

## THE THELEPHORACEAE OF INDIA—III\*

### The Genus *Tubulicrinis* and *Hyphoderma* in India

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THIS paper gives an illustrated account of seven species belonging to the genera *Tubulicrinis* Donk and *Hyphoderma* Wallr. emend. Donk, collected from the various localities in the North-Western Himalayas. Out of these, six are new records for India. The material of these collections has been deposited in the Herbarium of the Botany Department, Panjab University, Chandigarh, India, and National Fungus Collections, Beltsville, Maryland, U.S.A.

#### *Tubulicrinis*

It is a natural genus proposed by Donk (1956) and includes most of the species of *Peniophora* sect. *Tubuliferae* Bourd. and Galz. Weresub (1961) has made a detailed study of the section. The genus is recognised by its thick-walled and rooted cystidia, the wall being soluble in 10% KOH. Donk (1956) has introduced the term lyocystidia for such cystidia. The diagnosis of the genus as given by Donk (1956) follows:

“Fruit-bodies wholly resupinate, usually closely adnate, often (very) thin and pruinose to closed, often somewhat waxy patches with indeterminate margin, rarely thin cottony-membranous or starting as somewhat fleshy patches and separable in fragments, often white or whitish, the surface (under the handlens) hispid to tomentose. Trama with basal layer consisting of narrow, thin-walled hyphae which usually soon become agglutinated and indistinct, pervaded by firmer and more distinct hyphae from which the cystidia arise; and a layer of ascending, collapsing, often indistinct hyphae giving rise to the hymenium; in a few species tramal hyphae distinct, the basal ones more or less thick-walled. Cystidia (lyocystidia) arising from the

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\* This is a continuous series dealing with the taxonomic study of Indian Thelephoraceae started by the senior author. The title “the Thelephoraceae of the Mussoorie Hills” has been replaced by “Thelephoraceae of India,” since the study is being extended to the other regions in India.

distinct basal hyphae (many with 2 more roots), often far-protruding, slender, cylindrical to slightly conical, very thick-walled (lumen capillary) but becoming more or less abruptly thin-walled towards the pointed to capitate swollen, thin-walled apex, breakable, with smooth surface, not encrusted except often at thin-walled (apical) portion with loosely attached crystals or sheathing caps, colourless; wall not stainable by eosin, often more or less amyloid, dissolving in 10% potassium hydroxide. Basidia clavate, undivided; sterigmata 2–4. Spores globular to curved-cylindric, even in outline, small to medium-sized, colourless; wall smooth, non-amyloid; not exhibiting repetition.”

Epixyloous, usually on very rotten wood.

*Type species.*—*Tubulicrinis glebulosa* (Bres.) Donk.

*Distribution.*—World-wide.

#### KEY TO SPECIES

- Sporophores 1,000  $\mu$  or more thick, cystidial base not broadened and not rooted .. 1. *T. karstenii*
- Sporophores thin (*less than 200  $\mu$* ), cystidial base broadened or rooted
- Cystidia with an attenuated and pointed apex
- Lumen capillary and not expanding at the top.. 2. *T. chaetophora*
- Lumen capillary and expanding into an acute conical apex .. 3. *T. subulata*
- Cystidia cylindrical, apex obtuse, lumen capillary expanding abruptly into a cylindrical bulb .. 4. *T. gracillima\**

#### 1. *Tubulicrinis karstenii* (Bres.) Donk. *Fungus*, 1956, 26, 14.

*Sporophores* annual, resupinate, membranous, somewhat fleshy and thick, adnate, often arising as small pinhead colonies which later become widely effused often covering large areas up to 50 × 30 cm., up to 1.5 mm. thick in section; hymenial surface pale yellow to yellowish-brown, smooth, thicker specimens crack deeply and irregularly on drying; margin abrupt, thick, concolorous, adnate, young colonies have thick but finely fibrillose margin. *Context* subhyaline in section, composed of intertwined thick-walled

\* Recorded as *Peniophora gracillima* Ell. and Everh. by Rehill and Bakshi (1965) from Dehra Dun (India). This species has not been encountered during the course of the present studies.

hyphae; hyphal system monomitic, hyphae in the context are  $1.5-4.5\ \mu$  wide, hyaline, branched, thick-walled, wall up to  $1.2\ \mu$  thick, rarely septate, rarely clamped; subhymenial hyphae  $1.5-2.5\ \mu$  wide, hyaline, thin-walled, septate, clamped, clamps common. *Cystidia*  $100-350 \times 5-8\ \mu$ , cylindrical, hyaline, with tapering base, thick-walled with capillary lumen, lumen widens towards the apex, cystidial wall soluble in 10% KOH, incrustated, incrustations in patches all along the length of the cystidia, immersed or projecting up to  $35\ \mu$  out of the hymenium. *Basidia* up to  $40\ \mu$  long and  $2.5-3\ \mu$  broad, hyaline, clavate, slightly projecting out of the hymenium, 4-spored, sterigmata up to  $3\ \mu$  long. *Basidiospores*  $4.5-6 \times 1.2-1.8\ \mu$ , cylindrical to narrowly ellipsoid, hyaline, smooth, non-amyloid, aguttate or with one or two small guttules, minutely apiculate (Plate XIII, Fig. 1; Text-Fig. 1).

*Substratum*.—On stumps and fallen logs of conifers.

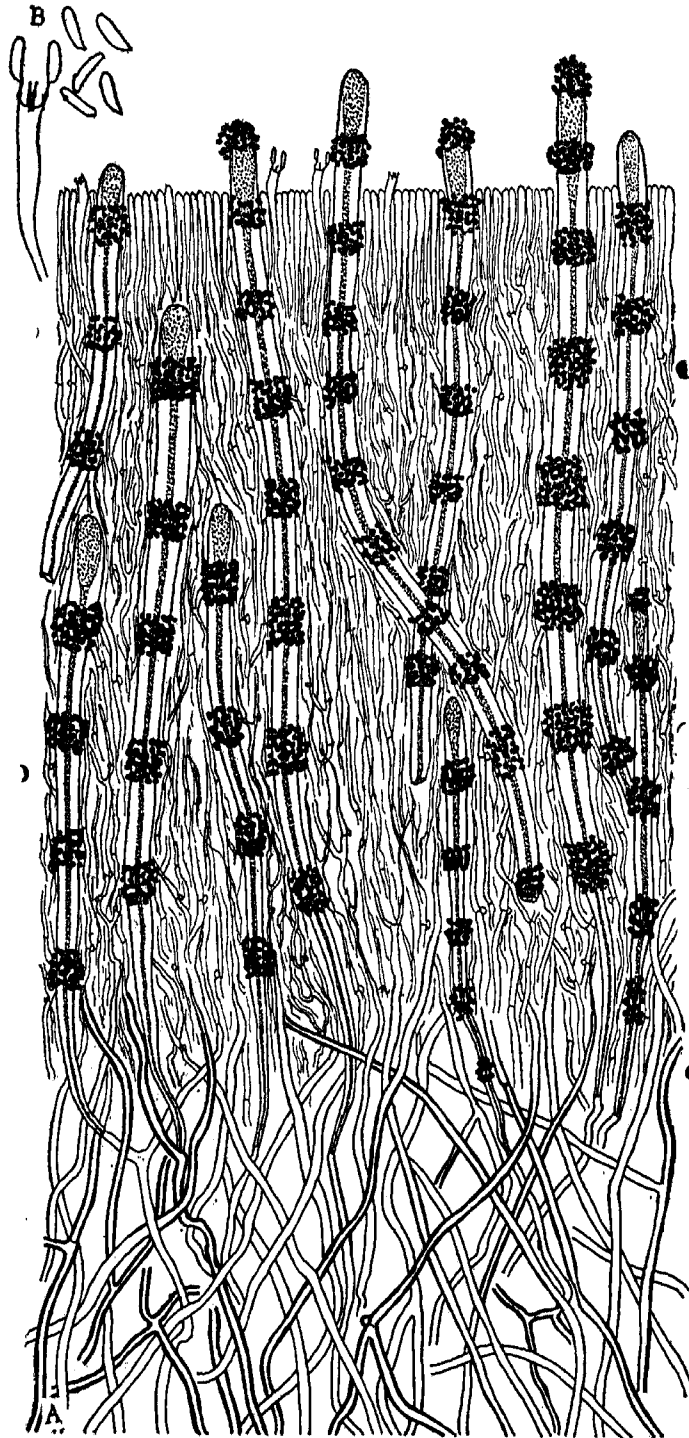
*Collections examined*.—On a log, Khanag, Kulu, H.P., September 14, 1965, 5034; on a log, Jalori, Kulu, H.P., September 19, 1965, 5044; on a stump of *Cedrus deodara*, Kalatope, Dalhousie, H.P., July 30, 1966, 5120; on a log, Lakkarmandi, Dalhousie, H.P., August 4, 1966, 5131; on a stump, Kilor Gâla, Chamba, H.P., August 30, 1966, 5191; on a stump of *Cedrus deodara*, Patnitop, J. & K., August 8, 1967, 5223, 5228; on *Cedrus deodara*, Sanasar, J. & K., August 10, 1967, 5235; on *Abies*, Sangri, Bhadarwah, J. & K., August 17, 1967, 5248; on *Abies*, Basti, Bhadarwah, J. & K., August 18, 1967, 5253; on *Cedrus deodara*, Seoj, Bhadarwah, J. & K., August 20, 1967, 5258; on *Pinus excelsa* and *Abies*, Bisaran, Pahelgam, J. & K., August 31, 1967, 5267; under a mixed forest, Chadwick Falls, Simla, H.P., September 25, 1967, 5304; on *Cedrus deodara*, Narkanda, Mahasu, H.P., October 5, 1967, 5337; on a log of *Abies*, Bagi, Mahasu, H.P., October 13, 1967, 5347; on a log of *Abies*, Narkanda, Mahasu, H.P., October 18, 1967, 5370.

*Distribution*.—North America, Europe, India.

This species appears to be widely distributed in the coniferous forests of North-Western Himalayas. Collections have been made from Simla, Kulu, Dalhousie, Jammu and Kashmir Hills.

This species is easily recognised by its thick fleshy fruit bodies and long cylindrical lycostidia with incrustations in patches.

There is some confusion regarding the exact position of this species. It was first described by Bresadola as *Stereum karstenii* [I.R. Acad. Agiati



TEXT-FIG. 1. *Tubulicrinis karstenii*. A. Vertical section through sporophores,  $\times 400$ , B. Basidiospores,  $\times 1,000$ ,

*Atti*, 1897, 111 (3), 108]. Later, Rogers and Jackson (1943) transferred it to *Peniophora* where this specific epithet was preoccupied by a Massee name. A later synonym *P. crassa* Burt was therefore taken and *S. karstenii* was listed as its synonym. Donk (1956) transferred it to *Tubulicrinis* where the specific epithet was not occupied and so the species got its original name. Eriksson (1958) and Weresub (1961), however, showed that this species does not have the typical cystidia of the genus *Tubulicrinis* and pointed out some other differences also. Eriksson provisionally kept it under *Peniophora* and accepted the name *P. crassa* for it.

2. *Tubulicrinis chaetophora* (Hoehn.) Donk, *Fungus*, 1956, 26, 14.

*Sporophores* annual, resupinate, densely pruinose to pilose, separable, widely effused often following the contours of the substratum, usually thin and delicate, 45–100  $\mu$  thick in section but sometimes may be as much as 300  $\mu$  thick; hymenial surface densely pilose due to the cystidia, white to cream when fresh, becoming ochraceous on drying, smooth but thicker specimens become rough and cracked also; margin thinning out, separable and concolorous. *Context* indistinct; hyphae (1.5) 2–3.5  $\mu$  wide, hyaline, branched, septate, clamped, with firm walls, collapsing and often clustering around the cystidia. *Cystidia* 45–180  $\times$  6–12  $\mu$ , hyaline, conical with a broad rooting base, tapering uniformly to a pointed apex, thick-walled with capillary lumen not expanded at the top, wall smooth, non-amyloid to strongly amyloid, soluble in 10% KOH. *Basidia* 12–20  $\times$  4–5  $\mu$ , clavato-cylindrical, hyaline, 4-spored, sterigmata up to 4.5  $\mu$  long. *Basidiospores* 5–7 (–8)  $\times$  3–3.5  $\mu$ , ellipsoid, hyaline, smooth, non-amyloid, shortly apiculate. (Plate XIII, Fig. 3; Text-Fig. 2).

*Substratum*.—On rotten wood of conifers.

*Collections examined*.—On *Cedrus deodara*, Khajjiar, Dalhousie, H.P., August 4, 1966, 5137; under *Cedrus deodara* and *Abies*, Kalatope, Dalhousie, H.P., August 12, 1966, 5152; under *Cedrus deodara* and *Pinus excelsa* Sanasar, J. & K., August 10, 1967, 5232.

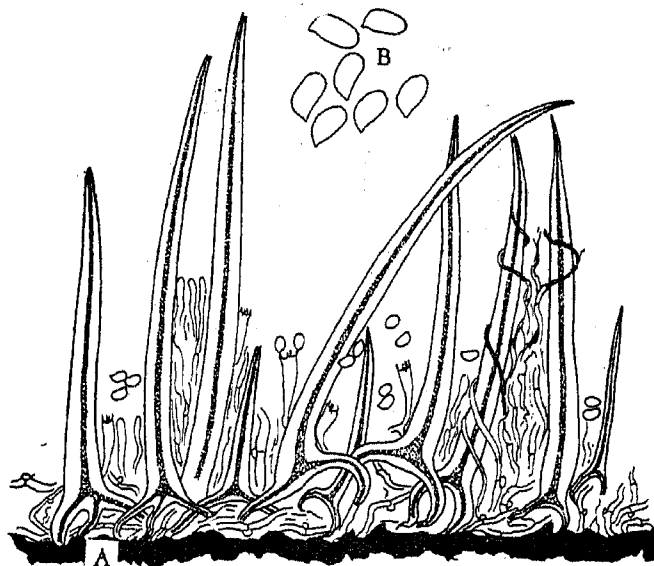
*Distribution*.—North America, Europe, India.

This species is marked by its conical cystidia with a pointed apex and capillary lumen. The lumen remains uniform and does not expand at the top.

3. *Tubulicrinis subulata* (Bourd. & Galz.) Donk, *Fungus*, 1956, 26, 14.

*Sporophores* annual, resupinate, membranous, adnate but easily separable when fresh, widely effused, up to 150  $\mu$  thick in section; hymenial surface

deep cream to pale ochre, pilose due to the projecting cystidia, even when young but becomes irregularly and areolately cracked exposing the substratum; margin indeterminate, concolorous. *Context* subhyaline in sec-



TEXT-FIG. 2. *Tubulicrinis chaetophora*. A. Vertical section through sporophores,  $\times 500$ . B. Basidiospores,  $\times 1,250$ .

tion, hyphae often collapsing and indistinct,  $2-3\ \mu$  wide, hyaline, branched, septate, thin-walled, clamped. *Cystidia*  $55-100 \times 6.5-14\ \mu$ , conical, subhyaline, thick-walled, lumen capillary but widens towards the top forming an acute conical apex ( $15-20\ \mu$  long and  $4-4.5\ \mu$  broad at the base), cystidia rooted, often arising from the base in young sporophores but from different parts of the context in thicker ones, immersed or projecting to  $50\ \mu$  out of the hymenium, usually somewhat incrustated especially near the apex, wall amyloid and soluble in 10% KOH. *Basidia*  $17-20 \times 3.5-4.3\ \mu$ , clavate, hyaline, 4-spored, sterigmata up to  $4\ \mu$  long. *Basidiospores*  $5-7 \times 1.5-2\ \mu$ , hyaline, cylindrical or narrowly ellipsoid, thin-walled, smooth, non-amyloid, minutely apiculate (Plate XIII, Fig. 2; Text-Fig. 3).

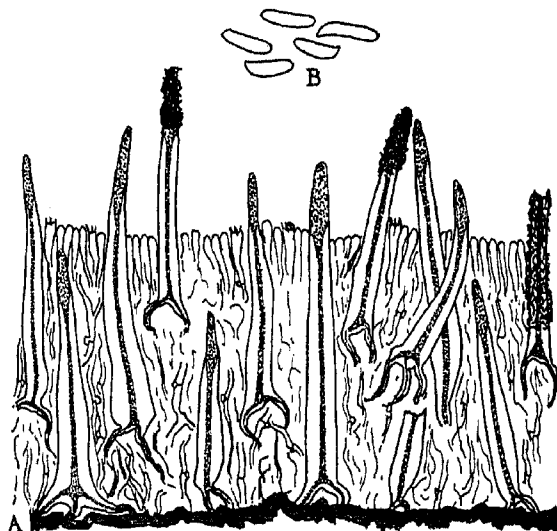
*Substratum*.—On coniferous wood.

*Collection examined*.—On a log, Bisaran, Pahelgam, J. & K, August 21, 1967, 5269.

*Distribution*.—North America, Europe, India.

This fungus can be identified by its thick-walled, broad-based, rooted cystidia with capillary lumen which widens at the top forming an acute

conical apex, indistinct context and narrowly ellipsoid to cylindrical basidiospores.



TEXT-FIG. 3. *Tubulicrinis subulata*. A. Vertical section through sporophores,  $\times 500$ . B. Basidiospores,  $\times 1,250$ .

### *Hyphoderma*

As emended by Donk it is a natural and large genus with 24 new combinations proposed initially. It includes *Gloeocystidium* sect. *ceracea* Bourd. & Galz., *Peniophora* sect. *gloeocystidiales* Bourd. & Galz. and related species in other genera. It shows some resemblance with *Tylospora* Donk, *Hyphodontia* Eriksson and *Hypochnicium* Eriksson with some characters intergrading between them. Unless a detailed study of *Hyphoderma* and related genera is made it is not possible to clearly define this genus. According to Donk (1957), the average species of *Hyphoderma* may be characterised as follows:

“The hyphae in the tramal layer are mostly interwoven, distinct, thin- to firm-walled and not readily collapsing, with conspicuous clamp-connections; the spores are usually cylindrical to oblong and flattened to somewhat depressed on one side (tending to be sausage-shaped), medium-sized to rather long (on an average usually about 6–16  $\mu$  long), thin-walled, smooth, colourless and non-amyloid. Gloeocystidia or firm-walled (but not very thick-walled, heavily incrusted) cystidia which may occur both and then usually with intermediate states are present except in a few species. Fruit body strictly resupinate; hymenium rather compact, somewhat fleshy

when fresh rather than waxy, usually smooth, or toothed or raduloid in a few species."

*Type species.*—*Hyphoderma spiculosum* Wallr.

*Distribution.*—World-wide.

## KEY TO SPECIES

- Sporophores waxy to subwaxy, gloeocystidia present .. 1. *H. pubera*  
 Sporophores not waxy, gloeocystidia absent.
- Cystidia subulate, thin-walled, non-septate and un-  
 incrustated .. .. . 2. *H. argillaceum*
- Cystidia cylindrical, thin-walled, transversely septate,  
 unincrusted to incrusted.
- Basidiospores more than  $8\mu$  long, sporophores  
 usually odontoid, texture subpelliculose to  
 membranous .. .. . 3. *H. setigerum*
- Basidiospores less than  $8\mu$  long, texture floccose 4. *H. polonense*

1. *Hyphoderma pubera* (Fr.) Wallr., *Fl. Krypt. Germ.*, 1833, 2, 576.

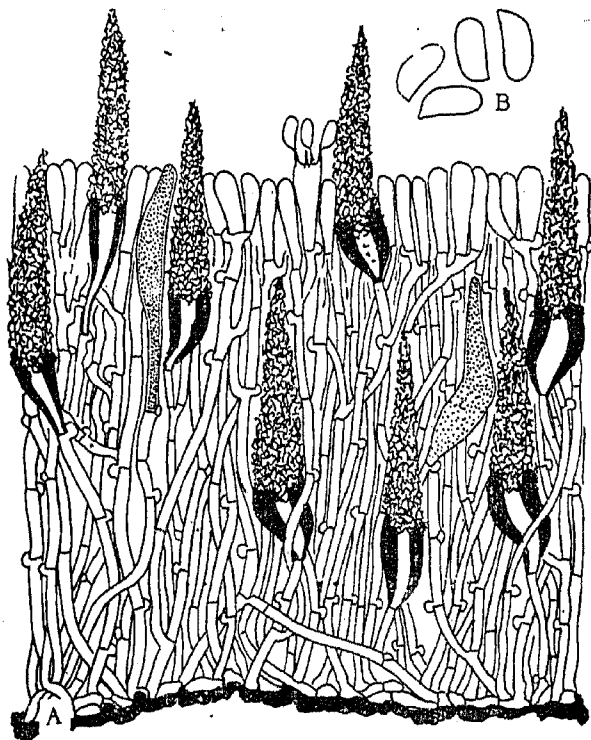
*Sporophores* annual, resupinate, subwaxy to waxy, adnate, widely effused, up to  $200\mu$  thick in section; hymenial surface white to cream, even, farinose to somewhat hairy due to the projecting cystidia; margin thinning out, adnate, white to paler concolorous. *Context* subhyaline in section, composed of a basal layer of few repent hyphae and an intermediate layer of vertically arranged hyphae, sometimes the basal layer wanting; hyphal system monomitic, hyphae  $2-5\mu$  wide, hyaline, branched, thin-walled, nodose-septate. *Basidia*  $25-30 \times 6-7.5\mu$ , hyaline, clavate, 4-spored, stigmata up to  $4.5\mu$  long. *Gloeocystidia* scanty,  $65-80 \times 7-10\mu$ , hyaline, staining deeply with phloxine, cylindrical to flexuous, immersed or rarely projecting slightly, thin-walled. *Cystidia* abundant,  $50-120 \times 10-18\mu$ , subhyaline, conical to subfusiform, thick-walled, heavily incrusted, often arising from different parts of the context, immersed or projecting up to  $60\mu$  out of the hymenium. *Basidiospores*  $6-9 \times 3-4.2\mu$ , hyaline, ellipsoid, thin-walled, smooth, non-amyloid, minutely apiculate (Plate XIII, Fig. 4; Text-Fig. 4).

*Substratum.*—On rotten wood of gymnosperms and angiosperms.

*Collections examined.*—On a stump under *Cedrus deodara* and *Quercus incana* forest, Jandri Ghats springs, Dalhousie, H.P., July 25, 1966, 5110;



on a stump of *C. deodara*, Batote, J.&K., September 25, 1966, 5208; on a fallen log under a mixed forest, Gulmarg, J. & K., September 11, 1967, 5291



TEXT-FIG. 4. *Hyphoderma pubera*. A. Vertical section through sporophores,  $\times 500$ . B. Basidiospores,  $\times 1,250$ .

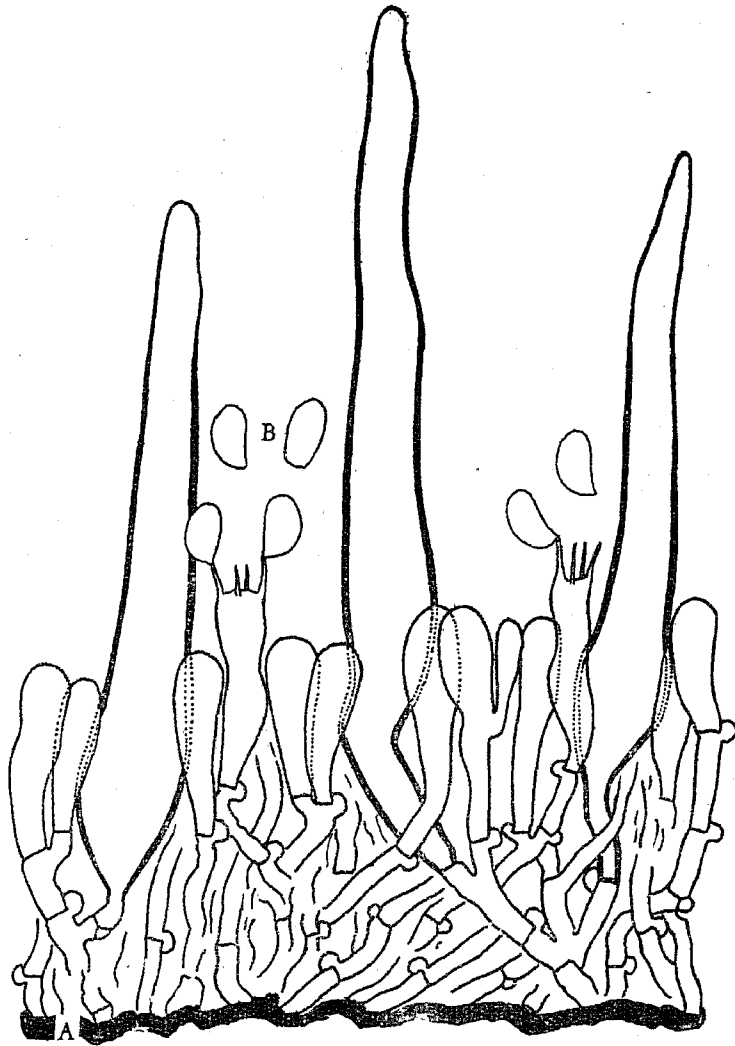
*Distribution*.—North America, Great Britain, Europe, India, Australia.

It is easily recognised by its waxy to subwaxy nature, nodose-septate hyphae, heavily incrustated conical to subfusiform cystidia and by the presence of gloecystidia. Christiansen (1960) transferred this species to *Phlebia* on the basis of its subwaxy to waxy sporophores. Donk (1962) has, however, argued that the large size of the basidiospores ( $8-11 \mu$  long against  $3.5-7 \mu$  long for most of the species of *Phlebia*) and loosely interwoven hyphae in the basal layer of the fruit body are more typical of *Hyphoderma* rather than of *Phlebia*.

2: *Hyphoderma argillaceum*, (Bres.) Donk, *Fungus*, 1957, 27, 14.

*Sporophores* annual, resupinate, floccose, adnate, widely effused often following the contours of the substratum, up to  $75 \mu$  thick in section; hymenial surface cream-coloured changing to light ochraceous on drying, discontinuous, pruinose, smooth to hairy due to the projecting out cystidia;

margin thinning out, concolorous, adnate. *Context* composed of few loosely arranged hyphae; hyphae  $3\text{--}5\ \mu$  wide, hyaline, branched, thin-walled, nodose-septate. *Basidia*  $22\text{--}25 \times 5\text{--}6\ \mu$ , hyaline, clavato-cylindrical to flexuous, 4-spored, sterigmata up to  $6\ \mu$  long. *Cystidia*  $70\text{--}110 \times 7.5\text{--}13\ \mu$ , subhyaline, subulate, slightly thick-walled, unincrusted, projecting a greater part of their length out of the hymenium. *Basidiospores*  $7.5\text{--}8.5 \times 4.2\text{--}4.6\ \mu$ , hyaline, broadly ellipsoid, thin-walled, smooth, shortly apiculate, non-amyloid (Plate XIII, Fig. 6) Text-Fig. 5).



TEXT-FIG. 5. *Hyphoderma argillaceum*. A. Vertical section through sporophores,  $\times 1,250$ . B. Basidiospores,  $\times 1,250$ .

*Substratum*.—On wood of gymnosperms.

*Collection examined*.—On a rotten stump of *Cedrus deodara*, Kalatope, Dalhousie, H.P., July 30, 1966, 5121.

*Distribution.*—North America, Europe, India.

It is characterised by its floccose context, subulate, thin-walled and non-septate cystidia.

3. *Hyphoderma setigerum* (Pr.) Donk, *Fungus*, 1957, 27, 15.

*Sporophores* annual, resupinate, subpelliculose to membranous, adnate, often arising as small colonies which fuse later and become widely effused, up to 300  $\mu$  thick in section; hymenial surface white to deep cream, smooth to somewhat odontoid due to the projecting cystidia, even when young, becoming irregularly cracked at maturity; margin thinning out, adnate, concolorous to paler concolorous. *Context* subhyaline in section, composed of a basal zone of few repent hyphae and an intermediate zone of semi-erect hyphae, mostly hyphae are loosely arranged in the lower part of the context but are more compact in the upper part and subhymenial zone; hyphal system monomitic, hyphae 2.5–5.5  $\mu$  wide, hyaline, branched, septate, clamped, thin to slightly thick-walled, wall up to 0.8  $\mu$  thick. *Basidia* 30–35  $\times$  5–5.5  $\mu$ , hyaline, clavate, 4-spored, sterigmata up to 5.5  $\mu$  long. *Cystidia* 70–180  $\times$  8.5–10  $\mu$ , hyaline, cylindrical, septate, some septa with clamps, slightly thick-walled, wall up to 1.5  $\mu$  thick, immersed or projecting up to 60  $\mu$ , apex obtuse and often incrustated with crystals. *Basidiospores* 8–10  $\times$  3–4  $\mu$ , hyaline, cylindrical, thin-walled, smooth, non-amyloid, shortly apiculate (Plate XIII, Fig. 5; Text-Fig. 6).

*Substratum.*—On wood of conifers.

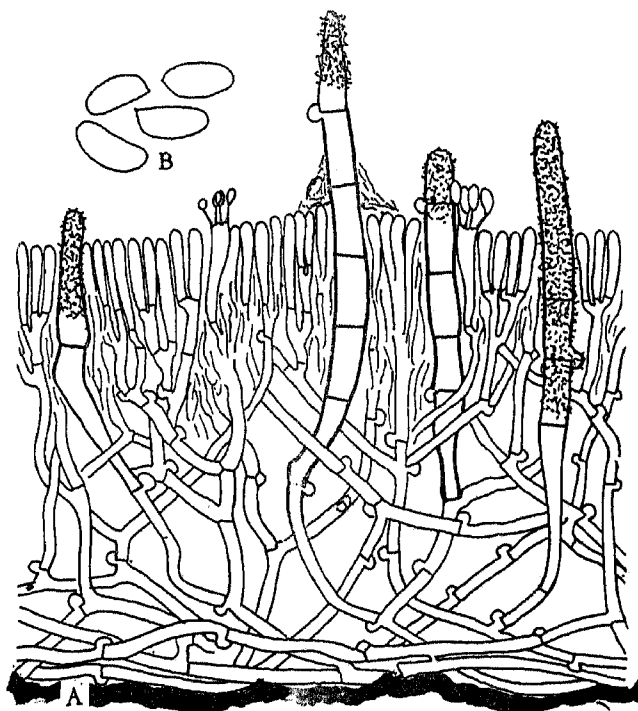
*Collection examined.*—On bark of *Cedrus deodara*, Ardu, Pehalgam, J & K., September 1, 1967, 5271.

*Distribution.*—North America, Great Britain, Europe, India, Australia and New Zealand.

It appears to be uncommon in India. Only one collection has been made from Kashmir so far. It can be easily recognised by the tranversely septate, slightly incrustated cystidia and long ellipsoid to cylindrical basidiospores. The hymenial surface shows a great deal of variation. It may be smooth to tuberculate to almost odontoid. The odontoid feature is in fact due to the spore deposit as well as the tissue growth around the bases of cystidia. Miller and Boyle (1943) and Nikoljeva (1961) have treated this species under *Odontia* (Hydnaceae) while Rogers and Jackson (1943), Slysh (1960) and Cunningham (1963) maintain that it truly belongs in *Peniophora* (Thelephoraceae). Donk (1957) transferred it to *Hyphoderma* Wallr. emend Donk which includes members both from Hydnaceae and Thelephoraceae,

4. *Hyphoderma polonense* (Bres.) Donk, *Fungus*, 1957, 27, 15.

*Sporophores* annual, resupinate, floccose, adnate, arising as small colonies which may become widely effused later, up to  $250\ \mu$  thick in section; hymenial surface white to cream, discontinuous, finely hispid due to the projecting cystidia, somewhat farinaceous; margin thinning out, adnate, paler concolorous. *Context* subhyaline in section; hyphae loosely arranged, finely incrustated especially in the subhymenial zone; hyphal system monomitic,



TEXT-FIG. 6. *Hyphoderma setigerum*. A. Vertical section through sporophores,  $\times 500$ . B. Basidiospores,  $\times 1,250$ .

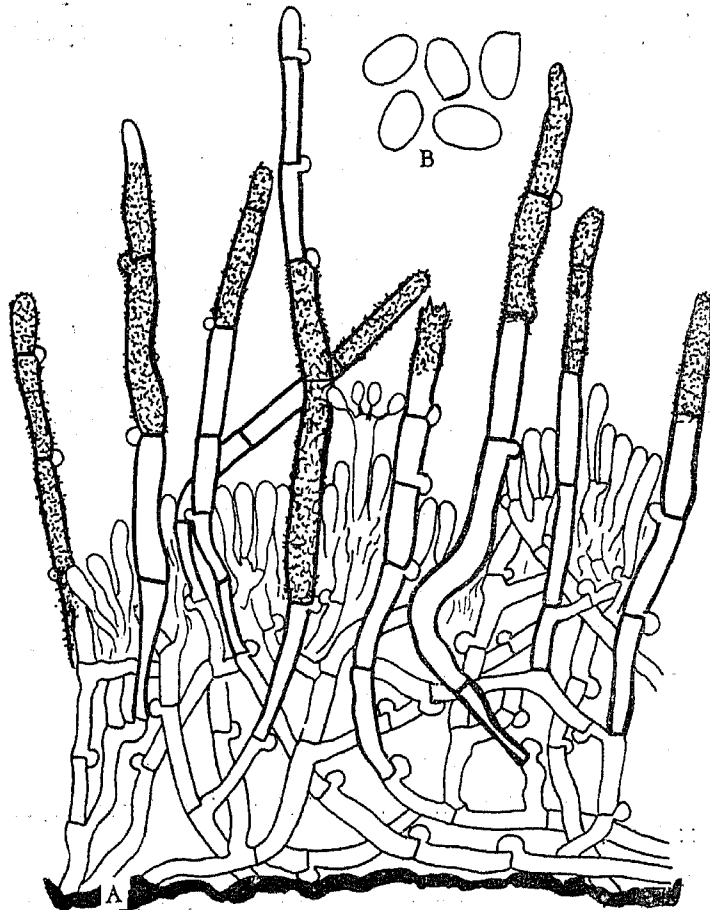
hyphae  $4-8\ \mu$  wide, hyaline, branched at wide angles, thin to slightly thick-walled, nodose-septate. *Basidia*  $25-30 \times 5-6\ \mu$ , subclavate but often flexuous, hyaline, 4-spored, sterigmata up to  $4\ \mu$  long. *Cystidia* up to  $250\ \mu$  long and  $6-11\ \mu$  broad, subhyaline, abundant, cylindrical, transversely septate, with or without clamps, often arising from the base of the sporophores, immersed or projecting to  $125\ \mu$ , slightly thick-walled, wall up to  $1.5\ \mu$  thick, finely incrustated. *Basidiospores*  $7-8 \times 4.5-5.5\ \mu$ , broadly ellipsoid, subhyaline, smooth, thin-walled, non-amyloid (Plate XIII, Fig. 7; Text-Fig. 7).

*Substratum*.—On rotten wood of conifers.

*Collections examined*.—On a stump of *Cedrus deodara*, Lakkarmandi, Dalhousie, H.P., July 21, 1966, 5101; on a fallen log under a coniferous forest, Narkanda, Mahasu, H.P., October 5, 1967, 5335.

*Distribution.*—North America, Europe, India.

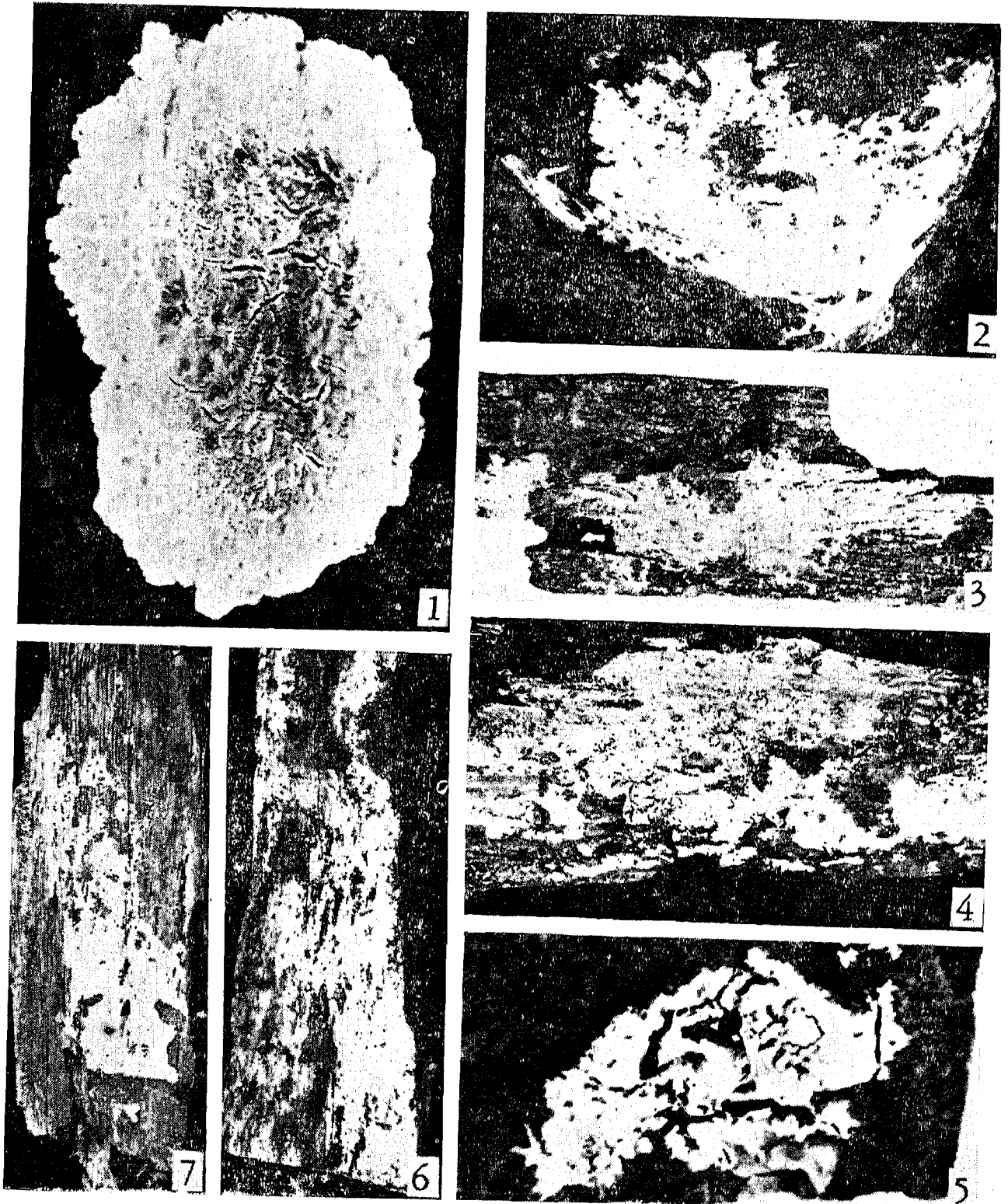
This species does not appear to be common in the North-Western Himalayas. It is characterised by its floccose texture, large and transversely septate cystidia and ellipsoid basidiospores ( $7-8 \times 4.5-5.5 \mu$ ).



TEXT-FIG. 7. *Hyphoderma polonense*. A. Vertical section through sporophores,  $\times 500$ . Basidiospores,  $\times 1,250$ .

#### ACKNOWLEDGEMENTS

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FIGS. 1-7

