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Short Communication

Acanthophysis-like structures from wood submerged in freshwater streams in the tropics

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Acanthophysis-like structures which commonly occur on submerged wood in the tropics are described and illustrated at the light microscope level. These are produced on fibre-like or rope-like strands and produce numerous detachable spinulose cells at their ends. These cells lack contents, do not germinate, and do not appear to be dispersal propagules. The acanthophysis-like structures may function as rhizomorphs enabling the fungus to colonize adjacent woody tissue, or serve to uptake oxygen from the water and these possibilities are discussed.

Key Words——aquatic fungi; Basidiomycota; lignicolous fungi; Polyporales; tropical fungi.

During our investigation of tropical freshwater microfungi, we have frequently encountered a distinctive synnematous-like taxon on submerged woody material (Hyde and Goh, 1998; Hyde et al., 1998). This fungus produces hyaline, spinulose, cylindrical to clavate, thallic cells aggregated on fibre-like or rope-like strands. We were tempted to describe this species as a new synnematous hyphomycete, but repeated attempts to isolate this taxon from the spinulose 'propagules' have failed. We have therefore come to the conclusion that these cells are not dispersal propagules and have therefore investigated other explanations as to the nature and role of these structures.

Despite its common occurrence in most tropical freshwater habitats, this fungus has not previously been described. The inclusion of this species in *Spinulospora* Deighton (Deighton, 1973) or *Fusticeps* Webster & Davey (Webster and Davey, 1980), both of which produce rough-walled mitosporic propagules, has been carefully considered. Neither of these genera can satisfactorily accommodate it. Our fungus superficially resembles *Spinulospora* Deighton (1973), a monotypic genus, because in *S. puccinilphila* Deighton clavate-cylindric, non-dematiaceous, non-detachable, continuous, coarsely and densely spinulose, thallic conidia are produced on micronematous conidiophores. These fungi, however, differ in their unique habitats, arrangement of hyphae in their 'synnemata,' and the shape and size of their conidia/cells, and the way in which the conidia/cells are produced. Our fungus is also comparable with *Fusticeps*, an aero-aquatic genus (Fisher, 1977), which develops spinulose or verrucose air-trapping buoyant propagules. The conidia of *Fusticeps*, however, are holoblastic, clavate, septate, dematiaceous, and produced on distinct conidiophores.

Similar spinulose cells have been reported for basidiomycetes growing on terrestrial wood. Heavily encrusted cystidia which are similar in appearance to the spinulose cells in our fungus are produced in the basidial layer within the pores tubes of *Polyporus zonalis* Berk. in the Asian tropics (Bose, 1938). Bose (1938) also observed the production of these heavily encrusted cystidia in culture. Similar structures are also found in the basidiocarps of *Rigidoporus lineatus* (Pers.) Ryv. (Gilbertson and Ryvarden, 1987). It may be that our fungus is a polypore that has become adapted to decaying wood submerged in freshwater. Similar spinulose non-propagative structures similar to basidiomycete cystidia are also produced in apothecial ascomycetes, e.g., the "finely granulate hairs" surrounding the apothecium of *Lachnum spartinae* Cantrell (Cantrell et al., 1996). Our fungus may therefore also be an incompletely developed discomycete.

Acanthophyses produced by *Botryonipha alba* Preuss also resemble the spinulose cells produced by our fungus. In the illustration provided by Hughes (1969) the structures appear to be identical. However, *Botryonipha* Preuss was considered a synonym of *Stilbella* Lindau, which was conserved over *Botryonipha* (Seifert, 1985). Hughes (1969) has also shown that *B. alba* is based on acanthophyses of a hymenomycete, and therefore this species cannot be a species of *Stilbella.*

Botryonipha could therefore be used as a genus in which we could accommodate our fungus. However, based on such scant information we feel that if would be unwise to formally describe our species from freshwater based on the acanthophysis-like structures and therefore will only describe and illustrate it.

Materials and Methods

Submerged wood was collected in the field at various locations and returned to the laboratory where it was incubated on moist tissue paper in plastic boxes at room temperature. The acanthophysis-like structures were usually apparent before incubation, but were also present following long periods of incubation.

Results

Colonies on wood were sparse but conspicuous, visible with the unaided eye, fruticose, composed of radiating, branched, fibre-like or rope-like strands, up to 15× 10 mm in diam, white to straw-coloured when young, becoming pale brown when mature. Mycelia were composed of septate hyphae, which were partly immersed in the substratum and partly superficial and lacked clamp connections. Synnema-like structures formed on the stromata which were superficial, filamentous, fibre-like or rhizoid to fruticose, stout, but elastic, flexuous, hyaline or cream-colored to brown, individual strands being up to 15 mm long, 21–100 μm in diam, smooth, simple or occasionally branched at ca 20–30° angle, tapered or slightly swollen at the apices and bearing a white tuft of spinulose cells (Figs. 1, 2), composed of septate, subhyaline to pale yellowish, parallel and occasionally branched hyphae. Individual cells in the stroma were more or less rectangular, 15–50 × 4–6 μm, and thick-walled (Figs. 3, 4, 12). Spinulose cells were thallic, acrogenous, solitary, dry, seceding schizolytically, cylindrical or cylindric-clavate, broadly rounded at the apex, truncate at the base, 30–70 × 5–9 μm, straight or rarely slightly curved, hyaline, devoid of noticeable contents, thick-walled and covered with dense and coarse spines, except at the basal portion. Spines were mostly 1–2 μm long (Figs. 6–11, 13–15).

Habitat: on submerged decaying wood in tropical freshwater streams.

Known distribution: Australia, Brunei, Mauritius, South Africa.

Specimens examined: Australia, Queensland, Cow Bay, Cape Tribulation, on submerged wood, April 1995, T. M. and K. D. Hyde, CB5 (HKU(M) 2230); ibid., (HKU(M) 2263); ibid., BRIP 23241. Brunei Darussalam, Temburong, Sungai Belalong, on submerged wood, March 1995, K. D. Hyde, B147 (HKU(M) 1947). Mauritius, Tamarin, Black River, on submerged wood, Aug. 1995, K. D. Hyde and A Poonyth, MAUR 28 (HKU(M) 2396). South Africa, Durban, Palmiet River, on submerged wood, Nov. 1994, K. D. Hyde and T. Steinke, SAPR 31 (HKU(M) 2177).

Discussion

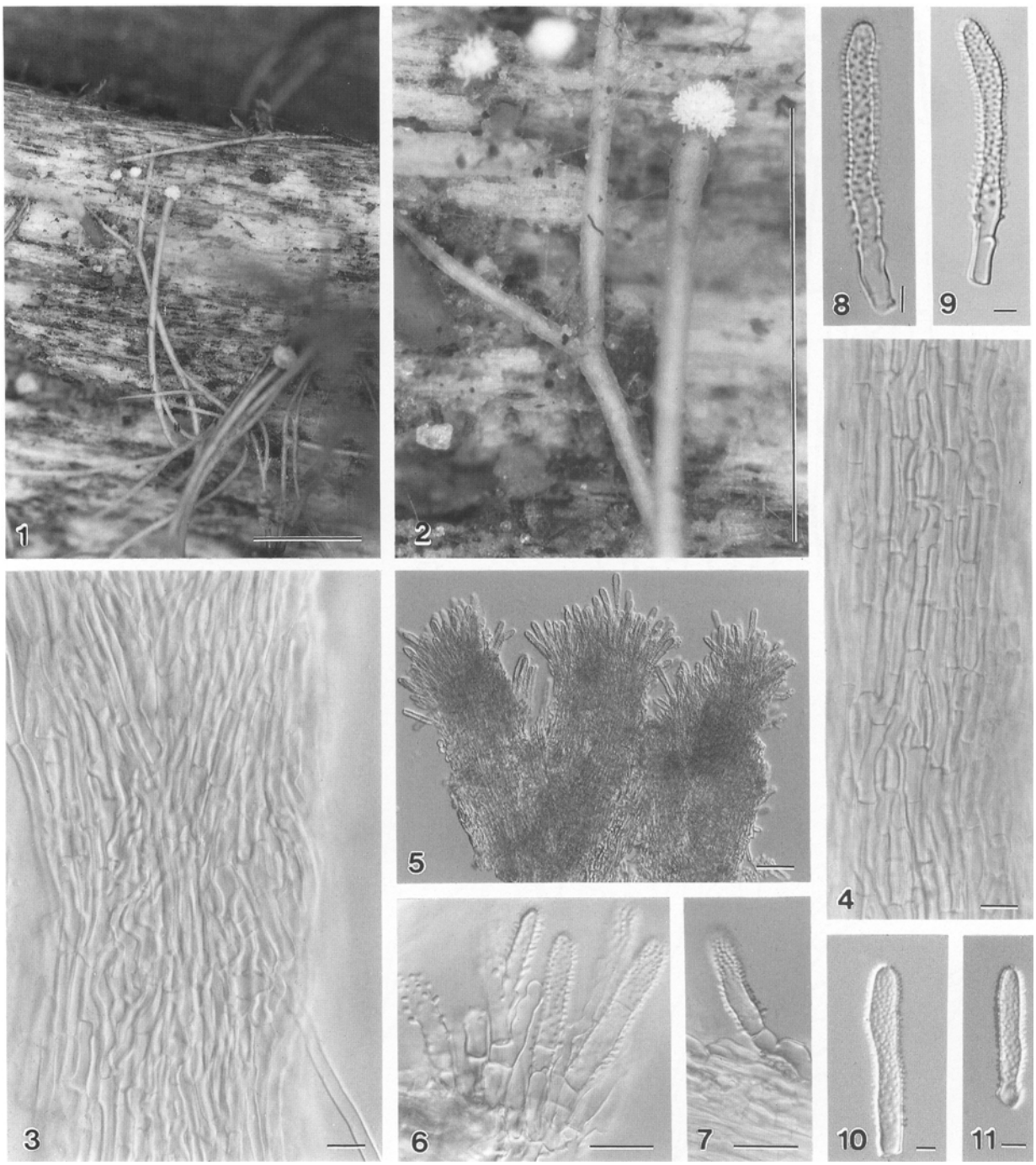
We cannot formally describe this species as the acanthophysis-like structures may be an immature basidiomycete fruiting body, possibly in the Corticiaceae, or a discomycete. However, despite lengthy incubation of up to 1 yr these structures do not develop any further. If it is a basidiomycete or discomycete we see little value in formally describing the taxon as we have little information on the species. We have also considered that this may be a synnematous hyphomycete. However, this is not the case as the spinulose cells appear to be devoid of cytoplasmic contents. We have attempted to isolate this fungus on at least 20 occasions from both spinulose cells and cords, but neither were successful. We must therefore conclude that the spinulose cells are not conidia or dispersal propagules, and must play some other role.

What are the possible roles of the fibre-like or rope-like strands? They may act like rhizomorphs found in aerial basidiomycetes, which grow between adjacent leaves and hold them together in the canopy so the fungus can utilise the leaf nutrients (Hedger et al., 1993). A similar situation may occur in adjacent wood in the river bed, where the synnema-like structures connect adjacent wood pieces. The fibre-like or root-like strands may act as sticky devices that function to adhere adjacent woody structures, while the hyphae penetrate and colonise these samples. However, there is no evidence of this. Adjacent wood samples incubated in plastic boxes are not connected by these fibre-like or root-like strands, even following long periods of incubation.

Basidiomycetes rarely occur in freshwater habitats (Hyde and Goh, 1996) and methods of wood decay and lack of oxygen may be limiting factors. The spinulose cells may function to take up oxygen from the surrounding water which can then be transported through the fungal mycelium. The bunches of spinulose cells are able to trap air when mounted in water on a microscope slide and the fact that appear to be devoid of contents, reinforce this idea.

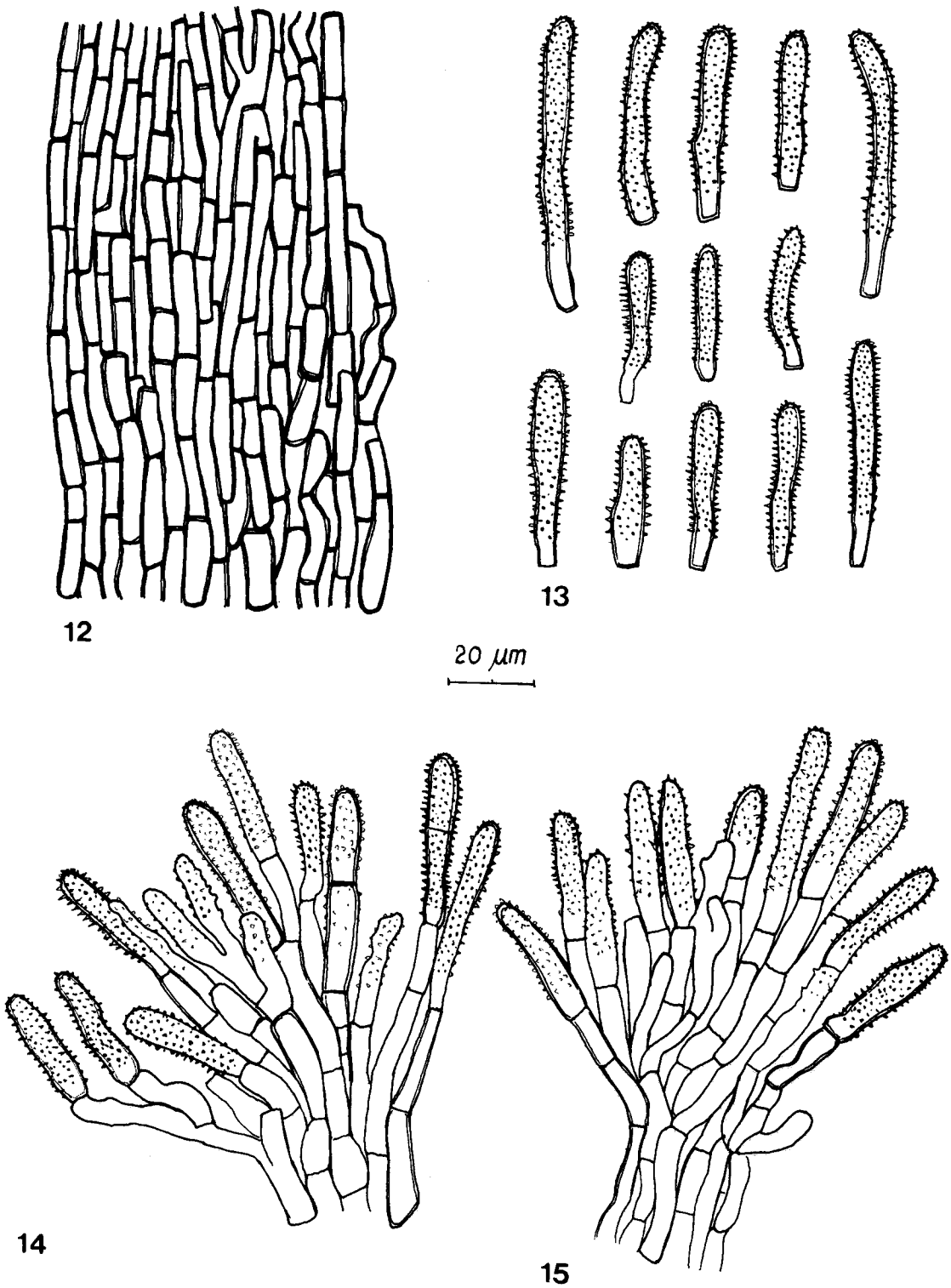
We can only speculate upon the function of the fibre-like or rope-like strands and the spinulose cells. This fungus, is however, very common on wood in freshwater ecosystems and obviously plays an important role in the degradation of submerged woody tissues (Palmer et al., 1997). We therefore feel that it is important that this fungus is described and illustrated so that it can be discussed and compared by other workers in the field of aquatic mycology. We propose to call the fungus Acanthophysis-like Basidiomycete until the species can be formally identified.

In the process of writing this paper it came to our attention that similar structures had grown from disks cut from submerged mangrove leaves, plated onto oomycete-selective agar and incubated at 25°C in light /dark conditions for about 2 wk (S. Y. Newell, personal communication). The samples containing these acanthophysis-like structures were from the same Bahamian stations as cited by Newell and Fell (1997). Their dimensions were similar to those described in this paper, they were light to dark brown and they were almost certainly similar to the structures described in this paper. The acanthophysis-like structures grew in and out of the leaf disks, but not in the agar. Newell (personal communication) has commonly observed higher fungi growing and sporulating on leaf samples plated onto oomycete-selective agar which contains the fungal inhibi-



Figs. 1–11. Acanthophysis-like structures.

1. Colony on submerged wood (fresh material). Note the fibre-like or root-like strands which may be branched and bear tufts of spinulose cells at the slightly swollen apices. 2. Higher magnification of Fig. 1 to show the branched fibre-like or root like strands, slightly swollen apex and the white tuft of spinulose cells. 3, 4. Hyphal system that makes up the fibre-like or root-like strands. 5. Squash mount (lactophenol) of the apical region of fibre-like or root-like strands showing synnema-like structures producing spinulose cells. 6, 7. Close-up of hyphae with developing spinulose cells. 8–11. Detached spinulose cells. Scale bars: 1, 2 = 1 mm; 3, 4 = 10 μm; 5 = 20 μm; 6, 7 = 10 μm; 8–11 = 5 μm.



Figs. 12–15. Acanthophysis-like structures, diagramatic representation.
12. Hyphal system that makes up the fiber-like stromata. 13. Detached spinulose cells. 14, 15. Part of the terminal portions of the stroma bearing spinulose cells. Scale bar: 12–15 = 20 µm.

tors amphotericin and thiabendazole, and this appeared to be the case here.

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