

FUNGAL REMAINS FROM SOME TERTIARY DEPOSITS OF INDIA

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THE records of fossil fungi in India are rather meagre. Sahni & Rao (1943) described a number of fungal hyphae, fruit bodies designated *Palaeosordaria lagena* gen. et. sp. nov., and *Perisporiacites varians* sp. nov., and detached spores, from the silicified intertrappean cherts of the Deccan. Rao (1943) described a bit of a septate mycelium in the basal part of a Jurassic conifer seed *Nipaniostrobus sahnii*. Jacob & Jacob (1950) described for the first time some fungi belonging to the Microthyriaceae and Trochopeltaeae occurring on the surface of some leaf cuticles found in the tertiary lignites of Cuddalore, S. Arcot, India. Mrs. S. D. Chitale (1951) recorded the occurrence of different kinds of fungal fructifications, some of them probably belonging to the Microthyriaceae, Pleosporaceae and Mucoraceae in the Deccan intertrappean cherts. She has recently (1957) described and figured some of them. During the course of the microfossil studies of lignites from Palana attention was also drawn to the occurrence of some similar fungal remains (RAO, 1954). Subsequent macerations of lignites from Palana (Bikaner), Warkalli (Travancore), Cuddalore (S. Arcot, Madras) — all of Tertiary Age have brought to light similar but slightly different types of fungal fruit bodies or thyriothecia and these constitute the subject of this paper. Most of these get scattered during maceration. But one or two specimens were found still attached to the host tissue even after maceration.

The first type of thyriothecium which is from Palana (Eocene) (PL. 1, FIGS. 1, 2) measures 250 μ in diameter, with radially arranged squarish or rectangular cells more or less of the same size (10.5 μ across) except some of the peripheral ones which are slightly smaller. The central portion is not preserved. In most of the cells there is a single clear area almost like an aperture. But in some cells there are often 3-4 of these whose nature it has not been possible to determine. No mycelia are found attached to these thyriothecia but different kinds of

mycelia are found in the macerated matrix. An osteole is not also very clear either.

The thallus can be referred to the Coleochaetaceae amongst the Algae or to the Discomycetes amongst the fungi. The absence of any type of chaetae or the presence of sex organs or fruit bodies in all the thalli so far examined rules out the possibility of these being discoid algae. On the other hand, with the data available the specimen could well be referred amongst the fungi to the Microthyriaceae which have superficial, radiate dimidiate thyriothecia with mycelia lacking or absent (CLEMENTS & SHEAR, 1931, p. 94; BESSEY, 1952, p. 294). The radiate and superficial nature of the thyriothecium, its circular form and the absence of mycelia suggest that my specimens too can be referred to the Microthyriaceae. It is difficult to compare the fossil specimen further with living types in view of the unavailability of various diagnostic characters. But running through the synopsis of genera one feels that *Phragmothyrium* may well be a genus with which comparison is possible. Edwards (1922, p. 68) discussed briefly the history of the Microthyriaceae and instituted the genus *Phragmothyrites* for an epiphyllous Microthyriaceous fungus found in Eocene deposits of Mull in Scotland. He suggested that the name might be used for fossil forms belonging to the Microthyriaceae the exact position of which is uncertain but which appear to be most closely related to *Phragmothyrium* as defined by Von Höhnel. My specimen (PL. 1, FIG. 1) resembles in form and dimension the fossil ascostromata or thyriothecia described by Edwards (loc. cit.) under the name *Phragmothyrites eocenica* (FIGS. 2, 3 of EDWARDS) except for this difference that the peripheral cells are larger in *Phr. eocenica*. No mycelia or osteoles have been found in either case. A number of scattered phragmidiospores(?) found along with these thyriothecia bear a resemblance to the phragmidiospores described by Edwards.

Tilgner (1954) has figured what look like Microthyriaceous fruit-bodies from the

Tertiary brown coals of Germany. One of them (FIG. 3) is like the specimen figured as 1 in this paper, but is much smaller (95-98 μ) and has a distinct osteole.

The following living genera of the Microthyriaceae are known from India: *Asterina* (BUTLER & BISBY, 1931, pp. 15, 16; MUNDKUR, 1938, p. 12; RAMAKRISHNAN & SUBRAMANIAN, 1952, pp. 7, 8), *Asterinella* (BUTLER & BISBY, loc. cit. p. 16), *Lembosia* (BUTLER & BISBY, loc. cit. p. 26), *Microthyrium* (BUTLER & BISBY, loc. cit. p. 29), *Asterolibertia* (RAMAKRISHNAN & SUBRAMANYAM, 1952, p. 8). But all these except *Microthyrium* have clear superficial mycelia, so a comparison of my specimens with them is not possible. *Microthyrium* though without mycelia has bicedled phragmospores. Since such bicedled spores are absent in my collection either in attachment or in association with my specimens, a comparison with that genus is not possible. The only genus *Phragmothyrium* with which comparisons are possible is, so far as I am aware, not known from India.

Miss Cookson (1947) after her study of Southern Tertiary fungi pointed out how the genus *Phragmothyrites* was unacceptable for various reasons and instituted a new genus *Notothyrites* purely on the basis of external morphological features. My specimen can well be accommodated in this genus too. In fact there is some kind of a resemblance between the specimen figured as 1 in this paper and those figured as 5 and 6 by Miss Cookson under the name *Notothyrites setiferus*. But I refrain from actually placing my specimen in that genus or making any specific comparisons in view of the fact that the ostiole characters are not at all clear in my specimens where the central part is missing. I would prefer to place my specimen in the non-committal genus *Microthyriacites* instituted by Miss Cookson for radiate and dimidate ascostromata whose mycelial and ascospore characters are not fully known.

Microthyriacites Cookson

Microthyriacites sahnii sp. nov.

Diagnosis — Thyriothechia, flat superficial, dimidate, up to 250 μ in diameter, with radially arranged squarish or rectangular cells, peripheral cells smaller, cells with one or more small aperture-like areas. No mycelia or osteole clearly seen.

Locality — Palana, Bikaner, India.

Age — Eocene.

A similar bigger thyriothechium from South Arcot, Madras State (PL. 1, FIG. 3), measures about 150 μ . The central part is several cells thick almost up to the middle of the thallus. Some of the peripheral cells (as those on the right of the figure) are extremely small. This specimen looks slightly different from that figured as 1, but still, I think it belongs to the same type of thallus though not to the same species.

The second type of thallus (PL. 1, FIG. 4) found in the lignites of Warkalli (Miocene) in Kerala is also circular or with a slightly variable outline but with an entire margin and measures 88 μ in diameter. The central part is two or three cells thick and the peripheral part one cell thin. The cells in the centre are roughly hexagonal and thick-walled while those towards the periphery are long and radially disposed. Some of the divided marginal cells impart a characteristic appearance to the thallus. Unicellular stigmatocysts (PL. 1, FIG. 5), most probably of this species of thallus, have also been found scattered in the material. Some of these show stages of division (PL. 1, FIG. 6). They are shield shaped with a slightly crenulate margin and measure 30 μ in diameter. No hyphae are associated with these thalli which, evidently, are, like the previous ones, the ascomata of an epiphyllous fungus. The thyriothechium in view of its superficial, circular and discoid nature, entire margin, absence of mycelia can be referred to the Microthyreae of the Microthyriaceae. There is indeed a close resemblance in form and appearance between my specimen and the one figured by Edwards (1922, FIG. 4) as *Phragmothyrites eocenica* and found occurring on fossil conifer leaves in the Eocene deposits of Mull in Scotland. My specimens cannot, however, be referred to this species as the thyriothechia are much smaller and the stigmatocysts much larger than those in *Phr. eocenica*. For reasons already explained above the reference to the genus *Phragmothyrites* is also inadvisable.

Miss Cookson (1947, pp. 240, 241) has described three species of *Microthyriacites*, but all of them are much bigger than my specimen and also look different. But the diagnosis of the genus is wide enough to accommodate my specimen and I, therefore, refer it to the genus *Microthyriacites*.

Microthyriacites Cookson*Microthyriacites edwardsi* sp. nov.

Diagnosis — Thyriothecia, flat dimidate, superficial up to 90 μ in diameter, central cells more or less hexagonal, outer cells radially arranged, elongated, peripheral cells cleft, stigmatocysts shield shaped. No mycelia or osteole seen.

Locality — Workalli, Kerala, India.

Age — Miocene.

The third type of thallus occurs in large numbers in the South Arcot as well as Palana lignites and varies much in form, orbicular, shield shaped (PL. 1, FIG. 7), oval, elliptic (PL. 1, FIG. 8) and often approaching a dimidate condition. In size they range from 145 to 245 μ in diameter. In these thalli which generally appear to be thinner than the above two types, the central part is more compact and made up of fairly thick-walled isodiametric cells. The broad, peripheral part is made up of long thin-walled cells — sometimes very long and narrow. The margin is sinuous but entire. The aperture-like area seen in the first type of thallus is not seen here. Fig. 9 shows a very young thallus (80 μ). A slightly older thallus (145 μ in diameter) found in another slide is seen on a fragment of the lower epidermis of an unidentified leaf (PL. 1, FIG. 10).

The specimens described above (PL. 1, FIGS. 7-10) can also be referred to the *Microthyriacites* in spite of the absence of a confirmed dimidate condition of the ascumata, because they seem to have the same general organization of the ascumata attributed to this genus. But they cannot be compared to any of the species described by Miss Cookson although a certain degree of similarity may be seen between my specimens and *M. grandis* which is slightly different from the type specimen.

Microthyriacites Cookson*Microthyriacites cooksoni* sp. nov.

Diagnosis — Thyriothecia, flat, slightly dimidate and orbicular or shield shaped, 145-245 μ in diameter, central region of thick-walled compact cells, outer region of elongated, thin-walled cells.

Locality — Palana and South Arcot.

Age — Eocene and Miocene respectively.

None of the above described thyriothecia can be compared with the ones figured by

Mrs. Chitale (1957). Besides, her specimens seem to have mycelia attached to them while no mycelia are clear in my specimens.

In the macerated material are met with several kinds of bodies some of which at least are remarkably like fungal spores and hyphae. Some of these are described below. Fig. 11 appears to be a four-celled phragmospore which measures $50 \times 34.5 \mu$ and is broadly elliptic in shape. The end cells have slightly flattened end walls and are partly clear while the two central cells are more dark with filled-up contents. Another four-celled stalked spore is coiled and measures $92.3 \times 20.6 \mu$, with rounded cells (PL. 1, FIG. 12). The transverse as well as vertical walls are two-layered. The spore looks very much like that of *Helicoma* and *Helicomina* (BARNETT, p. 955, p. 79). The stalk is thin-walled and only about 12 μ length of it is preserved. Another closely coiled spore-like body (PL. 1, FIG. 13) resembles the coiled conidiospore of *Helicosporium* or *Helicomycetes* (BARNETT, 1955, p. 79; CLEMENTS & SHEAR, 1931, PL. 54, FIG. 9a). There are three coils, the breadth is throughout uniform and about 37 compartments can be made out; the end cell is rounded. Fig. 14 shows another thick-walled spore-like body with about 8 cells, the last of which is comparatively elongated and clear. The entire thing narrows down at both ends and the biggest diameter would be about 10 μ . It is difficult to say whether this is a multicellular phragmospore or an intercalary chlamydospore. Fig. 15 shows a small bit of a hypha about 8 μ broad with clamp connections. All the above-mentioned three spores have been found in Warkalli lignites. The meagre data at our disposal and the absence of any kind of definite fructifications make it difficult as well as inadvisable to attempt any further comparison of these spores with living genera.

The occurrence of the Microthyriaceae in the various Tertiary deposits of India so far studied has already been noted (RAO, 1954 and 1955). This confirms the widespread occurrence of this group of fungi during the Eocene periods in India and incidentally suggests that similar climatic conditions probably prevailed in these widely separated regions.

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EXPLANATION OF PLATE I

1. *Microthyriacites sahnii* sp. nov. × 160.
2. Part of the above magnified to show the aperture-like areas in the cells seen as white hazy areas in the cells of the photograph. × 480.
3. Another specimen probably belonging to the same species showing the central area more than one cell thick and the peripheral one cell thin area. Some of the peripheral cells like those on the right are very small. × 250.
4. *Microthyriacites edwardsi* sp. nov. Central cells hexagonal peripheral cells elongated and divided. × 680.
5. Unicellular stigmatocyst. × 680.
6. A stigmatocyst which has divided into two cells. × 680.
7. *Microthyriacites cooksoni* sp. nov. Shield-shaped thyrtothecium with central part of thick-walled isodiametric cells and peripheral thinner part of thin-walled radially disposed cells. × 250.
8. Oval thyrtothecium of the same species. × 250.
9. A very young thyrtothecium of the same species. × 250.
10. A thyrtothecium seen on the lower epidermal surface of an unidentified leaf. × 380.
11. A four-celled phragmospore. × 680.
12. Another coiled phragmospore. × 680.
13. A closely coiled septate conidiospore with a large number of chambers. × 680.
14. A multicellular phragmospore? × 680.
15. Part of mycelium showing clamp-like connections. × 680.

