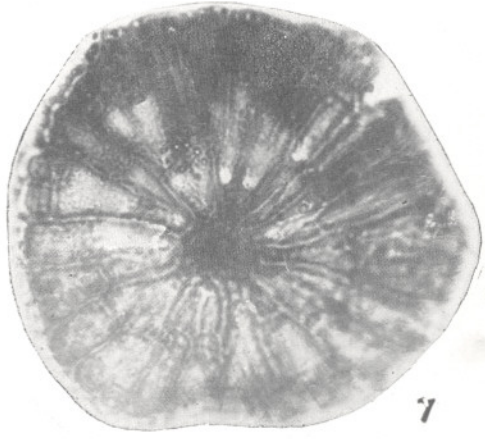

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EXPLANATION OF PLATE

(*All photomicrographs are enlarged ca.* × 500)

PLATE 1

1-5. *Phragmothyrites* sp. *cf.* P. *eocaenicus.* Slide nos. 186/15, 186/16, 188/29, 188/10, 188/14.

6-7. *Pseudosphaerialites senii* gen. et sp. nov. Slide nos. 171/29, 171/20.

8-11. *Sphaerialites ovatus* gen. et sp. nov. Slide nos. 186/10, 188/22, 188/2, 171/9.