

Hypocreales of the Southeastern United States: An Identification Guide

Gary J. Samuels, Amy Y. Rossman, Priscila Chaverri,
Barrie E. Overton and Kadri Põldmaa



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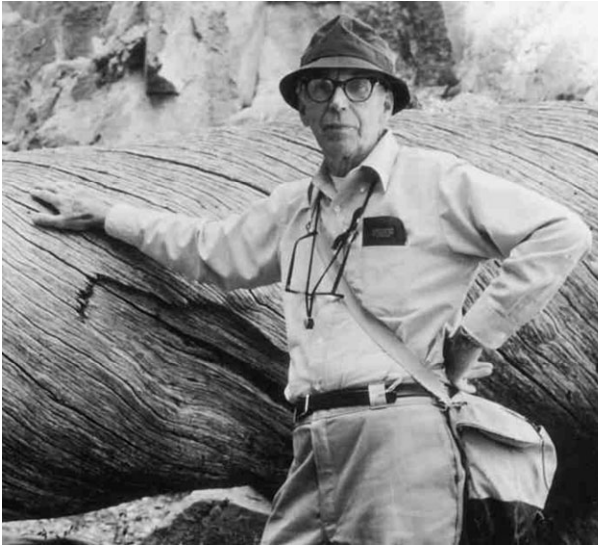
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DEDICATION



We dedicate this work to the memory of Dr. Clark Thomas Rogerson, our teacher and friend, who introduced us, directly or indirectly, to these beautiful fungi (photo courtesy of Robert Fogel). We also dedicate this work to Dr. Samuel S. Ristich in appreciation of one who has led many people to the wonders of the Fungi (photo courtesy of Gerald Scheine).

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PREFACE

This identification guide was developed for a workshop on the *Hypocreales* of the Great Smoky Mountains National Park (GSMNP) that was held in association with the Annual Meeting of the Mycological Society of America in Asheville, NC, on July 23, 2004. Because species of the *Hypocreales* in the GSMNP are not well known, the species included in this book are those that occur in the states adjoining the park covering the majority of the southeastern United States excluding Florida. It is anticipated that this guide will be useful to those conducting the All Taxa Biodiversity Inventory (ATBI) of the GSMNP who will discover these species inside the Park boundaries. In addition, some relatively rare species are included that have been collected only a few times. With the intense scrutiny for microfungi, it is hoped that these rare species will be re-collected and can be more accurately characterized.

The contents of this book represent the culmination of decades of research initiated in our lifetimes by Dr. Clark T. Rogerson. The publication of Rogerson (1970) synthesized the state of knowledge at that time into keys to the *Hypocreales* and *Clavicipitales*. The publication marked the beginning of a new era of

research on these groups of fungi. Both Gary Samuels and Amy Rossman benefited greatly from Clark Rogerson's generosity and willingness to place his accumulated resources at their disposal. A number of scientists have contributed to the increased knowledge of hypocrealean fungi including Rosalind Lowen, New York Botanical Garden, and Hans-Josef Schroers, Centraalbureau voor Schimmelcultures. In addition, many studies were made possible with the help of funding from the National Science Foundation (NSF) grant through the Partnership in Enhancing Expertise in Taxonomy (PEET) program specifically 9712308: 'Monographic studies of hypocrealean fungi: *Hypocrea* and *Hypomyces*' to the Pennsylvania State University. This grant supported three graduate students (Holly Chamberlain, Priscila Chaverri, and Barrie Overton) and four postdoctoral fellows (Sarah Dodd, Payam Fallah, Bingsheng Lu, Kadri Põldmaa). Their individual and cooperative research revealed much diversity in the hypocrealean fungi. We are all deeply indebted to Dr. James Rodman of the United States National Science Foundation for his vision in seeing the need for and persistence in developing the PEET program.



Map of the United States showing the four states North Carolina (NC), South Carolina (SC), Tennessee (TN) and Georgia (GA) that include or surround the Great Smoky Mountains National Park (GSMNP).

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Abstract

An illustrated guide is presented to the members of the ascomycete order *Hypocreales* that are known to occur in the southeastern states of the United States, including North and South Carolina, Tennessee and Georgia. Species were selected mainly based on records in the United States National Fungus Collections (BPI). These states include or surround the Great Smoky Mountains National Park. Species of the *Hypocreales* are among the most numerous, and certainly most conspicuous, of the microfungi. The order also includes some of the most economically important fungi. This guide is intended for individuals who are participating in All Taxa Biological Diversity studies of the Great Smoky Mountains National Park as well as other interested professionals and amateurs. Short descriptions and colour illustrations of one-hundred and one species and two varieties in twenty genera are provided. Keys to genera and species are included. The new combination *Neonectria ditissima* is proposed.

INTRODUCTION

The ascomycetous order *Hypocreales* and its anamorphs include fungi of economic importance ranging from virulent plant pathogens and producers of powerful antibiotics to effective agents of biological control and sources of potent mycotoxins. The *Hypocreales* is one of the orders recognized by Eriksson (2005) in the *Sordariomycetes* of the *Ascomycota*.

In the last thirty years progress toward understanding the systematics of the *Hypocreales* has been made through descriptive accounts centred around the genera *Bionectria*, *Calonectria*, *Hypocrea*, *Hypomyces* and *Nectria*. Careful study of hypocrealean fungi has revealed relationships among species that are based on suites of correlated characters including those of the anamorph. Combined with phylogenetic analyses based on DNA sequence data, these serve as the basis for revised generic concepts, especially for those species previously classified as *Nectria sensu lato*. The revised genera for three of the four major families of the *Hypocreales*, specifically the *Bionectriaceae*, *Hypocreaceae*, and *Nectriaceae*, has been accounted for in Rossman *et al.* (1999). The order also includes the *Clavicipitaceae* and *Niessliaceae* (Samuels & Barr, 1998) but species of the latter family are not included here. This book includes descriptions and illustrations of one-hundred and one species and two varieties in twenty genera of hypocrealean fungi in the *Bionectriaceae*, *Clavicipitaceae*, *Hypocreaceae* and *Nectriaceae* that are known to occur in the states that include and surround the Great Smoky Mountains National Park. We have included two representative genera of the *Clavicipitaceae*, viz. *Cordyceps* and

Neobarya, although undoubtedly many more species of this family occur in the Great Smoky Mountains National Park.

SUBSTRATA AND PATHOGENICITY

Members of the *Bionectriaceae*, *Clavicipitaceae*, *Hypocreaceae* and *Nectriaceae* are associated with a variety of substrata ranging from living and decaying plant material, dung, and soil to fungi, insects, and, occasionally, animals and humans. Although often unrecognized as such, a majority of hypocrealean fungi are mycoparasitic or mycosaprobic and are extremely versatile in their abilities to exploit fungal substrata (Gams *et al.*, 2004). In some species the fungicolous nature is conspicuous with ascomata developing on other fungi, as, for example, *Cosmospora episphaeria* on old carbonous black pyrenomycetes, species of *Hypomyces* parasitizing mushrooms, or *Nectriopsis violacea* growing on myxomycetes. Less conspicuous are the hypocrealean fungi that occur on rotting wood, but actually are necrotrophic on the fungal hyphae in the wood. These include many of the biocontrol fungi in the *Hypocrea-Trichoderma* complex, such as *T. virens* and *T. harzianum* and *Bionectria ochroleuca* often encountered as its anamorph, *Clonostachys rosea* (Schroers, 2001). A number of hypocrealean species occur on lichens such as species of *Pronectria* (Rossman *et al.*, 1999). Although primarily fungicolous, the genus *Cosmospora* also includes insecticolous species such as *C. flammea*, having in common the ability to degrade chitin as a substratum (Rossman *et al.*, 1999).

Aggregations of ascomata of species in the *Nectriaceae* are often found in quantity erupting through the bark of recently killed woody substrata. Some species appear to function as endophytes residing

harmlessly in the healthy plant but sporulating profusely following the death of the host. *Trichoderma* species, the anamorphs of *Hypocrea*, and *Clonostachys* species, the anamorphs of *Bionectria*, recently have been found to dominate the endophyte mycota of trunks of *Theobroma gileri*, a wild cacao, in Ecuador (Evans *et al.*, 2003). Despite their primarily saprobic nature, many hypocrealean fungi, especially members of the *Nectriaceae*, are facultative and virulent plant pathogens, causing serious problems on crop plants, often encountered in the anamorph. These include the *Cylindrocladium* anamorphs of species of *Calonectria*, causing twig dieback of *Ilex* and potato tuber rot (Crous, 2002), *Fusarium sambucinum*, anamorph of *Gibberella pulicaris*, cause of hop canker and root rot of many crops, and other species of *Gibberella* and related anamorphs, including *F. oxysporum* (Samuels *et al.*, 2001), *Nectria cinnabarina*, often seen as the *Tubercularia* anamorph, causing coral spot of fruit and hardwood trees (Sinclair *et al.*, 1987), and *Neonectria coccinea* var. *faginata*, cause of beech bark disease (Sinclair *et al.*, 1987).

MORPHOLOGICAL CHARACTERISTICS

STROMA.— A stroma is any vegetative tissue that subtends or surrounds the ascomata. The stroma may be pseudoparenchymatous, consisting of hyphae that have lost their hypha-like structure, prosenchymatous, consisting of cells that retain their hyphal integrity, or reduced to a hyphal subiculum. The structure of an individual stroma may vary from prosenchymatous to pseudoparenchymatous forming distinct regions. Placement of the ascomata within the stroma and location of the stroma within the substratum are characteristic of certain genera. Within the *Bionectriaceae*, the stroma is often lacking or reduced to a subiculum as in *Nectriopsis*. Within the *Hypocreaceae*, most genera have ascomata embedded in a more or less extended pseudoparenchymatous stroma. The stroma may be large and expansive as in *Hypocreopsis*, in which the stromata are lobed and spreading up to 20 mm diam across the substratum. In *Hypocrea* the stroma may range from 1–3 mm or more in diameter with or without a stipe. In some species of *Hypomyces* the stroma may completely cover and obliterate the hymenium of the host, particularly those occurring on members of the *Agaricales*, or the stroma may be a thin subiculum beneath which the host fungus can still produce viable basidiospores. Within the *Nectriaceae* the stroma may be inconspicuous or absent as in most species of *Cosmospora*, or it may be basal, consisting of a pseudoparenchymatous pad of tissue giving rise to two or more ascomata. The pseudoparenchymatous basal stroma is often continuous with the outer region of the ascomatal wall and is frequently associated with the anamorph, as in

Nectria sensu stricto, in which the basal stroma is initially associated with a sporodochial, synnematal or pycnidial anamorph.

ASCOMATA AND ASCOMATAL WALL STRUCTURE.—

Ascomata are generally light- to bright-coloured, soft-textured, uniloculate perithecia that are hyaline, white, pale yellow, orange, red, to purple, or brown. For all genera the ascomatal colour is slightly darker in dried specimens. Descriptions given here are based on the colour of rehydrated ascomata. The nature of the ascomatal pigmentation, specifically the reaction in 3% KOH or 100% lactic acid, correlates with other characteristics useful in defining relationships within genera and families. In general, species of the *Nectriaceae* react with KOH darkening to a blood-red colour or purple and turn yellow in lactic acid while species in the *Bionectriaceae* do not react with KOH or lactic acid. Within the *Hypocreaceae*, some species of *Hypomyces* and *Hypocrea* have ascomata and/or stromal tissues that become red in KOH, e.g. *Hypomyces lactifluorum* and *Hypocrea pallida*. In the *Hypocreaceae* the significance of this colour reaction does not extend above the species level.

Within the *Bionectriaceae* and *Nectriaceae* ascomatal wall structure is often useful in defining genera, and this structure correlates with other morphological characteristics of both the teleomorph and anamorph. The ascomatal wall of hypocrealean fungi generally consists of one to three regions of cells with each region of two to four cell layers. The outer region is usually composed of angular to globose cells with walls that may or may not be thickened. The inner region is almost always of thin-walled, hyaline cells elongated parallel to the centrum. In the *Hypocreaceae*, the ascomatal wall features are generally the same in all genera and thus are not used as defining characters. In the *Bionectriaceae* and *Nectriaceae* the structure of the wall may be characteristic of the genus, e.g., the ascomatal wall of *Hydropisphaera* consists of large, thin-walled, globose cells. In *Neonectria*, the cells near the ascomatal surface are thick-walled and flattened, forming a *textura epidermoidea* that results in a varnished appearance. In some species of this group an additional outer layer of loose cells obscures the *textura epidermoidea*, yet the distinctive structure is evident in longitudinal sections. Some genera have characteristic features on the surface of the ascomata. In certain species of *Bionectria*, the ascomata have large wart-like projections on the surface, and the outermost walls of the outer wall cells are greatly thickened on the outside edge, a characteristic described as capitata. Other genera have more subtle ascomatal structures such as the large, loose, globose outer wall cells of *Calonectria* and *Haematonectria* (Rossman *et al.*, 1999).

Centrum characters, such as the presence/absence of the apical paraphyses and the periphyses lining the ostiole, are similar for all hypocrealean fungi exclusive

of the *Clavicipitaceae*, in which apically free paraphyses form. The ostiolar canal is always periphysate in perithecial members of the *Hypocreales*. Intertheelial elements in hypocrealean fungi are, by definition, apical paraphyses; these may often appear as deliquescent strands in mature ascomata, although they may be present as thin-walled, inflated cells as they go through the process of deliquescing (Rossman *et al.*, 1999).

ASCI AND ASCOSPORES.— The asci of hypocrealean fungi are unitunicate. They may or may not have a ring at the apex. The presence of an apical ring generally correlates with ascospore size and shape and is useful only in defining species. In hypocrealean species having relatively short ascospores, i.e. less than 20 μm , the asci frequently have an apical ring; species having elongate or large ascospores generally lack an apical apparatus. In many hypocrealean species the relatively short ascospores are forcibly discharged. In others the asci deliquesce, releasing the ascospores into the centrum. As the soft-textured ascomata periodically dry out, and swell up again when rehydrated, aided by the gelatinous, deliquescing apical paraphyses, the ascospores are extruded *en masse* through the ostiole and appear as a cirrus or column emerging from the ascomatal apex. Neither the apex nor any other part of the ascus or centrum reacts with iodine.

Within the *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae*, ascospores are typically one-septate, ellipsoid to fusiform with rounded apices, although there is some variability. Ascospores may be non-septate as in *Neocosmospora*. As the result of disarticulating, bicellular ascospores, the part-ascospores of some species of *Hypocrea* appear globose. After disarticulating the part-ascospores may be the same size and shape termed monomorphic or the two parts of the part-ascospores may have a slightly different shape and size termed dimorphic. The ascospore apices of many species of *Hypomyces* are apiculate. Ascospore colour is generally hyaline to golden-yellow or golden-brown, as in *Cosmospora* in the *Nectriaceae*, although *Viridispora* and some species of *Hypocrea* in the *Hypocreaceae* have green ascospores. Ascospore ornamentation in the hypocrealean fungi is variable, ranging from smooth to verrucose or striate, and is sometimes characteristic of a genus. For example, ascospores of species of *Hypomyces* are often verrucose to tuberculate; in *Cosmospora* ascospores tend to be verrucose and golden-brown; in *Hydropisphaera*, the ascospores are generally striate. Traditionally the genus *Nectria sensu lato* has included species with one-septate ascospores. However, in *Nectria sensu stricto* ascospores are variable in size and septation, ranging from one-septate in *N. cinnabarina* to ellipsoid and transversely septate in *N. coryli* to very long and transversely septate in *N. cucurbitula* or muriform in *N. pseudotrichia*. Within

the *Clavicipitaceae* ascospores are generally cylindrical and filiform. Neither germ slits nor germ pores are known in the *Hypocreales*.

ANAMORPHS.— The anamorphs of the *Bionectriaceae*, *Clavicipitaceae*, *Hypocreaceae* and *Nectriaceae* are primarily phialidic, producing hyaline or bright-coloured conidia, although there are some exceptions. Conidiomata range from non-existent to acervular, pycnidial or synnematal. Conidia may be aseptate or septate, ranging from having one or multiple, transverse septa to muriform, and are generally hyaline or slightly yellow to yellow-brown or green, but not brown or black. Although emphasis is placed here on teleomorphic states, hypocrealean fungi are commonly encountered as anamorphs. For some species, the anamorphic state appears to have a much wider geographic distribution than the teleomorph. Asexual states of most genera in the *Bionectriaceae* are reduced, often described as acremonium-like, although there are exceptions such the anamorphs of *Bionectria* classified in *Clonostachys* (Schroers *et al.*, 1999; Schroers, 2001). Anamorph genera connected to teleomorphs in the *Hypocreales* include *Cladobotryum* (Gams & Hoozemans, 1970; Rogerson & Samuels, 1994), *Gliocladium* (Seifert, 1985), *Stilbella* (Seifert, 1985), and *Trichoderma* (Bissett, 1984, 1991 a, b; Gams & Bissett, 1998; Chaverri & Samuels, 2003; Samuels *et al.*, 1998). The greatest diversity of anamorphs occurs in the *Nectriaceae* including the following pairs of teleomorph/anamorph genera: *Calonectria-Cylindrocladium* (Crous, 2002); *Nectria-Tubercularia* (Seifert, 1985) and *Neonectria-Cylindrocarpon* (Brayford *et al.*, 2004).

MATERIALS AND METHODS

To examine specimens of hypocrealean fungi, a drop of water was placed directly on the ascomata for a few minutes. Ascomata are routinely mounted in 3% KOH. Cotton blue in lactic acid is often helpful in revealing surface ornamentation of ascospores. The test for colour reaction of the ascomata was made by placing a drop of 3% KOH and 100% lactic acid directly on the rehydrated ascomata or mounting the rehydrated ascomata in these media. If the wall of the ascomata changes colour usually to a dark blood red or purple, this is indicated as KOH+. If the wall of the ascomata becomes yellow in lactic acid, this is indicated as lactic acid becoming yellow. Longitudinal median sections were made using a freezing microtome. To make sections, ascomata were picked off the substratum, rehydrated briefly in water, placed on a freezing stage, and mounted in Tissue-Tek (Miles, Inc., Elkhart, IN). Sections of ascomata and stromata were approximately 15 μm thick.

Cultures of fresh specimens were obtained by the isolation of single or mass ascospores in the laboratory.

Recently collected fresh or air-dried specimens were rehydrated with water. Several ascomata were placed in a drop of sterile water in the well of a hanging drop slide. The ascomata were smashed with a needle, releasing asci and ascospores into the water, and stirred vigorously in order to distribute the centrum contents evenly. The drop of water with asci, ascospores and remnants of the ascomata was placed on a plate of agar using a sterile micropipette. Firm cornmeal dextrose agar with antibiotics (Difco cornmeal agar + 2% dextrose and 2 mg/L each of streptomycin, tetracyclin and neomycin) was used for primary isolation. The drop was spread over the surface of the agar plate using a sterile blunt glass rod. Plates were incubated overnight at room temperature. The next day the agar surface was examined using a 50× binocular dissecting microscope with transmitted light. Germinated single

or mass ascospores with subtending agar were picked out of the agar with a fine insect pin and transferred to agar plates and tubes. Several ascospores were placed in a drop of cotton blue in lactic acid for observation of germination and to check the identity of the isolated ascospores. Alternatively, cultures were isolated using a micromanipulator as described in Kendrick (1979). Cultures derived from mass and single ascospores were placed on cornmeal agar slants (lacking dextrose) in screw top tubes and placed in a cold room (10° C), in 10% glycerine in cryovials, in vapour phase of liquid nitrogen, or in 10% glycerine in cryovials at -80° C. Specimens from which cultures were obtained, dried cultures, and living cultures were deposited at BPI or NY. Abbreviations used for herbaria are those of Holmgren *et al.* (1990).

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KEY TO THE FAMILIES OF THE *HYPOCREALES*

1. Perithecia dark brown to black, soft-textured, generally solitary; anamorphs acremonium-like, *Monocillium*, *Stachybotrys*, or unknown.....*Niessliaceae* (not included, see Samuels & Barr, 1998)
1. Perithecia hyaline to light or bright-coloured, rarely brown or appearing black but internally bright-coloured, soft-textured, solitary or aggregated; anamorphs generally phialidic.....2
2. Ascospores filiform, multiseptate, usually disarticulating within ascus; ascal apex usually thickened, penetrated by a narrow pore; on living grasses, insects or fungi.....*Clavicipitaceae*
2. Ascospores globose, ellipsoid to long-fusiform, never truly filiform, disarticulating or not; ascal apex usually not distinctly thickened, rather with an apical ring or simple; on all kinds of substrata, rarely on living grasses3
3. Ascospores generally disarticulating; perithecia generally immersed in a stroma; on soil, wood or other fungi *Hypocreaceae*
3. Ascospores not disarticulating; perithecia superficial on substratum, subiculum or stroma, or immersed in a hyphal to well-developed stroma4
4. Perithecia white, pale yellow to orange or brown, not reacting in KOH or lactic acid; perithecia superficial on substratum or stroma, or immersed in a hyphal to well-developed stroma.....*Bionectriaceae*
4. Perithecia generally orange to red or dark red to purple, reacting in KOH and lactic acid; perithecia superficial on substratum or stroma *Nectriaceae*

For comprehensive keys to all genera included in the *Bionectriaceae*, *Hypocreaceae*, and *Nectriaceae*, consult Rossman *et al.* (1999).

KEY TO GENERA OF THE *HYPOCREALES* INCLUDED IN THIS BOOK

Key to Genera of *Bionectriaceae*

1. Perithecia on myxomycetes..... *Nectriopsis*
1. Perithecia on plant substrata 2
2. Perithecia globose to subglobose, becoming distinctly cupulate upon drying due to perithecial wall of globose, thin-walled cells; ascospores often striate *Hydropisphaera*
2. Perithecia not distinctly cupulate upon drying; ascospores striate or not 3
3. Perithecia with tan hyphae covering perithecial wall; ascospores spinulose or verrucose; anamorph synnematos *Stilbocrea*
3. Perithecia without hyphal covering; ascospores smooth, spinulose, striate or verrucose; anamorph *Clonostachys*, not synnematos *Bionectria*

Synoptic Key to Species of *Bionectriaceae*

Substrata

- Parasitic on myxomycetes: 6, 7, 8, 10
 Parasitic on stroma of other fungi or directly on living grasses or ferns: 3
 On non-lichenized ascomycetes except *Clavicipitaceae*: 2, 4
 On lichens: 9
 On basidiomycetes: 5, 8
 On decaying cloth: 5
 On herbaceous tissue: 8
 On bark of recently dead trees: 1, 2, 4, 11
 On rotted wood or bark: 2, 4, 5, 8, 11
 On dung: 5
 On soil: 2

Perithecial placement

- Superficial: 1, 2, 4, 5, 9, 12
 Slightly immersed to fully immersed in stroma or subiculum: 3, 6, 7, 8, 10, 11

Perithecial collapse

- Not collapsed: all except as below
 Laterally pinched: 9
 Slightly cupulate: 4, 11
 Deeply cupulate: 5

Perithecial surface

- Smooth: 2, 4, 5, 11
 Finely warted to granulose: 3, 4, 5, 11
 Conspicuously warted: 1
 With hairs or setae: 6, 7, 8, 9, 10

Ascospore shape

- Oblong to ellipsoidal: all except as below
 Narrowly fusiform: 9
 Cylindrical: 10

Ascospore septation

- All one-septate

Ascospore ornamentation

- Smooth: 2, 3, 6, 7, 9, 10
 Spinulose: 1, 2, 3, 4, 8, 11
 Striate: 5

Ascospore size

- 5–10 µm: 2, 3, 6, 7, 8, 10, 11
 10–15 µm: 1, 2, 3, 4, 5, 11
 15–20 µm: 5, 9

Species of *Bionectriaceae*:

1. *Bionectria byssicola*
2. *Bionectria compactiuscula*
3. *Bionectria epichloë*
4. *Bionectria ochroleuca*
5. *Hydropisphaera peziza*
6. *Nectriopsis candicans*
7. *Nectriopsis exigua*
8. *Nectriopsis oropensooides*
9. *Nectriopsis rubifaciens*
10. *Nectriopsis violacea*
11. *Stilbocrea gracilipes*

Key to *Clavicipitaceae*

1. Perithecia superficial, not immersed in a well-developed stroma; parasitic on pyrenomycetes *Neobarya parasitica*
1. Perithecia immersed in well-developed stroma; parasitic on insects, specifically pupae of lepidopterous insects or hypogeous fungi *Cordyceps*

Key to Genera of *Hypocreaceae*

1. Ascospores 1-septate, usually disarticulating within ascus 2
1. Ascospores not disarticulating within ascus 3
2. Part-ascospores monomorphic, conical, with apiculus; stroma always very thin, cottony and white or off white *Arachnocrea* sp.
2. Part-ascospores not monomorphic or, if monomorphic, not conical or apiculate; stroma typically pulvinate, tuberculate or discoidal, sometimes club-shaped, sometimes thin and effused and then tissues compact and surface often yellow or white *Hypocrea*
3. Stroma extensive, indefinite, radiately spreading, often lobate; ascospores ellipsoid to fusiform, unicellular, becoming 1-septate, rarely 3-septate *Hypocreopsis rhododendri*
3. Stroma densely cottony or highly compacted; ascospores 1-septate 4
4. Ascospores typically fusiform, apiculate, often coarsely warted, less frequently smooth or spinulose; perithecia typically partly or wholly immersed in a densely cottony or highly compacted subiculum; on *Aphyllophorales*, agarics, or fleshy ascomycetes *Hypomyces*
4. Ascospores ellipsoid to naviculate, non-apiculate, spinulose; perithecia superficial on a subiculum; on *Aphyllophorales* *Sphaerostilbella aureonitens*

Synoptic Key to Species of *Hypocrea* and *Arachnocrea****Substratum***

On rotted wood or bark: 1, 2, 3, 5, 6, 7, 8, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22, 24, 25, 27, 28, 29, 30, 31, 32, 33
 On herbaceous litter: 11, 13, 18
 On soil: 11, 13, 16
 On mushrooms: 4
 On resupinate basidiomycetes including jelly fungi (*Exidia*): 6, 10, 32
 On polypores: 12, 23, 26
 On bird's nest fungi (*Cyathus* spp.): 15
 On black pyrenomycetes: 9

Fruit body shape

Effuse: 1, 3, 4, 10, 11, 12, 13, 15, 19, 20, 23, 26, 32
 Pulvinate: 5, 6, 7, 8, 9, 14, 17, 18, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 33
 Stipitate: 2, 16

Fruit body colour

White: 4, 7, 13, 15, 23, 31
 Pale yellow: 8, 9, 11, 16, 22, 23, 24, 25, 30, 31, 32, 33
 Greyish yellow: 10, 11, 12, 20, 26, 30, 32
 Buff to tan: 1, 3, 12, 13, 16, 18, 25, 27, 31

Golden yellow: 2

Brownish orange: 5, 12, 16, 20, 26

Reddish brown to red: 6, 22, 29

Pale to medium brown: 1, 2, 3, 14, 18, 19, 21, 22, 24, 27

Dark brown or dark green to black: 17, 28

KOH reaction

KOH– : All negative except as below.

KOH+ : 5, 6, 7, 12, 17, 23, 24, 25, 26, 32, 33

Part-ascospores monomorphic or dimorphic

Monomorphic: 8, 12, 13, 21, 25, 26, 28, 29, 30

Dimorphic: 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 31, 32, 33

Part-ascospores apiculate or non apiculate

All not apiculate except 1

Ascospore colour

Green: 5, 6, 8, 9, 17, 30, 31, 33

White: 1, 2, 3, 4, 7, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 32

Yellow: 25

Ascospore ornamentation

Smooth: 12, 26

Spinulose: 1, 2, 3, 4, 6, 7, 10, 11, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32, 33

Warted/tuberculate: 5, 8, 9, 17, 19, 30, 31

Species of *Hypocrea* and *Arachnocrea*:

1. *Arachnocrea* sp.
2. *Hypocrea alutacea*
3. *Hypocrea atroviridis*
4. *Hypocrea avellanea*
5. *Hypocrea ceracea*
6. *Hypocrea ceramica*
7. *Hypocrea chionea*
8. *Hypocrea chlorospora*
9. *Hypocrea chromosperma*
10. *Hypocrea cineroflava*
11. *Hypocrea citrina* var. *citrina*
12. *Hypocrea citrina* var. *americana*
13. *Hypocrea farinosa*
14. *Hypocrea koningii*
15. *Hypocrea latizonata*
16. *Hypocrea leucopus*
17. *Hypocrea lixii*
18. *Hypocrea lutea*
19. *Hypocrea megalocitrina*
20. *Hypocrea microcitrina*
21. *Hypocrea minutispora*
22. *Hypocrea pachybasioides*
23. *Hypocrea pallida*
24. *Hypocrea patella*
25. *Hypocrea* cf. *pseudostraminea*
26. *Hypocrea pulvinata*
27. *Hypocrea rufa*
28. *Hypocrea schweinitzii*
29. *Hypocrea scutellaeformis*
30. *Hypocrea sinuosa*
31. *Hypocrea strictipilosa*
32. *Hypocrea sulphurea*
33. *Hypocrea virens*

Dichotomous Key to Species of *Hypocrea* and *Arachnocrea*

1. On mushrooms, polypores, jelly fungi or bird's nest fungi 2
1. On soil, litter, wood, bark, or fruiting bodies of ascomycetes 7
2. On bird's nest fungi (*Cyathus* spp.) *H. latizonata*
2. On mushrooms, polypores, or jelly fungi 3
3. On jelly fungi (*Exidia nucleata*) *H. sulphurea*
3. On mushrooms or polypores 4
4. On mushrooms (*Marasmius subnudus*) *H. avellanea*
4. On polypores 5
5. On *Trametes* and other thin polypores *H. pallida*
5. On *Ganodermataceae* 6
6. Distal and proximal part of part-ascospores globose to subglobose *H. citrina* var. *americana*
6. Distal and proximal part of part-ascospores different in shape *H. pulvinata*
7. Ascospores green 8
7. Ascospores colourless 15
8. Stromata with pale red colouration *H. ceramica*
8. Stromata pale yellow, white or dark green to black 9
9. Stromata dark green to black *H. lixii*
9. Stromata pale yellow or white 10
10. Distal and proximal part ascospores subglobose 11
10. Distal part ascospores subglobose, proximal part ascospores wedge-shaped 13
11. Stromata 0.3-1 mm diam, comprising more than 20 perithecia; often on very wet, decorticated wood *H. chlorospora*
11. Stromata with fewer than 15 perithecia; usually on dry wood 12
12. Stroma surface papillate and scaly, orange in KOH; conidia in drops of green liquid, anamorph *Trichoderma virens* *H. virens*
12. Stroma surface not papillate or scaly, not changing colour in KOH; conidia not conspicuously wet, anamorph *Trichoderma sinuosum* *H. sinuosa*
13. Distal part ascospores $5.2-5.5 \times 4.7-5 \mu\text{m}$; proximal part ascospores $5.7-6.2 \times 4.7-5.2 \mu\text{m}$ *H. strictipilosa*
13. Distal part ascospores $4.2-4.3 \times 4.0-4.2 \mu\text{m}$, proximal part ascospores $4.2-5 \times 3.5-3.7 \mu\text{m}$ 14
14. Stromata with fewer than 10 perithecia; distal part ascospores $4.5-4.7 \times 4.0-4.2 \mu\text{m}$, proximal part ascospores $4.8-5.0 \times 3.5-3.7 \mu\text{m}$ *H. ceracea*
14. Stromata with more than 20 perithecia; distal part ascospores $4.2-4.3 \times 4-4.2 \mu\text{m}$, proximal part ascospores $4.2-4.5 \times 3.5-3.8 \mu\text{m}$ *H. chromosperma*
15. Stromata very dark-green to black; on bark *H. schweinitzii*
15. Stromata red, brown or lightly coloured 16
16. Stromata club-shaped 17
16. Stromata discoidal to tuberculate or effused but never club-shaped 18

17. On wood *H. alutacea*
 17. On ground *H. leucopus*
18. Stromata white, 1–1.5 mm diam, cushion-shaped, consisting of hyphal tissue; on wood *H. chionea*
 18. Stromata effused or tuberculate, white, brightly coloured, red, yellow or brown,
 tissue mostly cellular but sometimes hyphal when effused; on wood or litter 19
19. Mature stromata brown or red brown, discoidal to tuberculate; young stage often present, tan
 with a white margin; young and mature stromata often appearing velvety from short
 hairs on the stroma surface; ostiolar openings not visible or obscure; anamorphs *Trichoderma*
 with green conidia 20
19. Mature stromata white to brightly coloured, yellow-brown, sometimes tan, rarely red brown,
 tuberculate, discoidal or effused, often extensively effused; young stromata not as above and
 stromata when tuberculate or discoidal not with short hairs and not appearing velvety (for species
 with effused stromata often appearing velvety and having short hairs on the surface, go to 27) 23
20. Stroma surface with very thick-walled cells; no hairs seen *H. scutellaeformis*
 20. Cells of stroma surface not conspicuously thick-walled; short hairs usually visible 21
21. Distal part ascospores $4.2\text{--}5.2 \times 4\text{--}4.5 \mu\text{m}$; proximal part ascospores $5\text{--}5.7 \times 2.5\text{--}4.2 \mu\text{m}$;
 conidia subglobose, warted *H. rufa*
 21. Distal part ascospores $3.5\text{--}5 \times 2.5\text{--}4.7 \mu\text{m}$; proximal part ascospores $3.5\text{--}5.5 \times 2.2\text{--}4 \mu\text{m}$ 22
22. Distal part ascospores $3.5\text{--}5 \times 3.2\text{--}4.7 \mu\text{m}$; proximal part ascospores $3.5\text{--}5.5 \times 3\text{--}4 \mu\text{m}$;
 anamorph *Trichoderma atroviride*, conidia globose, smooth; colonies often with
 coconut odor *H. atroviridis*
 22. Distal part ascospores $3.2\text{--}4.5 \times 2.5\text{--}3.6 \mu\text{m}$; proximal part ascospores $3.7\text{--}4.7 \times 2.2\text{--}3 \mu\text{m}$;
 anamorph *Trichoderma koningii*, conidia ellipsoidal to oblong, smooth;
 colonies sometimes with coconut odor *H. koningii*
23. Stromata discoidal to tuberculate or pulvinate, not effused 24
 23. Stromata thin and effused to a greater or lesser extent 28
24. Stromata pale yellow, pulvinate; anamorph *Gliocladium viride*, conidia borne in
 drops of green liquid at the tips of long conidiophores *H. lutea*
 24. Stromata deep yellow to brownish 25
25. Stromata yellow-orange or yellow-brown, crowded; discoidal to semieffused 26
 25. Stromata bright yellow to brownish, solitary or in groups of few; discoidal to cushion-shaped 27
26. Stromata light brown to brown, discoidal; ostiolar openings very conspicuous as many
 very dark dots; stroma surface of distinctly angular cells *H. patella*
 26. Stromata yellowish to light orange, semieffused; ostiolar openings viscid, slightly darker
 orange than the surrounding tissue but not dark *H. cf. pseudostraminea*
27. Conidia white, *Trichoderma polysporum* *H. pachybasioides*
 27. Conidia green, *Trichoderma minutisporum* *H. minutispora*
28. On decorticated wood; stroma < 1 mm thick, appearing as an indefinitely effused,
 greyish yellow film *H. cinereoflava*
 28. On bark, decorticated wood or litter; stroma thicker, white to yellow 29
29. On litter 30
 29. On wood or bark, sometimes on *Exidia* 31
30. Part-ascospores with an apiculus; stroma < 1.5 mm thick, hyphal, white with orange ostiolar
 openings *Arachnocrea* sp.
 30. Part-ascospores not apiculate; stroma thicker, pale yellow to white; tissue cellular,
 not hyphal *Hypocrea citrina* var. *citrina*

31. Stroma deep yellow, on *Exidia* on bark *H. sulphurea*
 31. Stroma pale yellow to white or greyish orange; on wood or bark, not on *Exidia* 32
32. Part ascospores conical, grossly warted; distal part-ascospores $4.5\text{--}5.8 \times 3.7\text{--}5\ \mu\text{m}$;
 proximal part-ascospores $4.5\text{--}6 \times 3.7\text{--}4.7\ \mu\text{m}$ *H. megalocitrina*
 32. Part ascospores smaller, not conical 33
33. Stroma very thin, with conspicuous, areolate orange, ostiolar openings
 sharply limited in extent *H. microcitrina*
 33. Stroma thicker, ostiolar openings not different from the surrounding
 stroma tissue, not areolate *H. farinosa*

Synoptic Key to Species of *Hypomyces*

Substratum

- On rotted wood, bark, litter or soil: 1, 15, 18, 22
 On mushrooms and mushroom-like fungi except
 boletes: 1, 2, 7, 8, 9, 11, 12, 14, 15, 18, 23
 On boletes: 3, 4, 5, 6, 13
 On resupinate basidiomycetes including jelly fungi:
 1, 17
 On polypores: 14, 17, 19, 22
 On *Stereum*: 21
 On fleshy ascomycetes: 10, 16, 20

Subiculum colour

- White to pale yellow: 1, 2, 4, 5, 7, 9, 10, 12, 13, 14,
 15, 18, 19, 20, 21, 22, 23
 Yellow: 5, 9, 11
 Buff: 2, 3, 4, 5, 7, 9, 10, 12, 14, 15, 17, 21, 22
 Orange: 1, 8, 15
 Pink, rose, red or purple: 8, 18
 Bluish green to dark green: 10, 11
 Brown to olivaceous brown: 3, 4, 6
 Absent: 16

Subiculum KOH reaction

- KOH–: All except as listed below
 KOH+: 1, 3, 6, 8, 18

Ascospore shape

- Fusiform: 1, 2, 3, 6, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18,
 19, 21, 22
 Naviculate: 3, 4, 5, 7, 10, 13, 16, 19, 20, 21
 Ellipsoidal: 10, 23

Ascospore septum

- Non-septate: 2, 6, 9, 10, 11, 13, 16, 17, 20
 Median: 1, 3, 4, 8, 12, 13, 14, 15, 17, 18, 19, 21, 22,
 23
 Submedian: 3, 4, 5, 7, 13, 19, 21
 Supramedian: 19, 21

Ascospore ends

- Apiculate: 1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 18,
 19, 21, 22
 Non-apiculate: 3, 10, 13, 16, 17, 19, 20, 21, 23

Ascospore ornamentation

- Smooth: 3, 4, 10, 13, 16, 19, 20, 21
 Finely verrucose: 2, 4, 9, 11, 13, 17, 19, 21
 Verrucose: 1, 5, 6, 7, 8, 12, 14, 18, 19, 23
 Warted: 15, 22

Ascospore length

- 10–14 μm : 3, 4, 10, 13, 16, 20, 21, 23
 15–20 μm : 1, 5, 7, 14, 16, 17, 19, 21
 21–25 μm : 1, 5, 9, 14, 17
 26–30 μm : 6, 9, 11, 18
 31–35 μm : 2, 6, 11, 12, 15, 18, 22
 36 μm or more: 2, 8, 11, 12, 15, 22

Species of *Hypomyces*

1. *Hypomyces aurantius*
2. *Hypomyces banningeriae*
3. *Hypomyces boletiphagus*
4. *Hypomyces chlorinigenus*
5. *Hypomyces chrysospermus*
6. *Hypomyces completus*
7. *Hypomyces hyalinus*
8. *Hypomyces lactifluorum*
9. *Hypomyces lateritius*
10. *Hypomyces leotiicola*
11. *Hypomyces luteovirens*
12. *Hypomyces macrosporus*
13. *Hypomyces microspermus*
14. *Hypomyces mycophilus*
15. *Hypomyces ochraceus*
16. *Hypomyces papulasporae*
17. *Hypomyces polyporinus*
18. *Hypomyces rosellus*
19. *Hypomyces sibirinae*
20. *Hypomyces stephanomatis*
21. *Hypomyces sympodiophorus*
22. *Hypomyces tegillum*
23. *Hypomyces tremellicola*

Key to Genera of *Nectriaceae*

1. Ascospores non-septate, globose to ellipsoid, yellow to yellow-brown, ornamented;
isolated from soil or as a plant pathogen *Neocosmospora* 2
1. Ascospores 1–3 or more septate or muriform, ellipsoid to fusiform or elongate 2
2. Perithecia with yellow to golden, spinulose, rarely smooth, hairs; ascospores striate;
anamorph *Actinostilbe*, sporodochial or synnematos *Lanatonectria* 3
2. Perithecia without yellow to golden, spinulose hairs 3
3. Perithecia purple-black, warted; dark red in KOH and yellow in lactic acid;
anamorph *Fusarium* *Gibberella* 4
3. Perithecia typically red, red-orange to dark red or almost black 4
4. Perithecia small, less than 300 µm diam, smooth, non-stromatic or on an inconspicuous
basal stroma, globose to pyriform, collapsing laterally when dry; perithecial
wall of thin-walled cells *Cosmospora* 5
4. Perithecia with warts or, if smooth-walled, then larger than 300 µm diam, with or
without a stroma, collapsing transversely or laterally when dry; perithecial wall
of thick-walled cells 5
5. Ascospores green, smooth; where known, anamorph *Penicillifer* *Viridispora* 6
5. Ascospores hyaline to yellow or yellow-brown 6
6. Perithecia often shiny, smooth to slightly surfy, scurfy covering thick perithecial wall, generally
larger than 300 µm diam; anamorph *Cylindrocarpon* *Neonectria* 7
6. Perithecia warted, never smooth; anamorph *Cylindrocladium*, *Fusarium*, or *Tubercularia* 7
7. Perithecia aggregated, usually on a well-developed stroma, often collapsed cupulate
when dry; on dead wood of deciduous trees *Nectria* 8
7. Perithecia solitary, not on a well-developed stroma; on dead leaves, herbaceous stems,
or wood 8
8. Perithecia solitary, firmly attached to substrata by blackened base; ascospores hyaline,
1–3- or 5-septate; on dead leaves and herbaceous stems; anamorph *Cylindrocladium* *Calonectria* 8
8. Perithecia solitary or aggregated without stroma; ascospores yellow to yellow-brown,
1-septate; on woody substrata; anamorph *Fusarium* *Haematonectria* 8

Synoptic Key to Species of *Nectriaceae****Substratum***

- Fungicolous on non-lichenized ascomycetes: 4, 5, 7,
8, 10, 11, 12, 16
- On decaying herbaceous tissue including leaves: 1, 2,
3, 9, 13, 14, 15, 16, 27
- On bark or cankers of living trees: 12, 13, 18, 28, 29,
30
- On bark of recently dead trees: 15, 16, 18, 21, 25, 29,
30, 31
- On decaying wood, woody tissue such as cones,
twigs, or bark: 1, 2, 16, 17, 18, 19, 20, 21, 22, 23,
24, 25, 26, 29, 30, 32
- Isolated from soil: 15, 27, 32
- On scale insects: 6
- Erumpent through needle scars and twigs of conifers:
19, 23

Perithecial colour

- All but below orange-red to red
- Bright yellow with blackened base: 1, 20
- Dark red, dark purple to black: 13, 14, 18, 19, 20, 22,
23

Perithecial collapse

- Not collapsed: 1, 2, 5, 12, 13, 14, 16, 17, 19, 20, 24,
27, 28, 29, 30, 31, 32
- Cupulate: 5, 6, 7, 13, 14, 17, 18, 19, 21, 22, 23, 25,
26
- Laterally pinched: 1, 2, 3, 4, 5, 8, 9, 10, 11, 13, 14,
15, 24

Perithecial surface

Smooth without apical disk: 3, 4, 5, 7, 8, 9, 11, 12, 22, 28, 29, 30, 32

Smooth to scaly with apical disk: 10, 31

Slightly to conspicuously warted or tuberculate: 1, 2, 6, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27

With hairs or setae: 8, 16

With bright-yellow or greenish scurf: 17, 19, 20, 23

Ascospore shape

Globose to irregularly globose: 20, 27

Broadly ovoid: 32

Broadly to narrowly ellipsoid: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 24, 25, 26, 28, 29, 30, 31, 32

Broadly to narrowly fusiform: 1, 2, 3, 4, 7, 8, 9, 12, 13, 14, 19, 22, 23, 24, 26, 29, 30

Narrowly clavate or pyriform: 18, 23

Naviculate: 3

Ascospore septation

All one-septate except:

Non-septate: 27, 32

3-septate: 1, 2, 4, 13, 14

3+ transversely septate: 2, 17, 23

Muriform: 18, 19, 20, 25

Ascospore ornamentation

Smooth: 1, 2, 3, 5, 6, 7, 8, 9, 13, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 32

Spinulose: 24, 28, 29, 30

Striate: 4, 15, 16

Warted/tuberculate/rugose: 5, 6, 10, 11, 12, 27, 31

Ascospore size

5-10 μm : 5, 9, 10, 11, 18, 20, 24, 28

10-15 μm : 3, 5, 7, 8, 9, 10, 11, 12, 15, 16, 18, 21, 22, 24, 26, 27, 28, 29, 30, 31

15-20 μm : 6, 8, 15, 17, 19, 21, 25, 27, 29, 30, 31, 32

More than 20 μm : 1, 2, 4, 13, 14, 17, 19, 23, 25, 30, 32

Ascospores producing ascoconidia

Not except: 19, 20, 22, 23

Species of Nectriaceae:

1. *Calonectria colhounii*
2. *Calonectria pyrochroa*
3. *Cosmospora consors*
4. *Cosmospora diminuta*
5. *Cosmospora episphaeria*
6. *Cosmospora flammea*
7. *Cosmospora magnusiana*
8. *Cosmospora papilionacearum*
9. *Cosmospora peponum*
10. *Cosmospora purtonii*
11. *Cosmospora vilior*
12. *Cosmospora* sp.
13. *Gibberella pulicaris*
14. *Gibberella zeae*
15. *Haematonectria haematococca*
16. *Lanatonectria flocculenta*
17. *Nectria aurigera*
18. *Nectria austroamericana*
19. *Nectria balsamea*
20. *Nectria chlorinella*
21. *Nectria cinnabarina*
22. *Nectria coryli*
23. *Nectria cucurbitula*
24. "*Nectria*" *mariannaeae*
25. *Nectria pseudotrichia*
26. *Nectria rubicarpa*
27. *Neocosmospora vasinfecta*
28. *Neonectria coccinea* var. *faginata*
29. *Neonectria discophora*
30. *Neonectria ditissima*
31. *Neonectria veuillotiana*
32. *Viridispora diparietispora*

BIONECTRIA Speg.

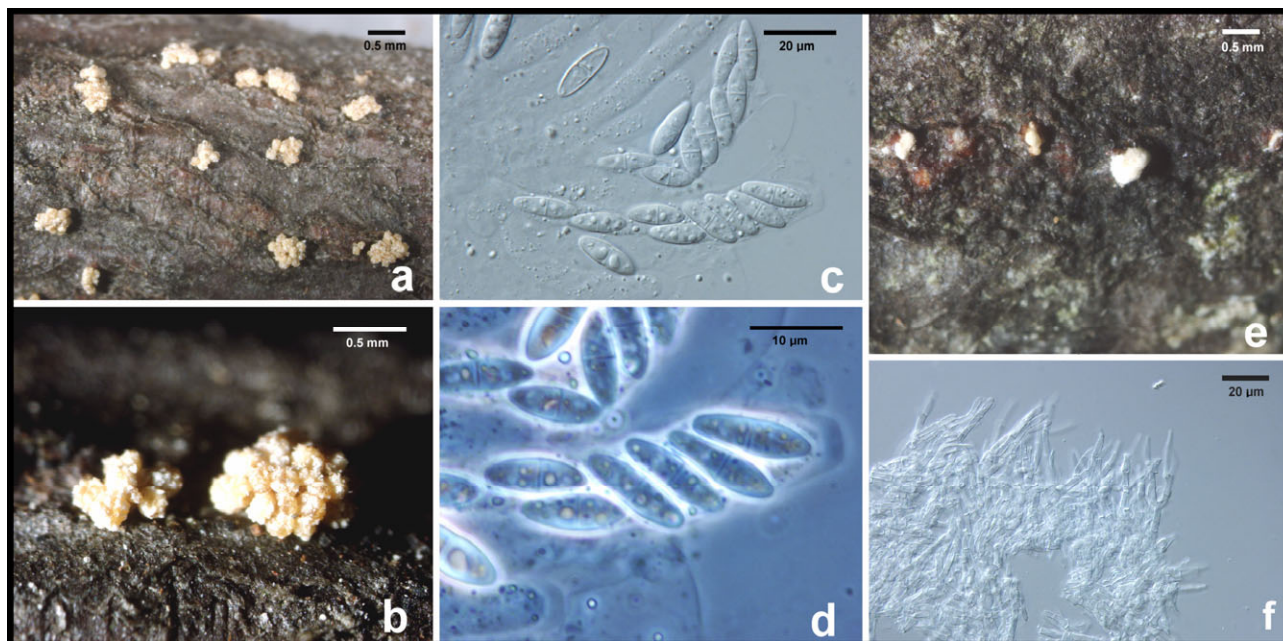
Bionectriaceae

Perithecia solitary to gregarious, superficial to slightly immersed in an erumpent or sometimes superficial stroma, often occurring on other fungi. Perithecia pale yellow, yellow, pale orange, tan or brown, KOH–, wall smooth to warted or with scales, thin-walled hairs, or flexuous setae, subglobose or globose to ovoid, when dried not collapsing or collapsing irregularly, ostiolate. Asci narrowly clavate to clavate. Ascospores 1-septate, rarely multi-septate, hyaline, smooth to spinulose or slightly warted. Anamorph *Clonostachys*. On leaves and decaying woody substrata.

Literature:

Schroers, H-J. (2001). A monograph of *Bionectria* (*Ascomycota*, *Hypocreales*, *Bionectriaceae*) and its *Clonostachys* anamorphs. *Studies in Mycology* **46**: 1–214.

Anamorph: *Clonostachys byssicola* Schroers



Habitat: On bark of recently dead trees.

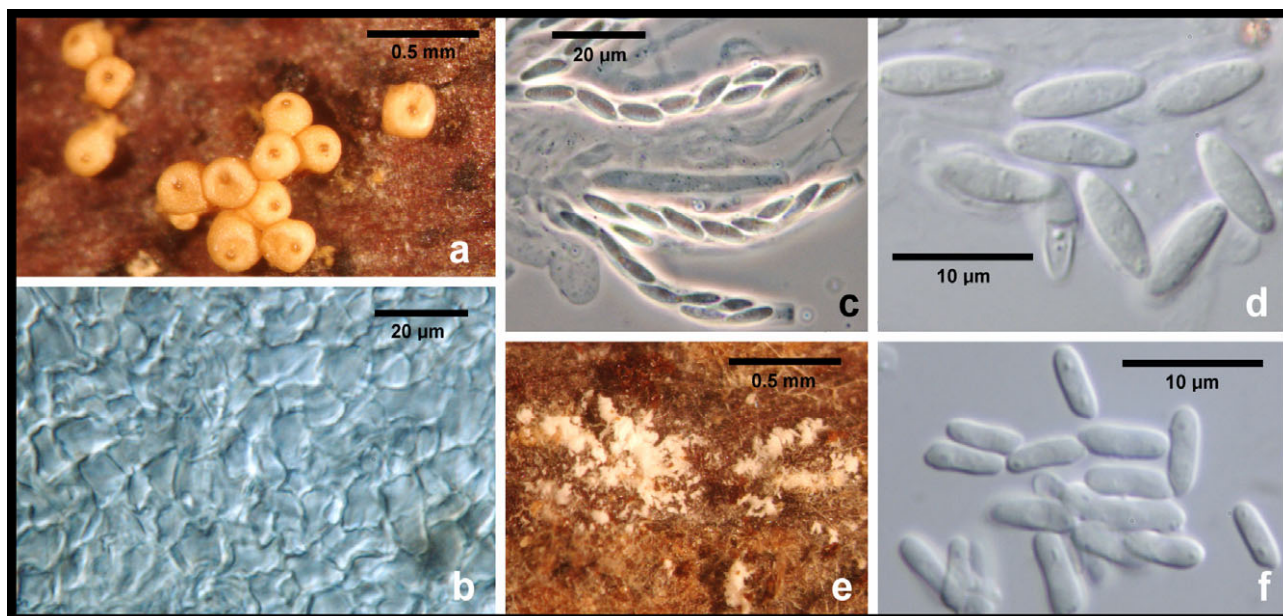
Known distribution: Tropical to temperate.

Description:

Perithecia (a, b) solitary or crowded on a superficial to erumpent stroma that may also bear sporodochia (e). Perithecia 250–400 µm high, 100–315 µm wide, conspicuously warted (b) to rough, orange to brownish orange, laterally pinched when dry. Asci narrowly clavate to clavate, 55–65 × 7.5–10 µm; apex rounded, with a ring (c, d). Ascospores (c, d) ellipsoidal to oblong-ellipsoidal, 11.2–13.5 × 3.7–4.5 µm, spinulose, with a median septum. Sporodochia (e) sometimes associated with perithecial clusters, pale orange, bearing penicillately branched conidiophores from surface (f). Conidia minutely curved, with a laterally displaced basal hilum, 4.5–6.0 × 2.5–3.0 µm.

Notes: This species is very common in all warm temperate and tropical areas. It is recognized readily by the white warts on the perithecia.

Anamorph: *Clonostachys compactiuscula* (Sacc.) D. Hawksw. & W. Gams



Habitat: Soil, bark, apothecium of *Sclerotinia sclerotiorum*. Perithecia on bark of recently dead trees, frequently or close to fruiting structures of pyrenomycetes. Anamorph associated with perithecia and appearing in soil isolations.

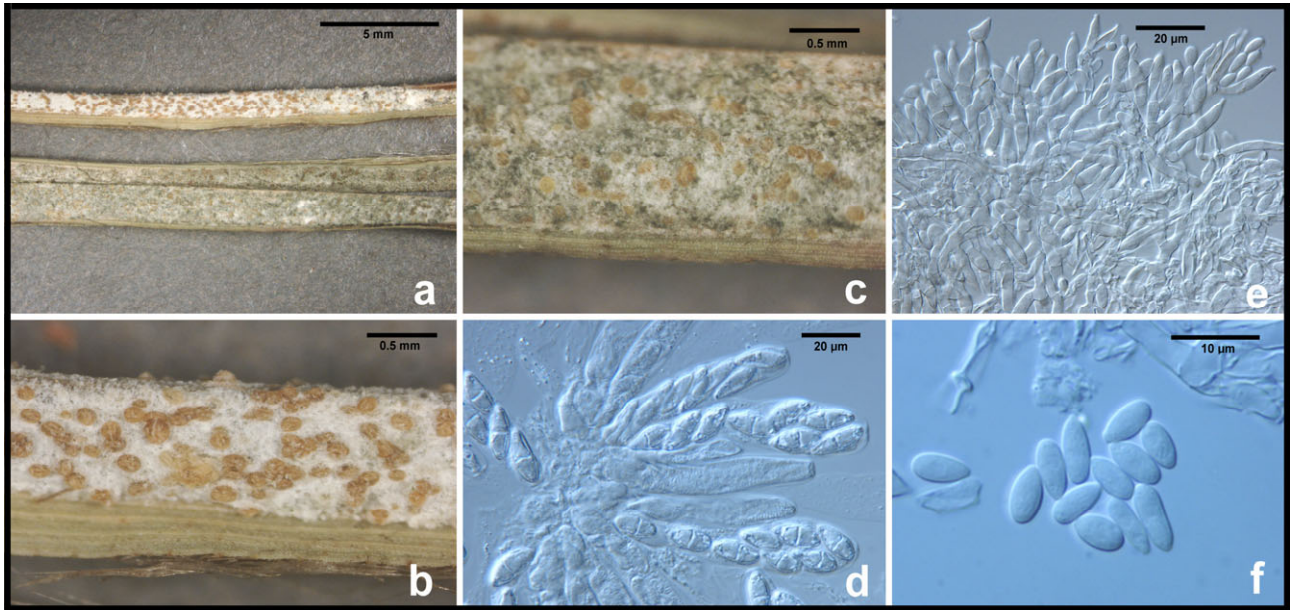
Known distribution: Primarily north temperate but also tropical American. Known from United States (NY, NC, SC, VA), Bermuda, Ecuador, France, French Guiana and Japan.

Description:

Stroma well-developed, erumpent through bark, frequently seated on or close to fructifications of other pyrenomycetes. Perithecia (a) in groups of up to 100 on a common stroma, rarely solitary, globose, subglobose to pyriform, 240–290 µm high, 180–320 µm diam, not collapsed when dry, pale orange to yellowish orange, rarely brownish orange, when dry with a pale brown, slightly sunken ostiolar region, not or minutely papillate, with a smooth surface. Cells of perithecial surface (b) angular to globose, 7–10 µm diam. Asci (c) narrowly clavate with a truncate apex, 50–60 × 6.0–7.5 µm, 8-spored; apex flat with somewhat rounded edges, with a visible ring. Ascospores (d) ellipsoidal to oblong-ellipsoidal, finely spinulose, rarely smooth (but ornamentation can be difficult to observe), (6.2–)9.0–10.5(–13.5) × (2.2–)2.7–3.5(–4.5) µm. Conidiophores (e) frequently scattered on or close to perithecia. Two types of conidiophores formed. Primary conidiophores verticillium-like, rare, sometimes not formed, conidia held in colourless drops of liquid. Secondary conidiophores gliocladium-like, conidia held in imbricate chains that appear as pinkish, pale yellow, orange or white columns, with several columns arising from a single conidiophore. Conidia (f) hyaline, ellipsoidal to cylindrical, almost straight but with a laterally displaced hilum, with broadly rounded distal ends, (4.0–)5.5–7.5(–12.5) × (1.5–)2.0–2.5(–3.2) µm.

Notes: This species is morphologically similar to *B. ochroleuca* but is distinguished by its nearly cylindrical conidia. This description is paraphrased from Schroers (2001).

Anamorph: *Clonostachys epichloë* Schroers



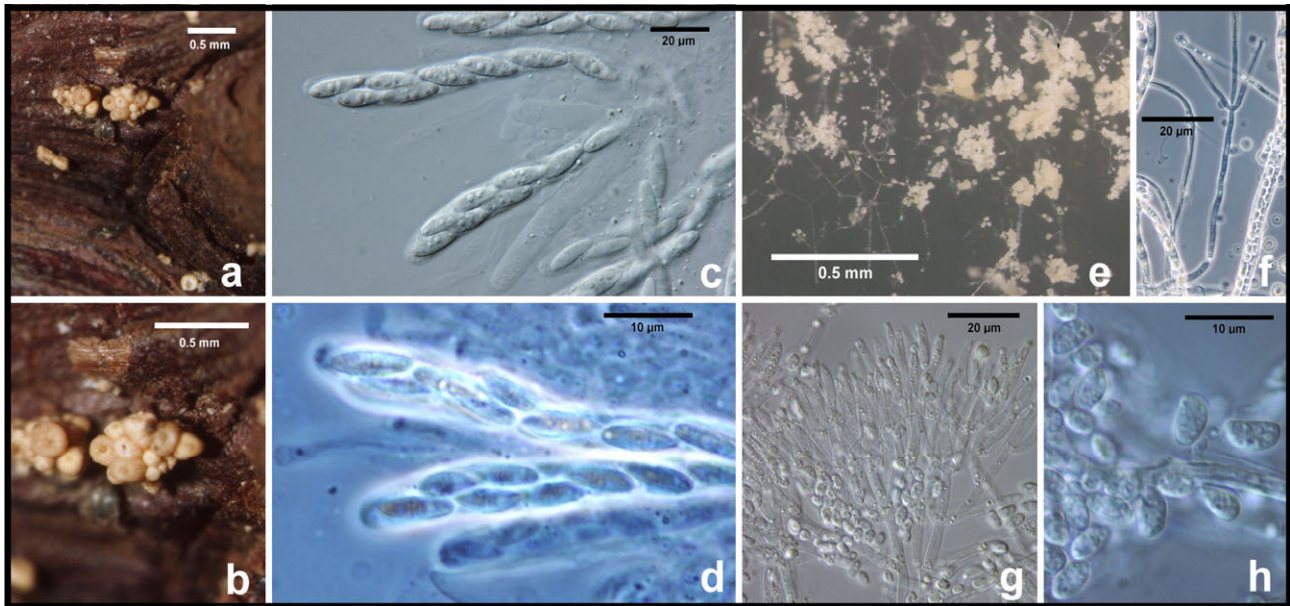
Habitat: On stromata of *Epichloë* sp. and *Balansia* sp. on grasses; dead rachises of ferns (*Pteridium aquilinum*), *Sasa* sp., and other grasses.

Known distribution: United States (GA), the Neotropics, Japan.

Description:

Perithecia growing over fungi on grasses or ferns, solitary to gregarious, loosely disposed in a white hyphal subiculum (a, b), often associated with green conidia of anamorph (a, lower; c; e). Perithecia (b, c) 140–240 µm high, 140–200 µm wide, minutely papillate, pale yellow to orange or brownish, finely warted, especially in upper part, apically or laterally pinched when dry. Asci clavate to narrowly clavate, 35–50 × 7–10 µm; apex rounded to truncate, with a ring (d). Ascospores ellipsoidal, 9–11 × 3–5 µm, smooth to finely spinulose, hyaline; septum median or slightly displaced. Conidiophores (e) penicillately branched, densely scattered, forming a palisade between perithecia. Conidia (f) ellipsoidal to narrowly clavate, 6–7 × 2.2–2.8 µm, unicellular, dark green in mass, held in linear chains with overlapping ends.

Anamorph: *Clonostachys rosea* (Link : Fr.) Schroers et al. f. *rosea*



Habitat: Perithecia on bark of recently dead trees, frequently on ascomata of other ascomycetes; anamorph a common soil fungus.

Known distribution: Teleomorph pantropical and subtropical, rare in temperate regions; anamorph cosmopolitan temperate and tropical.

Description:

Perithecia (a, b) typically occurring in large numbers on an erumpent stroma, globose to subglobose, $160\text{--}370 \times 150\text{--}360 \mu\text{m}$, yellow-orange, light orange, rarely brownish orange, often with a slightly darker ostiolar region, typically smooth, slightly cupulate upon drying. Asci (c, d) narrowly clavate, $50\text{--}57 \times 6.5\text{--}7.5 \mu\text{m}$, apex with a ring that appears triangular in optical section (d). Ascospores ellipsoidal to oblong ellipsoidal, $(7.5\text{--})9.5\text{--}10.8\text{--}(14.5) \times (2.2\text{--})3.0\text{--}3.5\text{--}(4.8) \mu\text{m}$, hyaline, spinulose, with a median septum (c, d). Cultures pale salmon in colour; conidiophores arising in aerial mycelium (e). Two types of conidiophores forming. Primary conidiophores verticillium-like (e, f); secondary conidiophores gliocladium-like (e, g). Conidia (h) from secondary conidiophores slightly curved, with one slightly flattened side, distally broadly rounded, with laterally displaced hilum, $4.8\text{--}5.5\text{--}(6.5) \times (2.0\text{--})2.5\text{--}3.0\text{--}(3.5) \mu\text{m}$, held in imbricate columns that can collapse to form slimy masses (e).

Notes: This is a very common temperate and tropical species, often used in biological control applications.

HYDROPISPHAERA Dumort.

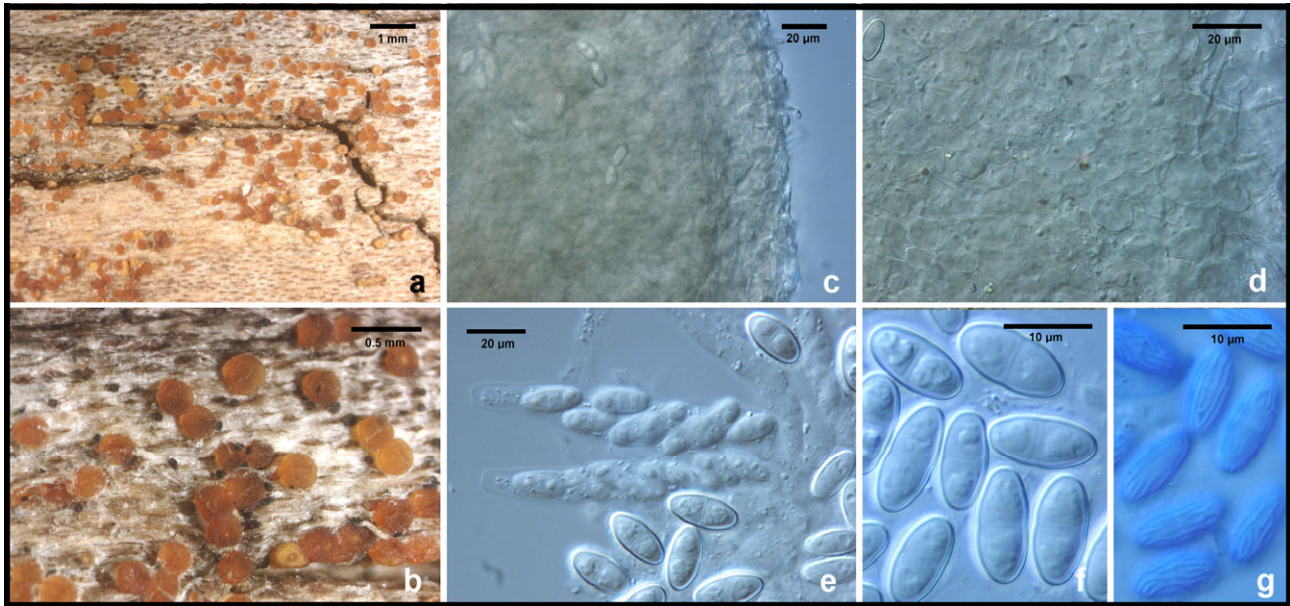
Bionectriaceae

Perithecia superficial, non-stromatic, pale yellow, orange or umber, KOH –, globose to subglobose or doliiform, usually collapsed and deeply cupulate, smooth or with fasciculate hairs. Perithecial wall generally over 25 µm thick, of two regions; outer region of thin-walled, globose cells. Asci clavate. Ascospores ellipsoid, 1- to multiseptate, hyaline, generally finely to coarsely striate, rarely smooth or spinulose. Anamorph, where known, acremonium-like. On dead herbaceous or woody monocotyledonous or dicotyledonous substrata.

Literature:

- Booth, C. (1959). Studies of pyrenomycetes. IV. *Nectria* (part 1). *Mycological Papers* **73**: 1–115.
- Rossmann, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (Hypocreales, Ascomycetes). *Studies in Mycology* **42**: 1–248.
- Samuels, G.J. (1976). A revision of the fungi formerly classified as *Nectria* subgenus *Hyphomycetia*. *Memoirs of the New York Botanical Garden* **26**: 1–126 (as *Nectria peziza*-group).

Anamorph: *Acremonium* sp.



Habitat: On well-rotted wood, bark, dung, decaying cloth and basidiomes of polypores.

Known distribution: Cosmopolitan in north temperate regions.

Description:

Perithecia (a, b) solitary to gregarious, superficial or basally immersed, stroma lacking or very thin, white, subglobose, globose to urniform or almost discoidal with a flattened top, smooth, 370–420 × 370–430 µm, without or with short, acute papilla, cupulate upon drying, smooth or slightly furfuraceous. Perithecial wall with a conspicuous, wide outer region in optical section (c); cells of perithecial wall (d) nearly circular in outline, thin walled, easily seen in optical section. Asci (e) clavate, 60–75 × 8–10 µm, with flattened apex, 8-spored, with biseriate ascospores. Ascospores (f, g) broadly ellipsoid, 11–14 × 5–7 µm, longitudinally striate (g), with a median septum.

Notes: This is a common species in temperate regions, recognized by its wide perithecial wall and striate ascospores. In tropical regions it is replaced by *H. suffulta* (Berk. & M.A. Curt.) Rossman & Samuels. Although superficially similar to *Bionectria ochroleuca* and *Ochronectria calami*, the wide perithecial wall formed of thin-walled, nearly circular cells and the broadly ellipsoidal ascospores with blunt ends are characteristic of members of the genus *Hydropisphaera*. *Bionectria grammicospora* also has striate ascospores, but its pale orange perithecia bear conspicuous white warts.

Perithecia superficial or immersed in substratum, not conspicuously stromatic, generally less than 200 µm diam, nearly white to pale yellow or orange, rarely violet or purple, KOH–. Perithecial wall less than 20 µm thick, of a single region of small, thin-walled, non-descript cells; wall cells at surface forming *textura epidermoidea*. Anamorph, where known, *Acremonium*, gliocladium-like, or verticillium-like. On free-living fungi, lichens, and myxomycetes, less frequently on herbaceous substrata.

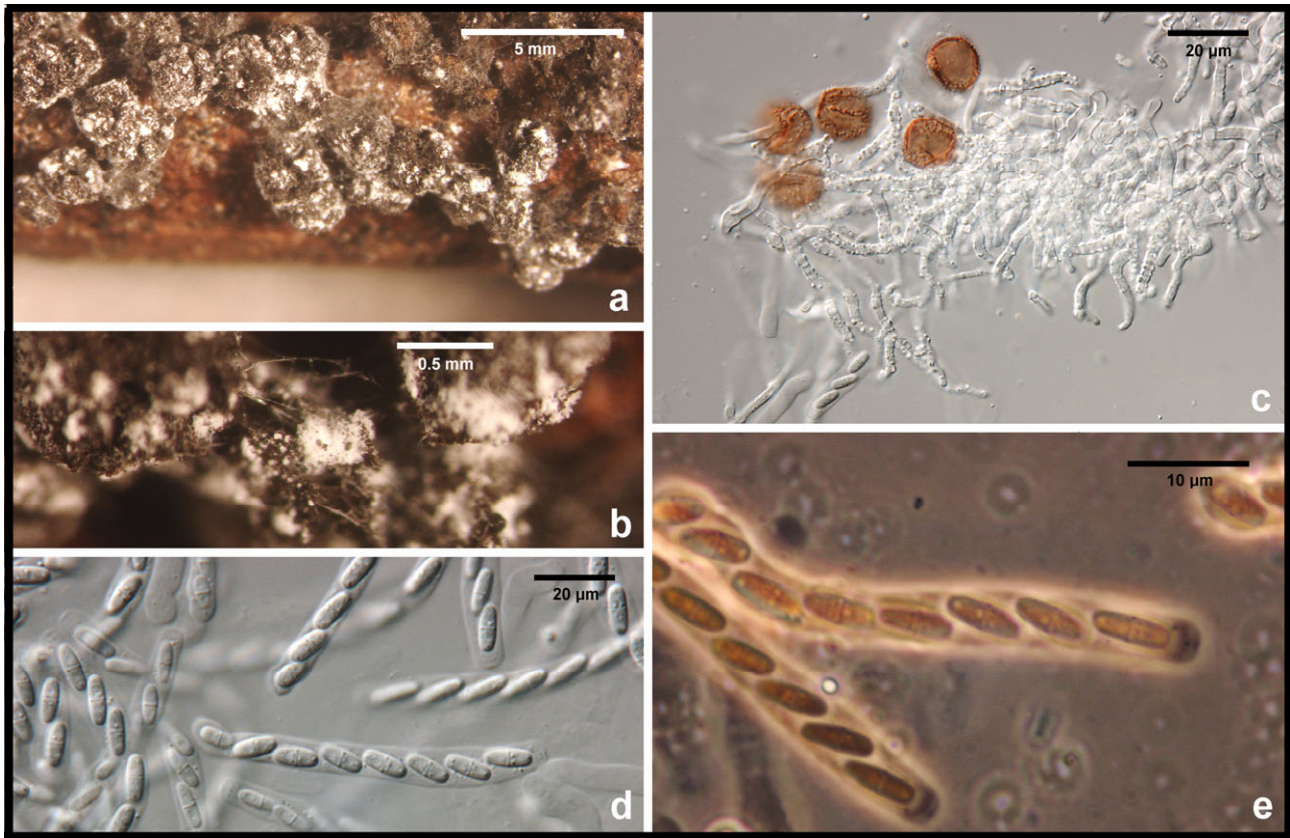
Notes: The meliolicolous species included by Samuels (1988) are now placed in the segregate genus *Dimerosporiella* Speg. by Rossman *et al.* (1999). The genus remains too broadly circumscribed.

Literature:

Lowen, R. (1995). *Acremonium* section *Lichenoidea* section nov. and *Pronectria oligospora* species nov. *Mycotaxon* **53** : 81–95.
 Rossman, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies of Mycology* **42**: 1–248.

Samuels, G.J. (1973). The myxomyceticolous species of *Nectria*. *Mycologia* **64**: 401–420.
 Samuels, G.J. (1988). Fungicolous species of *Trichonectria*, *Peristomialis*, *Nectriopsis*, and *Nectria*. *Memoirs of the New York Botanical Garden* **48**: 1–78.

Anamorph: *Acremonium* sp.



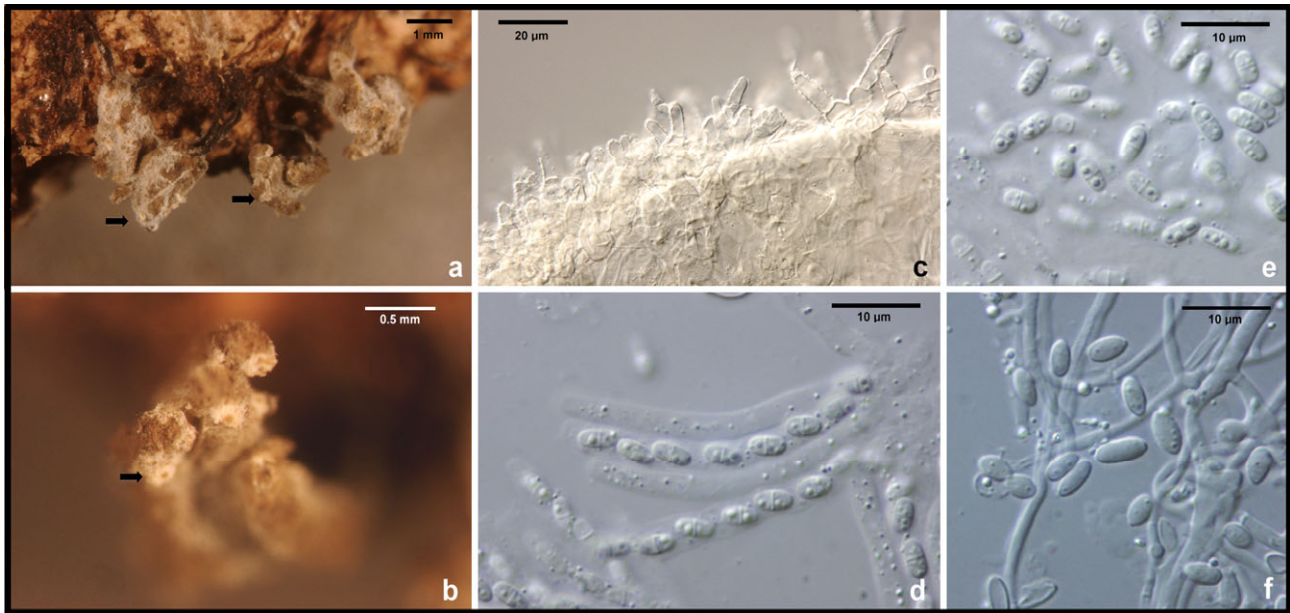
Habitat: On myxomycete sporangia or aethalia.

Known distribution: North temperate regions, Australasia.

Description:

Perithecia (a, b) immersed in white mycelium. Perithecia $170\text{--}210 \times 140\text{--}165\ \mu\text{m}$, pyriform to globose, white; spinulose, branched, thin-walled, septate hairs arising from perithecial surface (c). Asci (d, e) cylindrical, $(36\text{--})45\text{--}55(\text{--}60) \times 3\text{--}5\ \mu\text{m}$; apex broad, with a ring (e); 8-spored. Ascospores (d, e) oblong to narrowly ellipsoidal with truncate ends, $6\text{--}7 \times 2\text{--}3\ \mu\text{m}$, smooth, with a median septum, with hyaline appendage often visible at each end of ascospore. Conidiophores hyaline, acremonium-like. Conidia in solitary, hyaline, slimy heads at tips of phialides, $7.5\text{--}9.5 \times 3\text{--}4\ \mu\text{m}$.

Anamorph: *Verticillium rexianum* (Sacc.) Sacc.



Habitat: On myxomycete sporangia.

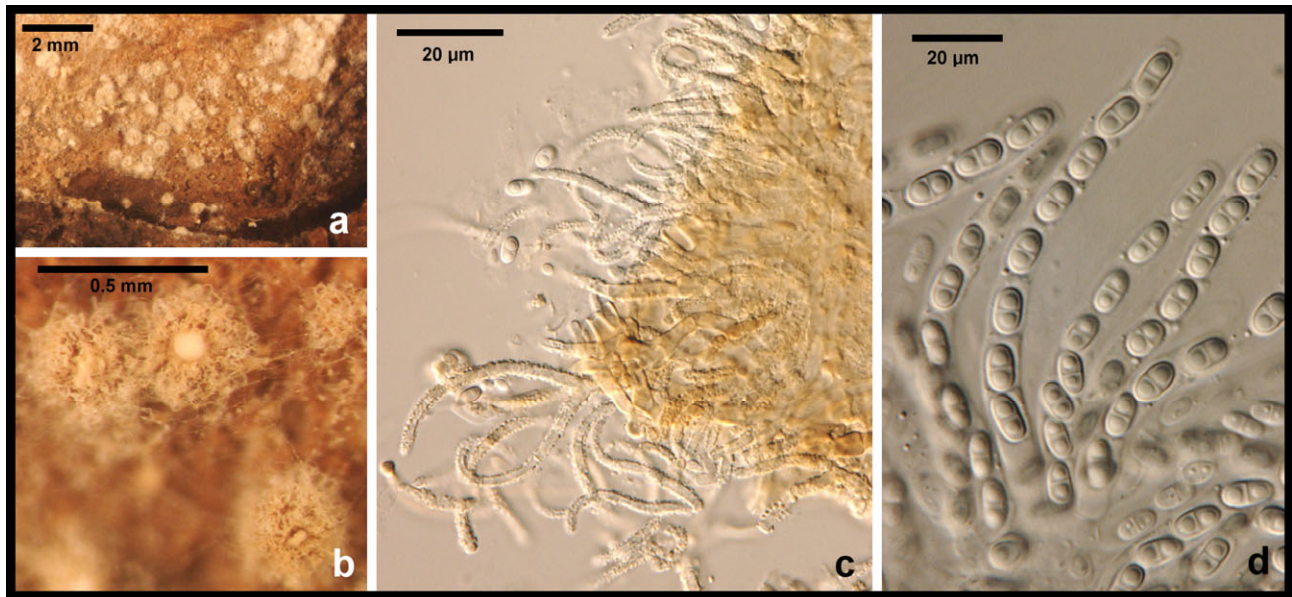
Known distribution: North America, Neotropics. Anamorph known from Europe (United Kingdom, Germany).

Description:

Perithecia (a, b) free or immersed in mycelium, solitary or gregarious. Perithecia (b) $140\text{--}216 \times 125\text{--}200\ \mu\text{m}$, subglobose or globose, white to pale yellow, with spinulose, cellular hairs, $20\text{--}100 \times 3\text{--}5\ \mu\text{m}$ wide at base, tapering to apex (c). Asci (d) cylindrical to clavate, $40\text{--}50 \times 2.5\text{--}6\ \mu\text{m}$, with an apical ring; 8-spored. Ascospores (e) oblong, $4.7\text{--}5.5 \times 2\text{--}3\ \mu\text{m}$, hyaline, smooth, with a median septum. Conidiophores hyaline, verticillium-like. Conidia (f) ellipsoidal, $6\text{--}7 \times 2\text{--}3\ \mu\text{m}$, in hyaline, slimy heads at tips of phialides.

Notes: This species is widely distributed in the New World, but infrequently collected. It is the most common of the tropical myxomyceticolous species. In Samuels (1973) this species is referred to as *Nectria myxomyceticola*.

Anamorph: *Acremonium* sp.



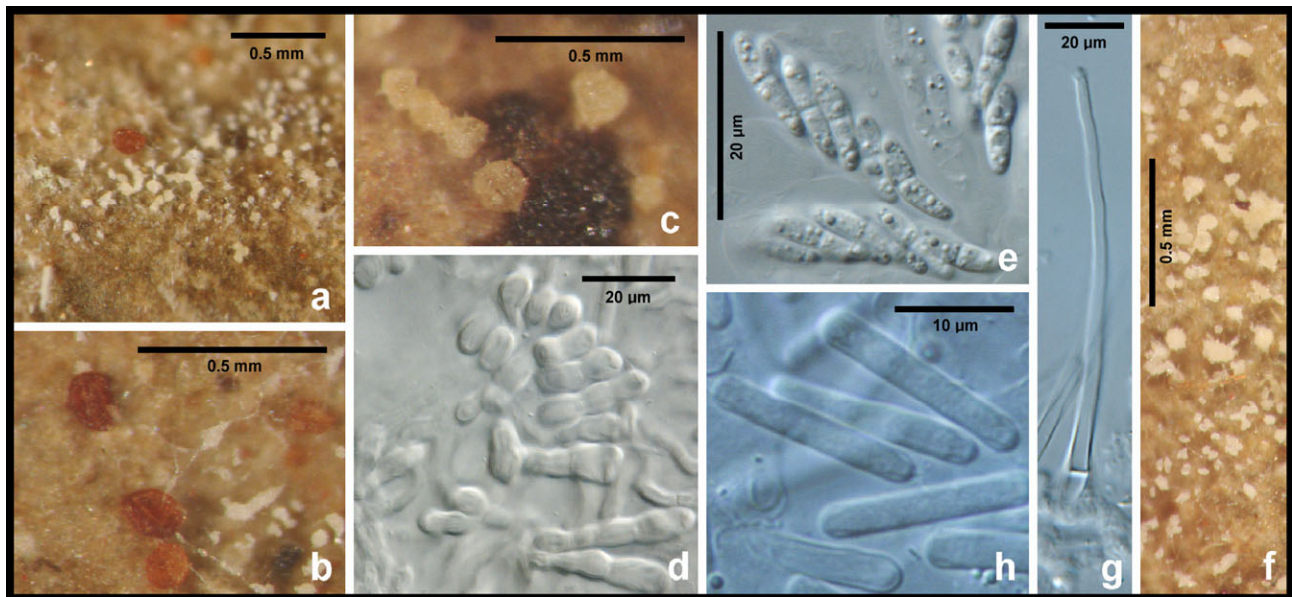
Habitat: On bark, herbaceous tissue, basidiocarps, rarely myxomycete sporangia.

Known distribution: North temperate, Neotropics and Thailand.

Description:

Perithecia (a, b) solitary or gregarious, seated in white mycelium, superficial, easily removed from substratum. Perithecia (b) 190–210 μm diam, globose, white to amber-coloured, wall covered by white to off-white hyphae arising from surface (c), hyphae 2–3 μm diam, branched, septate, thin-walled, spinulose, with many free, often circinate ends (c). Asci (d) cylindrical, 45–57 \times 4.5–6 μm , with an apical ring. Ascospores (d) oblong to broadly ellipsoidal with obtuse ends, 5.3–6.7 \times 2.8–3.4 μm , spinulose, with a median septum. Conidiophores arising in aerial mycelium, 35–50 μm long, straight, smooth or spinulose, unbranched or branched once or twice, each branch terminating in a single phialide. Phialides 30–40 μm long, 2–3 μm wide at base, straight, smooth or spinulose. Conidia globose to subglobose, 2.7–3.5 \times 1.8–3 μm .

Anamorph: *Acremonium* sp.



Habitat: On lichens, *Parmelia* spp.

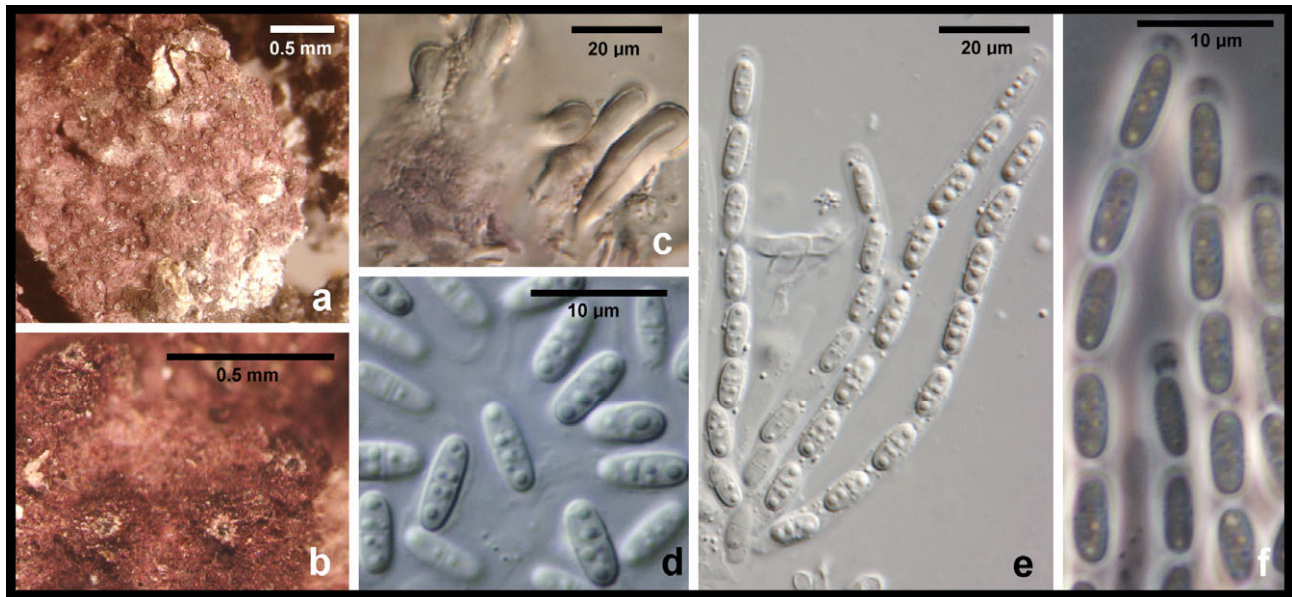
Known distribution: Europe, North America.

Description:

Perithecia (a–c) solitary to gregarious, superficial on lichen thallus, red, dull orange to buff-coloured, globose, non-papillate, 150–200 µm diam, collapsing by lateral pinching, smooth, with setae arising from upper part of perithecium. Setae (d) cylindrical to clavate, 10–30 µm long, 5–7 µm wide, unbranched or dichotomously branched, septate, wall 2.0–2.5 µm thick. Asci (e) clavate, 35–55 × 8–10 µm; apex rounded, simple, 8-spored, with bi- to multiseriate ascospores. Ascospores (e) narrowly fusiform, (15–) 18–21 × 2.5–3.5(–4.0) µm, hyaline, smooth; with a median septum. Associated anamorph acremonium-like; conidiophores (g) unbranched, somewhat thick-walled below. Conidia (h) cylindrical, 15–20 × 2.5–3.5 µm, with conspicuously thickened wall at tip and base, hyaline, unicellular, held in slimy, buff-coloured heads (f).

Notes: It is unlikely that this species belongs in *Nectriopsis*. It also does not seem to belong in *Trichonectria* as *T. rubifaciens* (Ellis & Everh.) Diederich & Schroers. Perithecia of *Pronectria oligospora* Lowen & Rogerson, a member of the *Bionectriaceae*, are immersed in the thallus of species of *Punctelia* (Lowen, 1995). The anamorph of *P. oligospora* forms simple conidiophores on the surface of the thallus; conidia are held in a drop of pale orange liquid at the tip of each conidiophore.

Anamorph: *Acremonium fungicola* (Sacc.) Samuels



Habitat: On sporangia of *Fuligo septica*.

Known distribution: North America, Europe.

Description:

Perithecia (a, b) immersed in white to violet mycelium covering infected myxomycete. Perithecia broadly pyriform to globose, $240\text{--}275 \times 240\text{--}260 \mu\text{m}$, violet to purple, with acute papilla and thick-walled setae (c) with rounded ends forming a fringe around papilla. Asci (d–f) cylindrical, $50\text{--}60 \times 3\text{--}5 \mu\text{m}$, apex with ring, 8-spored, with uniseriate ascospores. Ascospores (e, f) cylindrical, $7\text{--}8 \times 2.5\text{--}3 \mu\text{m}$, hyaline, smooth, with a median septum. Conidiophores arising from surface and aerial mycelium, hyaline, producing unbranched phialides. Conidia ellipsoidal, $6\text{--}9.5 \times 2\text{--}3 \mu\text{m}$, unicellular, smooth, hyaline, held in solitary, slimy, hyaline heads at tips of phialides.

Notes: This species is easily recognized by the violet colouration of aethalia of *Fuligo septa*. It is the only species of *Nectriopsis* that we have found on this myxomycete.

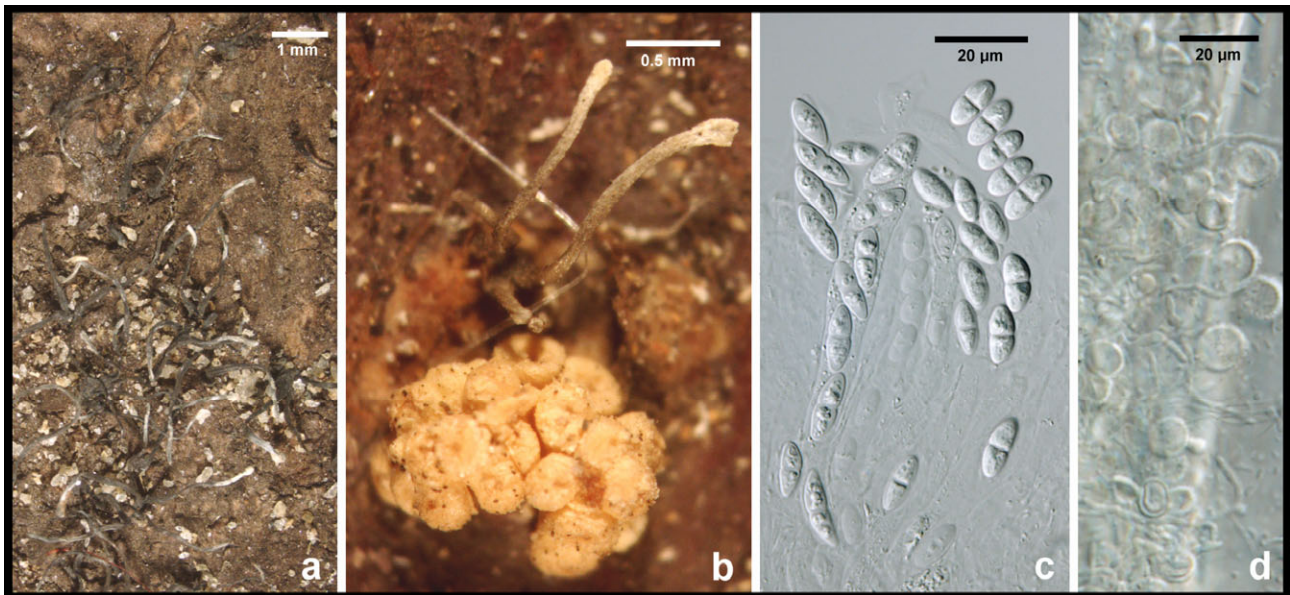
Perithecia superficial or slightly immersed in a hyphal stroma that forms a continuous or discontinuous layer. Perithecia globose to ellipsoid or ovoid, pale luteous to orange, becoming red-brown or dark olive-green with age, KOH–, with relatively thick, more than 25 µm walls. Asci narrowly clavate to cylindrical, 8-spored. Ascospores ellipsoid to ellipsoid–fusiform, 1-septate, hyaline, verrucose, echinulate or conspicuously spinulose. Anamorph acremonium-like or *Stilbella*. On dead woody dicotyledonous and monocotyledonous substrata as well as decaying ascomycetous stromata.

Literature:

Rossmann, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* **42**: 1–248.

Seifert, K.A. (1985). A monograph of *Stilbella* and some allied Hyphomycetes. *Studies in Mycology* **27**: 1–234

Anamorph: *Stilbella clavulata* (Mont.) Seifert



Habitat: On dead wood and bark of dicotyledonous plants and palms.

Known distribution: The teleomorph is pantropical, extending north into Florida and Louisiana. The anamorph is common in the U.S.A. as far north as New York City.

Description:

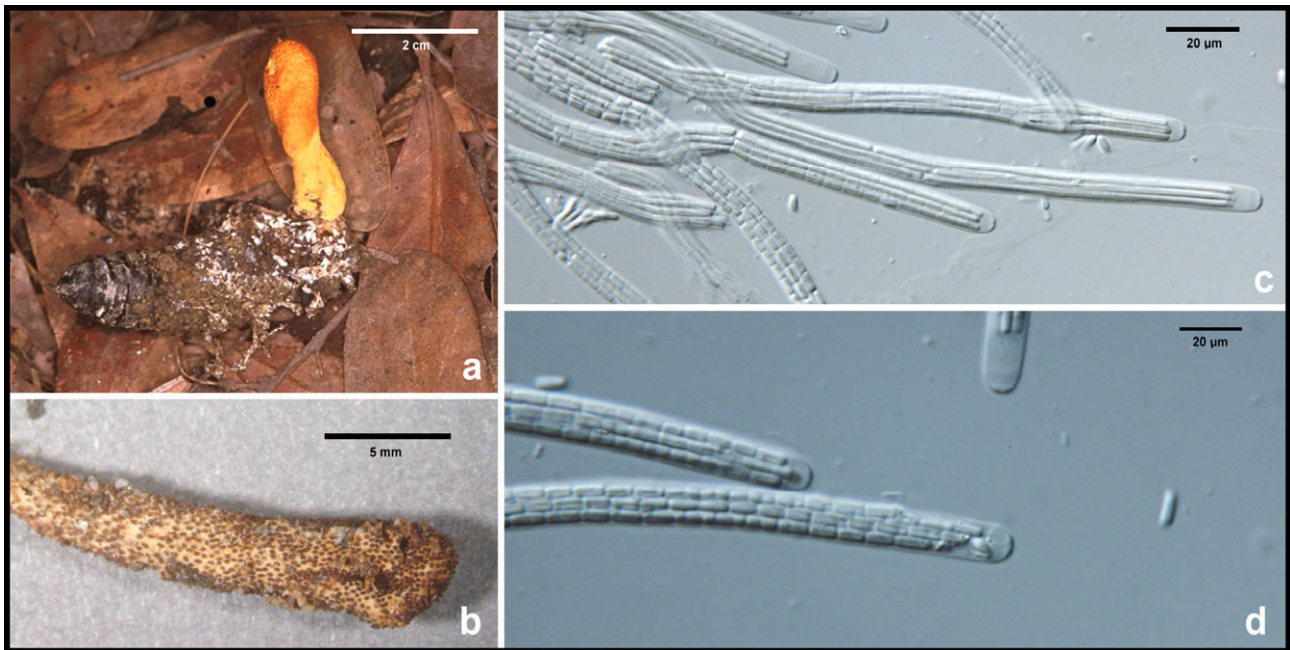
Synnemata (a, b), scattered, gregarious, caespitose, often 2–10 synnemata aggregated, emerging from a white subiculate stroma or ascomatal stroma, cylindric-capitate, subulate-capitate to spatulate, straight, nodding or sinuous, unbranched to highly branched, stipe 500–4000 µm tall × 50–250 µm wide, up to 450 µm wide at base, black, grey or grey-brown, smooth to hirsute at base, with granulose upper parts, grey to white; ornamenting cells (d) covering upper one third to three quarters of stipe, globose, subglobose, ellipsoidal, clavate, obpyriform, lateral or terminal on marginal hyphae, forming in chains of 4–5, spinulose, 3–5 µm diam. Phialides subulate or cylindrical, 10–25 µm long, 1.5–3 µm wide. Conidial mass orange or green, at times yellow, red or brown. Conidia ellipsoid, oblong-ellipsoid or ovoid, straight or slightly curved, 4–7 × 2–3 µm. Perithecia (b) caespitose, rarely solitary, superficial or slightly immersed in a white, grey or brown, erumpent stroma. Perithecia 200–375 µm diam, globose to ellipsoid, sometimes collapsed cupulate, pale yellow, orange or pink when young, becoming brown with age, finally black, smooth to granulose. Asci (c) cylindrical, 60–90 × 5–7 µm, without ring at apex. Ascospores (c) ellipsoidal, often flattened on one side, 9.5–15 × 3.5–6 µm, spinulose, with a median septum.

Stromata stipitate, straight or branched, becoming clavate or globose at apex; stipe usually sterile, apical portion fertile; perithecia scattered, partially or fully immersed in stroma, often darker than stroma; asci long cylindrical, with distinctly thickened apex penetrated by a fine pore, usually 8-spored. Ascospores filiform, multiseptate, often disarticulating into part-spores. Anamorphs *Hirsutella*, *Hymenostilbe*, *Metarhizium* or *Paecilomyces*. On lepidopteran and coleopteran larvae and pupae, cicadas, moths, termites, ants, and spiders, rarely on other fungi (*Elaphomyces* sp.).

Literature:

- Brady, B.L.K. (1979). *Cordyceps militaris*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria **605**: 1–2.
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Anamorph: *Lecanicillium* sp. (*Cephalosporium militare* Y. Kobay.)



Habitat: Pupae of lepidopterous insects

Known distribution: Cosmopolitan and common; considered by Mains (1939) to be the most common species of *Cordyceps* in North Carolina and Tennessee.

Description:

Stromata (a, b) clavate, variable in size, soft, fleshy, orange. Perithecia (b) partially embedded in the stroma. Asci (c, d) cylindrical, 400 µm or more long, 4 µm wide, 8-spored, with a thickened cap near apex. Ascospores (c, d) filiform, nearly as long as the asci, multiseptate, disarticulating early into part-spores; part-spores $3\text{--}6 \times 1$ µm.

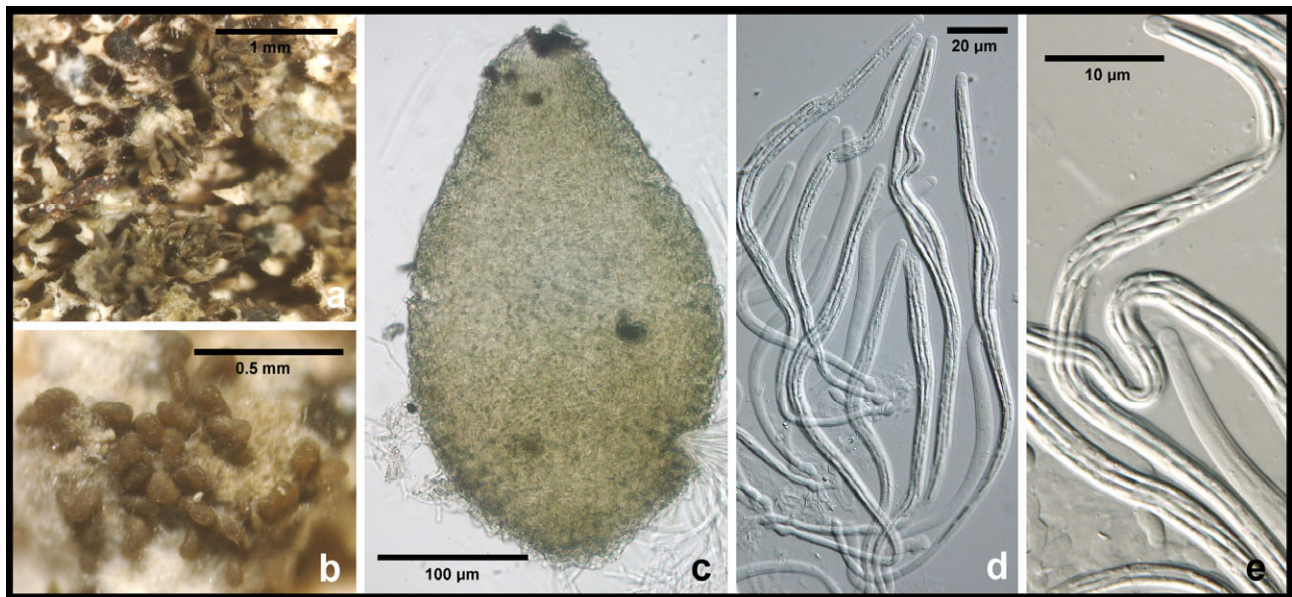
Notes: This species is included because of its similarity to the stipitate species of *Hypocrea*, *H. leucopus* and *H. alutacea*, both of which are known from this region. *Cordyceps* can be distinguished from *Hypocrea* immediately because its stromata arise from parasitized insects. *Cordyceps* is a genus of the *Hypocreales* in the *Clavicipitaceae*. Several species of *Cordyceps* have been described and illustrated from North Carolina and Tennessee (Mains, 1939). The anamorph of *C. militaris* has long been incorrectly considered to be the conspicuous *Isaria farinosa*; it is now known to be a species of *Lecanicillium* (Zare & Gams, 2001).

Stromata poorly developed, consisting of white to pale yellow subiculum. Perithecia superficial on substratum or slightly immersed in hyphal subiculum, ovoid to conical or flask-shaped with long neck, white, yellow or orange. Asci elongated, cylindric, with thickened apex penetrated by a pore, eight-spored. Ascospores filiform, hyaline, non-septate, not separating into part-spores. Fungicolous.

Literature:

- Bigelow, H.E. & Barr, M.E. (1963). Contribution to the fungus flora of northeastern North America. III. *Rhodora* **65**: 186–198.
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Anamorph: None known.



Habitat: Perithecia of black, stromatic pyrenomycetes.

Known distribution: North temperate, New Zealand

Description:

Perithecia (a–c) clustered in groups of up to 20, with base immersed in a cottony white to yellow or grey subiculum growing over the surface of the host pyrenomycete, fleshy, olivaceous, collapsing by lateral pinching, KOH–, egg-shaped with a subacute apex, 350–500 µm tall, 200–300 µm wide, smooth. Asci (d, e) held in a basal fascicle, long-clavate, (100–)120–140(–150) × (5.0–)5.5–8.0(–9.0) µm, with apex having a conspicuous cap penetrated by a pore, 8-spored, containing spores spiralled around each other. Ascospores (d, e) filiform, ca. 200 × 3 µm, tapering uniformly from middle to each end, with several cross septa, hyaline, smooth.

Notes: *Neobarya*, formerly known as *Barya*, is a genus of the *Hypocreales* in the *Clavicipitaceae*. Perithecia are superficially like those of some members of the *Hypocreaceae*, but are easily differentiated by the long, filiform ascospores. *Neobarya parasitica* is characterized by the pale olivaceous, egg-shaped perithecia that grow over black perithecial pyrenomycetes. The ascus cap is conspicuous and typical of the family *Clavicipitaceae*.

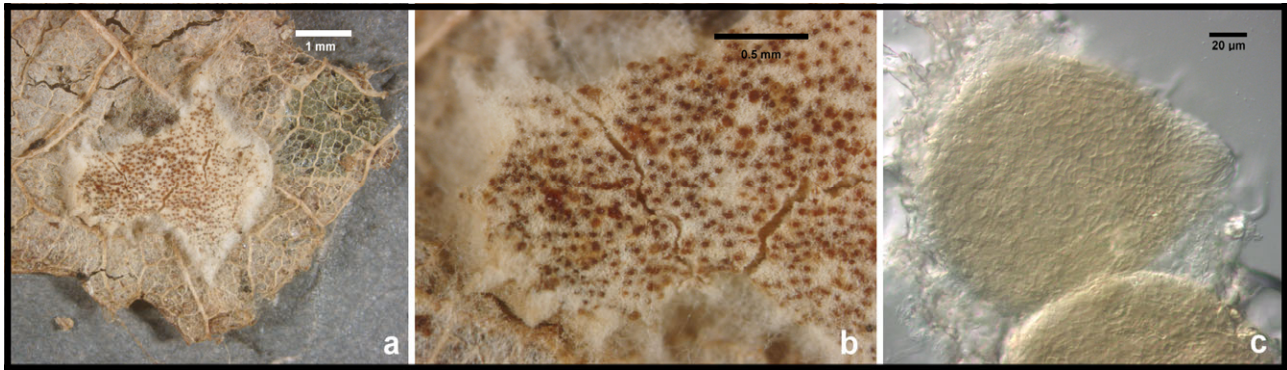
Perithecia immersed in a loose subiculum with only papillae visible, individual perithecia remaining discrete within the subiculum, easily separated from it; perithecial wall of a single, 20–30 µm thick region. Asci cylindrical, with more or less thickened apex, sessile or stalked. Ascospores fusiform, equally 1-septate, disarticulating into conical, monomorphic part-ascospores, hyaline, smooth to slightly spinulose. Anamorph where known verticillium-like. On decaying wood, herbaceous substrata or polypores.

Literature:

Doi, Y. (1972). Revision of the *Hypocreales* with cultural observations. IV. The genus *Hypocrea* and its allies in Japan (2). Enumeration of the species. *Bulletin of the National Science Museum, Tokyo* **15**: 649–751.

Rossman, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* **42**: 1–248.

Anamorph: None known.



Habitat: On litter and bark.

Known distribution: United States (NC).

Description:

Subiculum (a, b) effuse, spreading, white becoming cream to pale brown when dry, 1–4 cm diam, ca. 0.5 mm thick, comprising loosely disposed hyphae, KOH–. Perithecia (c) completely immersed in subiculum, remaining free, thin-walled, orange-amber, KOH–. Part-ascospores hyaline, finely spinulose, monomorphic, conical with a flat base, $3.5\text{--}4.2\text{--}4.5 \times (2.0\text{--})2.2\text{--}2.5\text{--}2.7 \mu\text{m}$, with a blunt, $0.5\text{--}1 \mu\text{m}$ long apiculus.

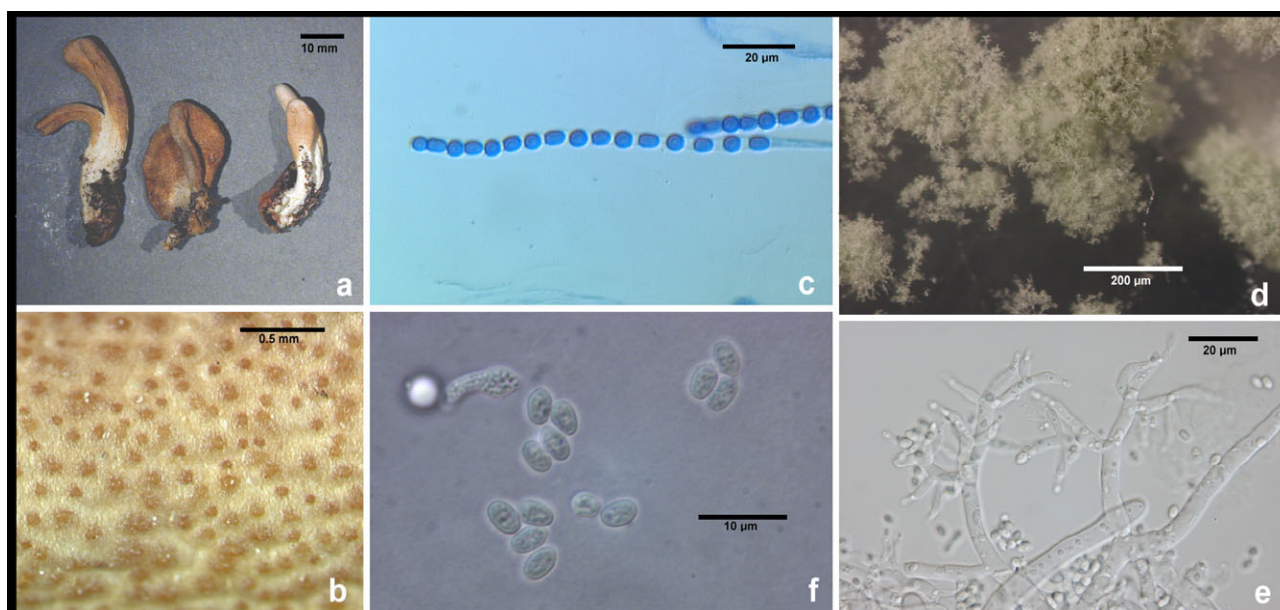
Notes: The only specimen of this species that we have seen during the study of fungi from the southeastern United States, illustrated here, was collected in the region of the GSMNP and it was overmature, with only discharged part-ascospores. The part-ascospores in this collection are smaller than are spores of either of the only two members of this genus, *A. stipata* (Fuckel) Z. Moravec and *A. scabrida* Yoshim. Doi. *Arachnocrea scabrida* is known from litter and wood while *A. stipata* is found on carpophores of polypores. Neither of these species has apiculate part-ascospores. This specimen is similar to *Hypocrea delicatula* Mont. in its gross morphology and in occurring on leaf litter, however, part-ascospores of *H. delicatula* are dimorphic and not apiculate. We include this species here in the hope that it will be recollected and cultured.

Stromata discrete to effused, consisting of pseudoparenchyma or highly compacted hyphae, with ascomatal elevations evident or not, with variously wrinkled stromatal surface, creased or tuberculate, with margins of stromata free from or adherent to substratum, nearly hyaline, white, yellow, rufous, dark brown to nearly black. Ascomata immersed in the stroma, ascomatal wall and stromal tissues KOH+ or KOH-. Asci cylindrical. Ascospores 1-septate, disarticulating early in development into two equal or unequal, globose, subglobose, ovoidal, oblong or wedge-shaped part-ascospores, hyaline or green, typically spinulose or warted, rarely smooth. Anamorphs: acremonium-like, gliocladium-like, *Stilbella*, *Trichoderma* and verticillium-like. On decaying woody substrata, also on other fungi. Anamorphs common in soil and as endophytes of trees.

Literature:

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Anamorph: trichoderma-like



Habitat: On corticated, but typically wet, rotten wood. Also found on wood chips.

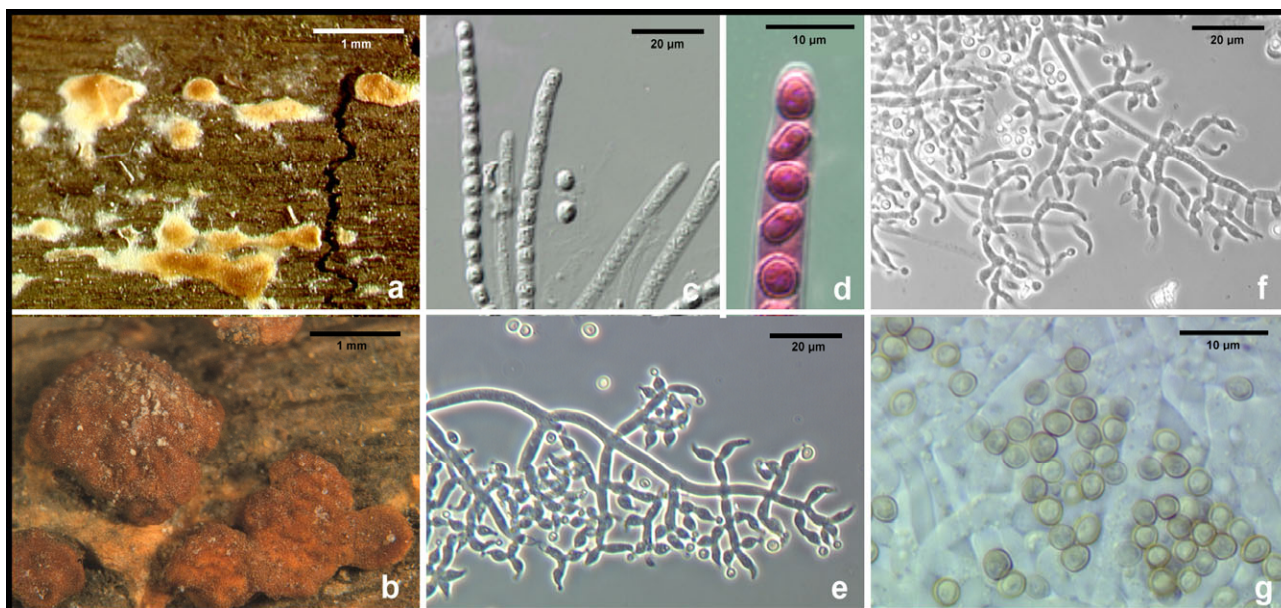
Known distribution: United States (common in the GSMNP), Europe.

Description:

Stromata (a) clavate, typically gregarious, single or sometimes fused, sometimes branched or lobed, fertile along all or most of stipe. Total stroma length (0.5–)2.5–4.5(–8.0) cm, delineation between fertile and sterile parts sometimes evident; KOH–, golden yellow to a shade of brown, surface glabrous, sometimes wrinkled, perithecial elevations not evident or surface slightly tuberculate, ostiolar openings (b) visible as small dots against pale yellow background. Stipe where sterile, white to beige, velvety or not; adjacent stipes often appearing fused, with fissures demarcating individual stipes. Asci (c) cylindrical (45–)65–90(–113) × (2.2–)2.5–4.5(–5.4) µm, with slightly thickened apex, uniseriate ascospores. Part-ascospores hyaline, finely verrucose, dimorphic. Distal part-ascospores globose to subglobose, (2.2–)2.7–3.7(–4.5) × (2.2–)2.5–3.5(–4.5) µm; proximal part-ascospores subglobose to conic (2.2–)3.0–4.0(–6.0) × (1.5–)2.2–2.7(–3.7) µm. Anamorph not seen in nature. In culture, conidia forming in pale green tufts (d). Conidiophores (e) irregularly branched, each branch terminating in 1 to few phialides. Phialides lageniform, tapering uniformly from base to tip, at most only slightly swollen toward middle (7.5–)9.5–13.5(–15.7) µm long, at base (1.7–)2.2–3.2(–3.5) µm wide, arising from a cell (1.7–)3.0–4.0(–4.7) µm wide. Conidia (f) oblong to ellipsoidal (2.2–)2.7–4.5(–5.2) × (1.0–)1.2–1.7(–2.0) µm, lacking a visible basal abscission scar, smooth, green. Chlamydospores not seen.

Notes: *Hypocrea alutacea* differs from *H. leucopus* in being lignicolous, in its more brown colouration and in its trichoderma-like anamorph with green conidia.

Anamorph: *Trichoderma atroviride* P. Karst.



Habitat: On decorticated wood; the anamorph is a common soil fungus.

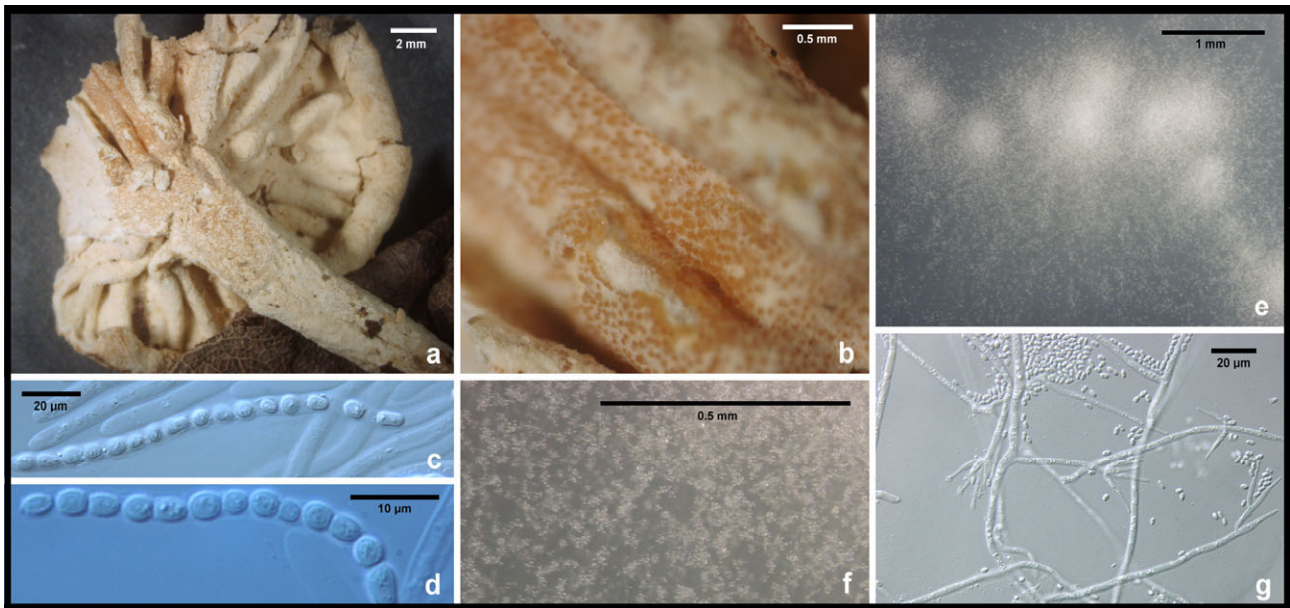
Known distribution: The teleomorph is found in United States (GA, IN, VA, WA), Costa Rica, Europe and Sri Lanka.

Description:

Stromata at first semi-effused, light honey-coloured (a) to tan with a lighter, almost white margin, becoming pulvinate with maturity, solitary to gregarious, (0.5–)0.9–2.5(–7.0) mm diam, becoming darker brown (b), pruinose at first, with ostiolar openings not visible or only barely visible as minute dots. Asci (c, d) cylindrical, (60–)80–90(–105) × (3.5–)4.2–6.2(–7.2) µm, with a barely visible ring at apex; containing 16-part ascospores. Part-ascospores (d) dimorphic, hyaline, spinulose; distal part globose to subglobose, (2.5–)3.5–5.0(–5.7) × (2.5–)3.2–4.7(–5.7) µm; proximal part oblong to wedge-shaped, (3.0–)3.5–5.5(–6.2) × (2.0–)3.0–4.0(–5.0) µm. Conidiophores (e, f) with paired branches, each terminating in a whorl of lageniform phialides. Conidia (g) dark green, subglobose, (2.7–)3.0–3.8(–5.0) × (2.3–)2.8–3.5(–4.0) µm. Chlamydospores abundant. Colonies typically with a strong, sweet coconut odor.

Notes: This species is a member of *Trichoderma* sect. *Trichoderma*, closely related to *H. rufa*. It is characterized by its brown stromata with barely visible ostiolar openings, subglobose conidia, and coconut odor of colonies.

Anamorph: verticillium-like



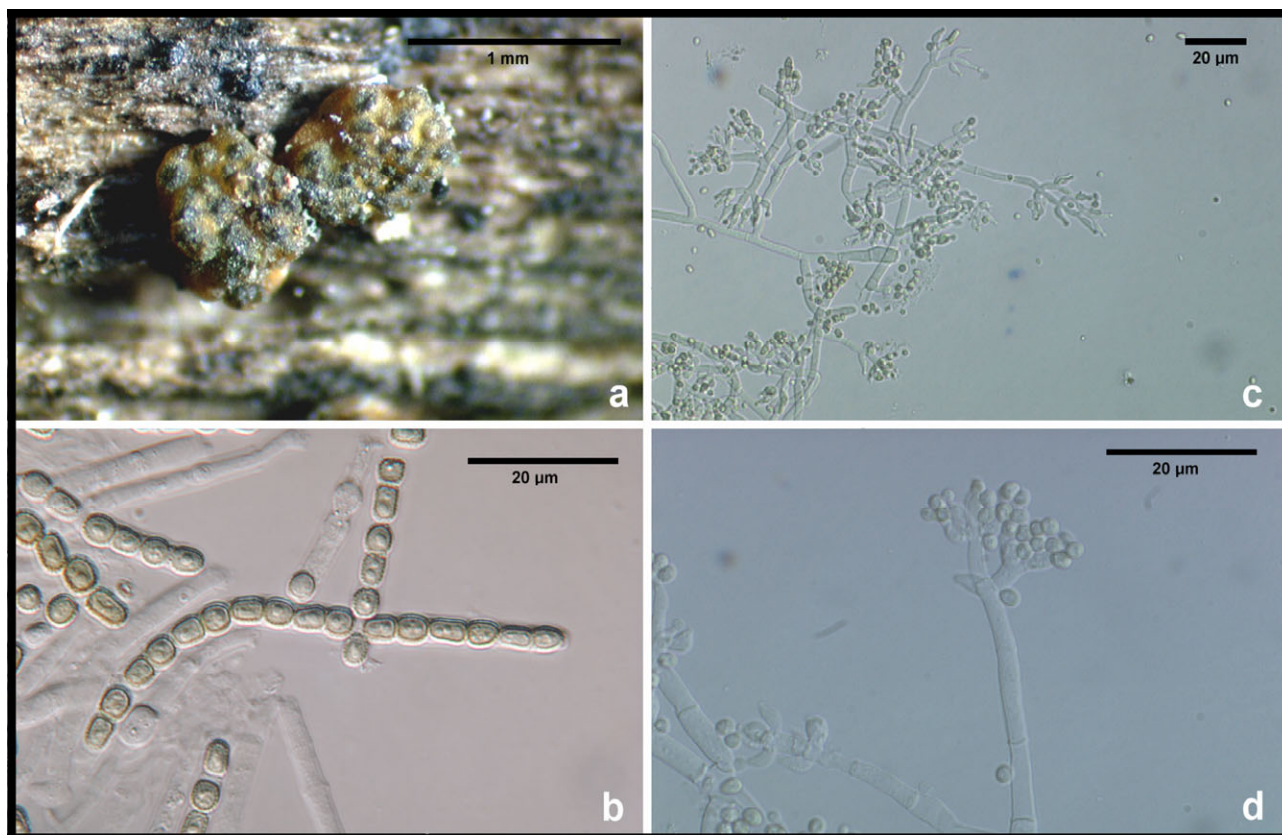
Habitat: On carpophores of *Marasmius subnudus* (Ellis) Peck [*Collybia subnuda* (Ellis) Gilliam]

Known distribution: Common in eastern United States.

Description:

Carpophores (a) at first covered in light buff to ochraceous buff mycelium within which a verticillium-like anamorph produced profusely. Perithecia (b) developing later or not at all, forming a continuous layer over hymenium and upper part of host stipe, globose to broadly pyriform and papillate, (100–)150–270(–310) µm tall, (100–)120–200 µm wide, avellaneous, to light brown, partially to completely immersed in hyphae of subiculum. Asci (c, d) cylindrical, (51–)57–87(–97) × 3–5 µm, with a minute apical pore; containing 16 part-ascospores. Part-ascospores (c, d) hyaline, smooth to spinulose, dimorphic. Distal part-ascospores globose to subglobose, 2–4 × 2–3.5 µm; proximal part-ascospores truncate-ellipsoidal or truncate-subglobose, rarely globose, 2.5–5 × 2–3.5 µm. Conidiophores (e–g) producing verticals of phialides at up to two levels. Conidia (g) oblong to ellipsoidal, 3.0–9.2 × 1.5–5.0 µm, hyaline, unicellular, produced in drops of clear, watery liquid.

Anamorph: *Trichoderma ceraceum* Chaverri & Samuels



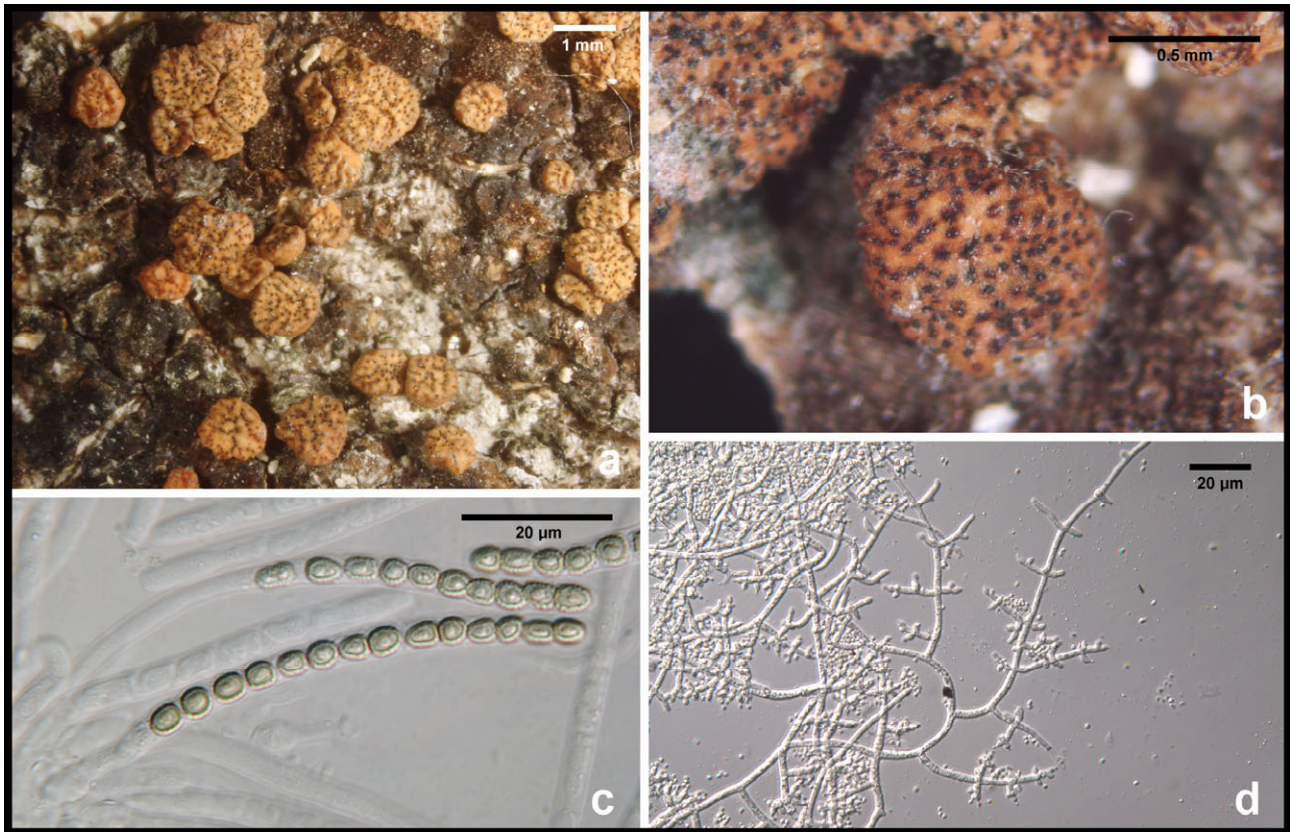
Habitat: On blackened decorticated wood.

Known distribution: United States (NC, NY).

Description:

Stromata (a) scattered, solitary or in pairs, pulvinate, circular in outline, 0.5–1 mm diam, 0.7–1.0 mm high, broadly attached, with smooth, waxy surface, with perithecial protuberances, brownish orange, becoming darker in KOH, ostiolar openings obvious due to green ascospores. Part-ascospores (b) green, warty, dimorphic. Distal part-ascospores globose to subglobose $4.5\text{--}4.7 \times 4.0\text{--}4.2 \mu\text{m}$; proximal part wedge-shaped to subcylindrical $4.8\text{--}5.0 \times 3.5\text{--}3.7 \mu\text{m}$. Conidiophores (c, d) erect, branching somewhat regularly, with secondary branches longer near base and shorter towards tip of conidiophores; secondary branches rarely re-branching; conidiophore elongations rare. Phialides ampulliform, formed in whorls of 3–5, rarely solitary, $6.5\text{--}7.7 \times 3.0\text{--}3.5 \mu\text{m}$, l/w 2.0–2.5. Conidia green, smooth, subglobose to ellipsoidal, rarely oblong $3.4\text{--}3.7 \times 3.0\text{--}3.2 \mu\text{m}$, l/w 1.2–1.3(–1.7), held in drops of clear green liquid.

Anamorph: *Trichoderma ceramicum* Chaverri & Samuels



Habitat: Decorticated wood, bark, and resupinate basidiomycetes.

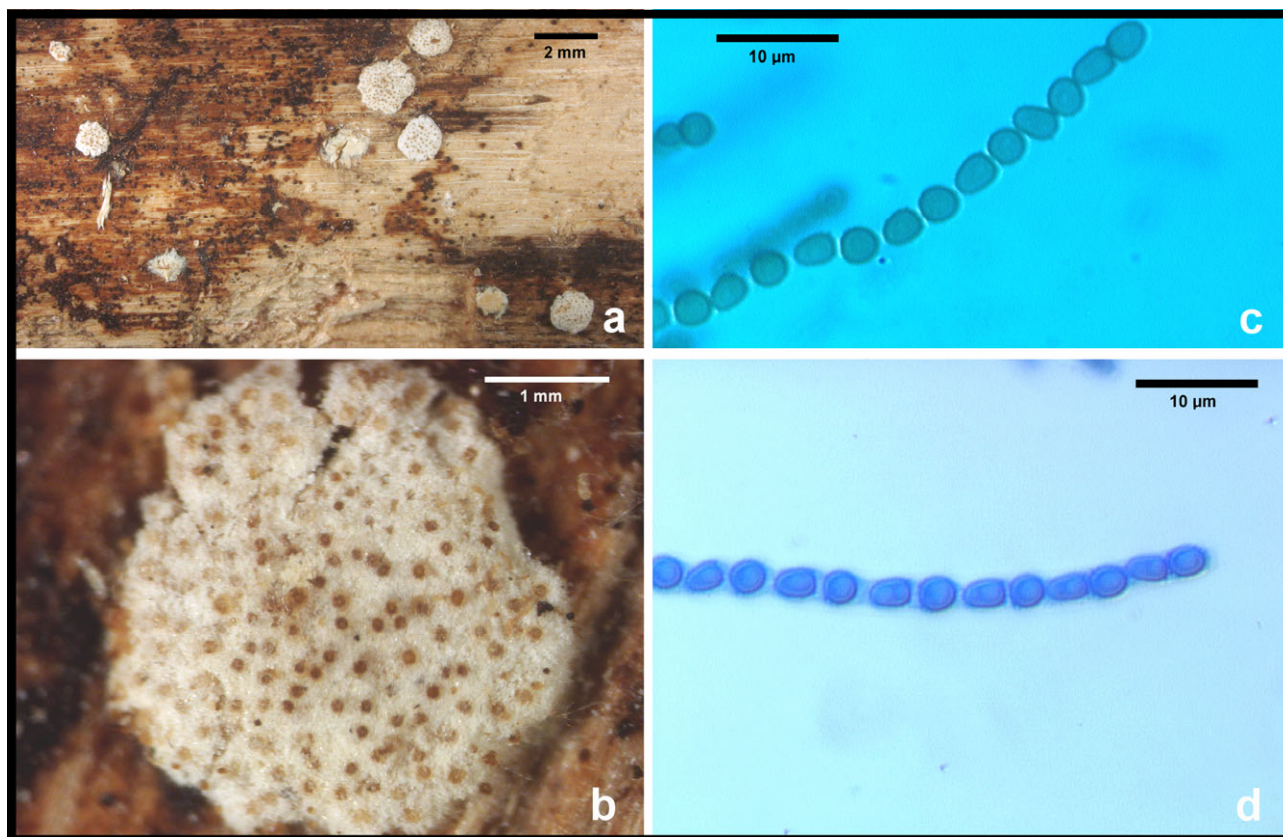
Known distribution: United States, possibly Japan.

Description:

Stromata (a, b) scattered or confluent, nearly circular in outline, 0.6–2.1 mm diam, 0.8–1.0 mm high, broadly attached, with smooth surface, with perithecial protuberances, reddish brown, becoming slightly darker in KOH, ostiolar openings obvious due to green ascospores. Part-ascospores (c) green, spinulose, dimorphic. Distal part-ascospores globose to subglobose, $3.9\text{--}4.7 \times 3.4\text{--}4.2 \mu\text{m}$, proximal part wedge-shaped, $4.2\text{--}5.2 \times 3.1\text{--}3.7 \mu\text{m}$. Conidiophores (d) irregularly branched; phialides ampulliform, broader in middle, and constricted at tip, formed in whorls of (1–)3(–4), $6.5\text{--}8.0 \times 3.5\text{--}4.0 \mu\text{m}$, l/w 1.7–2.2; conidiophore elongations rare, fertile or sterile, generally terminating in one phialide. Conidia green, smooth, ellipsoidal, $3.3\text{--}3.7 \times 2.7\text{--}3.0 \mu\text{m}$, l/w 1.1–1.3, formed in dry masses.

Notes: This species is characterized by the reddish colour of its stroma, in combination with its green ascospores.

Anamorph: None known.



Habitat: On decorticated wood; on bark of *Rhododendron* sp. and *Vitis* sp.

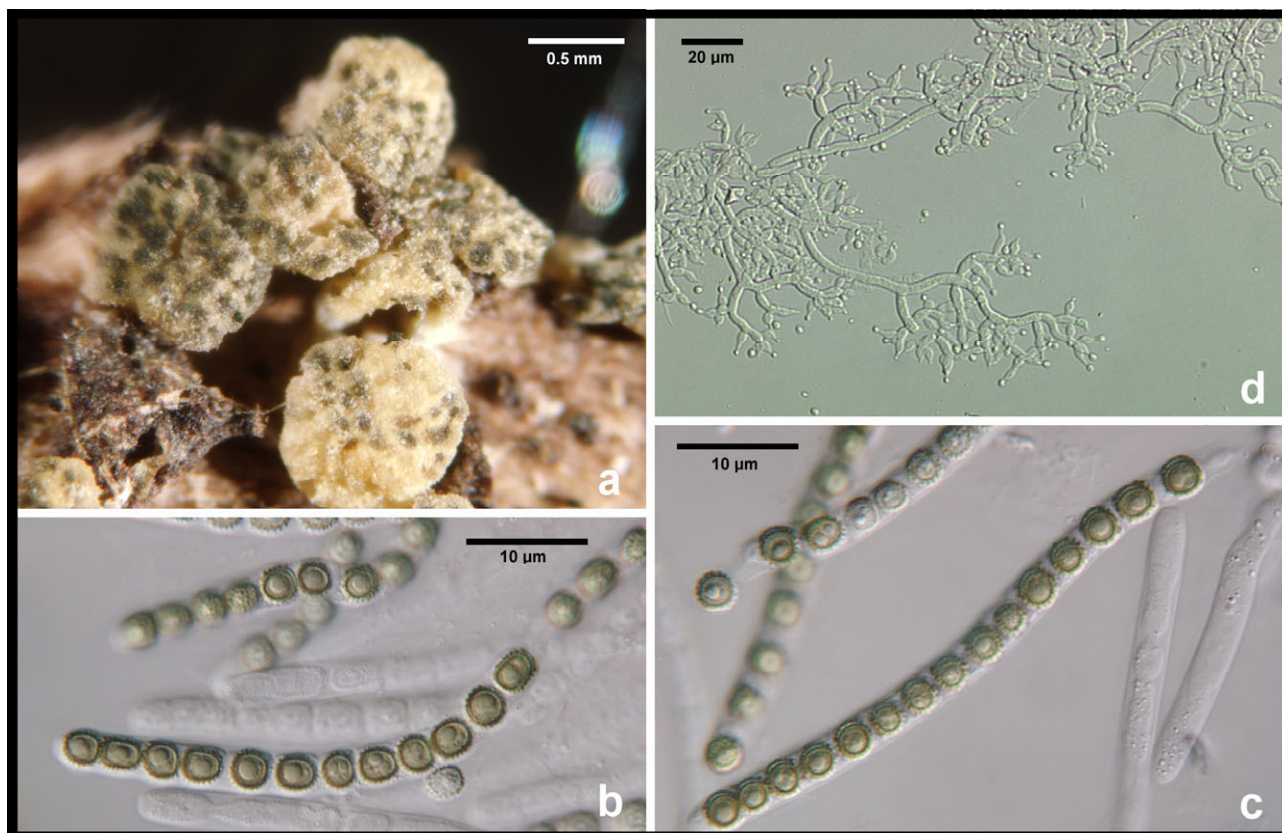
Known distribution: United States (NC, TN: GSMNP, Nantahala National Forest), Canada (Ontario).

Description:

Stromata (a, b) discrete, scattered, pulvinate, 1–1.5 mm diam, broadly attached, white, with furfuraceous surface, with ostiolar openings appearing as conspicuous, amber-coloured dots; stroma formed of intertwined, much-branched, 3–4 µm wide hyphae. Asci (c, d) cylindrical, 50–70 × 2.5–4.5 µm; with 16 part-ascospores, with thickened ring in apex. Part-ascospores hyaline, finely spinulose, dimorphic; distal part globose to subglobose, 2.2–3.0 × (2.3–)2.5–3.0(–3.5) µm; proximal part wedge-shaped, (2.3–)2.7–3.7(–4.0) × (1.7–)2.0–2.5(–2.7) µm.

Notes: The white, hyphal stroma combined with hyaline ascospores is diagnostic for this species.

Anamorph: *Trichoderma chlorosporum* Chaverri & Samuels



Habitat: On wet, very rotten, decorticated wood, sometimes bark.

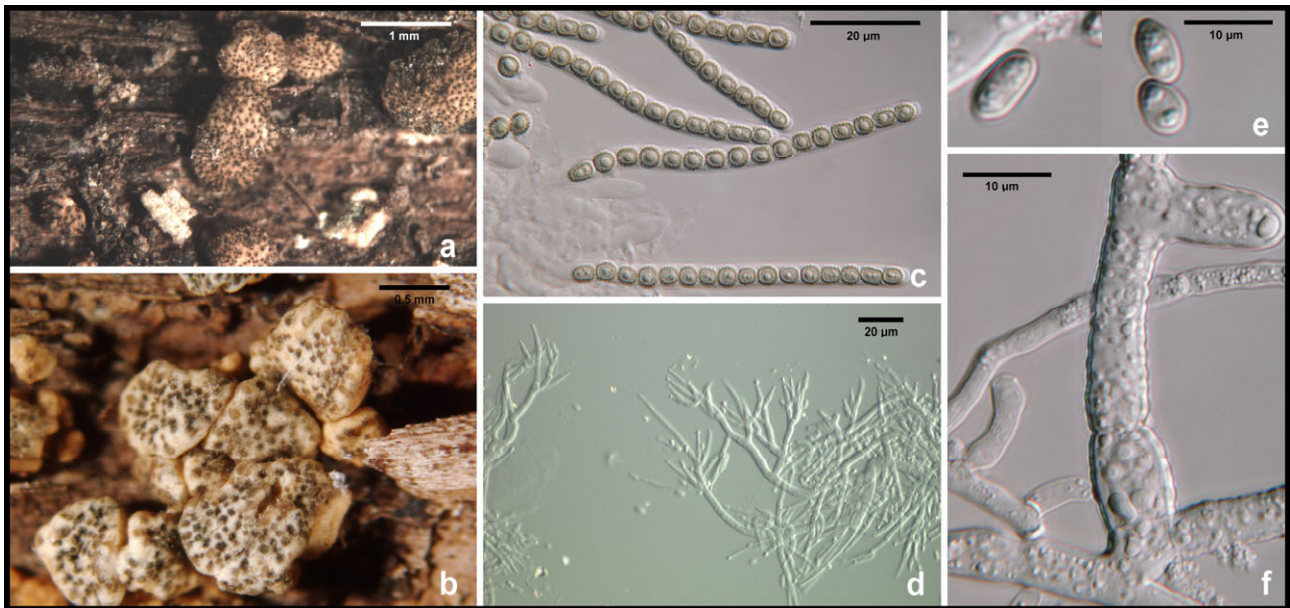
Known distribution: United States (CO, MD, NC, NY) and Costa Rica.

Description:

Stromata (a) generally aggregated, rarely solitary, pulvinate, hemispherical, circular in outline, 0.3–1.0 mm diam, 0.4–0.9 mm high, broadly attached, with smooth to roughened, somewhat transparent surface, with perithecial protuberances, pastel yellow, generally not changing colour in KOH, but in some specimens the center of stroma becoming pale brownish; ostiolar openings obvious due to green ascospores, not sunken. Asci (b, c) cylindrical, (73–)87–92(–110) × (4.0–)5.5–6.0(–7.5) µm; containing 16 part-ascospores; apex thickened, with a ring. Part-ascospores (b, c) green, warted, almost monomorphic, globose to subglobose. Distal part-ascospores 5.0–5.2 × 4.8–5.2 µm; proximal part-ascospores 5.0–5.3 × 4.5–4.7 µm. Conidiophores (d) generally sinuous, sometimes straight, thicker at base and tapering towards tip of main axis and lateral branches, irregularly branching; sterile conidiophore elongations sometimes present. Phialides ampulliform to flask-shaped, somewhat hooked, 7.7–8.0 × 4.0–4.2 µm, l/w 1.9–2.0. Conidia green, smooth, globose to subglobose, 4.0–4.3 × 3.5–3.8 µm, l/w 1.1–1.2. Chlamydospores not observed.

Notes: This species is commonly found on very rotten, wet wood and is characterized by its rather large, subglobose ascospores and anamorph with sinuous conidiophores and globose to subglobose conidia.

Anamorph: *Trichoderma chromospermum* Chaverri & Samuels



Habitat: On blackened decorticated wood, bark, and black pyrenomycetes including *Xylariales*; probably fungicolous.

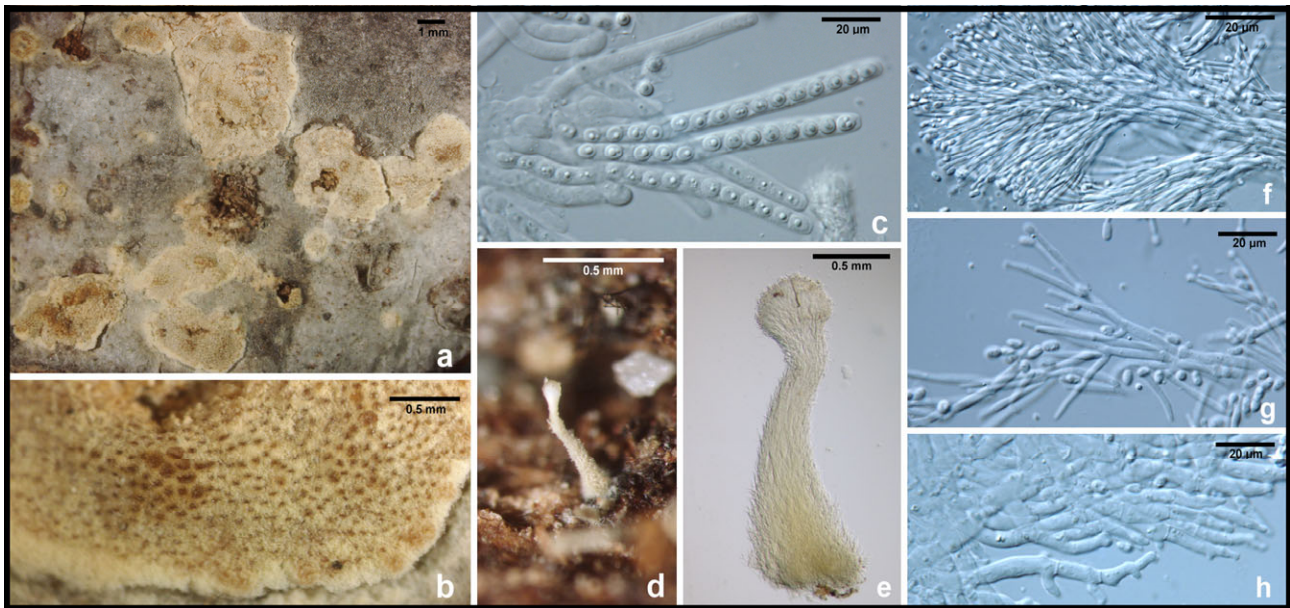
Known distribution: Eastern United States.

Description:

Stromata (a, b) generally highly aggregated to confluent, sometimes scattered, pulvinate to somewhat flattened, circular in outline, 0.8–1.7 mm diam, 0.4–0.6 mm high, broadly attached, with smooth surface, with slight perithecial protuberances, pale yellow, slightly changing colour in KOH, tissue of stroma not changing colour in KOH, ostiolar openings obvious due to green ascospores. Asci (c) cylindrical, (78–) 85–90(–102) × (4.0–)5.2–5.5(–6.7) µm, apex thickened, with a ring. Part-ascospores (c) green, warted, dimorphic. Distal part-ascospores globose to subglobose 4.2–4.3 × 4.0–4.2 µm; proximal part-ascospores wedge-shaped to subglobose, 4.2–4.5 × 3.6–3.8 µm. Conidiophores (d) short, with conspicuous, thick-walled verrucose base (f), irregularly branching 2–3 times; branches generally highly intertwined, sinuous or twisted, arising generally at narrow angles; few phialides formed. Phialides flask-shaped or lageniform, tapering uniformly from base to tip, slender, sometimes twisted and short, formed singly or in pairs, 6.9–14.5 × 2.5–3.5 µm, l/w 2.5–4.8. Conidia (e) pale green, smooth, ellipsoidal to oblong, 4.0–6.5 × 3.7–3.8 µm, l/w 1.4–1.7.

Notes: This common species is characterized by its dimorphic, green part-ascospores and conidiophores that are thickened and verrucose at base.

Anamorph: *Stilbella flavipes* (Peck) Seifert



Habitat: On *Hymenochaetaceae* and decorticated wood.

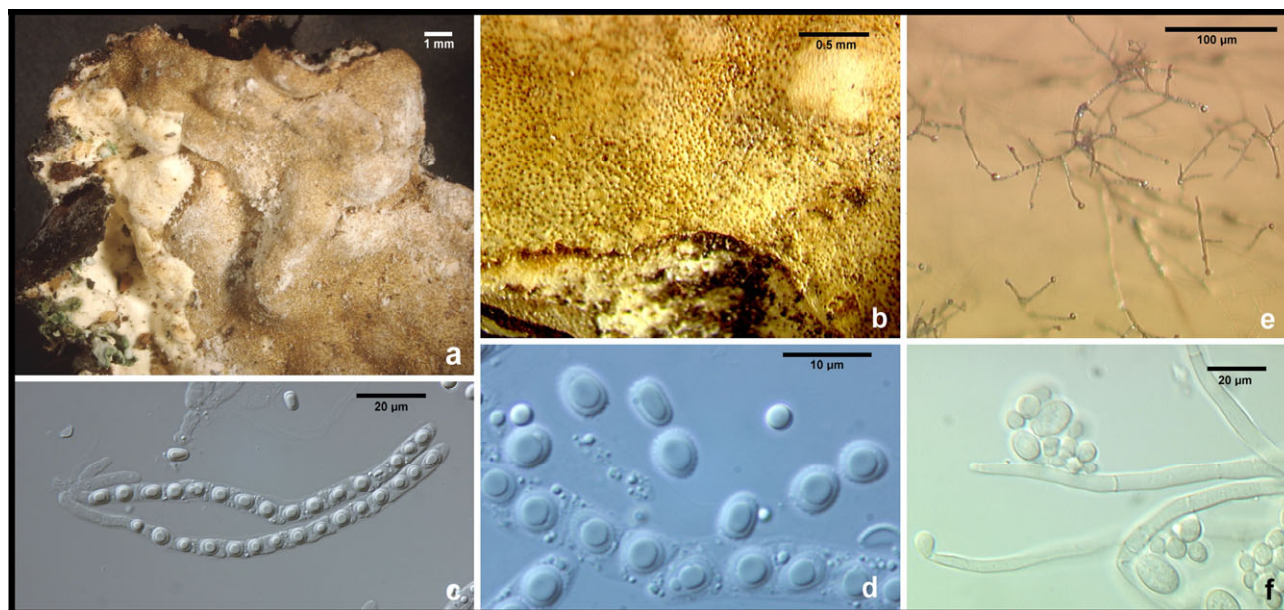
Known distribution: Eastern and central North America. One record from Japan.

Description:

Stromata (a, b) thin (<0.5 mm thick), effused but limited in extent (5–10 mm diam), obscure, grayish yellow; margin 0.5 mm wide, white, sterile, arachnoid; stroma surface velutinous, perithecial openings not visible or appearing as orange or amber dots against the lighter background, KOH–. Perithecia completely immersed or papilla slightly emergent from the stroma, KOH–; tissue of stroma of intertwined hyphae. Asci (c) cylindrical, (53–)64–77(–85) × (3.0–)3.5–5.0(–5.5) µm, apex with a shallow ring. Part-ascospores (c) hyaline, spinulose, dimorphic. Distal part-ascospores subglobose to globose, (2.5–)3.0–4.0(–4.5) × (2.0–)2.5–3.0(–3.5) µm, proximal part-ascospores oblong to ovoidal or wedge-shaped, (2.5–)3.0–4.0(–5.0) × (2.0–)2.5–3.0 µm. Synnemata (d, e), scattered, gregarious, 0.5–2.0 mm tall, terminating in a fascicle of slender phialides (f, g); stipe white to yellow-green, becoming green-black to black in age, covered with a powdery to scurfy layer of marginal hyphae; marginal hyphae (h) typically lobed. Conidial mass 50–350 µm diam, yellow-green, orange, brown-green to almost black, hemispherical to globose. Conidia (g) ellipsoidal, (2.0–)2.5–3.7(–4.5) × 1.5–2.0 µm.

Notes: This species is characterized by its extremely thin, greenish-yellow stroma that looks like a thin, resupinate basidiomycete. It is the only species of *Hypocrea* known to have a synnematosus anamorph.

Anamorph: *Trichoderma lactea* Bissett



Habitat: On decorticated wood, moss-covered bark (moss = *Dreplanocladus uncinatus* in North America), leaf litter and rich soils, especially soil near decaying stumps.

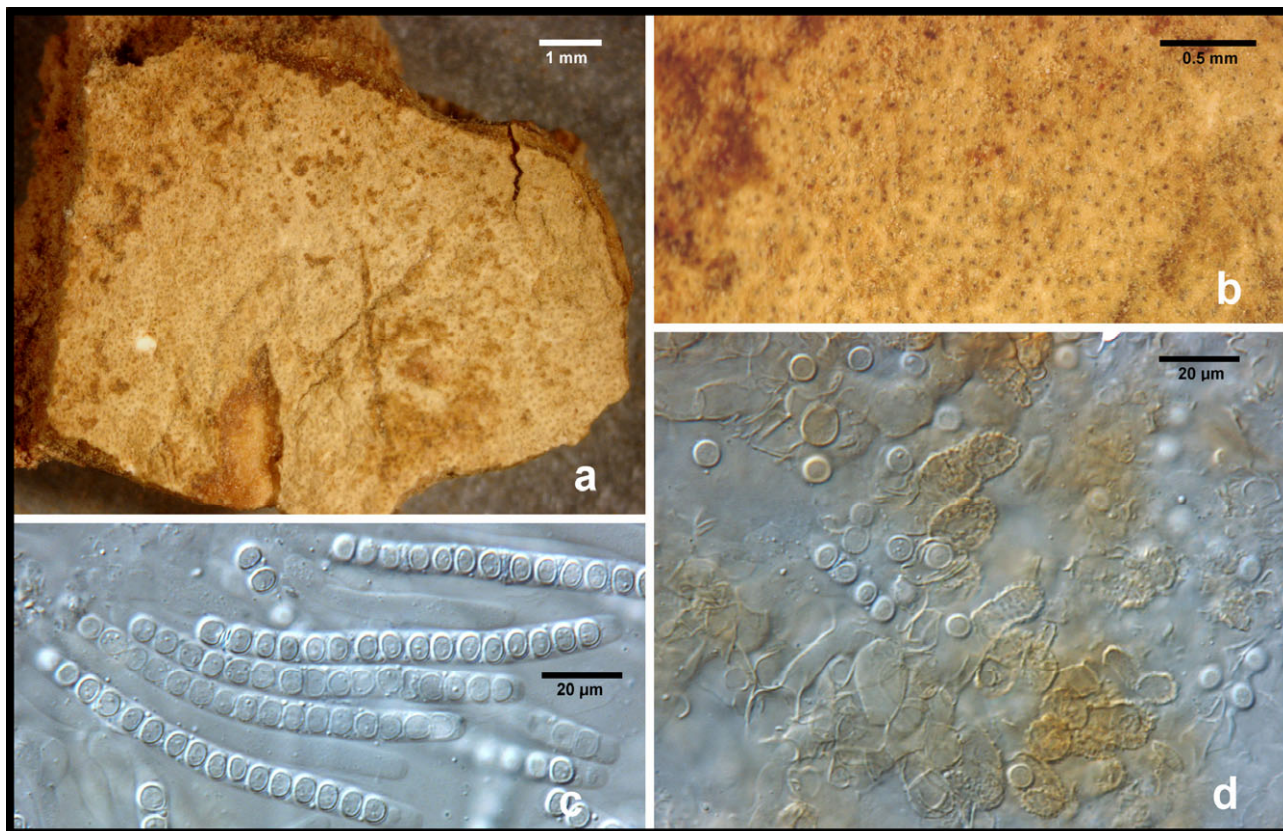
Known distribution: North America, Europe, Japan.

Description:

Stromata effuse (a, b), extensive, generally about 25 × 10 mm, largest continuous stroma, 140 × 40 mm, smallest continuous stroma, 3 × 2 mm, anastomosing, varying in colour, sometimes white to light pastel, usually yellow to greyish-yellow, sometimes orange yellow to brownish yellow; ostiolar openings appearing as light brown dots on stroma surface. Asci (c) cylindrical, (65–)80–102(–114) × (3.7–)6.2–7.2(–9.6) μm; tip slightly thickened, with uniseriate part-ascospores. Part-ascospores hyaline, thick-walled, minutely spinulose, dimorphic (d). Distal part-ascospores subglobose, sometimes ellipsoidal, (3.2–)4.1–5.2(–6.3) × (2.9–)3.7–4.8(–5.7) μm; proximal part-ascospores ellipsoidal, sometimes subglobose to ovate, (3.3–)4.4–6.0(–7.0) × (2.5–)3.3–4.9(–6.3) μm. Anamorph known only from cultures derived from ascospores. Cultures on most media fast growing, producing scant to abundant white, cottony aerial mycelium; conidiophores (e, f) arising in the aerial mycelium, unbranched and acronium-like or verticillium-like and more profusely branched near the tip, each branch terminating in one or more gently tapering phialides; phialides reaching 20 μm long. Conidia (f) subglobose to ellipsoidal, 3.5–6(–10) × (3–)4–5(–6) μm, hyaline, forming in a colorless drop of liquid at the tip of each phialide

Notes: This species is common on leaf litter. The name *H. citrina* has been misapplied to *H. pulvinata*, a common species that occurs on polypores.

Anamorph: *Trichoderma* sp. sect. *Hypocreanum*



Habitat: On polypores, *Fomitopsis pinicola* and *Piptoporus betulinus*.

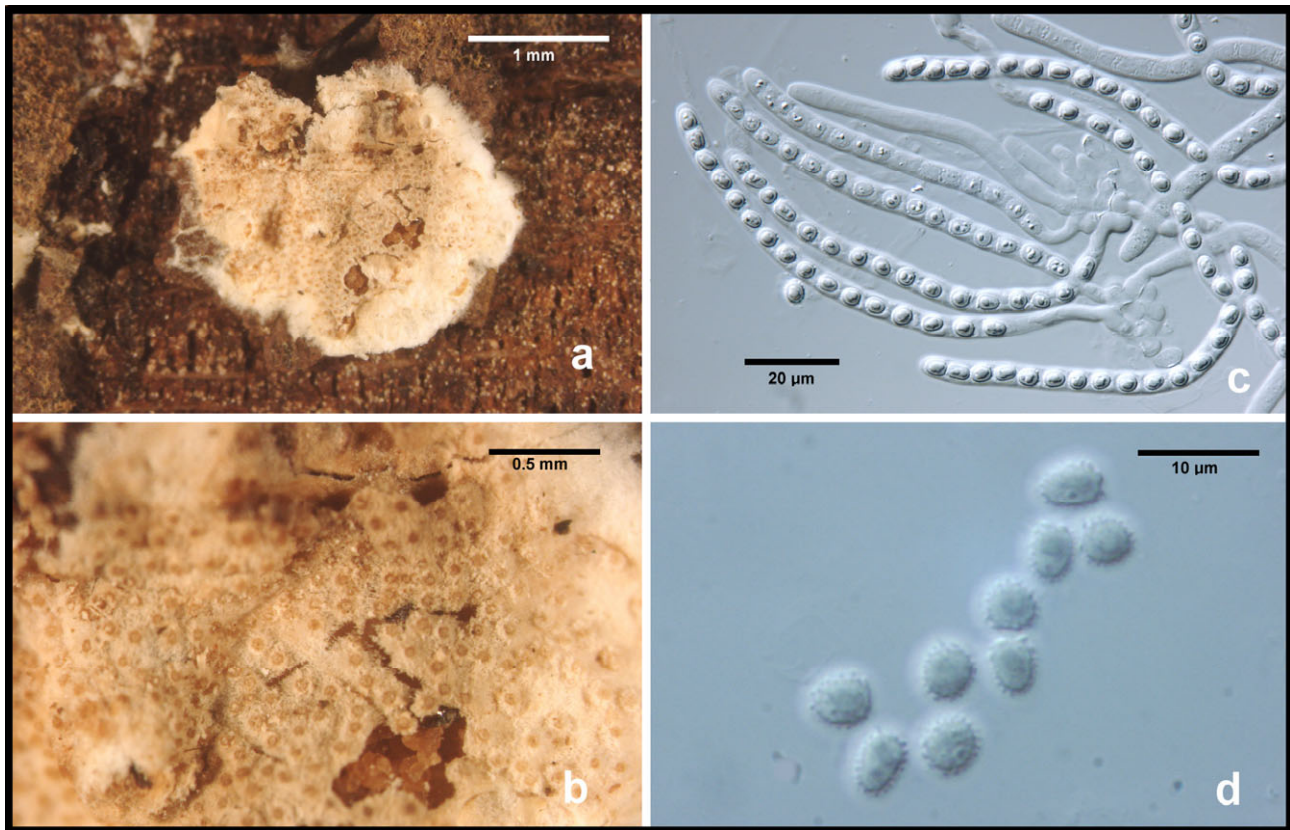
Known distribution: North America.

Description:

Stromata (a, b) effuse to pulvinate, anastomosing, extensive, largest continuous stroma 50 × 20 mm, smallest continuous stroma 3 × 2 mm, varying in colour, usually orange to brownish yellow, or orange yellow to greyish-yellow, with warted hairs at surface of stromata (d); perithecial necks or openings barely distinguishable from stromal surface; KOH+, reaction variable, generally stromata becoming dark orange or red. Perithecia numerous and completely immersed in stromata, generally widely spaced but compact near centre of stroma. Asci (c) cylindrical, (49–)59–79(–106) × (3.3–)4–5(–6.2) µm, with slightly thickened apex, with uniseriate part-ascospores. Part-ascospores (c) hyaline, thin-walled, smooth, monomorphic, usually subglobose to rhomboidal, broader than long. Distal part-ascospores (1.7–)2.7–3.7(–6.2) × (2.4–)3.2–4.2(–5.3) µm; proximal part-ascospores (1.8–)2.6–3.8(–5.7) × (2.5–)3.2–4.2(–5.4) µm.

Notes: Results of phylogenetic analysis (Overton, 2003) indicate that *H. citrina* var. *americana* can be distinguished from *H. citrina* var. *citrina* at species level. This species is easily recognized by its habitat and rhomboidal or subglobose, hyaline ascospores.

Anamorph: verticillium-like



Habitat: On bark, possibly fungicolous.

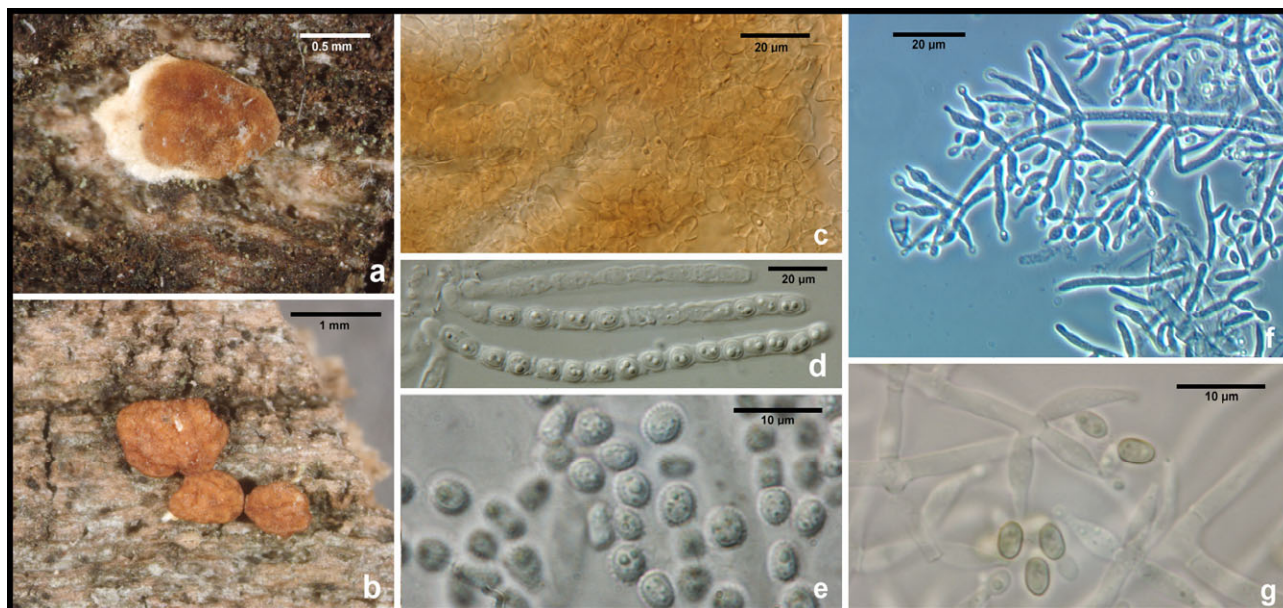
Known distribution: United States (GA, NC), Europe, Japan.

Description:

Subiculum (a, b) effuse, thin, mealy, white becoming pale tan, comprising loosely disposed hyphae, KOH-. Perithecia white to pale luteous, completely immersed in subiculum, KOH-. Asci (c) cylindrical, $50\text{--}60 \times (3.5\text{--})4\text{--}5.5\text{--}(6.5) \mu\text{m}$. Part-ascospores (d) hyaline, spinulose, dimorphic to nearly monomorphic. Distal part-ascospores subglobose, $(3.0\text{--})3.5\text{--}4.0\text{--}(4.5) \times (2.0\text{--})2.5\text{--}3.0\text{--}(3.3) \mu\text{m}$; proximal part-ascospores wedge-shaped to oblong, $(3.2\text{--})3.5\text{--}4.2\text{--}(4.5) \times (2.0\text{--})2.2\text{--}2.7\text{--}(3.0) \mu\text{m}$.

Notes: Ascospore measurements given above are taken from the type specimen (K). Doi (1971) described an anamorph for *H. farinosa* that is suggestive of *Trichoderma* sect. *Hypocreanum* Bissett with conidia hyaline, subglobose to subcylindrical, $2\text{--}15 \times 1.5\text{--}2.5 \mu\text{m}$. The similar species, *Hypocrea delicatula*, may be a synonym of *H. farinosa* (Overton, 2003).

Anamorph: *Trichoderma koningii* Oudem.



Habitat: Teleomorph on decorticated wood. The anamorph is often reported as a soil fungus.

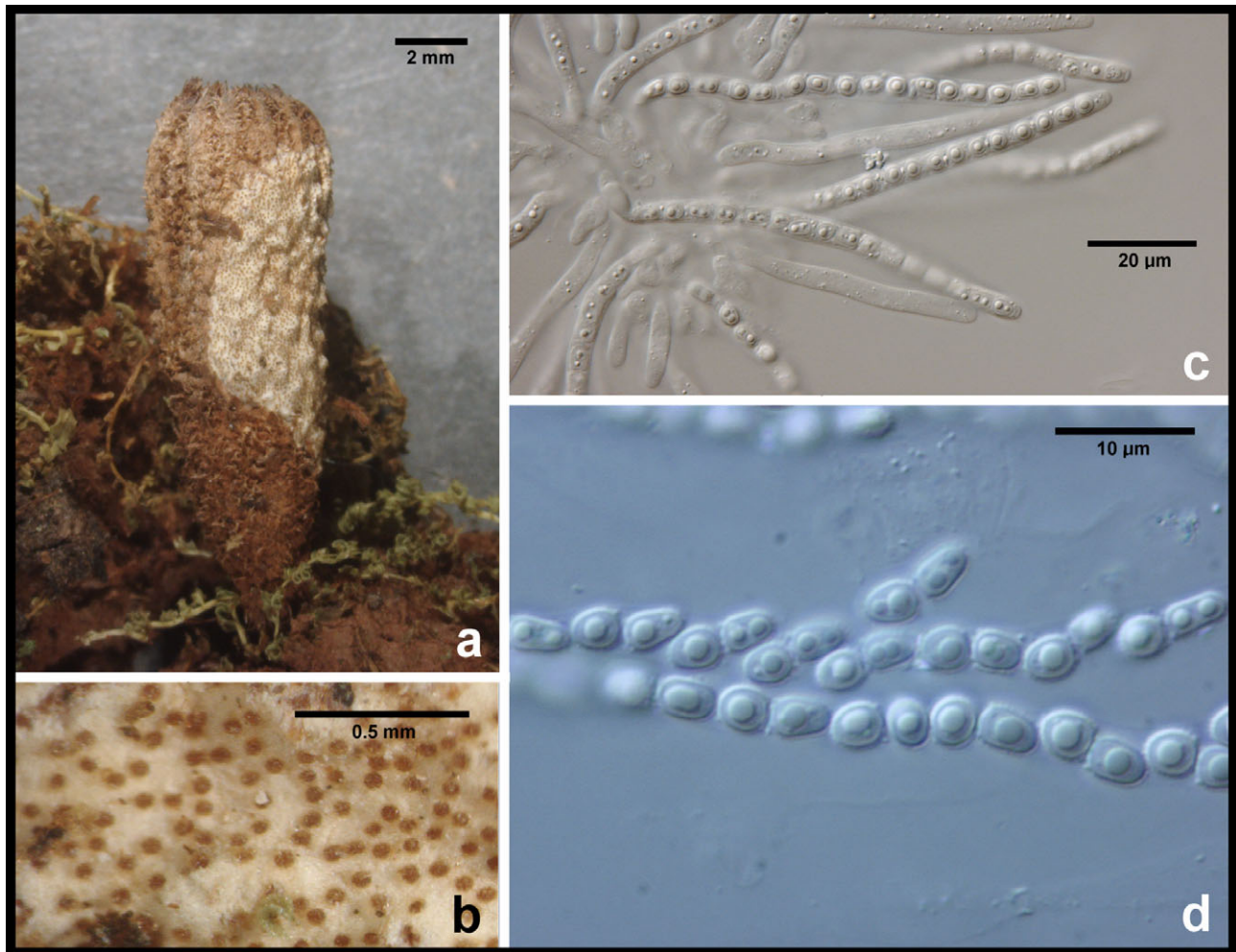
Known distribution: The teleomorph is known only from three locations in Unites States (MD, PA) and two locations in Europe (Austria, The Netherlands). The anamorph is often reported but is confirmed from few collections in Europe (UK, Hungary) and the United States (WI).

Description:

Stromata (a, b) scattered, circular in outline, to 1 mm diam, pulvinate, broadly attached, brown, with plane surface, at first (a) with a light tan, fibrillose margin and velutinous surface (c), later becoming glabrous; perithecial openings at most barely visible. Asci (d) cylindrical to narrowly clavate, $(56-73(-80) \times (4.2-4.5-6.5(-7.0) \mu\text{m})$; with slightly thickened apex and a pore. Part-ascospores (d, e) hyaline, spinulose, somewhat dimorphic. Distal part-ascospores conical to subglobose, $(2.8-3.6-4.5 \times (2.5-3.0-3.6(-3.8) \mu\text{m})$; proximal part-ascospores ellipsoidal to wedge-shaped, $(3.3-3.8-4.6(-5.2) \times (2.2-2.5-3.0(-3.7) \mu\text{m})$. Conidiophores (f) typically with paired branches; branches terminating in lageniform phialides. Conidia (g) oblong, $(3.0-3.8-4.6(-5.0) \times (2.0-2.3-2.7(-3.0) \mu\text{m})$, smooth, green. Chlamydospores produced in some strains.

Notes: The *T. koningii* morphology is shared by several species that differ in subtle characters of conidia and/or growth rates. Two of these unnamed species are found in the GSMNP. *Trichoderma koningii* in its strict sense is rather rare despite its many reports in the literature. The stromata of *H. koningii* are also similar to stromata of several other species. Characters of the anamorph are crucial for the correct identification of ascomata. A detailed taxonomic study on the *T. koningii* species is in progress.

Anamorph: None known.



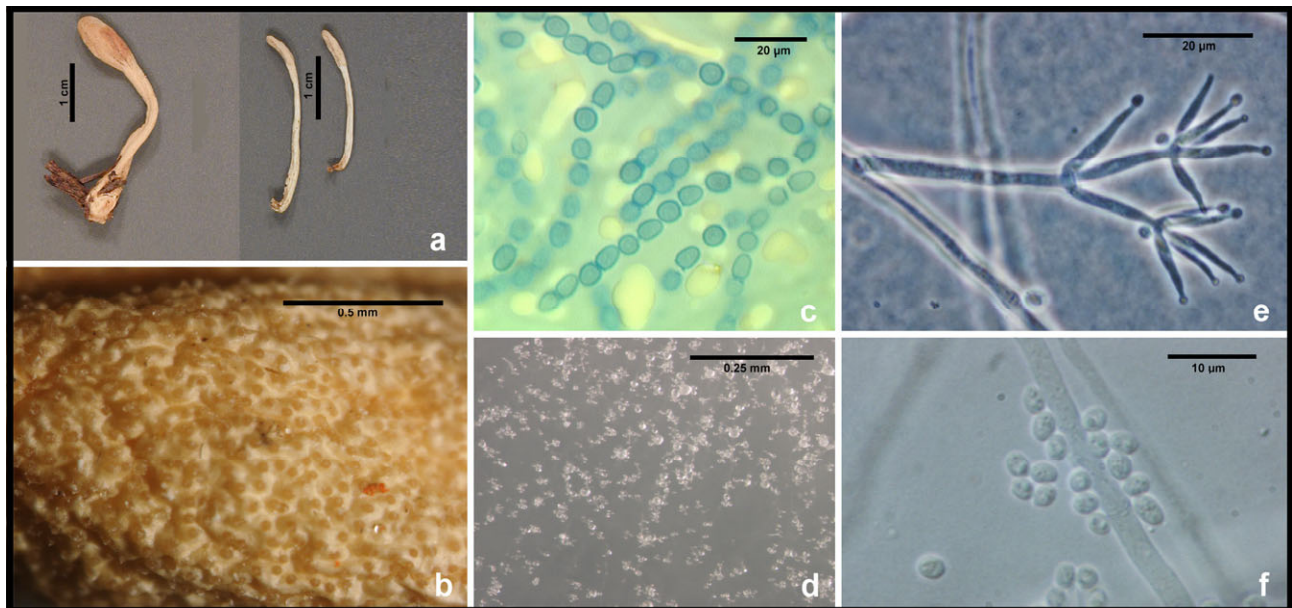
Habitat: On basidiomes of *Cyathus striatus*.

Known distribution: Eastern United States, Canada, and Venezuela.

Description:

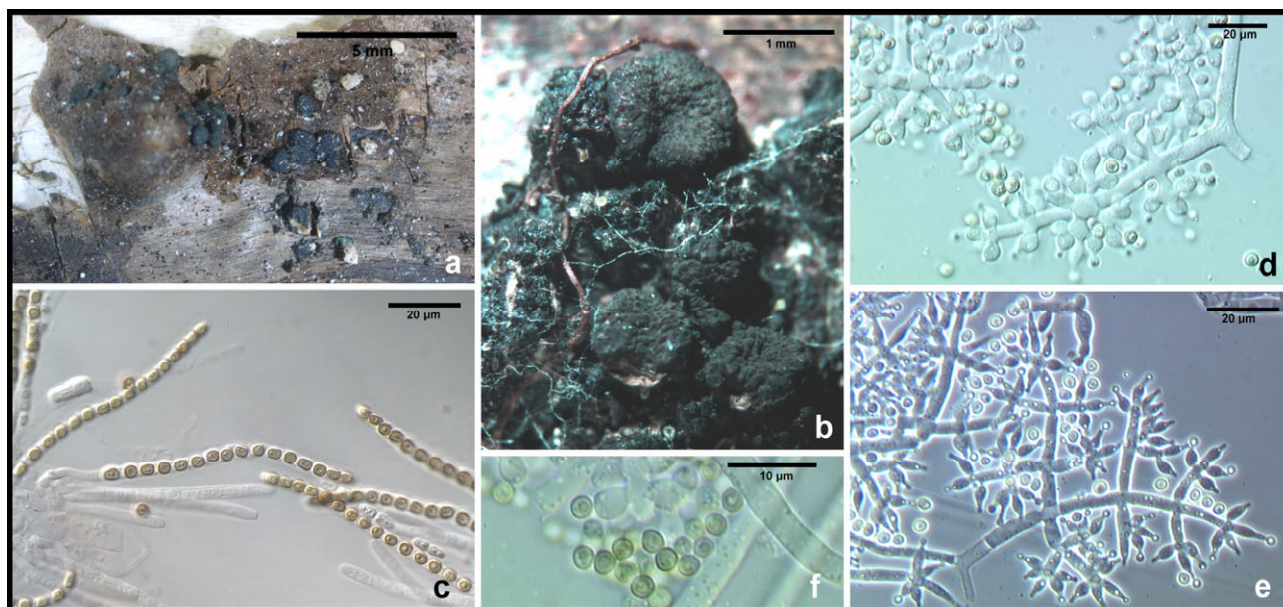
Stroma (a) growing on outside surface of infected basidiome, white, hyphal. Perithecia (b) densely disposed, completely immersed in hyphal stroma; ostiolar openings appearing as pale orange dots. Asci (c) cylindrical, with a slightly thickened apex and a pore. Part-ascospores (d) hyaline, spinulose, dimorphic. Distal part-ascospores subglobose to conical, $3.5\text{--}4.0 \times 3.0\text{--}3.5 \mu\text{m}$; proximal part-ascospores wedge shaped to truncate-ellipsoidal, $3.5\text{--}4.5 \times 2.3\text{--}3.0 \mu\text{m}$.

Notes: Despite numerous attempts, we have not been able to germinate ascospores of this distinctive species.

Anamorph: verticillium-like**Habitat:** On ground among litter, typically in mixed forest type.**Known distribution:** North America, northern Europe.**Description:**

Stromata (a) clavate, single, sometimes fused or branched; separated into fertile upper part and sterile stipe, sometimes slightly confluent with stipe; stroma (1.5–)3–5(–8) cm tall, KOH–. Fertile part pale yellow to golden brown, KOH–, with (b) glabrous, sometimes wrinkled, surface, slightly tuberculate from perithecial elevations, ostiolar openings visible as small viscid dots slightly darker than background. Sterile part white to beige, slightly velvety or not, adjacent stipes often fused, with fissures demarcating individual stipes, KOH–. Asci (c) cylindrical (62–)70–90(–114) × (2.7–)3.7–4.7(–6.7) μm, with a slightly thickened apex and a pore. Part-ascospores (c) hyaline, finely spinulose, dimorphic. Distal part-ascospores subglobose to conic, (2.0–)2.5–3.0(–4.0) μm diam; proximal part-ascospores cuneate to ellipsoidal (2–)3–4(–5) × (1.7–)2.0–3.0 (–3.5) μm. Anamorph not known in nature, in culture forming conidiophores with terminal drops of colourless, clear liquid (d). Conidiophores (e) verticillium-like with phialides held singly or in verticals of 3–5. Conidia (f) ellipsoidal, 2.7–3.7(–4.5) × 2.0–2.5(–3.0) μm, lacking a visible basal abscission scar, smooth, hyaline. Chlamydospores not seen.

Notes: The two common stipitate species of *Hypocrea*, formerly placed in *Podostroma*, viz. *H. leucopus* and *H. alutacea*, can be separated on the basis of habitat and anamorphs. *Hypocrea leucopus* typically occurs on the ground.

Anamorph: *Trichoderma harzianum* Rifai

Habitat: Fungicolous, corticolous, lignicolous, soil; infrequently on rotting leaves of palms.

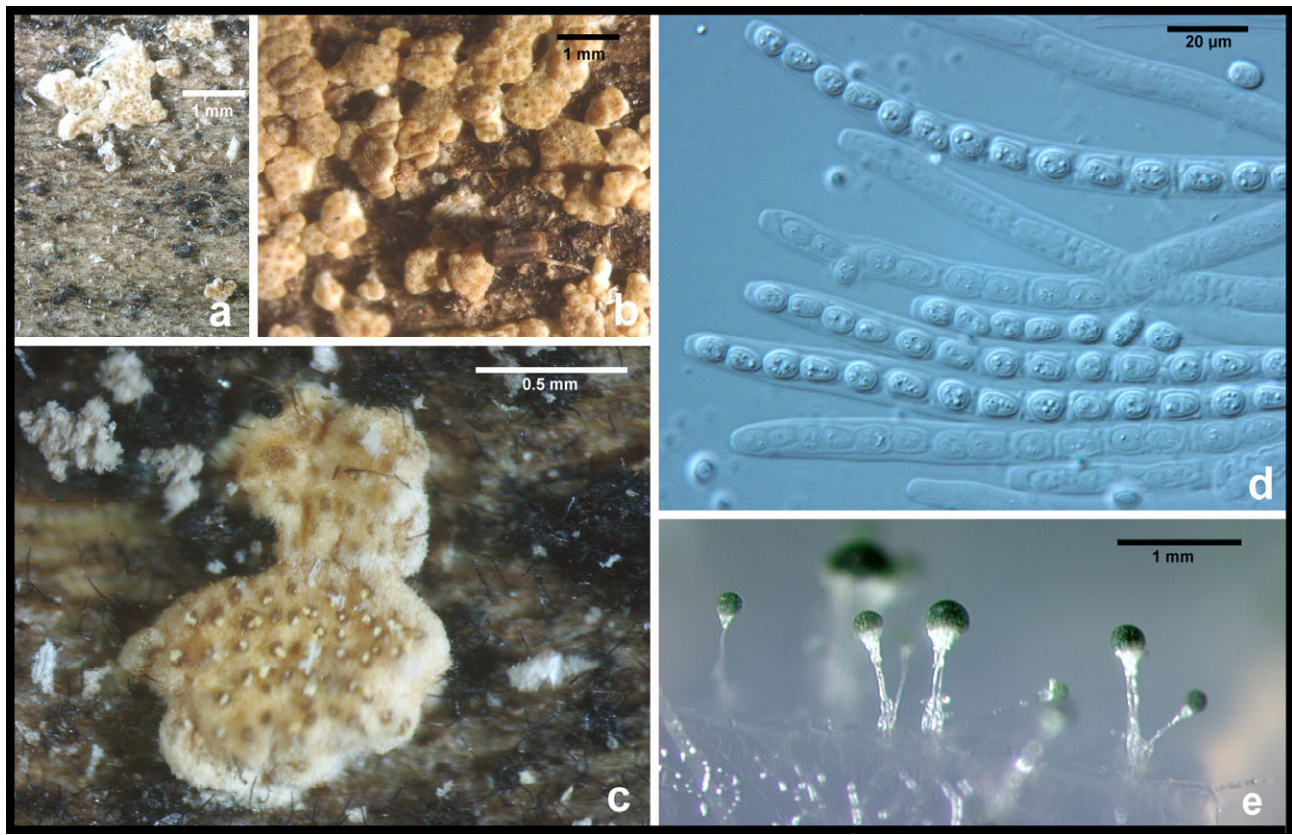
Known distribution: Cosmopolitan.

Description:

Stromata (a, b) solitary or aggregated, pulvinate, nearly circular in outline, 0.3–3.0 mm diam, 0.4–1.4 mm high, broadly attached, with smooth surface, sometimes with slight perithecial protuberances, dark brown, dark green, almost black, changing colour from dark green to brown in KOH, if stromata dark brown then KOH–, ostiolar openings not obvious due to dark colour of stromata. Asci (c) cylindrical, (44–)63–68(–138) × (3.0–)4.5–4.7(–6.5) µm; with thickened apex and a pore. Part-ascospores (c) green, warted, dimorphic. Distal part-ascospores globose to subglobose, 4.3–4.4 × 3.9–4.0 µm, proximal part-ascospores wedge-shaped to cylindrical, 4.5–4.6 × 3.5–3.7 µm. Conidiophores (d, e) not well defined, branching generally 2–3 times in a pyramidal fashion, with longest branches paired near base of main axis; branches towards tip, secondary, and tertiary branches arising at wide angles. Phialides ampulliform, 4.8–8.5 × 2.5–3.5 µm, l/w 2.0–2.5. Conidia (f) green, smooth, subglobose to ovoidal, 2.7–3.5 × 2.5–3.0 µm, l/w 1.0–1.3. Chlamydospores sometimes observed, globose to subglobose, terminal or intercalary in hyphae.

Notes: *Hypocrea lixii* is unusual in the dark colour of its stromata. Ascomata of *H. lixii* are commonly collected in tropical regions but seem to be less common in temperate regions. This is possibly the most common species of *Trichoderma*, mostly encountered in its anamorph.

Anamorph: *Gliocladium viride* Matr.



Habitat: Ascomata frequently encountered on wood, rarely on leaf litter, commonly isolated from as anamorph (Domsch *et al.*, 1980).

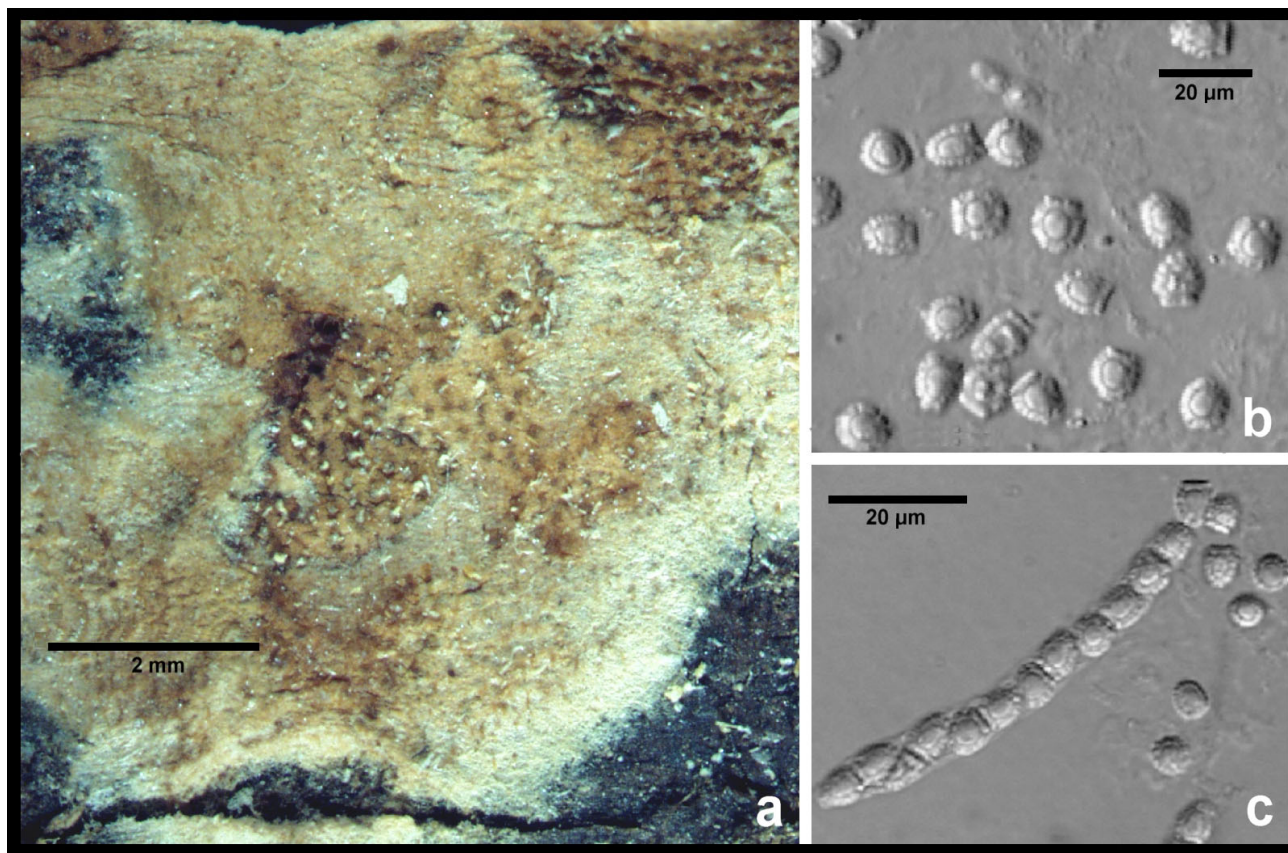
Known distribution: Cosmopolitan and common.

Description:

Stromata (a–c) solitary and scattered to gregarious, byssoid and plane when young, becoming pulvinate, to 3 mm diam, often with a narrow, byssoid margin, broadly attached; pale ochraceous, ostiolar openings appearing as darker dots; perithecial papilla not visible; KOH–. Asci (d) cylindrical, $90\text{--}100 \times 5\text{--}6 \mu\text{m}$; apex slightly thickened, with a pore. Part-ascospores (c) hyaline, finely spinulose, dimorphic. Distal part-ascospores subglobose to globose, $3.5\text{--}4.0 \times 3.0\text{--}3.5 \mu\text{m}$; proximal part-ascospores wedge-shaped to truncate-ellipsoidal, $4.0\text{--}6.5 \times 3\text{--}4 \mu\text{m}$. Conidiophores (e) gliocladium-like, robust, $120\text{--}250 \mu\text{m}$ long, with lateral branches arising from lower half of conidiophore and anchoring it to substratum. Phialides narrow, held in a dense penicillus. Conidia oblong to subglobose, $2.5\text{--}4.0 \times 2.2\text{--}2.5 \mu\text{m}$, held in a large globose, drop of clear green liquid at tip of each conidiophore.

Notes: Despite its hyaline ascospores, this species is phylogenetically closely related to species that have green ascospores. Phylogenetically, Chaverri & Samuels (2003) have shown this species to form a sister clade to *H. citrina* and its relatives.

Anamorph: *Trichoderma* sp. sect. *Hypocreanum*



Habitat: On decayed trunks of broadleaf trees including *Acer* sp.

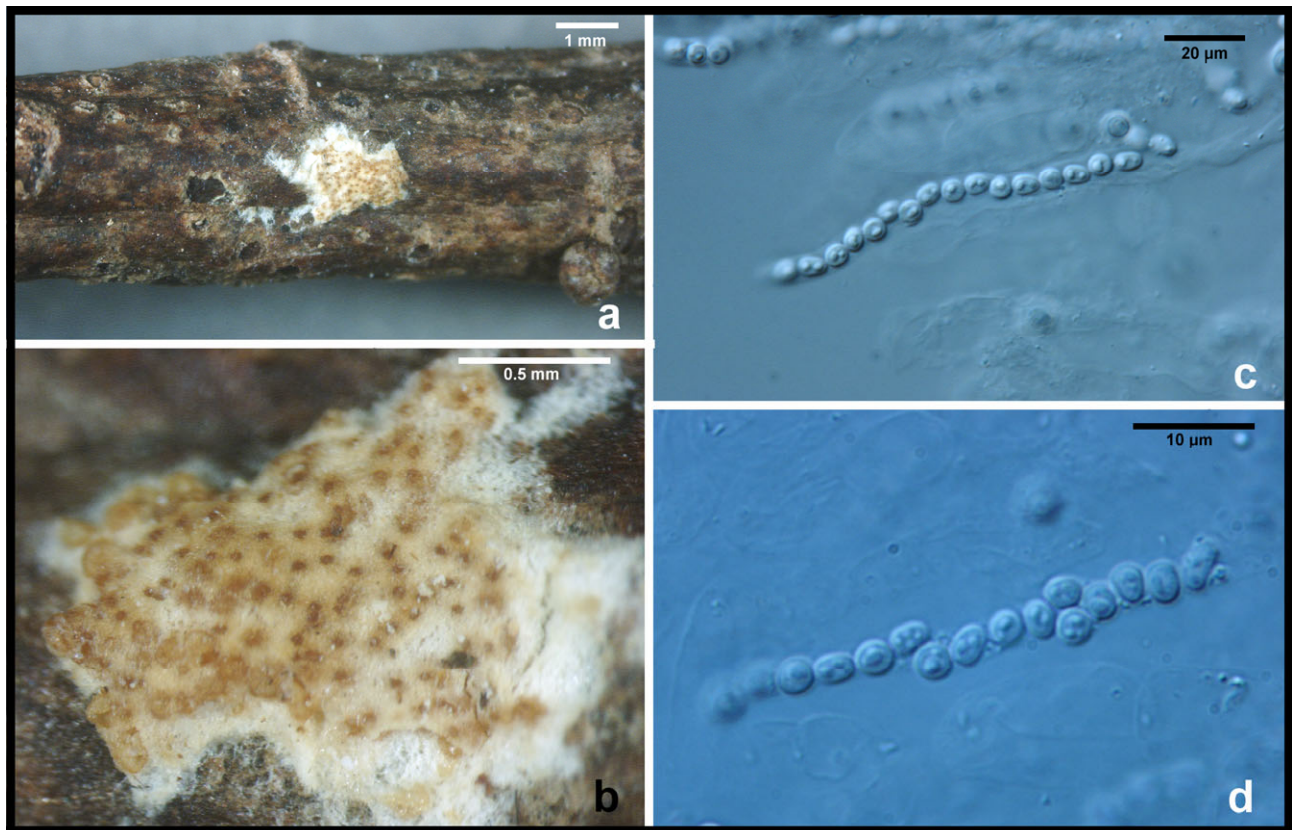
Known distribution: United States (MD, NC), Japan.

Description:

Stromata (a) effuse, anastomosing, extensive, largest continuous stroma, 40 × 30 mm, smallest continuous stroma, 3 × 2 mm, varying in colour, usually light brown; KOH–; surface of stromata appearing slightly roughened from protruding perithecial apices. Perithecia numerous, generally widely spaced but compact near centre of stroma. Asci (c) cylindrical, (66–)79–97(–118) × (4.7–)5.3–6.6(–7.4) µm, tip slightly thickened; part-ascospores uniseriate. Part-ascospores (b, c) hyaline, thick-walled, nodulose, dimorphic. Distal part-ascospores subglobose to conical, (3.2–)4.5–5.8 (–6.6) × (3–)3.8–5(–6) µm; proximal part ellipsoidal, rarely subglobose, sometimes appearing thimble-shaped or conical, (3.7–)4.6–5.9(–7) × (3.1–)3.7–4.8(–5.8) µm.

Notes: This rare species is characterized by its effused stroma and grossly warted ascospores.

Anamorph: *Trichoderma* sp. sect. *Hypocreanum*



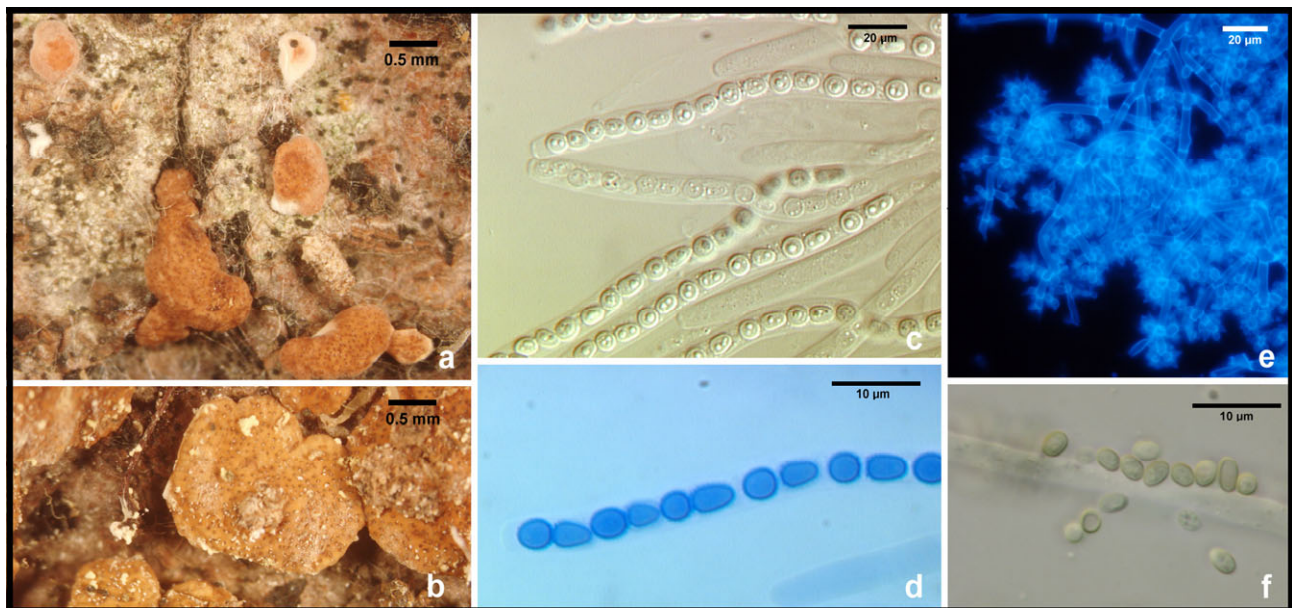
Habitat: On bark, possibly fungicolous.

Known distribution: North America, Japan.

Description:

Stromata (a, b) effuse, extensive and anastomosing, largest continuous stroma, 12 × 11 mm, smallest continuous stroma, 2 × 2 mm, with a white byssoid margin, varying in colour, greyish-yellow to orangish brown, sometimes light yellow ostiolar openings visible at stromal surface, appearing orange; KOH+, reaction variable, stromata becoming darker orange. Stromal surface appearing granulose because of minutely roughened hyphal protrusions. Perithecia completely immersed; tightly compacted near stromal centre, fewer perithecia near margin. Asci (c, d) cylindrical, (48–)53–67(–77) × (3.3–)3.9–4.9(–5.8) µm, tip slightly thickened; part-ascospores uniseriate. Part-ascospores (c, d) hyaline, thick-walled, finely spinulose, dimorphic; distal part-ascospores subglobose, sometimes globose, (2.3–)2.7–3.5(–4) × (2.3–)2.7–3.3(–3.8) µm; proximal part-ascospores ellipsoidal, sometimes subglobose to ovoidal, (2.6–)3.1–3.9(–4.7) × (1.9–)2.4–2.9(–3.6) µm.

Anamorph: *Trichoderma minutisporum* Bissett



Habitat: On corticated and decorticated wood, frequently isolated from soil as the anamorph.

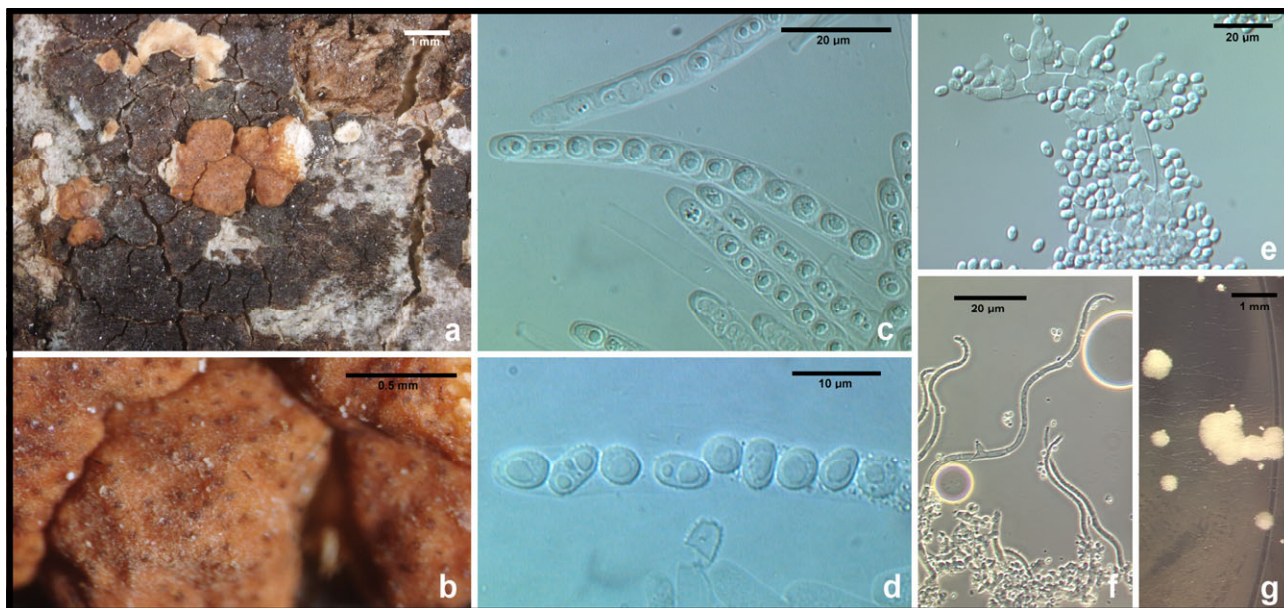
Known distribution: Both anamorph and teleomorph are north temperate (North America, Europe).

Description:

Stromata (a, b) mostly gregarious to caespitose, less frequently solitary, $0.5\text{--}2.0 \times 0.5\text{--}3.0$ mm, stromata of variable shape, mostly irregular when aggregated and with overlapping margins of individual stromata, occasionally rounded or elongate especially when solitary with margins typically fully attached to substratum, sometimes constricted at base, uniformly light-brown to yellowish-brown, with white margins when young. Stroma surface smooth, wrinkled or creased, occasionally slightly tuberculate from perithecial apices. All tissues except perithecial wall KOH-. Ostiolar openings visible as slightly raised, purple-brown spots. Asci (c, d) cylindrical, $(66\text{--})75\text{--}100 \times (3.5\text{--})4.5\text{--}6.5(\text{--}7.5)$ µm, tip thickened and with a pore. Part-ascospores (c, d) uniseriate, hyaline, finely spinulose, dimorphic to monomorphic. Distal part-ascospores globose to subglobose, $(3.2\text{--})3.7\text{--}4.7(\text{--}6.5) \times (2.7\text{--})3.5\text{--}4.5(\text{--}5.5)$ µm; proximal part-ascospores subglobose, oblong, ellipsoidal or wedge-shaped, $(3.5\text{--})4.0\text{--}5.5(\text{--}6.7) \times (2.2\text{--})2.7\text{--}4.0(\text{--}5.5)$ µm. Conidia forming in flat, green pustules. Conidiophores (e) with paired branches and short internodes between branches, each branch terminating in several short, broad phialides. Conidia (f) ellipsoidal, $(1.7\text{--})2.5\text{--}4.0(\text{--}9.7) \times (1.5\text{--})2.0\text{--}3.0(\text{--}6.5)$ µm, l/w $(0.9\text{--})1.1\text{--}1.5(\text{--}1.9)$, mostly light green to green, smooth. Chlamydospores typically not formed.

Notes: See Lu *et al.* (2004) for full description of *H. minutispora* and closely related species.

Anamorph: *Trichoderma polysporum* (Link : Fr.) Rifai



Habitat: On bark and decorticated wood and shiitake-infected logs, frequently encountered from soil as the anamorph.

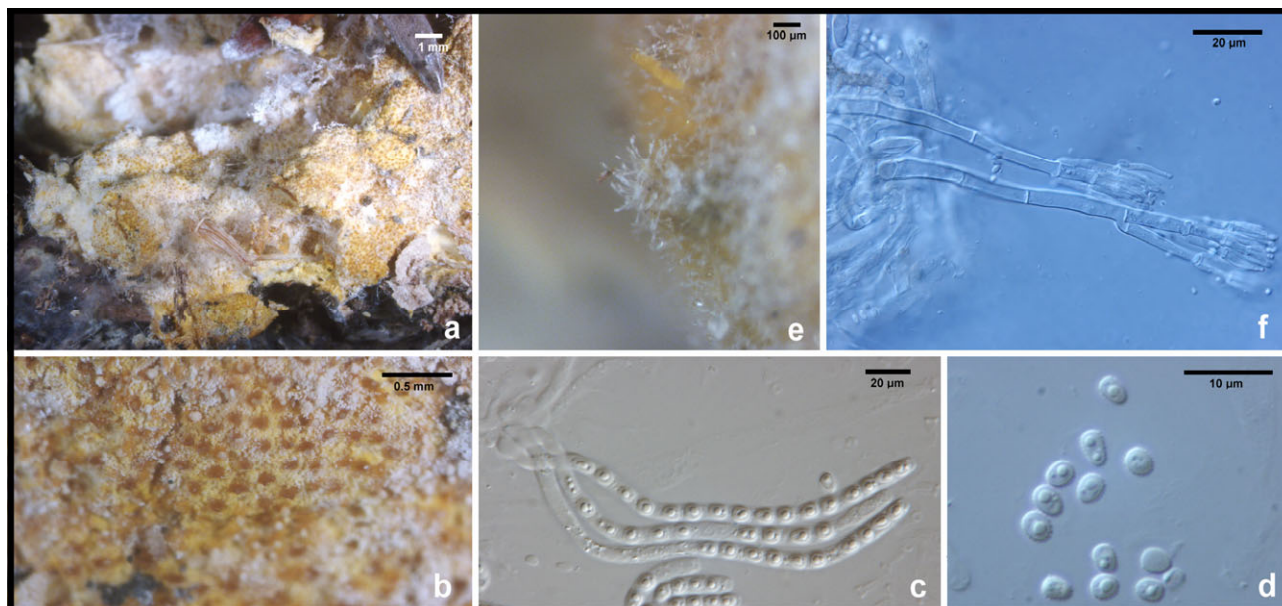
Known distribution: Anamorph and teleomorph are found in north and south temperate regions, rare or absent in tropical regions.

Description:

Stromata (a, b) gregarious to caespitose, 0.5–2.0(–6.0) × 0.5–1.5(–4.5) mm, variably shaped, mostly rounded to elongate, or sometimes irregular in outline, particularly when aggregated or caespitose, pulvinate, usually with margins fully attached to substratum, but sometimes slightly constricted at base; colour variable among different collections and different stages of same collection, mostly brown to reddish-brown, some collections yellow or light-brown particularly when young, collections from Japan purple-brown to black-brown; colour of most stromata nearly uniform, but margins of young stromata often white; all tissues KOH–. Stromatal surface (b) wrinkled or creased, plane but infrequently slightly tuberculate from perithecial apices. Ostiolar openings mostly visible as minute, purple-brown to blackish-brown flat or slightly raised dots. Asci (c, d) cylindrical, (48–)75–100(–133) × (3.5–)4.5–6.0(–8.5) µm, tip thickened and with a pore. Part-ascospores (c, d) hyaline, uniseriate, finely spinulose, dimorphic. Distal part-ascospores globose to subglobose or conical, (2.2–)3.2–4.5(–6.0) × (2.0–)3.0–4.0(–5.7) µm. Proximal part-ascospores mostly subglobose to oblong, sometimes wedge-shaped or attenuated toward base, tending to be more oblong toward base of ascus, (2.5–)3.7–5.2(–7.2) × (1.7–)2.5–3.5(–4.5) µm. Conidia forming in white pustules (g); sinuous, spinulose, unbranched, with sterile hairs (f) arising from pustules. Conidia (e) ellipsoidal, occasionally oblong or subglobose, (1.2–)2.5–3.5(–5.5) × (1.0–)1.5–2.5(–3.0) µm, hyaline, smooth, formed from crowded, short and broad phialides.

Notes: See Lu *et al.* (2004) for full description of this and related species.

Anamorph: *Gliocladium* cf. *penicillioides* Corda



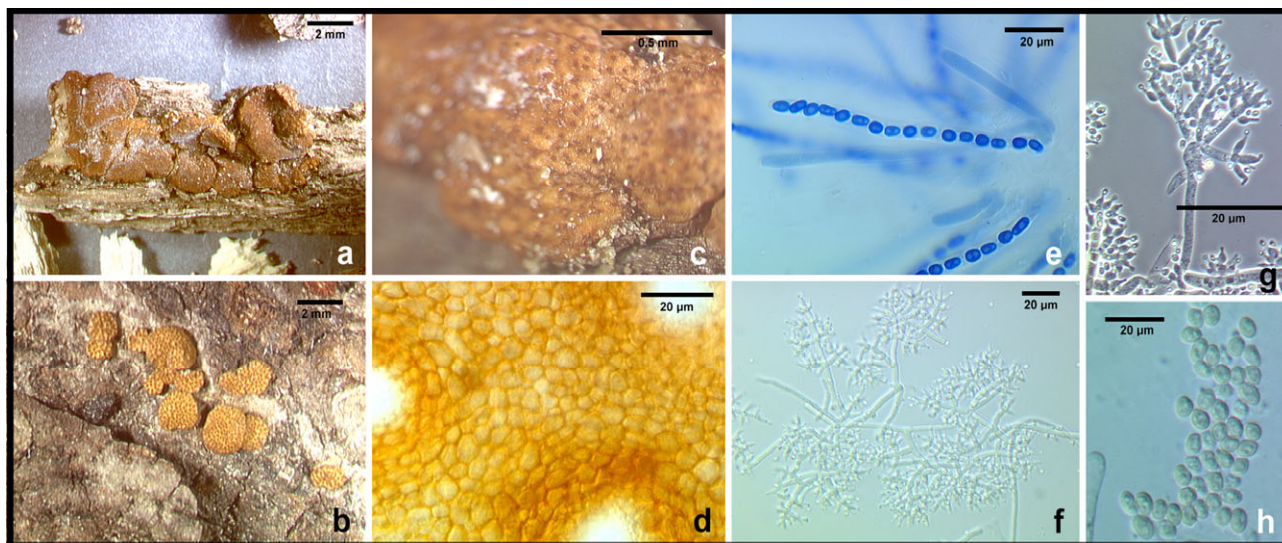
Habitat: On *Aphyllphorales*, mainly *Tyromyces* (Doi & Yamatoya, 1989)

Known distribution: Cosmopolitan, temperate and tropical.

Description:

Subiculum (a, b) effuse, thin, whitish, pale yellow-ochre or pale orange to orange. Perithecia (b) densely gregarious or solitary, partially to completely immersed in subiculum and forming a continuous, stroma-like layer over surface of infected polypores, orange, KOH+ red. Asci (c) cylindrical, $55\text{--}62 \times 2.5\text{--}3.0$ μm , apex slightly thickened and with a pore. Part-ascospores (c, d) hyaline, spinulose, dimorphic. Distal part-ascospores subglobose to obovate, $2.7\text{--}3.0 \times 2.2\text{--}2.6$ μm ; proximal part-ascospores obovate to ellipsoidal, $3.0\text{--}3.5 \times 2.2\text{--}2.5$ μm . Anamorph (e, f) gliocladium-like, usually forming on host. Conidiophores conspicuous, to 400 μm long, often fasciculate, smooth, monoverticillate to biverticillate; phialides held in compact penicilli. Conidia oblong ellipsoidal, ovoidal or slightly ovate, $2.2\text{--}5.5 \times 1.0\text{--}1.8$ μm , hyaline, smooth.

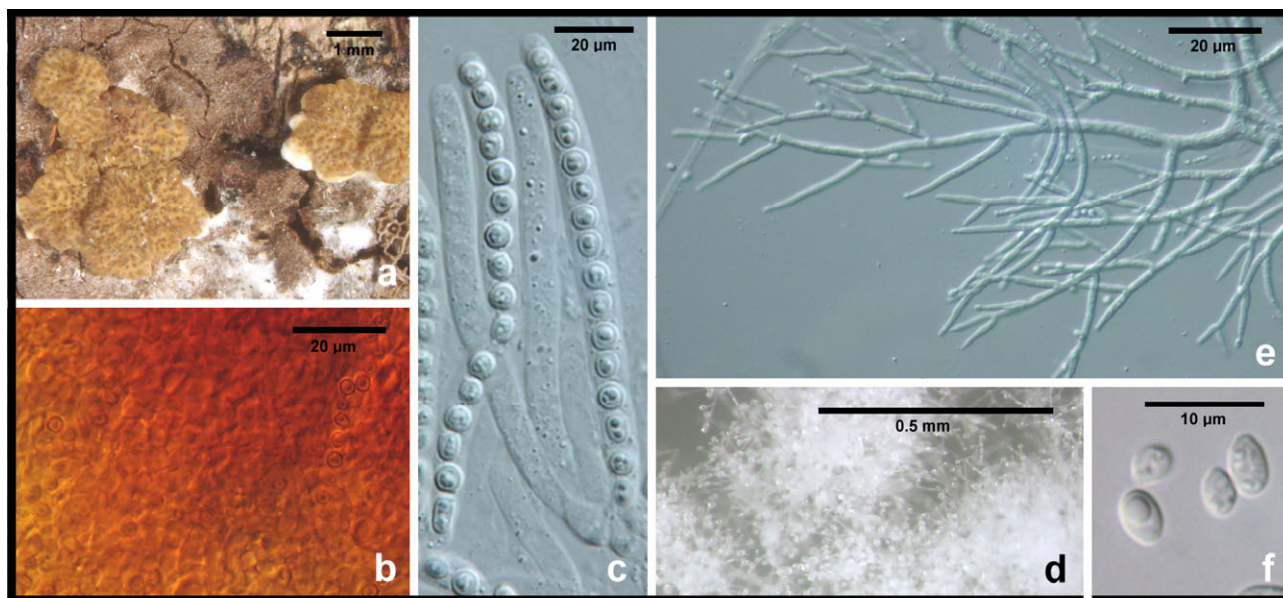
Notes: Phylogenetic analyses indicate that this species falls outside of *Hypocrea* (Rehner & Samuels, 1994). The conidiophores differ from those of *Sphaerostilbella aureonitens* in being smooth. Although herein considered a synonym of *H. pallida*, *Hypocrea aurantiaca* Peck may be a distinct species for which Doi & Yamatoya (1989) provide a description of this and closely related species.

Anamorph: *Trichoderma* sp.**Habitat:** On decorticated wood.**Known distribution:** Eastern North America, Europe.**Description:**

Stromata (a, b) forming on decorticated wood, light brown to brown, nearly circular to slightly elliptical in outline, somewhat constricted at base and then with margins free, discrete to caespitose in great numbers, confluent if adjacent, $(0.5\text{--}1.5\text{--}2.5\text{--}8.2) \times 0.5\text{--}1.7\text{--}4.7$ mm; surface plane and perithecial elevations not evident, or perithecial elevations appearing as minute papillae; ostiolar openings (c) appearing as small, brown dots; stroma surface and perithecial wall reddish in KOH and yellow in lactic acid. In surface view, cells of stroma angular (d), $5\text{--}10\text{--}17 \times 5\text{--}8\text{--}10$ μm , with $1.0\text{--}1.5$ μm thick walls. Asci (e) cylindrical $(60\text{--}67\text{--}85\text{--}97) \times (3\text{--}4\text{--}6\text{--}8)$ μm , apex with a refractive ring. Part-ascospores (e) hyaline, finely spinulose, dimorphic. Distal part-ascospores subglobose, $2.5\text{--}3.5\text{--}4.7 \times (2.0\text{--}2.5\text{--}3.0\text{--}4.0)$ μm ; proximal part-ascospores oblong to wedge-shaped, $(2.5\text{--})3\text{--}4\text{--}7 \times (1.7\text{--})2.0\text{--}3.0\text{--}3.8$ μm . Conidiophores (f, g) tending to comprise a long, sterile base and paired branches arising over upper half to two-thirds, smooth, thin-walled, septate, $100\text{--}150$ μm long, ca. $4\text{--}6$ μm wide at base. Phialides held in divergent penicilli, lageniform. Conidia (h) ellipsoidal, $(2.5\text{--})3.0\text{--}3.7\text{--}4.7 \times (1.7\text{--})2.2\text{--}2.5\text{--}3.2$ μm , lacking a visible basal abscission scar, thin-walled, smooth, green. Chlamydospores not seen.

Notes: This species is characterized by the crowded stromata on decorticated wood, red colour in KOH and angular cells at the stroma surface. Other possibly undescribed species are identified frequently as *H. patella*. Compare to *H. cf. pseudostraminea* and *H. pachybasoides*.

Anamorph: *Trichoderma* sp. (verticillium-like)



Habitat: On bark, including *Quercus*, *Rhododendron*, *Tsuga*.

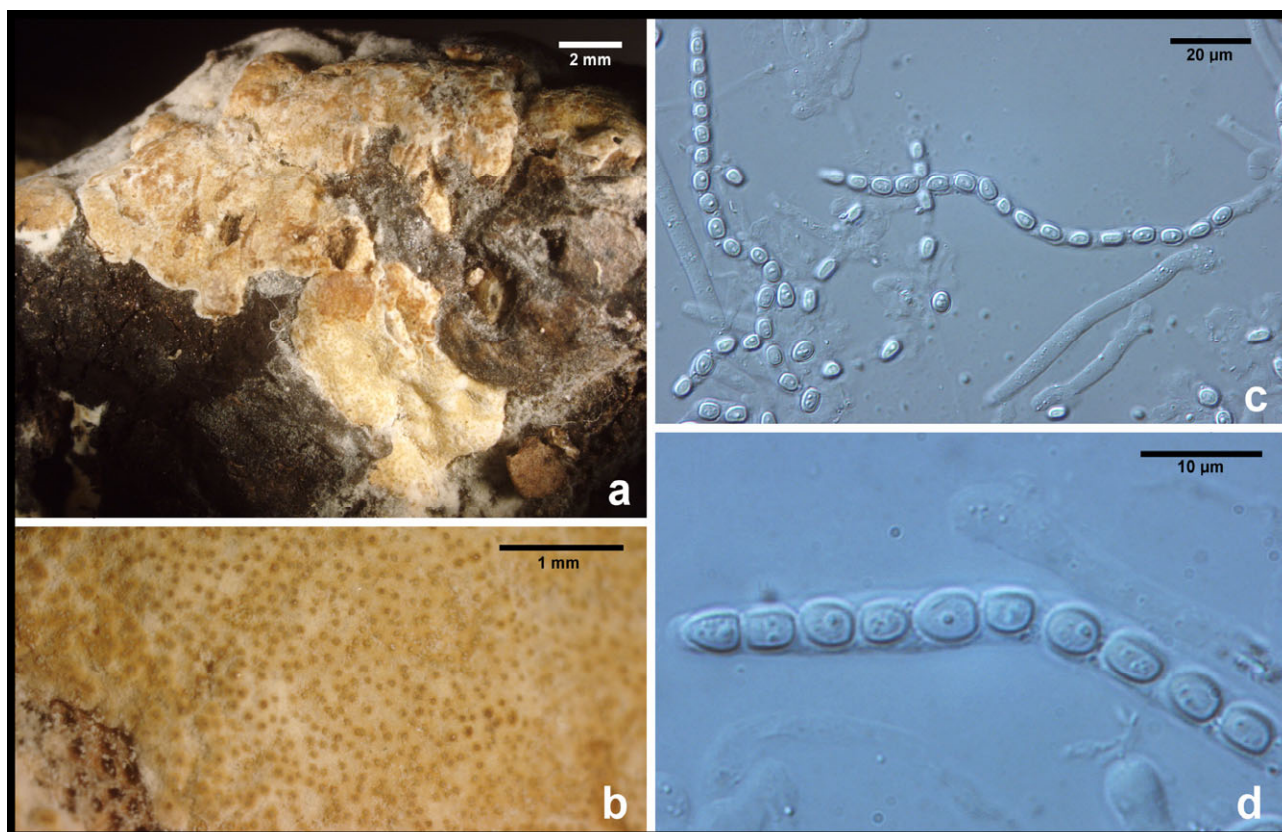
Known distribution: United States. (TN, GSMNP), Japan.

Description:

Stromata (a) disciform, circular or irregular in outline, adjacent if overlapping, sometimes covering an extensive area and appearing to be semieffused if confluent; individual stromata 1.5–2.0 mm diam, yellowish to light orange; stroma surface and perithecial walls KOH+ red (b), yellow in lactic acid; surface of stromata plane, slightly wrinkled, perithecial elevations not evident, ostiolar openings minutely apiculate, darker orange than the surrounding stroma tissue. Cells at stroma surface (b) pseudoparenchymatous or appearing as \pm thick-walled hyphae with no free ends. Asci (c) cylindrical, (60–)65–75(–80) \times (3–)4–5(–6) μm , apex thickened, with a ring, 8-spored; part-ascospores (c) uniseriate. Part-ascospores yellow when discharged, spinulose, nearly monomorphic and subglobose to ellipsoidal or dimorphic, distal part-ascospores globose to subglobose, (2.5–)2.7–3.0(–3.5) \times (2.5–)2.5–3.2(–3.5) μm ; proximal part-ascospores cuneate to ellipsoidal (2.2–)2.7–3.5(–4.2) \times (2.0–)2.2–2.7(–3.0) μm . Anamorph forming dense masses of conidiophores on agar surface and in the aerial mycelium, conidial masses as white slime (d). Conidiophores (e) \pm verticillium-like, often thick-walled and warted bases; phialides long, slender. Conidia (f) ellipsoidal, (3.0–)3.8–4.0(–5.5) \times (2.2–)2.5–2.7(–3.0) μm . Colonies with a yellow pigment diffusing through agar; colonies with a strong, sweet, coconut odor.

Notes: *Hypocrea pseudostraminea* was described from Japan. Stromata in Japanese material are semieffused whereas stromata in the two specimens for the southeastern United States, studied here, are disciform. DNA sequence analyses in our laboratory have shown that isolates from the southeastern United States are related to *H. rufa*. Close relatedness of both species is also supported by the coconut odor of cultures. Overton (2003) linked true *H. pseudostraminea* to an acremonium-like anamorph and found it to have a different phylogenetic placement. Stromal morphology is likely conserved and what we report here is an undescribed species. This species is morphologically similar to the unrelated *H. patella*, the most conspicuous difference being in their anamorphs; conidia of *H. patella* are green.

Anamorph: acremonium-like (*Trichoderma* sp. sect. *Hypocreanum*)



Habitat: On a variety of polypores, including *Fomitopsis pinicola*, *Ganoderma* spp., *Laetiporus sulphureus*, and *Piptoporus betulinus*.

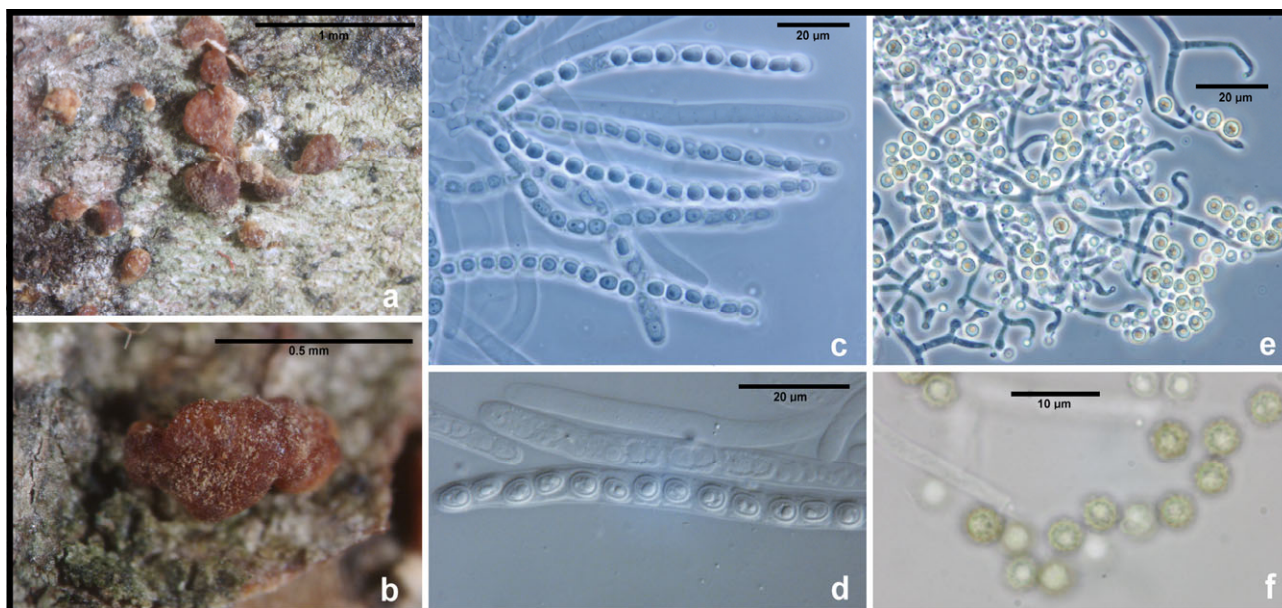
Known distribution: North temperate regions (North America, Europe, Japan).

Description:

Stromata (a, b) effuse to subpulvinate, extensive, anastomosing, continuous, 3–60 × 2–20 mm, variable in colour, usually orange-yellow to grey-orange, sometimes brown-yellow to golden-yellow, KOH+ reaction variable, sometimes weak, typically stromata becoming orange or red; ostiolar openings visible on stromal surface. Warty hairs at surface of stromata conspicuous. Perithecia (b) numerous, completely immersed in stromata. Asci (c) cylindrical, (44–)66–90(–115) × (2.8–)3.6–5.2(–7.9) µm, tip slightly thickened; part-ascospores uniseriate. Part-ascospores (d) hyaline, thin-walled, smooth to minutely spinulose, typically monomorphic, ellipsoidal to subglobose. Distal part-ascospores (2.8–)3.7–4.7(–6.0) × (2.3–)2.9–3.7(–4.6) µm; proximal part-ascospores (2.8–)3.8–5(–6.7) × (2.3–)2.8–3.8(–4.7) µm.

Notes: There has been confusion about the identity of *H. citrina*, *H. lactea*, and *H. pulvinata* (see Webster & Rifai, 1966). *Hypocrea citrina*, with *H. lactea* as its synonym, occurs on litter but not on fungi. *Hypocrea pulvinata* only occurs on basidiomes of members of the *Aphyllphorales*. *Hypocrea fungicola* Karst. is a synonym of *H. pulvinata*.

Anamorph: *Trichoderma viride* Pers.



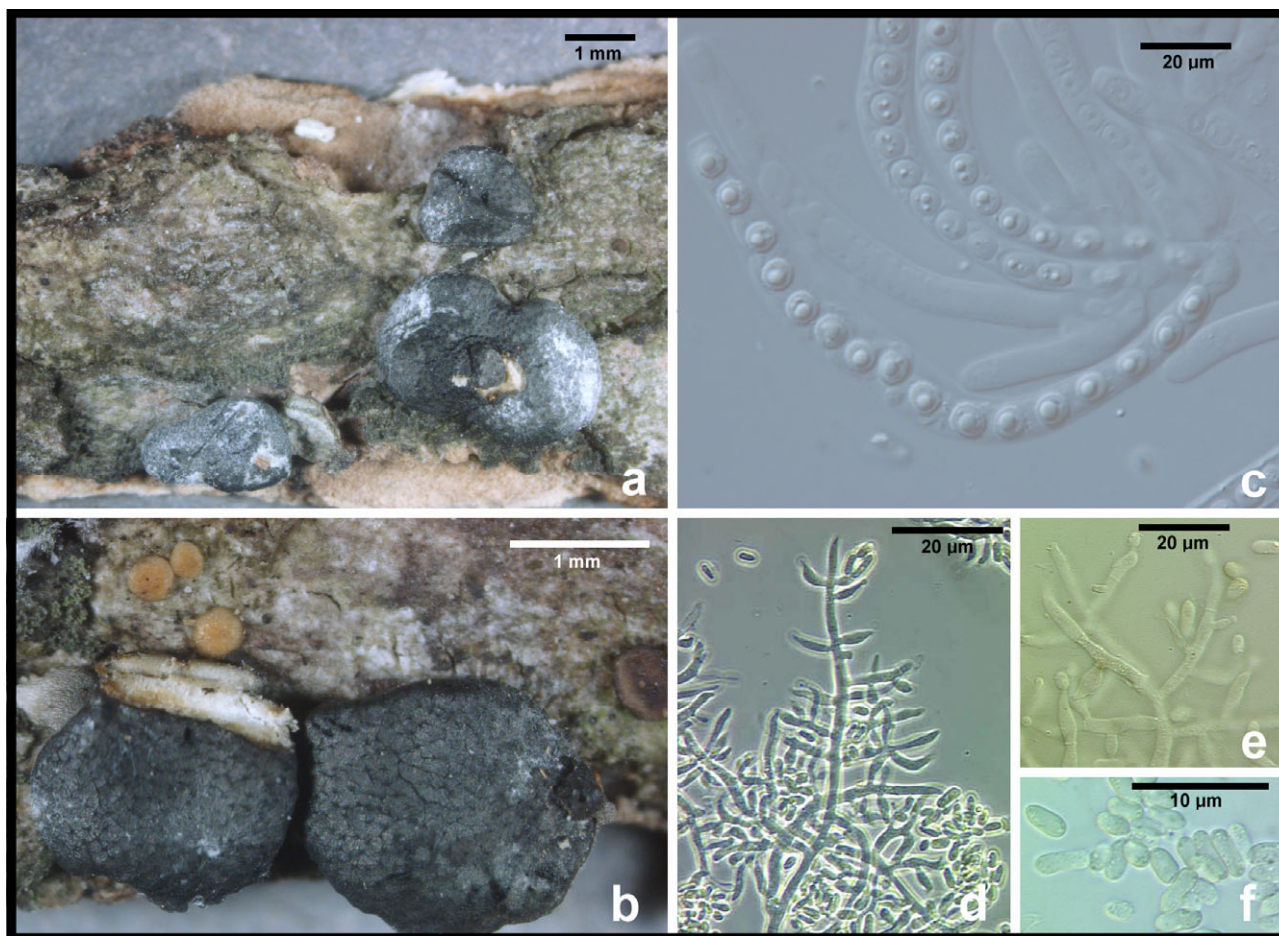
Habitat: On wood.

Known distribution: North America, Europe; relatively rare.

Description:

Stromata (a, b) solitary to gregarious, initially slightly effused, pale tan and velvety, gradually becoming darker red-brown, pulvinate, 0.5–1.5 mm diam, not changing colour in KOH; surface plane or somewhat tuberculate from perithecial mounds, initially velvety but becoming glabrous (short hyphal hairs on stroma surface seen in microscope); ostiolar openings not visible or at most barely visible, openings often signaled by presence of minute white balls of exuded ascospores, KOH–. Asci (c, d) cylindrical, (70–)85–105(–115) × (4.2–)6–8(–10) µm, apex slightly thickened and with a pore; ascospores uniseriate with slightly overlapping ends. Part-ascospores (c, d) hyaline, finely spinulose, dimorphic. Distal part-ascospores conical to subglobose, (3.7–)4.2–5.2(–6.8) × (3.5–)4.0–4.5(–5.2) µm; proximal part-ascospores wedge-shaped to conical, (4.0–)5.0–5.7(–7.7) × (3.0–)3.5–4.2(–5.0) µm. Conidiophores (e) irregularly branched. Phialides (d) often hooked or sinuous. Intercalary phialides common. Conidia (f) globose to subglobose, (3.6–)3.8–4.2(–4.5) × (3.2–)3.3–4.0(–4.3) µm, l/w (0.8–)1.0–1.2(–1.5), green, conspicuously warted.

Notes: Despite many reports in the literature, the anamorph and teleomorph of this species are rather uncommon and restricted in distribution to north temperate regions of North America and Europe. Most reports of *T. viride* refer to *T. asperellum* Samuels *et al.* or *Eidamia viridescens* Horne & Williamson (= *Trichoderma* with *Hypocrea* cf. *rufa* teleomorph).

Anamorph: *Trichoderma citrinoviride* Bissett

Habitat: On bark of dicotyledonous trees. The anamorph has been reported from a wide range of organic and inorganic substrata and humans whose immune systems have been suppressed.

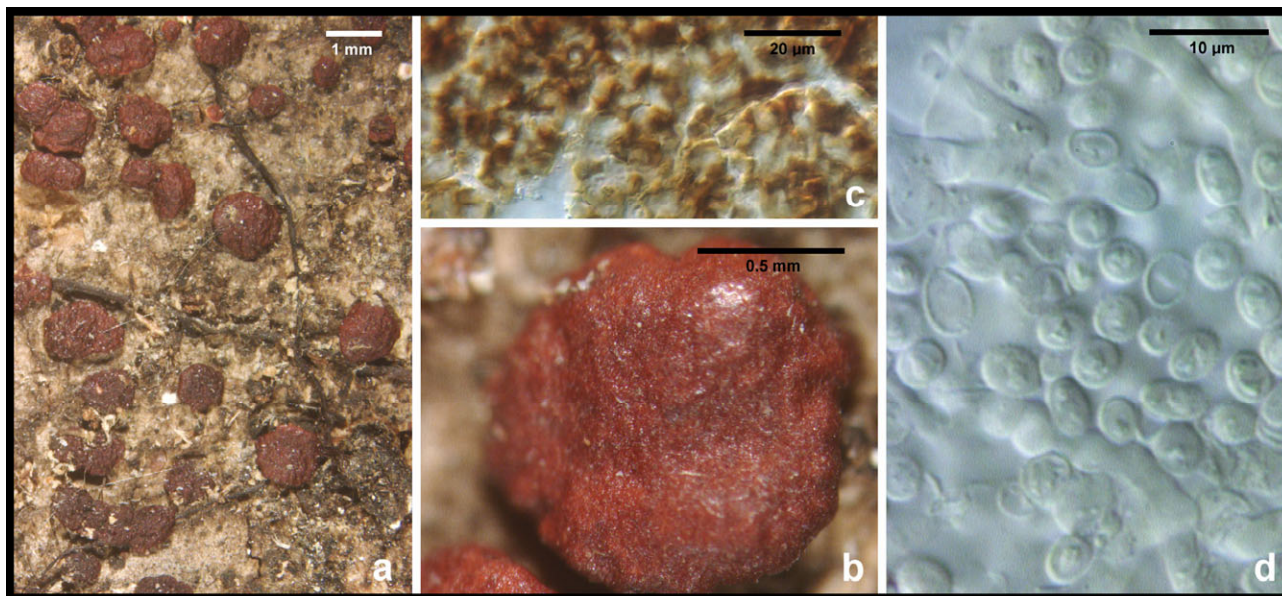
Known distribution: The teleomorph is known only from temperate to subtropical North America (NY, LA) and western Europe. The anamorph is cosmopolitan on a diversity of substrata; it is not a common soil fungus.

Description:

Stromata (a, b) solitary to densely gregarious and individual stromata overlapping each other, circular to irregular in outline, sometimes margin lobed, (0.5–)1.0–3.5(–11.7) mm diam, broadly attached but margins free; surface (b) plane to slightly wrinkled; ostiolar openings appearing as small cracks in stroma surface, very dark green to black. Asci (c) cylindrical, (34–)59–79(–101) × (3.0–)4.2–5.7(–9.2) µm. Part-ascospores (c) hyaline, spinulose, monomorphic, subglobose, (1.7–)2.7–4.2(–6.0) µm. Conidiophores (d, e) with a conspicuous main axis from which solitary phialides arise for a considerable distance or single phialides surmount a single cell, intercalary phialides common (e). Conidia (f) oblong to narrowly ellipsoidal, (2.5–)3.0–5.0(–10.7) × (1.5–)2.0–2.8(–4.2) µm, green, smooth.

Notes: *Hypocrea schweinitzii* is conspicuous for its monomorphic, subglobose part-ascospores and nearly black stromata. It is unusual in being able to grow and sporulate at 40° C. The anamorph is distinctive for having solitary phialides that are often accompanied by short, spur-like phialides known as ‘intercalary phialides.’

Anamorph: None known.



Habitat: On bark of *Acer rubrum*, associated with effete stroma of ?*Diatrype* sp.

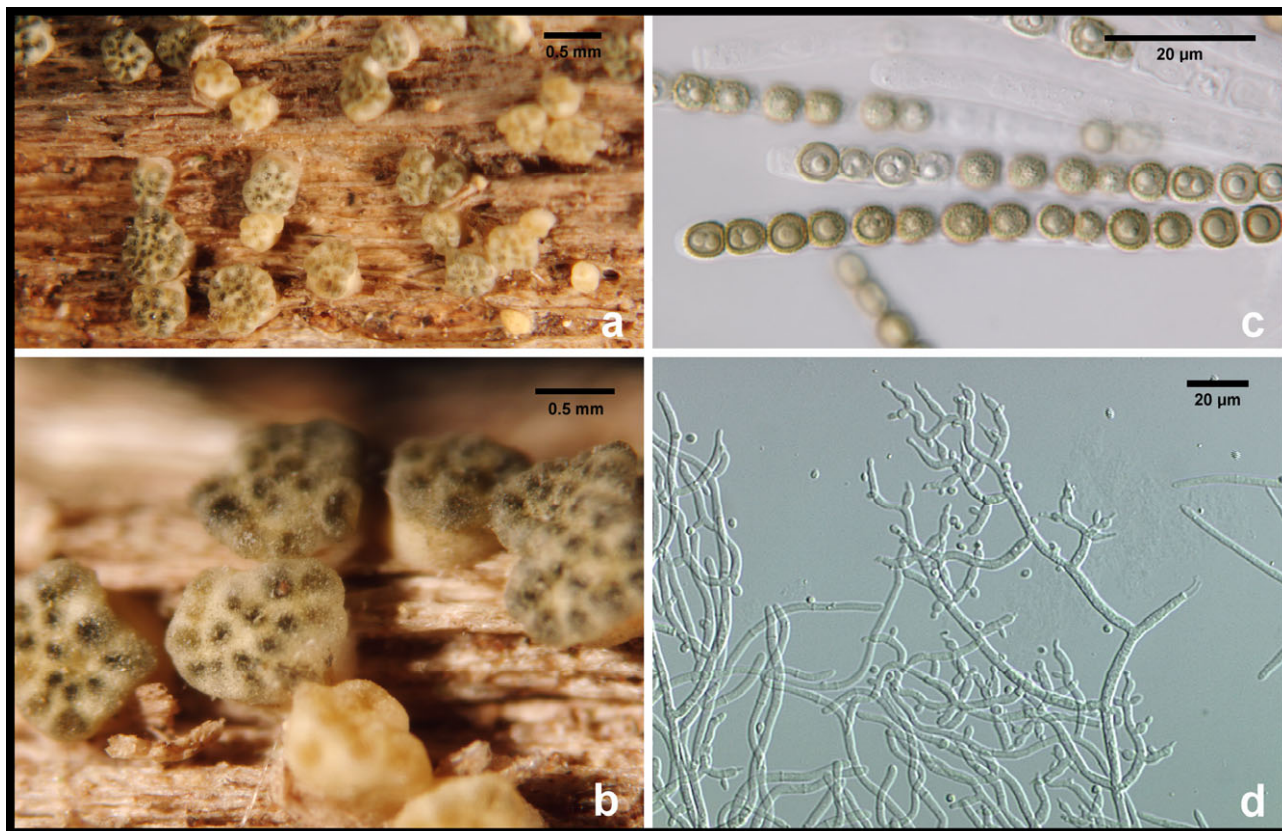
Known distribution: United States (SC).

Description:

Stromata (a, b) disciform to tuberculate, ca. 1 mm diam, gregarious, appearing to arise from the partly immersed stroma of the ?*Diatrype*, 1–1.5 mm diam, reddish-brown, KOH–; surface of stromata plane, perithecial elevations and ostiolar openings not evident in dry specimen. Cells at stroma (c) surface ± *textura epidermoidea* to angular, cells with thick, unevenly pigmented walls. Asci not observed. Discharged part-ascospores (d) hyaline, spinulose, thin-walled, not swollen, globose to subglobose or wedge-shaped to ellipsoidal, monomorphic. Globose to subglobose part-ascospores $(3.0\text{--})3.2\text{--}4.0 \times 3\text{--}4 \mu\text{m}$.

Notes: This species is known only from the original gathering. It is conspicuous for the red colouration and surface of the stromata that glistens, appearing to be lacquered. The thick-walled cells of the stroma surface are distinctive. This species was described in Ellis & Everhart, North American Pyrenomycetes p. 80. 1892. No collecting locality beyond ‘Carolina’ was provided but we presume that, like most of Ravenel’s collections, the type specimen was collected in the Aiken region of South Carolina.

Anamorph: *Trichoderma sinuosum* Chaverri & Samuels



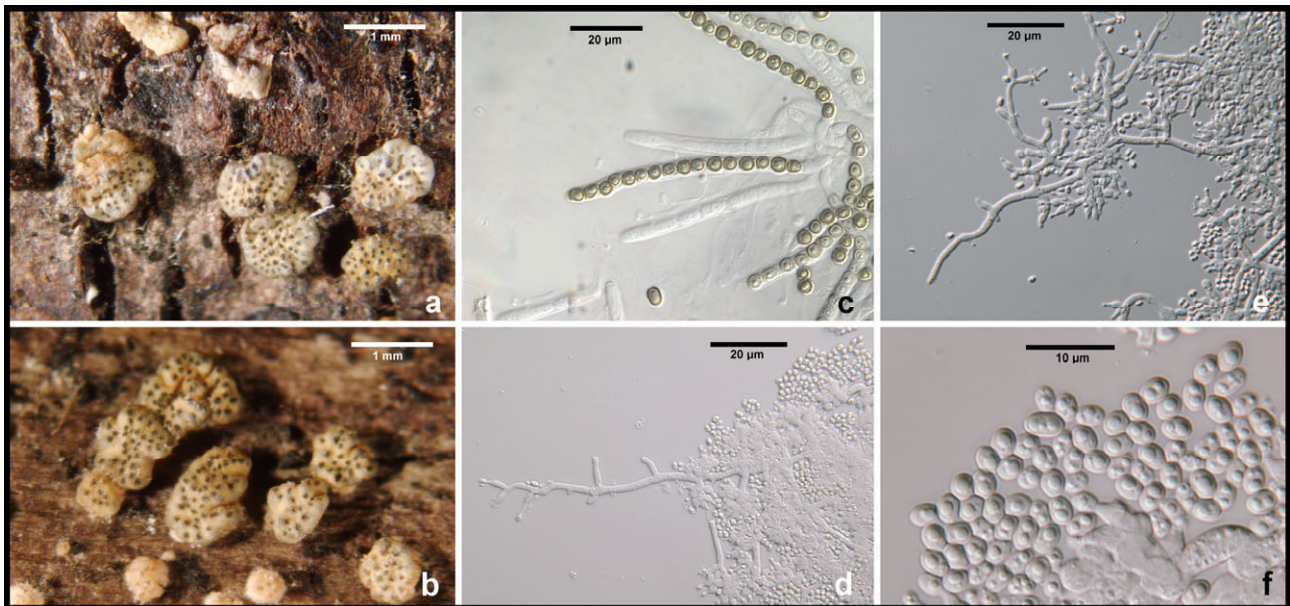
Habitat: On well-rotted, decorticated wood, sometimes on bark.

Known distribution: United States, Puerto Rico, France, Guyana (probably cosmopolitan).

Description:

Stromata (a, b) generally aggregated, sometimes solitary, pulvinate, circular in outline, 0.4–1.0 mm diam, 0.9–1.2 mm high, with a broad, subiculate base, adjacent stromata connected through their bases; stroma surface smooth, opaque to transparent, with slight perithecial protuberances, pale yellow to greyish yellow, generally not changing colour in KOH, but in some specimens the centre of stroma becoming pale brown; ostiolar openings obvious due to green ascospores, generally sunken. Asci (c) cylindrical, (75–)100–103(–128) × (4.5–)6.5–6.7(–9.5) µm, apex thickened, with a pore. Part-ascospores (c) green, warted, almost monomorphic. Distal part-ascospores globose to subglobose, 5.5–5.7 × 5.0–5.5 µm; proximal part-ascospores globose to subglobose, 5.5–5.7 × 4.7–5.0 µm. Conidiophores (d) lacking a defined central axis, sinuous, branching 2–3 times. Phialides ampulliform, somewhat hooked, 7.5–8.0 × 3.5–3.7 µm, l/w 2.0–2.2. Conidia green, smooth, subglobose, 4.5–4.7 × 3.5–3.7 µm, l/w 1.2–1.3, held in dry masses. Chlamydospores formed in some isolates, globose to subglobose, terminal or intercalary.

Anamorph: *Trichoderma strictipile* Bissett



Habitat: On ascomycetous and basidiomycetous fungi and wood.

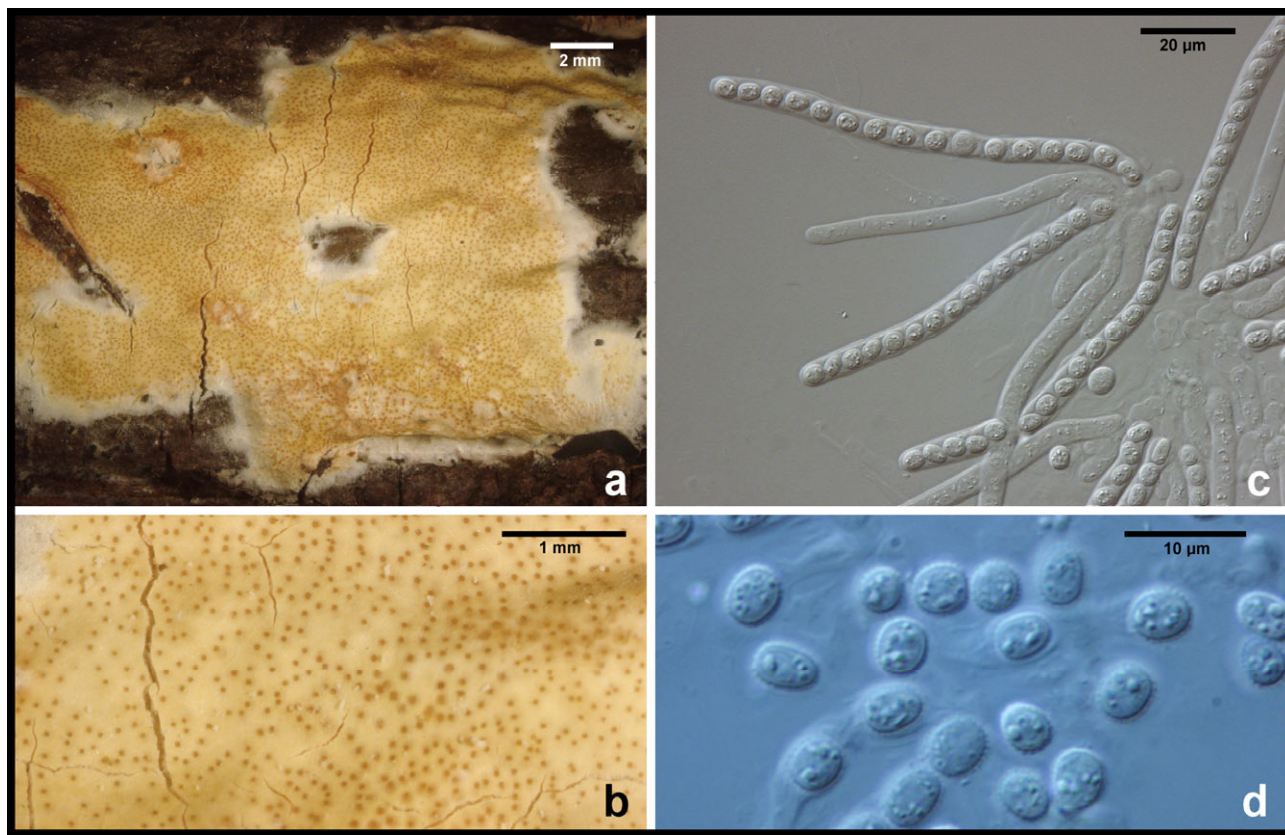
Known distribution: Eastern United States, Canada (Québec), northeastern Europe (Denmark, Estonia, France, Germany), Japan; probably a cosmopolitan temperate species.

Description:

Stromata (a, b) aggregated, in groups of 2–7, pulvinate, circular in outline, 0.5–2.0 mm diam, 0.5–1.0 mm high, broadly attached, surface smooth, with slight perithecial protuberances, yellowish white to pale brown, tissue of stroma KOH–; ostiolar openings conspicuous due to green ascospores. Asci (c) cylindrical, $(66\text{--}92\text{--}98\text{--}119) \times (3.5\text{--}5.7\text{--}6.0\text{--}10.2) \mu\text{m}$, apex thickened, with a pore. Part-ascospores (c) green, warted, dimorphic. Distal part-ascospores globose to subglobose, $5.2\text{--}5.5 \times 4.7\text{--}5.0 \mu\text{m}$; proximal part-ascospores generally wedge-shaped to subglobose, $5.7\text{--}6.2 \times 4.7\text{--}5.2 \mu\text{m}$. Conidiophores (d, e) typically consisting of a central axis with lateral branches arising singly or in pairs, longer branches arising near base. Conidiophore elongations long, branched or unbranched, straight or flexuous, sterile or fertile. Phialides ampulliform, $7.2\text{--}7.7 \times 4.0\text{--}4.2 \mu\text{m}$, l/w 1.8–2.0. Conidia (f) green, ellipsoidal, smooth, $4.5\text{--}4.7 \times 3.5\text{--}3.7 \mu\text{m}$, l/w 1.3.

Notes: This is one of the most common species of *Hypocrea*. It is frequently found on very wet, decorticated wood.

Anamorph: *Trichoderma* sect. *Hypocreanum* Bissett (acremonium/verticillium-like)



Habitat: Typically on decorticated wood and bark with *Exidia* spp., sometimes occurring on decorticated wood without visible evidence of *Exidia* spp.

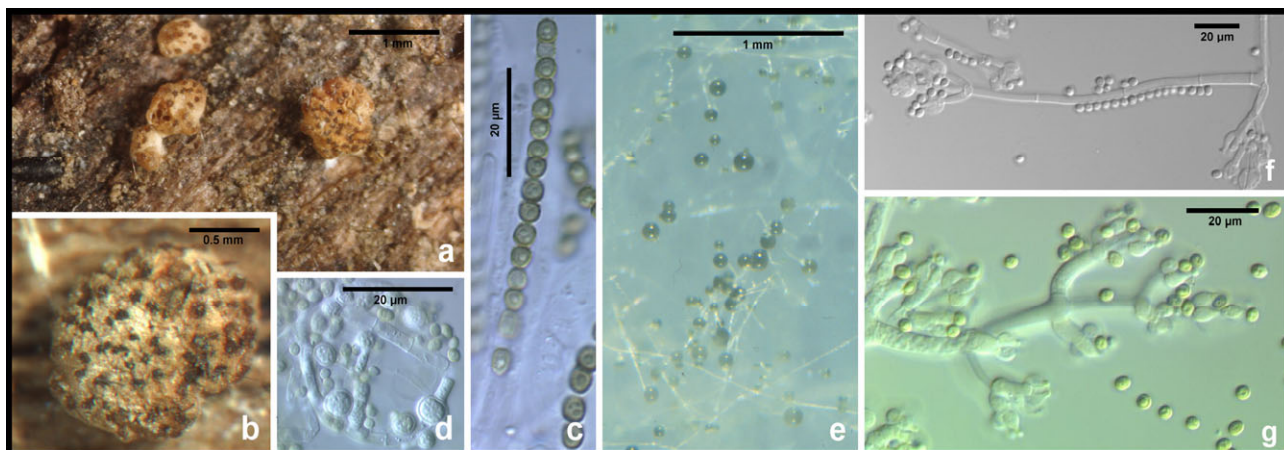
Known distribution: North America, Europe, Japan.

Description:

Stromata (a) effused, extensive, largest continuous stroma 70 × 30 mm, smallest continuous stroma 1 × 1 mm, many stromata not larger than 25 × 10 mm, anastomosing, varying in colour, sometimes vivid yellow, usually light yellow to greyish yellow, KOH+ or –, reaction variable, usually weak with stroma becoming light orange; ostiolar openings visible on stromal surface, appearing as light orange dots. Stroma surface (b) glabrous, smooth, plane, perithecial elevations not evident. Perithecia completely immersed, generally widely spaced, compact in some regions, sometimes completely absent near margins or regions of extensive stromal growth. Asci (c) cylindrical, (80–)94–116(–150) × (4.2–)5.2–7.0(–8.2) µm, tip slightly thickened. Part-ascospores (d) hyaline, thick walled, spinulose, dimorphic. Distal part-ascospores obovate, sometimes subglobose or broadly ellipsoidal, (4.2–)5.2–6.5(–7.5) × (4.2–)5.2–7.0(–8.2) µm; proximal part-ascospores, ellipsoidal, sometimes subcylindrical, (4.5–)5.5–7.0(–8.5) × (2.7–)4.0–5.0(–6.5) µm.

Notes: *Hypocrea sulphurea* is morphologically most similar to *H. citrina* because both form extensively effused, yellow stromata. *Hypocrea citrina* does not occur on bark and *H. sulphurea* typically grows on *Exidia* species such as *E. nucleata* on bark.

Anamorph: *Trichoderma virens* (Miller, Giddens & Foster) Arx



Habitat: The teleomorph has been found only once, on wet decorticated wood. The anamorph is a common soil fungus.

Known distribution: The teleomorph is only known from one collection in the United States (IN). The anamorph is cosmopolitan. The species has been found as an endophyte in trunks of *Theobroma gileri* in Ecuador.

Description:

Stromata (a, b) solitary and scattered, pulvinate, light yellow, KOH+, nearly circular in outline, (0.7–)0.8–1.0(–1.4) mm diam, (0.7–)0.8 mm high, with a wide base, surface smooth with slight perithecial protuberances, (13–)25–50(–80) perithecia per stroma, ostiolar openings visible due to green contents of centrum. Perithecia generally widely spaced. Asci (c) cylindrical, (85–)95–103(–114) × (5.0–)5.5–6.0(–6.5) µm, with a slightly thickened tip; part-ascospores uniseriate. Part-ascospores (c) dark green, spinulose, slightly dimorphic, globose to subglobose. Distal part (4.0–)5.0–5.5(–6.5) × (4.0–)5.0–5.5(–6.5) µm, proximal part sometimes slightly tapered (4.0–)5.0–5.5(–6.5) × (4.5–)5.0–5.5 µm. Anamorph (d–g) gliocladium-like, collarettes of phialides often pigmented green. Conidia (g) subglobose, (3.5–)4.5–4.7(–5.7) × (3.0–)3.8–4.0(–4.8) µm, smooth, green, rarely yellow, held in a drop of clear green liquid at tip of each conidiophore. Chlamydospores (d) abundant in cultures.

Notes: This species is included here because the apparent rarity of the teleomorph in the hope that it will be recollected. The anamorph, *T. virens*, is commonly used in biological control applications.

HYPOCREOPSIS P. Karst.

Hypocreaceae

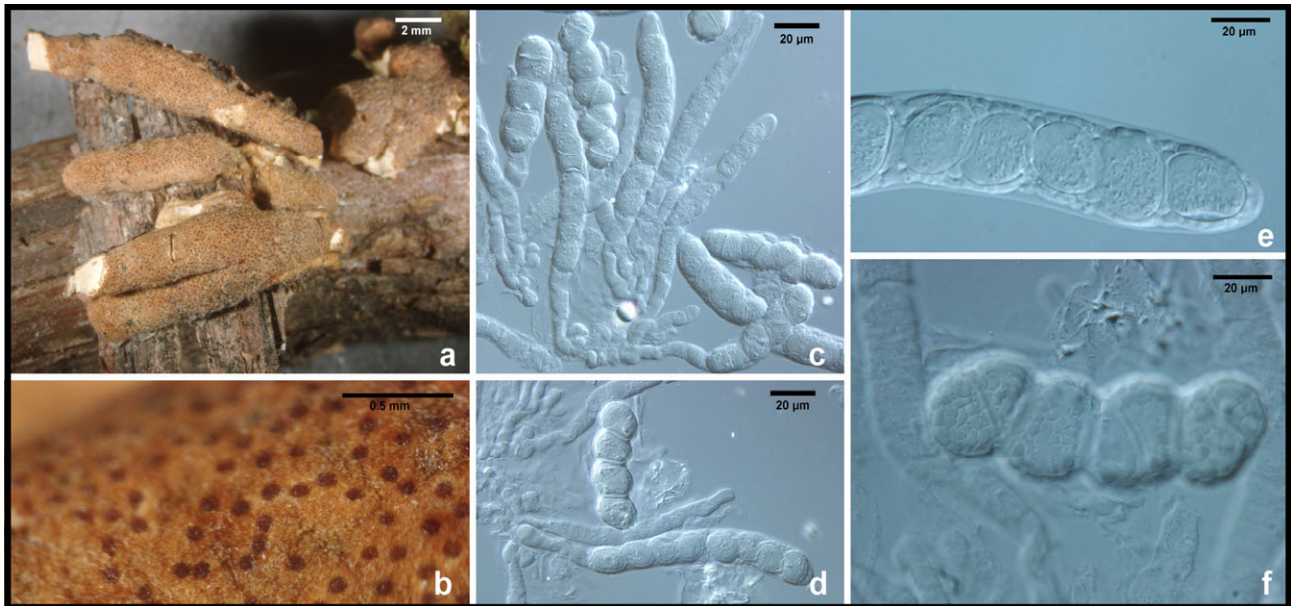
Perithecia immersed in a well-developed, radiately spreading, indefinite, often lobate, pseudoparenchymatous stroma; stromal surface reddish brown to grey, generally smooth in young lobes, becoming rugose, with minute, black ostioles of perithecia evident, occasionally covered with conidiophores of anamorph; stromal context soft, light-coloured. Perithecia globose, white to pale yellow, KOH–, thin-walled. Asci cylindrical, 8-spored. Ascospores ellipsoid to fusiform, 1-septate, rarely 3-septate, often agglutinated, hyaline, minutely to coarsely warted. Anamorph, where known, *Stromatocrea*. On decaying woody substrata, often on *Hymenochaete* spp. and other resupinate basidiomycetes.

Literature:

Candoussau, R. (1990). *Hypocreopsis rhododendri* in southern France. *Mycologist* **4**: 170–171.
Candy, B. & Webster, J. (1988). *Hypocreopsis rhododendri*, a rare conspicuous fungus. *Mycologist* **2**: 18–21.

May, T. & Eichler, J. (1993). A *Hypocreopsis* (Fungi) from Nyora, Victoria. *Victorian Naturalist* **110**: 76–77.

Anamorph: None known.



Habitat: On *Hymenochaete* on *Kalmia* and *Rhododendron*.

Known distribution: Rare, originally described from United States (TN), also in United States (MD to NC, WV), England, and southern France.

Description:

Stromata (a, b) developing as radiating ridges, up to 10 cm diam, 1–5 mm thick, divided into separate lobes forming finger-like projections, encircling substratum, brown to greyish, paler at margins, with pale tan, soft to corky context, surface (b) slightly furfuraceous, smooth on young lobes, becoming rugose in central areas. Perithecia immersed, ostioles visible as black dots (b). Perithecia 180–250 µm diam, globose. Asci (c–e) cylindrical, 80–100 × 7–11 µm, with round, simple apex, 8-spored. Ascospores (c–f) globose, 12–17 × 12–13.5 µm, unicellular, most becoming bicellular by development of a transverse septum, often with several spores cemented together, thick-walled, irregularly coarsely warted (f).

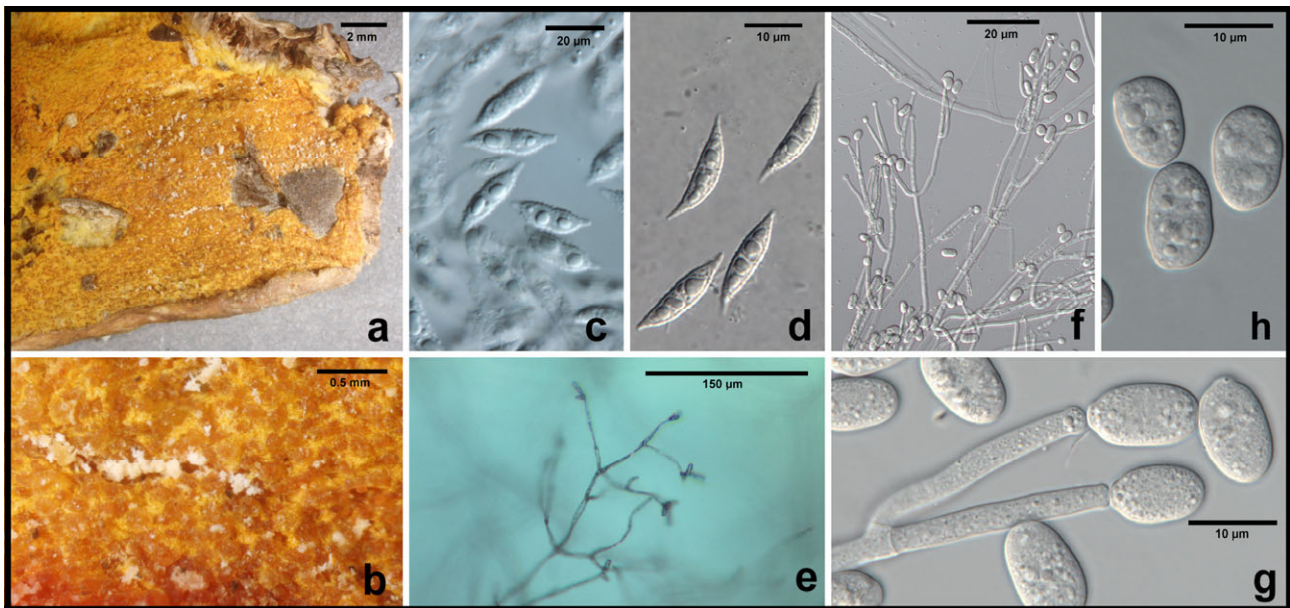
Notes: This species is macroscopically identical to *H. lichenoides* except for the ascospores which are larger, 22–30 × 7–9.5 µm, in *H. lichenoides*. The anamorph of *H. lichenoides* is *Stromatocrea cerebriformis* W.B. Cooke.

Subiculum of loosely intertwined or compacted hyphae, sometimes forming thin, separable sheets upon which perithecia are seated, or a firm stroma-like tissue within which perithecia are completely immersed, light- to bright-coloured, reacting or not to KOH. Perithecia solitary to densely gregarious or caespitose, superficial on or immersed in subiculum to a greater or lesser extent, pyriform, papillate. Perithecial wall smooth, generally less than 25 µm thick, nearly hyaline or in shades of yellow, orange, tan or green; part or all of each ascoma becoming red or purple in KOH or not reacting to KOH. Asci cylindrical, apex thickened to a greater or lesser extent, with a pore, 8-spored. Ascospores ellipsoid, lanceolate with rounded ends, or fusiform with a blunt or acute apiculus at each end; apiculus obscure to conspicuous, unicellular, or 1-septate with a median or submedian septum, rarely 3-septate, hyaline, smooth, spinulose to tuberculate.

Anamorphs: acremonium-like, *Cladobotryum*, *Mycogone*, papulospora-like, *Sepedonium*, *Stephanoma*, or verticillium-like.

Literature:

- Põldmaa, K. & Samuels, G.J. (1999). Aphyllophoricolous species of *Hypomyces* with KOH-negative perithecia. *Mycologia* **91**: 177–199.
- Põldmaa, K. (2003). Three species of *Hypomyces* growing on basidiomata of *Stereaceae*. *Mycologia* **95**: 921–933.
- Põldmaa, K., Farr, D.F., & McCray, E.B. (2005) *Hypomyces* Online. Systematic Botany & Mycology Laboratory, ARS, USDA. <http://nt.ars-grin.gov/taxadescriptions/keys/HypomycesIndex.cfm>
- Põldmaa, K. & Samuels, G.J. (2004). Fungicolous *Hypocreaceae* (*Ascomycota*: *Hypocreales*) from Khao Yai National Park, Thailand. *Sydowia* **56**: 79–130.
- Rogerson, C. & Samuels, G.J. (1985). Species of *Hypomyces* and *Nectria* occurring on Ascomycetes. *Mycologia* **77**: 763–783.
- Rogerson, C.T. & Samuels, G.J. (1989). The boleticolous species of *Hypomyces*. *Mycologia* **81**: 413–432.
- Rogerson, C.T. & Samuels, G.J. (1993). Polyporicolous species of *Hypomyces*. *Mycologia* **85**: 231–272.
- Rogerson, C.T. & Samuels, G.J. (1994). Agaricolous species of *Hypomyces*. *Mycologia* **86**: 839–866.
- Sahr, T., Ammer, H., Besl, H. & Fischer, M. (1999). Infrageneric classification of the boleticolous genus *Sepedonium*: species delimitation and phylogenetic relationships. *Mycologia* **91**: 935–943

Anamorph: *Cladobotryum varium* Nees

Habitat: Growing on basidiomes, wood, bark, or occasionally on litter, mosses or ground, next to decayed fungi. Hosts belonging to Agaricales, mostly wood-decaying species, *Aphylllophorales* or rarely heterobasidiomycetes. Covering hymenophore or hymenophore and pileus of host; host basidiomata becoming decayed or with no apparent change.

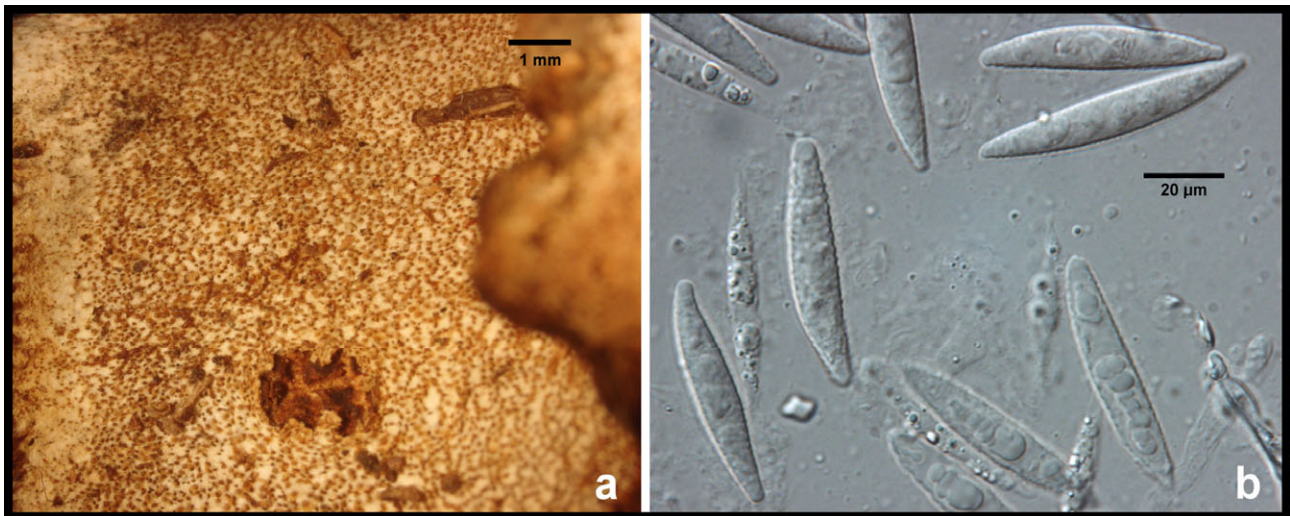
Known distribution: Common in northern and southern temperate regions but rare in tropical regions.

Description:

Subiculum (a, b) profuse, floccose and effuse, often covering entire host, varying from almost white to orange, KOH+ purple. Perithecia gregarious or caespitose, semi-immersed in subiculum, (250–) 350–570 × 200–375 µm, papillate, orange, KOH+ purple (b, below). Asci 100–160 × 6–7 µm. Ascospores (c, d) fusiform, 20–25 × 4–6 µm, with median septum, verrucose walls, apiculi 2–4.5 µm long. Anamorph (e–h) forming a profuse powdery pure white cottony mat. Conidiophores (e, f) branching irregular to verticillate. Conidiogenous cells in verticals of 2–5(–7), forming 1 conidiogenous locus (g) that forms up to 50 conidia held in end-to-end chains. Conidia (g, h) ellipsoidal to cylindrical or obovoid, (10–)12–17(–25) × (5–)6–8(–10) µm, hyaline, 1-(rarely 2–3) septate. Chlamydospores terminal, lateral or intercalary on aerial or submerged hyphae, yellow or pale brown.

Notes: *Hypomyces aurantius* is indistinguishable from *H. subiculosus* in its colouration of subiculum and perithecia. In *H. subiculosus* the KOH+ purple reaction occurs only at the base of the papilla. Also, the ascospores of *H. subiculosus* are 12–18 × 3.5–6 µm, with wall prominently warted and apiculi <2 µm long.

Anamorph: None known.



Habitat: On basidiomes of *Lactarius* spp. Covering hymenophore of host, turning basidiomata firm.

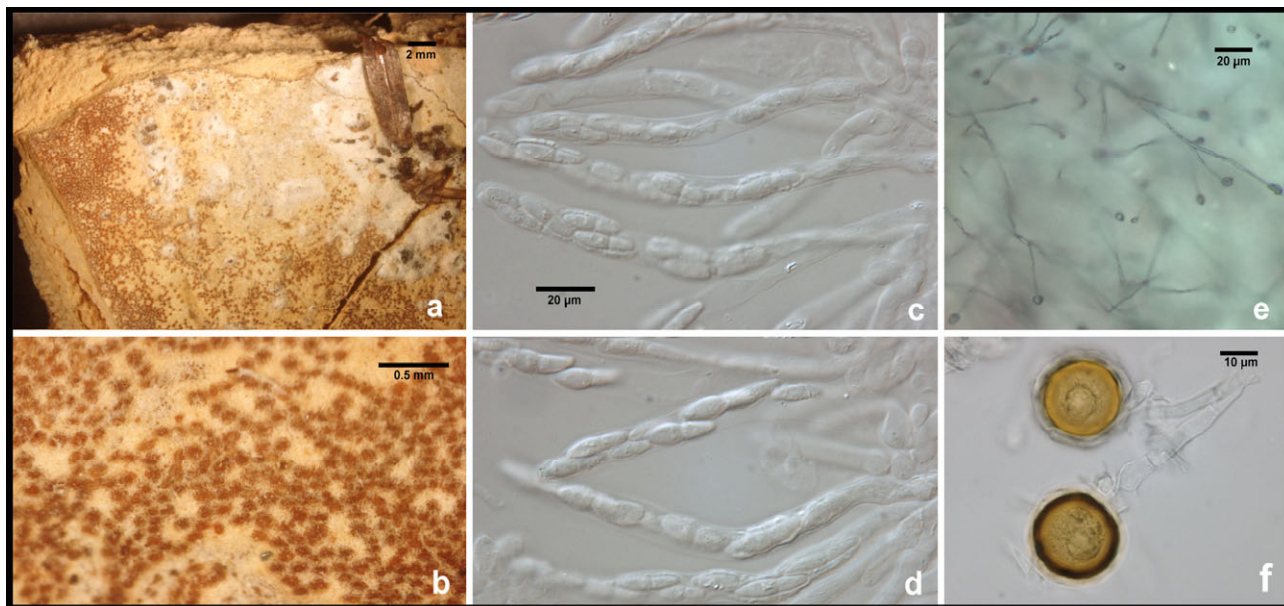
Known distribution: Eastern United States (MA, MD, NC, NJ, NY, PA, SC, VA); uncommon.

Description:

Subiculum (a) profuse, covering entire hymenophore with perithecia, white or buff, KOH–. Perithecia (b) formed on hymenophore of host, caespitose, immersed in subiculum except papilla, 350–500 × 300–350 µm, buff or yellow, KOH–, with papilla 100–150 µm high. Asci 220–320 × 6–9 µm. Ascospores (b) fusiform, (30–)34–41(–43) × (4.5–)5–6.5 (–7.5) µm, aseptate, wall finely verrucose, when young ornamentation barely visible, apiculi 1.5–2.5(–3) µm long or ends bluntly thickened.

Notes: *Hypomyces banningiae* is reminiscent of *H. macrosporus* in the colour of its subicular layer and the large ascospores. Ascospores of the latter species, however, are 1-septate and clearly apiculate.

Anamorph: *Sepedonium* sp.



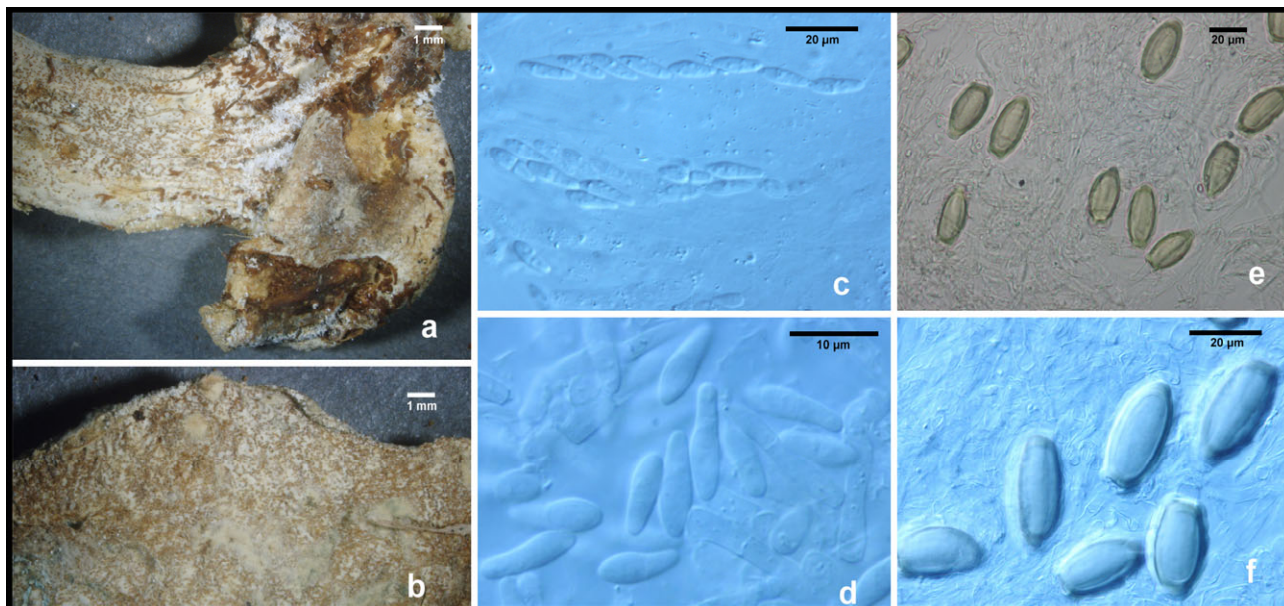
Habitat: On Boletales: *Austroboletus gracilis*, *Gyroporus castaneus*, *Pulveroboletus ravenelii*, *Strobilomyces floccopus*. Covering hymenophore or hymenophore, pileus and upper part of stipe of host.

Known distribution: United States (NC, PA, TN, WV) and Costa Rica, Java, New Zealand; uncommon.

Description:

Subiculum (a, b) at first white, becoming buff or brown. Perithecia caespitose, first immersed in subiculum except for papilla, at maturity densely aggregated with no evidence of subiculum; $210\text{--}280 \times 170\text{--}220 \mu\text{m}$, papillate; orange-red to red-brown, KOH+ yellow or red. Asci (c) $70\text{--}90 \times 4\text{--}5 \mu\text{m}$. Ascospores (c, d) fusiform to naviculate, $(8\text{--})10\text{--}13\text{--}(14) \times (2\text{--})2.5\text{--}4\text{--}(4.5) \mu\text{m}$, l/w 3–4.5, with median or submedian septum, smooth or sometimes finely verrucose wall, and non-apiculate ends. Anamorph forming a buff to pale brown layer, mostly on tube layer of host. Conidiophores (e) irregularly or verticillately branched. Conidiogenous cells in verticils of 1–3, $35\text{--}70\text{--}(90) \mu\text{m}$ long, $1.5\text{--}2.5\text{--}(3.5) \mu\text{m}$ wide at base, forming 1 conidiogenous locus that forms up to 20 conidia held in liquid. Conidia cylindrical, ellipsoidal or clavate, of irregular shape and size, equilateral or inequilateral, with base truncate or rounded, basal hilum absent, $(6\text{--})7.5\text{--}15\text{--}(19) \times (1.5\text{--})2\text{--}4.5\text{--}(6) \mu\text{m}$, aseptate. Aleurioconidia (f) formed singly in terminal position on very short lateral branches of hyphae; hyaline, oblong to ellipsoidal when young, later turning yellow and subglobose to globose, $25\text{--}30 \mu\text{m}$ diam, with ridged wall.

Anamorph: *Sepedonium chlorinum* (Tul. & C. Tul.) Damon



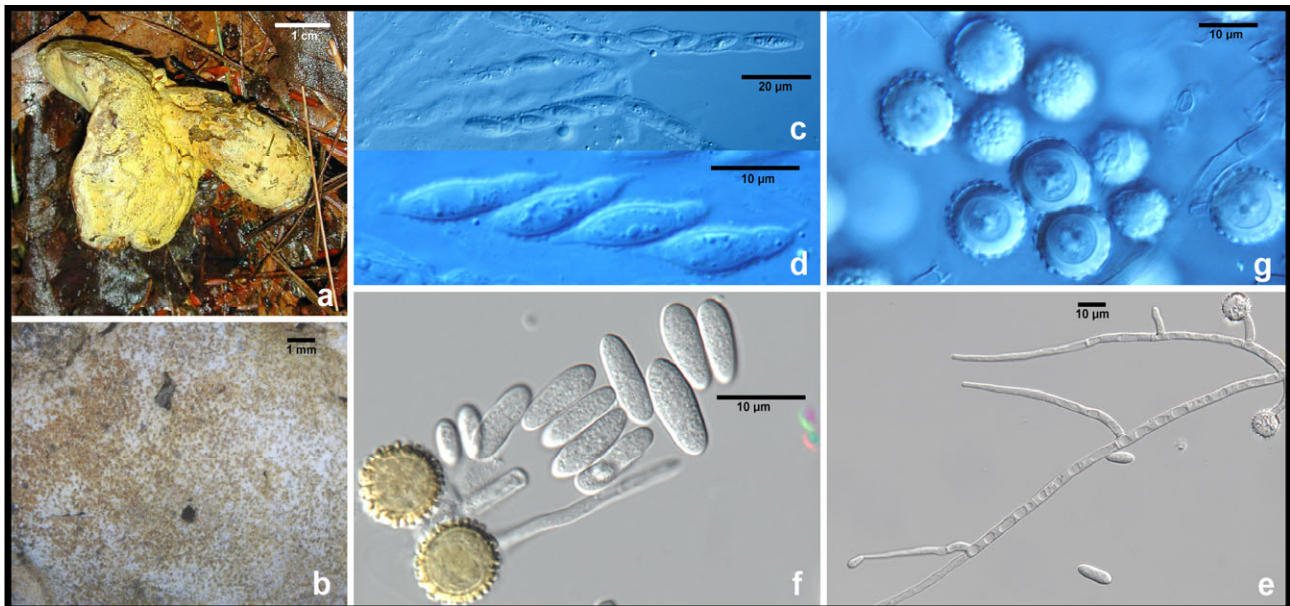
Habitat: On basidiomes of *Boletales*. Covering hymenophore, pileus, and stipe of host, causing decay.

Known distribution: United States (FL, GA, IL, LA, MD), Central and South America, Europe, Caucasus, Siberia, Asia, Malaysia and New Zealand; common.

Description:

Subiculum (a, b) white, buff, brown or pale yellow, KOH–. Perithecia scattered to caespitose, immersed in subiculum except papilla, 190–280 × 150–250 µm, papillate, amber, buff to brown, KOH–. Asci (c) 70–90 × 3–5 µm; with apex slightly thickened, no pore observed. Ascospores (c, d) naviculate, (7–)8–2(–12.5) × 2–4 µm, l/w 2.3–4.4, with median or submedian septum, finely verrucose or smooth walls, non-apiculate ends. Anamorph forming a cottony mat, at first white, turning yellow when chlamydospores formed, covering hymenophore of host, often spreading over basidiome causing total decay. Conidiophores unbranched or branching irregular. Conidiogenous cells in verticils of 2–4(–6), 30–70 µm long, 2.5–3.5 µm wide at base, forming 1 conidiogenous locus with up to 50 conidia held in liquid. Conidia cylindrical, ellipsoidal or obovoid, without basal hilum, (5–) 8–13(–16) × 2.5–6 µm, aseptate or rarely 1-septate. Aleurioconidia (e, f) formed singly in terminal position on lateral branches of aerial hyphae, yellow, oblong to ellipsoidal, (25–)35–45(–50) × (10–) 15–18 µm, with 2.5–5 µm thick, ridged walls.

Anamorph: *Sepedonium chrysospermum* (Bull.) Fr.



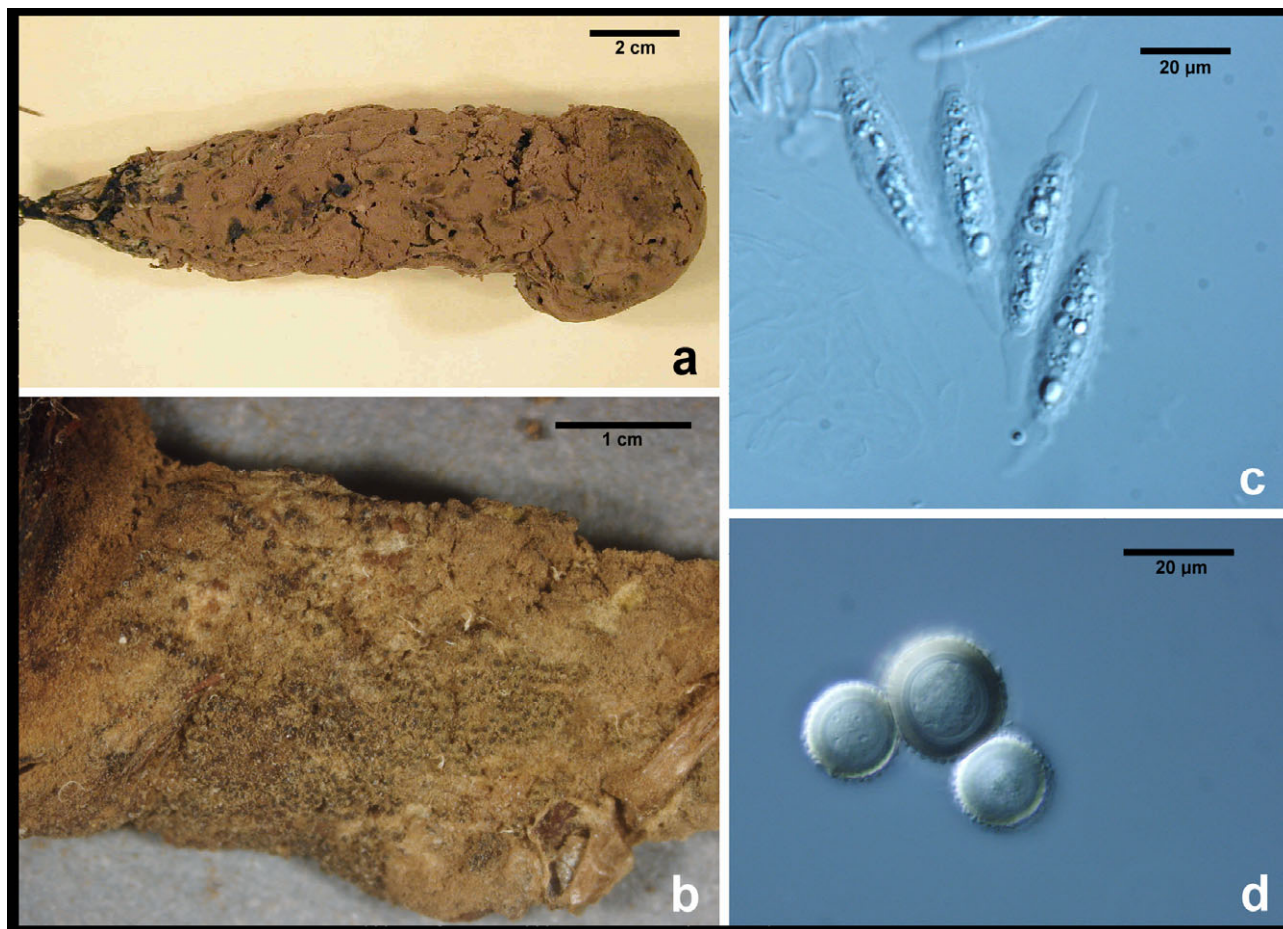
Habitat: On fruitbodies of *Boletales*. Covering hymenophore or hymenophore, pileus and part of the stipe of host, causing decay.

Known distribution: Probably cosmopolitan; anamorph common and very abundant, teleomorph uncommon.

Description:

Subiculum profuse, first white, turning yellow (a, b) or ferrugineous in age, KOH–. Perithecia (b) formed all over subiculum, caespitose, immersed in subiculum except papilla, $300\text{--}450 \times 200\text{--}320\ \mu\text{m}$, yellow, orange-yellow, brick-red, red- or rufous brown, KOH–, or in some collections with reddish perithecia, basal part of perithecial papillum turning purple. Asci (c) $110\text{--}150 \times 6.5\text{--}9\ \mu\text{m}$. Ascospores (d) naviculate, $(13\text{--})15\text{--}20(\text{--}25) \times 4\text{--}6\ \mu\text{m}$, with submedian septum; verrucose, with verrucae arranged uniformly or occasionally in rows, resulting in a ridged appearance; apiculi $1\text{--}2(\text{--}3)\ \mu\text{m}$ long at upper end, $0.5\text{--}1.5(\text{--}2)\ \mu\text{m}$ long at lower end. Anamorph forming a cottony mat, first white, turning yellow when chlamydospores formed, covering hymenophore of host, usually spreading over whole basidiome of host finally causing its total decay. Conidiophores (e) branched verticillately or irregularly. Conidiogenous cells 2–4 in a verticil, forming one conidiogenous locus with up to 50 conidia held in liquid. Conidia (f) cylindrical to ellipsoidal, equilateral, without basal hilum, $7\text{--}20(\text{--}25) \times 3\text{--}10\ \mu\text{m}$, aseptate. Aleurioconidia (e–g) formed singly in terminal position on lateral branches on conidiophores, yellow, subglobose to globose, $(10\text{--})12\text{--}21(\text{--}25)\ \mu\text{m}$ diam, 2–3 μm thick, warted walls.

Anamorph: *Sepedonium brunneum* Peck



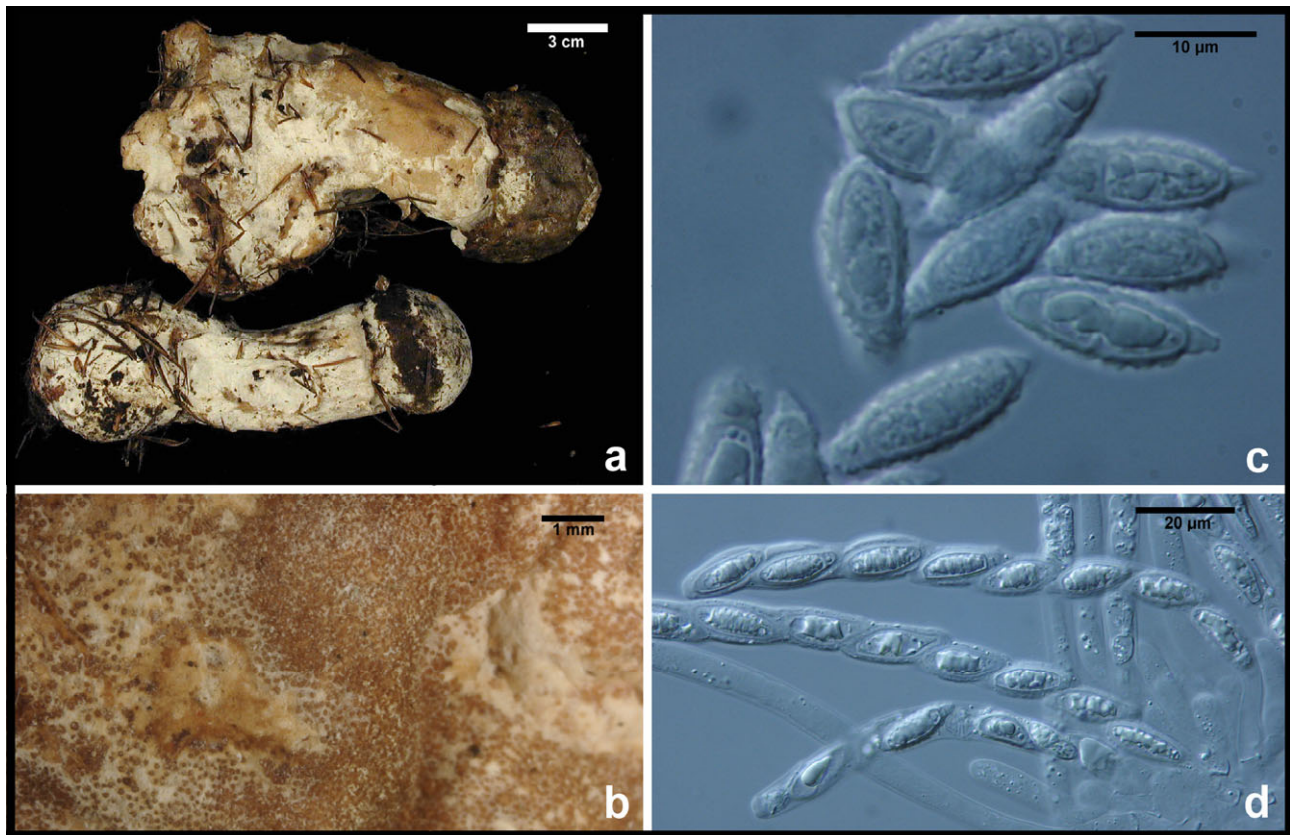
Habitat: On fruitbodies of *Boletales*, primarily *Suillus spraguei* (= *S. pictus*), type on *Boletinus* (*Suillus*) *oxydabilis*. Covering hymenophore or hymenophore, pileus and stipe of host; basidiomata decayed.

Known distribution: United States (ME, MI, NC, NY, PA, TN, VT) and Siberia; anamorph common in some areas, teleomorph uncommon.

Description:

Subiculum (a, b) scanty, brown to yellowish or olivaceous brown, KOH–. Perithecia (b) caespitose, immersed except papilla to semi-immersed in subiculum, (350–)500–550(–650) × (300–)350–375(–385) µm, papillate, pale to dark brown to black, turning yellow or fading to pale olivaceous to pale yellow-brown in KOH. Asci 180–210 × 5–7 µm. Ascospores (c) fusiform, 25–35(–40) × (5–)6–8(–9) µm, l/w 3.5–5.5, aseptate, with verrucose walls, apiculi (3–)4–6(–7) µm long. Anamorph forming a white cottony mat, turning cocoa-brown (a) when aleurioconidia produced; spreading over whole fruitbody of host. Conidiogenous cells in verticals, 45–150 µm long, 3–4 µm wide at base, producing one conidiogenous locus with up to 50 conidia held in heads or drops of liquid. Conidia cylindrical or ellipsoidal, equilateral, of variable size, with basal hilum absent or with small central hilum, 15–22(–28) × 5.5–7(–9.5) µm, aseptate. Aleurioconidia (d) formed singly in terminal position on lateral branches on conidiophores or on submerged hyphae, yellowish to chocolate brown, subglobose to globose, 17–23 µm diam, with finely warted walls.

Anamorph: None known.



Habitat: On fruitbodies of various species of *Amanita*. Covering hymenophore, pileus and stipe of host, basidiomata becoming firm.

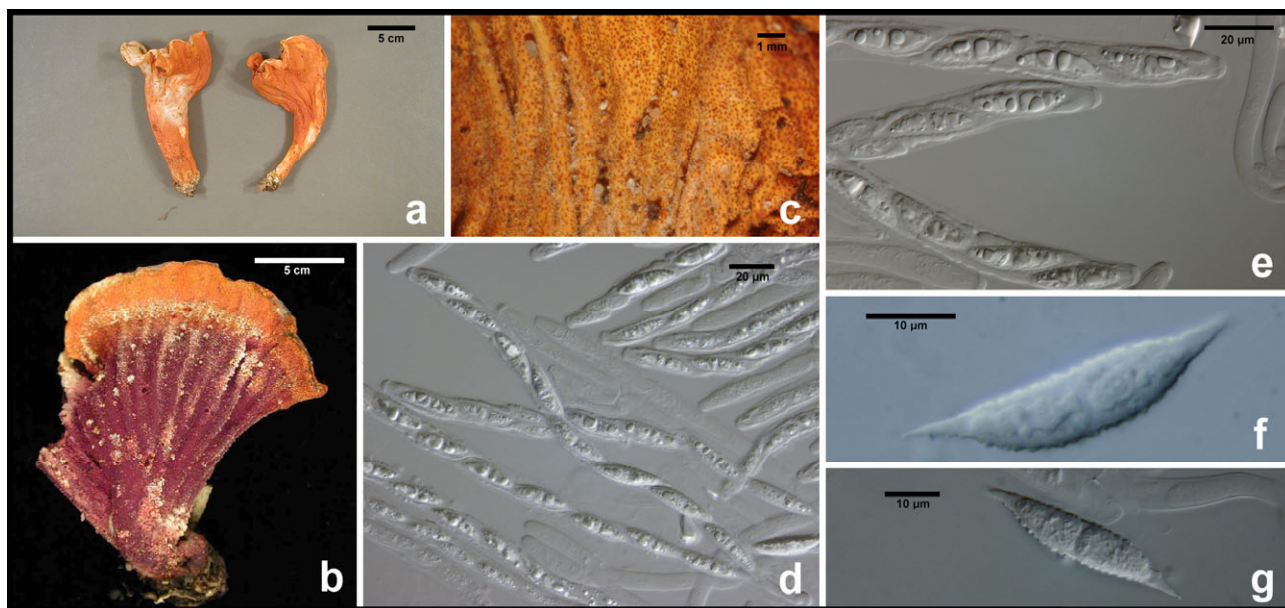
Known distribution: United States (ID, MD, MO, NC, TN, VA, WA), eastern Canada, China, eastern Asia; common in North America.

Description:

Subiculum (a, b) profuse, white or buff, or tinged pink, yellow or brown, KOH–. Perithecia (b) formed all over subiculum, caespitose, gregarious or scattered, immersed in subiculum except papilla, 250–325 × 180–210 µm, papillate, buff or pale orange or pale brown, KOH–. Asci (d) 110–130 × 4–6 µm. Ascospores (c) fusiform or naviculate, 15–20 × 4.5–6.5 µm, with submedian septum, verrucose walls, apiculi 1–2.5 µm long. Often associated with white mycelium covering mummified host, usually where perithecia not yet formed, embedding mycogone-like, thick-walled cells, held singly or in pairs.

Notes: Colonization of hosts by *H. hyalinus* leads to their total destruction. Destroyed fruiting bodies cannot be identified although molecular sequence data have allowed the identification of tissue inside aborted basidiocarps. A mycogone-like anamorph has been observed in some collections but the connection of this or any other anamorph with *H. hyalinus* remains unproven.

Anamorph: None known.



Habitat: On fruitbodies of *Lactarius* spp., *Russula* spp. and unidentified agarics; basidiocarps turning firm.

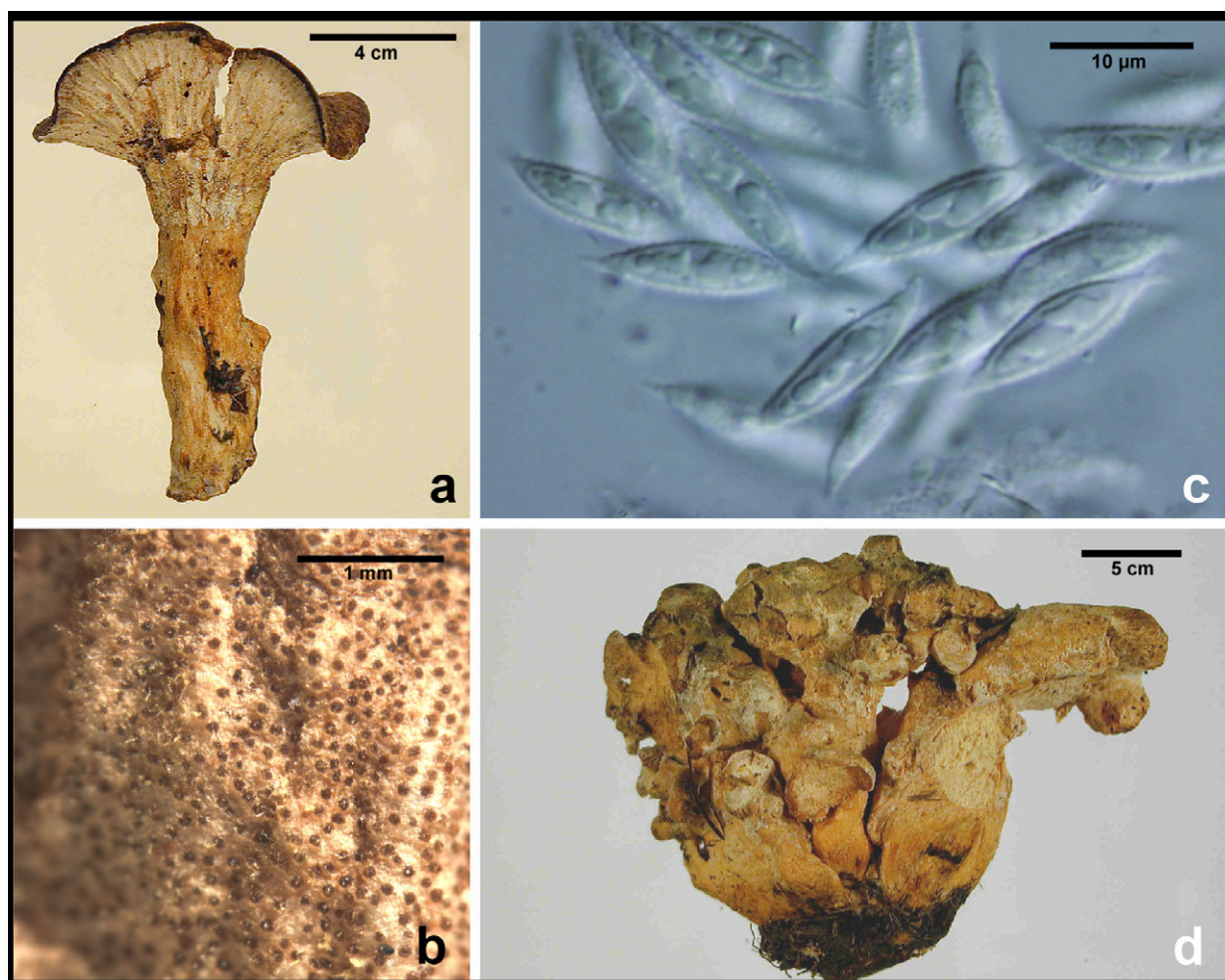
Known distribution: North and Central America; common.

Description:

Subiculum (a–c) covering pileus, deforming hymenophore and stipe, profuse, pale to deep orange or yellowish or reddish orange, red to purple when old, KOH+ purple. Perithecia (c) formed all over subiculum on hymenophore and stipe, sometimes also in small patches on pileus, caespitose, immersed in subiculum except papilla, 400–600 × 250–450 µm, deep orange, lobster to brownish cherry red, KOH+ purple, KOH reaction in perithecial wall usually much weaker than in papilla or sometimes lacking. Asci (d, e) 200–260 × 6–10 µm. Ascospores (d–g) fusiform, with one side sometimes flattened, 35–45 × 5–8 µm, with median septum, verrucose walls, apiculi 4.5–7.5 µm long.

Notes: The species is known under the name ‘lobster mushroom.’ Mushrooms infected with *H. lactifluorum* are edible. It appears in succeeding years in the same place suggesting that the mycelium of the host has been infected. *Hypomyces lactifluorum* is the type species of *Hypomyces*.

Anamorph: *Acremonium tulasnei* G. Arnold



Habitat: On fruitbodies of *Lactarius*. Covering hymenophore; basidiocarps turning firm.

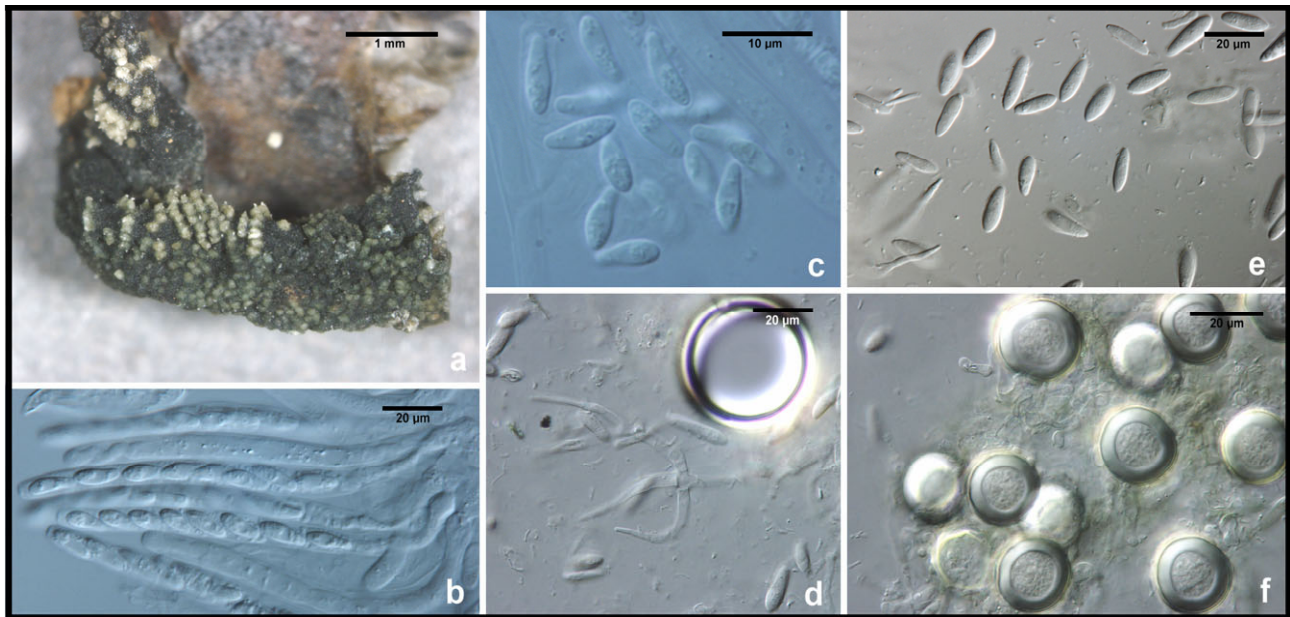
Known distribution: World-wide wherever *Lactarius* occurs, reported from all major regions of the United States, including Alaska; common.

Description:

Subiculum (a, b) white to lemon yellow, becoming buff or ochraceous, KOH–. Perithecia (b) formed all over subiculum on hymenophore of host, caespitose, immersed in subiculum except papilla, 300–470 × 170–360 μm, papillate, dark amber, buff to brown, KOH+ yellow. Asci 90–150 × 4–8 μm. Ascospores (c) fusiform, (15–)21–27(–30) × (3–)4–5.5(–6) μm, aseptate, with finely verrucose walls, apiculi 1.5–3(–4) μm long. Anamorph on mummified basidiomata of host (d) before perithecia develop, appearing as a white cottony mycelium, filling space between lamellae and cavities inside fruitbody of host. Conidiophores unbranched or with verticillate or irregular branching. Conidiogenous cells solitary or in verticils of 2–4(–6), forming conidiogenous locus with up to 6 conidia. Conidia subglobose, equilateral, (4.5–)5–6.5(–7.5) × 4.5–6(–7) μm, aseptate. Chlamydospores absent.

Notes: The ascospores of *H. lateritius* have never been observed to germinate and thus there is no proven anamorph for the species. The described anamorph has been found in association with perithecia in several collections. A similar species, *H. lithuanicus*, known earlier as *H. torminosus* (Durieu & Mont.) Tul., differs in darker, cinnamon subiculum, perithecial papilla that turn reddish in KOH and smaller ascospores.

Anamorph: *Sepedonium leotiarum* (Fayod) Rogerson & Samuels



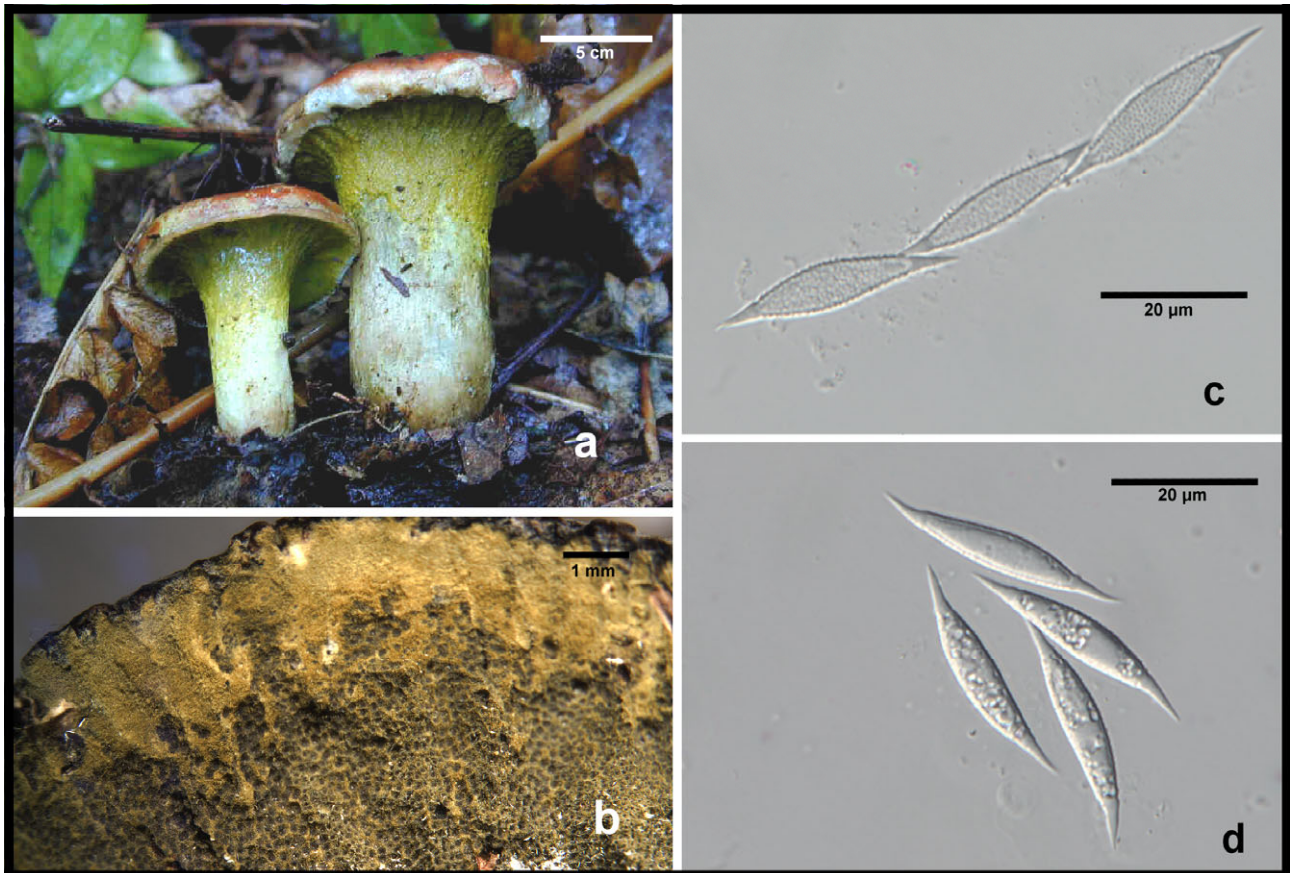
Habitat: On ascocarps of *Leotia lubrica* Fr.

Known distribution: Eastern United States, Switzerland.

Description:

Subiculum not observed. Perithecia (a) forming a continuous layer on host, caespitose, (185–)225–250 × (125–)150–180 µm, whitish to pale buff at first, becoming bluish green at maturity, KOH–, non-papillate or with a short papilla. Asci (b) 60–100 × 4–6 µm. Ascospores (c) naviculate to ellipsoidal (6–)7.5–9.5(–11) × (2–)2.5–3.5(–5) µm, aseptate, smooth, non-apiculate. Anamorph formed as white mycelium on hymenium, less frequently on stipe of host. Conidiophores (d) unbranched or verticillately branched, 40–60 µm long. Conidiogenous cells (d) straight, curved or sinuous, 20–35 µm long, 2–4 µm wide at base, forming one conidiogenous locus with one conidium, proliferation of conidiogenous locus not observed. Conidia (e) narrowly ellipsoidal to oblong, occasionally naviculate, without basal hilum or rarely with minute basal frill, (7–)12.5–16.5(–23.5) × (2.5–)3–4(–5) µm, aseptate. Aleurioconidia (f) formed laterally from hyphae within host tissue, globose, one-celled, pale green, subglobose, (17–)19–22(–25) µm diam, with 4–5 µm thick walls, smooth, subtended by a *ca.* 5 µm diam, smooth, thin-walled suspensory cell.

Anamorph: None known.



Habitat: On fruitbodies of *Russula* spp. Covering hymenophore and upper part of the stipe of host; basidiocarp turning firm.

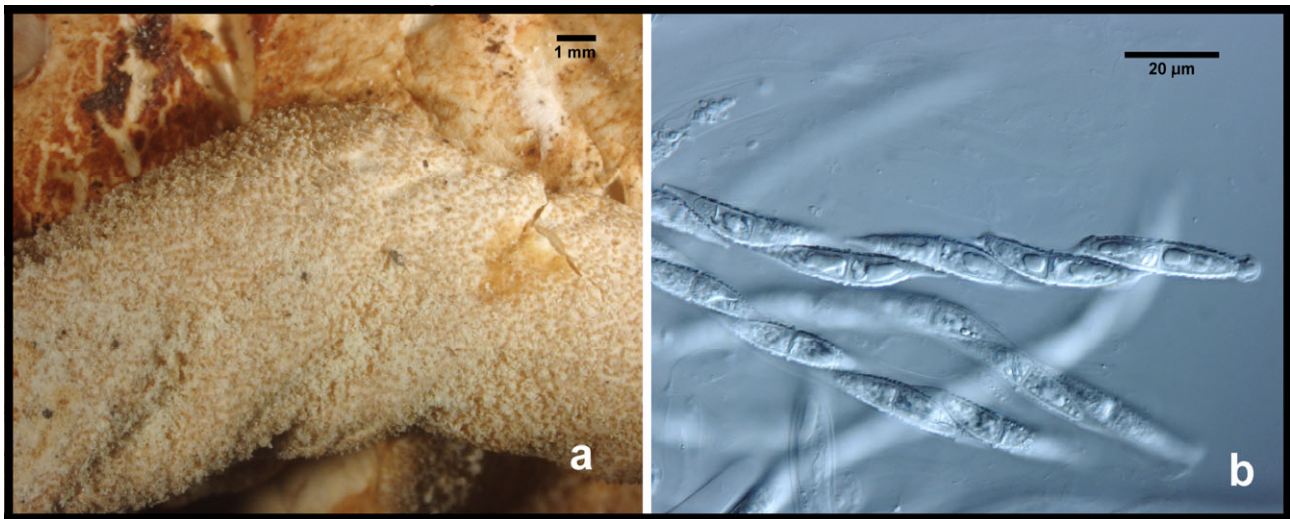
Known distribution: North temperate regions, common.

Description:

Subiculum (a, b) profuse, first yellowish to bright yellow, becoming yellowish green to dark green, KOH–. Perithecia (b) formed all over subiculum, caespitose, immersed in subiculum except papilla, 380–480 × 180–290 µm, first yellow, becoming green to blackish when mature, KOH–, papilla 95–120 µm high with moniliform hyphae extending from its surface. Asci 160–200 × 5–8 µm. Ascospores (c, d) fusiform, (27–)30–36 × 4.5–5.5(–6.5) µm, aseptate, with finely verrucose walls, apiculi 2.5–7 µm long.

Notes: The species cannot be mistaken for any other *Hypomyces* species growing on agarics because of its green subiculum and perithecia.

Anamorph: None known.



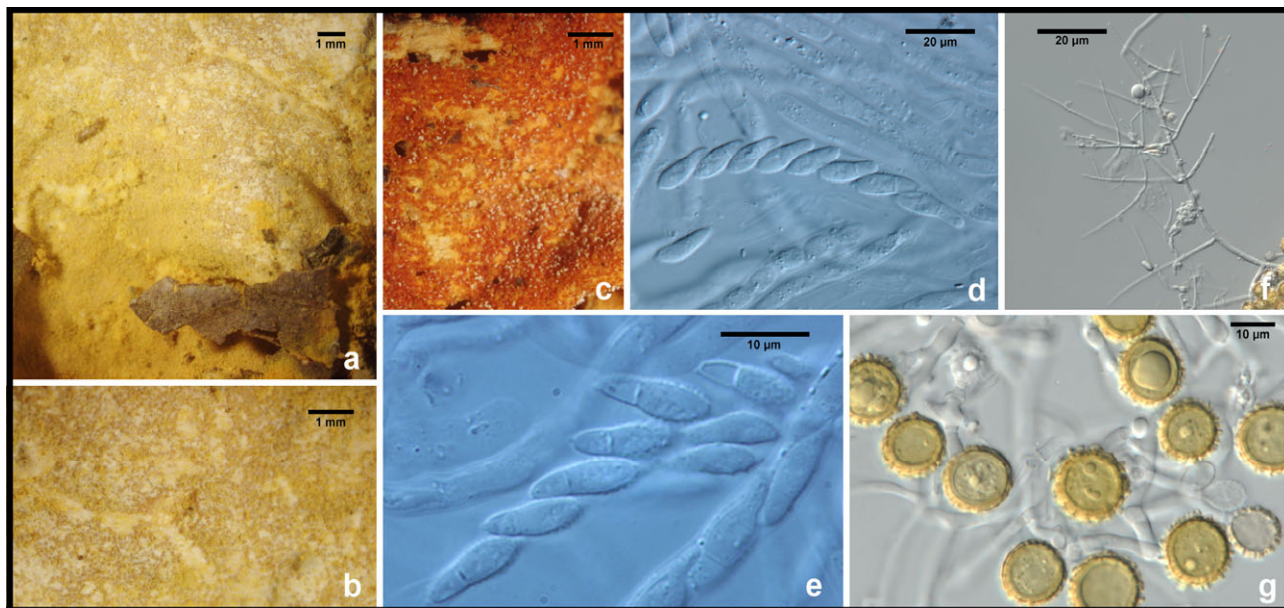
Habitat: On fruitbodies of agarics belonging to *Russulales*. Covering hymenophore and stipe of host, turning basidiocarps firm.

Known distribution: United States, Mexico; common.

Description:

Subiculum (a) profuse, white to buff, KOH–. Perithecia (a) immersed in subiculum except papilla, 320–480 × 240–300 μm, papillate, buff to yellowish amber, KOH–. Asci (b) 210–270 × 7.5–10 μm. Ascospores (b) fusiform, 34–42 × 5–7 μm, with median septum, with prominently verrucose walls, apiculi 3–7 μm long.

Notes: The species differs from *H. lactifluorum* only in its colour and lack of a reaction to KOH. It may represent the ‘albino’ variant of the latter. As in *H. lactifluorum*, mushrooms colonized by *H. macrosporus* are edible and have been found in the markets in Mexico.

Anamorph: *Sepedonium microspermum* Besl

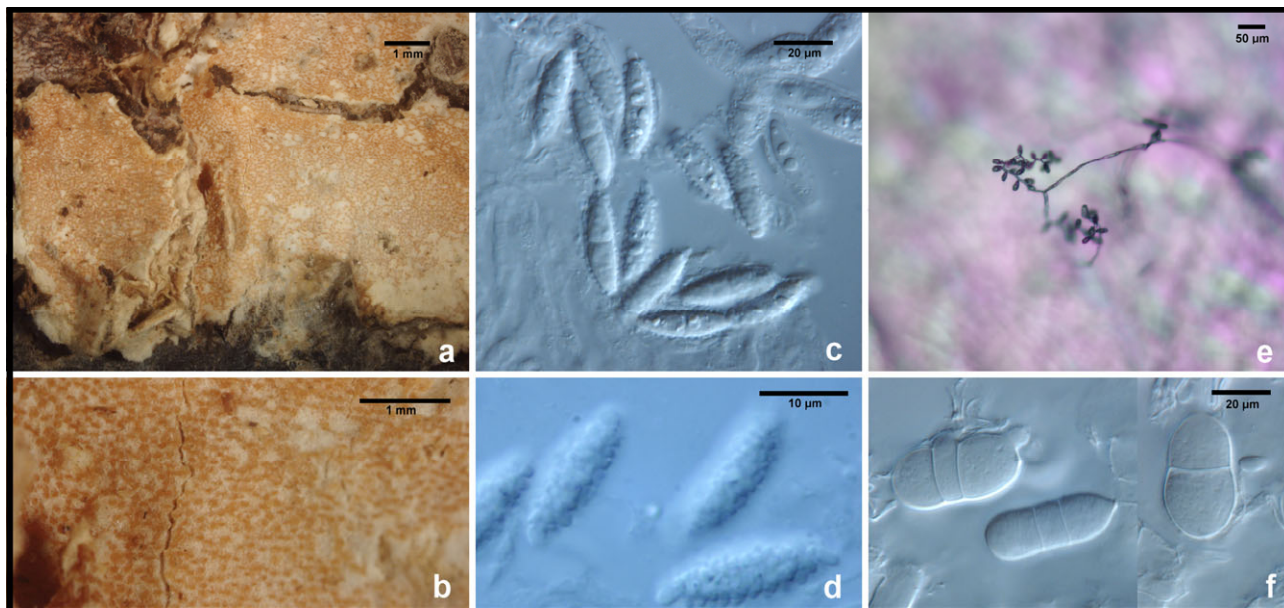
Habitat: On basidiomes of *Boletales*, *Xerocomus chrysenteron* and related taxa (*X. communis*, *X. porosporus*, *X. rubellus*), also reported on *Boletus affinis* and *B. badius*. Covering hymenophore, or hymenophore, pileus, and stipe of host; basidiocarps becoming decayed.

Known distribution: United States, eastern Canada, Europe, Japan, Java; New Zealand; common.

Description:

Subiculum (a, b) scanty or profuse, first white, becoming pale yellow. Perithecia (b, c) caespitose, immersed in subiculum except papilla or semi-immersed in subiculum, (230–)300–330(–400) × (180–)240–250(–330) µm, papillate, yellow, orange, brick red, cinnabar red, orange red or brown, perithecia KOH+ purple (c). Asci (d) 110–120 × 4–6 µm. Ascospores (d, e) naviculate, (8–)10–14(–15) × (2.5–)3–4(–4.5) µm; 1-septate or occasionally aseptate, with submedian or occasionally median septum; finely verrucose or smooth; with apiculate or nonapiculate ends, apiculi 1 µm long. Anamorph forming a cottony mat, at first white, becoming yellow when chlamydospores formed, covering hymenophore of host but often spreading over whole basidiome of host, finally causing its total decay. Conidiophores (f) verticillately branched. Conidiogenous cells in verticils of 2–4, each forming 1 conidiogenous locus that forms up to 50 conidia held in drops of liquid. Conidia ellipsoidal to obovoid, equilateral, (5–)9–14(–17) × 3–5(–7) µm, aseptate. Aleurioconidia (g) yellow, subglobose to globose, (8.5–)10–15 µm diam, with 2 µm thick walls, warted, with 1–1.5 µm high verrucae.

Anamorph: *Cladobotryum polypori* (Dearn. & House) Rogerson & Samuels



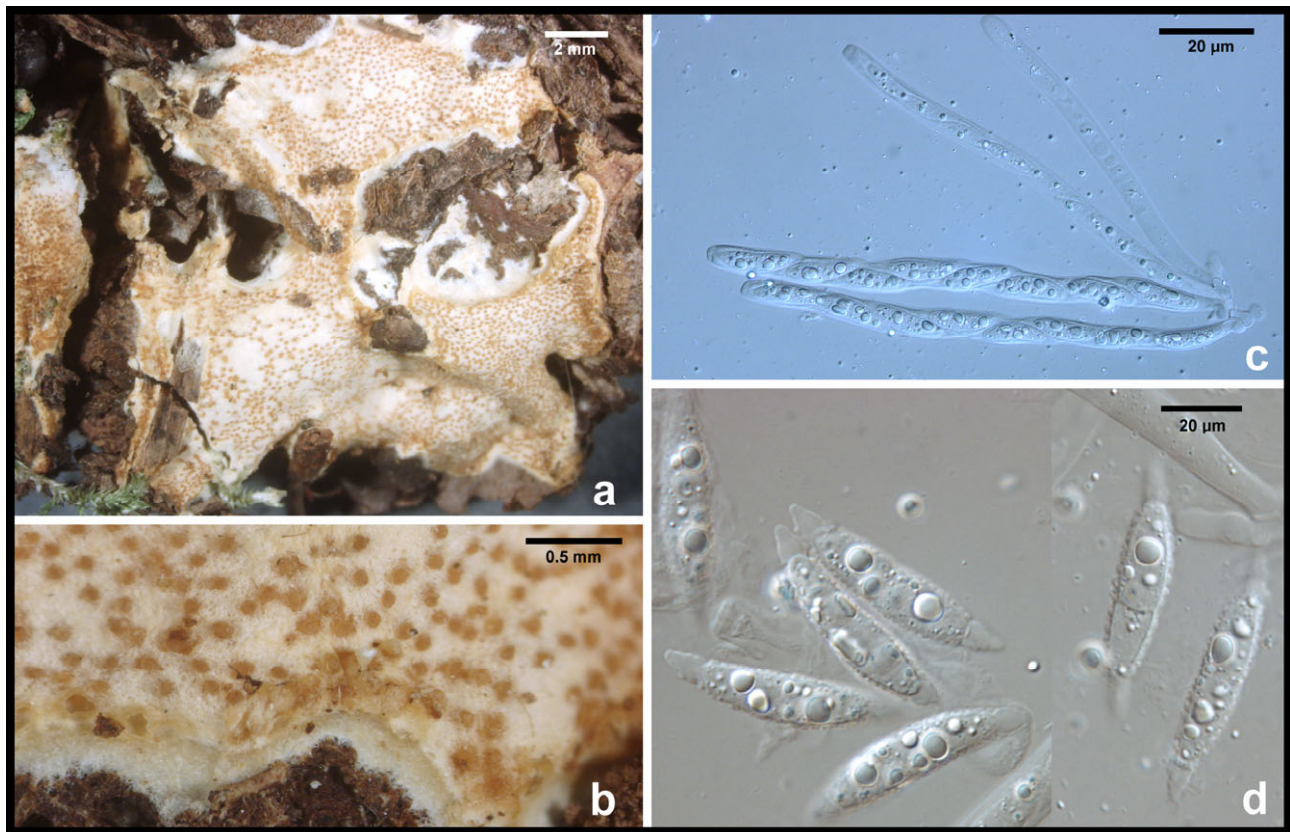
Habitat: On basidiomata of *Agaricales* or *Aphylllophorales*; the few known teleomorph collections mostly on *Polyporus* spp. Covering hymenophore, sometimes spreading to other parts of host.

Known distribution: Teleomorph: United States (CO, IL, MA, NC, NY). Anamorph: United States (IL, MD, VA, WV), Cuba, China, Thailand, Japan; teleomorph known from only five collections, anamorph common.

Description:

Subiculum (a, b) scanty, white to cream-coloured or buff, KOH–. Perithecia (b) formed on subiculum, gregarious, semi-immersed in subiculum, 275–330(–360) × 165–300(–320) μm, peach, salmon or buff to pale brown, KOH– or KOH+ yellow, papilla 50–90 μm high. Asci 140–150 × 4–6 μm. Ascospores (c, d) fusiform, 17–23 × 5–6.5 μm; with median septum, in some specimens aseptate; grossly warted, apiculi 1–2(–2.5) μm long. Anamorph forming a profuse buff cottony mat covering whole basidiocarp of host sometimes extending over adjacent substrata. Conidiophores (e) branched verticillately or irregularly. Conidiogenous branches in verticils of 1–2(–3), proliferating progressively, forming 20–50 conidiogenous loci, forming 1(–6) conidia from first formed conidiogenous locus, then held in imbricate chains. Conidia (f) ellipsoidal, rarely cylindrical to clavate, equilateral, with a central basal hilum, 14–22(–25) × 7.5–10 μm, (0–)1(–2)-septate. Chlamydospores formed in terminal position on lateral branches of submerged hyphae, hyaline to pale or yellowish brown; cells subglobose to globose, 20–30 × 18–25 μm, smooth.

Anamorph: *Cladobotryum verticillatum* (Link) S.J. Hughes



Habitat: Anamorph growing on fruitbodies of *Lactarius* and *Russula* spp.; teleomorph on litter, mosses, ground, wood or bark next to decayed agarics.

Known distribution: Mainly from northern temperate regions; anamorph very common, teleomorph uncommon.

Description:

Subiculum (a, b) profuse, white, buff or orange, KOH–. Perithecia (b) formed all over subiculum, gregarious or scattered, immersed to semi-immersed in subiculum to superficial, $260\text{--}360 \times 240\text{--}250\ \mu\text{m}$, papillate; buff, amber, orange or red, KOH–. Asci (c) $170\text{--}180 \times 6\text{--}8\ \mu\text{m}$. Ascospores (d) fusiform, $32\text{--}40 \times 5\text{--}8\ \mu\text{m}$, with median septum, wall grossly warted, apiculi $3\text{--}4.5\ \mu\text{m}$ long. Conidiophores branched forming profuse white cottony mould, covering pileus and hymenophore or often whole basidioma of host, often extending over adjacent substrata. Conidiophores branched verticillately or irregularly. Conidiogenous cells in verticils of 2–5(–7). Conidia broadly ellipsoidal to (sub)globose, obovoid, pyriform or rarely cylindrical, with a central or laterally placed basal hilum, $(7\text{--})11\text{--}24(\text{--}30) \times (5\text{--})7\text{--}12(\text{--}14)\ \mu\text{m}$, 0(–1)-septate. Chlamydospores terminal on lateral branches, intercalary on vegetative hyphae or in soft sclerotia-like aggregations of irregular shape, hyaline or pale brownish yellow, with cells $10\text{--}30\ \mu\text{m}$ diam or $22\text{--}42 \times 20\text{--}35\ \mu\text{m}$, held by 3–10 when in chains, wall $2\ \mu\text{m}$ thick, smooth.

Notes: This species is unusual in the genus because the teleomorph is formed on non-fungal substrata surrounding the host after its decay by the anamorph. Similar development can be seen occasionally in *H. rosellus*.

Hypomyces papulasporae Rogerson & Samuels
var. *americanus* Rogerson & Samuels

Hypocreaceae

Anamorph: *Papulaspora* sp.



Habitat: On geoglossaceous ascomycetes (*Geoglossum* spp., *Trichoglossum* spp.)

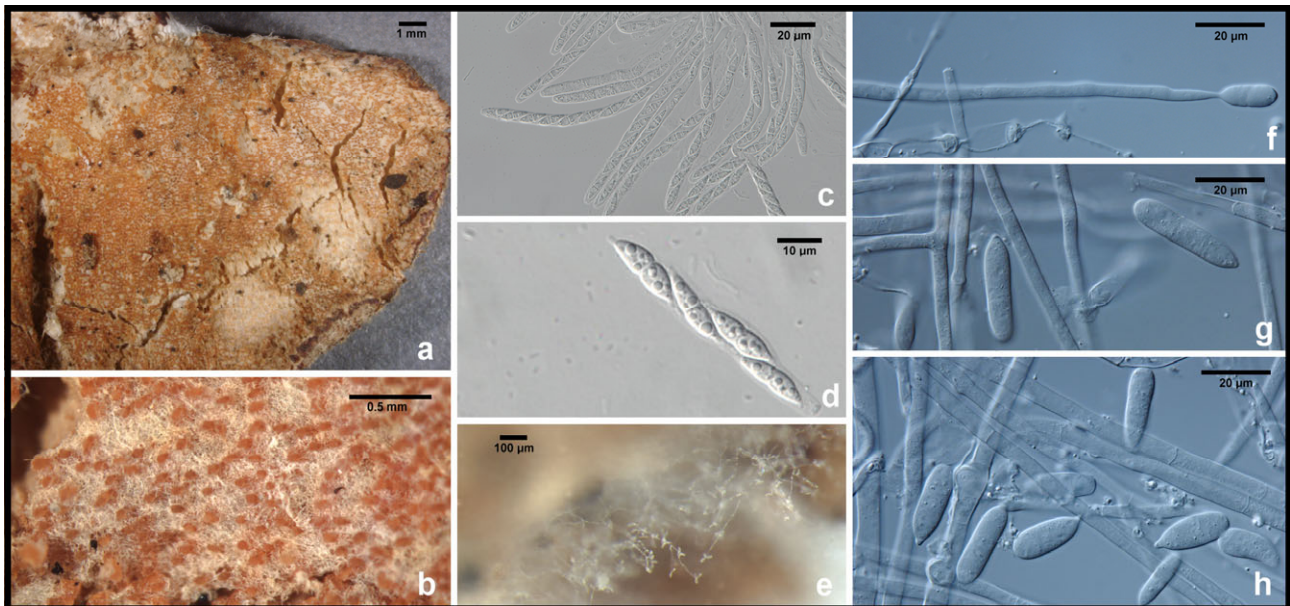
Known distribution: United States (CO, MA, MN, NC, NJ, NY, TN, VA); China.

Description:

Subiculum absent. Perithecia (a) formed in a continuous layer, $125\text{--}410 \times 125\text{--}290\text{ }\mu\text{m}$, after cessation of conidial production directly on hymenium of host, colourless to pale yellow, KOH–, nonpapillate or with a short acute papilla. Asci $(70\text{--})80\text{--}120(\text{--}135) \times (3\text{--})4.5\text{--}5(\text{--}6)\text{ }\mu\text{m}$. Ascospores fusiform to naviculate, $(12\text{--})13.5\text{--}16.5(\text{--}18) \times 2.5\text{--}3.5(\text{--}5)\text{ }\mu\text{m}$, aseptate, smooth-walled, nonapiculate. Anamorph (b, c) white, cottony, spreading from fertile portion of host downwardly to base of stipe. Conidiophores unbranched or infrequently branched, $40\text{--}100\text{ }\mu\text{m}$ long. Conidiogenous cells borne singly, $(19\text{--})28\text{--}47(\text{--}67)\text{ }\mu\text{m}$ long, $2\text{--}3\text{ }\mu\text{m}$ wide at base, not proliferating, forming one conidiogenous locus that produces one conidium. Conidia (b) oblong to ellipsoidal, with a protuberant basal abscission scar, $(8\text{--})12\text{--}17(\text{--}21) \times 3\text{--}5\text{ }\mu\text{m}$, aseptate. Papulospores (c) formed singly at tips of lateral branches of hyphae, $(16\text{--})20\text{--}25(\text{--}30)\text{ }\mu\text{m}$ diam, comprised of a globose, $11\text{--}16(\text{--}20)\text{ }\mu\text{m}$ diam, thick-walled, lightly pigmented central cell surrounded by an indefinite number of globose, $7\text{--}15\text{ }\mu\text{m}$ diam, thin-walled, lightly pigmented cells and a basal stalk cell.

Notes: This species is far more common in its anamorph than its teleomorph. *Hypomyces papulasporae* var. *papulasporae* occurs in New Zealand. It differs from var. *americanus* only in producing smaller papulospores and larger conidia. Figures b and c, here, are taken from var. *papulasporae*.

Anamorph: *Cladobotryum clavisporum* (Gray & Morgan-Jones) Rogerson & Samuels



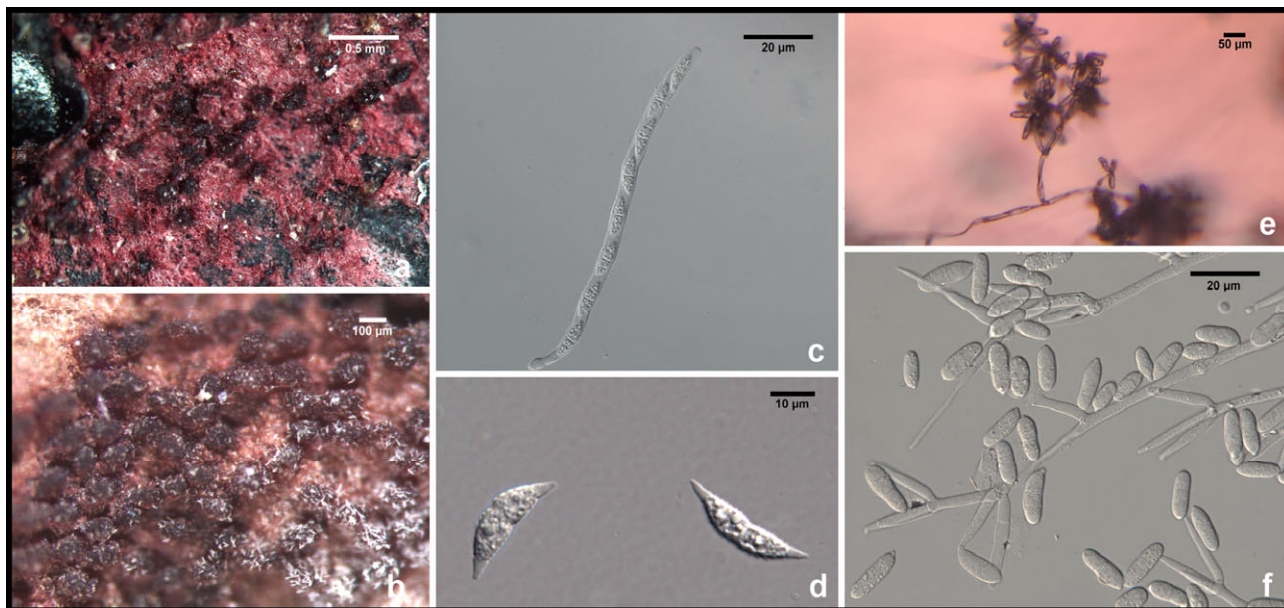
Habitat: On fruitbodies of *Aphyllphorales*, mostly *Trametes versicolour*, occasionally *T. pubescens*, *Polyporus* sp., or *Auricularia auricula*. Covering hymenophore or occasionally pileus of host, often extending over several adjacent basidiocarps.

Known distribution: Teleomorph: eastern United States, eastern Canada; northern and south western Europe, Australia. Anamorph: northern, east and middle Europe; Indo-China, both stages common in North America but rare elsewhere.

Description:

Subiculum (a, b) profuse when young, becoming scanty when old, buff, not changing colour in KOH. Perithecia (b) formed all over subiculum, scattered to gregarious, semi-immersed in subiculum or immersed in subiculum except papilla, 250–400 × 165–250 µm, peach, salmon, brownish or reddish orange or orange-brown, KOH– or turning bright yellow. Asci (c) 95–120 × 4–5.5 µm. Ascospores (d) fusiform, 15–21 × 3–4 µm, l/w 4.5–5.9; with median septum, occasionally aseptate, finely verrucose, apiculi 1–1.5(–2) µm long. Anamorph (e–h) forming a delicate buff mat (e) over host's hymenophore. Conidiophores irregularly branched. Conidiogenous cells (f) or branches in verticils of 1–2(–3), each with 0–4 septa, proliferating progressively, sympodially, forming 1–3 conidiogenous loci, forming up to 20 conidia held in imbricate chains. Conidia (g, h) cylindrical to ellipsoidal or clavate, equilateral, with centrally or laterally placed basal hilum, (18–)22–28(–32) × (5–)7–8.5(–10) µm, (0–)2(–3)-septate. Chlamydospores terminal on lateral branches or intercalary on hyphae, hyaline, subglobose to globose, smooth.

Anamorph: *Cladobotryum dendroides* (Bull.) W. Gams & Hoozemans



Habitat: On basidiomata of *Russulales*, *Agaricales*, *Aphyllorphorales* or wood, bark, litter, mosses or ground, next to decayed agarics. Covering hymenophore or hymenophore, pileus and stipe, often extending to nonfungous substrata nearby, causing decay of host basidiomata or with no apparent change observed.

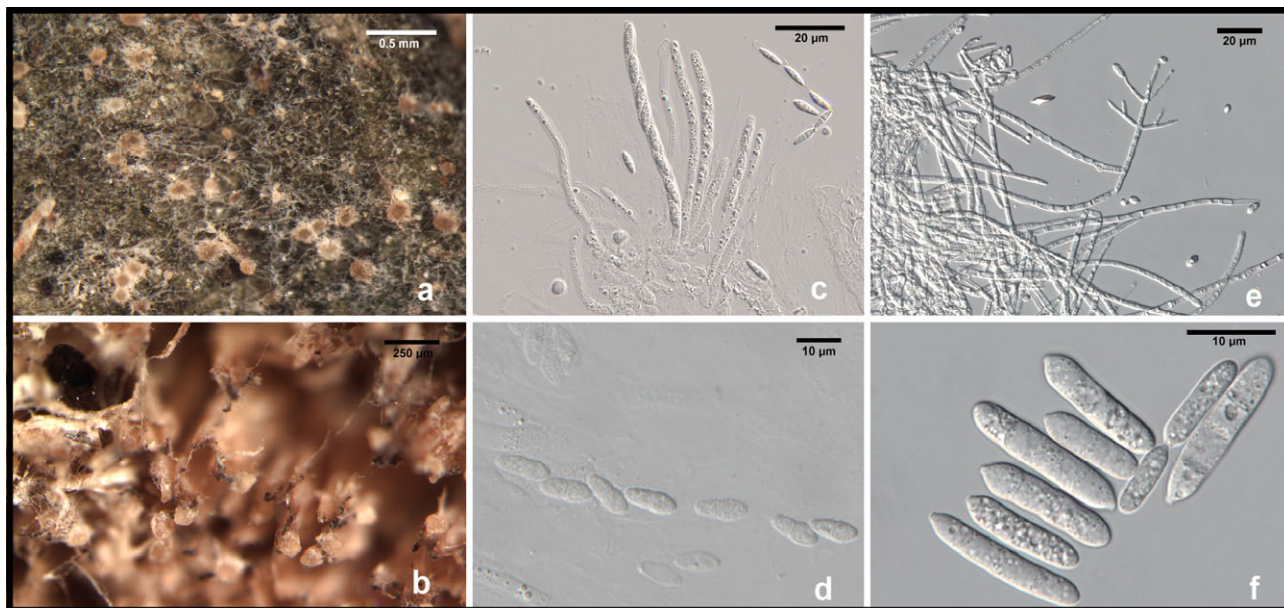
Known distribution: Probably cosmopolitan, both the teleomorph and anamorph common.

Description:

Subiculum (a, b) profuse, at first white, becoming pink, rose or red, KOH+ purple. Perithecia formed over subiculum, gregarious or scattered, semi-immersed in subiculum, papillate, $250\text{--}460 \times 150\text{--}360 \mu\text{m}$, red or occasionally brown, KOH+ purple. Asci (c) $140\text{--}160 \times 5\text{--}7 \mu\text{m}$. Ascospores (d) fusiform, $25\text{--}35 \times 4\text{--}6(-7.5) \mu\text{m}$, with median septum, verrucose, apiculi $4\text{--}6 \mu\text{m}$ long. Anamorph (e, f) forming a delicate yellowish to red mycelium with erect conidiophores; each conidiophore bearing conidia at tip (e), appearing as white tufts. Conidiophores (f) verticillately or irregularly branched. Conidiogenous cells (f) in verticils of 3–5, $20\text{--}50 \mu\text{m}$ long, $3\text{--}4.4 \mu\text{m}$ wide at base, forming 1–10(–15) conidiogenous loci, each forming 1 conidium. Conidia (f) cylindrical to ellipsoidal, equilateral, with central or occasionally laterally placed basal hilum, $18\text{--}30(-36) \times (6\text{--})8\text{--}10(-12) \mu\text{m}$, hyaline, 1–3-septate. Chlamydospores formed in irregular globular masses terminating lateral branches or forming hard subglobose to globose sclerotia, brown or red, cells subglobose to globose, smooth.

Notes: The red colouration is due to the pigment aurofusarin, produced by *H. rosellus*, *H. odoratus* G. Arnold and some anamorphic *Cladobotryum* species. Collections identified as *H. odoratus* by Rogerson & Samuels (1994) from the United States including one from NC (*C.T. Rogerson 76-207*) and Puerto Rico represent a morphologically similar, undescribed species.

Anamorph: *Cladobotryum hughesii* Rogerson & Samuels



Habitat: On basidiomata of *Aphyllophorales*: *Fomitopsis dochmius*, *Polyporus* sp., *Trichaptum bifforme*. Covering hymenophore or occasionally also pileus with no apparent change in basidiomata.

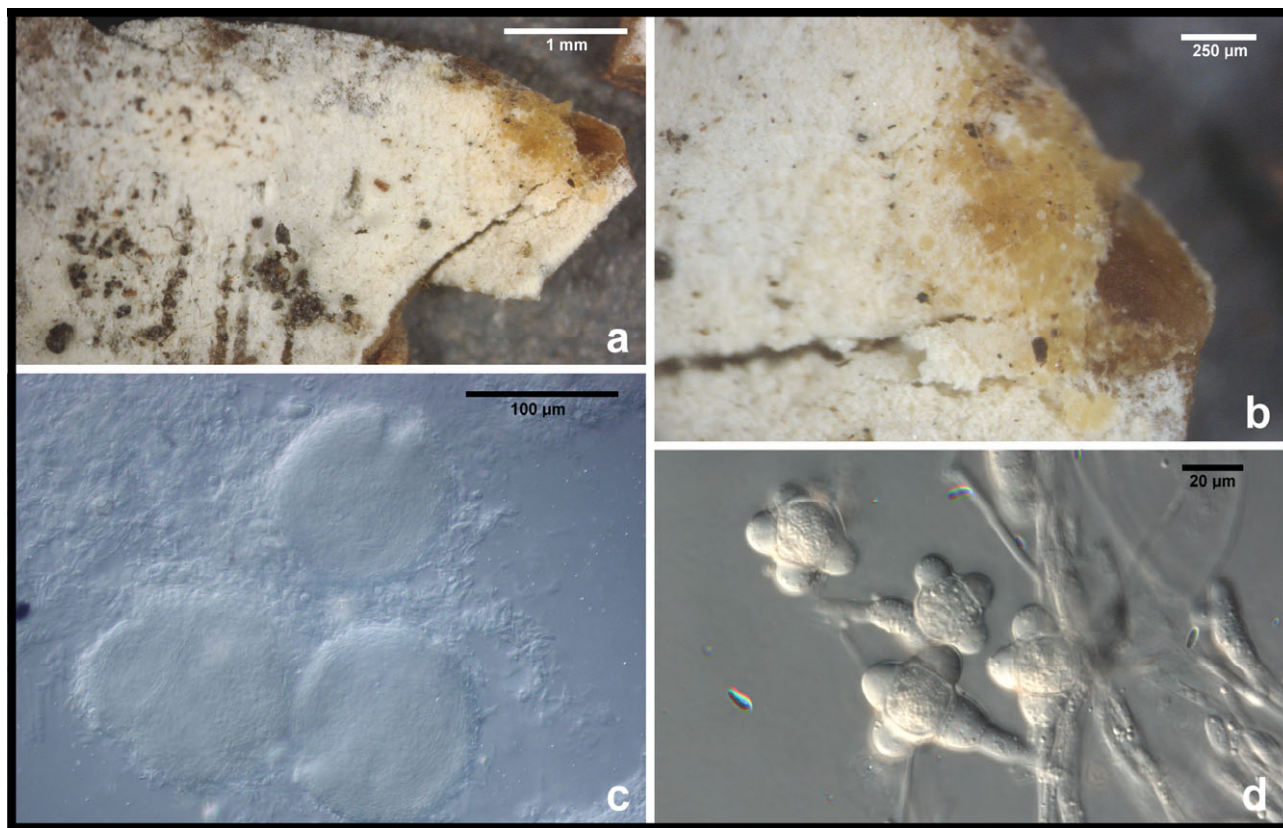
Known distribution: Southeastern United States (MD, NC), Thailand, Indonesia (North Sulawesi); uncommon.

Description:

Subiculum (a) present or absent, scanty, white, KOH-. Perithecia (a, b) formed directly on basidiomata or all over scarce subiculum, scattered or gregarious, superficial or occasionally semi-immersed in subiculum, 220–360(–400) × 160–250(–275) µm, papillate, buff, yellow or rarely pale brown, KOH-. Asci (c) 110–130 × 4.5–6.5 µm. Ascospores (d) fusiform or naviculate, some bent at base, (13–)15–19(–21) × 3.5–4.5 µm, septum median, sub- or supramedian, finely verrucose, smooth or verrucose, ends nonapiculate or occasionally apiculate with apiculi 0.5–1 µm long. Anamorph forming a delicate buff mycelium effused over hymenophore of host. Conidiophores (e) irregularly branched. Conidiogenous cells in verticils of 3–10(–12), forming 1(–2) conidiogenous loci, each forming 1(–2) conidia singly or in imbricate chains. Conidia (f) cylindrical or rarely clavate, variable in size and shape, with a central basal hilum, (5–)15–25(–35) × (3–)4–5.5(–6.5) µm, 0–3(–4)-septate. Chlamydospores absent.

Notes: A poorly known species that might be common but is easily overlooked because of its scarce mycelium and inconspicuous perithecia similar in colour to the hymenophore of the host.

Anamorph: *Stephanoma strigosum* Wallr.



Habitat: On *Humaria hemisphaerica* (Wiggers : Fr.) Fuckel

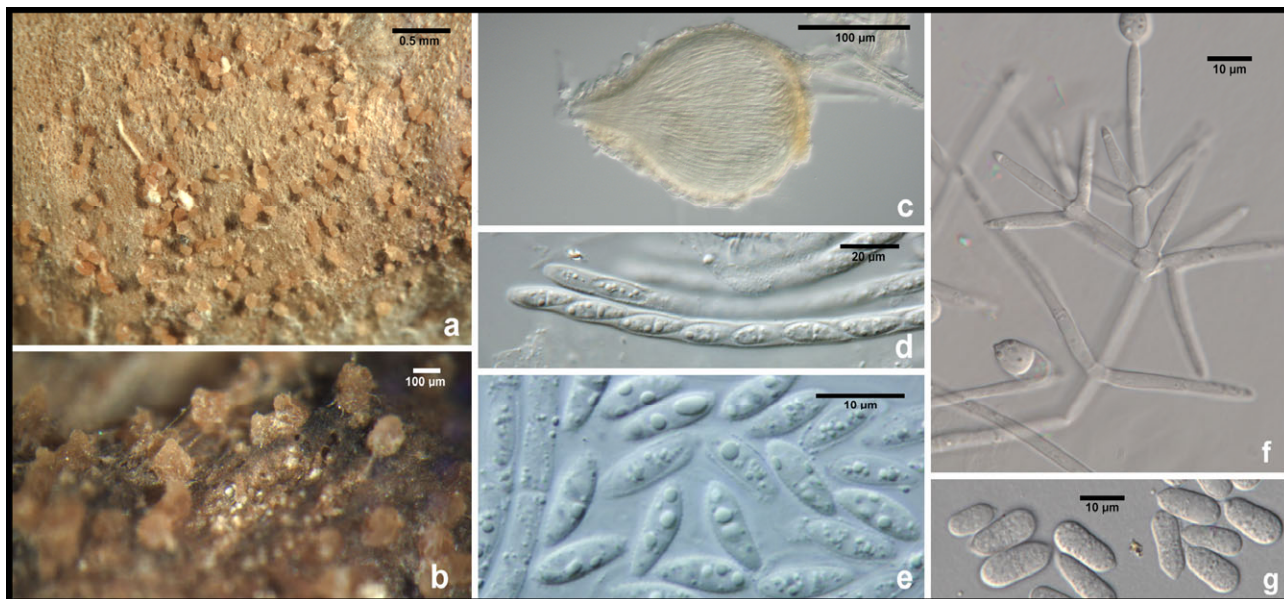
Known distribution: Teleomorph: United States (MA, NC, NY, OH). Anamorph: United States (CO, GA, KS, MA, MI, NC, NY, TN, WV), eastern Canada, Europe; anamorph common, teleomorph rare.

Description:

Subiculum (a) absent or scanty, white, KOH–. Perithecia (b, at right; c) formed on hymenophore of host, hyphae growing from perithecial wall forming a mantle around papilla and venter of perithecium, 190–250(–280) × 130–220 µm, papillate, pale yellow, KOH– or colourless. Asci (60–)70–95(–115) × 4.5–6(–7.5) µm. Ascospores naviculate, (8–)10–12(–12.5) × (2–)2.5–3.5(–4.5) µm, aseptate, wall smooth, ends nonapiculate, with upper end more pointed than lower end. White mycelium spreading over host hymenium, producing first verticillately or irregularly branched conidiophores, later becoming tan and powdery from aleuriospores. Conidiophores verticillately or irregularly branched. Conidiogenous cells in verticils of 2–6, forming 1 conidiogenous locus, conidia held singly or in drops of liquid. Conidia cylindrical to ellipsoidal, equilateral, without basal hilum but with a flat basal abscission scar, (8–)10–15(–18.5) × 3.5–5.5 µm, aseptate. Aleurioconidia (d) formed singly in terminal position on lateral branches on conidiophores, hyaline to tan, subglobose to globose, central cell (11–)13–19(–21) µm diam, formed on a subglobose supporting cell, covered with hemispherical 6–8 × 10 µm diam swellings, wall 1.5–2 µm thick, smooth.

Notes: *Hypomyces stephanomatis* is readily recognized through its *Stephanoma* anamorph forming in thick white mycelium on the hymenium of the operculate discomycete *Humaria hemisphaerica*. As with many species, this species is far more commonly found in its anamorph than in its teleomorph.

Anamorph: *Cladobotryum uniseptatum* (Castañeda) K. Pöldmaa



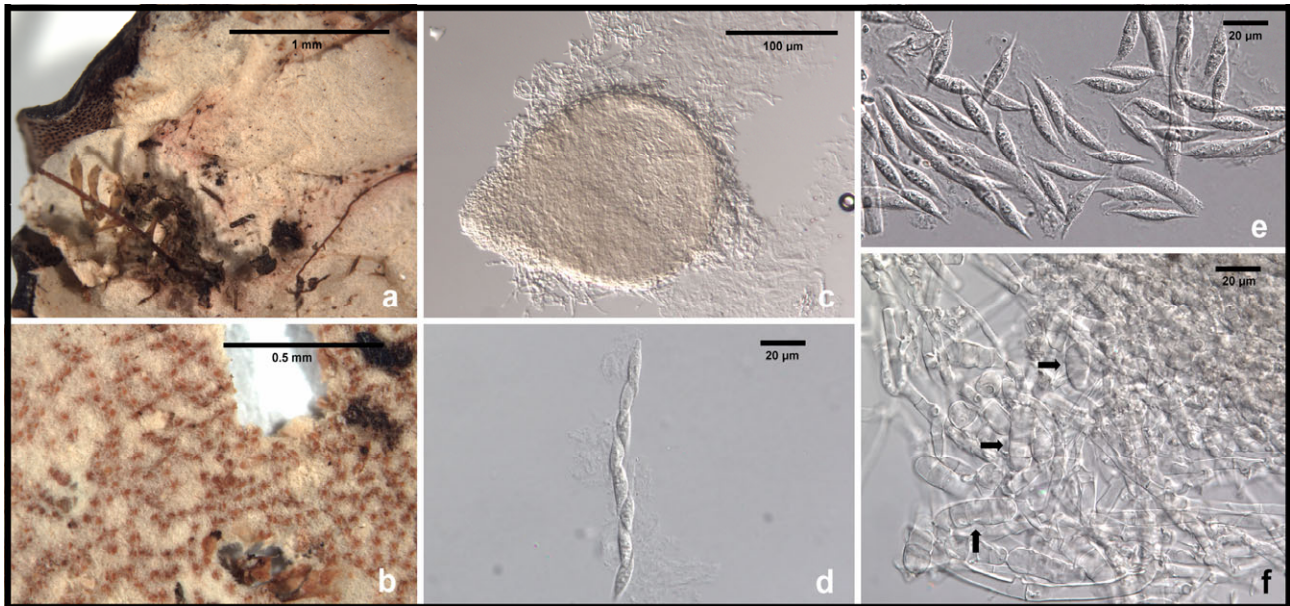
Habitat: On *Stereum ostrea* and *S. subtomentosum*.

Known distribution: Probably cosmopolitan, reported from United States, Europe, Thailand, Australia; probably common, especially the anamorph, but easily overlooked.

Description:

Subiculum (a, b) absent or a very scanty mycelium on host hymenophore and disappearing in age, white to buff, KOH–. Perithecia (b, c) formed usually directly on host hymenophore, scattered or occasionally gregarious, superficial, 240–300(–360) × 220–240(–300) µm, papillate, buff, amber or orange-brown, KOH–. Asci (d) 95–130 × 4–5.5 µm. Ascospores (e) fusiform or naviculate, 13–16(–18) × 3–4(–4.5) µm, with median septum, submedian, supramedian, or occasionally absent, finely verrucose or smooth, ends nonapiculate or occasionally apiculate, apiculi 0.5–1 µm long. Anamorph forming a pure white, sometimes delicate and inconspicuous but usually profuse mycelium effused over host hymenophore; usually densely formed conidiophores and conidia giving a characteristic powdery appearance. Conidiophores (f) verticillately or irregularly branched. Conidiogenous (f) cells in verticils of 3–10, forming 1–3(–7) conidiogenous loci each producing 1 conidium. Conidia (f, g) cylindrical to ellipsoidal, clavate or pyriform, with a central basal hilum, (7–)10–16(–25) × 5–7(–10) µm, 1(2–3)-septate. Chlamydospores intercalary on submerged hyphae, hyaline, subglobose to globose, 7–14 µm diam, solitary, paired or in long chains, smooth.

Anamorph: ?*Cladobotryum* sp.



Habitat: On decaying wood and polypores.

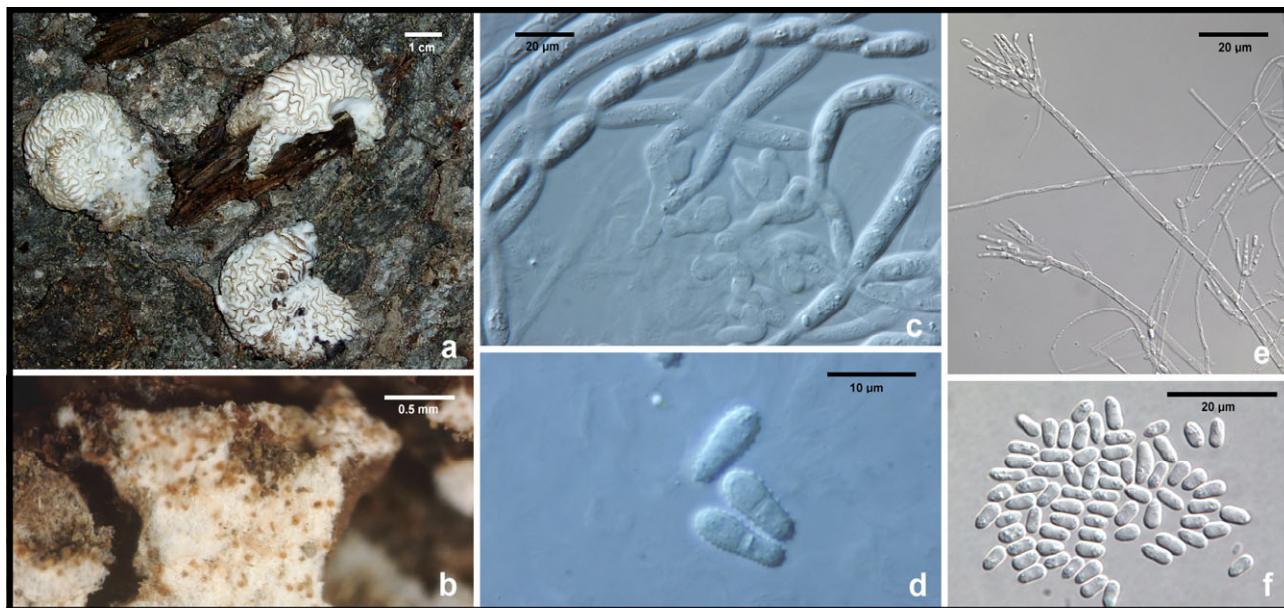
Known distribution: Tropical to subtropical, known from United States (SC), Panama, Brazil.

Description:

Subiculum (a, b) thin, parchment-like, white to buff, KOH–. Perithecia (b, c) gregarious, immersed to semi-immersed or almost superficial in subiculum, $220\text{--}360\text{--}(400) \times 160\text{--}250\text{--}(275) \mu\text{m}$, papillate, peach to pale yellowish, or reddish brown, KOH–. Asci (d) $130\text{--}140 \times 5\text{--}10 \mu\text{m}$. Ascospores (e) fusiform $30\text{--}40 \times 5\text{--}9 \mu\text{m}$, with median septum, coarsely warty, apiculi $4\text{--}8 \mu\text{m}$ long. Anamorph found in subiculum. Conidia (f) ellipsoidal, cylindrical or slightly clavate, with a central or laterally displaced basal hilum, $17\text{--}46 \times 8\text{--}14 \mu\text{m}$, (1–)3(–4)–septate. Chlamydospores in chains or irregular clusters, yellowish brown, cells globose, $15\text{--}25 \mu\text{m}$ diam, wall $1.5\text{--}4 \mu\text{m}$ thick, smooth.

Notes: There is no proven anamorph known for *H. tegillum* but, because perithecia in three tropical collections contain a similar anamorph, it is considered to be the anamorph of *H. tegillum*. Further collections and living cultures are needed to prove the conspecificity of the tropical specimens with the type of *H. tegillum*, which originates from South Carolina.

Anamorph: verticillium-like



Habitat: On wood-inhabiting agarics, mainly species of *Crepidotus*, which may turn firm, sometimes also spreading onto adjacent wood or bark.

Known distribution: United States (IL, KS, LA, MD, NC, WI), Canada, South America, Europe, New Zealand; anamorph common, teleomorph less common.

Description:

Subiculum (a, b) covering host hymenophore, profuse, white, KOH-. Perithecia (b) formed in parts of subiculum, caespitose, immersed in subiculum except papilla to superficial, 450–600 × 300–350 µm, papillate, buff or reddish brown, KOH-. Asci (c) cylindrical, 60–75 × 4–5 µm; apex thickened and with a ring (c). Ascospores (d) ellipsoidal, 7–13 × 3–4 µm, with median septum, verrucose, ends nonapiculate. Anamorph forming a white cottony mat usually over whole basidioma of host. Conidiophores (e) verticillately or irregularly branched. Conidiogenous cells (e) in verticils of 3–5(–7), formed directly on conidiophore or on short lateral branches, each forming 1 conidiogenous locus that produces up to 50 conidia in liquid. Conidia (f) cylindrical to ellipsoidal, equilateral, without a basal hilum, (4–)5–8(–12) × 2–3(–5) µm, aseptate or rarely 1-septate. Chlamydospores absent.

Notes: This species can easily be recognized through its anamorph and the ellipsoidal, non-apiculate ascospores. Among agaricicolous *Hypomyces*, only *H. succineus* is also known to form a *Verticillium* anamorph. The ascospores of *H. succineus* are (12–)16–20 × (3–)4–5 µm often with small apiculi. *Hypomyces succineus* is known only on *Pholiota* sp. in NY.

Subiculum not conspicuous; at most, forming a thin compact layer on host hymenium. Perithecia superficial, solitary to gregarious, obpyriform, non-papillate, smooth, perithecial wall less than 25 µm thick. Asci cylindrical, apex slightly thickened, with uniseriate ascospores. Ascospores naviculate to ellipsoid, with one median or slightly sub-median septum, non-disarticulating in asci, hyaline, finely spinulose. Anamorph *Gliocladium*. On decaying *Aphyllphorales*, rarely wood.

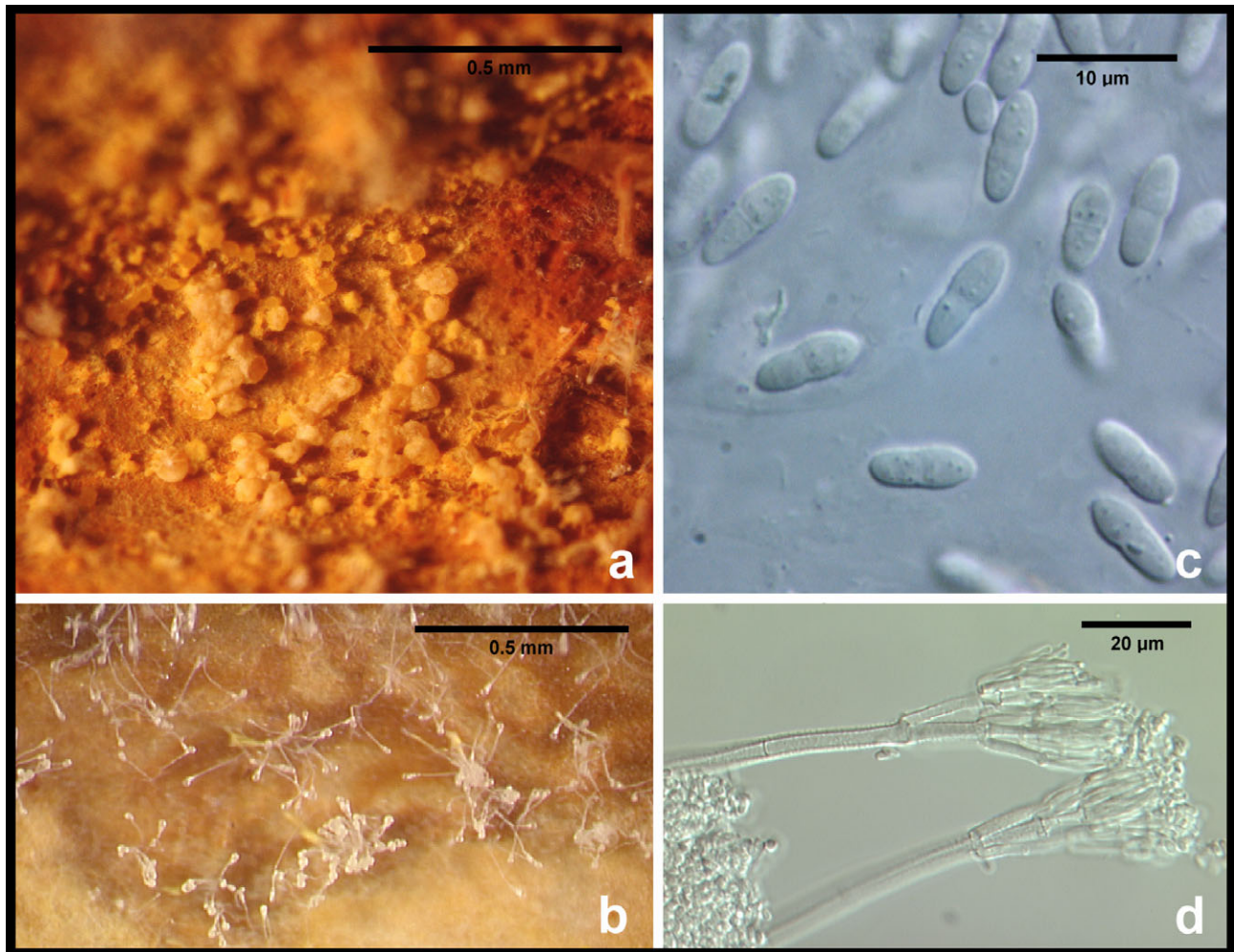
Literature:

Samuels, G.J. (1976). A revision of the fungi formerly classified as *Nectria* subgenus *Hyphonectria*. *Memoirs of the New York Botanical Garden* **26**: 1–126 (teleomorph).

Seifert, K.A. (1985). A monograph of *Stilbella* and some allied hyphomycetes. *Studies in Mycology* **27**: 1–234 (anamorph).

Sphaerostilbella aureonitens (Tul. & C. Tul.) Seifert, Samuels & W. Gams *Hypocreaceae*

Anamorph: *Gliocladium penicillioides* Corda



Habitat: On *Stereum* spp.

Known distribution: Cosmopolitan, temperate and tropical; common.

Description:

Mycelium (a) spreading over hymenium of host basidiome, at first white, floccose, becoming golden-yellow, flat and compact. Perithecia (a) forming after anamorph, scattered to gregarious, pyriform, (185–) 250–320(–400) × (150–)200–260(–340) µm, non-papillate, collapsing by lateral pinching, golden-yellow, KOH–. Asci cylindrical, (70–)75–100(–127) × 3–5 µm, with an apical ring; with uniseriate ascospores. Ascospores (c) fusiform-ellipsoidal to naviculate, (7–)8–11(–15) × 2–3 µm, hyaline, finely spinulose; medially to supramedially 1-septate. Conidiophores (b, d) arising throughout colony before perithecia, conidiophores 75–250 µm long, with verrucose stalk, erect, bright yellow near base, bi- to quatri-verticillately branched, each branch terminating in a penicillus of narrow phialides. Conidia (d) oblong-ellipsoidal, 3–4.5(–7) × (1–)1.5–2 µm, held in a globose, hyaline to white, watery mass at tip of each conidiophore.

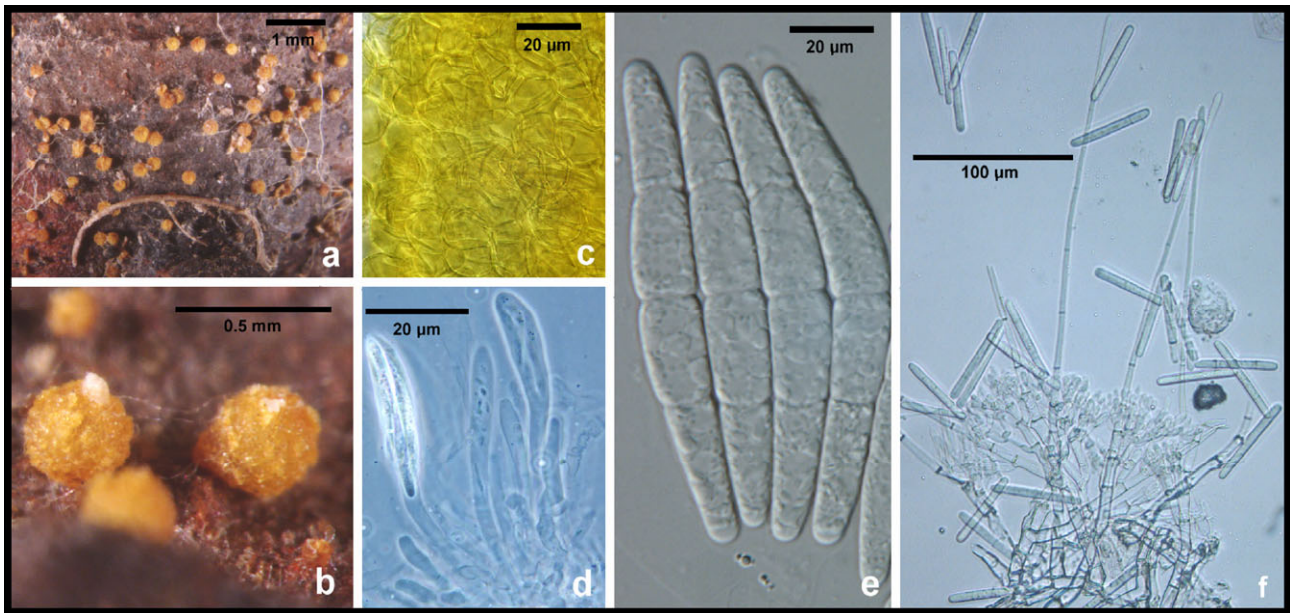
Notes: Perithecia are often immature, but the anamorph is highly diagnostic of the species.

Perithecia solitary or in small groups, superficial, without a stroma, firmly attached to substratum at blackened base, orange to red, rarely yellow, KOH+ although occasionally KOH– with lower portion KOH+ red, globose to ovoid with flattened apex, laterally pinched or not collapsing when dry, without papilla, surface with concolourous warts up to 70 µm high, of loose, globose cells. Perithecial wall of two regions, outer region of elongate to angular cells with thickened, orange walls, inner region of hyaline, elongate, thin-walled cells. Asci narrowly clavate with truncate apex, without ring, eight-spored, rarely four-spored, multiseriate. Ascospores narrowly fusiform, straight or slightly curved, (1–)3–5(–7–9) septate, often slightly constricted at septa, hyaline, smooth. Conidiophores long-stalked with penicillate branches forming a head of conidiogenous cells each bearing a long-stalked seta with an apical vesicle. Conidia cylindric with truncate ends, 3–5(–7) septate, hyaline, smooth. Chlamydospores and microsclerotia sometimes present. Anamorph *Cylindrocladium*. On decaying substrata especially leaves and fruits of woody plants; some species cause diseases as the *Cylindrocladium* state, for example, black rot of peanuts caused by *C. parasiticum* Crous *et al.*

Literature:

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Anamorph: *Cylindrocladium colhounii* Peerally



Habitat: On decaying, leathery leaves and twigs of dicotyledonous plants especially trees, decaying cone scales of *Pinus*.

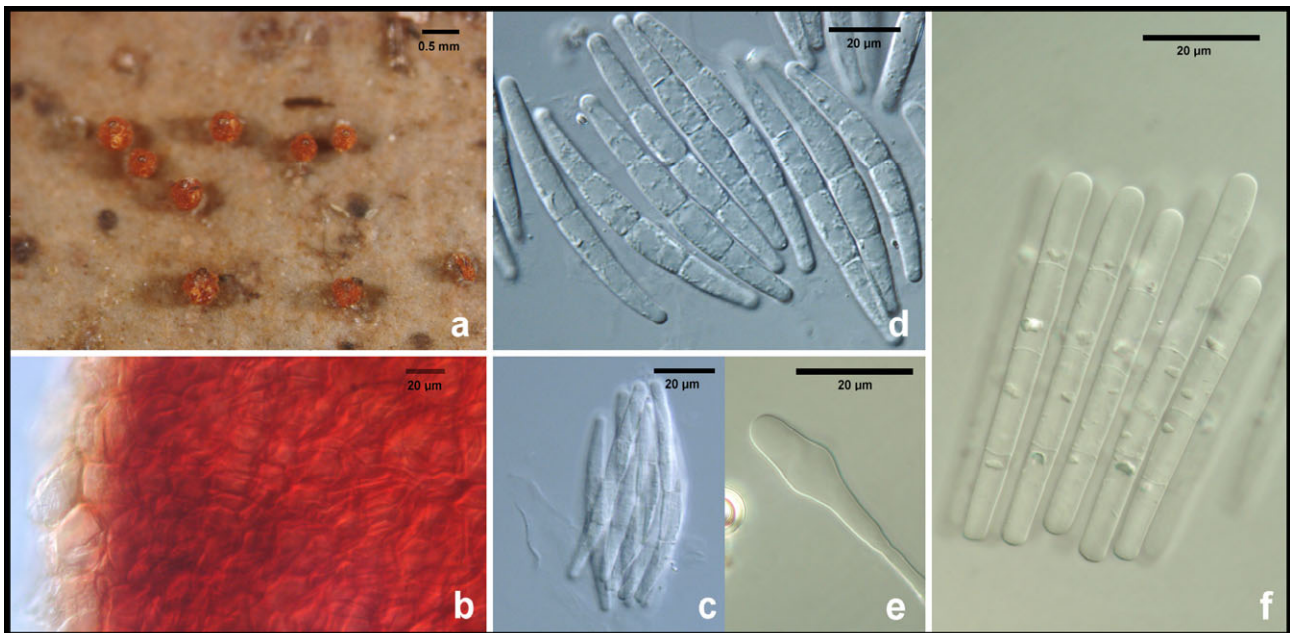
Known distribution: Pantropical and warm temperate, reported from the United States (FL, HI, LA, NC, OR, SC, VA), Costa Rica, Colombia, India, Mauritius, Thailand, South Africa, Japan, and Australia.

Description:

Perithecia (a, b) solitary or in small groups, superficial, without a stroma, firmly attached to substratum at blackened base, bright yellow to orange, KOH– although lower portion of perithecia often KOH+ red, globose to ovoid with flattened apex, laterally pinched or not collapsing when dry, $350\text{--}500 \times 320\text{--}400$ µm diam, without papilla; surface with concolourous warts up to 70 µm high, of loose, globose cells (c). Perithecial wall of two regions; outer region of elongate to angular cells with thickened, orange walls; inner region of hyaline, elongate, thin-walled cells. Asci (d) $75\text{--}170 \times 15\text{--}30$ µm, narrowly clavate with truncate apex, without ring, four-spored, multiseriate. Ascospores (e) $33\text{--}85 \times 4.5\text{--}8$ µm, narrowly fusiform, straight or slightly curved, (1–)3-septate, often slightly constricted at septa, hyaline, smooth. Conidiophores (f) long-stalked with penicillate branches forming a head of conidiogenous cells each bearing a long-stalked seta with a long-clavate apical vesicle. Conidia (f) cylindrical, 3 (–)5 septate, $45\text{--}80 \times 4\text{--}6$ µm, hyaline, smooth.

Notes: *Calonectria colhounii* is unusual in this genus in having yellow, KOH– perithecia, however, all other characteristics such as the blackened, firmly attached base and the *Cylindrocladium* anamorph confirm that this species belongs in *Calonectria*.

Anamorph: *Cylindrocladium ilicicola* (Hawley) Boedijn & Reitsma



Habitat: On rotting leaves, also on decaying twigs and woody fruit of woody, dicotyledonous plants.

Known distribution: Pantropical and warm temperate, extending as far north as England and United States (FL, NC, SC).

Description:

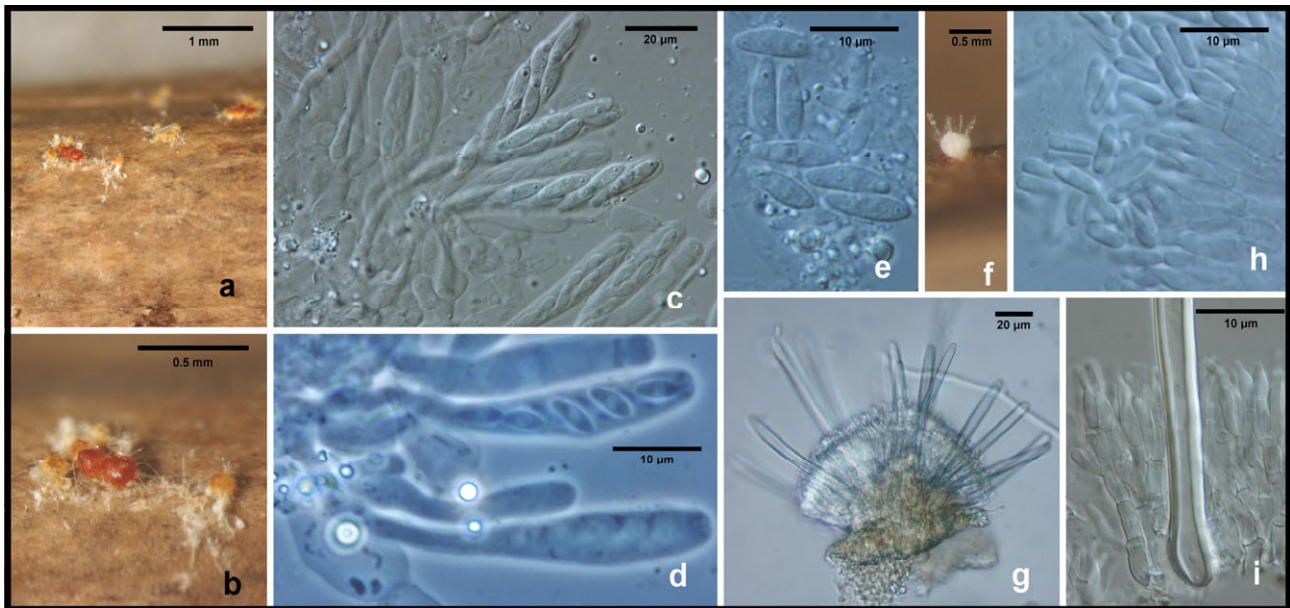
Perithecia (a) solitary or in small groups, superficial, without a stroma, firmly attached to substratum at blackened base, orange to scarlet, KOH+, globose to ovoid, laterally pinched or not collapsing when dry, $300\text{--}580 \times 300\text{--}440\text{ }\mu\text{m}$ diam, without papilla; surface with concolourous warts up to $50\text{ }\mu\text{m}$ high, of loose, globose cells (b). Perithecial wall of two regions, outer region of elongate to angular cells with thickened, orange walls; with inner region of hyaline, elongate, thin-walled cells. Asci (c) $65\text{--}130 \times 17\text{--}30\text{ }\mu\text{m}$, broadly obovate to clavate, without ring, eight-spored, with multiseriate ascospores. Ascospores (d) $40\text{--}80\text{--}(100) \times 4\text{--}8.5\text{ }\mu\text{m}$, narrowly fusiform with rounded ends, straight or slightly curved, 3–5 septate, often slightly constricted at septa, hyaline, smooth. Conidiophores long-stalked with penicillate branches forming a head of conidiogenous cells each bearing a long-stalked seta with an obpyriform to narrowly ellipsoidal apical vesicle (e). Conidia (f) cylindrical, 3-septate, $50\text{--}70 \times 5\text{--}6\text{ }\mu\text{m}$, hyaline, smooth. Chlamydospores forming in chains of 2–10, globose, $6\text{--}15\text{ }\mu\text{m}$ diam, with luteous walls.

Notes: *Calonectria pyrochroa* is the type species of the genus *Calonectria*.

Perithecia solitary to densely gregarious, superficial, rarely immersed, non-stromatic or seated on a thin basal stroma, globose, obpyriform to broadly obpyriform, small to medium-sized, usually less than 300 µm diam, collapsing laterally or not collapsing when dry, orange to red or dark red, rarely pale yellow, usually becoming darker in KOH, rarely KOH–, smooth to slightly scaly, glabrous or with few to numerous hairs arising from cells of the perithecial wall surface; papilla of parallel hyphal elements with rounded ends; cells of the perithecial wall surface lacking a definite shape, often with a meandering aspect with walls of variable thickness and narrow lumina, with adjacent cells joined by fine pores. Perithecial wall thin, less than 20 µm thick, often translucent, of a single region of intertwined hyphae, rarely of two regions; cells lacking a definite shape or appearing ellipsoid. Asci cylindrical to narrowly clavate, apex simple or with a ring, sessile or short-stalked, 8-spored, generally with uniseriate ascospores. Ascospores ellipsoid to ellipsoid-fusiform, rarely ovoid or cylindrical, 1(–3)-septate, usually yellow-brown, also hyaline, usually spinulose to tuberculate, rarely striate or smooth. Anamorphs, where known, acremonium-like, with colonies and microconidia similar to those of *Fusarium* sect. *Eupionnotes*, *Chaetopsina*, *Stilbella*, and *Volutella*. On other fungi and scale insects, less frequently on decaying woody substrata.

Literature:

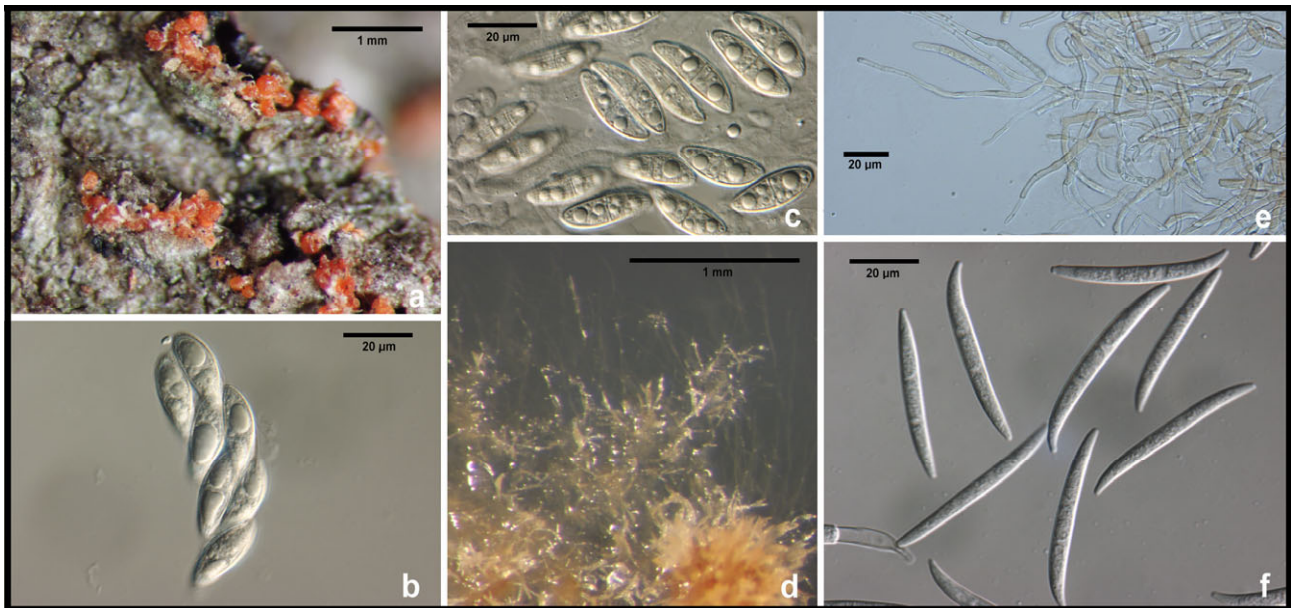
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Anamorph: *Volutella minima* Höhnelt**Habitat:** On decaying herbaceous debris.**Known distribution:** Pantropical and subtropical extending into the GSMNP.**Description:**

Perithecia (a, b) superficial, solitary or in groups of 2–6, pyriform with an acute papilla, $210\text{--}270 \times 150\text{--}220\text{ }\mu\text{m}$, red to red-orange with a darker papilla, collapsing by lateral pinching when dry, smooth and often shining. Asci (c, d) cylindrical to narrowly clavate, $40\text{--}55 \times 5\text{--}6\text{ }\mu\text{m}$, with a prominent ring in apex (d), 8-spored. Ascospores (e) fusiform, ellipsoidal or naviculate, $(9\text{--})10\text{--}11(\text{--}13) \times 3\text{--}4\text{ }\mu\text{m}$, hyaline or light brown, smooth, with median or slightly supramedian septum. Anamorph sporodochial (f, g) with long, glassy setae; arising from hymenium (g, i). Phialides forming in a hymenium (h, i). Conidia (h) ellipsoidal to bacillar, $(4.5\text{--})5\text{--}7(\text{--}13) \times 1.5\text{--}2.5(\text{--}3)\text{ }\mu\text{m}$, hyaline, unicellular.

Notes: Although this species has been included in *Cosmospora*, it probably does not belong in that genus.

Anamorph: *Fusarium* sp. sect. *Eupionnotes*



Habitat: On stromata of ascomycetes, including *Botryosphaeria* and *Valsa*.

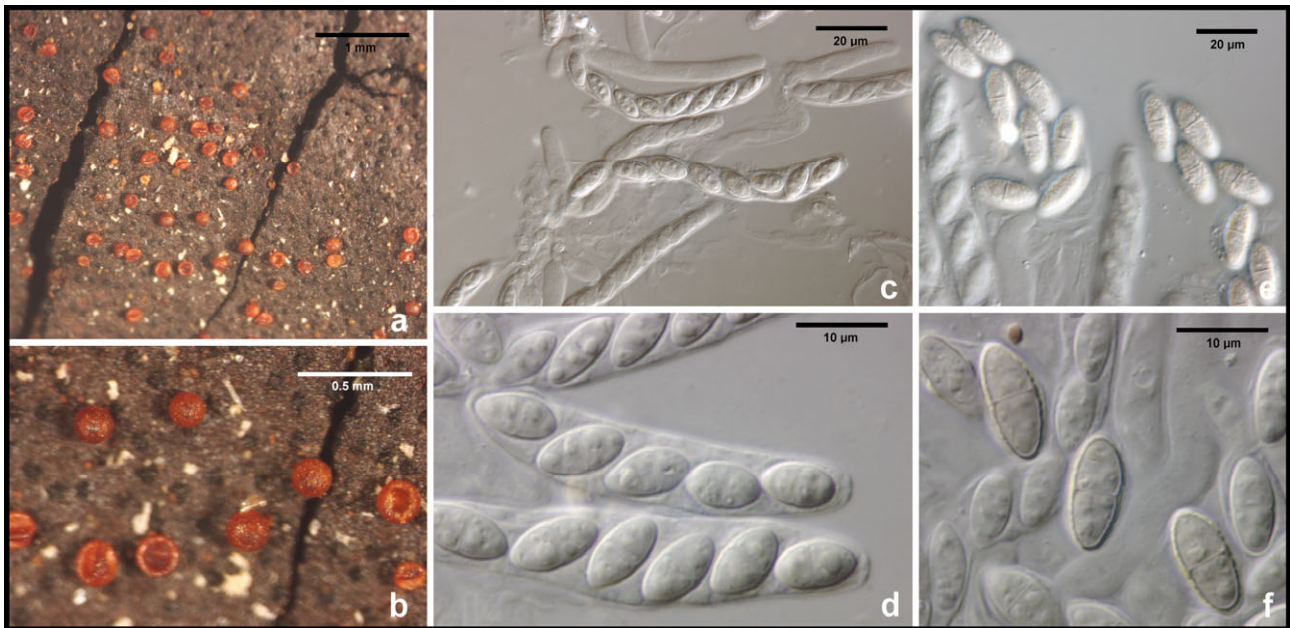
Known distribution: United States (NC, SC), Sri Lanka; rare.

Description:

Perithecia (a) typically gregarious or less commonly solitary, arising from a thin stromatic base growing over ostiola of host ascomycete, pyriform with a subacute papilla, 150–240 μm high \times 110–165 μm wide, red, smooth. Asci (b) broadly clavate, 50–85 \times 10–20 μm , with thin, simple apex, with biserial ascospores. Ascospores (c) ellipsoidal to fusiform, (18–)25–30(–36) \times (4.5–)6.0–9.0(–11) μm , striate, becoming pale brown, 1–3-septate. Growing very slowly on cornmeal dextrose agar; forming conidia in yellow-brown, sporodochial aggregates (d) with many projecting, pigmented, sterile hairs (e) mixed with conidiophores. Conidia (f) straight to slightly curved, more strongly curved at tip, with somewhat constricted, basal cell, (1–)3–4(–8)-septate, (24–)28–55(–70) \times 2.8–5.0 μm .

Notes: The *Fusarium* anamorph of this species has not previously been described. This is apparently a rare but cosmopolitan species, originally described from Sri Lanka.

Anamorph: *Fusarium aquaeductuum* (Radlk. & Rabenh.) Lagerh. var. *medium* Wollenw.



Habitat: On old stromatic ascomycetes on hardwood trees.

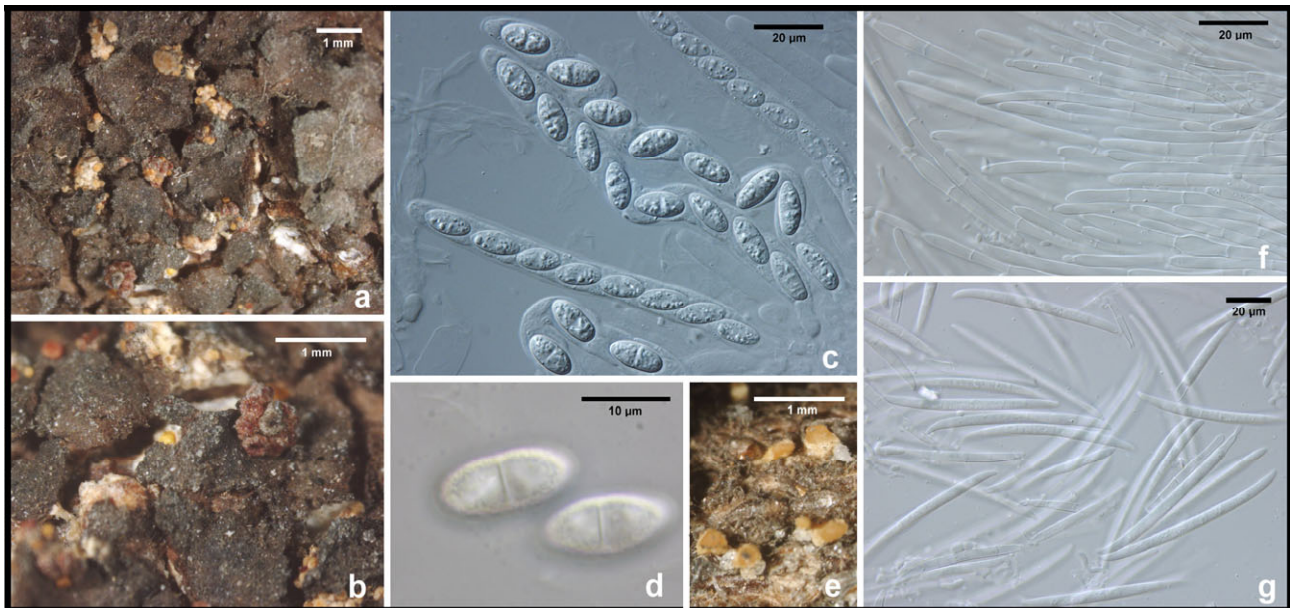
Known distribution: Common in north temperate regions.

Description:

Perithecia (a, b) superficial, on a thin, spreading stromatic or hyphal base, pyriform with an acute or round papilla, 125–140(–200) µm diam, KOH+ bright red, smooth, cupulate or laterally pinched when dry. Asci (c, d) cylindrical to narrowly clavate, 56–70 × 5–6 µm; with prominent ring at apex (d), 8-spored. Ascospores (e, f) ellipsoidal, (7.9–)8.8–10.8(–11.5) × (3.5–)4.0–4.7(–5.0) µm, pale yellow-brown when mature, smooth but tuberculate when mature (e, surface view of mature ascospores). *Fusarium* anamorph producing macro- and microconidia in slow growing, slimy colonies. Microconidia arising from acromonium-like conidiophores, cylindrical to ovoidal, straight or slightly curved, 6–9 × 2–3 µm, hyaline, unicellular. Macroconidia falcate, 35–50 × 2.5–3.5 µm, with a foot cell, hyaline, with 2–5 indistinct, transverse septa.

Notes: *Cosmospora episphaeria* is most similar to *C. purtonii* and *C. vilior*. The anamorph is critical for identification of species of *Cosmospora*. The anamorph is a member of *Fusarium* sect. *Eupionnotes*. DNA sequence data indicate that these species are only distantly related to species of *Fusarium* including the type species associated with *Gibberella* teleomorphs.

Anamorph: *Fusarium coccophilum* (Desm.) Wollenw. & Reink.



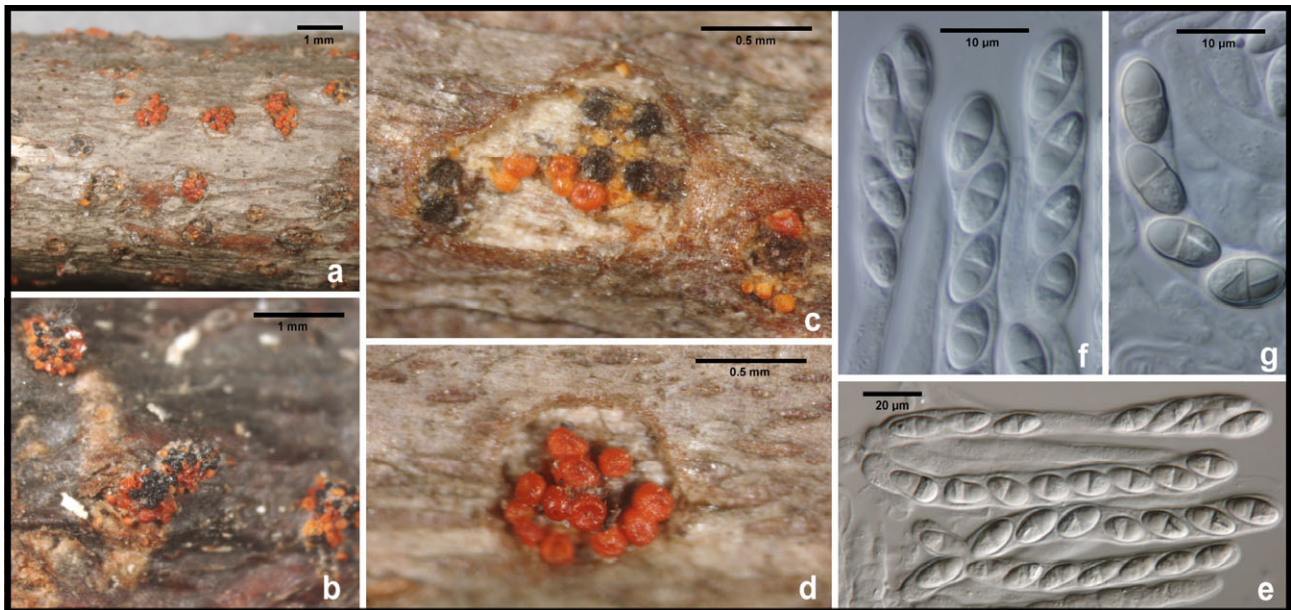
Habitat: On scale insects on leaves or bark.

Known distribution: United States (SC), Pantropical.

Description:

White stroma (a) forms on one side of or all around infected scale insects. Perithecia (a, b) arising from stroma around edge of insect, solitary to caespitose in groups of up to 12, globose with a blunt papilla, 380–400 µm diam, red, slightly roughened, cupulate when dry. Asci (c) cylindrical to narrowly clavate, 90–125 × 9–12.5 µm, with simple, rounded apex, 6–8 spored. Ascospores (d) ellipsoidal, 16–20 × 7.5–10 µm, smooth to slightly tuberculate, becoming pale yellow brown, with median septum. Sporodochia (a, b, e) arising from stroma on insect, forming a conical, horny orange mass of conidia (e). Conidia (g) arising from a palisade of cylindrical phialides (f), slightly curved, 80–100 × 6–7 µm, with or without a well-developed foot cell and 6–10 thin septa. Cultures very slow growing.

Anamorph: *Fusarium epistromum* (Höhn.) C. Booth



Habitat: On *Diatrypella* spp. on *Betula* spp., *Fagus* spp., *Quercus* spp., and *Wisteria* sp.

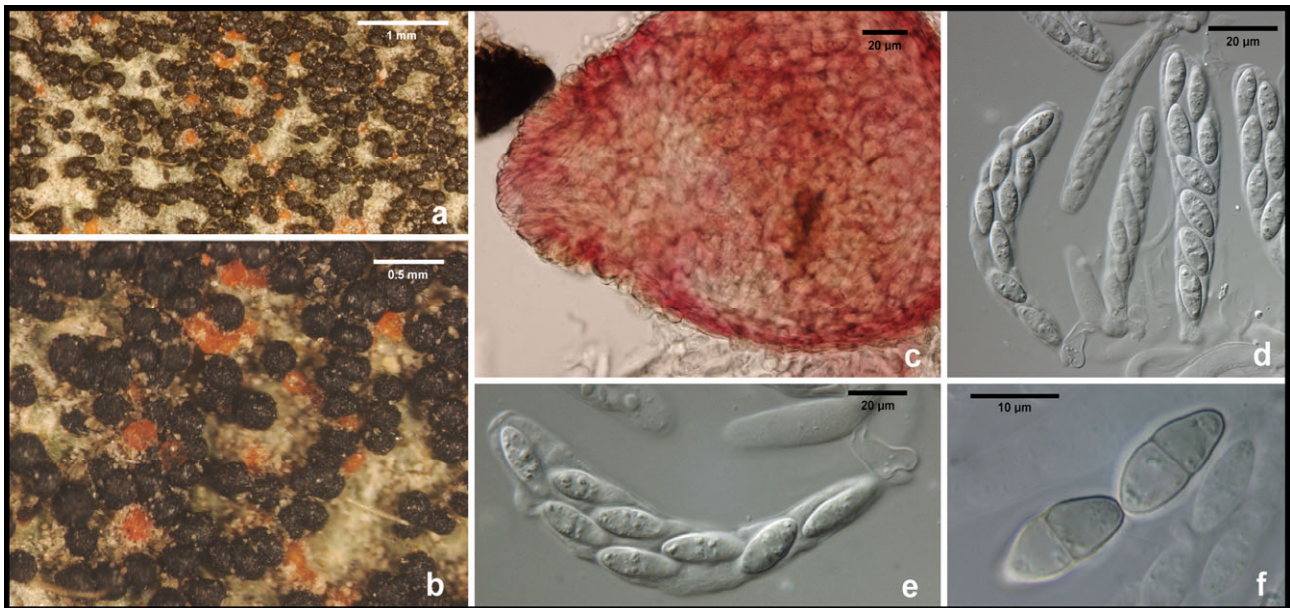
Known distribution: United States (SC), England, Europe.

Description:

Stroma first covering ostiolar regions of host *Diatrypella*. Perithecia (a–d) arising later, densely aggregated in groups of up to 20, globose with a flat ostiolar disk, collapsing cupulate, 250–350 μm diam, red, smooth. Asci (e, f) cylindrical to narrowly clavate, 72–94 × 9–12 μm, with broadly rounded, simple apex, 8-spored; with uniseriate ascospores with overlapping ends. Ascospores (g) broadly fusiform to broadly ellipsoidal, 10–15 × 4.5–6.0 μm, smooth, hyaline to pale yellow brown, with median septum. Conidiophores loosely branched synnemata. Conidia sickle-shaped, 17–27 × 2.5–4 μm, hyaline, 0–1-septate.

Note: According to Booth (1971), this species is a direct parasite of its host because the perithecia of *Diatrypella* do not mature.

Anamorph: None known.



Habitat: On *Parodiella perisporioides* and *P. grammodes* on leaves of dicotyledonous plants.

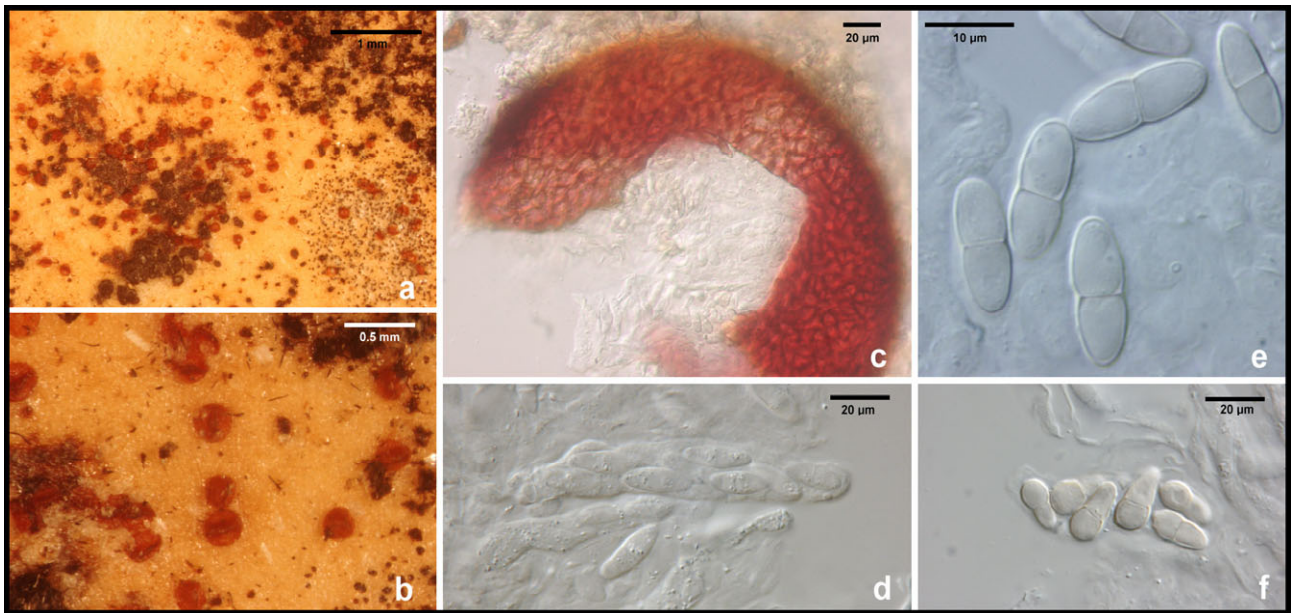
Known distribution: United States (MO, MS, NE, SC), Costa Rica.

Description:

Perithecia (a–c) forming on and among ascomata of host fungus, globose to broadly pyriform, 190–280 µm diam, with an obtuse apex, laterally pinched when dry, KOH+ red (c), smooth, glabrous or with scattered, 50 µm long hairs arising from perithecial surface. Asci (d, e) clavate, 65–100 × 10–15 µm, with conspicuous ring at broad apex, 8-spored, with biseriate ascospores. Ascospores (f) ellipsoidal to narrowly fusiform, 14–19(–28) × (5–)5.5–6.7(–8) µm, smooth, becoming pale yellow-brown, with median septum.

Notes: The wide distribution of this species indicates that it might be more common than is suggested by the herbarium holdings. Its occurrence on ascomycetes on leaves of plants is unusual for a member of the *Nectriaceae*.

Anamorph: None known.



Habitat: On fruit of *Cucurbita maxima* and herbaceous tissue of *Brassica* sp.

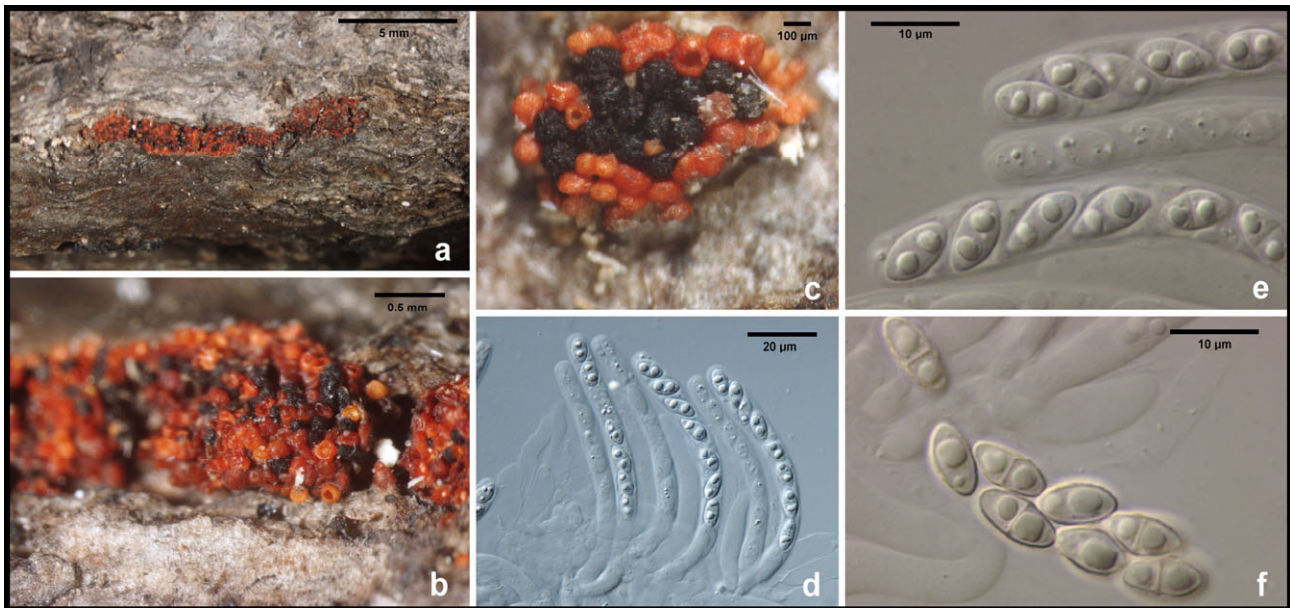
Known distribution: United States (FL, GA, NJ, SC, VA), England.

Description:

Perithecia (a, b) superficial, solitary to densely gregarious, non-stromatic, slightly immersed at base, pyriform, 190–280 µm high, 150–190 µm wide, with acute apex, red, KOH+ dark red, smooth, collapsing by lateral pinching; cells at surface of perithecial wall (c) distinctly angular, 7–10 µm diam. Asci (d) clavate, 55–70 × 7.5–12 µm, apex broadly rounded, with a minute ring, 8-spored. Ascospores (e, f) ellipsoidal to fusiform, 9.5–13 × 4–5 µm, smooth, becoming pale yellow-brown, with median or slightly supramedian septum.

Notes: No anamorph has been found in association with this infrequently collected species but it is likely to be a *Fusarium*.

Anamorph: *Fusarium aquaeductuum* (Radlk. & Rabenh.) Lagerh. var. *aquaeductuum*



Habitat: On old stromata of immersed pyrenomycetes especially *Diatrype stigma* and on bark of hardwood and conifer trees.

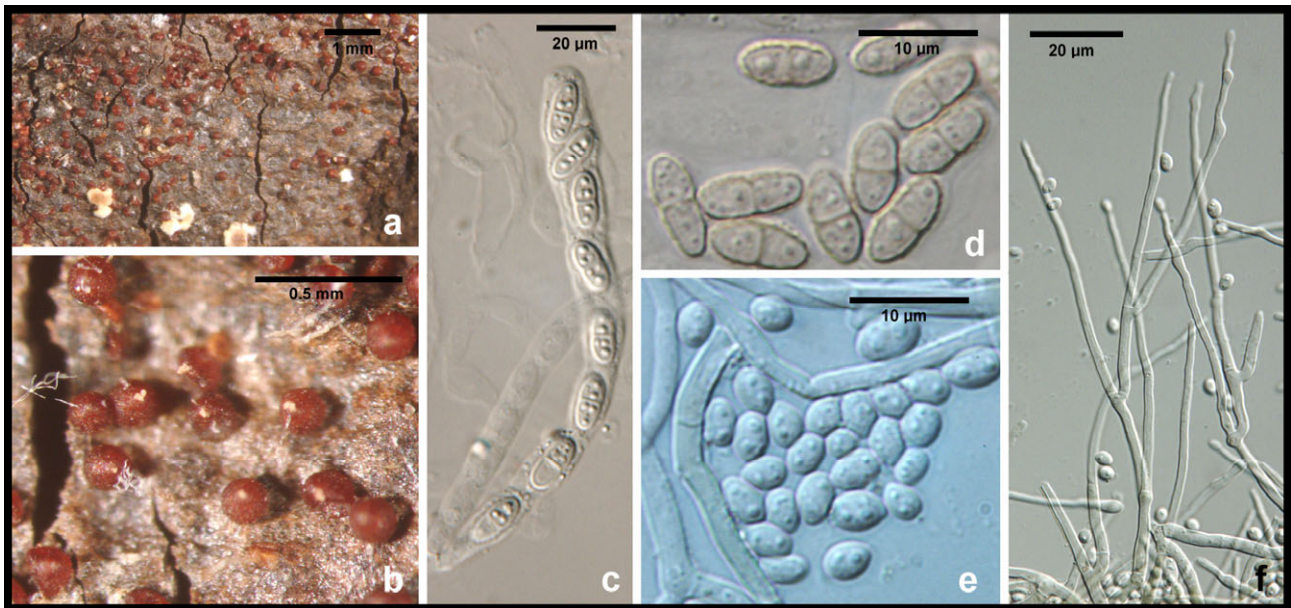
Known distribution: North temperate regions.

Description:

At first a thin, conidiogenous stromatic layer forming over ostiola of old, pyrenomycetous stromata. Perithecia (a–c) arising later from stroma, densely gregarious, broadly pyriform with a flat or concave apex, 150–230 µm diam, waxy, smooth, red, laterally pinched when dry. Asci (d, e) at first cylindrical but becoming clavate, 55–70 × 6–10 µm, with broad apex and an inconspicuous ring, 8-spored, ascospores becoming biseriate. Ascospores (e, f) ellipsoidal, 8–11 × 3.5–4.5 µm, becoming slightly tuberculate, pale yellow brown. Cultures slow growing, slightly yellow-brown, slimy. Microconidia allantoid, 5–7 × 1.5–2.0 µm. Macroconidia developing later, fusiform, curved, 20–24 × 1.5–2.0 µm, with a poorly developed foot cell, 1-septate.

Notes: This species is similar to *C. episphaeria* with which it is sympatric. The two species are most readily distinguished by their anamorphs. The perithecium of *C. purtonii* tends to have an apical disk. *Cosmospora vilior* is also similar but is distinguished by its smaller, more strongly tuberculate ascospores and its verticillium-like anamorph.

Anamorph: *Acremonium berkeleyanum* (P. Karst.) W. Gams



Habitat: Fungicolous, most frequently on old stromata of members of the *Xylariaceae* but also on other pyrenomycetes.

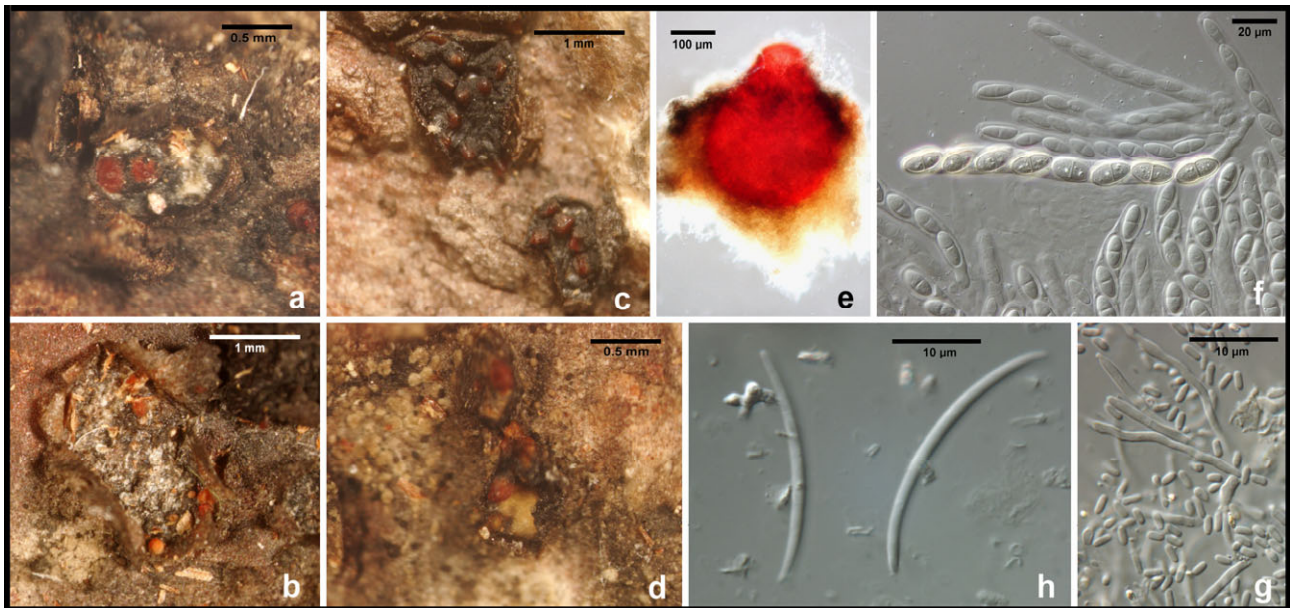
Known distribution: Cosmopolitan but especially common in tropical regions: United States (IN, LA, NC but probably widespread); pantropical, United Kingdom, Europe, New Zealand.

Description:

Perithecia (a, b) scattered to gregarious, apparently superficial but with base firmly attached, pyriform with an acute apex, 150–200 µm diam, smooth, red, KOH+ dark red, collapsing by lateral pinching. Asci (c) cylindrical, 70–75 × 6–10 µm; with a prominent ring in apex; 8-spored, with ascospores becoming partly biserial. Ascospores (d) ellipsoidal, (5.5–)8–11(–13) × (3–)3.7–5.5(–6) µm, conspicuously tuberculate, becoming yellow-brown, with median septum. Agar colonies green, often iridescent. Conidiophores (f) acremonium- or verticillium-like, often with green inclusions. Conidia (e) ellipsoidal, 7.5–10.0 × 4–5 µm, unicellular, held in drops of clear green liquid.

Notes: This species is common on members of the *Xylariaceae* in all tropical regions. In the northern hemisphere ascospores are not as conspicuously tuberculate as they are in tropical collections. Booth (1959) identified northern collections as *Nectria viridescens* C. Booth. Cultures derived from tropical and temperate collections are identical.

Anamorph: *Fusarium* sp. sect. *Eupionnotes*



Habitat: On *Abies fraseri*, possibly fungicolous.

Known distribution: United States (TN GSMNP).

Description:

Perithecia (a–d) arising in small lesions in bark, from 2–10 in each lesion, partially immersed in a hyphal matrix; matrix becoming black and crustose at surface when dry; hyphae of matrix ca. 3 µm wide, KOH+ yellow-brown, septate, slightly thick-walled, straight, no visible clamps. Perithecia (e) pyriform, apex acute, smooth, red, KOH+ dark red; cells at surface thick-walled forming *textura epidermoidea*. Perithecial wall made of a single region. Asci (f) cylindrical, (80–)89–102(–103) × (6.8–)7.8–9.5 µm, with a thickened apex and a ring; spores uniseriate with overlapping ends. Ascospores (f) ellipsoidal to fusiform, (10.0–)10.7–12.7(–14.0) × (4.5–)5.2–6.2(–6.8) µm, with median septum, yellow brown, with numerous small warts. Conidia forming in a yellow, slimy hymenium (d, g), oblong, minute, arising from phialides (g). *Fusarium* macroconidia (h) present around base of one observed perithecium, 32–48 × 2.3–3.2 µm, 1–3 septate, with a slightly foot-shaped basal cell.

Notes: This specimen is similar to *C. episphaeria* but has wider ascospores. The perithecia are associated with small cankers suggesting that it is a parasite of the *Abies*, however, most species of *Cosmospora* are parasitic on other fungi. Whether the conidial forms associated with these perithecia actually belong to it is not known. We include it here in the hope that it will be recollected.

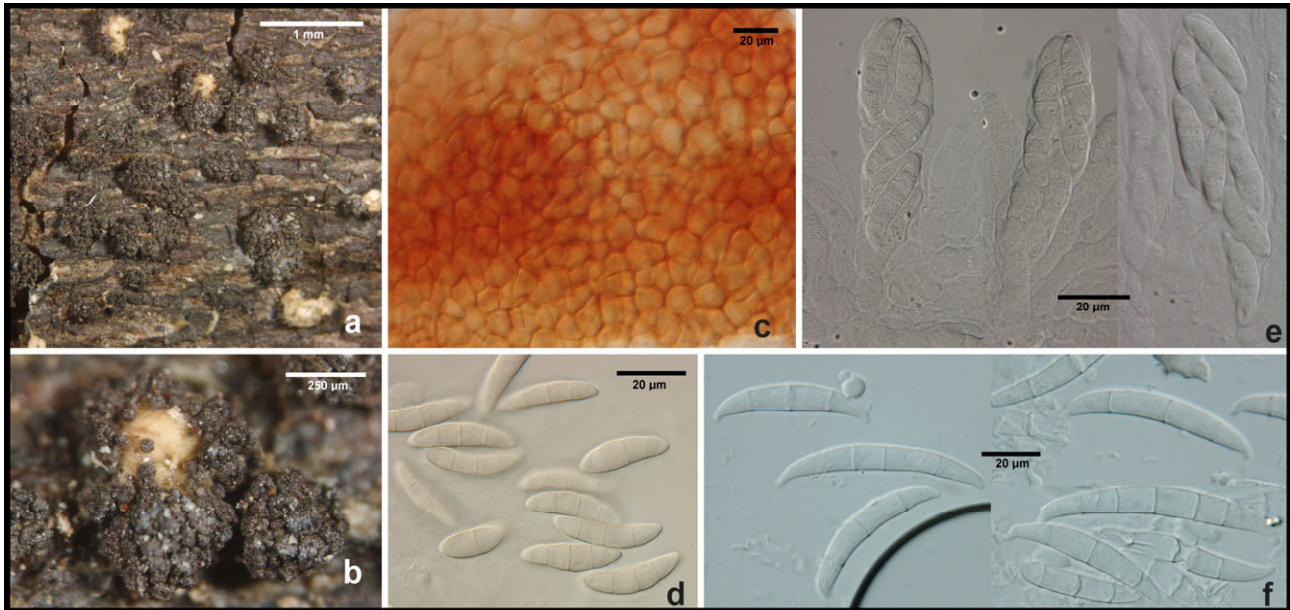
Ascomata superficial, solitary or caespitose in clusters of many, typically erumpent or at least difficult to remove from the substratum if not obviously stromatic. Ascomata subglobose to ovoidal, dark purple, appearing black by reflected light, in some species becoming red in KOH and yellow in lactic acid; in other species purple in KOH and red in lactic acid. Asci clavate, thin-walled, most often lacking an apical discharge mechanism. Ascospores fusiform, straight or sometimes curved, 1–3-septate when mature, pale yellow-brown following discharge. Cells of the perithecial surface angular, 15–30 × 10–20 µm, walls thickened, pigmented.

Anamorphs: *Fusarium* sects. *Roseum*, *Gibbosum*, *Fusarium* (= *Discolor*), *Lateritium*, and *Liseola*.

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Anamorph: *Fusarium sambucinum* Fuckel



Habitat: Tree canker, rot of potatoes.

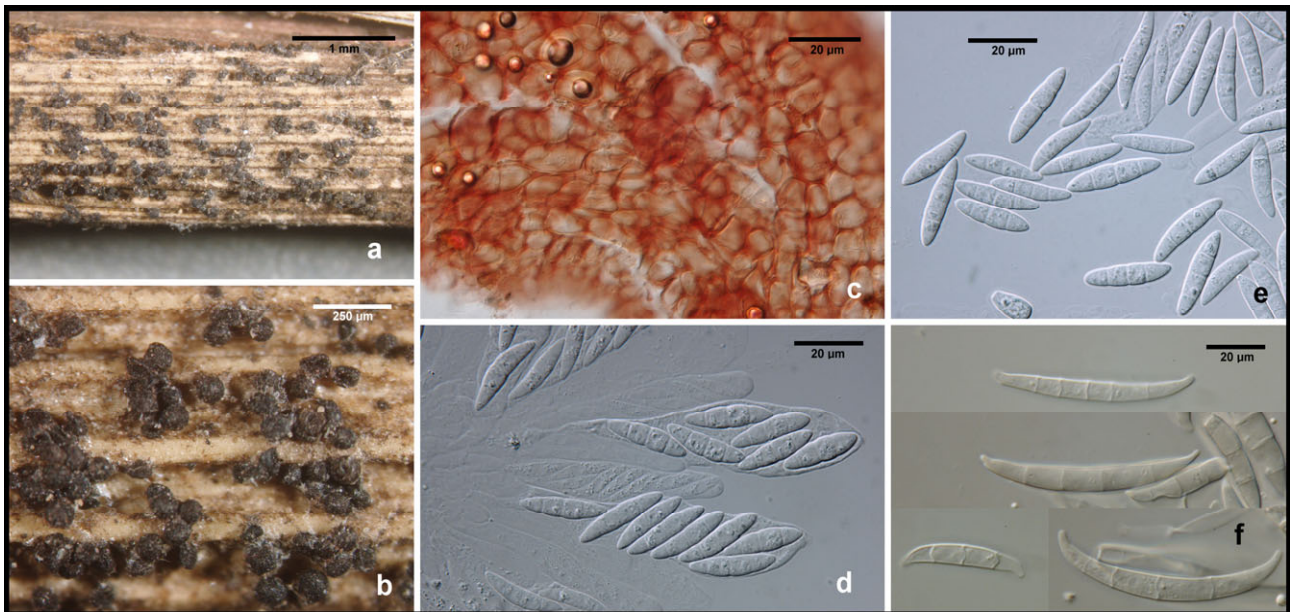
Known distribution: Common, cosmopolitan but probably more common in the northern hemisphere. Not yet known from this region but probably present.

Description:

Stromata erumpent through bark, sometimes conspicuous and at first producing conidia, later completely covered with perithecia (a, b), other times inconspicuous. Perithecia (b) forming in great numbers, dark purple, nearly black; purple in KOH, red in lactic acid, 220–266 µm high, 150–240 µm wide, warted. Cells at surface of perithecial wall and warts (c) angular, 7–10 µm diam, walls thickened, 2–2.5 µm, pigmented (c). Asci (e) containing 4–8 ascospores. Ascospores (d) eventually 3-septate, yellow-brown, 20–28 × 6–9 µm (from Booth 1971). Conidia (f) from nature 3–5-septate; 3-septate 22–35 × 4.0–5.2 µm; 4, 5-septate 26–44 × 4.0–5.6 µm (from Nirenberg 1976).

Notes: *Fusarium sambucinum* has been treated in a broad sense over the years. Nirenberg (1989, 1995) has limited it to collections from bark and potato. Ascospores of *G. pulicaris* are among the largest in the genus.

Anamorph: *Fusarium graminearum* Schwabe



Habitat: On cereals and other grasses but also on a wide range of dicotyledonous plants.

Known distribution: Worldwide.

Description:

Perithecia (a, b) dark purple to black when fresh and dry, red in lactic acid (c), ovoidal, 150–250 µm diam, tuberculate, collapsing by lateral pinching or becoming slightly cupulate when dry; cells at surface of perithecial wall angular, ca. 10 µm diam, walls slightly thickened. Asci (d) clavate, thin-walled, 4–8-spored, apex lacking a discharge mechanism. Ascospores (e) fusiform to ellipsoidal, 3-septate, 20–30 × 3.5–4.5 µm, pale brown after discharge. Cultures on PDA fast growing, whitish, pinkish, golden yellow, ochraceous to grayish rose, crimson, finally dark purple to vinaceous. Sporodochial conidia (f) (3–)5–6(–9)-septate, 40–60 × 4.5–5.0 µm when 5-septate; homothallic.

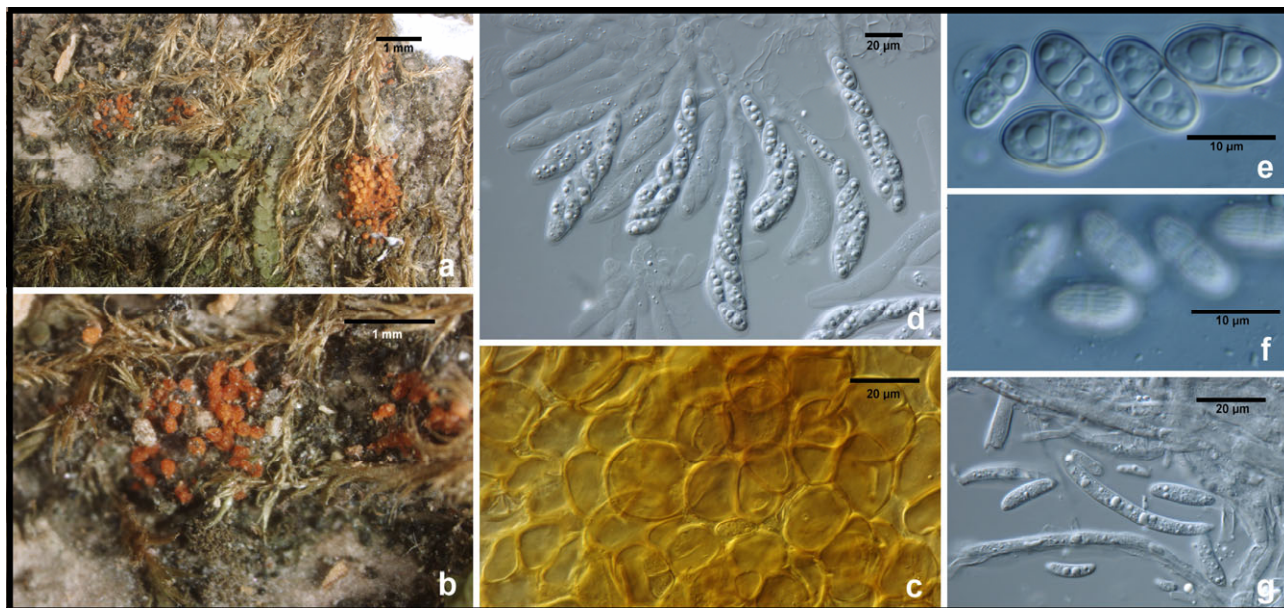
Notes: This species has not been recorded for this region, but certainly occurs here.

Perithecia non-stromatic or with a basal stroma, solitary to gregarious, superficial, globose to pyriform, yellow to red, KOH+ slightly darkening, collapsing laterally when dry, coarsely warted, warts formed of angular cells, 15–30 µm diam, with thickened walls, with simple apex, of clavate hyphal elements. Asci clavate, apex simple, rarely with a ring, ascospores biseriate above, uniseriate below. Ascospores ellipsoid, often with ends slightly truncate, translucent yellow-brown, striate or spinulose. Anamorph *Fusarium* sect. *Martiella* or unknown. Saprobiic and pathogenic on woody and herbaceous substrata.

Literature:

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- O'Donnell, K. (2000). Molecular phylogeny of the *Nectria haematococca-Fusarium solani* species complex. *Mycologia* **92**: 939–954.
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- Samuels, G.J. & Brayford, D. (1994). Species of *Nectria* (*sensu lato*) with red perithecia and striate ascospores. *Sydowia* **47**: 75–161.

Anamorph: *Fusarium* cf. *solani* (Mart.) Sacc.



Habitat: On bark of recently dead trees, sometimes on herbaceous tissue.

Known distribution: The type specimen from Sri Lanka is distinct from more widely distributed specimens. The current concept of the species is too broad to accurately reflect distribution. Collections of this species in the broad sense have been made in North Carolina.

Description:

Perithecia (a, b) solitary to densely gregarious, superficial, not obviously stromatic but difficult to remove from substratum, globose to broadly pyriform (225–)275–325 µm, red to orange-red, with coarse red to yellowish warts, KOH+ dark red, yellow in lactic acid (c, wall surface in lactic acid), non-papillate or with acute papilla, collapsing laterally. Cells at wall surface (c) large, angular. Asci (d) broadly cylindrical to clavate, 60–90 × 10–17 µm, 8-spored, with obliquely biseriate ascospores. Ascospores (e = surface view, f = optical section) ellipsoidal, (9–)13–16(–18) × (4–)6–8(–9) µm, 1-septate, hyaline at first, becoming yellow-brown, finely striate. *Fusarium* anamorph (g) typically producing microconidia in wet heads from long, acremonium-like phialides, and macroconidia. Macroconidia (g) typically 3–5-septate, with a more or less well-developed basal foot cell.

Notes: The grossly warted, red perithecia, and yellow-brown, striate ascospores are diagnostic of this ‘species.’ The current concept of *H. haematococca* is polyphyletic, comprising several species, many of which may be morphologically indistinguishable. *Haematonectria ipomoeae* (Halst.) Samuels & Nirenberg, a homothallic species described from *Solanum melongena* in New Jersey, is morphologically indistinguishable from *H. haematococca*, at least as the anamorph. *Neocosmospora*, which is derived from within *Haematonectria*, provides an older name (see O’Donnell, 2000).

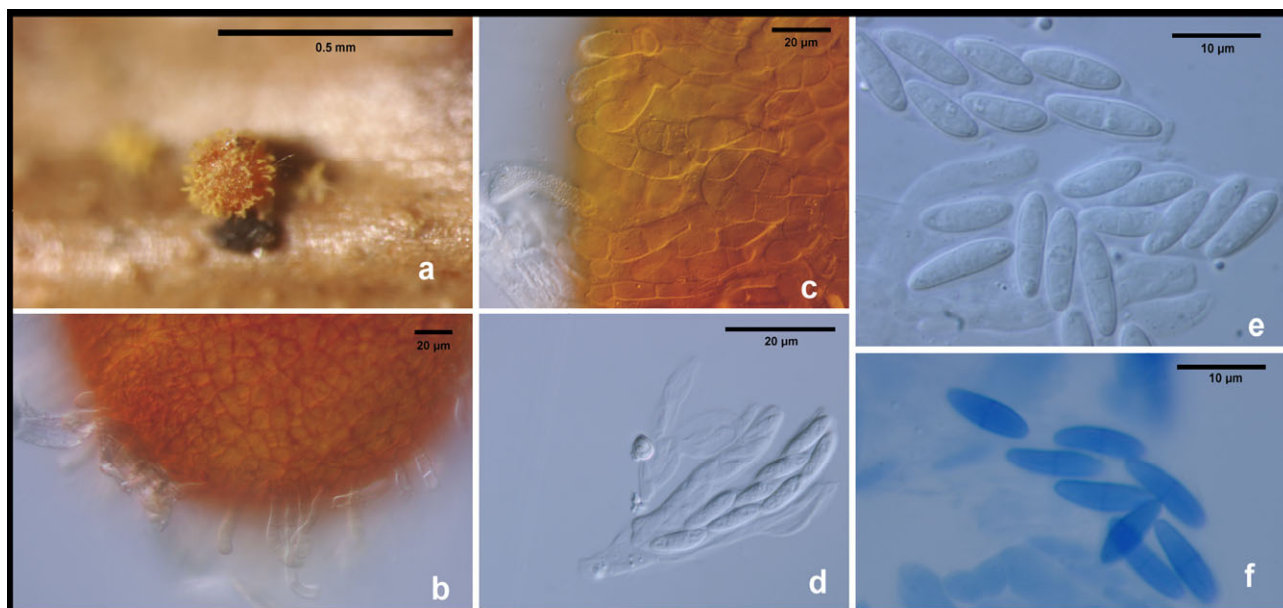
Stroma continuous with perithecial base, pseudoparenchymatous or of highly compacted, somewhat thick-walled hyphae. Perithecia superficial on a minute basal stroma that had previously borne conidia, or at base of a synnema, subglobose to broadly obpyriform, not collapsing when dry; red, KOH+ dark red, yellow in lactic acid, non-papillate or with a minute papilla, with hyaline to yellow hyphal hairs; hairs smooth or spinulose, hooked or straight, septate, thin-walled, arising from surface of perithecial wall and from around perithecial base, sometimes forming a tomentum on perithecial surface. Perithecial wall with outer region of conspicuously angular cells, 10–15 µm diam, with 1.5–2 µm thick walls. Asci clavate to fusiform, with simple apex or with a ring, with biseriate ascospores. Ascospores ellipsoid to fusiform, medially 1-septate, hyaline or rarely pale yellow-brown, striate. Anamorph, where known, *Actinostilbe*. On decaying woody and herbaceous substrata, also on stromatic fungi.

Literature:

Rossman, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (Hypocreales, Ascomycetes). *Studies in Mycology* **42**: 1–248.

Samuels, G.J. & Brayford, D. (1994). Species of *Nectria* (*sensu lato*) with red perithecia and striate ascospores. *Sydowia* **47**: 75–161.

Anamorph: *Actinostilbe macalpinei* (Agnihotrudu & Barua) Seifert & Samuels



Habitat: On recently dead twigs of woody plants, also on pyrenomycetous stromata and herbaceous debris, including pods of *Theobroma cacao* and stems of *Smilax* sp.

Known distribution: United States (TN GSMNP), pantropical.

Description:

Perithecia (a) solitary, superficial, possibly erumpent, non-stromatic, globose to broadly pyriform, ca. 150 µm diam, red, KOH+ dark red, not collapsing; cells at surface (b) distinctly angular, 5–14 µm diam; hairs (c) scattered over upper half. Hairs (a, b, c) yellow, straight or hooked at tip, often enlarged at tip, septate, conspicuously spinulose, 25–70 µm long, 6–10 µm wide. Asci (d) clavate, ca. 40 × 9 µm, with a ring at apex, with biseriate ascospores. Ascospores (e, f in cotton blue/lactic acid) narrowly ellipsoidal, 10–13 × 2.5–4.5 µm, hyaline, striate, medially 1-septate.

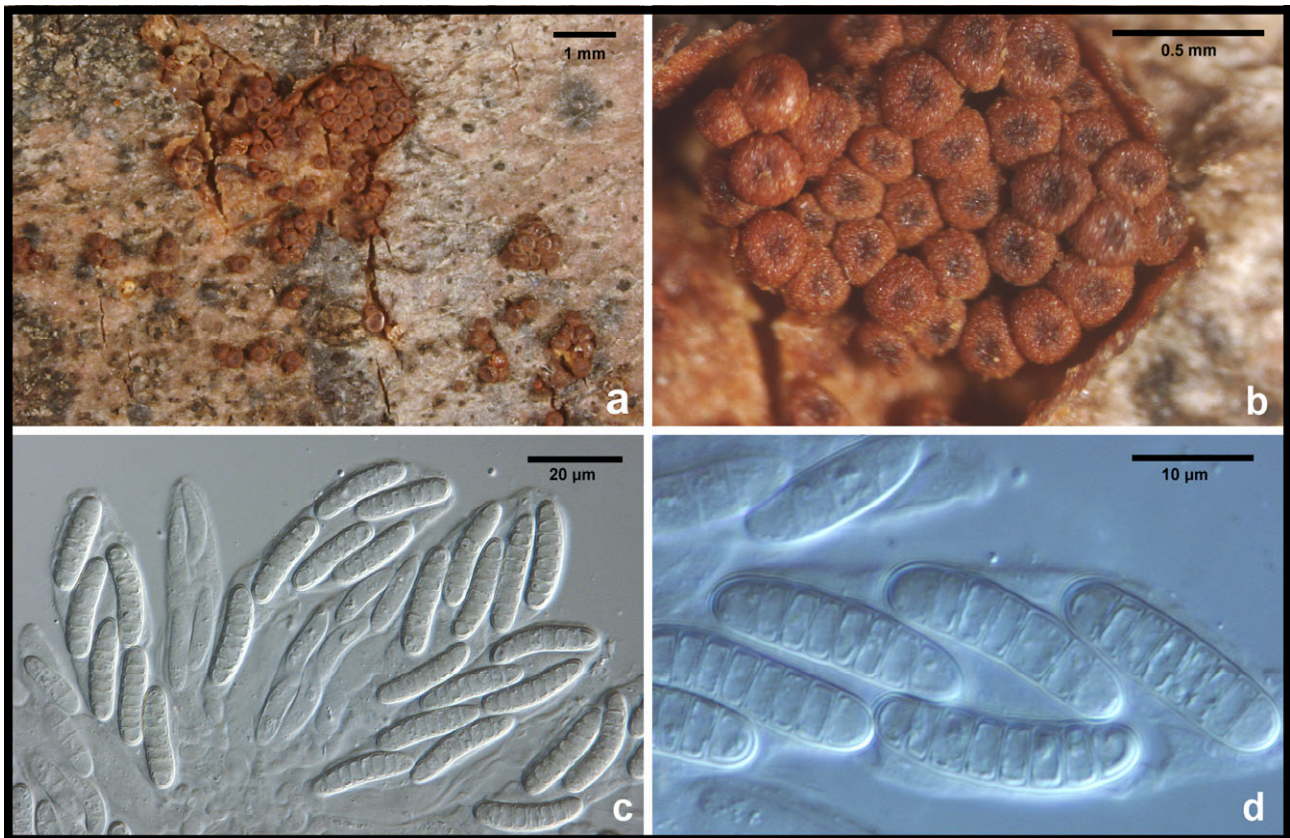
Notes: This description and illustrations are based on the type specimen of *Nectria flavociliata* Seaver, which was collected in GSMNP on stems of *Smilax* sp. It is typical of *L. flocculenta*, a common and widespread tropical species, which is better known and misidentified as *Nectria flavolanata* Berk. & Broome.

Stroma well-developed, pseudoparenchymatous. Perithecia superficial, generally aggregated on a stroma. Perithecia subglobose, globose to ellipsoid, collapsing cupulate, red to dark red, KOH+ purple, ostiolate, with walls more than 25 µm thick, often with warted outer region of thick-walled cells. Asci 8-spored, rarely 4-spored. Ascospores broadly ellipsoid to long-fusiform, aseptate, 1- to multi-septate, or muriform, hyaline to yellow-brown, smooth to striate. Anamorph *Tubercularia* and related pycnidial and synnematal species. On decaying woody dicotyledonous substrata, also on decaying leaves of *Agavaceae*.

Literature:

- Bedker, P.J. & Wingfield, M.J. (1983). Taxonomy of three canker-causing fungi of honey locust in the United States. *Transactions of the British Mycological Society* **81**: 179–183.
- Booth, C. (1959). Studies of pyrenomycetes. IV. *Nectria* (part 1). *Mycological Papers* **73**: 1–115.
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- Samuels, G.J., & Seifert, K.A. (1991). Two new species of *Nectria* with *Stilbella* and *Mariannaea* anamorphs. *Sydowia* **43**: 249–263.
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- Seifert, K.A. (1985). A monograph of *Stilbella* and some allied hyphomycetes. *Studies in Mycology* **27**: 1–234.

Anamorph: None known.



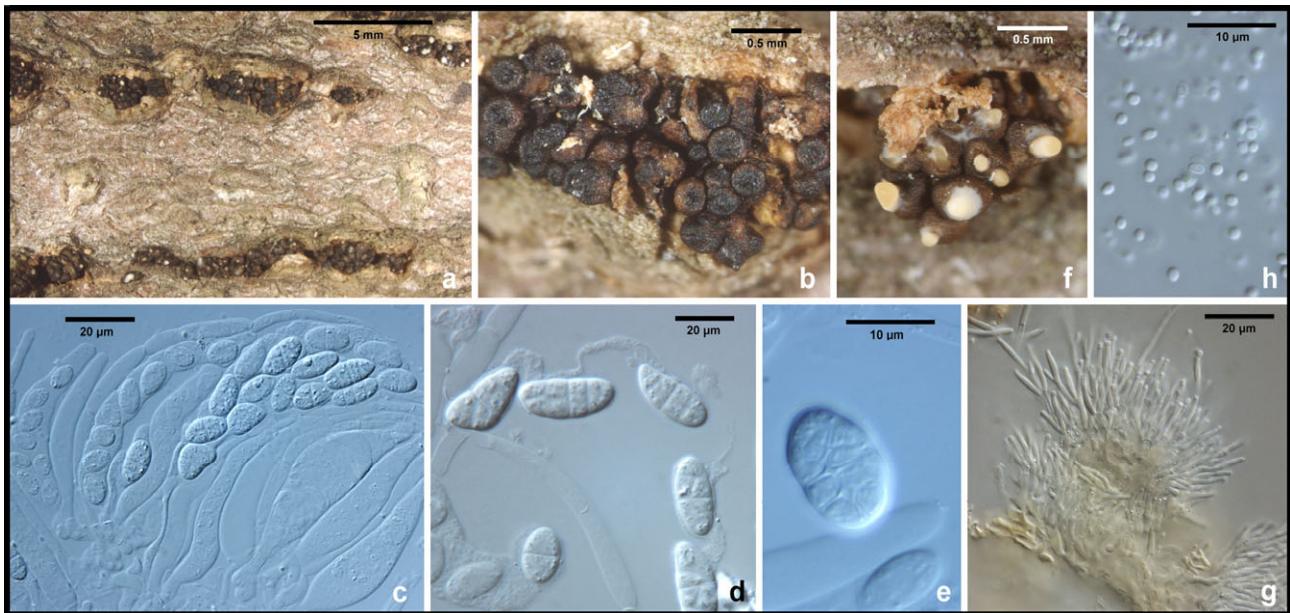
Habitat: Primarily known from members of the *Oleaceae* including *Chionanthus*, *Fraxinus*, *Jasminum* and *Ligustrum*. Also reported on *Liquidambar* and *Ulmus*.

Known distribution: United States (AL, DE, NJ, SC), recently discovered on *Fraxinus* in France (Lechat, 2002).

Description:

Perithecia (a, b) solitary or in groups up to 30, superficial on well-developed stroma, fruiting bodies scarlet, darker when dry, KOH+ purple, globose, subglobose or turbinate, often apically flattened, slightly cupulate or not collapsing when dry, $275\text{--}425 \times 280\text{--}450 \mu\text{m}$, without papilla but often with sunken apex that is darker than body, surface with pure yellow to greenish yellow scurf. Asci (c) clavate, $35\text{--}65 \times 12\text{--}18 \mu\text{m}$, with simple apex. Ascospores (d) $18\text{--}26 \times 5\text{--}6.5 \mu\text{m}$, long-ellipsoid, curved with broadly rounded ends, (4–6–)7-septate, smooth.

Anamorph: *Gyrostroma austroamericana* Seeler (pycnidial)



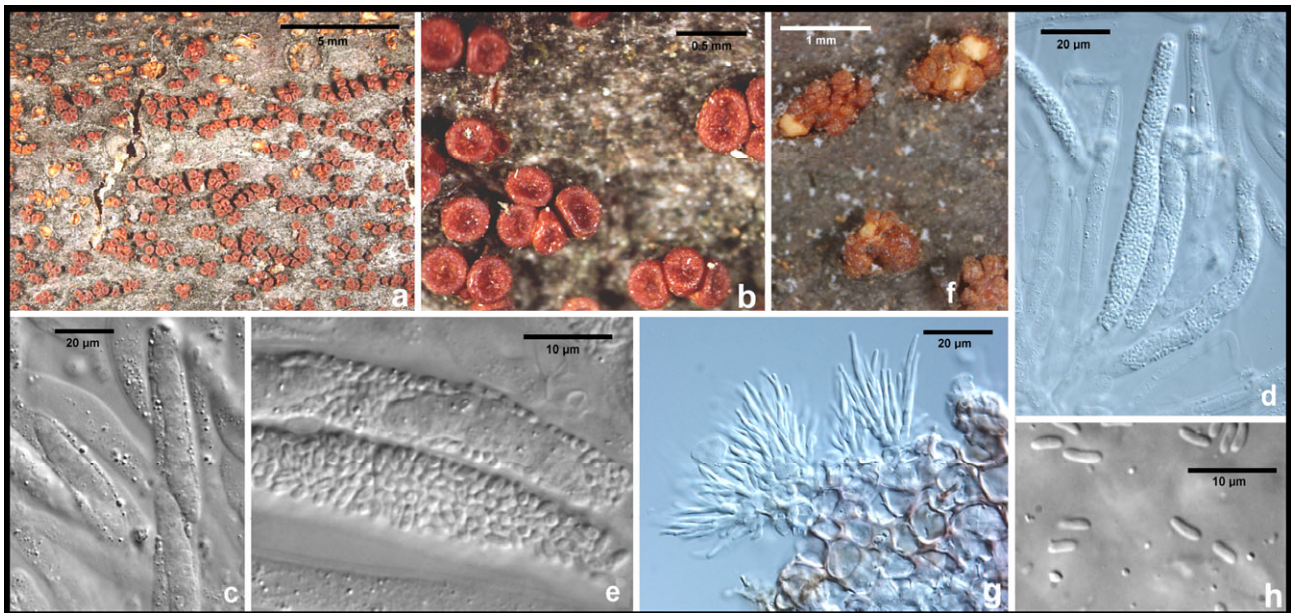
Habitat: On *Gleditsia triacanthos*, causing a canker of honey-locust in North America, and *Gleditsia japonica*; also reported from *Acacia* sp. in South America.

Known distribution: North and South America.

Description:

Perithecia (a, b) in clusters, crowded, superficial or slightly embedded on a well-developed stroma, yellow-brown or grey, becoming dark, often black, KOH+ darker, globose to turbinate, cupulate when dry, 200–450 μm diam, with dark, shining papilla, with finely wrinkled to granular outer surface. Asci (c) 60–100 × 8–19 μm. Ascospores (c-e) 8–16 × 4.5–9 μm, broadly ellipsoidal, irregularly septate, with 3–6-transverse and one longitudinal septae, smooth, occasionally budding in asci. Anamorph stromatic, pycnidial (f); phialides (g) lining entire inner wall of pycnidia. Conidia (h) ellipsoidal, (1.5–)2.2–3.0(–3.2) × 1.0–1.7(–2.0) μm, hyaline, in pale salmon slime.

Anamorph: *Zythiostroma* sp. (pycnidial)



Habitat: Erumpent through needle scars and on twigs and branches of recently killed conifers.

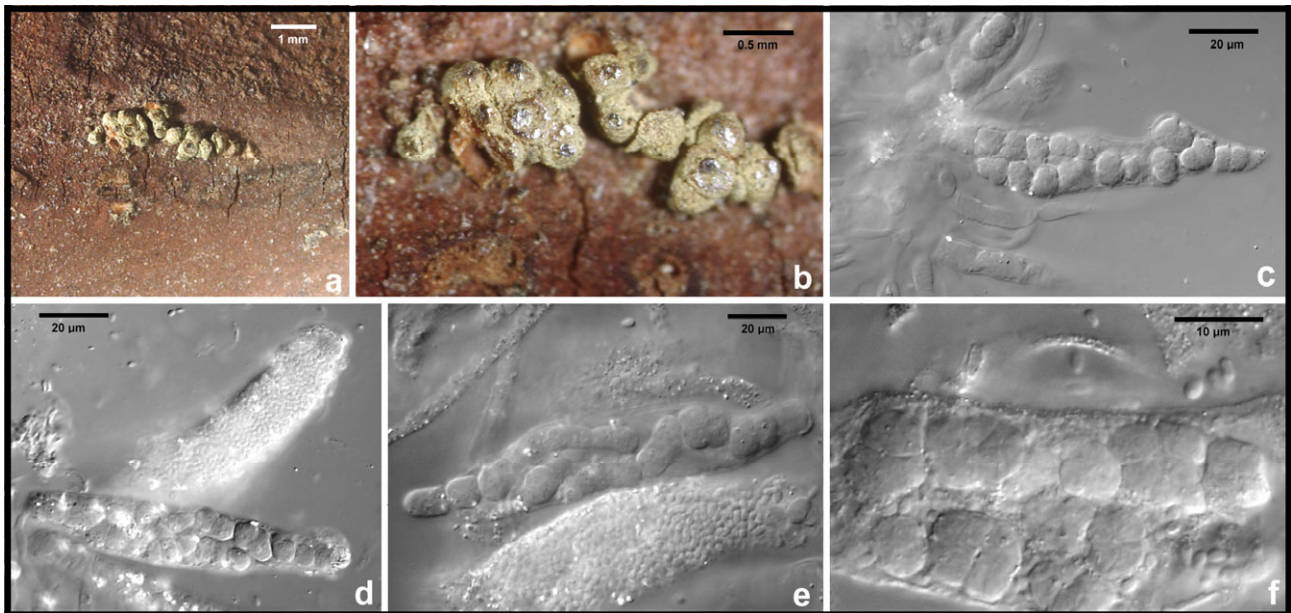
Known distribution: Known primarily from North America, also reported from Europe.

Description:

Perithecia (a, b) in groups of up to 20, superficial on a well-developed stroma, often erumpent through needle scars on small twigs, scarlet, becoming dark with age, KOH+ purple, globose to subglobose, cupulate when dry, 300–425 µm diam, often with sunken apex and surrounded by darkened area, with short papilla; outer surface with scurf that varies from white to pure yellow, greenish-yellow or concolourous with wall. Asci (d, e) 75–120 × 6–10.5 µm, 1–4 spored. Ascospores (c–e) 17–26 × (3–)5–6 µm, ellipsoid to fusoid, irregularly 3–5 septate with one irregular longitudinal, often oblique septum, smooth, budding early. Ascoconidia filling asci early (e), 3–4 × 1 µm, ellipsoid to allantoid, unicellular, hyaline, smooth. Anamorph stromatic, pycnidial (f), appearing before perithecia but similar in colour, somewhat irregular in shape. Phialides (g) lining interior of pycnidial wall. Conidia (h) bacillar to allantoid, minute.

Notes: *Nectria balsamea* is identical to *N. cucurbitula* except for the much longer ascospores of *N. cucurbitula*. The shape and septation of the ascospores are obscured at maturity by the production of numerous ascoconidia.

Anamorph: None known.



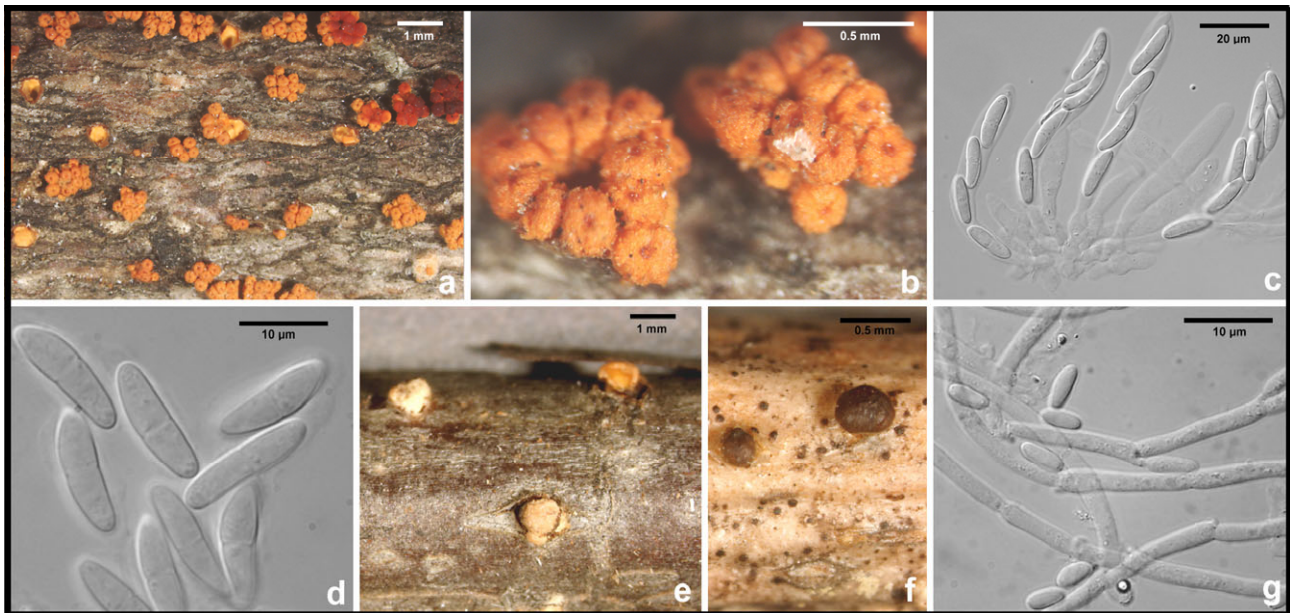
Habitat: Known only on inner bark of *Ulmus americana*.

Known distribution: United States (AL, NC).

Description:

Perithecia (a, b) solitary or in groups of 2–8, with protruding papilla, often covered with bright yellow scurf, KOH+ purple. Asci (c, d) $80\text{--}90 \times 10\text{--}15\ \mu\text{m}$, usually 4-spored. Ascospores (e, f) finely muriform, deeply constricted, disarticulating into single cells, $4.5\text{--}8.5\ \mu\text{m}$ diam, budding to produce numerous ascoconidia (e, f). Ascoconidia $2\text{--}2.5\ \mu\text{m}$ long, hyaline.

Anamorph: *Tubercularia vulgaris* Tode : Fr.



Habitat: Common on newly killed and weakened woody substrata.

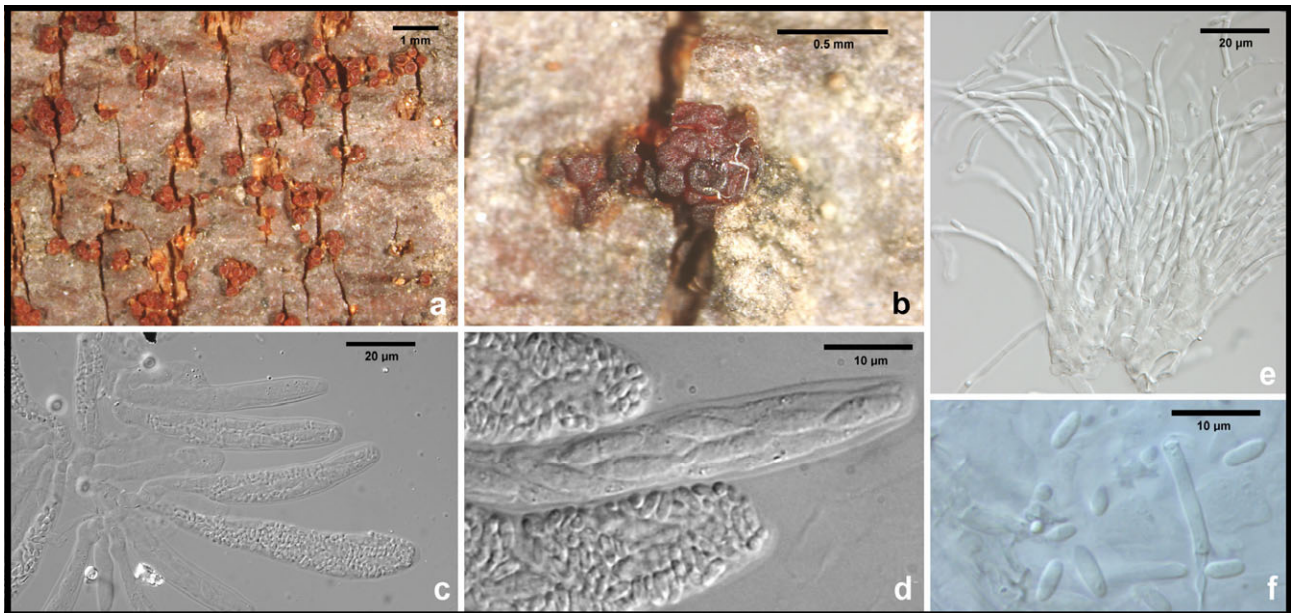
Known distribution: Widespread in north temperate regions, also known from southern temperate regions.

Description:

Perithecia (a, perithecia in upper right of figure treated with KOH; b) in groups up to 15 on an erumpent, well-developed stroma, sometimes clustered around pink to pale orange sporodochia, orange to red-brown, KOH+ purple, globose to slightly cupulate, 250–400 µm diam, non-papillate, often darker around ostiole, usually with a conspicuously warted wall, though sometimes smooth-walled. Asci (c) 60–90 × 7–11(–14) µm. Ascospores (d) (14–)16–23 × 4–6 µm, ellipsoid, usually slightly curved, 1(–3) septate, smooth. Anamorph sporodochial. Sporodochia (e, f) erumpent through bark, appearing before perithecia, with an hymenium of conidiophores and phialides covering surface. Conidiophores often elongating sympodially. Conidia (g) ellipsoidal to allantoid or ovoidal, 5–7 × 2–3 µm, held in masses of cream and later coral-coloured slime.

Notes: In tropical regions, *Nectria pseudotrichia* fills the ecological niche of *N. cinnabarina*. Although appearing similar to *N. cinnabarina*, *N. pseudotrichia* has muriform, striate ascospores, and the anamorph is synnematous.

Anamorph: *Tubercularia* sp.



Habitat: On dead wood of deciduous trees.

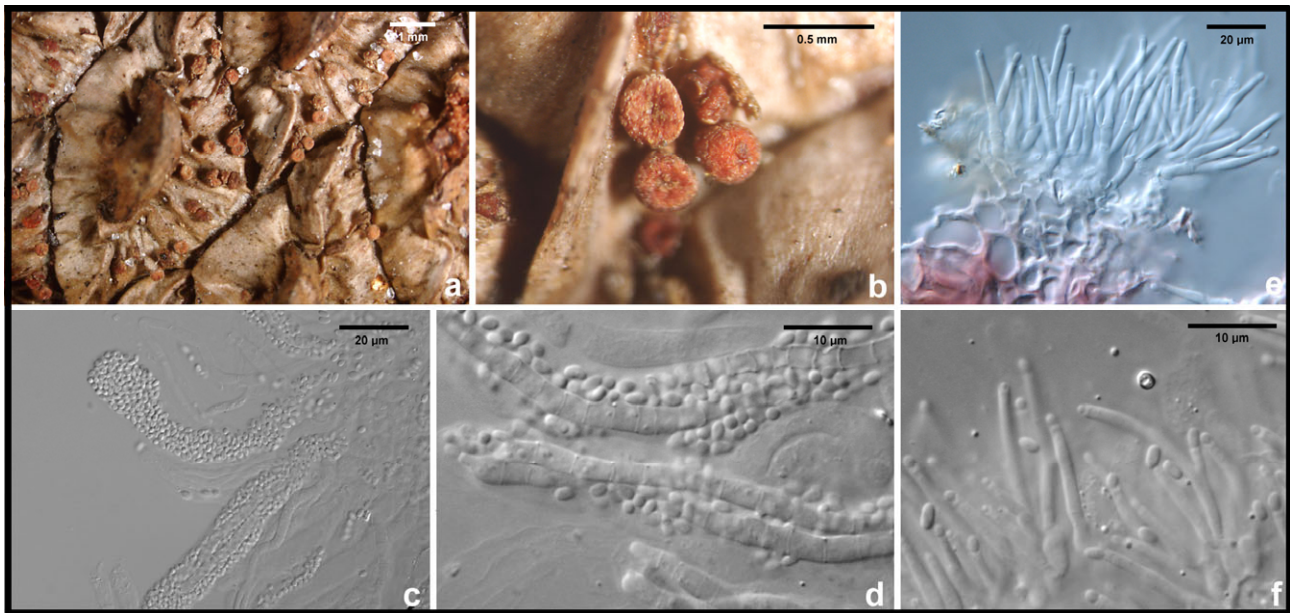
Known distribution: North America and Europe.

Description:

Perithecia (a, b) grouped on well-developed stroma, red, becoming darker with age, KOH+ purple, cupulate when dry, 290–350 µm, non-papillate, smooth. Asci (c, d) 60–65 × 6–8 µm. Ascospores (d) 11–13 × 3–3.5 µm, broadly fusiform, 1-septate, producing numerous ascoconidia; ascoconidia (d) 3–5 × 1–1.5 µm, allantoid, hyaline. Anamorph sporodochial (e), known only from cultures. Conidia (f) allantoid, 3–5 × 1–1.5 µm, hyaline.

Notes: The anamorph of this species is unknown from nature. Booth (1959) described it from culture.

Anamorph: *Zythiostroma pinastri* (Karst.) Höhn. ex Weese (pycnidial)



Habitat: Erumpent through needle scars and bark of recently killed conifers.

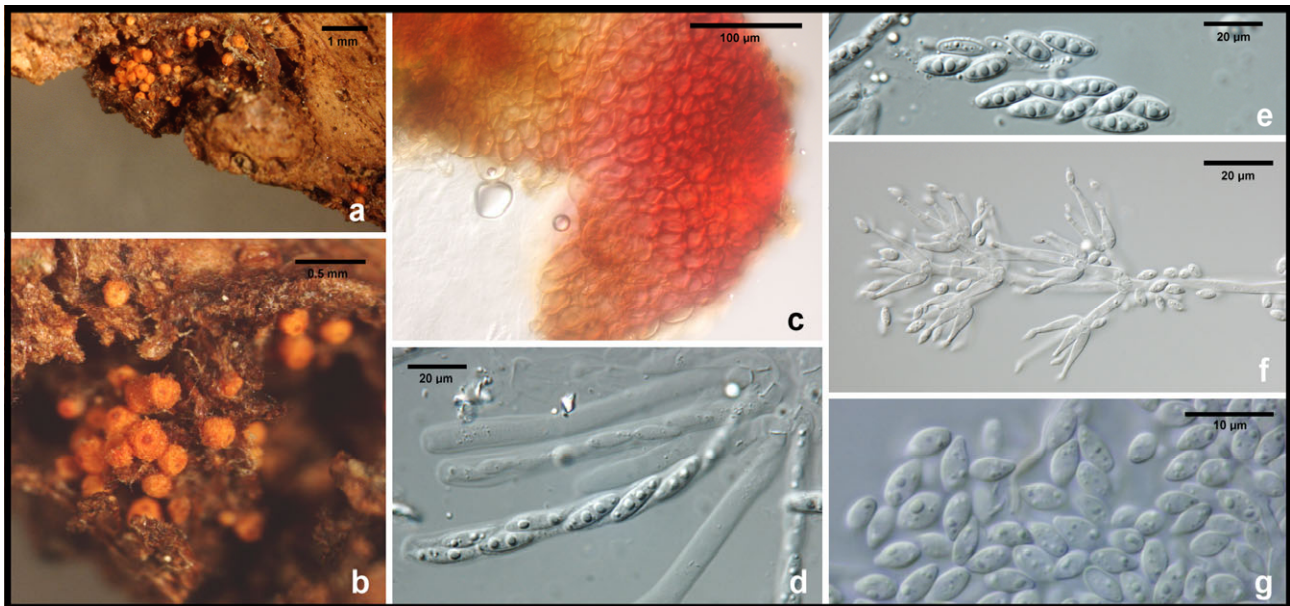
Known distribution: North America and Europe.

Description:

Perithecia (a, b) in groups of up to 20, superficial on a well-developed stroma, often erumpent through needle scars on small twigs, scarlet, becoming dark with age, KOH+ purple, globose to subglobose, cupulate when dry, $240\text{--}440 \times 250\text{--}500 \mu\text{m}$, often with sunken apex and surrounded by darkened area, with short papilla; outer surface with scurf that varies from white to pure yellow, greenish-yellow or concolourous with wall. Asci (c, d) $60\text{--}80\text{--}(100) \times 7\text{--}9\text{--}(10) \mu\text{m}$, 2–4 spored, with ascospores parallel and twisted around each other. Ascospores (d) $30\text{--}77 \times 2\text{--}4 \mu\text{m}$, cylindrical, long vermiform to narrowly clavate with broadly rounded ends, 11–20 septate, septa often oblique, smooth, budding and filling asci. Ascoconidia (d) $2.5\text{--}4.5 \times 1 \mu\text{m}$, ellipsoid to allantoid, unicellular, hyaline, smooth. Anamorph stromatic, pycnidial, erumpent through bark before perithecia, morphologically similar to perithecia but more irregular in shape, with phialides entirely covering internal wall (e, f). Conidia (f) ellipsoidal to allantoid, $4\text{--}6 \times 1 \mu\text{m}$.

Notes: *Nectria cucurbitula* is identical to *N. balsamea* except for the much shorter, muriform ascospores of *N. balsamea*. The shape and septation of the ascospores are obscured at maturity by the production of numerous ascoconidia.

Anamorph: *Mariannaea cf. elegans* (Corda) Samson



Habitat: Teleomorph on bark of hardwood trees; anamorph on bark, decaying wood, and soil.

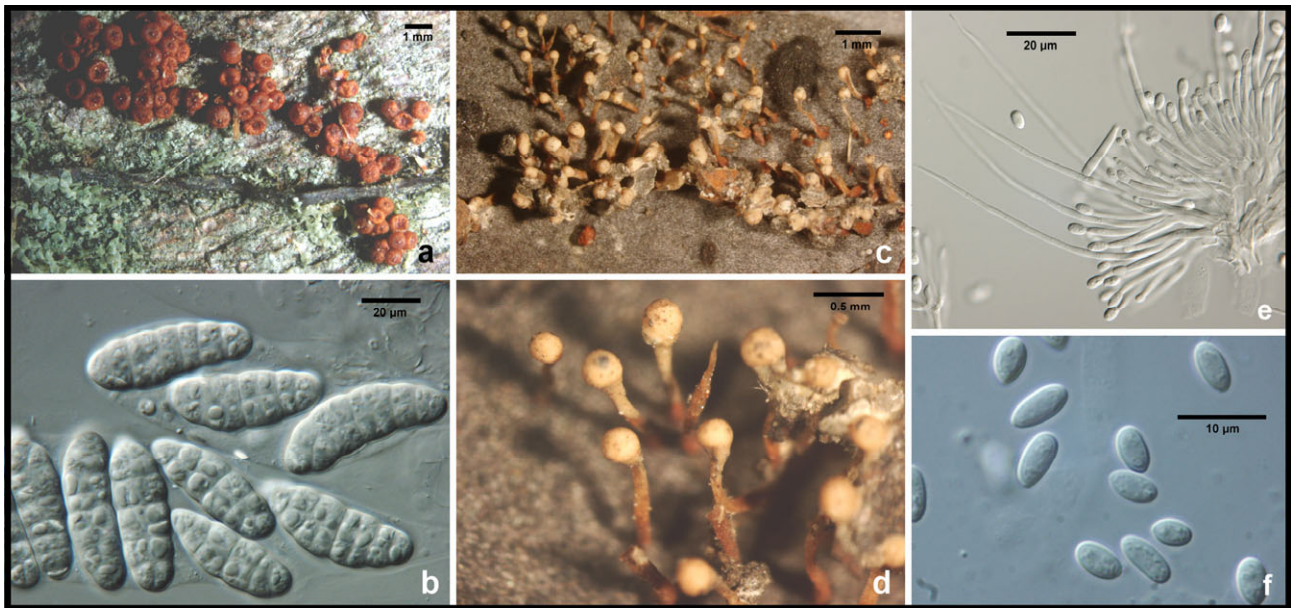
Known distribution: Teleomorph rare, known from two collections (Jamaica, North Carolina); anamorph widely distributed in the Northern Hemisphere, also found in South Africa.

Description:

Perithecia (a, b) solitary to gregarious, superficial, non-stromatic, with base immersed in substratum, globose to tympaniform, 250–350 µm high, 310–340 µm wide, with flattened apex, not collapsing or pinching slightly when dry, at first pale yellow, becoming orange to brown, with variable KOH reaction; surface roughened, cells at surface (c, in KOH) circular, 15–30 µm diam. Asci (d) cylindrical to narrowly clavate, (43–)56–72(–80) × (4–)5–7(–8) µm, with thickened apex and a ring. Ascospores (e) narrowly ellipsoidal to narrowly fusiform, (7–)8.7–10.5(–11) × 3.5–4.5(–5) µm, hyaline, smooth or finely spinulose, 1-celled, with median septum. Anamorph hyphomycetous. Conidiophores (f) 80–400 µm tall, with slightly thickened walls at base of stipe, branching 1–3-level verticillate. Phialides (f) subulate to acerose, in terminal or intercalary whorls of 3–9, sometimes single or in pairs. Conidia (g) fusiform, often apiculate, 5–9(–17) × (2–)2.5–4.5 µm, sometimes with flattened base, in long, white imbricate chains that collapse to white, slimy masses with age. Chlamydospores in culture terminal or intercalary, up to 9 cells in a chain, 10–14 × 5–8 µm.

Notes: This species is not a *Nectria sensu stricto* but its taxonomic position is not known.

Anamorph: *Tubercularia lateritia* (Berk.) Seifert



Habitat: Plurivorous; saprobic or mildly parasitic on a wide variety of woody plants.

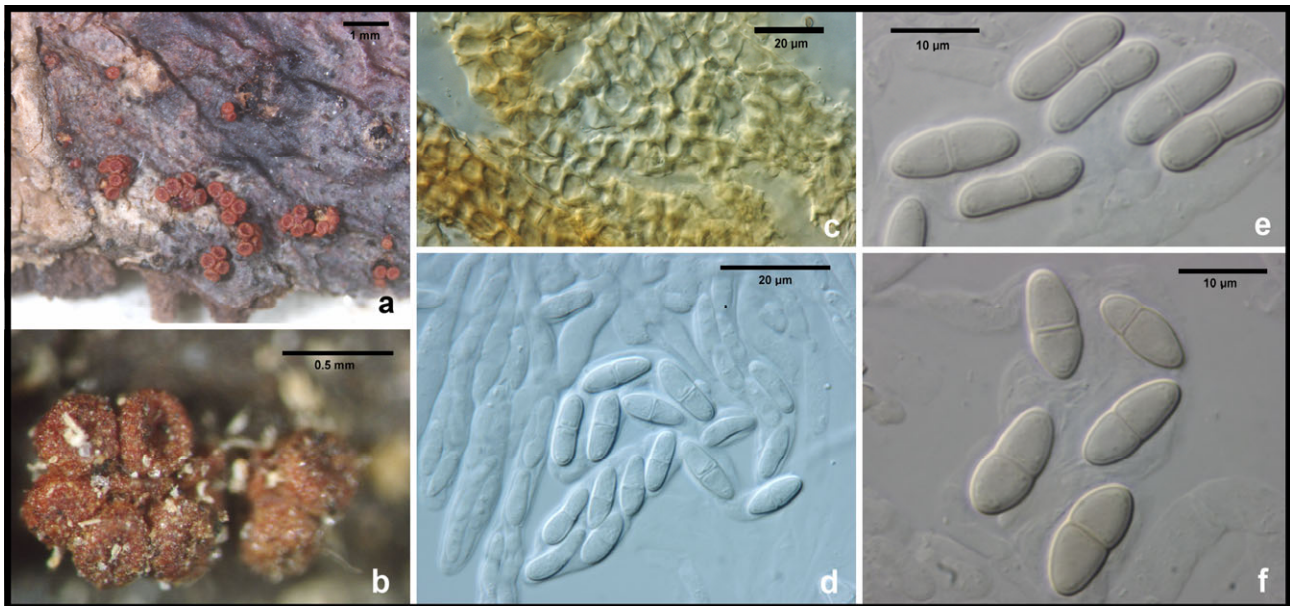
Known distribution: The teleomorph is common in pantropical and south temperate regions, uncommon in North America; the anamorph extends into more northern regions, including Florida, Louisiana and North Carolina.

Description:

Perithecia (a) in groups up to 15 on an stroma erumpent through bark, often covering extensive areas of young trees, orange to red-brown, KOH+ purple, globose to slightly cupulate, 250–400 µm diam, non-papillate, often darker around ostiole, usually with a conspicuously warted wall, sometimes smooth, almost always associated with synnemata of anamorph, collapsed cupulate. Ascospores (b) dictyosporous, ellipsoidal, 15–40 × 7–15 µm, smooth, hyaline. Synnemata (c, d) solitary to gregarious, cylindrical-capitate, 0.5–2(–6) mm tall, red-brown at base, sometimes almost black in age, fading to yellowish above with base KOH+ red; conidial masses (d) globose, hemispherical or more or less discoidal, pink to orange when fresh, drying cream-yellow, orange, or red-brown, 75–800 µm diam. Conidiophores (e) in compact or diffuse whorls, bearing phialides and sterile hyphae. Conidia (f) ellipsoidal, obovate or oblong-ellipsoidal, sometimes slightly curved, (3–)5–6(–8.5) µm, hyaline, unicellular.

Notes: The *Tubercularia lateritia* anamorph of *N. pseudotrichia* is indistinguishable from the anamorph of *N. lateritia* Rossman, a tropical species. Because *N. pseudotrichia* is much more common than is *N. lateritia*, we assume that the anamorph collections from this area are those of *N. pseudotrichia*.

Anamorph: None known.



Habitat: On bark of *Gelsemium sempervirens*.

Known distribution: United States (AL, SC).

Description:

Perithecia (a, b) indistinguishable from those of *N. cinnabarina*, KOH+ purple; cells at surface of perithecial wall (c) angular, with slightly thickened walls. Asci (d) clavate, with broadly rounded, simple apex. Ascospores (e, f) broadly to narrowly ellipsoidal or fusiform, sometimes broadly constricted at septum, $(10.0\text{--})10.3\text{--}13\text{--}(15.5) \times (3.5\text{--})4.2\text{--}5\text{--}(5.5) \mu\text{m}$, hyaline, smooth, 1-septate, with median septum.

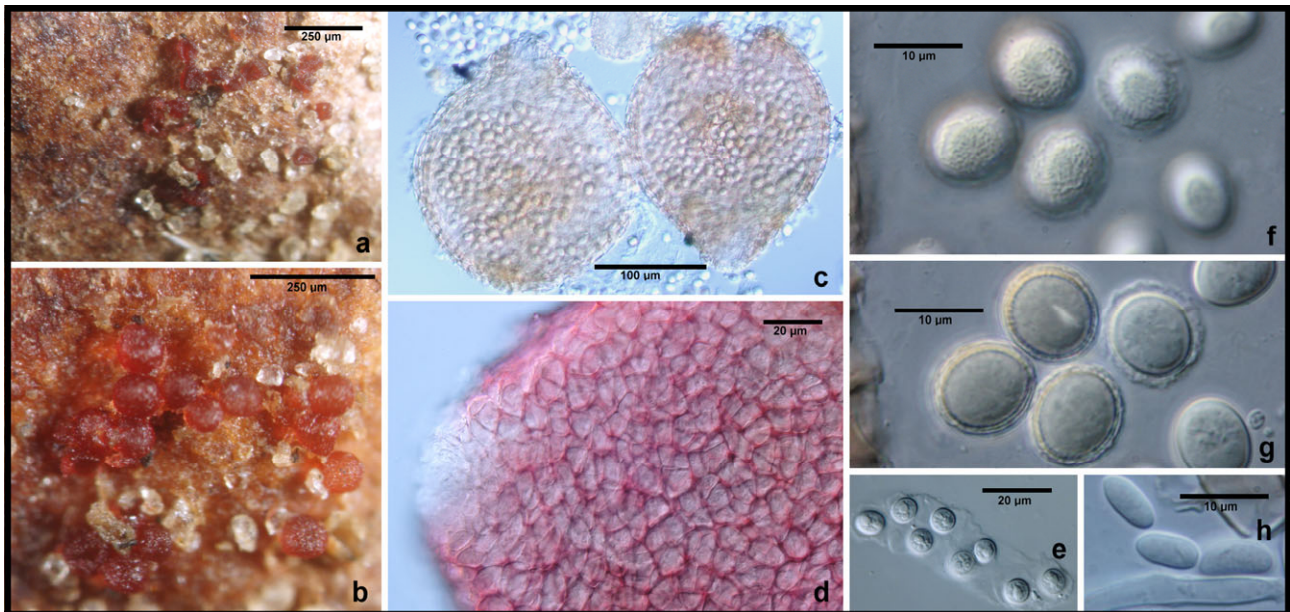
Notes: *Nectria rubicarpa* is similar to *N. cinnabarina*, but the ascospores measured ($n = 42$) from the two known collections on *Gelsemium sempervirens* are considerably smaller than ascospores of *N. cinnabarina*. No anamorph was found on either of the collections illustrated.

Perithecia solitary to sparsely aggregated, superficial, stroma lacking, globose to pyriform, orange-brown to red, rarely hyaline, KOH+ darker, ostiolate, not collapsing when dry, surface smooth to slightly roughened. Perithecial wall of two regions, outer region pigmented, of thick-walled cells, inner region hyaline. Asci narrowly clavate to cylindrical, apex simple, 8-, rarely 6–7, spored, uniseriate. Ascospores globose to ellipsoid, non-, rarely one-, septate, hyaline to pale yellow or yellow-brown or reddish brown, variously ornamented with longitudinal or transverse striations or with bumps, ridges, flanges, or spines. Chlamydospores often present. Anamorph: acremonium-like. On herbaceous substrata, isolated from soil.

Note: This genus is derived from within *Haematonectria* (O'Donnell, 2000).

Literature:

- Cannon, P. & Hawksworth, D. (1984). A revision of the genus *Neocosmospora* (*Hypocreales*). *Transactions of the British Mycological Society* **82**: 673–688.
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- Udagawa, S.-I., Horie, Y. & Cannon, P.F. (1989). Two new species of *Neocosmospora* from Japan with a key to the currently accepted species. *Sydowia* **41**: 349–359.

Anamorph: acremonium-like

Habitat: Isolated from soil, also from nematodes, pathogenic on crop plants causing root- and fruit-rots and seedling damping off diseases.

Known distribution: Warm temperate and tropical regions.

Description:

Perithecia (a–d) solitary to sparsely aggregated, superficial, stroma lacking, globose, 200–500 µm diam, orange-brown to red, KOH+ dark red, ostiolate, with neck 30–70 µm long × 40–100 µm diam, not collapsing when dry, surface smooth to slightly roughened. Perithecial wall of two regions, outer region pigmented, of thick-walled cells, inner region hyaline. Asci cylindrical, 80–105 × 10.5–16 µm, apex simple, 8-, rarely 6–7-, spored, uniseriate. Ascospores (e–g) globose to ellipsoid, (9–)10–15.5(–18) × (7–)7.5–12(–13.5) µm, non-septate, hyaline to pale yellow, buff to salmon pink in mass, rugose. Conidiogenous cells elongate cylindrical, (20–)30–100(–150) × 1–2 µm diam, hyaline. Conidia (h) cylindrical to oblong-ellipsoid, sometimes allantoid, 5–13 × (1.5–)2–3.5 µm, non-septate, hyaline, aggregating in a slimy mass at apex of conidiogenous cell. Chlamydospores often present, hyaline to pale yellow, globose to obovoid, terminal or intercalary, smooth, 5–10 × 4–8 µm.

Notes: This is the most commonly encountered species of *Neocosmospora*.

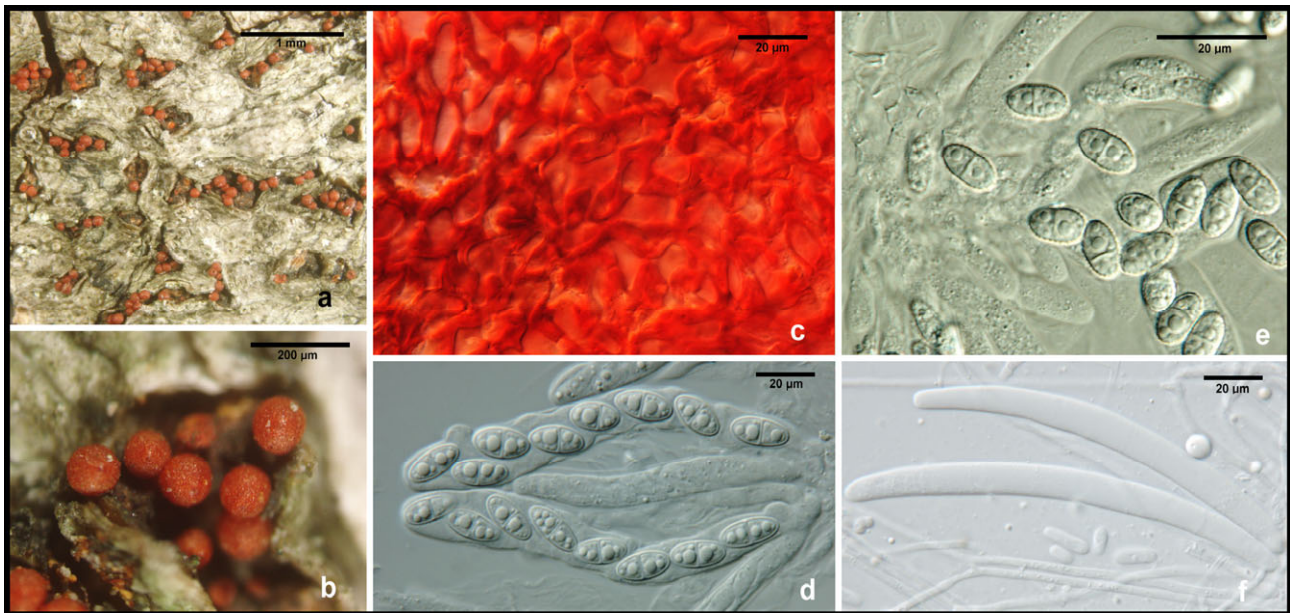
Perithecia superficial on a minute to erumpent basal stroma, or at base of a synnema; subglobose to broadly obpyriform, collapsing laterally or not collapsing when dry, non-papillate or with a minute papilla, red, KOH+ dark red, yellow in lactic acid, smooth, varnished to scurfy. Perithecial wall 50 or more μm thick, of two or three regions: outer region of conspicuously angular cells, 10–15 μm diam, of cells having walls 1.5–2 μm thick; middle region, if present, of thick-walled cells oriented perpendicular to centrum; inner region of thin-walled, hyaline, elongate cells. Asci fusiform to clavate, sessile, with simple apex or with a refractive ring, with biseriate ascospores. Ascospores ellipsoidal to fusiform, medially 1-septate, smooth to finely spinulose or verrucose, hyaline. Anamorph, where known, *Cylindrocarpon*. On woody substrata.

This genus includes species of nectrioid fungi that have *Cylindrocarpon* anamorphs. Many of these species are phenotypically similar, differing primarily in their anamorphs. Only limited phylogenetic analyses have been undertaken.

Literature:

- Booth, C. (1959). Studies of pyrenomycetes. IV. *Nectria* (part 1). *Mycological Papers* **73**: 1–115.
- Booth, C. (1966). The genus *Cylindrocarpon*. *Mycological Papers* **104**: 1–54.
- Booth, C. (1967). *Nectria galligena*. *Commonwealth Mycological Institute Descriptions of Pathogenic Fungi & Bacteria* **147**: 1–2.
- Brayford, D., Mantiri, F. Honda, B. & Samuels, G.J. (2004). *Neonectria* and *Cylindrocarpon*: the *Nectria mammoidea* group and species lacking microconidia. *Mycologia* **96**: 572–597.
- Brayford, D. & Samuels, G.J. (1993). Some didymosporous species of *Nectria* with non-microconidial *Cylindrocarpon* anamorphs. *Mycologia* **85**: 612–637.
- Cotter, H.V.T. & Blanchard, R.O. (1981). Identification of the two *Nectria* taxa causing bole cankers on American beech. *Plant Disease* **65**: 332–334.
- Lohman, M.L. & Watson, A.J. (1943). Identity and host relations of *Nectria* species associated with diseases of hardwoods in the Eastern states. *Lloydia* **6**: 77–108.
- Mahoney, E.M., Milgroom, M.G., Sinclair, W.A. & Houston, D.R. (1999). Origin, genetic diversity, and population structure of *Nectria coccinea* var. *faginata* in North America. *Mycologia* **91**: 583–592.
- Rossmann, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* **42**: 1–248.
- Samuels, G.J. & Brayford, D. (1993). Phragmosporous *Nectria* species with *Cylindrocarpon* anamorphs. *Sydowia* **45**: 55–80.
- Samuels, G.J. & Brayford, D. (1990). Variation in *Nectria radicola* and its anamorph, *Cylindrocarpon destructans*. *Mycological Research* **94**: 433–442.
- Samuels, G.J. & Brayford, D. (1994). Species of *Nectria* (*sensu lato*) with red perithecia and striate ascospores. *Sydowia* **46**: 75–161.

Anamorph: *Cylindrocarpon faginatum* Booth



Habitat: On *Fagus grandifolia*, often in association with beech scale.

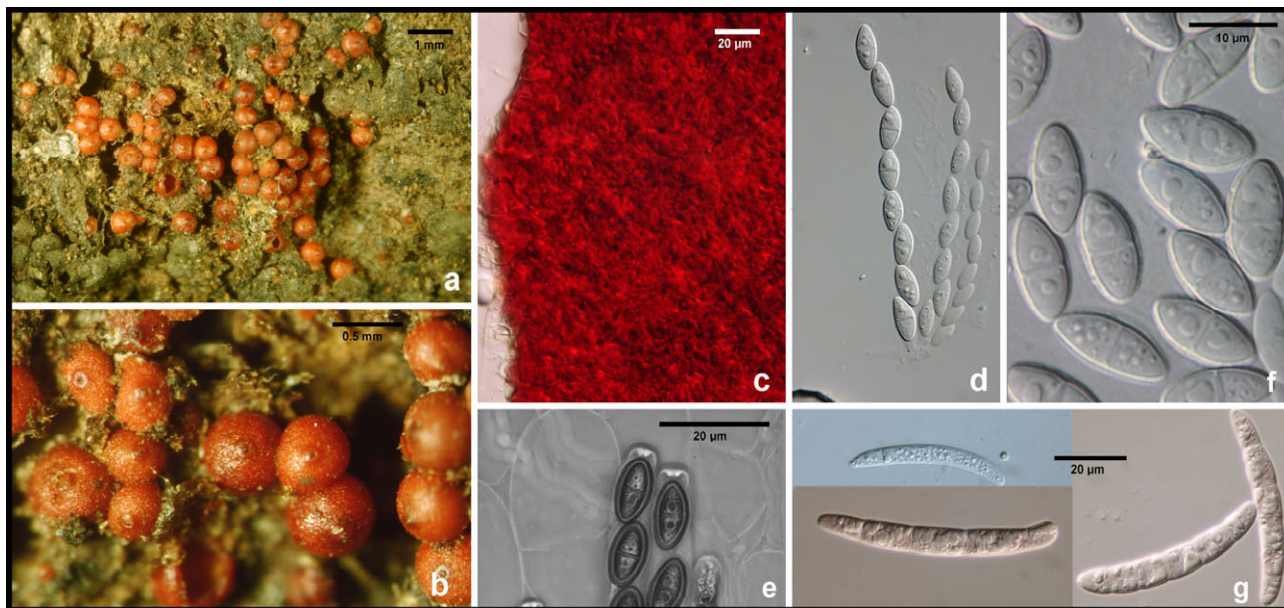
Known distribution: North America.

Description:

Perithecia (a–c) in groups of 5–35 on a common stroma that develops in cortical tissue of host, typically with all stages of perithecial development present in same group, solitary and scattered when formed on wood without stroma, globose, non-papillate or with a minute papilla; orange to red, often with darker ostiolar area when dry, KOH+ dark red, smooth, not collapsing when dry. Asci (d) cylindrical, $75\text{--}100 \times 7\text{--}10\ \mu\text{m}$, with obliquely uniseriate ascospores. Ascospores (e) ellipsoidal, $9.8\text{--}12.4 \times 4.8\text{--}6.4\ \mu\text{m}$, finely spinulose, 1-septate, with median septum. Anamorph with micro- and macroconidia. Microconidia (f) cylindrical, sometimes slightly curved, $4\text{--}9 \times 1.5\text{--}3\ \mu\text{m}$, unicellular or 1-septate. Macroconidia (f) cylindrical with rounded ends, often strongly curved, $82\text{--}120 \times 6.4\text{--}9.4\ \mu\text{m}$, 3–7-septate.

Notes: *Neonectria coccinea* var. *faginata* Lohman *et al.* only occurs in eastern to central North America, including outlying collections from Appalachian North Carolina and Tennessee; we have recently found it in GSMNP. It is the dominant species found on scale-infested beech trees. A second species of *Neonectria*, *N. ditissima*, occurs on *Fagus* in North America. Cotter & Blanchard (1981) distinguished *Neo. coccinea* var. *faginata* from *Neo. ditissima* (as *N. galligena*) by ascospore length, respectively, mean length of 25 ascospores $< 13.3\ \mu\text{m}$ and $> 14.3\ \mu\text{m}$. Taxonomy of this group is far from resolved. *Neo. coccinea* var. *coccinea* is the main colonist of scale-infested beech bark in Europe.

Anamorph: *Cylindrocarpon ianthothele* Wollenw. var. *majus* Wollenw.



Habitat: On bark of twigs and branches of recently dead trees, less frequently on palm trunks.

Known distribution: Cosmopolitan, north and south temperate, tropical.

Description:

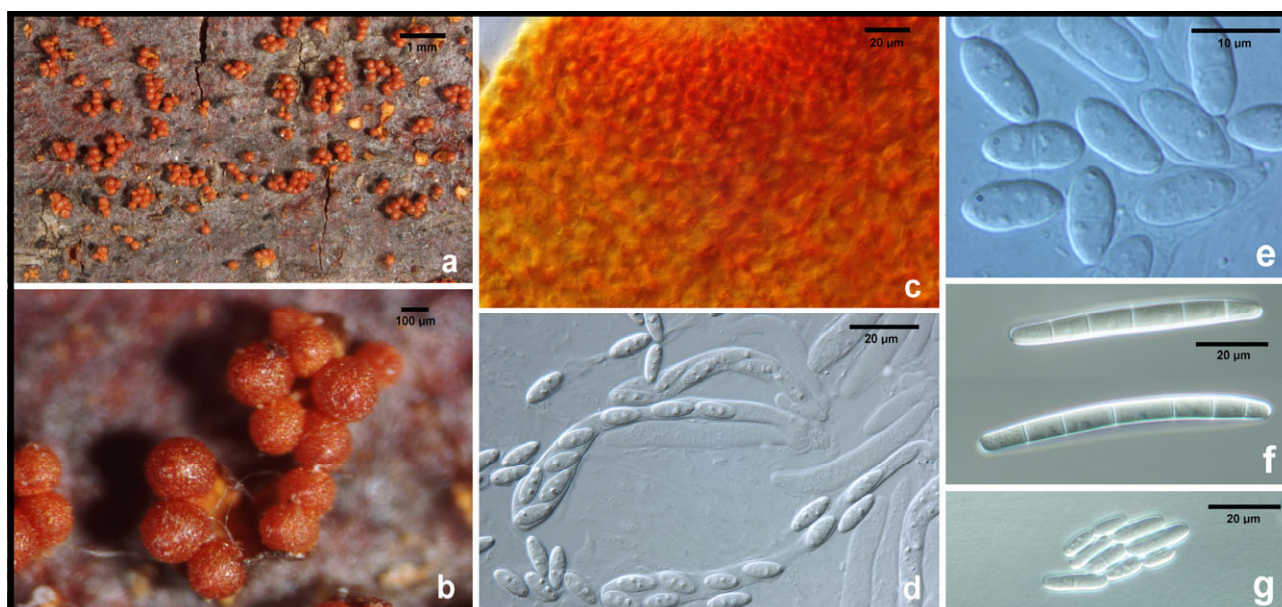
Mycelium not visible on host. Stroma with conidia developing first, having long, unbranched hyphal hairs, often in fissures in bark. Perithecia (a, b) solitary to gregarious or caespitose in groups of a few, superficial or with base partially immersed in substratum or superficial on a minute stroma, globose, (260–) 300–550(–670) µm diam, non-papillate or with a broad, mammiform apex, not collapsed when dry, red to dark red, appearing almost black, smooth, often shining; with ostiolar area often darker red than perithecial body, KOH+ dark red, yellow in lactic acid. Cells at surface of perithecial wall (c) lacking a definite outline, appearing to be intertwined hyphae with lumina irregular in shape, 2–2.5 µm in greatest dimension. Asci (d, e) cylindrical, (68–)72–95(–120) × 7–10(–15) µm, with a refractive ring in apex, 8-spored, with uniseriate ascospores having overlapping ends. Ascospores (d–f) ellipsoidal, (10–) 12–17(–20) × (4–)5–8(–9) µm, equally 2-celled, not constricted at septum, spinulose, pale brown. Cultures typically slimy, strongly pigmented, blood colour or purple-slate with pale vinaceous margin. Macroconidia (g) (2–)3–5(–7) septate, 43–73 × 4–6 µm, cylindrical, but often broader in upper half, uniformly curved or more strongly curved at tip, with apical cell rounded and basal cell rounded to truncate. Microconidia or chlamydospores not formed. Perithecia often developing in cultures.

Notes: This species is easily recognized by its typically shining, smooth, globose perithecia that may have an areolate apical disk.

***Neonectria ditissima* (Tul. & C. Tul.) Samuels & Rossman, **comb. nov.** – MB 500509 ***

Basionym: *Nectria ditissima* Tul. & C. Tul., Sel. Fung. Carp. iii: 73. 1865.

Anamorph: *Cylindrocarpon heteronema* (Berk. & Broome) Wollenw.



Habitat: On a wide range of deciduous trees, cause of canker, crown dieback and fruit rot in apple and pear.

Known distribution: Probably cosmopolitan, north and south temperate.

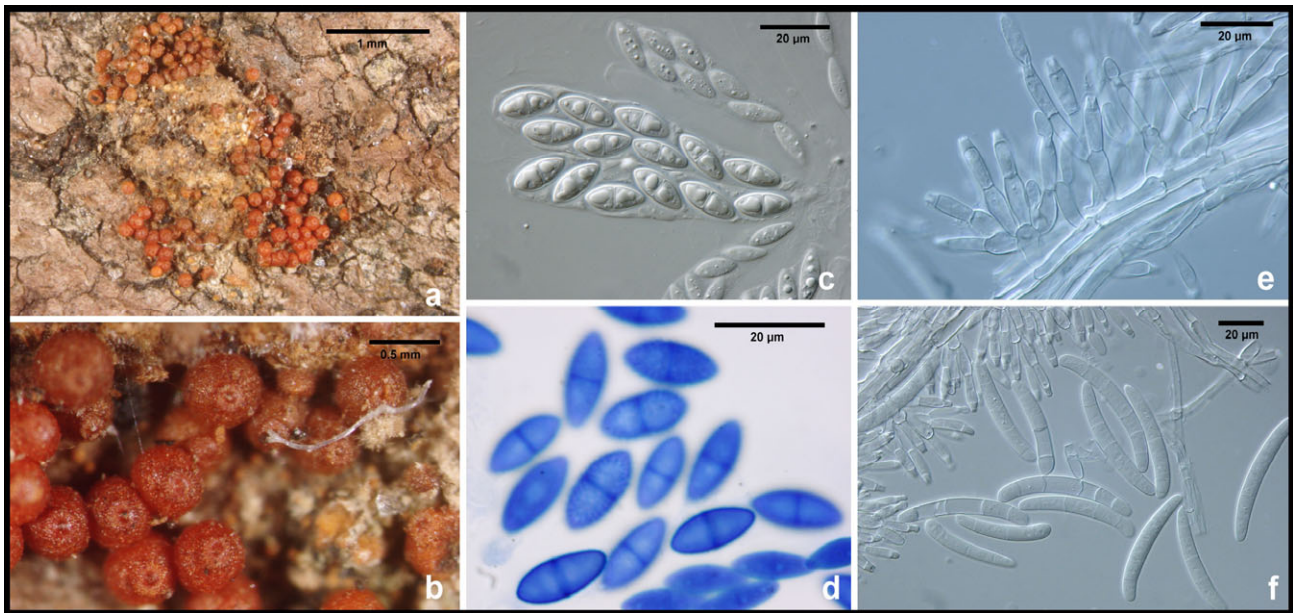
Description:

Perithecia (a, b) gregarious on surface or edge of cankers, subglobose to globose, red, KOH+ purple, 250–350 µm diam, with a slightly convex, darker ostiolar disk, not collapsing, cells at surface of perithecial wall (c) globose to angular, thick-walled. Asci (d) clavate, 75–95 × 12–15 µm. Ascospores (e) ellipsoidal to narrowly fusiform, 14–22 × 6–9 µm, smooth to verrucose, hyaline becoming pale yellow-brown. *Cylindrocarpon* anamorph producing macro- and microconidia. Macroconidia (f) straight, predominantly 3–5-septate, 36–65 × 4–7 µm. Microconidia (g) ellipsoidal, 4–8 × 2–3 µm, unicellular.

Notes: *Neonectria ditissima* occurs on a diverse range of hardwood hosts including *Fagus* and differs from the other species of *Neonectria* on *Fagus* in North America, namely *Neonectria coccinea* var. *faginata*, in the size of the ascospores. *Neonectria ditissima* (Cotter & Blanchard, 1981 as *Nectria galligena*) has longer ascospores than those of *N. coccinea* var. *faginata*. *Neonectria galligena* (Bres.) Rossman & Samuels and *Nectria magnoliae* Lohman & Hepting are synonyms of *Neonectria ditissima* (L. Castlebury, pers. comm.).

* Mycobank number see www.mycobank.org

Anamorph: *Cylindrocarpon candidulum* (Sacc.) Wollenw.



Habitat: On bark of diverse hardwood trees; found once on the woody part of a stem of *Anthurium* sp. and once on the leaf of a monocotyledonous plant.

Known distribution: United States (NC, NY, VA), Caribbean (Dominica, Jamaica, Puerto Rico), Ecuador, Europe (France, Germany, Ireland, United Kingdom), India, Japan.

Description:

Perithecia (a, b) solitary to densely gregarious, typically forming in cracks in bark, covering large expanse of recently fallen trees, globose with a broad, often constricted, 'knobby' apex, 280–400 µm high, 250–360 µm wide, red to orange-red, KOH+ red, smooth to scaly with apical disk, not collapsing when dry. Asci (c) clavate, (70–)76–97(–115) × 10–14(–16) µm, apex with a ring. Ascospores (d, in cotton blue/lactic acid, surface view) ellipsoidal to inequilateral, (13–)15–19(–25) × (5–)7–8(–9) µm, hyaline to very pale brown, warted, 1-septate, with median septum. *Cylindrocarpon* anamorph forming only macroconidia from cylindrical phialides (e). Macroconidia (f) cylindrical, slightly curved with an almost straight lower half, more sharply curved above, (3–)4–5(–6)-septate; 4–5-septate conidia (48–)54–77(–81) × (5–)5.7–7.3(–8) µm.

Notes: *Neonectria veuillotiana* is common on hardwood trees in the Great Smoky Mt. National Park.

Perithecia non-stromatic, superficial, solitary, globose to pyriform, red, orange-brown, tan, or brown, KOH+ red or KOH–, coarsely warted or glabrous. Asci clavate, with simple apex. Ascospores typically green, 1-septate, rarely non-septate, smooth. Anamorph, where known, *Penicillifer*. On decaying woody substrata, isolated from soil and plant roots.

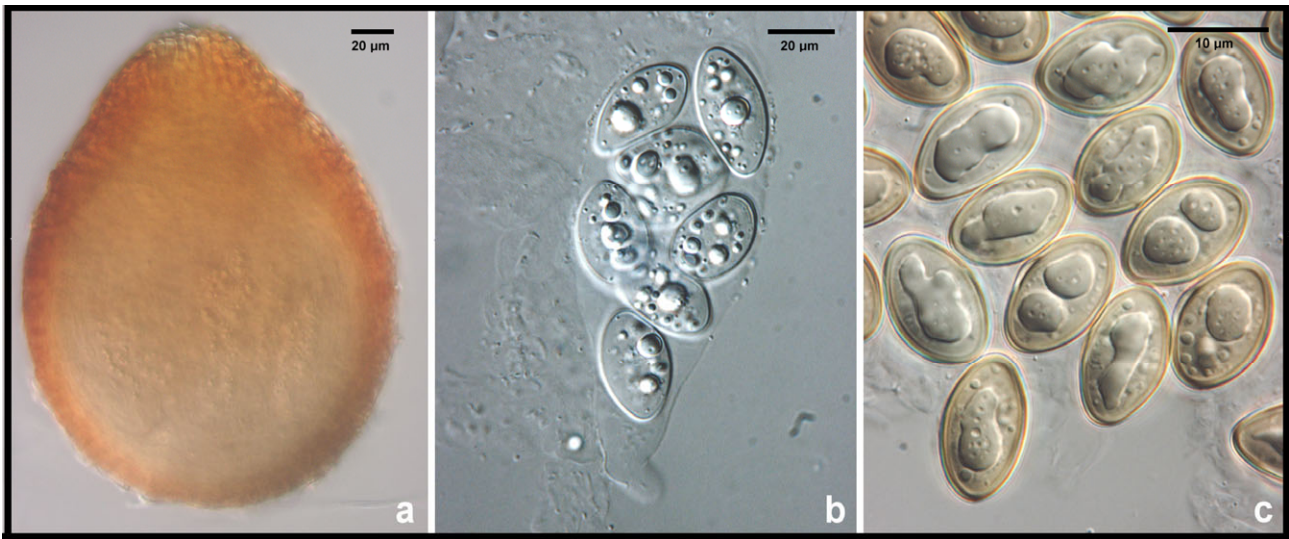
The genus *Viridispora* includes four species that are known primarily in culture, isolated from soil and roots or as endophytes of woody plants, although some species have also been found on woody substrata in nature. The genus is characterized by having *Penicillifer* anamorphs, perithecia in shades of red to dark red or orange-brown, and generally one-septate ascospores that are green in all but one species. Both green ascospores and *Penicillifer* anamorphs are rare in the ascomycetes and, in combination, are known for the two tropical species that occur on woody substrata in nature, namely *V. alata* and *V. penicilliferi*.

Literature:

Polishook, J., Bills, G. & Rossman, A. (1991). A new species of *Neocosmospora* with a *Penicillifer* anamorph. *Mycologia* **83**: 797–804.

Rossman, A.Y., Samuels, G.J., Rogerson, C.T., & Lowen, R. (1999). Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* **42**: 1–248.

Anamorph: *Penicillifer furcatus* Polishook, Bills & Rossman



Habitat: Isolated from forest soil and *Chamaecyparis*, *Crataegus*, and *Hudsonia*; also isolated from the interior of a basidiome of *Fomes fomentarius*.

Distribution: Eastern United States and Japan.

Description:

Perithecia (a) globose, ovoidal or pyriform, 270–350 µm high × (160–)240–270 µm diam, yellow-orange, orange to red-orange, KOH+ dark red, yellow in lactic acid, glabrous; surface cells angular, 10–20 µm diam, with *ca* 2 µm thick walls; perithecial wall 20–30 µm thick, of two regions; outer region of thick-walled, angular cells, 7.5–20 × 6.5–17.5 µm; inner region of thin-walled, elongate cells. Asci (b) clavate, 60–85 × 12–25 µm, with simple apex, biserial ascospores. Ascospores (c) ellipsoidal to broadly ovoidal, (16–)21–25 × 12–15 µm, non-septate, smooth, green when formed on V8 Juice agar, yellow on oatmeal agar. Anamorph hyphomycetous. Conidiophores 150–280 µm long, branched once or twice, each branch bearing a single, terminal penicillus of appressed phialides. Phialides cylindrical, 16–25 × 4–5 µm. Conidia cylindrical to slightly naviculate, 17–23 × 4–5 µm, one-septate, hyaline, smooth-walled, papillate at base, held end-to-end in chains.

APPENDIX 1. LIST OF SPECIMENS ILLUSTRATED

Species in the *Bionectriaceae*

Bionectria byssicola

BPI 749331 United States: North Carolina, Macon Co., Highlands, Highlands Biological Station, Lake Ravenel, 1994 Aug 31, Samuels G. J. & Schroers H.-J.

Bionectria compactiuscula

BPI 749329 United States: North Carolina, Jackson County, Nantahala National Forest, vic. Highlands, Ammons Camp, off Bull Pen Road, on bark, 29 Aug 1994, Samuels G.J. & Schroers H.-J.

Bionectria epichloë

PDD 30125 United States: Georgia, Newton County, on stroma of *Balansia henningsiana*, Oct 1978, C. Bacon s.n.

Bionectria ochroleuca

BPI 749339 United States: North Carolina, Macon Co., Blue Valley Rd., along east fork of Overflow Creek, on wood, 1994 Sep 01, Samuels G. J. & Schroers H.-J.

NY Venezuela: K.P. Dumont et al 1445, 1971, C.T. Rogerson 71-249.

Hydropisphaera peziza

BPI 552771 Canada: Point Rouge, 1938 Aug 16, Anselén.

Nectriopsis candicans

BPI 749343 United States: North Carolina, Macon Co., Blue Valley road along east fork of Overflow Creek, on unknown myxomycete, 1994 Sep 01, Samuels G. J. & Schroers H.-J.

Nectriopsis exigua

BPI 748377 Puerto Rico: Rio Grande, Caribbean National Forest, Luquillo Mts., Angelito Trail, on unknown, myxomycete, 1998 Jun 08, Samuels, G. J.

Nectriopsis oropenoides

BPI 1109335 United States: Louisiana, Port Hudson, East Feliciana Parish, on *Stereum* sp., 1991 Aug 01, Samuels G. J., Blackwell M. & Hawksworth D.

Nectriopsis rubifaciens

BPI 749356 United States: Missouri, Stoddard Co., Mingo National Wildlife Refuge, on *Parmelia* sp., 1994 Sep 17, Samuels G. J.

Nectriopsis violacea

BPI 744728 Luxembourg: Steinfort, Vallee d'Eisch between la borne 84 and le barrage (IFBL: L8.51.14 and 23), on *Fuligo septica*, 1996 Sep 20, Jean Lachapelle.

Stilbocrea gracilipes

BPI 447855 Liberia: Mt. Coffee, on bark, 1894 Apr, Cook O.F.

BPI 631160 United States: Florida, Winter Park, on *Vitis* sp. 1940 Jan 17, Shear C. L. (1281).

BPI 631158 United States: Louisiana, Pointe á La Hache, 1886 Apr.

Species in the *Clavicipitaceae*

Cordyceps militaris

OSC: coll. Spatafora, J.

BPI 749344 United States: North Carolina, Macon Co., Blue Valley Road along east fork of Overflow Creek, on insect larva, 01 Sep 1994, Samuels G.J. & Schroers H.-J.

Neobarya parasitica

BPI 1109369 United States: North Carolina, Clay Co., Standing Indian Campground, off Highway 64, on *Ber-tia moriformis* on *Trametes* sp., 15 Oct 1990, Doi Y., Rossman A.Y. & Samuels G.J.

Species in the *Hypocreaceae*

Arachnocrea sp.

BPI 1109387 United States: North Carolina, Macon Co., Blue Valley. off Clear Creek road, along Overflow Creek, on debris, 1990 OCT 16, Doi Y., Rossman A.Y., & Samuels G. J. (DOI 27)

Hypocrea alutacea

OULU F 49648 Denmark: Falster, Sønder Alslev, on rotten wood in beech forest, 16 Sep 1980 A. Pohjola. CBS 332.69.

OSC Japan: locality unknown. J. Spatafora 00-404.

Hypocrea atroviridis

NY United States: Indiana, Owen County, McCormick Creek State Park, 2 mi E of Spencer, on decorticated log, 15 Aug 1981, Rogerson C.T. 81-50.

DAOM 222096. Canada: Ontario, isolated from mushroom compost (a living culture).

United States: Pennsylvania, isolated from mushroom compost (a living culture).

Hypocrea avellanea

NY United States: Massachusetts: Ruggles Pond, Wendell State Forest, 17 Jun 1973, Carey 73-1.

NY 26 Aug 947. C.T. Rogerson 71-155.

NY 1946 Aug 26, coll. C.T. Rogerson

Hypocrea ceracea

NY United States: North Carolina: Jackson County, Nantahala National Forest, Bull Pen Road to Chattooga River, Ellicott Rock trail from Fowler Creek, on decorticated wood, 28 Sep. 1989, Samuels G.J., Rogerson C.T., Buck W.R., Harris R.C. (culture G.J.S. 89-136).

Hypocrea ceramica

BPI 843646 United States: North Carolina, Swain Co., Nantahala National Forest, Joyce Kilmer Memorial Forest, on resupinate basidiomycete, 2001 Jul 29, Grand L. F. & Vernia C.

BPI 843655 United States: North Carolina, Transylvania Co., North of Brevard, Pisgah National Forest, fish hatchery, on decorticated wood, 1988 Sep 29, Rodrigues K. F., Rogerson C. T., Samuels G. J. *et al.*

Hypocrea chionea

BPI 631351 Canada: Ontario, Westminster, on *Acer* sp., 1928 Nov 17, Dearness J.

BPI 744889 United States: North Carolina, Jackson Co., Nantahala National Forest. Ellicott Rock Trail off Bullpen Road, on living *Vitis* sp. 1994 Aug 30, Samuels G. J. (culture GJS 94-44).

Hypocrea chlorospora

BPI 744702 Costa Rica: Guanacaste. Parque Nac. Guanacaste (ACG), Sector Cacao, trail to Estacion

- Biologica, Cacao, on log, 1997 Sep 24, Huhndorf S. M. (3233). Culture PC 4.
- Hypocrea chromosperma*
BPI 737770 United States: Indiana, Yellow Wood State Forest, Brown Co. alt. 200 meters, 39°09'N, 86°06'W, Jackson Creek Management Trail, on decorticated wood, 1995 Sep 30, Samuels G. J.
- BPI 1112897 United States: Maryland, Prince George County, Greenbelt, Greenbelt Forest, on bark, 1991 Oct 06.
- BPI 744550 United States: Illinois, Ogle Co., White Pine Forest, on decorticated wood, 1996 Sep 28, Samuels G.J. & Pöldmaa K.
- Hypocrea cineroflava*
BPI 1112868 United States: Virginia, Giles Co., Cascades Recreation Site, 4 Mi N of Pembroke, Little Stony Creek. 37°2'N, 80°35'W, 840 m elev., on bark, 1991 Sep 18, Samuels G., Rogerson C., Huhndorf S., Rehner S., & Williams M.
- BPI 744522 United States: Louisiana, Port Hudson Commemorative Area, on Hymenochaetaceae on bark, 1996 Aug 19, Samuels G.J., Blackwell M., & Camara M.
- Hypocrea citrina* var. *citrina*
BPI 842426 United States: New York, Ulster Co., Catskill Forest Reserve, Trout Creek, under mixed oak/hemlock/maple/ birch, on litter, 2002 Sep 21, Hopkins S.
- BPI 748251 Austria: Niederoesterreich, near Krems, at Waldhof, beside Lake Egelsee, on bark, 2000 Aug 28, coll: Klofac, Wolfgang (WJ 1617), Samuels, G.J. (GJS 00-161).
- Hypocrea citrina* var. *americana*
BPI 737849 United States: Arizona, White Mountains, Apache Co. 19.1 miles S. of Forest Boundary, on *Fomes pinicola*, 1994 Aug 21, Rogerson C. T.
- Hypocrea farinosa*
BPI 744654 United States: North Carolina, Nantahala National Forest. Bullpen Rd., Ellicott Rock Trail, on unknown fungus, 1997 Oct 14, Samuels G. J., Lieckfeldt E., & Tong Xu.
- BPI 1107198 United States: Georgia, Rabun Co., Double Bridge Creek, Chatahoochee National Forest, along Little Creek road, on bark & decorticated wood, 1990 OCT 17, Samuels G. J. & Rossman A.Y.
- Hypocrea koningii*
BPI 745885 United States: Maryland, Garrett Co., ca. 10 mi SSE of Grantsville, near Bittinger, western Maryland 4-H, High Bog, on decorticated wood, 1989 Sep 23, Samuels G.J. (89-122), Rogerson C.T., Buck W.R., & Harris R.C. Holotype.
- BPI 842346 United States: Pennsylvania, Westmoreland Co., Laurel Summit Picnic Area, 2000 Sep 16, coll. Poldmaa, K. 00-143, Samuels, G.J. 00-156.
- Hypocrea latizonata*
BPI 631567 United States: Iowa, Stone House, Allamakee Co., on *Cyathus* sp., 1928 Sep 09, Shimek B.
- BPI 746694 United States: Indiana, Brown Co., Belmont. vic, on *Cyathus striatus*, 1999 Nov 06, Tansey, J.
- Hypocrea leucopus*
NY United States: North Carolina, Swain Co., Indian Creek, 14 Aug 1968 C.T. Rogerson 68-81.
- DAOM 226070 Canada: locality not known, on soil, Red-head, S. 8125.
- Hypocrea lixii*
BPI 744709 French Guiana: Commune de Saul. Mont. Galbao, base camp on NE side, near headwater of Mara River, on bark, 1997 Nov 11, Huhndorf S.M. (3758).
- BPI 744652 United States: Georgia, Rabun Co., Chatahoochie National Forest, vic. Clayton, Warwoman Dell, on bark, 1997 Oct 14, Samuels G.J., Lieckfeldt E., & Tong X.
- BPI 802600 United States: Wisconsin, Sand Co. Aldo Leopold Reserve, on decorticated wood, 1990 Jun 23, Samuels G. J. Costa Rica, isolated from *Theobroma cacao*, Samuels G.J. 01-136.
- Hypocrea lutea*
BPI 744503 United States: Virginia, Giles Co., Mt. Lake Wilderness, on decorticated wood of *Abies* sp., 1996 Jul 22, Rossman A.Y.
- BPI 744483 Puerto Rico: Luquillo Mountains, El Verde Research Area. Quebrada Prieta, on branch, 1996 May 06, coll: Lodge D.J. (PR 3214), Samuels G.J. (GJS 96-122).
- BPI 842350, G. Arnold, culture GJS 00-167.
- Hypocrea megalocitrina*
BPI United States: Maryland, Howard Co. and Carroll Co. border, Patapsco Valley State Park, N. of Ellicott City, on wood, 14 Oct 1999, Overton, B.E. 99-42.
- BPI United States: Macon Co., Glen Falls lower trail, Nantahala National Forest, 12 Jul 2000, L. Grand & C. Vernia, culture Overton, B.E. 00-09.
- Hypocrea microcitrina*
BPI 744660 United States: Georgia, Raybun Co., Chatahoochie National Forest. vic. Clayton, Warwoman Dell, on *Acer* sp. twigs with bark, 1997 Oct 14, Samuels G.J., Lieckfeldt E., & Tong X.
- Hypocrea minutispora*
BPI 842435 United States: New York, Ulster Co., Catskill Forest Preserve. Trout Creek, under hemlock, birch, maple, beech, on dead bark of *Abies* sp., 2002 Sep 21.
- BPI 1109372 United States: North Carolina, Macon Co., Ellicott Rock Trail. off Bull Pen road, on decorticated wood, 1990 Oct 14, Doi Y., Rossman A. Y. & Samuels G. J.
- Hypocrea pachybasioides*
BPI 1107148 Switzerland: Dischmatal, Graubunden Canton, Davos Vicinity, 1500-1700 m. alt., on decorticated wood of *Picea* sp., 1990 Sep 04, Samuels G.J.
- BPI 1107182 United States: North Carolina, Clay Co., Standing Indian Campground, off Hwy. 64, on *Aphyllophorales* on *Betula* sp., 1990 Oct 15, Samuels *et al.*
- Hypocrea pallida*
BPI 842455 United States: New York, Oswego Co., Syracuse, Cleveland, 1999 Oct 02, Samuels, G.J. (K. Pöldmaa 99-276).
- Hypocrea patella*
BPI 737750 United States: Indiana, Brown Co., Yellow Wood State Forest, Jackson Creek Management Trail, on bark, 1995 Sep 30, Parker A.
- BPI 1107192 United States: North Carolina, Macon Co., Overflow Creek, Blue Valley, off Clear Creek road, on *Liriodendron tulipifera*, 1990 Oct 16, Samuels, G.J. *et al.*
- BPI 1112910 United States: Maryland, Prince Georges Co., E of Largo in old growth forest at Church Rd, on decorticated wood, 1991 Oct 11, Samuels, G.J. *et al.*
- Hypocrea cf pseudostraminea*

- BPI 864172 United States: Tennessee, Great Smoky Mts. National Park, vic. Cosby, Greenbriar Ranger Station, Ramsey Cascade Trail, 35°43'N, 83°24'W, elev. 480 m, on bark of *Thuja*, 13 Jul 2004, Lowen R. & Samuels, G.J. 04-169.
- BPI 864063 United States: Tennessee, Cosby, Maddron Bald Trail, 35°46'N, 83°16'W, elev. 500 m, on bark of *Thuja*, 12 Jul 2004, Samuels, G.J. 04-165.
- Hypocrea pulvinata*
- BPI 802838 United States: New Mexico, Upper Fernando de Taos. alt. 8700 ft., Forest Service Map, T25n R15e S15, on *Polyporus betulinus*, 1992 Aug 15, Lowen R. (1003).
- Hypocrea rufa*
- BPI 744477 United States: North Carolina, Macon Co., northwest of Highlands, Cullasaja Gorge, Dry Falls, on bark of recently dead tree, 1989 Sep 20, Samuels G. J. (89-127), Rogerson C.T., Buck W.R., & Harris R.C.
- Hypocrea schweinitzii*
- BPI 1107183 United States: North Carolina, Clay Co. Standing Indian Campground, off Hwy #64, on bark of *Acer* sp. 1990 Oct 15, Samuels G. J., Doi Y., & Rossman A.Y. CBS 243.63.
- Hypocrea scutellaeformis*
- BPI (bound) United States: ?South Carolina, ad corticem *Aceris rubric*, Ravenel, Ravenel, Fungi caroliniani exsiccate IV: 31.
- NY Billings collection.
- Hypocrea sinuosa*
- BPI 843649 United States: New York, Green C., Diamond Notch, on well-rotted, decorticated wood and bark, 26 Sep 1998, P Chaverri.
- Hypocrea strictipilosa*
- BPI 744486 United States: Indiana, Lawrence Co., Hoosier National Forest, Hickory Ridge Trail, on well-rotted wood, 1996 Jul 27, Samuels G.J.
- BPI 744525 United States: Indiana, Porter Co., Indiana Dunes National Lakeshore, in hardwood area, on bark, 1996 Aug 19, Murphy J. (2206).
- BPI 745553 United States: Missouri, Mark Twain National Forest, Green Spring, at a point where Eleven Point River meets Rt 19, along a small stream, on decorticated wood, 1997 Oct 11, Samuels G.J. (97-236).
- BPI 748174 Japan: Nagano-prefecture, Sanado-Town, Kakuma valley, 1997 Aug 13, Schroers H.-J. *et al.* (222).
- Hypocrea sulphurea*
- BPI 737772 United States: Indiana, Brown Co., Yellow Wood State Forest. alt. 200 meters, 39°09'N, 86°06'W, Jackson Creek Management Trail, on bark, 1995 Sep 30, Samuels G. J.
- Hypocrea virens*
- BPI 737768 United States: Indiana, Brown Co., Vicinity of Pike's Peak, Happy Hollow Camp. alt. 250 meters, 39°09'N, 86°06'W, on decorticated wood, 1995 Sep 29, Samuels G.J.
- DAOM 167417 New Zealand.
- DIS 328a, a culture isolated as an endophyte from *Theobroma gileri* in Ecuador.
- Hypocreopsis rhododendri*
- BPI 631883 United States: West Virginia, Fayette Co., alt. 2000 ft, on *Kalmia latifolia*, 1893 Aug 24, Nuttall L. W. (567).
- Hypomyces aurantius*
- BPI 802786 United States: Missouri, Mingo Wilderness Refuge, on polypore, 1994 Sep 17, Samuels G. J., Seifert K. A. 655, 756, K. Pöldmaa 4-003.
- Hypomyces banningeriae*
- NY United States: New Jersey, Sussex Co., Stokes State Forest, S. of High Point State Park, On *Lactarius* sp., 26 Sep 1982, C.T. Rogerson 76-157.
- NY United States: North Carolina, Henderson Co., Green Cove Camp, Tuxedo, on *Lactarius*, 14 Sep 1974, coll. Mrs. Russell, det. C.T. Rogerson.
- Hypomyces boletiphagus*
- BPI 630625 United States: Pennsylvania, Hunt Co., Alan Segar Monument, on *Boletus* sp., 1938 Jun 26, Overholts L. O. Mrs.
- Hypomyces chlorinigenus*
- NY United States: Illinois, Jackson Co., Carbondale, campus of Southern Illinois University, 26 Aug 1975, W.J. Sundberg 2996, C.T. Rogerson 75-115.
- NY United States: Florida, Alachua Co., Split Rock Sink, Lower Sugar Foot Hammock, 27 Aug 1978, C.T. Rogerson 77-116, 77-122.
- Hypomyces chrysospermus*
- NY United States: New York, Hamilton Co., vic. Raquet Lake, Brown's Tract, 7 Sep 1986, coll.S. Stein, G.J. Samuels 86-536.
- Hypomyces completus*
- NY United States: North Carolina, Macon Co., Highlands Biological Station, on *Suillus pictus*, 10 Aug 1961, C.T. Rogerson 61-69.
- K. Pöldmaa 00-65.
- Hypomyces hyalinus*
- NY United States: Vermont, Chittenden Co., near Burlington Indian Brook Conservation Area, 29 Jul 2000, K. Pöldmaa 00-46.
- NY United States: Spock, COMA foray, C.T. Rogerson.
- Hypomyces lactifluorum*
- K. Pöldmaa 00-45
- NY United States: Michigan, Cheboygan Co., Univ. of Michigan Biol. Station, pine woods, 31 Jul 1964, C.T. Rogerson.
- Hypomyces lateritius*
- NY United States: New York, Westchester Co., Pound Ridge, on *Lactarius* sp., 3 Aug 1990, S. Scheine.
- Hypomyces leotiicola*
- NY United States: North Carolina, Transylvania Co., below Toxaway Falls along Toxaway Rivers, 27 Jul 1961, coll. C.T. Rogerson 61-15 with R. Petersen.
- NY United States: North Carolina, Transylvania Co., below Toxaway Falls along Toxaway Rivers, 17 Jul 1961, coll. C.T. Rogerson 61-56 with R. Petersen.
- Hypomyces luteovirens*
- K. Pöldmaa 00-157. United States: Pennsylvania, Westmoreland Co., Laurel Summit Picnic Area, 16 Sep 2000. 368.
- Hypomyces macrosporus*
- NY United States: Michigan, Cheboygan Co., Univ. of Michigan Biol. Station, Douglas Lake, on agaric among a cluster of *Hypomyces lactifluorum*, 2 Sep 1969, A.H. Smith, C.T. Rogerson 69-113.
- Hypomyces microspermus*
- NY United States: New York, Otsego Co., Oneonta College campus, on *Boletus chrysenteron*, 16 Aug 1985, C.T. Rogerson.
- NY G.J. Samuels 86-518 (both NY).

Hypomyces mycophilus

K. Pöldmaa 00-08.

NY United States: New York, Ulster Co., vic. Marlboro, on *Polyporus* sp., 16 Sep 1960, C.T. Rogerson 60-214.

Hypomyces ochraceus

BPI 802841 United States: Alabama, Clay Co., Talledega National Forest, Cheaha State Park, Creek Trail, on wood decorticated, 1992 Sep 23, Samuels G.J., Rogerson C.T., Huhndorf S.M.

Hypomyces papulasporae var. *americanus*

NY United States: Michigan, Emmet Co., Pellston Hills, on *Geoglossum* ?*glabrum*, 27 Jul 1953, coll. H. Clark, M.E. Barr Bigelow 1114.

NY New Zealand: Hokianga Co., S of Kaitaia, Puketi State Forest, bush walk from picnic area along Waipapa River, on *Trichoglossum hirstum*, 13 May 1981, coll. G.J.Samuels 81-89 with E. Horak.

Hypomyces polyporinus

BPI 744507 United States: New Jersey, Cumberland Co., Haleyville, at intersection of New Jersey Routes 649 and 718, in mixed hardwood, on *Trametes versicolor*, 1996 Jun 06 Samuels et al. K. Pöldmaa 00-166.

Hypomyces rosellus

BPI 630917 United States: California, Sonoma Co., Spring Mountain road, ca. 10 miles E. of Junction With Calistoga-santa Rosa road, on buried branches of *Quercus kelloggii*, 1963 Nov 21, Tavares I, Fuller J (1474), H.J.Schroers 03-3, K.Pöldmaa 128221.

Hypomyces sibirinae

K. Pöldmaa 00-17 United States: Maryland, Anne Arundel Co., Patuxent Wildlife Refuge, central part, SW part of River Rd., on a resupinate polypore, 02 Jul 2000.

K. Pöldmaa 00-28. United States: Maryland, Anne Arundel Co., Patuxent Wildlife Refuge, central tract, 200 m N of Duvall Bridge, on a resupinate polypore, 23 Jul 2000. G. Arnold 00-156. TFC 97-29.

Hypomyces stephanomatis

NY United States: New York, Tompkins Co., Enfield Glen near Ithaca, 20 Aug 1935, Conners & White ex DAOM 2979.

NY United States: North Carolina, on *Humaria*, 27 Sep 1988, coll. C.T. Rogerson, cultured G.J. Samuels 88-50.

Hypomyces sympodiophorus

BPI 749267 United States: West Virginia, Flatwoods, Sutton Lake. Bee Run Campground Coll: Samuels, G. J. on 1995 Sep 25. G. Arnold 00-105, 00-125.

K. Pöldmaa 99-251 Australia, Queensland, Crater Lakes Nat. Park, along Wrights Creek, on *Stereum ostrea* s.l., 30 Aug 1999.

K. Pöldmaa 00-83. United States: Kentucky, Daniel Boone National Forest, Menifee Co., Tarr Ridge, on *Stereum ostrea*, 29 Jul 1999.

Gunter Arnold 00-105

Hypomyces tegillum

NY Brazil: Amazonas, Pico Rondon, upper vine forest, on polypore on bark, 4 Feb 1984, G.J. Samuels 84-142. UPS-Fries United States: South Carolina, on pine, Curtis 2606 as *Sphaeria tegillum*.

Hypomyces tremellicola

NY United States: New York, Dutchess Co., near Tompkins Pond at base of Stissing Mt., on agaric (?*Crepidotus*), 9 Oct 1965, C. T. Rogerson 65-106.

UMO United States: Missouri, Stoddard Co., Mingo Refuge, 2005 Sept 24, B. Bomanz 228.

Sphaerostilbella aureonitens

BPI 1109361 United States: North Carolina, Macon Co., Blue Valley, off Clear Creek road, along Overflow Creek, on *Stereum* sp., 1990 Oct 16, Doi Y., Rossman A.Y., & Samuels G. J.

Species in the *Nectriaceae*

Calonectria colhounii

BPI 1112886 United States: Virginia. Giles Co., Cascades Recreation Site. alt. 840 meters, 37°2'N, 80°35'W, 4 miles N. of Pembroke, Little Stony Creek, on *Carya* sp. on pericarp of nut, 1991 Sep 18, Samuels G.J. 91-117

Calonectria pyrochroa

BPI 632095 Jamaica: between Woodcutter's Gap & Silver Hill Gap, on ground, 09 Jan 1971, Rossman A.

BPI 1104575 Venezuela: Federal Amazonas Territory, Cerro de La Neblina, 5.1 Km. N. E. Pico Phelps (=Neblina). alt. 1730-1850 meters, on leathery leaves, 12 Feb 1985, Rossman A. (2042)

Cosmospora consors

BPI 551399 Jamaica: St. Thomas Parish, elev. 650 ft., trail above Bath Fountain Hotel, Summit, 1986 Dec 12, Korf, R.P., Iturriaga, T., Zhuang W-y.

Cosmospora diminuta

BPI 865173 United States: North Carolina, Dare County, on *Quercus virginiana*, Aug 2002, L.F. Grand.

Cosmospora episphaeria

BPI 551823 United States: North Carolina, Candler, 1920 Nov, Stevens N. E.

Cosmospora flammea

BPI 631082 United States: Georgia, Thomasville, on *Carya oliviformis*, Demaree J. B.

BPI 1109085 United States: South Carolina, Florence, on *Septobasidium* sp., 1939 Aug 05, Hardin W. L.

Cosmospora magnusiana

BPI 552078 United States: South Carolina, Society Hill, on *Wisteria* sp., 1922 Jul 14, Rogers J. T.

BPI 802634 United States: North Carolina, Durham, on *Diatrype* sp., 1992 Jan 00, Rehner S.

Cosmospora papilionacearum

BPI 552721 United States: Nebraska, Peru, on *Desmodium* sp., 1900 Jul 21, Sheldon J. L.

Cosmospora peponum

BPI 552732 United States: South Carolina, Aiken, Ravenel H. W., Fungi Americani Exsiccati 338.

Cosmospora purtonii

BPI 1104745 United States: New York, Bronx Co., grounds of New York Botanical Garden, on *Robinia pseudoacacia*, 1979 Nov 15, Rossman A.Y., & Rogerson Clark T. (C.T.R. 79-318).

Cosmospora vilior

BPI 737773 United States: Indiana, Yellow Wood State Forest, Brown Co., alt. 200 meters, 39°09'N, 86°06'W, Jackson Creek Management Trail, on *Hypoxylon* sp., 1995 Sep 30, Samuels G. J.

Cosmospora sp.

BPI 552832 United States: Tennessee, Sevier County, Collins Gap, Great Smoky Mts. Nat. Park, along Appalachian Trail, on *Abies fraseri*, 1968 Aug 13, Rogerson C. T.

Gibberella pulicaris

BPI 632282 United States: California, Humboldt Co., Trinidad, Spruce Cove, on *Sambucus racemosa*, Apr 1946, coll. H.E. Parks 6925, det. Edith K. Cash.

Gibberella zeae

BPI 632217 United States: Kansas, Riley Co., Agronomy Farm, on *Andropogon scoparius*, 1955 Oct 2, coll. C.T. Rogerson.

BPI 632216 United States: Minnesota, Mapleton 10, on *Zea mays*, 1973 May 1973, J.C. Wolf 55, det. J. R. Liebermann, dried culture ATCC 24688.

Haematonectria haematococca

BPI 744657 United States: Georgia, Raybun Co., Chatahoochie National Forest, vic. Clayton, Warwoman Dell, on bark, 1997 Oct 14, Samuels *et al.*

Lanatonectria flocculenta

BPI 552091 United States: Tennessee, Great Smoky Mt. National Park, above Naturalist's Headquarters, on *Smilax* sp., 1939 Aug 17, Davidson R. W. & Stevenson J. A.

Nectria aurigera

BPI 550168 United States: South Carolina, on bark of *Fraxinus* sp., Ravenel Fungi Caroliniani Exsiccati Fasc. iii, no. 54.

Nectria austroamericana

BPI 550174 United States: Georgia, Athens, on *Mimosa* sp., 1942 Apr 01, Thompson G., Jackson W. R.

Nectria balsamea

BPI 746321 United States: North Carolina, Sparta, on dead branches and trunk of *Abies fraseri*, 1995 Aug 04, Grand L.F.

Nectria chlorinella

BPI (bound) United States: North Carolina, seaboard, on inner bark of *Ulmus americana*, 1881 Apr, coll. Cooke, Ravenel, Fungi Americani exc. 736

Nectria cinnabarina

BPI 550898 United States: North Carolina, near Jones Knob, on *Aesculus octandra*, 1910 Jul 29, Graves A.H.

Nectria coryli

BPI 551416 United States: North Carolina, Asheville, Bent Creek, on *Liriodendron tulipifera*, 1935 Jun 03, Hepting G.H.

BPI 551408 United States: New Hampshire, Thornton, on *Acer spicatum*, 1933 Jun 22, coll. Hansbrough J. R. (201), det: Seaver F. J.

Nectria cucurbitula

BPI 550405 United States: Georgia, on *Pinus* sp., 1932 Mar 26, Miller P.W.

"Nectria" mariannaeae

BPI 749338 United States: North Carolina, Macon Co. Blue Valley Rd., along east fork of Overflow Creek, on conifer bark, 1994 Sep 01, Samuels G. J., Schroers H.-J.

Nectria pseudotrichia

BPI 1109908 Venezuela: Sierra Nevada National Park, Coromoto, La Mucuy, Merida. alt. 2300 meters, 08°36'N, 71°02'W, above Tabay, 1990 Nov 09, coll:

Samuels G. J.; Hein B.; Huhndorf S. M.; Iturriaga T.; Rodriguez G.; Herrera M., Det. Samuels G. J. (6760).

BPI 745544 Puerto Rico: Caribbean National Forest. Luquillo Mountains, Rio Grande, trail to El Toro from Rt 186, on recently dead shrub, 24 Feb 1996, Samuels G. J., Schroers H.-J., & Lodge D. J. (8099).

BPI 552902 Puerto Rico: Rio Piedras, 1916 Jul 04, coll: Stevenson (5567), det, Seaver F. J., Herbarium C. E. Chardon 1289.

Nectria rubicarpa

BPI bound United States: South Carolina, Aiken, in ramis *Gelsemi*, Ravenel, Fungi Americani exs. 343, part of type.

BPI 553073 United States: Alabama, Auburn, Lee County, on *Gelsemium sempervirens*, 1896 Feb 15, Earle F. S.

Neocosmospora vasinfecta

BPI 630319 United States: Georgia, Ft. Gains, on *Arachis hypogaea*, 01 Aug 1930, Carver, G.W.

BPI 630316 Locality, date, substratum, collector not known from IMI 952924.

Neonectria faginata

BPI 864079 United States: Tennessee: Great Smoky Mountains National Park, road to Balsam Mt., on *Fagus grandifolia*, elev. 1570 m, 35°50'N, 83°11'W, 2004 July 15, coll. G.J. Samuels (GJS 04-159) and R. Baird.

BPI 870944 United States: Pennsylvania: Allegheny National Forest, tree 6, on *Fagus grandifolia*, 2004 Oct 7, coll. Martin MacKenzie, cultured Amy Rossman AR 4096 = CBS.

Neonectria discophora

NY Guyana: on *Clusia* branchlets, Mar 1987, G. Samuels *et al.* 5065.

BPI 1112875 United States: Virginia. Giles Co., Mt. Lake Biological Station. alt. 1170 meters, 37°22'N, 80°31'W, Little Spruce Bog, on dying base of *Rhododendron* sp., coll: Samuels G. J. (91-106).

BPI 802658 Scotland: Cowal Peninsula, Argyll Forest Park, alt. 20-100 meters, N. end of Loch Goil, on branch of *Larix* sp., 1992 Apr 12, Samuels G. J., & Brayford D. (8018).

Neonectria ditissima

BPI 550577 United States: North Carolina, John Rock near Pisgah Forest, on *Juglans nigra*, 1935 Oct, Hepting G. H.

BPI 552350 United States: North Carolina, Dillingham, on *Quercus velutina*, Hepting G. H.

Neonectria veuillotiana

BPI 1107265 United States: North Carolina, Jackson Co., on bark of *Acer rubrum*, 1989 Sep 28, Samuels G. J., Rogerson C. T., Buck W. R., & Harris R. C.

Viridispora diparietispora

BPI 802199 United States: Georgia, Davisboro, Forest Nursery, isol. from soil, 1955 Sep 14, Miller J. H. (2067) ATCC 13214, Isotype of *Pseudonectria diparietispora*.

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