

Eight new records of corticioid fungi from India

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Eight species of the corticioid fungi, i.e. *Ceraceomyces microsporus*, *Ceratobasidium cornigerum*, *Coniophora dimitica*, *Corticium lombardiae*, *Hypochnicium bombycinum*, *Phlebia coccineofulva*, *Radulomyces rickii* and *Rhizoctonia* cf. *sphaerospora* are newly reported from India. The specimens were collected in different parts of Shimla District (Himachal Pradesh). Descriptions, photographs and line drawings of the new records from India are provided.

Key words: Basidiomycota, Himalaya, wood rotting fungi, Himachal Pradesh, Shimla.

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Osm kornatcovitých hub – *Ceraceomyces microsporus*, *Ceratobasidium cornigerum*, *Coniophora dimitica*, *Corticium lombardiae*, *Hypochnicium bombycinum*, *Phlebia coccineofulva*, *Radulomyces rickii* a *Rhizoctonia* cf. *sphaerospora* – je uvedeno coby nové druhy pro Indii. Položky byly sebrány v různých částech okresu Šimla (stát Himáčalpradés). Popisy nově zjištěných druhů jsou doplněny fotografiemi a kresbami mikroskopických znaků.

INTRODUCTION

Corticioid fungi, an important group of lignin/cellulose-decaying fungi, are characteristic in having resupinate, effused to sometimes reflexed basidiocarps with a gymnocarpic, unilateral hymenium. The hymenial surface varies from smooth, tuberculate, ridged, warted and toothed to meruloid, with a colour range of white, grey or yellow to sometimes more bright shades of red, brown or blue. According to MycoBank (IMA on-line) and Species Fungorum (Kirk 2019) these fungi have been placed in 12 orders of the class Agaricomycetes (Agaricomycotina, Basidiomycota).

Some of the significant contributions on the taxonomy of corticioid fungi from Shimla District (Himachal Pradesh, India) include Thind & Khara (1968),

Thind & Rattan (1968, 1972), Rattan (1977), Dhingra & Singh (2009), Dhingra et al. (2009, 2014), Sharma (2012) and Kaur et al. (2013, 2014, 2015, 2018). Shimla District, one of the twelve districts of Himachal Pradesh, with a forest cover of 46.6%, offers varied climatic conditions because of the great variation in altitude. In accordance with Champion & Seth (1968), the vegetation of the district can be broadly classified into tropical dry deciduous forests, subtropical pine forests, subtropical dry evergreen forests, moist temperate forests, dry temperate forests, subalpine forests, moist alpine scrubs and dry alpine scrubs.

During field trips to different parts of Shimla District, the authors collected some interesting specimens of corticioid fungi. Based on macro- and micromorphological details and comparison with the literature, these were identified as eight species belonging to eight different genera. The aim of the present study is to describe and illustrate these eight species, all reported for the first time from India.

MATERIAL AND METHODS

The present account of corticioid fungi is based on specimens collected during field trips to different parts of Shimla District, Himachal Pradesh (India) during the monsoon season of the years 2011–2014. Basidiocarps of corticioid fungi were carefully separated from the substrate using a chisel and a hammer. Field observations regarding habitat, host/substrate, basidiocarp texture, colour and type of hymenial surface, margins, etc. of the collected specimens were recorded in the field. The collected specimens were cleared of any extraneous matter and were assigned a collection number. The collected specimens were dried either in the sun or using a portable electric drier. The dried specimens were packed in polythene bags, which were in turn packed in bond-paper envelopes and provided with a standard herbarium label. Crystals of 1,4-dichlorobenzene were added to the packets so as to preserve the specimens.

The micromorphological details of the basidiocarps collected were studied by making crush mounts and free hand cut sections, which were examined in water and 3%, 5% and 10% KOH solutions and stained in cotton blue (1% in lactophenol), Congo red (1% in distilled water), phloxine (1% in distilled water), sulphovanillin (0.5 mg vanillin + 4.0 ml conc. sulphuric acid + 2.0 ml distilled water) and Melzer's reagent (0.5 mg iodine + 1.5 mg KI + 20 mg chloral hydrate + 20 ml distilled water). The outlines of the microscopic structures were drawn in the form of line drawings with a camera lucida at different magnifications (100×, 400× and 1000×) of a compound microscope.

Macro- and micromorphological characters were compiled as a description, which was compared with published literature. The taxa were identified by com-

paring their descriptions with the literature (Burt 1926, Warcup & Talbot 1971, Weresub 1974, Rattan 1977, Ginns 1978, Larsson & Larsson 1998, Bernicchia & Gorjón 2010, Sharma 2012). The colour standards of Methuen's Handbook of Colours (Kornerup & Wanscher 1978) were used. Voucher specimens were deposited at the Herbarium of the Department of Botany, Punjabi University, Patiala (PUN).

RESULTS AND DISCUSSION

Ceraceomyces microsporus K.H. Larsson, Folia Cryptogamica Estonica 33: 75, 1998 Fig. 1

Description. Basidiocarps resupinate, adnate, effused, up to 200 μm thick in section; hymenial surface smooth, orange-white to pale orange to greyish orange or brownish orange when fresh, greyish red to brownish red on drying; margins thinning, pruinose, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae branched, nodose-septate, thin-walled; basal hyphae up to 2.7 μm wide, forming a very narrow zone parallel to the substrate; subhymenial hyphae up to 2.2 μm , vertical, with patches of crystals. Cystidia absent. Basidia 22–42 \times 3–5 μm , clavate, 4-sterigmate, somewhat sinuous, with basal clamp and oily contents; sterigmata up to 4 μm long. Basidiospores 2.7–3.7 \times 1.5–1.9 μm , ellipsoid to subcylindrical, smooth, thin-walled, with oily contents, IKI⁻, acyanophilous.

Remarks. *Ceraceomyces microsporus* differs from the closely related *C. eludans* K.H. Larss. by absent cystidia and narrower hyphae. Earlier, these two species were both included in *C. sublaevis* (Bres.) Jülich. Larsson & Larsson (1998) clearly showed that these two taxa are distinct both morphologically and in their DNA sequences. The present specimen differs from the previous descriptions (Larsson & Larsson 1998 and IMA online) in having crystalline encrustations occurring in the form of patches on the generative hyphae and comparatively narrower, ellipsoid to subcylindrical basidiospores. It has been reported from Switzerland, Germany, Norway, Sweden, Finland, Estonia, Belarus, Ukraine and Russia (Bernicchia & Gorjón 2010 and IMA on-line).

Collection examined: India, Himachal Pradesh, Shimla District, Tara Devi Temple, on bark of *Cedrus deodara*, 31 July 2013, Maninder 8945 (PUN) and Dhingra 8946 (PUN).

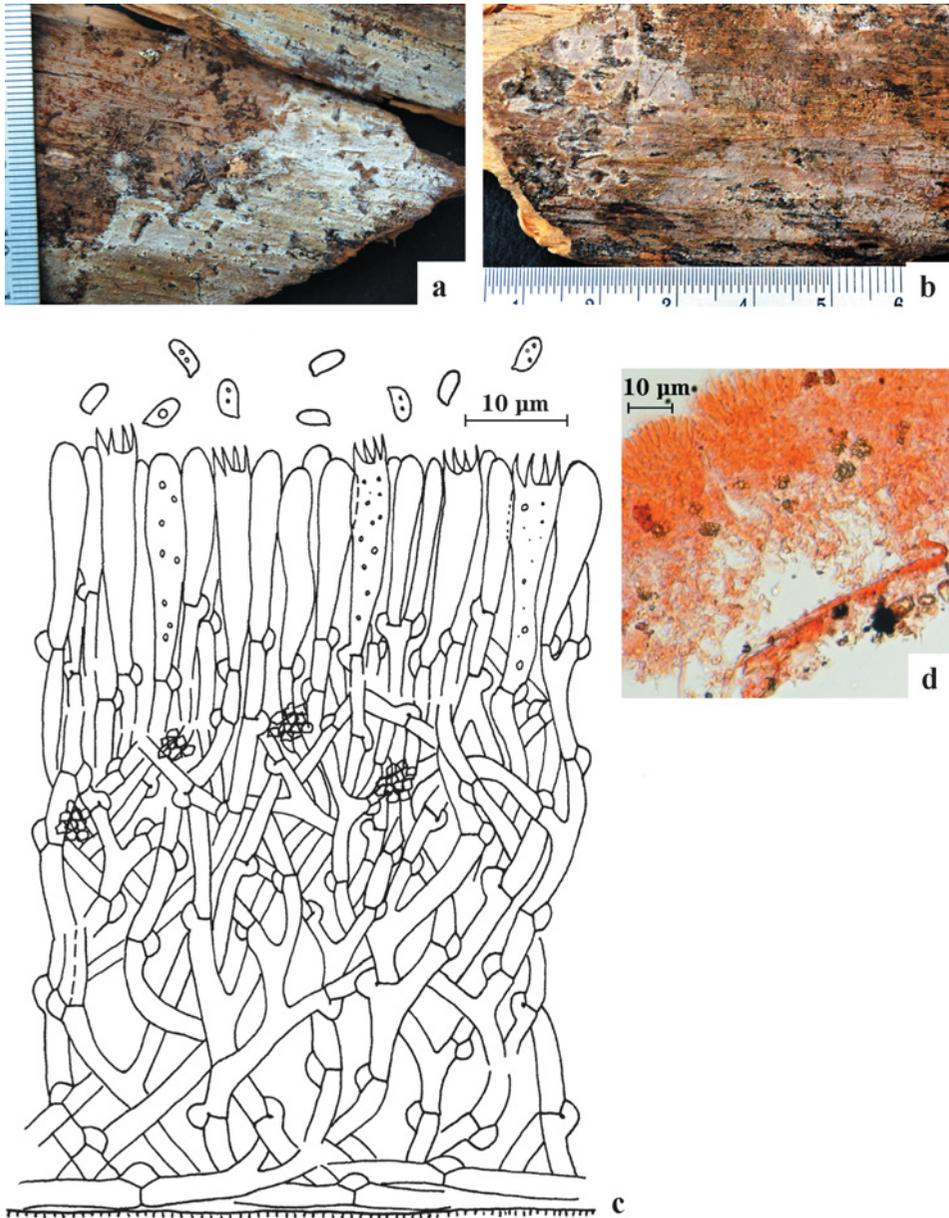


Fig. 1. *Ceraceomyces microsporus* (8945 PUN): **a** – hymenial surface (fresh); **b** – hymenial surface (dry); **c** – vertical section through basidiocarp showing hyphae, basidia and basidiospores; **d** – photomicrograph of vertical section through basidiocarp. Scale bars = 10 µm; del. & photomicrograph by Maninder Kaur (c, d). Photos by Avneet Pal Singh (a, b).

Ceratobasidium cornigerum (Bourdot) D.P. Rogers, University of Iowa Studies in Natural History 17(1): 5, 1935 Fig. 2

≡ *Corticium cornigerum* Bourdot, Revue scient. Bourbon. Cent. Fr.: 4, 1922

Description. Basidiocarp resupinate, effused, adnate, up to 100 µm thick in section; hymenial surface smooth, granular under lens, light grey when fresh, not changing much on drying; margins thinning, pruinose, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae septate, without clamps; basal hyphae up to 6.2 µm wide, parallel to the substrate, sparsely ramified at right angles, thick-walled; subhymenial hyphae up to 4.3 µm wide, vertical, more branched than basal hyphae. Cystidia absent. Basidia 8–12 × 6–7 µm, generally ovate, 4-sterigmate, without basal clamp; sterigmata up to 6.8 µm long. Basidiospores 5–9 × 3–4.3 µm, ellipsoid, repetitive, smooth, thin-walled, IK⁺, acyanophilous.

Remarks. This species is characteristic in having a smooth hymenial surface, granular under lens, ovate basidia and ellipsoid, repetitive basidiospores. It has been reported from Asia, Australia, Europe, North and South America (IMA on-line).

Collection examined: India, Himachal Pradesh, Shimla District, approx. 11 km from the town of Chaupal towards the village of Deha, on sticks of *Cedrus deodara*, 8 August 2012, Maninder 7913 (PUN).

Coniophora dimitica G. Cunningham, Transactions and Proceedings of the Royal Society of New Zealand 84: 495, 1957 Fig. 3

Description. Basidiocarp resupinate, effused, adnate, up to 250 µm thick in section; hymenial surface smooth, shiny, light brown to dark brown when fresh; violet-brown on drying; margins thinning, pruinose, pale orange to greyish orange, or indeterminate.

Hyphal system dimitic. Generative hyphae up to 2.8 µm wide, septate, without clamps, thin-walled. Skeletal hyphae up to 4.1 µm wide, abundant, brown, thick-walled, sometimes dichotomously branched. Basidia 64–99 × 6.8–8 µm, clavate to somewhat utriform, sinuous, 4-sterigmate, without basal clamp; sterigmata up to 7.7 µm long. Basidiospores 11–16 × 8–10 µm, ellipsoid to ovoid, thick-walled, smooth, yellowish brown to brown, with oily contents, cyanophilous, dextrinoid.

Remarks. *Coniophora dimitica* is distinctive, differing from the other taxa in this genus in having a dimitic hyphal system. It has earlier been reported only from New Zealand (Cunningham 1957 and IMA on-line).

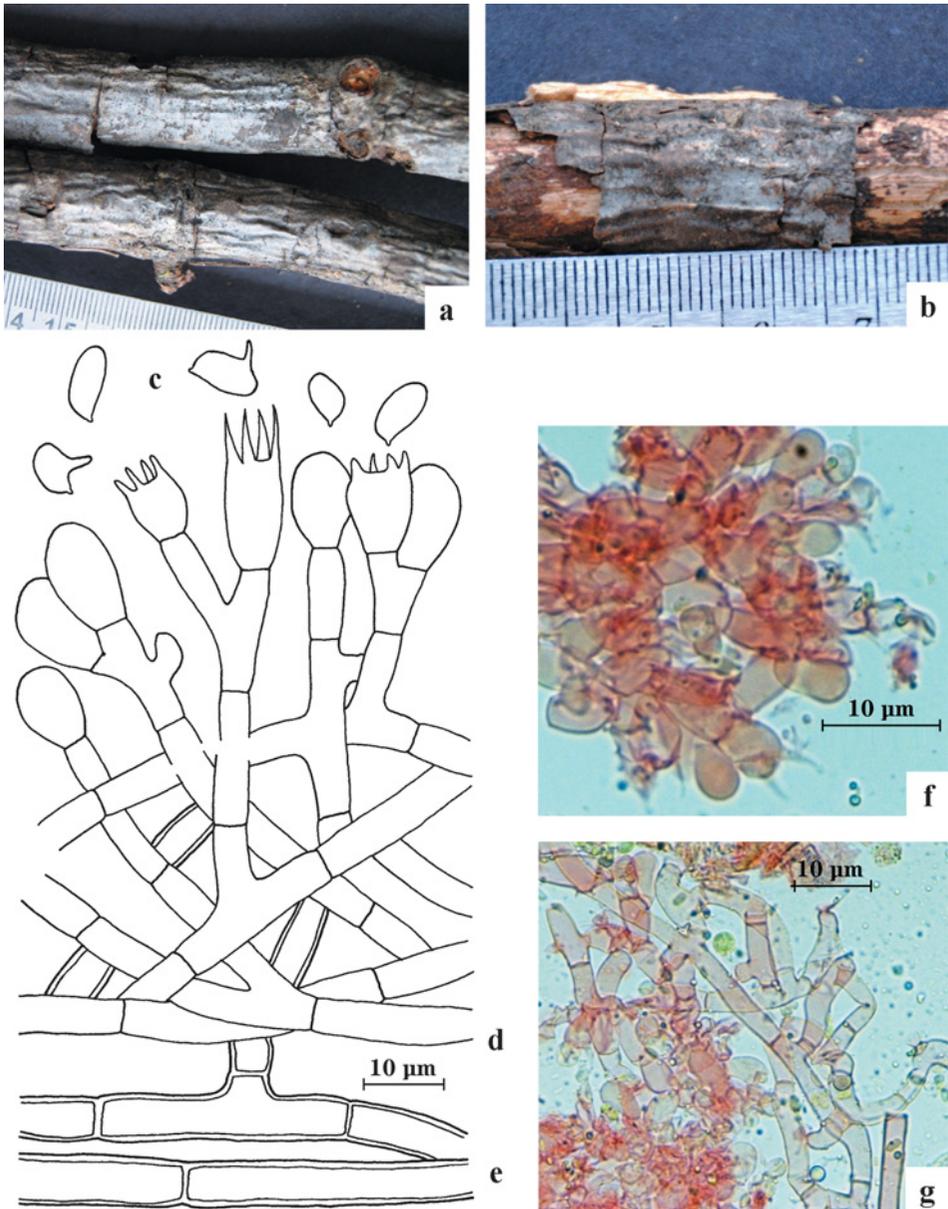


Fig. 2. *Ceratobasidium cornigerum* (7913 PUN): **a** – hymenial surface (fresh); **b** – hymenial surface (dry); **c** – basidiospores; **d** – reconstruction of hymenium and subhymenium; **e** – basal hyphae; **f** – photomicrograph of basidium; **g** – photomicrograph of generative hyphae. Scale bars = 10 µm; del. & photomicrograph by Maninder Kaur (c–g). Photos by Avneet Pal Singh (a, b).

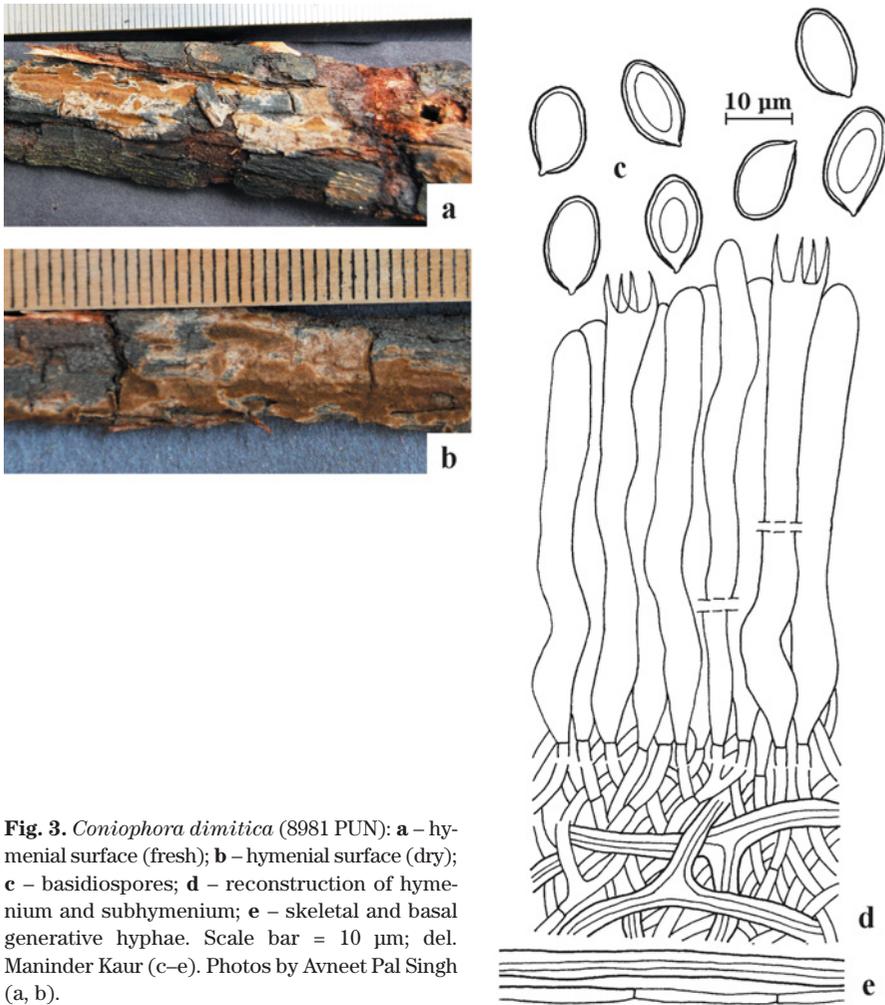


Fig. 3. *Coniophora dimitica* (8981 PUN): **a** – hymenial surface (fresh); **b** – hymenial surface (dry); **c** – basidiospores; **d** – reconstruction of hymenium and subhymenium; **e** – skeletal and basal generative hyphae. Scale bar = 10 µm; del. Maninder Kaur (c–e). Photos by Avneet Pal Singh (a, b).

Collection examined: India, Himachal Pradesh, Shimla District, approx. 4 km from the town of Chail towards the town of Kufri, on bark of *Rhododendron arboreum*, 3 August 2013, Avneet 8981 (PUN).

Corticium lombardiae (M.J. Larsen & Gilbertson) Boidin & Lanquetin, Bulletin de la Société Mycologique de France 99: 275, 1983 Fig. 4

≡ *Laeticorticium lombardiae* M.J. Larsen & Gilbertson, Mycologia 70: 206, 1978

Description. Basidiocarps resupinate, effused, adnate, up to 500 µm thick in section; hymenial surface tuberculate, brownish orange to light brown or

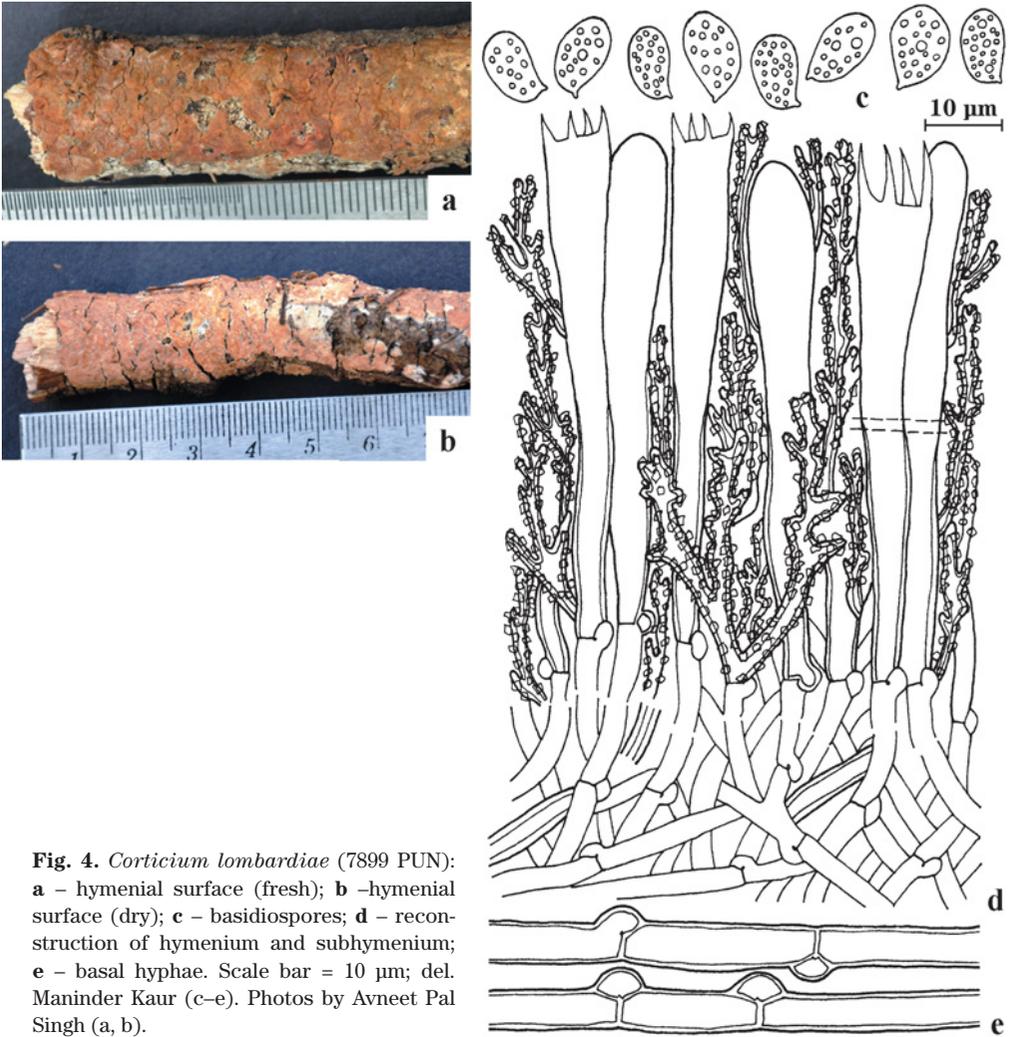


Fig. 4. *Corticium lombardiae* (7899 PUN): **a** – hymenial surface (fresh); **b** –hymenial surface (dry); **c** – basidiospores; **d** – reconstruction of hymenium and subhymenium; **e** – basal hyphae. Scale bar = 10 µm; del. Maninder Kaur (c–e). Photos by Avneet Pal Singh (a, b).

brown; cracking, greyish red to greyish brown on drying; margins thinning, pruinose, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae nodose-septate; basal hyphae up to 5.6 µm wide, parallel to the substrate, thick-walled; subhymenial hyphae up to 2.5 µm wide, vertical, thin-walled. Dendrohyphidia up to 3.5 µm wide, numerous, irregularly branched, heavily encrusted with crystalline matter. Cystidia absent. Basidia 60–83 × 6–12 µm, clavate, thick-walled at the base, wall gradually thinning upward, with basal clamp, 4-sterigmate; sterigmata up to 8.6 µm long.

Basidiospores $8.0\text{--}10.8 \times 5.2\text{--}7.4 \mu\text{m}$, ellipsoid, smooth, thin-walled, with oily contents, IKI⁻, acyanophilous.

Remarks. *Corticium lombardiae* is close to *C. roseum* Pers. but differs by its smaller basidiospores and encrusted dendrohyphidia. It has so far been reported from North America, France and Japan (IMA on-line).

Collection examined: India, Himachal Pradesh, Shimla District, Tara Devi, on way to Public Works Department Guest House, on sticks of *Cedrus deodara*, 4 April 2014, Maninder 7899 (PUN) and Dhingra 7900 (PUN).

Hypochnicium bombycinum (Sommerfelt) J. Eriksson, Symbolae Botanicae Upsalienses 16(1): 101, 1958 Fig. 5

= *Thelephora bombycina* Sommerfelt, Supplementum Florae lapponicae: 284, 1826

Description. Basidiocarp resupinate, effused, adnate, up to $250 \mu\text{m}$ thick in section; hymenial surface smooth, somewhat tuberculate under lens, greyish white to greyish orange when fresh, cracking, greyish orange to brownish orange on drying; margins thinning, pruinose to somewhat fibrillose, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae nodose-septate; basal hyphae up to $4.6 \mu\text{m}$ wide, loosely interwoven, thick-walled, horizontal; subhymenial hyphae up to $3.1 \mu\text{m}$ wide, compact, thin-walled, vertical. Cystidia absent. Basidia $40\text{--}67 \times 9\text{--}11.2 \mu\text{m}$, clavate, sinuous, 4-sterigmate, with basal clamp and oily contents; sterigmata up to $8.7 \mu\text{m}$ long. Basidiospores $9.3\text{--}12.4 \times 6.8\text{--}8.7 \mu\text{m}$, broadly ellipsoid to ovoid, smooth, thick-walled, with oily contents, IKI⁻, cyanophilous.

Remarks. *Hypochnicium bombycinum* is characteristic in having broadly ellipsoid to ovoid, smooth, thick-walled basidiospores and lacking sterile elements. It is pertinent to mention here that the presently described specimen has comparatively wider basidia ($40\text{--}67 \times 9\text{--}11.2 \mu\text{m}$) as compared to previous reports ($40\text{--}60 \times 6\text{--}8 \mu\text{m}$; IMA online and Bernicchia & Gorjón 2010). Earlier reports are from Portugal, Spain, United Kingdom, France, Belgium, Germany, Italy, Slovenia, Croatia, Hungary, Poland, Denmark, Norway, Sweden, Finland, Estonia, Belarus, Ukraine, Russia and Turkey (IMA on-line).

Collections examined: India, Himachal Pradesh, Shimla District, town of Chaupal, on sticks of *Cedrus deodara*, 16 August 2012, Maninder 7873 (PUN); approx. 1 km from the town of Shogli towards Tara Devi Temple, on bark of *C. deodara*, 1 August 2013, Dhingra 7872 (PUN) and Maninder 7874 (PUN).

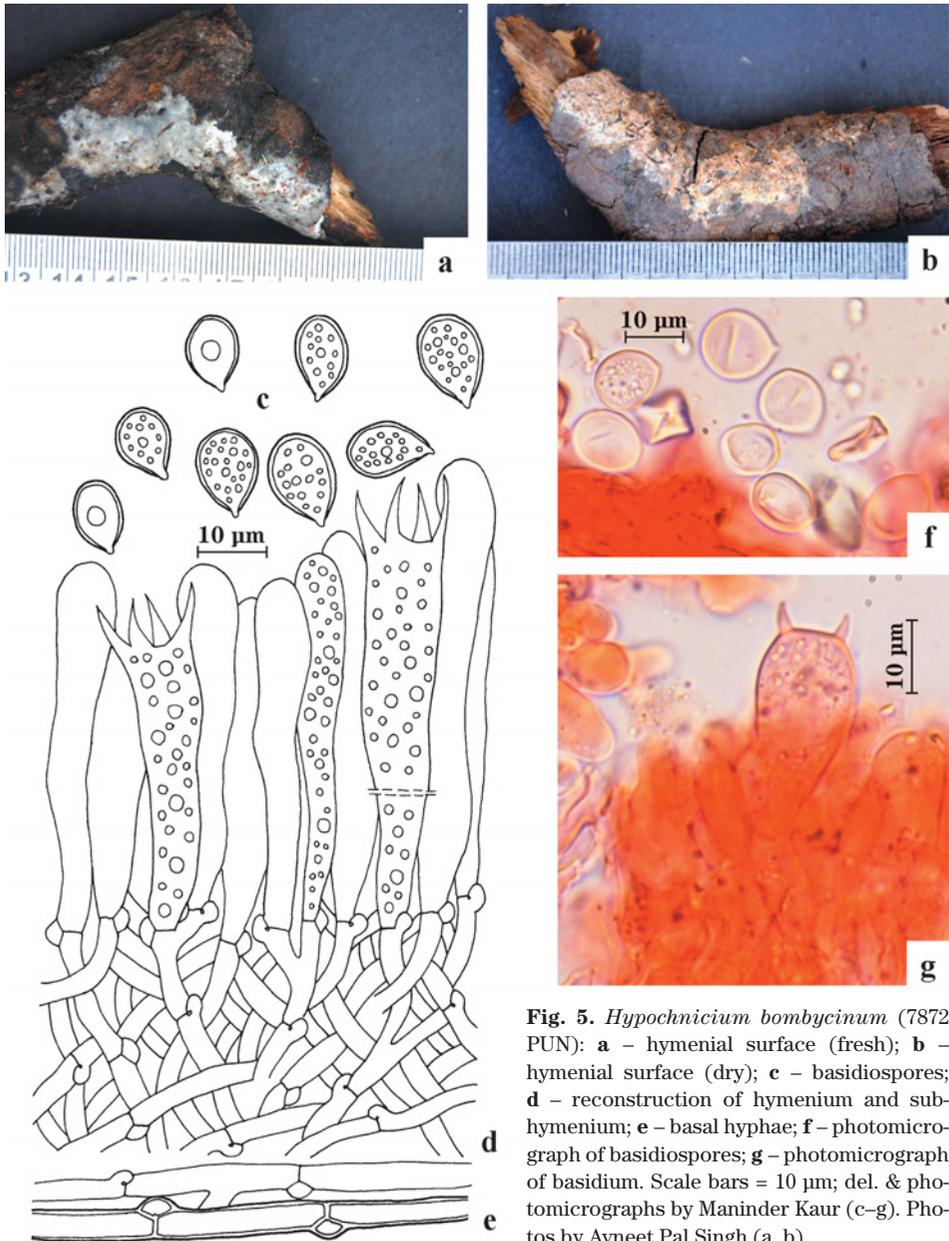


Fig. 5. *Hypochnicium bombycinum* (7872 PUN): **a** – hymenial surface (fresh); **b** – hymenial surface (dry); **c** – basidiospores; **d** – reconstruction of hymenium and subhymenium; **e** – basal hyphae; **f** – photomicrograph of basidiospores; **g** – photomicrograph of basidium. Scale bars = 10 µm; del. & photomicrographs by Maninder Kaur (c–g). Photos by Avneet Pal Singh (a, b).

Phlebia coccineofulva Schweinitz, Transactions of the American Philosophical Society 4(2): 165, 1832 Fig. 6

Description. Basidiocarp resupinate, effused, adnate, up to 500 µm thick in section; hymenial surface smooth, greyish red to brownish orange, light brown or brown; margins thinning, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae nodose-septate; basal hyphae up to 5 µm wide, thick-walled, less branched, horizontal; subhymenial hyphae up to 2.2 µm wide, thin-walled, more branched than basal hyphae, vertical. Cystidia 50–75 × 10–13 µm, numerous, subfusiform, thick-walled, heavily encrusted; projecting up to 30 µm out of the hymenium. Basidia 21–30 × 4–7 µm, clavate, 4-sterigmate, with basal clamp; sterigmata up to 3.5 µm long. Basidiospores 4.7–6.8 × 2.2–3.7 µm, ellipsoid to subcylindrical, smooth, thin-walled, IKI⁻, acyanophilous.

Remarks. This species is characteristic in having subfusiform, thick-walled, heavily encrusted cystidia in combination with ellipsoid to subcylindrical basidiospores. It has been reported from Europe, the former Soviet Union and North America (IMA on-line).

Collection examined: India, Himachal Pradesh, Shimla District, Tara Devi, on way to Public Works Department Guest House, on stump of *Cedrus deodara*, 14 April 2014, Maninder 8965 (PUN).

Radulomyces rickii (Bresadola) M.P. Christiansen, Dansk Botanisk Arkiv 19(2): 128, 1960 Fig. 7

≡ *Corticium rickii* Bresadola, Österreichische Botanische Zeitschrift 48(4): 136, 1898

Description. Basidiocarps resupinate, effused, adnate, up to 250 µm thick in section; hymenial surface smooth, orange-white to pale orange or greyish orange when fresh, not changing much on drying; margins thinning, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae up to 2.2 µm wide, nodose-septate, clamped, thin-walled; basal hyphae parallel to the substrate, less branched; subhymenial hyphae vertical, more branched than basal hyphae. Cystidioles 31–43 × 7.4–11 µm, clavate, thin-walled, with basal clamp, sometimes with lateral protuberances. Basidia 34–45 × 8–10 µm, clavate, constricted to somewhat sinuous, 4-sterigmate, with oily contents and basal clamp; sterigmata up to 9 µm long. Basidiospores 7.4–11.7 × 6.5–8.4 µm, broadly ellipsoid to subglobose, minutely warted, thin-walled, IKI⁻, acyanophilous.

Remarks. *Radulomyces rickii* is characteristic in having mostly minutely warted basidiospores. However, in *R. confluens* the basidiospores may rarely also be warted. The present specimen differs from the previous reports (Ghobad-Nejhad & Kotrianta 2007 and Bernicchia & Gorjón 2010) in having slightly larger

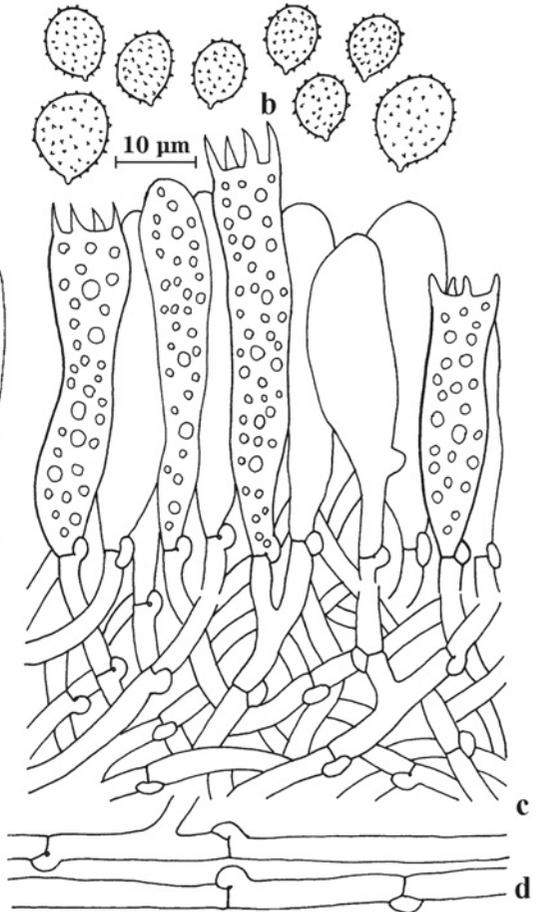
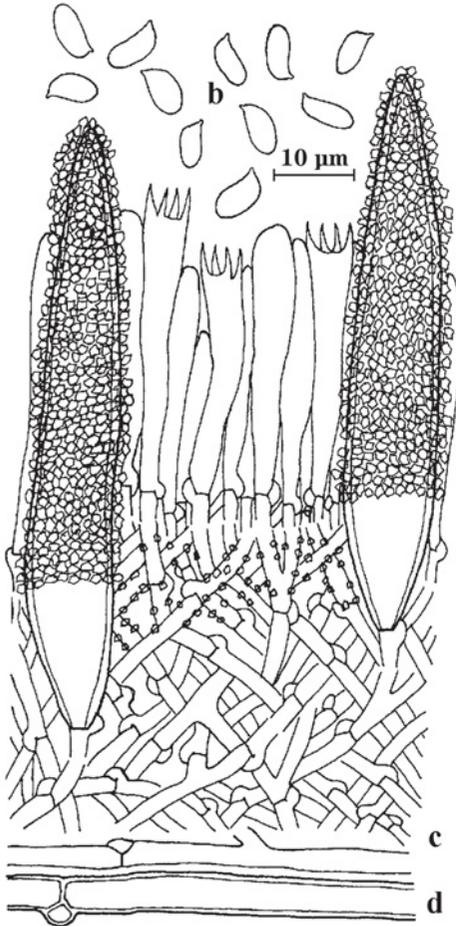


Fig. 6. *Phlebia coccineofulva* (8965 PUN): **a** – hymenial surface (fresh); **b** – basidiospores; **c** – reconstruction of hymenium and subhymenium; **d** – basal hyphae. Scale bar = 10 µm; del. Maninder Kaur (b–d). Photo by Avneet Pal Singh (a).

Fig. 7. *Radulomyces rickii* (7601 PUN): **a** – hymenial surface (fresh); **b** – basidiospores; **c** – reconstruction of hymenium and subhymenium; **d** – basal hyphae. Scale bar = 10 µm; del. Maninder Kaur (b–d). Photo by Avneet Pal Singh (a).

and relatively broader basidiospores. It has been reported from Spain, United Kingdom, France, Switzerland, Italy, Austria, Macedonia, Norway, Poland, Belarus, Ukraine and Russia (IMA on-line).

Collections examined: India, Himachal Pradesh, Shimla District, village of Seoni, on stump of *Pinus roxburghii*, 7 July 2013, Maninder 7601 (PUN); Tara Devi, on way to Public Works Department Guest House, on sticks of *Quercus incana*, 14 April 2014, Avneet 8970 (PUN) and Maninder 8971 (PUN).

Rhizoctonia* cf. *sphaerospora (Warcup & P.H.B. Talbot) Oberw., R. Bauer, Garnica & R. Kirschner, *Mycological Progress* 12: 775, 2013 Fig. 8

≡ *Ceratobasidium* cf. *sphaerosporum* Warcup & P.H.B. Talbot, *New Phytologist* 70: 38, 1971

Description. Basidiocarp resupinate, effused, adnate, up to 120 µm thick in section; hymenial surface smooth, appearing tuberculate because of substrate pattern, light grey to reddish grey when fresh, not changing much on drying; margins thinning, pruinose, paler concolorous, or indeterminate.

Hyphal system monomitic. Generative hyphae septate, without clamps; basal hyphae up to 7.4 µm wide, parallel to the substrate, sparsely ramified at right angles, thick-walled; subhymenial hyphae up to 5.2 µm wide, vertical, more branched than basal hyphae. Cystidia absent. Basidia 10–13 × 6–10 µm, broadly subclavate to ovoid, 4-sterigmate, without basal clamp; sterigmata up to 8 µm long. Basidiospores 5.9–7.8 × 5.6–6.5 µm, globose to subglobose, repetitive, smooth, thin-walled, acyanophilous, inamyloid.

Remarks. This species differs from *C. cornigerum* by having globose to subglobose basidiospores. It has only been reported from Australia as an orchid symbiont (Warcup & Talbot 1971 and IMA on-line). Rasmussen (2002) mentioned that fungi currently classified under *Rhizoctonia*, including orchid endophytes, are traditionally regarded as saprotrophs. On the other hand, saprotrophic *Rhizoctonia* species can be used to germinate terrestrial orchid seeds, as confirmed in an experimental study by Salman et al. (2002), which indicates that at least some orchid-associated rhizoctonias can also occur as saprotrophs. Based on this knowledge, Roberts (pers. comm.) also suspects that *Rhizoctonia sphaerospora* is a saprotrophic fungus which is a facultative associate of terrestrial orchids. Taking into account the previous reports, but also the fact that the current locality is very far from the Australian one, the present specimen is treated as *Rhizoctonia* cf. *sphaerospora*.

Collection examined: India, Himachal Pradesh, Shimla District, Jakhu Temple, on bark of *Cedrus deodara*, 31 July 2013, Maninder 7912 (PUN).

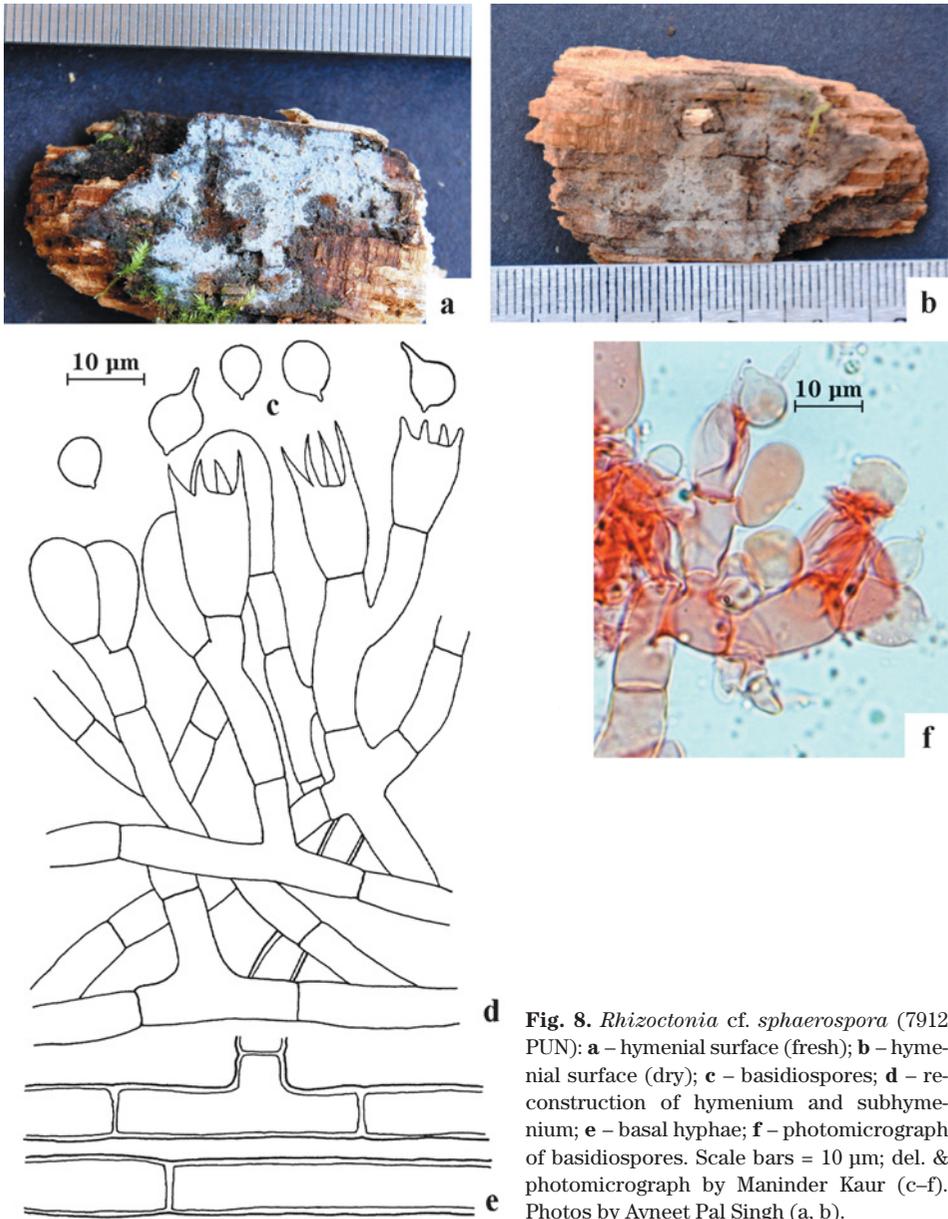


Fig. 8. *Rhizoctonia* cf. *sphaerospora* (7912 PUN): **a** – hymenial surface (fresh); **b** – hymenial surface (dry); **c** – basidiospores; **d** – reconstruction of hymenium and subhymenium; **e** – basal hyphae; **f** – photomicrograph of basidiospores. Scale bars = 10 µm; del. & photomicrograph by Maninder Kaur (c–f). Photos by Avneet Pal Singh (a, b).

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