

## Observations on *Neobarya*, including new species and new combinations

F. Candoussau<sup>1</sup>, M. Boqueras<sup>2</sup>, A. Gómez-Bolea<sup>2</sup>,  
T. Læssøe<sup>3</sup>, R. Lowen<sup>4</sup>, J.D. Rogers<sup>5</sup>, A.Y. Rossman<sup>6</sup> &  
G. J. Samuels<sup>6\*</sup>

<sup>1</sup> 26 rue Alphonse Daudet, 64000 Pau, France

<sup>2</sup> Universitat de Barcelona, Dpto. de Biología Vegetal, Avgda. Diagonal, 645, 08028 Barcelona, Spain

<sup>3</sup> Biological Institute, Øster Farimagsgade 2D, DK-1353, Copenhagen K, Denmark

<sup>4</sup> PO Box 1223, Lincoln, NH 03251, U.S.A.

<sup>5</sup> Dept. Plant Pathology, Washington State Univ., PO Box 646430, Pullman, WA 99164-6430, U.S.A.

<sup>6</sup> United States Dept. of Agriculture, Agriculture Research Service, Systematic Mycology and Microbiology Lab., Rm. 304, B-011A, 10300 Baltimore Ave., Beltsville, MD 20705, U.S.A.

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New combinations and new species are proposed in *Neobarya*: *N. aurantiaca* comb. nov., *N. byssicola* comb. nov., *N. lichenicola* comb. nov., *N. lutea* sp. nov., *N. peltigerae* sp. nov., *N. xylariicola* sp. nov. *Neobarya agaricicola*, and *N. parasitica* are redescribed. Anamorphs associated with *N. agaricicola* (*Calcarisporium*), *N. aurantiaca* (paecilomyces-like), *N. byssicola* (*Diplospora*), *N. danica* (lecanicillium-like), *N. parasitica* (lecanicillium-like), *N. peltigerae* (accremonium-like), and *N. xylariicola* (*Calcarisporium*) are described. *Barya montana* and *B. salaccensis* are excluded from *Neobarya*. A key to species is provided.

Key words: *Accremonium*, *Barya*, *Diplospora*, *Calcarisporium*, *Hypocrella*, *Lecanicillium*, systematics.

*Barya* Fuckel (Fuckel 1870) was originally described with the single species *B. parasitica* Fuckel for *Acrosporum*-like ascomycetes having fleshy, superficial perithecia in thin mycelium and hyaline, continuous ascospores that were as long as the long asci. The formation of uniseptate conidia was also included in the generic description. Saccardo (1883) included *Barya* among the scolecosporous Hypocreaceae, which comprised fungi traditionally included in the Clavicipitaceae. Rogerson (1970) included *Barya* in the Clavicipitaceae. Sung *et al.* (2007) divided the Clavicipitaceae into three

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\* e-mail: [gary.samuels@ars.usda.gov](mailto:gary.samuels@ars.usda.gov)

families, based mainly on molecular-phylogenetic evidence. Because we are not able to place *Neobarya* into the new scheme, we refer here to the Clavicipitaceae in the broad sense of Rogerson (1970). *Barya* has always been included in the Hypocreaceae or Clavicipitaceae and, indeed, the ascus apex of *B. parasitica* is typical of the Clavicipitaceae (see, e.g. Fig. 10 F). Fewer than ten species have been included in *Barya*. Lowen (in Eriksson & Hawksworth 1986), recognizing that *Barya* Fuckel is a later homonym of the flowering plant genus *Barya* Klotzsch 1854 (Bignoniaceae), proposed the new name *Neobarya* Lowen. Not all of the described species of the mycological *Barya* were transferred to *Neobarya*, and it is clear from their descriptions that *B. salaccensis* Racib. and *B. montana* Racib. do not belong in the genus and probably not in the Hypocreales. In the present paper we examine type and other material of described species of *Barya* and propose new combinations for three of them in *Neobarya*. In the past twenty years the collective authors of this paper have gathered new species of *Neobarya*. Here we describe these three new species and discuss taxonomy of *Neobarya* in relation to morphologically similar species in other genera.

## Methods

This research is based in large part on our study of herbarium specimens. Teleomorphs and anamorphs were rehydrated briefly with 3 % (aq.) KOH and crushed under a coverslip. The KOH was replaced with distilled water; measurements were made either in KOH or in water. Very few conidia or discharged ascospores were ever seen in crush mounts; these few were measured. Thus, the reported measurements cannot be considered to be statistically based. Conidial width was measured at the widest point. Cultures of *N. agaricicola*, *N. danica*, *N. lichenophila* and *N. xylariicola* were made from ascospores. Anamorphs and colonies are described from the following media: cornmeal dextrose agar (CMD, Difco cornmeal agar + 2% dextrose) and potato dextrose agar (PDA, Difco potato dextrose agar). Phloxine (1% aq.) was used to reveal septation in ascospores and the ascus cap.

## Characterization and relationships of *Neobarya*

Species of *Neobarya* are fungicolous or lichenicolous. Even *N. byssicola*, which was described from guinea pig dung, is most likely growing on coprophilous fungi. The outstanding morphological characteristic of *Neobarya* is its superficial, smooth, brightly or lightly colored (white or shades of yellow), narrowly ovoidal or flask-shaped perithecia. The perithecial apex is often slightly atte-

nuated, narrowly conical and often subacute. Asci are long, narrowly clavate to cylindrical; their apical cap is typical of the Clavicipitaceae and the ascus base is typically pedicellate (Figs. 5 G, 7 G). Typical ascospores are filiform, usually equal in length to the ascus and  $< 2 \mu\text{m}$  wide; they are described as aseptate but obscure septa form in at least some species. Peck (1890) illustrated septa in ascospores in the type specimen of *B. parasitica* var. *caespitosa* (= *N. parasitica*, Fig. 10 G), and we have observed septate ascospores in other collections of this species. Septate ascospores were also found in the new species *N. peltigeriae* (Figs. 12 G, I) and *N. usneae* Etayo (Etayo 2002). It is very difficult to measure ascospores. Discharged ascospores are rare in crush mounts. Ascospores in asci are either parallel or twisted around each other, thus making their measurement impossible. The longest described ascospores are those of *N. ciliaris* Etayo (150–200  $\mu\text{m}$  *fide* Etayo 2002), *N. lichenophila* (165–175  $\mu\text{m}$  *fide* Etayo 2002), and *N. usneae* (250–400  $\mu\text{m}$  *fide* Etayo 2002). In *N. peltigeriae* discharged ascospores are considerably longer than those still in asci. The perithecial wall is typically thin, comprising a single region of compressed cells. In *N. danica* short-celled, distorted hyphae issue from cells of the perithecial wall surface to form a hyphal mantle that partially covers the perithecium (Fig. 5 D, F). The perithecial apex of *Neobarya* species is often slightly enlarged, almost capitate, and formed of files of cells, the terminal of which are subglobose. An extreme in this development is seen in *N. lichenophila*, where adjacent files of cells separate from each other in crush mounts (Fig. 7 D). Perithecia typically arise in caespitose clusters of several, less frequently they are solitary. Perithecia may be joined at the base by an inconspicuous pseudoparenchymatous (Fig. 10 B, C) or less frequently hyphal (e.g. Fig. 12 C) stroma. *Neobarya aurantiaca* is exceptional in the genus because it arises from sclerotia of *Claviceps purpurea*; the stromatic base is elongated and becomes club-shaped (Fig. 3 A–C). Thus, *N. aurantiaca* is cordyceps-like in its gross morphology (see original illustrations reproduced as Fig. 3 A, B).

#### Anamorphs associated with *Neobarya* species

Perithecia of *N. parasitica* are almost constantly associated with the same anamorph. Like the perithecia, the anamorph is green. The conidiophores form in a loose hymenium over perithecia of the host; they appear to proliferate laterally from a previously formed conidiophore, leaving a spur-like process at the base (Fig. 11 B, C). This conidiophore is similar to that of *Lecanicillium lecanii* Zare & W. Gams, which is the anamorph of *Torrubiella confragosa* Mains (Zare & Gams 2001), another member of the Clavicipitaceae s. lat. The

green coloration of perithecia and conidiophores, and their constant association indicates that this is the anamorph of *N. parasitica*. A morphologically similar anamorph is associated with perithecia of the new species *N. lutea* (Fig. 9 A). A second new species, *N. peltigerae*, produced an acremonium-like anamorph in a culture derived from ascospores; that culture is no longer viable and the anamorph is not present in the dry culture deposited with the specimen. An acremonium-like anamorph was sparingly produced with perithecia on the specimen (Fig. 14 A, B). A *Calcarisporium* formed in dual cultures of the Rogers collection of *N. xylariicola* and its *Xylaria* host (Fig. 14 G), and a calcarisporium-like anamorph is associated with perithecia of that collection (Fig. 14 C–E). An acremonium-like anamorph is associated with the Candoussau collection of *N. xylariicola* but it is possibly the anamorph of *Cosmospora vilior* (Stärb.) Rossman & Samuels, a common parasite of *Xylaria* species. *Neobarya agaricicola* produced a calcarisporium-like anamorph in a culture that resulted from ascospores germinating in asci (Fig. 2 D). Hyaline sclerotia formed in the culture (Fig. 2 E), and somewhat similar sclerotia were found on one additional specimen (Fig. 2 B, C) suggesting that the link between *B. agaricicola* and the calcarisporium with sclerotia is not accidental. This anamorph suggests *Calcarisporium arbuscula* Preuss (Hoog 1974) but this species is said to be associated with brown sclerotia (Hughes 1951). Brown sclerotia similar to those associated with *N. agaricicola* are present on the only known collection of *N. danica*, as is a hyaline-conidial hyphomycete. We were not able to obtain a clear view of the morphology of the associated conidiophore, but the long, tapering phialides and fusiform conidia (Fig. 6) suggest *Lecanicillium* W. Gams & Zare. Only colourless sclerotia, similar to those found on the specimen except for the pigmentation, formed in a culture of this species. Perithecia in the only known specimen of *N. byssicola* form in a cottony, white mycelium that produces an anamorph in abundance. Conidiophores are hyaline and unbranched or once-branched, and smooth. Conidia arise holoblastically (Fig. 4 F, G) from one or two loci at the tip of the conidiophore or its branches; they develop in dry, simple or branched acropetal chains and are cylindrical, 1(–3)-septate and hyaline. Each conidium has a protuberant, flat scar at each end, sometimes two scars are observed at one end. This anamorph is very similar to *Diploospora longispora* Matsushima (Matsushima 1975) but with smaller conidia. The hyaline, denticulate conidiophores and holoblastically-produced conidia at least suggest the *Calcarisporium* anamorph of *N. agaricicola* and *N. xylariicola*. Plowright & Wilson (1884) described and illustrated a paecilomyces-like anamorph arising from the young stroma of *B. aurantiaca*; conidia of this anamorph (Fig. 3 A) were fusiform and held in chains. No

anamorph was observed on the only known collection of *N. licheno-phila*.

### Relationships of *Neobarya*

No species of *Neobarya* has been included in phylogenetic analysis. Because the cultures of *N. agaricicola* and *N. peltigerae* are no longer viable, and because we are unable to free our culture of *N. xylariicola* from its *Xylaria* host, we are not able to apply DNA-based phylogenetic analyses to determine the relationships of *Neobarya* and its species. However, the thick cap in the asci of all species is unequivocal evidence for membership in the Clavicipitaceae.

The diversity of associated anamorphs, presenting both enteroblastic-phialidic and holoblastic-denticulate conidiogenesis, suggests phylogenetic diversity among the species that we include in *Neobarya*, despite the uniformity in morphology and fungicolous habit. *Neobarya* is unusual in the Clavicipitaceae for its fungicolous habit, sharing this with species of *Elaphocordyceps* G.H. Sung & Spatafora (Sung *et al.* 2007) on *Elaphomyces* species, and three species of *Cordyceps* Fr. on *Claviceps* species (*Co. clavicipiticola* Toku-naga & Imai, *Co. clavicipitis* Örtengren and *Co. sclerotium* Y. Kobayasi), and *Epicrea insignis* Petrak on stromata of a *Hypocrella* species.

The most obvious similarity of *Neobarya* is with *Berkelella* (Sacc.) Sacc. Perithecia of the type species, *B. stilbiger* (Berk. & Broome) Sacc., are morphologically and anatomically very similar to those of *Neobarya*. They form on the surface of sporangia of myxomycetes in the Trichiales and most often in association with the synnematus anamorph *Blistum tomentosum* (Schraeder) Sutton (= *Polycephalomyces tomentosus* (Schraeder) Seifert). Seifert (1985) redescribed the species, as *Byssostilbe stilbiger* and *P. tomentosum*, and, because of the morphological similarities of the respective perithecia and parasitic habit, suggested that *Byssostilbe* could be an older name for *Neobarya*. However, ascospores in *Berkelella stilbiger* disarticulate at the septa while still in asci, unlike any species of *Neobarya*; for this reason, and because of the synnematus anamorph, we do not place *Neobarya* in synonymy of *Berkelella*. A molecular phylogenetic analysis of *Blistum tomentosum* placed it in a unique position in the Clavicipitaceae (Bischoff *et al.* 2003).

It is not difficult to envision the apparently simple *Neobarya* morphology as being derived from a number of different phylogenetic lines and, indeed, perithecia in some species of *Cordyceps* and *Hypocrella* are superficial on stromata. In addition to the above-mentioned *Cordyceps* and *Elaphocordyceps* species, perithecia in other genera of the Clavicipitaceae s. lat. are similar to those of

*Neobarya*. In *Torrubiella* Boud. superficial perithecia form in a mycelial mat on spiders and scale insects, but in *Torrubiella* ascospores disarticulate at the septa while still in asci and anamorphs are species of *Gibellula* Cavara, *Hirsutella* Pat., *Lecanicillium*, *Paecilomyces* Bainier, and *Simplicillium* W. Gams & Zare (Kobayashi 1982, Zare & Gams 2001). In *Epicrea insignis*, type of the monotypic genus, perithecia are densely cespitose and joined by pale orange mycelium that grows over the fertile part of a stroma of *Hypocrella chusqueae*. Perithecia of *E. insignis* are dark purple in 3 % KOH (Rossman *et al.* 1999).

**Taxonomy**

***Neobarya*** Lowen in Eriksson & Hawksworth, System. Ascom. 5: 121. 1986

≡ *Barya* Fuckel, Fungi rhenani 991. 1864 (on printed label) *non* Klotzsch, 1854 (Bignoniaceae).

= *Baryella* Rauschert, Haussknechtia 4:51. 1988.

Type species: *Neobarya parasitica* (Fuckel) Lowen

Ascomata soft, superficial, sessile, seated on a pseudoparenchymatous stroma or in a subiculum, light colored, white, green, yellow or orange, sometimes dark and horny when dry. Asci unitunicate, cylindrical or narrowly clavate to lanceolate, with enlarged thickened apical cap, *ca.* 3.5 × 3.5 µm, penetrated by a pore. Ascospores filiform, often flexuous, hyaline, guttulate, aseptate or septa obscure, remaining entire.

**Key to species of *Neobarya* and morphologically similar fungi**

- 1. On spiders and scale insects, ascospores disarticulating into parts in the ascus . . . . . *Torrubiella* (Kobayashi 1982)
- 1. On myxomycetes, agarics, Aphyllophorales, other pyrenomycetes (sometimes on guinea pig dung) or lichens. . . . . 2
- 2. On myxomycete sporangia (Trichiaceae), anamorph synnematous . . . . . *Berkelella stilbigera* (Seifert 1985)
- 2. On agarics, aphyllophorales, other pyrenomycetes (sometimes on dung) or lichens; anamorph not synnematous . . . . . 3
- 3. On small, marasmiod agarics . . . . . **1. *Neobarya agaricola***
- 3. On Aphyllophorales, lichens or pyrenomycetes including *Claviceps*, *Hypocrella*, *Xylaria*, *Bertia*, or dung-inhabiting species . 4
- 4. Perithecia green, mainly on *Bertia* . . . . **8. *Neobarya parasitica***
- 4. Perithecia white or in shades of yellow; on lichens, *Claviceps*, *Hypocrella*, *Xylaria* or on Aphyllophorales (appearing to be on decorticated wood) or dung-inhabiting pyrenomycetes . . . . . 5

5. Perithecia orange; on *Claviceps* stroma, perithecia arising from a stalk . . . . . **2. *Neobarya aurantiaca***
5. Perithecia orange, luteous or white; on lichens, *Xylaria*, *Hypocrella*, on Aphyllophorales or dung-inhabiting pyrenomycetes. . 6
6. On Aphyllophorales or appearing to be on decorticated wood, perithecia white, forming in a white tomentum . . . . . **4. *Neobarya danica***
6. On lichens, *Xylaria*, *Hypocrella* or dung-inhabiting pyrenomycetes . . . . . 7
7. Perithecia immersed in *Hypocrella* stroma . . . . . *Epicrea insignis* (Rossman *et al.* 1999)
7. On lichens, *Xylaria* stroma or dung-inhabiting pyrenomycetes . 8
8. On dung-inhabiting pyrenomycetes, associated with *Diplospora* anamorph. . . . . **5. *Neobarya byssicola***
8. On *Xylaria* or lichens . . . . . 9
9. On *Xylaria* . . . . . 10
9. On lichens . . . . . 11
10. Perithecia orange when dry; perithecial wall to 75 µm wide, formed of thick-walled cells, North Temperate . . . . . **10. *Neobarya xylariicola***
10. Perithecia pale luteous when dry; perithecial wall to 15 µm wide, formed of thin-walled cells; Puerto Rico . . . . . **7. *Neobarya lutea***
11. Ascospores in asci < 100 µm long; on *Peltigera membranacea*, perithecia yellow to orange when dry and fresh, ascospores in asci < 100 µm long . . . . . **8. *N. peltigerae***
11. Ascospores in asci > 150 µm long . . . . . 12
12. Ascospores 250–400 × 2.5–3.5 µm; on *Usnea* . **9. *Neobarya usneae***
12. Ascospores < 200 µm long, ≤ 1 µm wide. . . . . 13
13. On *Cladonia* sp.; ascospores 165–175 µm long; perithecia yellowish when fresh . . . . . **6. *Neobarya lichenophila***
13. On cilia of *Heterodermia*; ascospores 140–190 µm long; perithecia intensely orange . . . . . **3. *Neobarya ciliaris***

# Descriptions of the species of *Neobarya*\*

\* Color images of the fungi can be seen at <http://nt.ars-grin.gov/taxadescrptions/publications/>

## 1. ***Neobarya agaricicola*** (Berk.) Samuels & Lowen, **comb. nov.** – Figs. 1, 2.

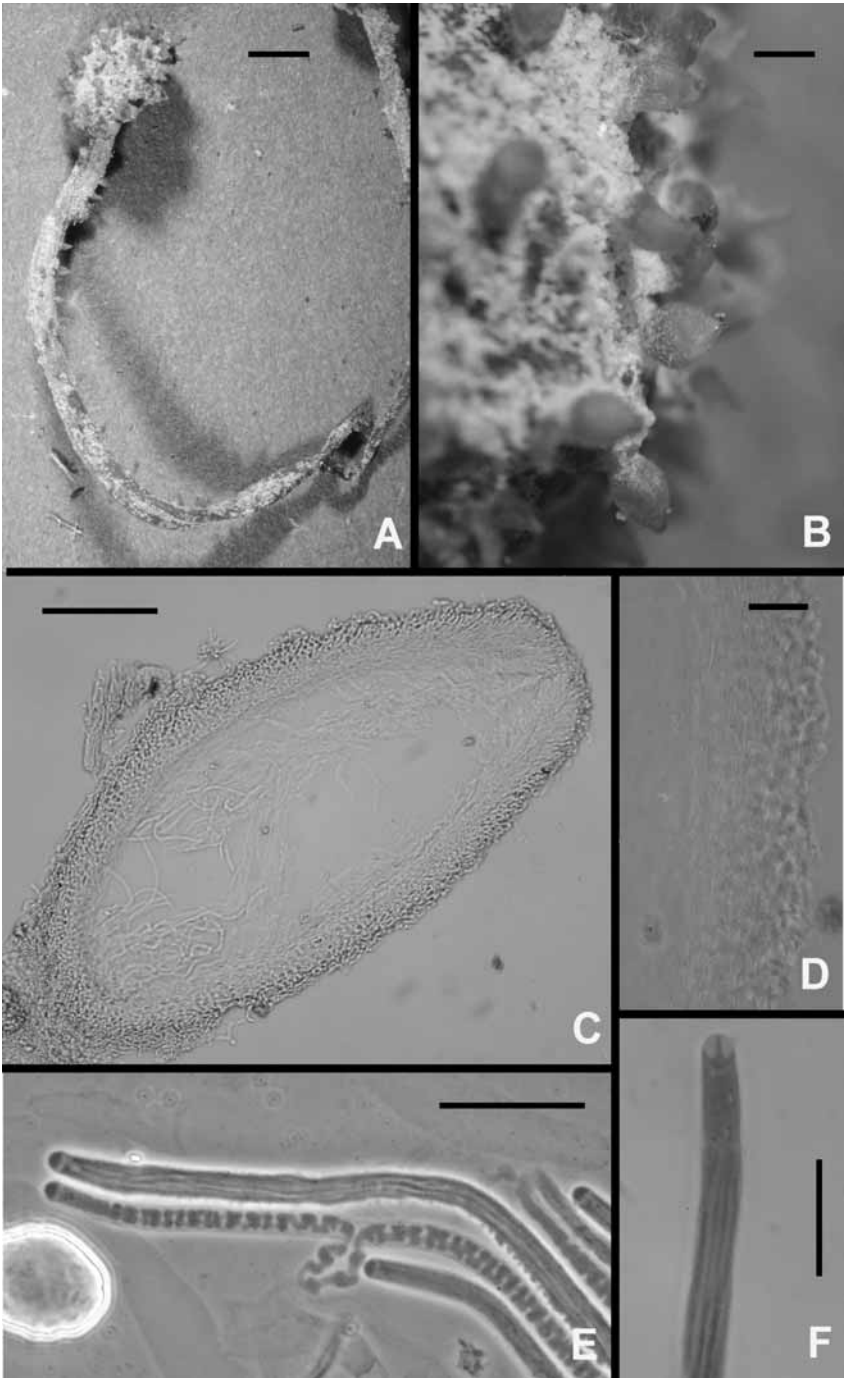
Basionym. – *Nectria agaricicola* Berk. in Hooker, Botany of the Antarctic Voyage. iii. Flora Tasmaniae 2: 278. 1859. [non P. Henn., 1899].

≡ *Ophionectria agaricicola* (Berk.) Sacc., Syll. Fung. 2: 563. 1883.

≡ *Barya agaricola* (Berk.) Höhnelt in Höhnelt & Weese, Annal. Mycol. 8: 464. 1910.

Anamorph: *Calcarisporium* sp.

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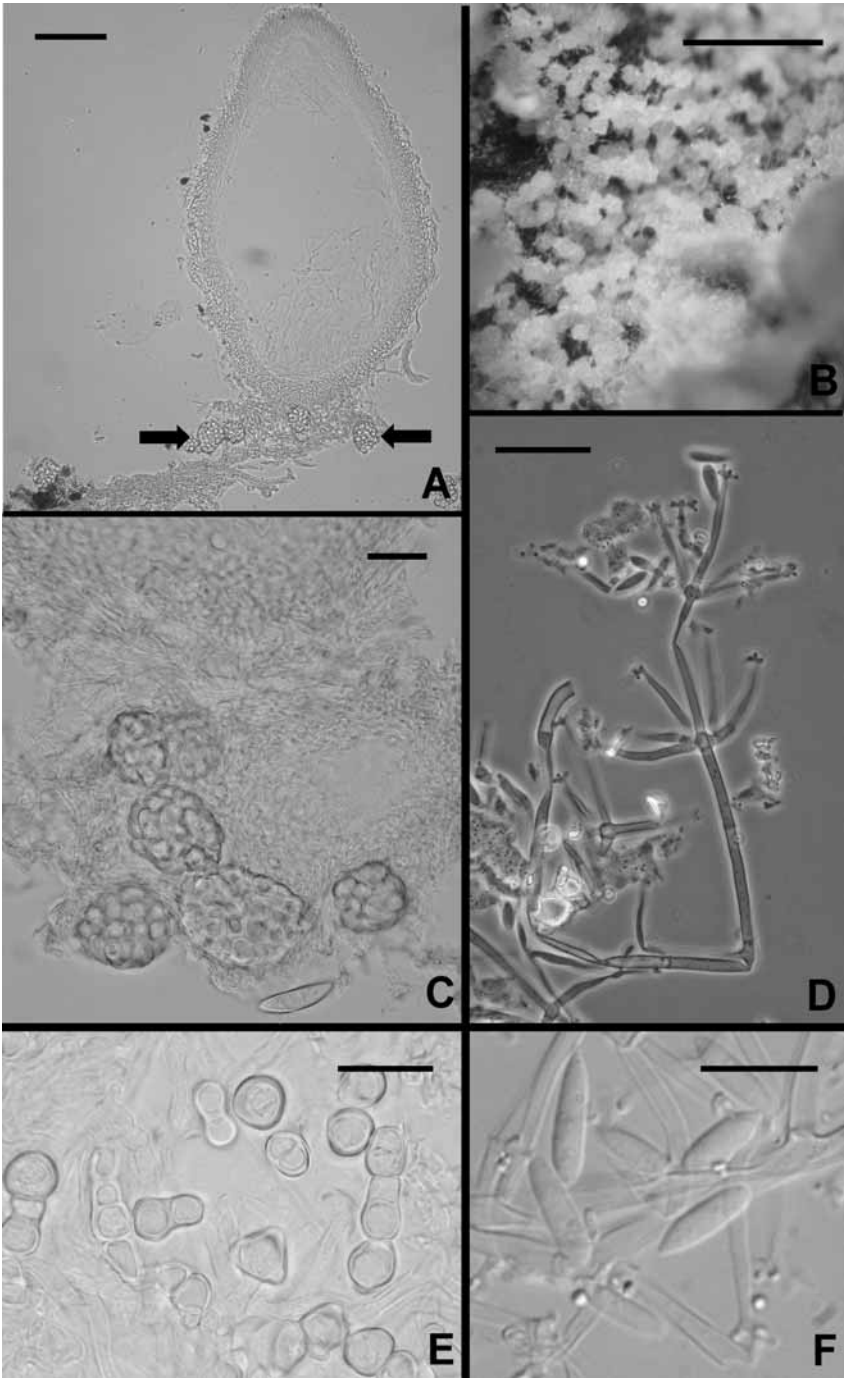


*Perithecia* solitary to densely gregarious on cap and stipe of small, marasmiod, white-spored agarics, superficial on a densely compacted layer of hyphae, elongate-ovoidal, 435–550 µm tall, 265–365 µm wide, with apex acute, smooth, orange, yellow in 3 % KOH, collapsing by lateral pinching. Perithecial wall *ca.* 45 µm wide, comprising 2 regions. External region *ca.* 30 µm wide, formed of intertwined hyphae, in section appearing pseudoparenchymatous, lumina 3–5 µm diam, walls conspicuously thick, 1.5–2.0 µm, cells becoming progressively more flattened toward the interior. Inner region *ca.* 20 µm wide, comprising several layers of highly flattened, thin-walled cells. Papilla formed of narrow hyphal elements continuous with outer region of perithecial wall; terminal cells tending to be clavate and slightly thick-walled except elements around the ostiolar opening; elements around ostiolar opening thin-walled, not enlarged, continuous with periphyses. Asci linear, 140–350 × 3.5–6.0 µm, apex thickened with a conspicuous cap; ascospores intertwined in the ascus. Ascospores thread-like, appearing to be the full length of the ascus 0.5–0.7 wide, aseptate (?), remaining entire, not often discharged. Sclerotia conspicuous, numerous on host, globose, 30–50 µm diam, white, formed of thick-walled cells, 3.5–9.0 µm diam, walls 1–3 µm wide.

Characteristics in culture. Cultures derived from individual asci slow growing, 1–2 mm diam on CMD and Difco PDA within 1 wk at 20 °C under 12 h darkness/12 h cool white fluorescent light, white, felty. Conidiophores arising abundantly in the aerial mycelium, verticillately branched, 50–130 µm long, smooth, septate, base 3–4 µm wide, unbranched or producing 1 or 2 verticils of 1–6 conidiogenous cells; conidiogenous cells tapering uniformly from base to tip, 20–30 µm long, 2–3 µm wide at base, producing a terminal cluster of 4–6 denticles; denticles to 3 µm long, cylindrical, flat, not cicatrized. Conidia cylindrical to slightly clavate, (5.7–)6.7–8.7(–10.0) × 3.0–4.5 µm, base attenuated to a protruding abscission scar, 0(–1)-septate, held in dry heads at the tip of each conidiogenous cell. White sclerotial bodies forming in cultures.

Material examined. AUSTRALIA, Victoria, Bealon Naringae between Cobden & Warrnambool, on agaric in Eucalyptus forest, 28 Jun 1971, G.Beaton 374 (IMI 200395). NEW ZEALAND, North Island, Gisborne, Urewera National Park,

**Fig. 1.** – *Neobarya agaricicola*, teleomorph. **A.** Marasmiod agaric with perithecia of *N. agaricicola* on stipe and cap. **B.** Perithecia on cap of agaric host. **C.** Median, longitudinal section of a mature perithecium. **D.** Section of the lateral wall of the perithecium. **E, F.** Asci showing thick apical cap and filamentous ascospores. **F** stained in phloxine (1 % aq.). A–D, F from PDD 50035, E from BPI 842162. Scale bars: A = 2 mm, B = 500 µm, C = 100 µm, D, E = 20 µm; F = 10 µm.



Lake Waikaremoana, on agaric, 9 May 2001, *E. Horak s.n.* (BPI 842162). NEW ZEALAND, South Island, Southland, Catlins State Forest, Table Hill Scenic Reserve, track to Matai Falls, on agaric, 18 Apr 1985, G.J. Samuels 85-20, P.K. Buchanan, L.M. Kohn (PDD 50035, cultured from ascospores).

Comments. – A culture of specimen PDD 50035 was obtained when ascospores in asci germinated. Although single ascospores were not observed to germinate, we consider the *Calcarisporium* that formed in those cultures to be the anamorph of *N. agaricicola*. Moreover, sclerotial bodies similar to those formed in culture, but much smaller, were also found on the specimen. We did not observe a *Calcarisporium* anamorph on the specimen and consider it unlikely that *Calcarisporium* conidia contaminated all cultures that were isolated. This culture is no longer viable, but dry cultures were deposited with the specimen. There is similarity of this *Calcarisporium* to *C. arbuscula* as described by Hughes (1951).

*Neobarya agaricicola* is a highly distinctive species because its relatively large perithecia form in great abundance on the small basidiomata of its marasmioid agaric host. Although it is not uncommon in eastern Australia (Tasmania, Victoria) and New Zealand, possibly only in *Nothofagus* forests, it is rarely reported from elsewhere (New York: Rossman, 1977; Java: Hennings & Nyman in Warburg, 1900).

## 2. *Neobarya aurantiaca* (Plowr. & A.S. Wilson) Samuels & Candous-sau, **comb. nov.** – Fig. 3.

Basionym. – *Barya aurantiaca* Plowright & A.S. Wilson, Gardner's Chronicle 21: 176. 1884.

≡ *Cordyceps aurantiaca* (Plowr. & A.S. Wilson) S. Imai, Acta. Phytotax. Geo. Bot. 13: 86. 1943 (*vide* Mycobank, not seen).

≡ *Baryella aurantiaca* (Plowr. & A.S. Wilson) Rauschert, Haussknechtia 4:51. 1988.

= *Claviceps wilsonii* Cooke, Grevillea 12: 77. Mar 1884

= *Claviceps purpurea* (Fr. : Fr.) Tul. var. *wilsonii* W.G. Smith, Diseases of Field and Garden Crops p. 232. 1884

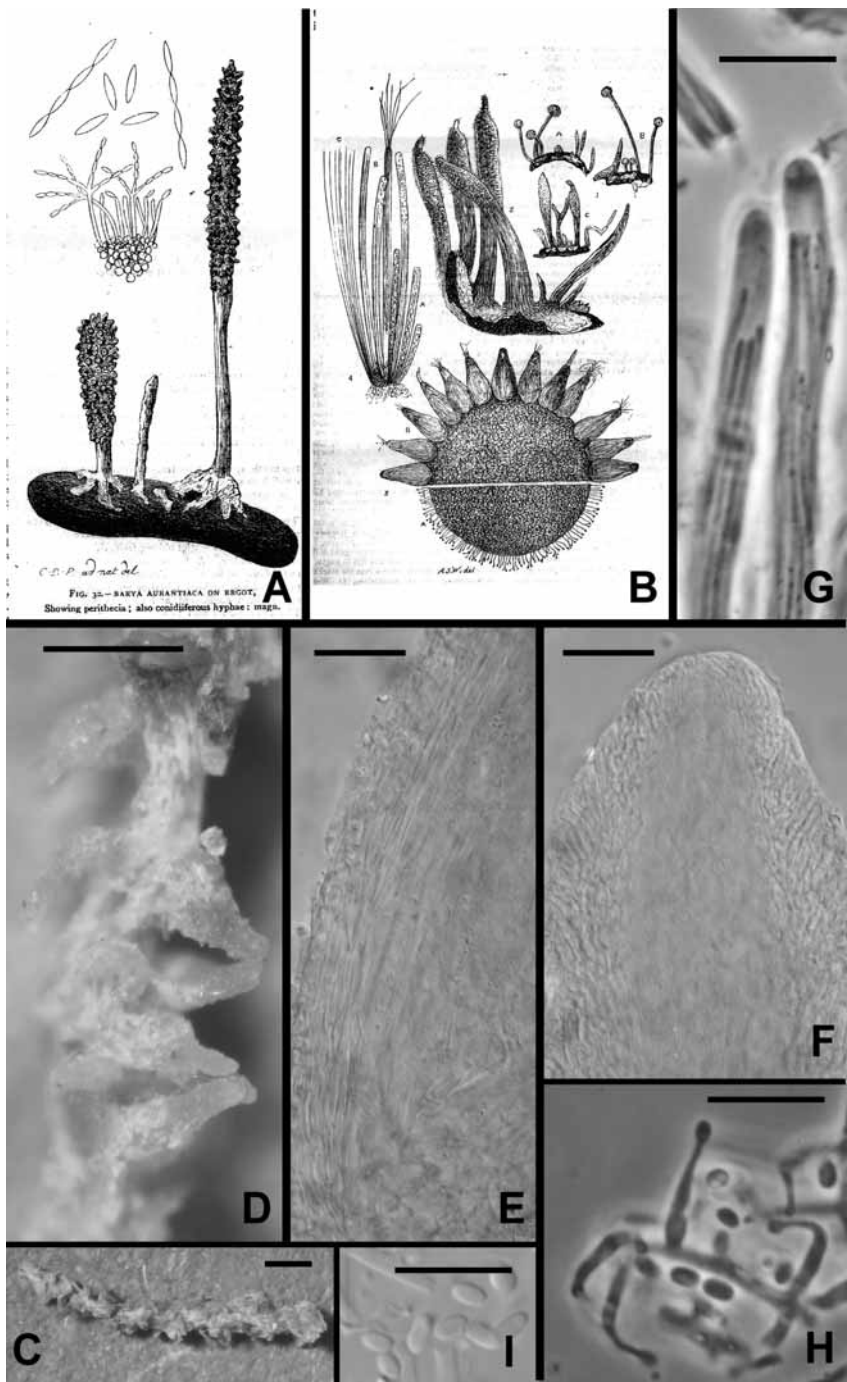
Anamorph: acremonium- or paecilomyces-like (associated)

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Stroma arising from sclerotia of *Claviceps purpurea*, to 10 mm long, 1 mm diam, cylindrical, orange, pale yellow in 3 % KOH, smooth, or stroma sessile. Perithecia superficial, crowded along

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**Fig. 2.** – *Neobarya agaricicola*, anamorph. **A.** Off center section of a perithecium showing sclerotia at the perithecial base (arrows). **B.** Sclerotia produced around perithecia on the host. **C.** Sclerotia in nature consist of balls of cells. **D.** *Calcarisporium* conidiophore produced in culture. **E.** Sclerotia produced in agar consist of single cells or a few cells in a chain. **F.** Conidia produced in culture. All from PDD 50035. Scale bars: A = 100 µm, B = 150 µm, C–E = 20 µm, F = 10 µm.



the length of the stroma and densely clustered at the tip, covering the surface of sessile stromata, narrowly ovoidal to narrowly obpyriform, 500–600  $\mu\text{m}$  tall, *ca.* 250  $\mu\text{m}$  wide, papilla to 150  $\mu\text{m}$  long, orange when dry, pale yellow in 3 % KOH, collapsing by lateral pinching, smooth, white hyphae covering the lower half of the perithecium. Perithecial wall *ca.* 25  $\mu\text{m}$  thick, comprising a single region of fusoid, cells 10–15  $\mu\text{m}$  long, walls slightly thickened toward the exterior. Papilla formed of narrow hyphal elements continuous with the outer region of the perithecial wall; terminal cells tending to be clavate and slightly thick-walled except elements around the ostiolar opening; elements around the ostiolar opening thin-walled, not enlarged, continuous with the periphyses. Asci linear, length could not be determined, *ca.* 5  $\mu\text{m}$  wide, apex thickened with a conspicuous cap, ascospores intertwined in the ascus. Ascospores could not be measured, thread-like, aseptate (?), remaining entire, discharged spores not seen.

Material examined. – ENGLAND ?, 'sine loc,' on sclerotium of *Claviceps purpurea* (?), on *Glyceria*, Wilson (K(m) 63316 ex hb. Cooke, HOLOTYPE). Second specimen, same data annotated anonymously: 'probably a part of the holotype' (K(m) 136881 ex hb. C.B. Plowright).

Comments. – The description given above is based on the type collection. *Neobarya aurantiaca* is distinguished by its occurrence on black sclerotia of *Claviceps* ? *purpurea* and by the formation of a cylindrical stroma. When the stroma is sessile, it is completely covered with perithecia, which, then, have the appearance of being seated directly on the host sclerotium.

An acremonium-like anamorph was found in the white mycelium at the perithecial base on K(m) 136881 (Fig. 3 H, I). Its link to the *Neobarya* is questionable but possible. Conidiophores arise from 1.5–1.7  $\mu\text{m}$  wide hyphae, 7.5–10  $\mu\text{m}$  long, 1.2–1.5(–2)  $\mu\text{m}$  wide at the base, tapering uniformly from base to tip. Conidia are oblong to ellipsoidal, (2.2–)2.5–2.7(–3.0)  $\times$  (1.2–)1.5–1.7  $\mu\text{m}$  wide, unicellular, hyaline.

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**Fig. 3.** – *Neobarya aurantiaca*. **A, B.** Illustrations from the protologue. Anamorph shown in upper left of A. Clavate stromata arising from sclerotium of *Claviceps purpurea* shown in A and B. Lower part of B showing arrangement of superficial Perithecia around the cylindrical stroma. **C, D.** Part of the holotype collection showing Perithecia arising from a cylindrical stroma (K). **E.** Lateral perithecial wall. **F.** Perithecial papilla. **G.** Ascus showing thickened cap and filamenous ascospores (stained in 1 % aq. phloxine). **H, I.** Anamorph associated on host. **H.** acremonium-like conidiophores. **I.** Conidia. C, D, G from K(m) 136881; E, F, H, I from K(m) 63316. Scale bars: C = 0.5 mm, D = 150  $\mu\text{m}$ , E, F = 20  $\mu\text{m}$ , G–I = 10  $\mu\text{m}$ .

Apparently *N. aurantiaca* occurs only on the floating grass *Glyceria fluitans* in the U.K. Smith (1884) described and beautifully illustrated this species as *Claviceps purpurea* var. *wilsonii* as follows (Smith 1884: 235): “The *Claviceps* grows from the interior of the ergot, and bursts through cracks on the surface. Sometimes the crack or opening is very small, and through this small opening the *Claviceps* emerges and speedily produces a matted base of mycelium upon the surface of the ergot, before the club is produced. In some instances the base of spawn is so thick that the *Claviceps* superficially resembles a parasite upon ergot rather than a true fruiting condition of ergot itself. Sometimes this effused mycelium spreads over the ergot, and several clubs arise from one stratum of mycelium which may have emerged from one minute hole or crack in the black ergot or *Sclerotium*.” Dennis (1981) illustrated it based on type material. Apinis & Chesters (1964) reported the species from the U.K. on litter of *G. fluitans* but their description does not mention sclerotia of a *Claviceps* or the formation of a stroma and the described perithecia are smaller than we have seen in the type specimen. Alderman (2003) reviewed the taxonomy and morphology of this species, although he incorrectly attributed the combination in *Neobarya* to Rauschert.

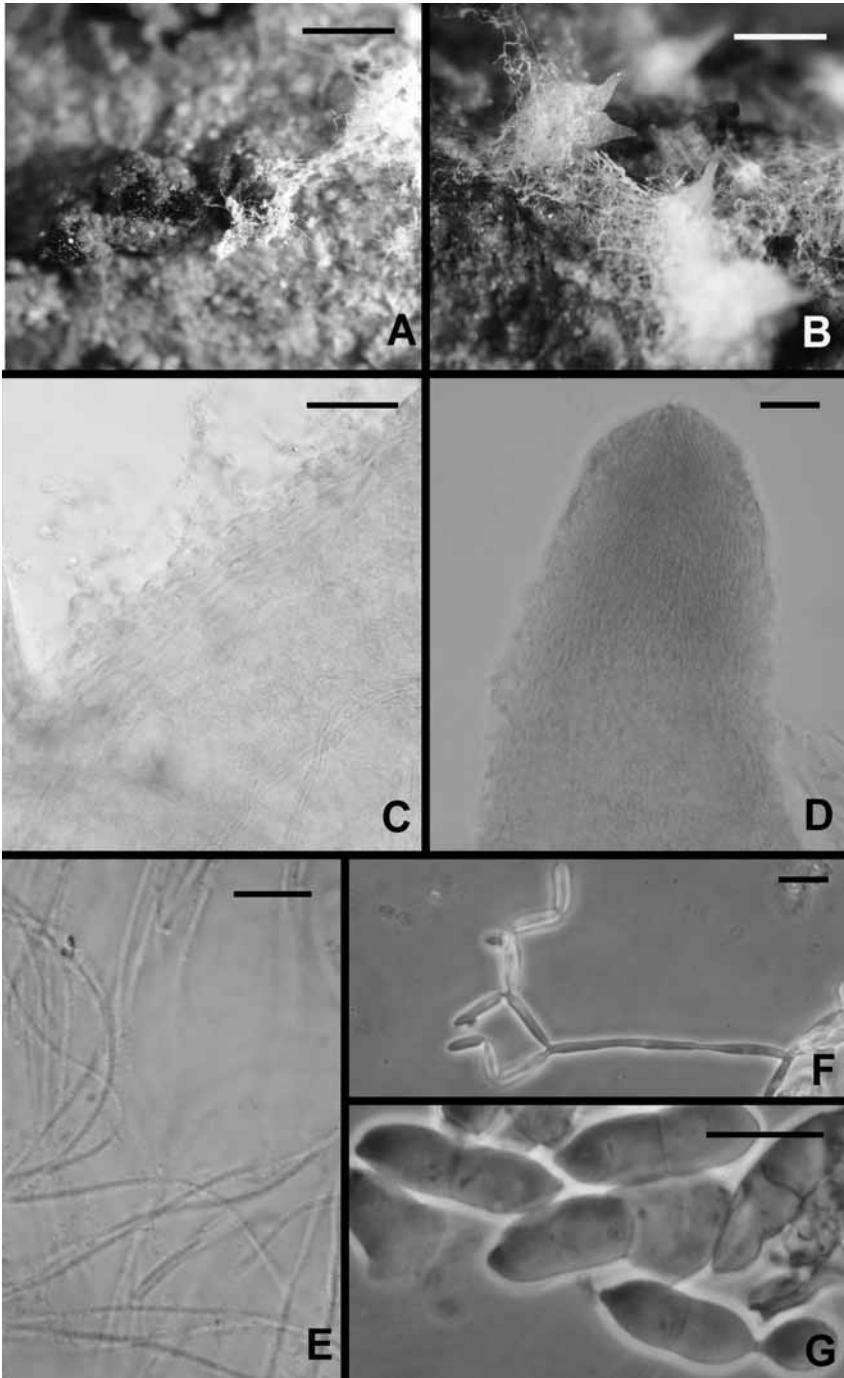
The combination ‘*Neobarya aurantiaca* (Plowr. & A.S. Wilson) Lowen’ was not validly published previously, and in species fungorum (<http://www.speciesfungorum.org/Names/GSDspecies.asp?RecordID=438742>) the combination is listed as ‘ined.’ This is the first valid publication of the combination *Neobarya aurantiaca*.

### 3. *Neobarya ciliaris* Etayo, Biblioth. Lichenol. 84: 74. 2002.

Perithecia scattered, ovoidal to obclavate, 400–600 µm tall, 120–180 µm wide, orange, laterally compressed. Perithecial wall blue in KI, *textura epidermoidea*. Asci cylindrical, 150–200 × 2.5–3.0 µm, 4-spored. Ascospores filiform, 140–190 × ca. 1 µm.

Holotype-COLOMBIA, Nariño, Pasto, El Encano, Sta. Isabel, S lago La Cocha (Guamués), 2700 m, on cilia of *Heterodermia lutescens*, 30 Jul 1998, Churchill, J. Etayo 17386, J. Muñoz & B. Ramírez (COL, not examined).

**Fig. 4.** – *Neobarya byssicola*. **A.** A pustule containing ascospores of *Coniochaeta* spp. and operculate discomycetes; the mycelium is produced by the *Neobarya* and grows from the pustule of a likely host fungus. **B.** Perithecia in white, conidiogenous mycelium. **C.** Lateral perithecial wall showing attached hyphae. **D.** Perithecial apex. **E.** Discharged, filamentous ascospores. **F, G.** Associated *Diplospora* anamorph. **F.** Conidiophore. **G.** Conidia. All from the holotype. Scale bars: A, B = 0.5 mm, C–F = 20 µm, G = 10 µm.



Comment: The description is paraphrased from the protologue (Etayo 2002). We have not seen this species.

4. ***Neobarya byssicola*** (Rossman) Rossman & Samuels, comb. nov. – Fig. 4.

Basionym. – *Barya byssicola* Rossman, Mycologia 69: 370. 1977.

Anamorph (associated): *Diploospora* cf. *longispora* Matsushima, Icones Microfungorum a Matsushima Lectorum p. 61, pl. 44. 1975

MYCOBANK 511233

Perithecia solitary to cespitose in groups of a few, partially immersed in cottony, white byssoid, conidiogenous mycelium, pale yellow, not changing color in 3 % KOH, flask-shaped with an attenuated apex, 585–650 µm tall, 300–400 µm wide below the middle, apex subacute, collapsing by lateral pinching. Perithecial wall *ca.* 15 µm wide, comprising a single region of flattened, compressed cells. Papilla formed of narrow hyphal elements, not anatomically distinct from the lateral perithecial wall. Asci linear, 250–450 × 2–3 µm, apex thickened with a conspicuous cap; ascospores intertwined in the ascus. Ascospores thread-like, appearing to be the full length of the ascus, 0.7–1.0 µm wide, aseptate (?), remaining entire, not often discharged.

Associated anamorph forming abundantly in the aerial mycelium. Conidiophores arising from hyphae, macronematous, mononematous, 90–100 µm long, cylindrical or tapering slightly from the *ca.* 4 µm wide base, septate, unbranched or once branched near the tip, straight, smooth, hyaline, producing conidia from one or two terminal loci and occasionally from a lateral locus. Conidia developing in acropetal chains, blastic, each apparently arising from the blown-out end of a previously formed conidium, cylindrical, 12–20 × 4.5–6.0(–6.5) µm, a flat, protuberant abscission scar at each end, 1(–3)-septate, slightly constricted or waisted at the septa, smooth, hyaline, dry.

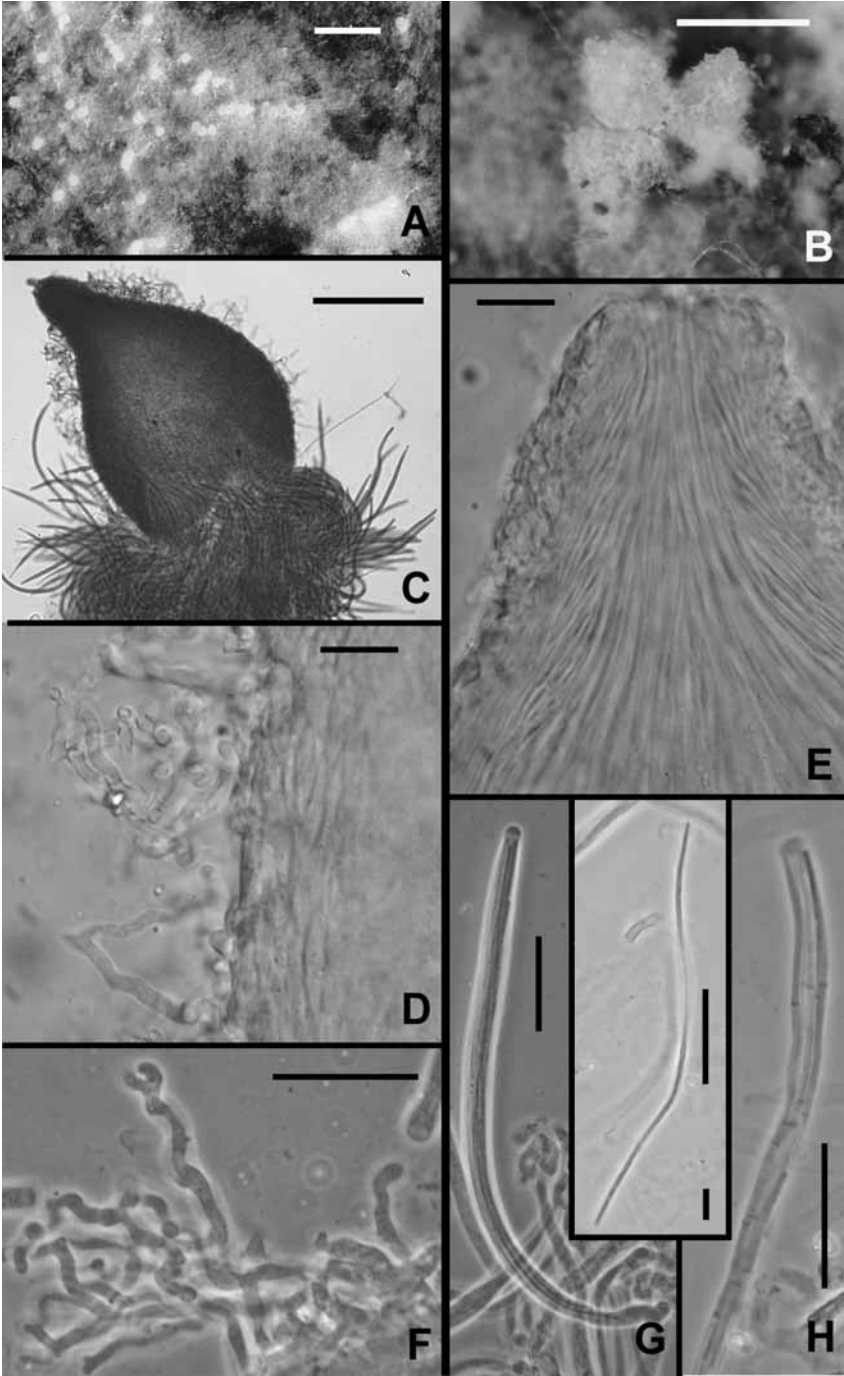
Holotypus. – ARGENTINA, Slavallol, 1905–1906, R. Thaxter 5262 (FH).

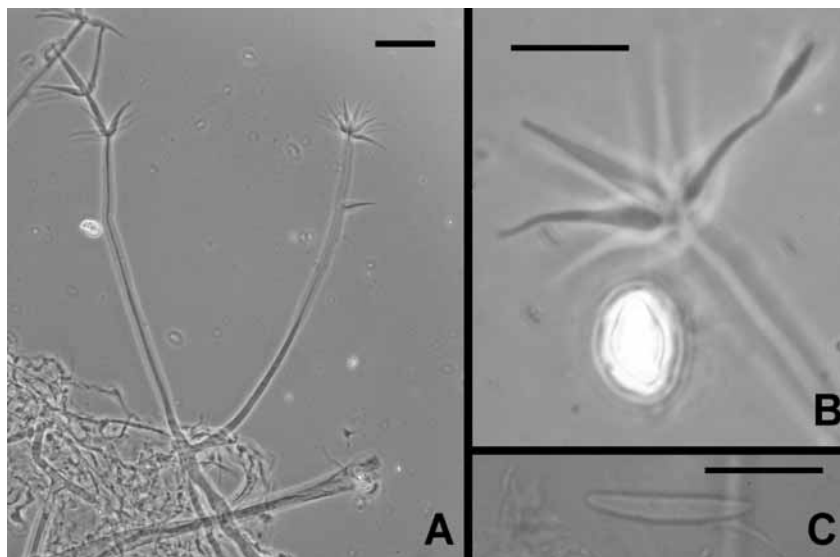
Comments: Rossman (1977) described and illustrated this species. It was described as occurring on dung of guinea pig. The holotype specimen comprises 3 dung pellets; two of them are conspicuously infected with the *Neobarya* along with other fungi. From

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**Fig. 5.** – *Neobarya danica*, teleomorph. **A–C.** Perithecia. **D.** Section of lateral wall of a perithecium showing attached hyphae. **E.** Section of the papilla. **F.** Hyphae arising from the perithecial wall. **G, H.** Asci. **I.** One ascospore. All from the holotype. Scale bars: A = 1 mm, B = 0.5 mm, C = 200 µm, D–I = 20 µm.







**Fig. 6.** – *Neobarya danica*, associated anamorph. **A.** Conidiophores. **B.** Verticillate conidiogenous cells. **C.** Conidium. All from holotype. Scale bars: A = 20 µm, B, C = 10 µm.

one microscope preparation of the fungi from which the associated white mycelium arose, ascospores of three or four species were observed, including one or two *Coniochaeta* species, one *Saccobolus* and one *Lasiobolus*. Thus the true substratum of this *Neobarya* is mostly likely one of these fungi and not the dung *per se*.

The white mycelium in which the *Neobarya* perithecia are formed is richly conidial. The illustration provided by Matsushima (1975) for *Diploospora longispora* is very similar to this associated anamorph, although the conidia of *D. longispora* are larger than we have observed. The type of *Diploospora* Grove, *D. rosea* Grove, occurs on dung but has much shorter, broadly ellipsoidal conidia (Hughes 1968).

**5. *Neobarya danica* J.G.B. Nielsen & Læssøe, *sp. nov.* – Figs. 5, 6.**

Anamorph. – *Lecanicillium* sp. (associated)

MYCOBANK 511234

Perithecia solitaria vel gregaria, in bysso albo superficiali vel basi immersa, ovoidea vel obpyriformia, ca. 350 µm alta, 245 µm lata, apice acuto praedita, alba, in 3 % KOH non mutabili, in sicco collapsa. Paries peritheci 25–30 µm crasso, papilla periphysibus. Asci lineares, 130–140 × 4.5–5.5 µm, pileo apicali incrassato. Ascosporae filiformes, aseptatae, 80–95 × 1.2–1.7 µm. Status anamorphicus: *Lecanicillium* consociatum.

Holotypus. – DENMARK, Sjælland [Sealand], Hillerød, Store Dyrehave, Rågård Mose, lignum *Piceae* sp., 19 Nov. 2005, J.G.B. Nielsen 05–049 (C).

Perithecia solitary to gregarious in groups of a few on decorticated wood and degenerated corticioid basidiomycete, superficial on a white byssus or with base immersed in the byssus, ovoidal to obpyriform, *ca.* 350  $\mu\text{m}$  high, 245  $\mu\text{m}$  wide, apex acute, white, not changing color in 3 % KOH, collapsed by lateral pinching when dry, hyphae forming a dense coat over the perithecial wall; hyphae 2–3  $\mu\text{m}$  wide, frequently septate and frequently branched dichotomously, anastomosing, many free ends visible, sterile. Perithecial wall 25–30  $\mu\text{m}$  wide, comprising a single region of fusoid cells 4–11  $\times$  2.0–2.5  $\mu\text{m}$ , walls at most slightly thickened, the hyphal mantle arising from cells at the exterior. Papilla with a thin mantle of small-celled pseudoparenchyma at the exterior, tissue within comprising narrow hyphal elements continuous with the inner regions of the perithecial wall and with the periphyses. Asci linear, 130–140  $\times$  4.5–5.5  $\mu\text{m}$ , apex thickened with a conspicuous cap. Ascospores thread-like, 80–95  $\times$  1.2–1.7  $\mu\text{m}$ , aseptate.

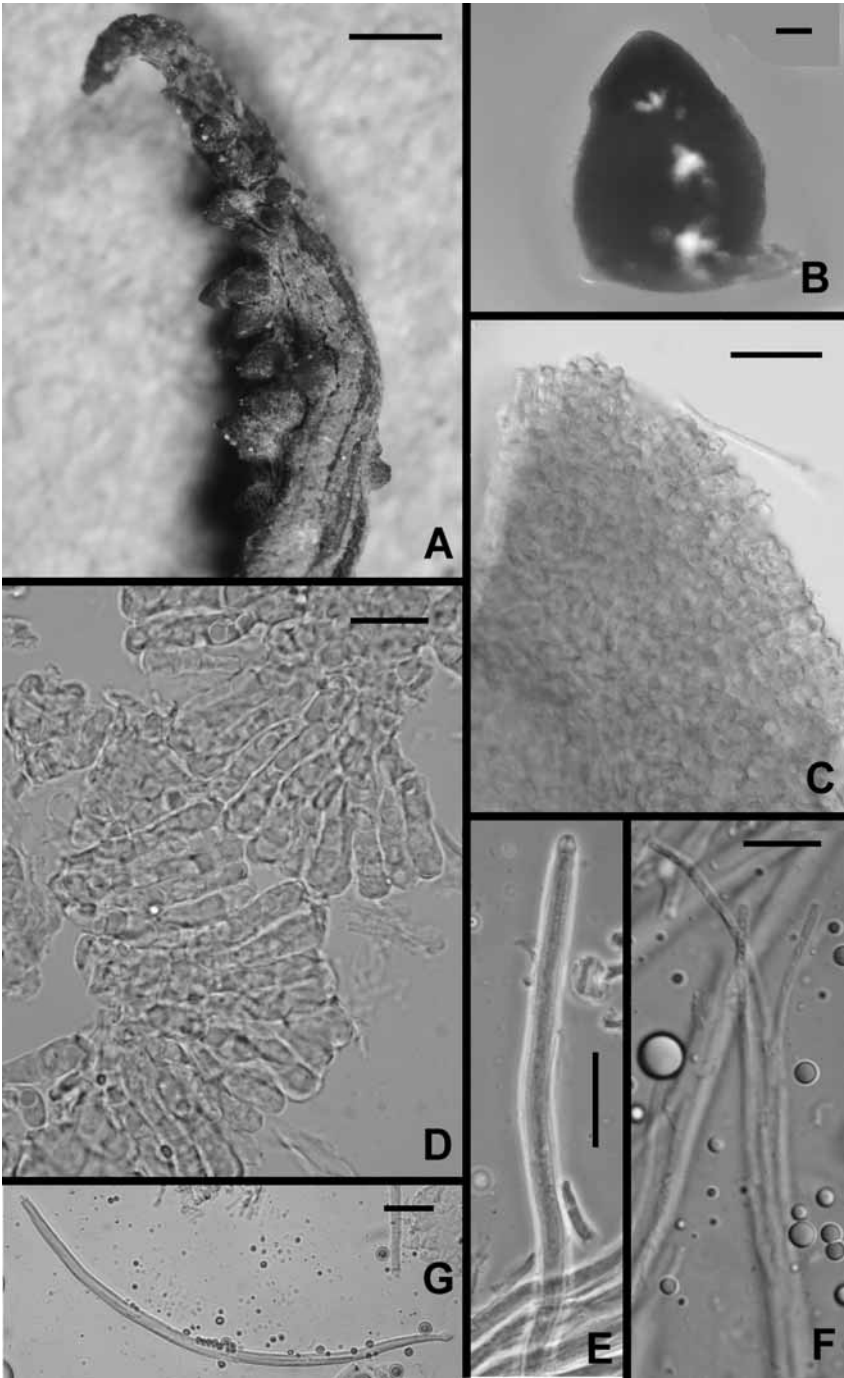
Characteristics in culture. – Colonies grown on potato dextrose agar (PDA, Difco) and cornmeal agar (Difco) with 2 % dextrose (CMD) for 6 wk at 25 °C under 12 h darkness/12 h cool white fluorescent light. Colonies on PDA 4 cm diam, waxy with no aerial mycelium, center of colony highly convoluted, crustose, buff in color, colony otherwise off-white; colony reverse convoluted. Chains of globose to angular cells forming in the submerged mycelium. Colonies on CMD 2 cm diam but with a much faster sector, white, mycelium immersed. Globose, multicellular sclerotial structures forming along the length of submerged hyphae. Individual cells of structures pseudoparenchymatous, 5–14  $\mu\text{m}$  diam, walls 0.5–1.0  $\mu\text{m}$  thick, hyaline. No hyphomycetous synanamorph observed in cultures.

Associated anamorph in nature lecanicillium-like; conidia, subfalcate, 9–10  $\times$  *ca.* 2  $\mu\text{m}$ , unicellular, formed sparingly on the substratum in association with perithecia. Conidiophores 135–150  $\mu\text{m}$  long, 2.5–2.5  $\mu\text{m}$  wide at the base, smooth; conidiogenous cells forming in one or two divergent whorls of up to 6, 12–14  $\times$  *ca.* 1.5  $\mu\text{m}$  at the base, tapering to an acute tip; conidiogenous locus fine, periclinal thickening not seen. The method of conidiogenesis not determined.

**Etymology.** – *Danica* refers to the country of origin, Denmark.

**Holotypus.** – DENMARK, Sjælland [Sealand], Hillerød, Store Dyrehave, Rågård's Mose, on disintegrated corticioid ? basidiomycete on decorticated wood of *Picea* sp., 19 Nov. 2005, J.G.B. Nielsen 05-049 (C)

**Comments.** – *Neobarya danica* is distinctive because of the spreading white mycelium in which perithecia form. The culture



described above was obtained by shooting ascospores onto agar. Apart from the sclerotia, that culture remained sterile. Sclerotia similar to those formed in culture were observed in the specimen. The lecanicillium-like anamorph found in nature is consistent with a member of the Clavicipitaceae and thus could be the anamorph of *N. danica*.

6. ***Neobarya lichenophila*** (Ferd. & Winge) Lowen & Samuels, **comb. nov.** – Fig. 7

Basionym. – *Barya lichenophila* Ferd. & Winge, Bot. Tidsskr. 29: 312. 1909.  
MYCOBANK 511235

Perithecia cespitose on an obscure stromatic base, forming toward the tip of a fertile branch of a *Cladonia* sp., erumpent, becoming superficial with remains of the lichen thallus adherent,  $\pm$  ovoidal, 270–350  $\mu\text{m}$  tall, 170–250  $\mu\text{m}$  wide, slightly constricted below the acute apex; black when dry, orange in 3 % KOH. Cells of the perithecial wall surface hyphal, densely intertwined; the perithecial apex formed of a *ca.* 70  $\mu\text{m}$  wide palisade of smooth,  $\pm$  dichotomously branched, thin-walled, septate hyphal elements, terminal cells of the palisade 8–11  $\times$  3–4  $\mu\text{m}$ . Asci narrowly lanceolate or cylindrical, 185–265  $\times$  4.5–7.2  $\mu\text{m}$ , apex with a conspicuous cap perforated by a pore, base  $\pm$  pedicellate. Ascospores narrowly filamentous, 165–175  $\times$  *ca.* 1.0  $\mu\text{m}$  wide, apparently aseptate.

Holotypus. – DENMARK, Jutland, Borris Hede, ‘in thallo subputrido Cladoniae sub Calluna, Aug 1907, leg. et det. Ferdinandsen & Winge’ (C!).

Comments. – Approximately 20 perithecia remain on the type collection. The most distinctive feature of this species, apart from its lichenicolous habit, is the ostiolar cap that is formed of a palisade of hyphal elements. These elements are easily separated from each other in crush mounts. As is typical with *Neobarya*, no discharged ascospores were seen in the type and only known collection of this species. The spore length reported above is taken from Etayo (2002).

‘*Neobarya lichenophila* (Ferd. & Winge.) Lowen’ is referred to by Etayo (2002) but that combination has not been made formally until now.

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**Fig. 7.** – *Neobarya lichenicola*. **A.** Perithecia erumpent through host epidermis. **B.** A single perithecium in a drop of 3 % KOH. **C, D.** Cells of the perithecial papilla. In D the loosely joined files of cells can be seen. **E–G.** Asci showing thickened apical cap (E, G), pedicellate base (G) and filamentous ascospores (F). All from the holotype. Scale bars: A = 0.5 mm, B = 100  $\mu\text{m}$ , D–G = 20  $\mu\text{m}$ .

**7. *Neobarya lutea* Samuels & Lodge, sp. nov. – Figs. 8, 9**  
**MYCOBANK 511230**

Perithecia dense gregaria, in stromatibus xylariae, in mycelio albo, elongate ovoidea vel obpyriformia, 390–450 µm alta, 110–240 µm crassa, apice acuto, lutea, levia, in 3 % KOH hyalinis, laterale collabentia. Paries perithecii 12–20 µm crasso, parte externe 10–15 µm crasso, parte interne 5–7 µm crasso. Papilla perithecii cum strato cellularum subglobosarum 5–7 µm diam., periphysibus. Ascii lineares, 180–250 × 3.5–5.5 µm, pileo apicali incrassato. Ascospores filiformes, aseptatae, 90–120 × 1.0–1.5 µm. Status anamorphicus ignotus.

Holotypus. - PUERTO RICO, El Yunque Ranger Station, near visitor's sign across from Rt 191 and 988, on *Xylaria* sp., 13 May 1996, D.J. Lodge 1163 & L. Fish (BPI 802494).

Perithecia densely gregarious, uniformly distributed on stromata of a *Xylaria* species, seated on a thin, white, spreading mycelium, elongate-ovoidal to obpyriform, 390–450 µm high, 110–240 µm wide, apex acute, smooth, yellow, hyaline in 3 % KOH, collapsing by lateral pinching. Perithecial wall 15–20 µm wide, comprising two regions. External region 10–15 µm wide, cells tangentially flattened, slightly thick-walled; inner region 5–7 µm wide, cells tangentially flattened, thin-walled. Papilla with a conspicuous 25 µm wide mantle of thin-walled, subglobose cells 5–7 µm diam; internal tissue of the papilla comprising thin elements, continuous with the inner region of the perithecial wall and with the periphyses. Ascii linear, 180–250 × 3.5–5.5 µm, apex thickened with a conspicuous cap; ascospores intertwined in the ascus. Ascospores thread-like, 90–120 × 1.0–1.5 µm, aseptate.

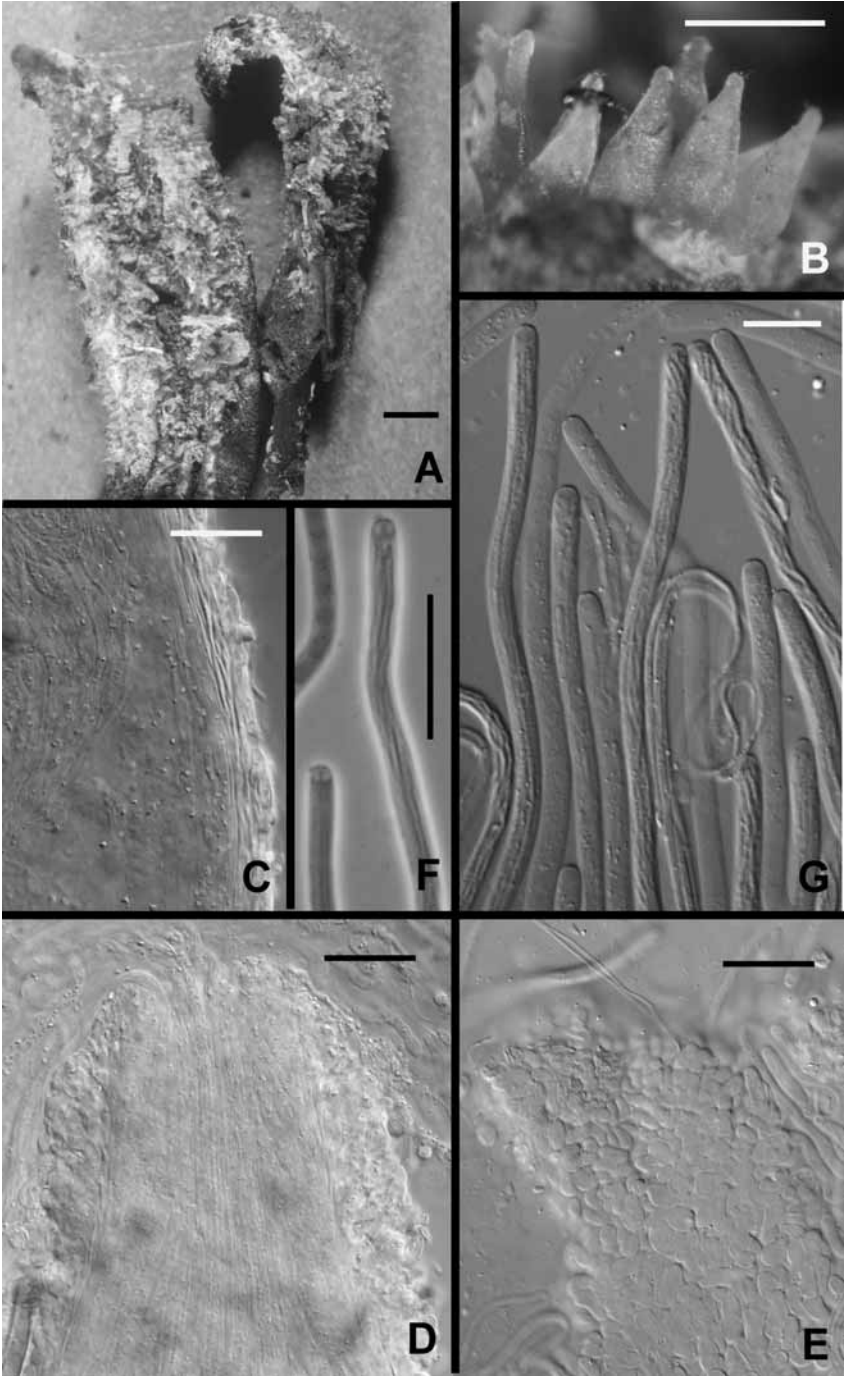
**Etymology.** – *lutea* refers to the color of the perithecia.

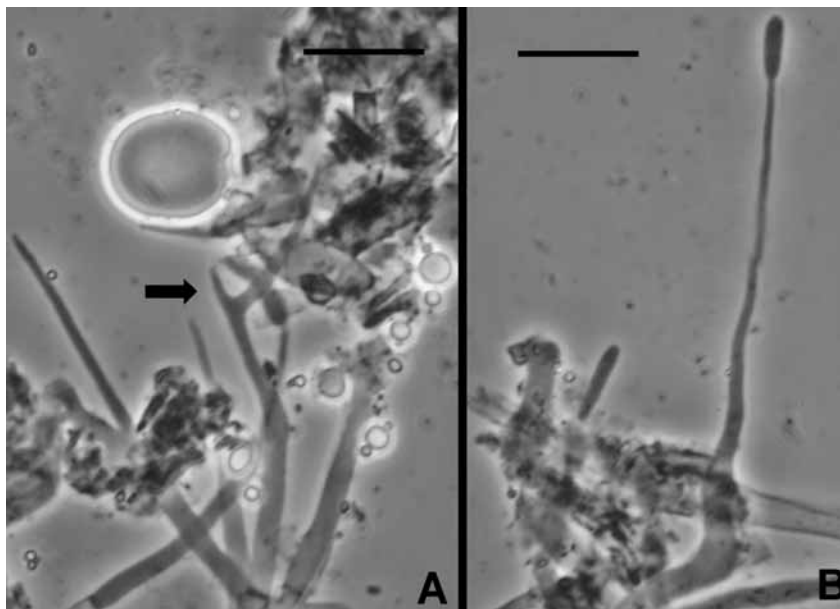
Holotypus. PUERTO RICO, El Yunque Ranger Station, near visitor's sign across from Rt 191 and 988, on *Xylaria* sp., 13 May 1996, D.J. Lodge 1163 & L. Fish (BPI 802494).

**Comments.** – An obscure, scantily-produced lecanicillium-like anamorph is present on the type specimen. Conidiophores are irregularly branched, each branch terminating in a single phialide; phialides 20–40 µm long, 1.5–2.0 µm at the base, sometimes phialides appear to be produced secondarily on previously produced phialides; conidia are cylindrical, 5.5–6.5 × 1.5–2.7 µm, hyaline, unicellular with

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**Fig. 8.** – *Neobarya lutea*, teleomorph. **A, B.** Perithecia. **A** Perithecia cover large parts of the *Xylaria* stroma. **C.** Lateral wall of a perithecium. **D.** Perithecial papilla. **E.** Cells of the perithecial papilla. **F, G.** Ascii showing thickened apical cap (F, G) and filamentous ascospores (G). **F** stained in phloxine (1 % aq.). All from BPI 802494. Scale bars: 1 mm, B = 150 µm, C–G = 20 µm.





**Fig. 9.** – *Neobarya lutea*, associated anamorph. **A, B.** Conidiophores. A lateral proliferation point shown by an arrow in A. From BPI 802494. Scale bars = 10 µm.

a protuberant, flat, basal abscission scar. In the possible secondary production of phialides from previously produced phialides, this anamorph suggests that of *N. parasitica*.

This species differs from *Neobarya xylariicola* in having a much thinner perithecial wall and in occurring in Puerto Rico, not in the north temperate region. Perithecia of *N. lutea* are yellow while those of *N. xylariicola* are orange.

**8. *Neobarya parasitica* (Fuckel) Lowen in Eriksson & Hawksworth, System. Ascom. 5: 121. 1986. – Figs. 10, 11.**

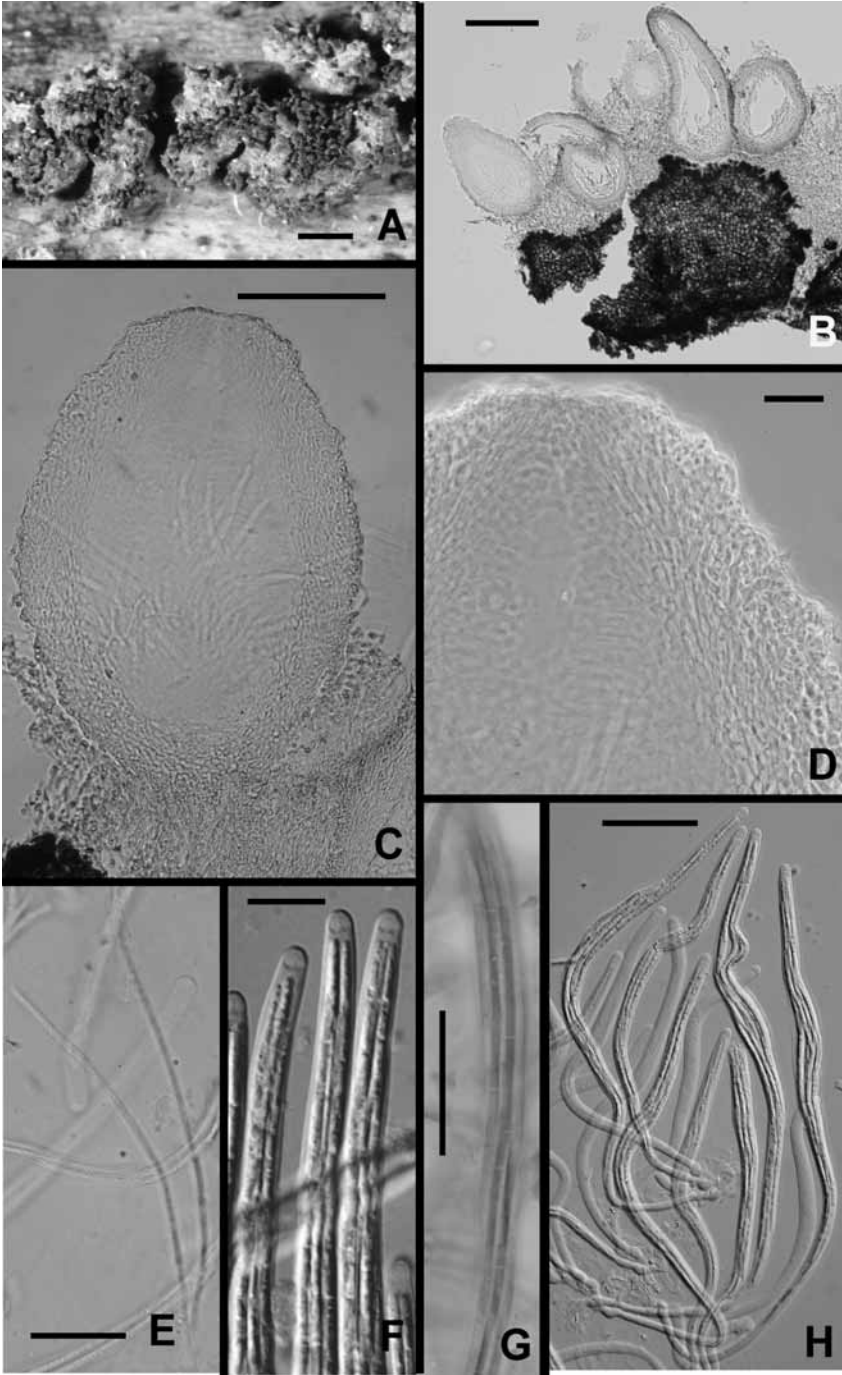
Basionym. – *Barya parasitica* Fuckel, Fungi rhenani 991. 1864 (on printed label).

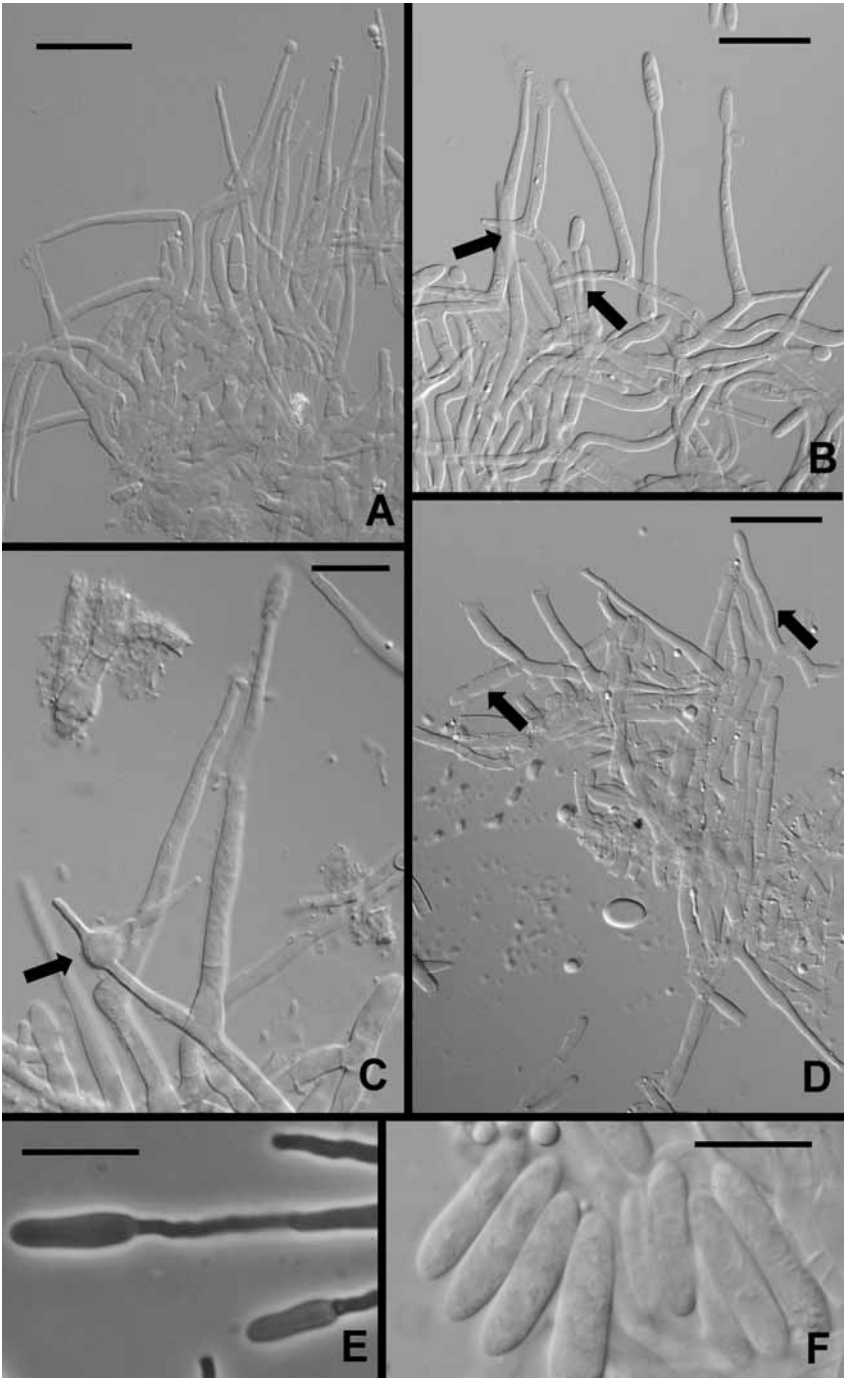
= *Epichloë virescens* Quélet, Grevillea 8:38. 1879 [fide Sydow, Mycothec. Germ. 1594, label].

= *Acrospermum virescens* (Quélet) Sacc., Syll. Fung. 2: 808. 1883.

**Fig. 10.** – *Neobarya parasitica*, teleomorph. **A.** Habit of perithecia overgrowing stromata of *Bertia moriformis*. **B.** Section through a group of *Neobarya* perithecia on the stroma of *Bertia moriformis*. **C.** Median longitudinal section through an immature perithecium. Note the stromatic base. **D.** Section through the papilla of a perithecium. **E.** Two discharged ascospores. **F–H.** Asci with ascospores. Septa in ascospores shown in G. A from BPI 748285. B–E from BPI 632879, F, H from BPI 109639; G from isotype of *B. parasitica* var. *caespitosa*, stained in phloxine (1 % aq.). Scale bars: A = 1 mm, B = 200 µm, C = 100 µm, D–H = 20 µm.







= *Barya parasitica* var. *caespitosa* Peck, Rep. NY State Mus. Nat. Hist. 1890: 34. 1890.

Anamorph: lecanicillium-like (associated).

Perithecia densely gregarious in groups of up to 20 on ascomata of *Bertia moriformis*, less frequently on other ascomycetes, base immersed in a dense subiculum of white to yellow, gray or light green, septate, ca. 3.5 µm wide hyphae, ovoidal to obovoidal, 350–500 µm tall, 200–300 µm wide, smooth, olivaceous, collapsing by lateral pinching, not changing color in 3 % KOH. Perithecial wall ca. 45 µm wide, formed of intertwined, slightly thick-walled hyphae, toward the centrum cells of the wall becoming fusoid. Perithecial papilla formed of intertwined hyphae, toward the ostiolar opening cells arranged in vertical files, innermost files continuous with the periphyses. Asci cylindrical to very narrowly clavate, (100–)120–140(–150) × (5.0–)5.5–8.0(–9.0) µm, apex thickened with a conspicuous cap; arising in a fascicle in the perithecial base; 8-spored, spores spiraled around each other. Ascospores filiform, 150–200 × 3.0–4.5 µm, tapering at each end, aseptate, hyaline.

Anamorph (associated). – Conidiophores green, arising among erect, cylindrical, septate hyphae in association with perithecia, macronematous, mononematous, terminating hyphae of the subiculum at the surface, lecanicillium-like, aculeate 30–45(–65) µm long, 3.0–4.5(–5.5) µm wide at the base, tapering to a fine tip, smooth; monophialidic, periclinal thickening not seen at the tip of the phialide; conidiophores appearing to arise secondarily on previously formed phialides leaving a phialidic spur ca. 15 µm long at the base of the new conidiophore. Conidia subcylindrical to narrowly clavate, (7.2–)13.0–18.0(–19.0) × (3.5–)4.0–5.2(–6.7) µm, (0–)1(–2)-septate, hyaline.

Material examined. – CANADA, Ontario, Lake Timigami, Bear Island, on *Bertia moriformis*, 15 Aug 1931, R.F. Cain (BPI 632879). FRANCE, Pyrénées Atlantiques, Forêt Domaniale d'Oloron 64, on ?*Cucurbitaria* sp., 28 Jan. 1996, F. Candoussau 4835-1 (BPI 744567). GERMANY, Brandenburg, bein Uetzdorf, Kreis Nieder-Barnim, on *Bertia moriformis* on *Fagus sylvatica*, 2 Aug 1920, H. & P. Sydow (BPI 632882, Mycotheca Germanica 1594). UKRAINE, Eastern Carpathian Mts., Borzava, Guklivij, on *Bertia moriformis* on *Fagus sylvatica*, 21 Jul 1998, M. Reblová, M 1210/98 (BPI 748285). UNITED STATES, New York, Catskill Mountains, on *Bertia moriformis*, Aug, Peck (isotype of *B. parasitica* var. *caespitosa*, NY). North Carolina, Clay Co., Standing Indian Campground, off highway 64,

**Fig. 11.** – *Neobarya parasitica*, anamorph. **A–C.** Conidiophores. On the host stroma the conidiophores form a loose hymenium, part of which can be seen in A. In B, C (arrows) examples of lateral proliferation of conidiophores can be seen. **D.** Hyphal hairs (arrows) associated with conidiophores. **E.** Conidiogenous locus. **F.** Conidia. A, D from BPI 632802; B, C, E, F from BPI 744567. Scale bars: A–D = 20 µm, E, F = 10 µm.

on *Bertia moriformis* on *Trametes* sp., 15 Oct 1990, Y. Doi, A.Y. Rossman & G.J. Samuels (BPI 1109369).

Holotypus. – (of *B. parasitica* var. *parasitica*). – GERMANY. Oestricher Wald, Aepfelbach, on *Bertia moriformis*, on *Fagus*, spring (Fuckel, F. Rhenani 991, IMI!).

Comments. – In the original description of *Barya parasitica*, Fuckel (1870) specifically described and illustrated an anamorph that is constantly associated with perithecia of the species. The description of the anamorph provided here is based on the French specimen cited above (BPI 744567). Because of the near constant association of this anamorph with perithecia of *B. parasitica*, we have no doubt that the two are an anamorph/teleomorph pair. This conidiophore is similar to that of *Lecanicillium lecanii* (Zimmerm.) Zare & W. Gams, the anamorph of *Torrubiella confragosa* Mains (Zare & Gams 2001).

The variety *caespitosa* was distinguished from var. *parasitica* by having longer and more slender ascospores than were illustrated by Fuckel for the latter (Peck 1890). Peck said that the ‘globose termination of the ascus is at the apex, not at the base as Fuckel has it.’ Peck (Pl. 4, fig. 15 illustrated a typical clavicipitaceous ascus apex for var. *caespitosa*. Fuckel (Pl. 4, Fig. 18a) illustrated an ascus with a globose body at its base. It is likely that Fuckel simply inverted the ascus, thinking that the conspicuous clavicipitaceous apex was the base. Peck (1890) described and illustrated the same anamorph for *B. parasitica* var. *caespitosa* that was reported by Fuckel and that we describe and illustrate here. From the description and illustrations provided by Peck, and from our study of an isotype specimen (NY), we consider var. *caespitosa* to be no different from var. *parasitica*.

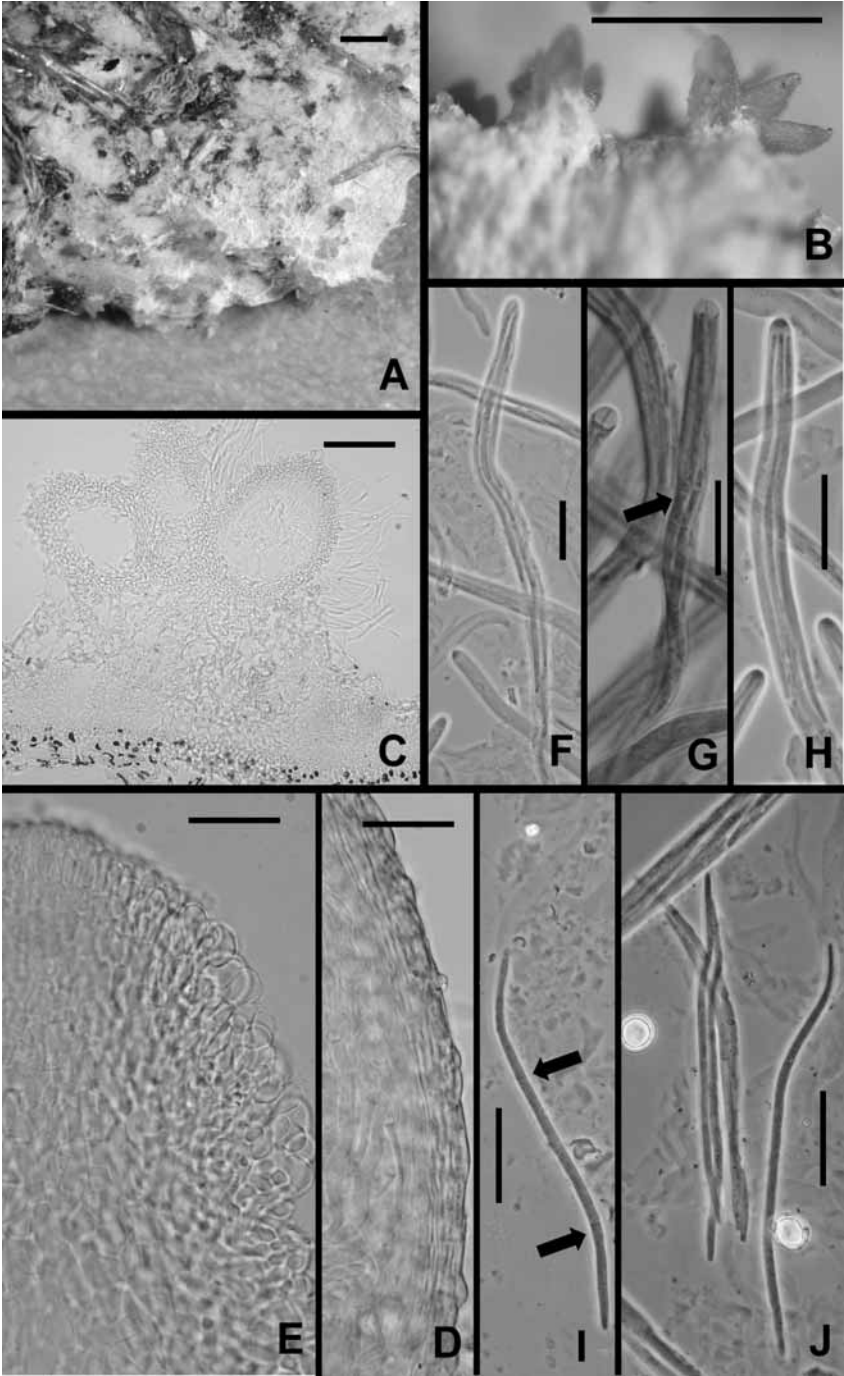
9. *Neobarya peltigerae* Lowen, Boqueras & Gómez-Bolea, **sp. nov.** – Figs. 12, 14 A, B

Anamorph. – Acremonium-like.

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Ascomata ellipsoidea, (260–)330–385(–480)  $\mu\text{m}$  alta  $\times$  (160–)225–250(–360)  $\mu\text{m}$  lata, caespitosa, aurantiaca. Parietes 20–40  $\mu\text{m}$  lati. Asci unitunicati, cylindrati, (110–)130–210(–235)  $\times$  (3.2–)5.0–8.2–9.5)  $\mu\text{m}$ , octospori. Ascospores filiformes, ad 130–185  $\times$  (4.5–)5.0–6.0(–6.5)  $\mu\text{m}$ , ad 15-septatae, hyalinae, laeves, guttulate. Status anamorphicus: acremonium similis.

**Fig. 12.** – *Neobarya peltigerae*. **A, B.** Perithecia on the host lichen. **C.** Section through a group of perithecia showing the hyphal base. **D.** Section through lateral wall of a perithecium. **E.** Section through the papilla. Note the cells at the exterior. **F–H.** Asci with apical cap and septate (arrow), filamentous ascospores. **G** stained in phloxine (1 % aq.). **I, J.** Discharged ascospores. Septa shown at arrows. **A, F–J** from Lowen 130; **B–D, E** from Boqueras 5239. Scale bars: **A, B** = 0.5 mm; **C** = 100  $\mu\text{m}$ , **D–J** = 20  $\mu\text{m}$ .



**Holotypus.** – SPAIN, País Valencià, Pobla de Benifassà, barranc de l'Avelanar (serra dels Ports), BF 5408, elev. 1100 m, on *Peltigera membranacea*, 21 Oct 1990, A. Gómez-Bolea & M. Boqueras (NY, Isotype BCC-Lich 5239).

Perithecia associated with cottony, conidiogenous white mycelium, cespitose in clusters of up to 20 from a common base, superficial, narrowly ovoidal, (260–)330–385(–480)  $\mu\text{m}$  tall, (160–)225–250(–360)  $\mu\text{m}$  wide, at most slightly constricted below the apex, smooth, yellow to yellow-orange, not changing color in 3 % KOH, collapsing by lateral pinching. Cells of the perithecial wall surface as densely intertwined hyphae. Perithecial wall 20–30  $\mu\text{m}$  wide laterally, composed of flattened, compressed cells. Perithecial apex formed of files of cells, the terminal cells subglobose to slightly clavate,  $6.5\text{--}12 \times 5\text{--}7.5$   $\mu\text{m}$ , thin-walled. Asci narrowly lanceolate to cylindrical,  $(110\text{--})130\text{--}210(235) \times (3.2\text{--})5.0\text{--}8.2(9.5)$   $\mu\text{m}$  ( $n = 37$ ), apex with a conspicuously thickened cap, base pedicellate, 8-spored, ascospores parallel in the ascus. Ascospores filiform,  $35\text{--}75 \times 1.5\text{--}3.5$   $\mu\text{m}$  in asci and 0,1-septate; discharged ascospores  $130\text{--}185 \times (4.5\text{--})5.0\text{--}6.0(6.5)$   $\mu\text{m}$ , up to 15-septate.

**Characteristics in culture.** – Ascospores producing a germ tube from each end after 2–3 da at ca. 4 C on tap water agar (15 g agar, 1 L tap water). Colonies grown on potato carrot agar ([http://www.cbs.knaw.nl/cbs\\_home/cbs\\_home.html?http://www.cbs.knaw.nl/food/media.htm~main](http://www.cbs.knaw.nl/cbs_home/cbs_home.html?http://www.cbs.knaw.nl/food/media.htm~main)) at 20 C under 12 h darkness/12 h cool white fluorescent light + nUV for 6 mo 1–2 cm diam; aerial mycelium cottony, white with brown in reverse. Conidial production beginning after several months. Conidiophores monophialidic, (25–)40–50 (–80)  $\mu\text{m}$  long, tapering uniformly from ca. 3.5  $\mu\text{m}$  at base to ca. 2.0  $\mu\text{m}$  at tip, 1,2-septate, roughened; tip with visible periclinal thickening, not flared. Conidia ellipsoidal to limoniform, (5–)7–9  $\times$  4–6  $\mu\text{m}$ , unicellular, with a protuberant, flat basal abscission scar, smooth, hyaline.

**Etymology.** – Named for the host genus, *Peltigera*.

**Holotypus.** – SPAIN, País Valencià, Pobla de Benifassà, barranc de l'Avelanar (serra dels Ports), BF 5408, elev. 1100 m, on *Peltigera membranacea*, 21 Oct 1990, A. Gómez-Bolea & M. Boqueras (NY, Isotype BCC-Lich 5239).

**Additional material examined.** – UNITED KINGDOM, Scotland, Caithness, Dunnett Wood, ND2270, on *Peltigera membranacea*, on ground in moss near *Cytisus*, 14 May 1985, R. Lowen 130–85 (NY).

**Comments.** – The Scottish collection was cultured, but the culture is no longer available and, unfortunately, we do not have adequate illustrations of the acremonium-like anamorph of this species that formed in that culture. An acremonium-like anamorph is spar-

ingly produced on the Scottish collection in association with perithecia (Fig. 14 A, B). Conidiophores are monophialidic and minutely roughened; conidia are cylindrical,  $11\text{--}14 \times 3\text{--}8\text{ }\mu\text{m}$ . We cannot judge whether the anamorph found in nature is the anamorph of *N. peltigerae*; its difference from the anamorph produced in culture is significant.

*Neobarya peltigerae* is distinctive in *Neobarya* for its relatively short and broad ascospores. The longest spores were found in the Scottish collection, but they were discharged; we did not observe discharged ascospores in the Spanish collection and spores in asci of the Scottish collection approached the shorter and narrower spores ( $48\text{--}55 \times 1.5\text{--}2.0\text{ }\mu\text{m}$ ) of the undischarged Spanish ascospores. The discrepancies in spore lengths most likely do not indicate taxonomic separation of the two collections given that all other characters are the same.

Although the name '*Neobarya peltigerae* Boqueras (2000)' is found in species fungorum (<http://www.speciesfungorum.org/Names/GSDspecies.asp?RecordID=474429>), Boqueras (2002) proposed this species provisionally and without a Latin description. This is the first valid publication of the species.

#### 10. *Neobarya usneae* Etayo, Biblioth. Lichenol. 84: 76. 2002

Perithecia solitary, ovoidal to pyriform,  $320\text{--}330\text{ }\mu\text{m}$  tall,  $220\text{--}330\text{ }\mu\text{m}$  wide, substipitate seated in a cottony white to grayish white subiculum, flattened laterally. Perithecial wall  $60\text{ }\mu\text{m}$  wide laterally, thicker at the base, blue in KI, comprising three regions; cells of the innermost region transversely flattened; cells of the middle region polyhedral; the outermost region formed of irregularly distributed, grey gelatinous material. Asci cylindrical,  $270\text{--}400 \times 10\text{--}11\text{ }\mu\text{m}$ , base bulbous; apex with a thin cap, lacking a pore. Ascospores filiform,  $250\text{--}400 \times 2.5\text{--}3.5\text{ }\mu\text{m}$ , multiseptate, with cells  $17\text{--}50\text{ }\mu\text{m}$ , spiraled in the ascus.

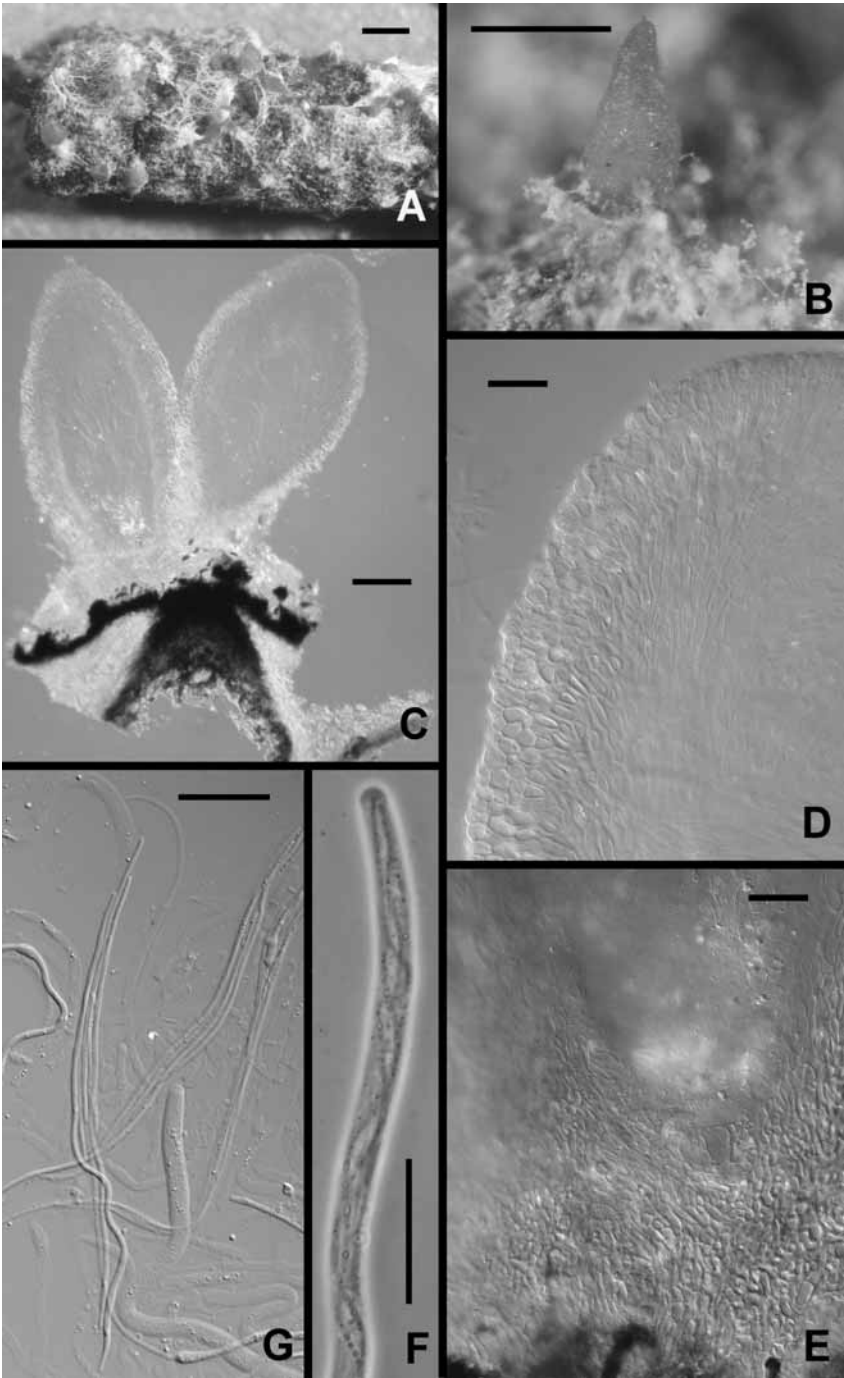
Holotypus. – COLOMBIA, Dept. Nariño, Pasto, bosque de Daza, Pasta-Buesaco Rd., 2750 m, on *Usnea rubicunda*, 28 Jul 1998, J. Etayo 16450 (COL, not examined).

Comments – We have not seen this species. The absence of a thick cap in the asci suggests that this is not a species of *Neobarya*. The description given here is paraphrased from the protologue (Etayo 2002).

#### 11. *Neobarya xylariicola* Candoussau, J.D. Rogers & Samuels, **sp. nov.** – Figs. 13, 14 C–G.

Anamorph. – *Calcarisporium* sp.

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A *Neobarya lutea* differt in colore peritheci aurantiaco, in pariete peritheci plus incrassato, in statu anamorphico *Calcarisporio*, et in distributione zonis temperatis.

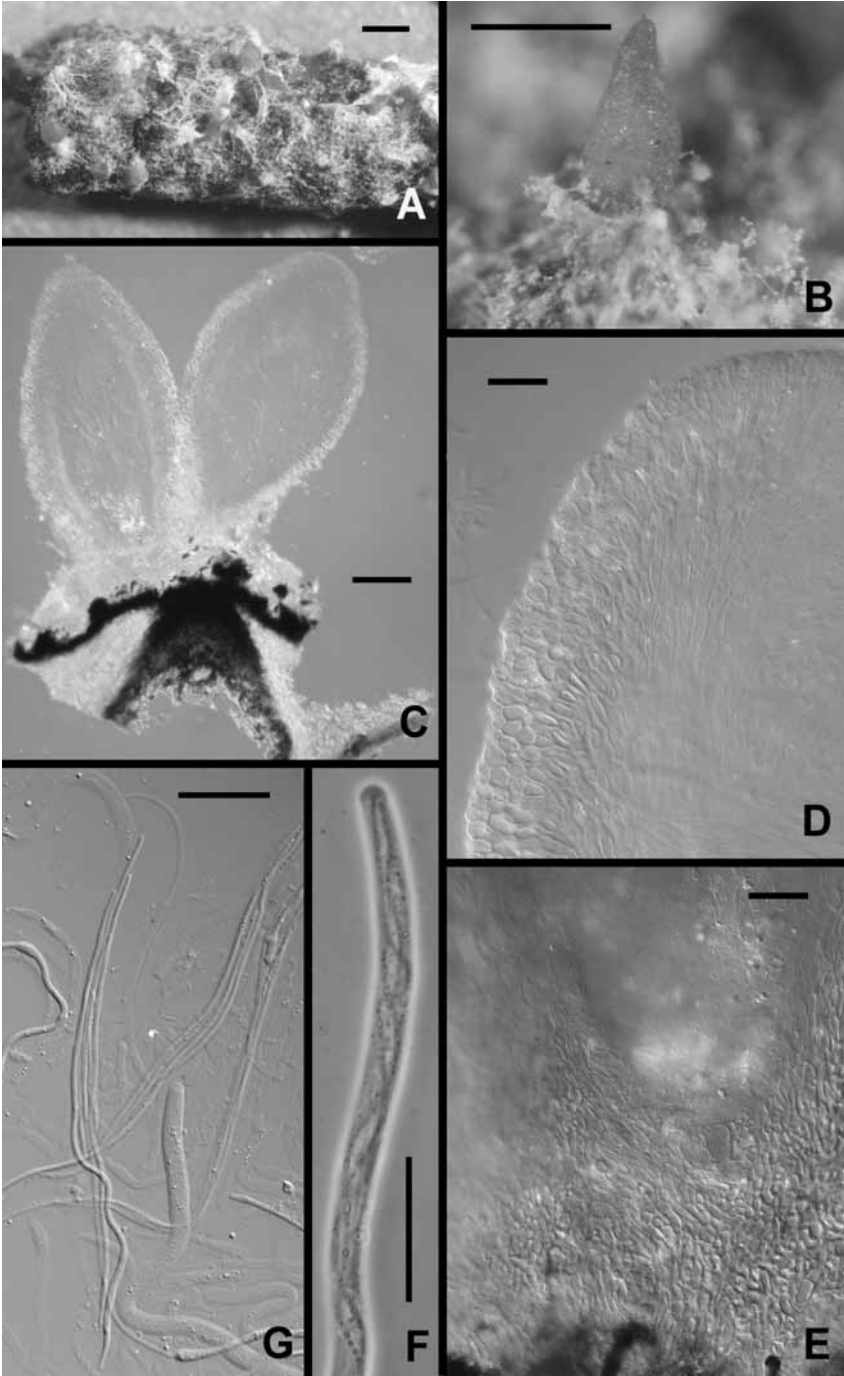
Holotypus. – UNITED STATES, Oregon, on *Xylaria* sp., 5 Dec 2005, M. Rogers, comm. J.D. Rogers (WSU).

Perithecia solitary or densely gregarious in clusters of 3–6 on stromata of a *Xylaria*, ovoidal to obovoidal, 470–530  $\mu\text{m}$  tall, 300–350  $\mu\text{m}$  wide, smooth, yellow to orange when dry, becoming pale yellow in 3 % KOH, collapsing by lateral pinching when dry, seated on a thin, spreading stromatic base of *textura epidermoidea*. Perithecial wall ca. 75  $\mu\text{m}$  wide, laterally comprising two regions; outer region 40–50  $\mu\text{m}$  wide, cells globose to irregular in outline, 12–15  $\mu\text{m}$  diam, becoming increasingly hyphal toward the interior, walls thickened; internal region ca. 30  $\mu\text{m}$  wide, cells flat and thin-walled toward the centrum, merging with the external region. Perithecial apex formed of files of cells, at the exterior continuous with the outer region of the perithecial wall and at the interior continuous with the inner region and with the periphyses; terminal cells of files tending to be subglobose, 5–10  $\mu\text{m}$  diam, walls thick, except surrounding the ostiolar opening; perithecial apex around the ostiolar opening formed of files of narrow, thin-walled cells, continuous with the periphyses. Asci cylindrical, 160–250  $\times$  4–6  $\mu\text{m}$ , apex thickened with a conspicuous cap, arising in a basal fascicle, 8-spored, ascospores lying parallel to each other in the ascus. Ascospores filiform, (60–)100–145 (–160)  $\times$  1.5–2.0  $\mu\text{m}$ , tapering at each end, aseptate, hyaline.

Anamorph in culture. – Conidiophores arising in white aerial mycelium around perithecia, 200–500  $\mu\text{m}$  long, 3–7  $\mu\text{m}$  wide at base, septate, smooth, producing up to 3 levels of wide branches bearing divergent conidiogenous cells. Conidiogenous cells 15–20  $\mu\text{m}$  long, tapering uniformly from 2–3  $\mu\text{m}$  wide at base; terminating in several prominent, flat denticles up to 1  $\mu\text{m}$  long. Conidia clavate to subcylindrical, highly variable in size, (3.2–)4.0–12.5(–18.5)  $\times$  (2.0–)2.5–4.0(–5.0)  $\mu\text{m}$ , with or without a protuberant, flat basal abscission scar, 0(–3)-septate, hyaline. Arrangement of conidia on conidiophores not seen.

Etymology. – *Xylariicola*, with reference to the host genus, *Xylaria*.

**Fig. 13.** – *Neobarya xylariicola*, teleomorph. **A, B.** Perithecia on host. **C.** Off center sections of mature perithecia. Note the stromatic base. **D.** Section through the papilla of a perithecium. **E.** Stromatic base. **F.** Ascus. **G.** Filamentous ascospores **A, B, F** from Rogers; **C–E** from BPI 746382. Scale bars: **A** = 0.5 mm, **B** = 250  $\mu\text{m}$ , **C** = 50  $\mu\text{m}$ , **D–G** = 20  $\mu\text{m}$ .



Material examined. – FRANCE, Pyrenées Atlantiques, Sauveterre de Born 64, 5 Dec 1992, on *Xylaria* sp., F. Candoussau 4835 (BPI 746382).

Holotypus. – UNITED STATES, Oregon, on *Xylaria* sp., 5 Dec 2005, M. Rogers, comm. J.D. Rogers (WSU).

Comments. – A *Calcarisporium* anamorph is abundant on the holotype specimen. One of us (JDR) cultured the Oregon collection from ejected ascospores and obtained abundant *Calcarisporium*. However, the culture eventually produced *Xylaria* stromata at the margins of Petri plates. The culture is a dual culture that also includes the *Xylaria*. Our inability to separate the two elements suggests that this is not a parasitic relationship on the part of the *Neobarya*. In any case, the *Calcarisporium* found in culture seems identical with the *Calcarisporium* found on the surface of the *Xylaria* stroma.

An acremonium-like anamorph is richly developed on the French collection, but it may be *Acremonium berkeleyanum* (Starback) W. Gams which is the anamorph of *Cosmospora vilior* (Starback) Rossman & Samuels, a common species on old stromata of *Xylaria* species.

It is possible that *N. xylariicola* and *N. lutea* ultimately will be found to be conspecific. However, the different distributions of the pertinent collections and other differing characteristics (see above) lead us to believe that accepting two species is justified with the current level of information and without molecular data.

This species differs from *Neobarya lutea*, which also occurs on *Xylaria*, chiefly in the darker color of perithecia, wider perithecial wall, anamorph and geography.

### Excluded species

***Barya montana*** Racib., Bull. Int. Acad. Sci. Cracovie, Cl. Sci. Math. 1906. p. 909. 1906.

Comments. – This species is described from a spider on leaves of *Podocarpus cupressina* in Indonesia (Java). It is most likely a species of *Torrubiella*.

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**Fig. 14.** – *Neobarya* species, associated anamorphs. **A, B.** *Neobarya peltigerae*, acremonium-like conidiophore (A) and conidia (B). From Lowen 130. **C–G.** *Neobarya xylariicola*. **C, D.** Verticillately branched *Calcarisporium* conidiophores. **E.** Denticulate conidiogenous cells. **F.** Conidia. **G.** *Calcarisporium* conidiophores formed in dual culture with *Xylaria* host. All from Rogers. Scale bars: A, C, D, G = 20 µm; B, E, F = 10 µm.

***Barya salaccensis*** Racib., Bull. Int. Acad. Sci. Cracovie, Cl. Sci. Math. 1906. p. 909. 1906.

Basionym. – *Hypocrella salaccensis* (Racib.) Petch in Sydow, Fungi exotici, fasc. ii: 84. 10 Feb 1913 (schedule announced in Ann. Mycol. 11: 207, 208. 30 Apr 1913).

= *Hypocrella raciborskii* Zimmerman, Zentbl. Bakt. ParasitKde, Abt. ii, 7: 876. 1901 *vide* Petch (1921: 243).

Comments. – The specimen label of *Hypocrella salaccensis* refers to *Barya salaccensis* and attributes the combination to Petch ‘in litt.’; the combination is printed in the schedule to the exsiccate set cited above. Petch apparently did not take up this name in any of his own publications.

Petch (1921) studied type material of *Hypocrella raciborskii* from Raciborski’s herbarium. He observed *Hypocrella* perithecia as well as pycnidial (*Aschersonia*) stromata and synonymized the name with *H. salaccensis*.

### Acknowledgments

Mike Adams (WSU) provided images of the anamorph of *N. xylariicola*. David Farr and Erin McCrae (BPI) enabled mounting color images on the internet. We appreciate the loan of specimens from IMI and NY. Drs. William Buck and Richard Harris (NY) provided essential literature.

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