

The lichen genus *Phlyctis* (Phlyctidaceae) in India

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ABSTRACT

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The paper provides an account of the status of lichen genus *Phlyctis* in India. Six species are known from India. A key for all the six species is also provided. Almost all the species exhibit their distribution in tropical rain forests of eastern Himalayas and Western Ghats. The genus needs thorough investigation to resolve taxonomic complexities and exhaustive collection to determine the exact status within India.

Key-words: *Phlyctis*, *Phlyctella*, depsidones, Western Ghats, eastern Himalayas, India.

INTRODUCTION

The genus *Phlyctis* comprises ca. 20 species world-wide (known from temperate to tropical forests of America, Africa, China, India and New Zealand). It was delimited from the closely related *Phlyctella* Kremp., on the basis of multicelled-muriform vs. transversely septate ascospores, which was considered to be of less taxonomic significance (Galloway 1988, 2007). In India, the genus is currently represented by six species. In addition to *P. himalayensis* and *P. polyphora*, the genus is supplemented by four recently described species: *Phlyctis karnatakana*, *P. subagelaea*, *P. monosperma* and *P. subhimalayensis* (Joshi et al. 2010, 2012). Until recently, the situation within India was rather poor as only two species (*P. himalayensis* and *P. polyphora*) were reported by Awasthi (1991, 2000) from eastern Himalayan region of India. The previously known *Phlyctella indica* D. D. Awasthi, *Phlyctis arachnoides* Kremp. and *Phlyctis effusa* Müll. Arg. have already been synonymized to *Graphidastra byssiseda* (Müll. Arg.) G. Thor, *Lasioloma arachnoideum* (Kremp.) R. Sant. and *Cryptothecia effusa* (Müll. Arg.) R. Sant., respectively. The diversity of *Phlyctis* is poorly studied in the country, even if it is expected to be spread in

tropical to temperate evergreen forests of Himalayas and Western Ghats. The scattered and poor collection, together with insufficient characterization of the genus, may be solely responsible for wide ignorance of the genus in India for the last one decade. Nevertheless, recent studies suggest high diversity of the genus in considerably wide, dense and humid forests of the country.

According to recent taxonomic developments and changes, the genus *Phlyctis* is currently known to represent vast variable characteristics perhaps due to transfer of *Phlyctomia*, *Phlyctella* and *Phlyctidea* to *Phlyctis*. The important morpho-anatomical and chemically distinguishing features such as thallus type, colour, ascospores size, configuration and number, and secondary metabolites explain no well defined criteria to discriminate species within *Phlyctis*. The genus represents crustose to sub-leprose thalli, 1- to 8-spored asci, transversely to muriform ascospores of inconsistent dimensions and a wide variety of secondary metabolites (depsidones) or lacking compounds. Such large diagnostic variations are usually unacceptable to delimit a genus, which further includes majority of taxa having either no well defined character to be considered as separate species or with dubious identities (Joshi et al. 2012).

The so far neglected genus *Phlyctis* in India is in much need of thorough taxonomic investigation due to hardly distinguishable, poor in taxonomically important characters. The present study is put forth in order to resolve our understanding of some poorly known groups in Indian lichen flora and thereby improving our knowledge of delimitation complexities among closely related genera within the family Phlyctidaceae.

MATERIAL AND METHOD

During the course of investigation on lichen genus *Phlyctis* from India, the specimens preserved in the herbarium of National Botanical Research Institute, Lucknow (LWG), and recent collections (by DKU) were segregated. The morphological and anatomical characters were studied under dissecting and compound microscopes respectively. The chemistry was performed by following the methods given by Orange et al. (2001). Lugol's solution was used to check the amyloidity of apothecial anatomy.

TAXONOMIC DISCRPTION

Phlyctis (Wallr.) Flot. nom. cons.
(Phlyctidaceae, Ostropales)

Phlyctis is generally characterized by crustose, corticolous, ±cracked-areolate or powdery, granular, arachnoid to byssoid, immersed or superficial thallus, in different shades of grey and white. Photobiont chlorococcoid. Prothallus often present, pale to whitish or blackish. Ascomata apothecia, small, often clustered or aggregated in groups to scattered, immersed, scarcely emergent to chroodiscoid, rounded to irregular in shape. Disc reddish brown, brown to black, mostly densely pruinose, concave or flat. Margins irregularly crenate to rounded or indistinct. Proper exciple poorly developed. Epihymenium granular, opaque to brownish, up to 90 µm high. Hymenium, hyaline, clear,

up to 310 µm high. Hypothecium hyaline to pale-brownish, up to 110 µm high. Paraphyses unbranched slender to branched, anastomosing, free to conglutinated in apices. Ascus clavate, 1–8-spored, I+ blue. Ascospores colourless, or smoky grey or pale yellow when old, with or without apiculae, fusiform, oblong to ellipsoid, transversely septate to densely muriform, I+ wine red to purplish blue or I–. Chemically, the genus, produces a wide range of secondary metabolites (atranorin, norstictic, connorstictic, stictic, constictic, hypostictic, protocetraric, fumarprotocetraric, salazinic and psoromic acids) or lacking compounds.

Key to *Phlyctis* species from India

1. Thallus lacking lichen substances.....
..... *P. subhimalayensis*
- 1a. Thallus containing lichen substances.....2
2. Ascospores transversely septate.....3
- 2a. Ascospores muriform.....5
3. Ascospores 130–180 × 30–40 µm.....
..... *P. monosperma*
- 3a. Ascospore 20–75 × 5–8 µm.....4
4. Ascospores 20–30 × 5–7 mm... *P. karnatakana*
- 4a. Ascospores 60–75 × 6–8 µm.... *P. himalayensis*
5. Asci 1-spored, ascospores 60–130 × 12–30 mm.....*P. subagelaea*
- 5a. Asci 3–8- spored, 60–110 × 7.5–9.5 µm
..... *P. polyphora*

Phlyctis himalayensis (Nyl.) D. D. Awasthi

Lichenol. Indian Subcontinent: 15. 2000=
Phlyctella himalayensis Nyl., Lich.
Nova Zealand 73. 1888.

Description: Thallus, corticolous, crustose, ash-grey with yellowish ting, subleprose. Apothecia minute to small up to 0.4 mm diam., adnate. Disc black-brown,

→

Plate 1

1-4. Recently described species of *Phlyctis* from India. 1. *P. karnatakana*. 2. *P. monosperma* (note the apothecia). 3. *P. subagelaea*. 4. *P. subhimalayensis*.

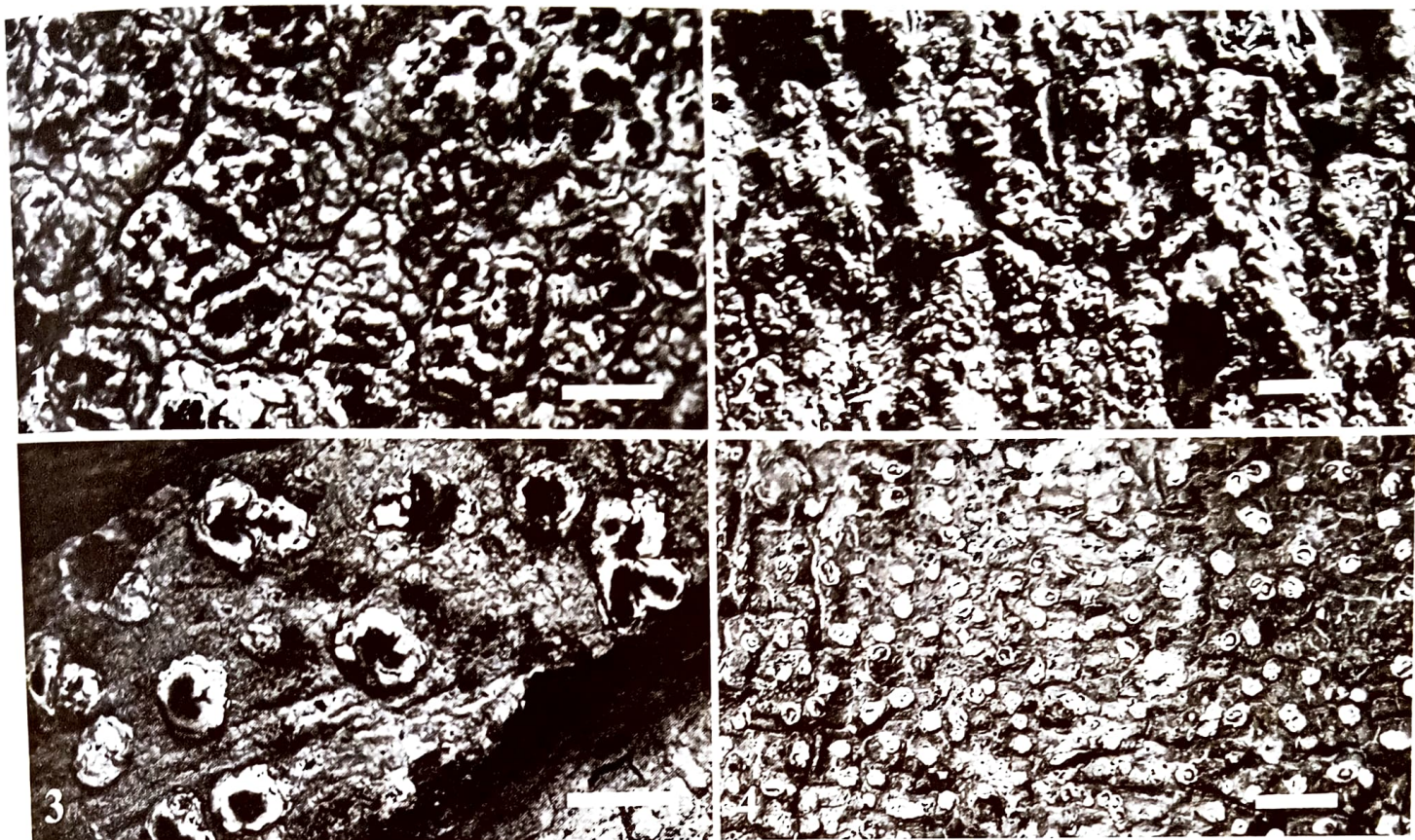


Plate 1

concave to flat. Exciple concolorous to thallus. Hymenium hyaline but brownish above. Hypothecium brownish. Paraphyses unbranched and free. Asci 8-spored. Ascospores hyaline, transversely 7-septate, fusiform, $60-75 \times 6-8 \mu\text{m}$.

Chemistry: K+ red (?). Norstictic acid.

Ecology and distribution: The species has been reported from tropical moist and humid rain forests of eastern Himalayan region of India (Meghalaya) and from Thailand.

Remarks: *P. himalayensis* exhibits similarity to *P. karnatakana* S. Joshi & Upreti in having 7-septate ascospores but is separated on the basis of ascospores size. The latter species has ascospores of $20-30 \times 5-7 \mu\text{m}$, which are comparatively smaller than $60-75 \mu\text{m}$ ascospores of *P. himalayensis*. The other 7-septate, *P. oleosa* has smooth, corticated thallus while *P. subuncinata* contain stictic acid in medulla. *P. longifera* differs from *P. himalayensis* in having somewhat larger ascospores of $55-86 \times 5-7 \mu\text{m}$ and containing stictic acid as major thallus compound. Due to unavailability of holotype (deposited in BM) the exact current status

of the taxa is still uncertain. The characters are based on the description provided by Awasthi (1991). The species has not been collected since 1967. The material (acc. no. 1258) collected from eastern Himalayan region in the state of Assam, Shillong district, Mawphlong, on bark by Dharme and Roychowdhury, at an altitude of 1500 m in 1967, shows subsimilarity to *P. himalayensis*.

***Phlyctis karnatakana* S. Joshi & Upreti**

The Bryologist 113 (4): 726. 2010.

Plate 1, figure 1

Description: Thallus corticolous, crustose, whitish-grey, subleprose, ecorticated, in irregular patches, cracked. Photobiont chlorococcoid. Prothallus indistinct. Apothecia numerous, mostly aggregated, round to irregular in margins, granular, semi-immersed, uneven, 0.3–0.4 mm in diam. Disc black, plane, slightly pruinose, 0.06–0.2 mm diam. Margin concolorous to thallus, straight to incurve, entire to eroded in older apothecia. Exciple indistinct to absent. Epihymenium minutely granular, brown-opaque, up to $25 \mu\text{m}$ thick, K–, I–. Hymenium hyaline, clear, 100–130 μm high.

K-, I- Hypothecium pale-yellow to pale-brown, 15–20 mm thick, K-, I-. Paraphyses, slender, simple, conglutinate, apices anastomosing, 1–1.5 mm diam. Asci 8-spored, clavate, thin walled, 75–80 × 15–25 mm, K-, I+ red. Ascospores hyaline, fusiform, crescent shaped, transversely 7-septate, I-, 20–30 × 5–7 mm.

Chemistry: Thallus K+ red, PD+ yellow-orange, C-. Norstictic acid detected in TLC.

Ecology and distribution: *Phlyctis karnatakana* grows on tree trunks in the evergreen forest. It is well distributed in tropical to temperate areas of Western Ghats in southern India at an altitude ranging between 644 and 2550 m. The species is described from Karnataka and Maharashtra.

Remarks: *Phlyctis karnatakana* is recognized by the whitish-grey, decorticate thallus and curved fusiform, transversely 7-septate ascospores, 20–30 × 5–7 µm in size. Other transversely 7-septate taxa are *P. himalayensis* Nyl., *P. oleosa* Stirt. and *P. subuncinata* Stirt. But all three species have larger ascospores of 60–75 µm, 45–85 µm, 40–72 µm, respectively. Further, *P. uncinata* produces stictic acid as thallus compound. *P. karnatakana* can be comparable with *P. longifera* (Nyl.) D. J. Galloway & D. Guzmán, in ascospores septation, those in latter ranges 7 to 11-septate per ascospore but the latter species too has larger ascospores (55–86 µm) and contains stictic acid in medulla.

Specimen examined: Karnataka, Shimoga district, near Jog Falls, Kargal, alt. 644 m, on bark in evergreen forest, Lumbsch, Upreti, Divakar & Tandon 19743/L (LWG); Goa, Goa proper near Panjim, on bark, May 2009, Jayesh Rawal 09–011804 (LWG); Chikmagalur district, Chikmagalur, way to Kummangundi, alt. ca. 1100 m, on bark of tree, 02.05.1979, Awasthi, Upreti & Misra 79–403, 79–458 (LWG-LWU); alt. 1300 m, on bark of tree twig, 02.05.1979, Awasthi, Upreti & Misra 79–443 (LWG-LWU); Mangalore district, Seklashpur, way to Mangalore, Shiradi Ghat, alt. 770 m, on bark, 03.05.1979, Awasthi, Upreti & Mishra 79–560, 79–591, 79–647, 79–656 (LWG); Maharashtra, Satara district, Devi Path, alt. 1394 m, on bark, 27.03.2010, R. Bajpai 10–013316 (LWG); Panchgani near

Koteshwar temple, on *W. fruticosa*, 27.03. 2011, R. Bajpai 11–015075 (LWG); near Forest Research Centre, Gureghar, alt. 1193m, on *W. fruticosa*, 27.03.2011, R. Bajpai 11–015532 (LWG); Koyana valley, Ghatmatha village, alt. 695m, on *Morus alba*, 23.03.2010, R. Bajpai 11–013857/B (LWG); alt. 631m, on *Erythrina* twigs, 24.03.2010, R. Bajpai 10–013323 (LWG); on *W. fruticosa*, 23.03. 2010, R. Bajpai 10–013988 (LWG); Mahabaleshwar, Lingmala fall near temple, on bark of *M. edule*, 26.03.2011, R. Bajpai 11–015068 (LWG); behind Pratapgarh fort, on twigs of *W. fruticosa*, 28.03.2011, R. Bajpai 11–015057 (LWG); Medha road near graveyard, on bark of *Memecylone umballatum*, 26.03.2011, R. Bajpai 11–015034 (LWG); Khandala, alt. 1200 m, on bark, 02.12.1962, P. Chandra, s.n. (LWG); Tamil Nadu, Nilgiri Hills, Upper Bhavani Road from Avalanche, Kolaripetta top, alt. 2550m, on *Rhododendron* tree twigs, 24.06.1971, K. P. Singh 71.713 (LWG-LWU); on way to Doddabetta, alt. ca. 1800 m, on bark of tree, 30.11.1973, K. P. Singh 73.416 (LWG-LWU).

***Phlyctis monosperma* S. Joshi & Upreti**

The Lichenologist, 44(3): 363. 2012.

Plate 1, figure 2

Description: Thallus corticolous, crustose, growing in association with epiphytic bryophytes, uneven, whitish to whitish-grey, coarsely to finely granular, loose, continuous, ±cracked due to bark texture. Photobiont chlorococcoid. Prothallus white to indistinct. Apothecia numerous, scattered, sometimes aggregated in groups of 2–3, mostly irregular, rarely roundish, uneven, 0.5 to 1.5 mm in diam., immersed to level with thallus. Disc concave to ±plane, greyish to brownish, covered heavily with white ± granular pruina, irregular, loose. Margins concolorous to thallus, up to 0.3 mm thick, raised, straight to slightly incurved, entire, eroded in older apothecia, ± granular. Proper exciple indistinct to poorly developed. Epithemium brownish, granular, opaque, 25–35 µm high, K-, I+ reddish. Hymenium hyaline, clear, 170–190 µm high, K-, I-. Hypothecium pale to hyaline, 35–40 µm high, K-, I-. Paraphyses densely anastomosing, branched, conglutinate, coherent, 2.0 to 2.5(–3) µm thick. Asci 1-spored, broadly clavate, 135–170(–197) × 35–45

μm , K–, I+ pale yellow turning reddish. Ascospores hyaline, oblong-ellipsoid with round apices, thin walled, transversely consistently 15-septate, appear multicelled muriform in older stage due to disintegration of transverse septa, (130–)140–150(–180) \times 30–40 μm , cells 9–13(–15) μm high, lenticular, I+ wine red.

Chemistry: K–, C–, KC–, P+ yellow. Psoromic acid chemosyndrome detected in TLC.

Ecology and distribution: The species occurs in subtropical evergreen forests of eastern Himalayas and Western Ghats of India. It inhabits the rough tree bark among epiphytic bryophytes at an altitude of above 2000 m.

Remarks: *Phlyctis monosperma* is characterized by whitish-grey, loose, \pm granular thallus, 1-spored asci, transversely 15-septate ascospores and the psoromic acid chemosyndrome. It shows close resemblance to *Phlyctis megalospora* (P. James) D. Galloway & G. Guzmán in its 1-spored asci, oblong-ellipsoid, transversely septate ascospores, presence of psoromic acid and its association with mosses. However, *Phlyctis megalospora* differs in containing atranorin, norstictic and protocetraric acids as an additional thallus compounds and larger, 285–390 \times 79–95 μm , 17–23-septate ascospores. Another psoromic acid containing *Phlyctis psoromica* Elix & Kantvilas, with transversely septate ascospores differs in having 4–8-spored asci and smaller, 3–7-septate ascospores of 30–52 \times 4–6 μm . A relatively rare and localized *Phlyctis chilensis* D. Galloway & G. Guzmán, from cool temperate region of south America, exhibits similarity with the new taxon in having 1-spored asci but differs in containing norstictic and connorstictic acids as thallus compounds and has larger, muriform ascospores (190–285 \times 55–70 μm). A muriform Indian species *Phlyctis subagelaea* S. Joshi & Upreti, also has 1-spored asci with ecorticated, whitish-grey thallus but differs from the new species in containing fumarprotocetraric acid as secondary compound (erroneously mentioned as containing norstictic acid in holotype discussion in Joshi et al. (2010).

Specimens examined: India, West Bengal, Darjeeling district, Sukhia forest, on bark among moss, 1976, S. Chandra & M. Ranjan, 26815 (LWG). Tamil

Nadu, Kodaikanal, Silver cascade, on bark, 1979, S. Chandra & M. Ranjan, 26816 (LWG).

***Phlyctis polyphora* Stirt.**

Proc. Roy. Soc. Glasgow 13: 184. 1881.

Description: Thallus corticolous, crustose, whitish to pale or pale red, thin. Apothecia 0.4–1.2 mm diam., pruinose. Hypothecium hyaline to yellowish. Asci 3–8-spored. Ascospores muriform, hyaline, oblong-fusiform 16–32 transverse and 1–2 vertical septate, 60–110 \times 7.5–9.5 μm .

Chemistry: K–, C–.

Ecology and distribution: Corticolous species reported over the bark of trees growing in evergreen forests in eastern region of India. It is endemic to India (Singh & Sinha 2010).

Distribution– India (Assam).

Remarks: *Phlyctis agelaea* (Ach.) Flotow closely resembles *P. polyphora* in having muriform ascospores but has K+ yellow-red thallus (norstictic acid) and somewhat smaller ascospores of 35–91 \times 11–35 μm . *P. nepalensis* Räs. also has muriform ascospores and K– thallus but differs in having 1- or rarely 2-spored asci, smaller ascospores of 45–53 \times 12–16 μm and thallus containing unknown lichen substance, producing grey spot at Rf class 5. The scanty diagnostic characters of *P. polyphora* are based on description provided by Awasthi (1991), due to unavailability of holotype (deposited in BM and GLAM) collected by A. Watt. The species has not been collected since 1881, thus exhaustive sampling is prerequisite to certify its occurrence and exact taxonomic placement based on recent systematic classification of the genus.

***Phlyctis subagelaea* S. Joshi & Upreti**

The Bryologist 113 (4): 725–726. 2010.

Plate 1, figure 3

Description: Thallus corticolous, crustose, ecorticated, whitish-grey, \pm roughened, uneven, cracked, usually thin, determinate, forming small patches. Photobiont a green protococcoid alga. Prothallus indistinct to \pm a blackish layer. Apothecia numerous, scattered, irregular to \pm rounded, emergent, 1–2 mm in diam. Disc brown to blackish, concave,

heavily pruinose. Epithecium granular, brownish, 10–15 mm thick, K–, I–. Hymenium hyaline, clear, 60–100 mm high, K–, I–. Hypothecium hyaline, 25–30 mm thick, K–, I–. Paraphyses branched, anastomosing, 1.5–2 mm thick. Asci 1-spored, broadly clavate, thin walled, 120–150 × 20–40 mm, K–, I+ reddish. Ascospores hyaline, oblong-ellipsoid, apices rounded, muriform, 60–130 × 12–30 mm, I+ purplish-blue.

Chemistry: Thallus K+ yellow, PD+ orange, C–, KC+ red. Fumarprotocetraric acid detected in TLC.

Ecology and distribution: *Phlyctis subagelaea* grows on bark of tropical rain forests trees of southern India. Presently, the species is described only from the type locality in India (Kerala).

Remarks: *Phlyctis agelaea* (Ach.) Flotow, is close to *P. subagelaea* in having ascospores size ranges (35–)45–80(–91) × 11–32(–35) mm but differs in the thallus containing norstictic acid, smaller apothecia of 0.2–0.5(–1) mm in diam., and 2(–4)–spored asci. The native species *P. polyphora* Stirt., differs from the new taxon in having a K– thallus and 3–8-spored asci as mentioned by Awasthi (1991). *Phlyctis subagelaea* is similar to *P. nepalensis* Räs., *P. argena* (Sprengel) Flotow and *P. chilensis* D. Galloway & G. Guzmán in having 1-spored asci. But, *P. nepalensis* has K– thallus (unknown grey spot at Rf- class 5), smaller apothecia of 0.1–0.3 mm diam. and epruinose disc. *Phlyctis chilensis* differs in having larger ascospores of (190–)230–270(–285) × 55–70 μm in size, whereas, *P. argena*, a soresiate species has smaller apothecia of 0.2–0.4 mm in diam., and ascospores of (75–)100–150(–205) × 25–50(–53) μm. Moreover, both the latter species produce norstictic and connorstictic acids (Galloway & Guzmán 1988; Tønsberg 2004).

Specimen examined: Kerela, Idukki district, Periyar Tiger Reserve, Thekkady, on bark, 23.03.2006, Biju Haridas 06–009837 (LWG).

***Phlyctis subhimalayensis* S. Joshi & Upreti**

The Lichenologist 44(3): 365. 2012.

Plate 1, figure 4

Description: Thallus corticolous, crustose, thin, smooth, greenish-grey to whitish-grey, continuous,

cracked, photobiont chlorococcoid. Prothallus indistinctly white to absent. Apothecia numerous, scattered, sometimes 2–3 confluent, roundish, elongate to angular, uneven, 0.5 to 1.0 mm diam., immersed, semi-immersed to chroodiscoid. Disc plane to concave, black, pruinose, rounded when completely exposed or sometimes slit-like when covered by margins, rarely irregular. Margins whitish, indistinctly 2–5 lobate, up to 0.3 mm thick, exfoliating in older apothecia, radially fissured and divided into 2–3 lamellae. Proper exciple undeveloped to poorly developed. Epihymenium brownish, minutely granular, opaque, 10–25 μm thick, K–, I+ blue, turning wine-red. Hymenium hyaline, clear, 60–90 μm high, K–, I–. Hypothecium slightly brownish to pale-yellow, 15–30 μm, K–, I–. Paraphyses simple, straight, slender, unbranched, coherent, up to 1.0 μm thick. Asci 8-spored, clavate, cylindrical, (45–)60–90 × 6–10 μm, K–, I+ blue, contents turning yellow-orange. Ascospores hyaline, transversely 5–7-septate, cells 2–6 μm high, acicular to fusiform, mostly curved, 20–35(–40) × 2–4 μm, I–, content turning yellow.

Chemistry: Thallus K–, C–, KC–, P–. No lichen substance detected in TLC.

Ecology and distribution: The species is described from cool temperate forests of Uttarakhand in northern Himalayas and Arunachal Pradesh in eastern Himalayas of India. It grows luxuriantly on *Quercus semecarpifolia* and *Acer nepalensis* trees at an altitude of 2500 m and higher.

Remarks: *Phlyctis subhimalayensis* is characterized by thallus lacking lichen substances, chroodiscoid apothecia with pruinose black apothecial discs, white exfoliating margins and transversely 5–7-septate ascospores. It shows a close resemblance to *Phlyctis himalayensis* (Nyl.) D.D. Awasthi and *P. karnatakana* S. Joshi & Upreti, in having transversely 7-septate ascospores but differs in thallus chemistry. Both *P. himalayensis* and *P. karnatakana* have a K+ red thallus with anonymous lichen compounds in the former and norstictic acid in the latter. Moreover, *P. himalayensis* has a subleprose thallus with comparatively larger ascospores of 60–75 × 6–8 μm. *Phlyctis subhimalayensis* is similar to the New Zealand taxa *P. longifera* (Nyl.) D. Galloway & G. Guzmán

and *P. megalospora* (P. James) D. Galloway & G. Guzmán in having transverse spore septation. However, the latter two species have larger ascospores ($55\text{--}86 \times 5\text{--}7 \mu\text{m}$ and $285\text{--}390 \times 79\text{--}95 \mu\text{m}$ in size) and presence of stictic and psoromic acids as major thallus compounds, respectively. The chroodiscoid apothecia *Phlyctis subhimalayensis* can be confused with the members of the lotremoid Graphidaceae (e.g. *Chapsa*) and also the non-lichenized genus *Stictis*.

Specimens examined: India, Uttarakhand, Pithoragarh district, Munsiyari, Kalamuni, alt. 2500 m, 2006, on *Quercus semecarpifolia* tree trunk, Y. Joshi & R. Bajpai 06–007019 (LWG); Ginny band, alt. 2500 m, 2009, on bark, D. K. Upreti et al. 09–012423 (LWG). Arunachal Pradesh, west Kameng district, enroute to Sela, 10 km before Sang, 2008, on *Acer nepalensis*, D. K. Upreti, U. Dubey, R. Khare & G. K. Mishra 08–009294 (LWG).

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