

Revised scientific names of the genus *Hemileia* (*Pucciniales*) based on the new ICN

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Academic editor: *D. Begerow* | Received 25 September 2012 | Accepted 20 September 2013 | Published 9 January 2014

Citation: Judith C, Rossman A (2014) Revised scientific names of the genus *Hemileia* (*Pucciniales*) based on the new ICN. MycoKeys 8: 1–10. doi: 10.3897/mycokeys.8.4040

Abstract

Based on the new International Code of Nomenclature for algae, fungi, and plants, specifically the effective deletion of Article 59, we provide a list of the revised scientific names of species in the genus *Hemileia* (*Pucciniales*). Five new combinations are proposed.

Key words

Coffee rust, International Code of Nomenclature for algae, fungi, and plants, rust fungi, unit nomenclature

Introduction

At the 18th International Botanical Congress in Melbourne, July 2011, the members agreed to fundamental changes concerning the naming of fungi. Of particular interest is the ending of the dual nomenclature system for fungi as previously governed by Article 59 of the outdated International Code of Botanical Nomenclature (McNeill et al. 2006). In the new International Code of Nomenclature for algae, fungi, and plants (ICN), one species of fungus may have only one scientific name. The use of separate names for the sexual and asexual states is no longer allowed. Thus, the legitimate and validly published names for one species must be considered with priority

given to the oldest species epithet. This new rule is effective immediately as dictated by the ICN (McNeill et al. 2012). Although moving to the use of one scientific name is problematic especially for rust fungi, this brings the fungi in line with all other groups of organisms.

The taxonomy of rust fungi has been confused partly because of the difficulty in determining sexual and asexual states and connecting the various states for an individual species. Many genera were defined based on the presence of teliospores that produce basidia. Also serving as the resting or overwintering stage, teliospores are produced on dikaryotic hyphae with meiosis taking place in the basidia that develop from germinating teliospores. Asexual states usually bearing aeciospores or urediniospores were placed in genera such as *Aecidium* and *Uredo* that generally lacked phylogenetic meaning i.e. these genera did not unite related species. Some rust species that lacked known teliospores were described using scientific names in the appropriate genus but these were considered invalid names because of the lack of teliospores as dictated by Article 59 of the International Codes of Botanical Nomenclature such as McNeill et al. (2006). Once a specimen with teliospores was discovered, a new name with another type specimen was published in the appropriate genus or, in some cases, the old name was considered to be validated by the species having teliospores. With the changes in the rules of the ICN, the scientific names of many rust fungi must be re-evaluated with priority given to the oldest epithet for a species regardless of the genus in which it was described.

The objective of this paper is to provide a list of scientific names of species in the rust genus *Hemileia* that brings the scientific names into accordance with the ICN. The genus *Hemileia* was recently revised by Ritschel (2005). At that time a number of species were placed in *Uredo* even though they were considered to belong in *Hemileia* because they lacked teliospores. With the new ICN these names compete for priority and can now be placed in *Hemileia*. This revision of the scientific names of *Hemileia* is based entirely on the account of the genus published by Ritschel (2005). Of the 42 names included Ritschel (2005), 26 names need to be changed i.e. the correct scientific name already exists but was not recognized as such in *Hemileia*. These include five new combinations required because the oldest epithet needs to be placed in the genus *Hemileia*. The scientific name of the fungus that causes coffee rust, thankfully, remains unchanged, as *Hemileia vastatrix*.

Material and methods

This account is based on the Ritschel (2005) “Monograph of the genus *Hemileia* (*Uredinales*).” Further literature was consulted when the comments in Ritschel (2005) did not provide sufficient information. For the implementation of the new rules concerning dual nomenclature, we consulted Braun (2012), Hawksworth et al. (2011) and Norvell (2011), articles describing the most significant changes and impacts of the new ICN on dual nomenclature of pleomorphic fungi.

Results

***Hemileia africana* (Lagerh.) Judith & Rossman, comb. nov.**

Mycobank: MB 801490

http://species-id.net/wiki/Hemileia_africana

Basionym: *Uredo africana* Lagerh., Bol. Soc. Brot. 7: 135, 1889.

= *Uredo ancylanthi* Henn. in Baum, Botanische Ergebnisse der Kunene-Sambesi-Expedition 1903, 728: 158, 1903.

≡ *Hemileia ancylanthi* (Henn.) Syd., Monogr. Ured. 3: 208, 1915.

Comments. The name *Uredo africana* 1889 has priority over the other basionym, *U. ancylanthi* 1903, thus *U. africana* is transferred to the genus *Hemileia*.

***Hemileia alafiae* (Cummins) Judith & Rossman, comb. nov.**

Mycobank: MB 801491

http://species-id.net/wiki/Hemileia_alafiae

Basionym: *Uredo alafiae* Cummins, Bull. Torrey Bot. Club 79: 230, 1952.

Comments: Only the uredinial stage is known for this species that is herein placed in the genus *Hemileia* based on the comments in Ritschel (2005).

***Hemileia aureospora* J.-M. Yen, Rev. Mycol. (Paris) 40: 127, 1976.**

= *Uredo aureospora* Cummins, Bull. Torrey Bot. Club 87: 41, 1960.

Comments. *Uredo aureospora* 1960 has priority but it cannot be moved to *Hemileia* because that name already exists in the genus. For this reason the next oldest name *H. aureospora* is the accepted scientific name for this species of which *U. aureospora* is a taxonomic synonym. Although the name *H. aureospora* was previously considered to be not validly published because the type specimen lacked teliospores and thus violated Article 59 of the now outdated International Code of Botanical Nomenclature (ICBN) (Stafleu et al. 1972), the new ICN allows this name to be used.

***Hemileia deightonii* Syd., Ann. Mycol. 35: 247, 1937.**

≡ *Uredo deightonii* (Syd.) Cummins, Bull. Torrey Bot. Club. 87: 42, 1960.

= *Hemileia rauwolfiae* J.-M. Yen & Gilles, in J.-M. Yen, Rev. Mycol. 40: 129, 1976.

Comments. Based on the principle of priority, *Hemileia deightonii* is the correct name for this species. This name had been placed in *Uredo* because of the lack of teliospores as dictated by the ICBN in effect at that time but is now allowed by the ICN.

***Hemileia dioscoreae-aculeatae* (Racib.) Syd., Monogr. Ured. 3: 220, 1915.**

≡ *Uredo dioscoreae-aculeatae* Racib., Paras. Alg. Pilz. Javas I: 30, 1900.

Comments. *Uredo dioscoreae-aculeatae* serves as the basionym for this species.

***Hemileia evansii* Syd., Ann. Mycol. 10: 34, 1912.**

≡ *Uredo evansii* (Syd.) Ritschel, Bibl. Mycol. 200: 78, 2005.

Comments. Because the presence of teliospores on the type material of *Hemileia evansii* could not be confirmed as required at that time, Ritschel (2005) published a new combination in the genus *Uredo*. This name is now listed as a nomenclatural synonym.

***Hemileia fadogiae* Syd., Ann. Mycol. 10: 34, 1912.**

= *Uredo fadogiae* Henn., Ann. Mus. Congo, Bot., Sér. 5 Vol. 2(2): 94, 1907.

Comments. *Hemileia fadogiae* is the correct name for this species because transferring the epithet having priority, *Uredo fadogiae*, into *Hemileia* would result in a later homonym. Because of this, it is necessary to use the next available epithet, in this case *H. fadogiae*.

***Hemileia gardeniae-floridiae* Sawada, Trans. Nat. Hist. Soc. Formosa 21: 234, 1931.**

≡ *Uredo gardeniae-floridiae* (Sawada) Hirats. f., Sci. Bull. Agric. Div. Univ. Ryukyus 7: 279, 1960.

Comments. Because Hiratsuka (1960) could not find the type specimen and thus could not confirm the presence of teliospores in *Hemileia gardeniae-floridiae*, he placed this epithet in *Uredo*. Under the ICN *H. gardeniae-floridiae* is the correct scientific name for this species.

***Hemileia hansfordii* Syd., Ann. Mycol. 37: 198, 1939.**

≡ *Hemileia wakefieldii* Ritschel, Bibl. Mycol. 200: 64, 2005.

[≡ *Hemileia hansfordii* Wakef. & Hansf., Proc. Linn. Soc. London 161:165, 1949, hom. illeg. non Syd. 1939]

Comments. The name *Hemileia hansfordii* Syd. has priority but was not used previously because of the lack of teliospores on the type specimen. Wakefield and Hansford (1949) described a new name for this species when they found teliospores but their name was a later homonym of the existing *H. hansfordii* Syd. Ritschel (2005) provided a new name for this species but that name, *H. wakefieldii*, is now considered a nomenclatural synonym because the oldest name is now legitimate.

***Hemileia holstii* (Henn.) Syd., Monogr. Ured. 3: 213, 1915.**

≡ *Uredo holstii* Henn., in Engler, Pflanzenw. Ost-Afrikas Teil C: 52, 1895.
 = *Uredo psychotriae-volkensii* Henn., in Engler, Pflanzenw. Ost-Afrikas Teil C: 52, 1895.
 = *Uredo mkusiensis* Henn., Bot. Jahrb. Syst. 34: 41, 1905.

Comments. The names *Uredo holstii* and *U. psychotriae-volkensii* were both published on the same page and thus are considered equal in priority. Because *Uredo holstii* had already been placed in *Hemileia*, this basionym is considered to have priority.

***Hemileia kilimanjarensis* (Ritschel) Judith & Rossman, comb. nov.**

Mycobank: MB 801492

http://species-id.net/wiki/Hemileia_kilimanjarensis

Basionym: *Uredo kilimanjarensis* Ritschel, Bibl. Mycol. 200: 83, 2005.

Comments. When Ritschel (2005) described *Uredo kilimanjarensis*, she recognized that it belonged in the genus *Hemileia* but this would have violated the ICBN in effect at that time. Under the ICN, this name may now be transferred accordingly.

***Hemileia kumasensis* (Cummins) Judith & Rossman, comb. nov.**

Mycobank: MB 801493

http://species-id.net/wiki/Hemileia_kumasensis

Basionym: *Uredo kumasensis* Cummins, Bull. Torrey Bot. Club 87: 42, 1960.

Comments: When Cummins (1960) described *Uredo kumasensis*, he recognized the affinities of this species with *Hemileia*. Under the ICN, this name is newly combined in *Hemileia*.

***Hemileia laurentii* (Henn.) Syd., Monogr. Ured. 3: 215, 1915.**

≡ *Uredo laurentii* Henn., in De Wildeman, État Indépendant du Congo. Mission Émile Laurent (1903–1904). Fasc. 4: 356, 1907.

Comments. Ritschel (2005) attributed this name in *Hemileia* to Syd., however, with the change in the ICN, *Uredo laurentii* Henn. serves as the basionym for this species and the author citation should be (Henn.) Syd.

***Hemileia mbelensis* (Henn.) Syd., Monogr. Ured. 3: 223, 1915.**

≡ *Uredo mbelensis* Henn., Ann. Mus. Congo, Bot., Sér. 5 Vol. 2(2): 94, 1907.

Comments. Prohibited from recognizing this epithet in *Hemileia* by the ICBN in effect at the time, Ritschel (2005) included this species as *Uredo mbelensis* in her monograph. With the new ICN, this species can now be recognized in the appropriate genus.

***Hemileia mildbraedii* (Syd.) Syd., Monogr. Ured. 3: 212, 1915.**

≡ *Uredo mildbraedii* Syd., Deutsche Zentral-Afrika Expedition, 1907/08, 2: 98, 1911.
= *Hemileia sydowiorum* Ritschel, Bibl. Mycol. 200: 56, 2005.
[= *Hemileia pavetticola* Roger, Bull. Soc. Mycol. France 54: 48, 1938, nom. nud.]

Comments. Because the type specimen of *Uredo mildbraedii* lacked teliospores, Ritschel (2005) described a new species, *Hemileia sydowiorum*, using a type specimen having teliospores. With the new ICN, *U. mildbraedii* provides the epithet of priority for this species. The name *H. pavetticola* Roger was published without a Latin diagnosis. Ritschel (2005) lists 1914 as the year of publication for the name *Uredo mildbraedii*, while, in fact, this name was published earlier in the account of the first expedition that appeared in 1911.

***Hemileia mussaendae* Vienn.-Bourg., Bull. Soc. Mycol. France 67: 431, 1951.**

= *Hemileia pieningii* Deighton, Trans. Brit. Mycol. Soc. 55: 497, 1970.
[= *Hemileia mussaendae* Cummins, Bull. Torrey Bot. Club. 87: 36, 1960 non Vienn.-Bourg. 1951, hom. illeg. non Vienn.-Bourg. 1951]

Comments. *Hemileia mussaendae* Vienn.-Bourg. was the first name published for this species. Because the type specimen lacked teliospores, Cummins (1960) established a new name using another type specimen. Because Cummins' (1960) name is a later homonym of *H. mussaendae* Vienn.-Bourg., Deighton (1970) provided a new name based on the same type specimen. With the new ICN, the oldest epithet has priority.

***Hemileia oxyanthi* Cummins, Bull. Torrey Bot. Club 68: 467, 1941.**

≡ *Uredo oxyanthi* (Cummins) Cummins, Bull. Torrey Bot. Club 87: 42, 1960.

Comments. Following the new ICN, *Hemileia oxyanthi* (1941) is the correct name for this species.

***Hemileia phaji* (Racib.) Syd., Monogr. Ured. 3: 222, 1915.**

≡ *Uredo phaji* Racib., Paras. Alg. Pilz. Javas II: 32, 1900.

Comments. With the new ICN, *Uredo phaji* serves as the basionym for this species recognized in *Hemileia*.

***Hemileia rhois* E. Castell., Nuovo Giron. Bot. Ital., new ser. 49: 20, 1942.**

= *Hemileia castellanii* Ritschel, Bibl. Mycol. 200: 21, 2005.

Comments. Because *Hemileia rhois* is based on urediniospores, Ritschel (2005) published a new name for this species based on a type specimen with teliospores. With the new ICN, the correct name based on the rules of priority is the oldest one.

***Hemileia scheffleri* (Syd. & P. Syd.) Syd., Monogr. Ured. 3: 220, 1915.**

≡ *Uredo scheffleri* Syd. & P. Syd., Bot. Jahrb. Syst. 45: 262, 1910.

Comments. When Sydow and Sydow (1915) published the name *Hemileia scheffleri*, they attributed it only to Syd., however, the name is clearly based on *Uredo scheffleri* i.e. both names are based on the same type specimen. With the new ICN, this name in *Hemileia* is the correct name for this species.

***Hemileia scitula* Syd., Ann. Mycol. 35: 247, 1937.**

≡ *Uredo scitula* (Syd.) Cummins, Bull. Torrey Bot. Club 87: 43, 1960.

Comments. Following the new ICN, *Hemileia scitula* is the correct name for this species.

***Hemileia secamones* Wakef. & Hansf., Proc. Linn. Soc. London 161: 166, 1949.**

≡ *Uredo secamones* (Wakef. & Hansf.) Gjaerum, in Gjaerum et al., Lidia 5: 2, 2000.

Comments. With the new ICN, *Hemileia secamones* can be resurrected as the correct name for this species.

***Hemileia smallii* Wakef. & Hansf., Proc. Linn. Soc. London 161: 166, 1949.**

= *Hemileia smalliana* Gjaerum, in Gjaerum et al., Lidia 5: 2, 2000.

[= *Hemileia smallii* Fernier, Rev. Mycol. (Paris), Suppl. Colon. 19: 62, 1954 *hom. illeg.* non Wakef. & Hansf. 1949]

Comments. Following the new ICN, *Hemileia smallii* has priority even though the type specimen includes only the asexual stage of this species. Fernier (1954) described a name for the teleomorph using a different type specimen. Because he used the same epithet, that name is an illegitimate, later homonym. For this reason Gjaerum et al. (2000) established another name for this species based on a different type specimen that is here regarded as a taxonomic synonym.

***Hemileia solaninum* (Henn.) Judith & Rossman, comb. nov.**

Mycobank: MB 801494

http://species-id.net/wiki/Hemileia_solaninum

Basionym: *Uredo solaninum* Henn., Bot. Jahrb. Syst. 28: 319, 1901.

= *Uredo scholzii* Henn., Bot. Jahrb. Syst. 33: 34, 1904.

= *Hemileia scholzii* Syd. & P. Syd., Bot. Jahrb. Syst. 45: 260, 1910.

Comments. Based on the comments in Ritschel (2005), *Uredo solaninum* is considered to be the oldest name for this species and is thus transferred to *Hemileia*. The other names are based on different type specimens that occur on different hosts but are considered by Ritschel (2005) to apply to the same species, thus they are listed here as taxonomic synonyms.

***Hemileia sonsensis* (Henn.), Syd. & P. Syd., Monogr. Ured. 3: 217, 1915.**

≡ *Uredo sonsensis* Henn. Ann. Mus. Congo, Bot. Sér. 5(2): 94, 1907.

Comments. Considering the new ICN and comments by Ritschel (2005), this species should be classified in *Hemileia*.

***Hemileia thomasii* Thirum. & Naras., Ann. Bot. 11: 87, 1947.**

= *Hemileia randiicola* Thaug, Trans. Brit. Mycol. Soc. 66: 108, 1976.

Comments. Because of the lack of teliospores on the type specimen of *Hemileia thomasii*, Thaug (1976) established a new species with another type specimen. With the new ICN the name, *H. thomasii* has priority as the name for this species.

Acknowledgments

Dr. Andrew Minnis, Center for Forest Mycology Research, Northern Research Station, U.S. Forest Service, Madison, Wisconsin, is acknowledged for helpful comments on an early draft of this paper based on his extensive knowledge of the various codes of nomenclature as they pertain to fungi.

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LIAS light – Towards the ten thousand species milestone

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Academic editor: *G. Hagedorn* | Received 12 November 2013 | Accepted 17 December 2013 | Published 10 January 2014

Citation: Rambold G, Elix JA, Heindl-Tenhunen B, Köhler T, Nash III TH, Neubacher D, Reichert W, Zedda L, Triebel D (2014) LIAS light – Towards the ten thousand species milestone. *MycoKeys* 8: 11–16. doi: 10.3897/mycokeys.8.6605

Abstract

Over the past 12 years, the lichen trait database *LIAS light* as a component of the *LIAS* information system, has grown to a considerable pool of descriptive data based on 71 different qualitative, quantitative, and text characters, for nearly 10.000 lichen taxa, being phylogenetically arranged according to the *MycoNet* classification. It includes information on morphological, ecological and chemical traits. Multilinguality or internationalization options have become a central challenge of the project. At present, 18 language versions of the database and web interface exist. *LIAS light* data are accessible in DELTA format and to be used locally and web browser-based, via *NaviKey* applet.

Key words

Identification, trait database, characters, biodiversity informatics

Project features and concepts for the future

For the purpose of giving access to treated taxa, monographic and floristic treatments are often assigned with traditional dichotomous or polytomous identification keys. Until today, such keys have proven to be of highest value as they mostly provide identification criteria optimized for a specific set of taxa or an area. Nevertheless, the growing use of the internet as well as the need of open access to information and knowledge on biodiversity at a higher or global scale has led to an increased use of internet-related technologies for identifying taxa (Hagedorn et al. 2010; Nash et al. 2002).

Over the past 12 years, the lichen trait database *LIAS light* (<http://liaslight.lias.net>) has grown to a considerable pool of descriptive data for lichens with information on morphological, ecological and chemical traits. It is part of the *LIAS* data platform, which has been initiated as a web project in 1995 (Rambold 1996, Triebel et al. 2007) and actually includes two further active segments: *LIAS names* (<http://liasnames.lias.net/>) with more than 40,000 names including synonyms, isonyms and homonyms, as well as *LIAS glossary* (<http://glossary.lias.net/>). Data from *LIAS names* along with data from *LIAS light* form the Global Species Database *LIAS* (Rambold 2012 onwards; <http://www.catalogueoflife.org/col/details/database/id/79>) as taxonomic backbone for lichens in the megascience platform Catalogue of Life (Triebel et al. 2012).

There are two other parts of the site (*LIAS main* and *LIAS checklists*) which have been frozen in favour of *LIAS light* which works based on a reduced number of descriptors (see below) and will incorporate in the near future occurrence data at the country level as well. While the concept of *LIAS main* was based on lichenologist community driven data input, entry of *LIAS light* data was primarily taken over by laboratory members of the first author, starting with compilation data from outstanding lichen floras like Wirth (1995) for Baden-Württemberg (Germany), Purvis et al. (1992) for the United Kingdom, Nash et al. (2002, 2004, 2007) for the Sonoran Desert (U.S.A. and Mexico). By inclusion of a wide range of additional literature with descriptions of lichen taxa from all regions of the world, the project first slowly, then rapidly increased with regard to the number of taxa included and quality of entered data.

The number of taxa is now close to 10,000. Estimate numbers of accepted names of lichens at a global scale range between 13,500 and 20,000. Given the number of 17,000 described, accepted lichen species of the world as proposed by Chapman (2009), *LIAS light* content now covers about 60% of the accepted taxa. The included traits are based on about 71 different qualitative (i.e. categorical), quantitative (i.e. numerical), and text characters. Several are only used for data management issues, but about 50 only concern diagnostic traits to be used for identification and data analysis purposes. The full list of these characters is provided under http://liaslight.lias.net/Identification/Navkey/World/en_GB/chars. Outstanding and therefore worthwhile to be mentioned is the categorical trait ‘secondary metabolites <compound>’, which covers about 1,020 lichen metabolite names as character states. The highly different quality of the individual data records (‘species profiles’) is due to the most different level of completeness in the literature sources, which include original articles with species descriptions as well as monographic treatments. This means that the coverage and reliability of traits per taxon is relatively unequally distributed. However, the individual data records of each species are being continuously revised by considering additional articles with relevant and reliable species descriptions or trait data. Of the current 10,000 data records, entered by members of the editorial board and co-workers, about 3,000 data records have already been revised at least once. Aside from the purpose of identification, *LIAS light* data collection may also be applied as background data for reconstructing phylogenetic character evolution by mapping of character states onto phylogenetic trees, as well as for ecological studies with a focus on the distribution

of phenotypic traits in a given area by correlating environmental or occurrence data (Zedda et al. 2011).

The taxon names used for the *LIAS light* dataset are maintained in *LIAS names*. For most of the records, modern taxonomic concepts are applied when literature references exist. The higher classification backbone is based on *MycNet* data (<http://fieldmuseum.org/explore/myconet>) and updated accordingly. By activating the resulting *LIAS light* taxon names, access to additional information and links to further resources is provided. Aside from *LIAS names* (see above), they include a) an interface using the web service of *Recent Literature of Lichens* (http://www.bio.uni-bayreuth.de/liaslight/service/rll_wrap.php); b) a lichen image accession interface (<http://www.bio.uni-bayreuth.de/liaslight/service/LichenImages.php>) to reliable web sites with significant images; and c) several less specific portals like *Wikispecies*, *Google Images*, *NCBI Search* and others.

Associated with *LIAS light* is *LIAS metabolites* (<http://liaslight.lias.net/Identification/Navkey/Metabolites/index.html>), a database compiled by J. A. Elix with additions of K. Kalb (Neumarkt, Germany). This *LIAS* database component includes the values of TLC, HPLC and MS for about 880 secondary lichen compounds, together with additional information like the substance class and names of related metabolites. It is useful for interpreting chromatographic and spectroscopic analysis results. Soon each data record of *LIAS metabolites* will be supplemented with the chemical formulas and further representations including SMILE codes.

Multilinguality or internationalization options have become a central challenge of the *LIAS light* project. At present, versions in 18 languages exist: aside from English, being Arabic, Armenian (Fig. 1), Chinese, Esperanto, Farsi, French, German, Hebrew, Italian, Korean, Kyrgyz, Polish, Portuguese, Romanian, Russian, Uzbek, Spanish, and Turkish. The translation of the subject-specific vocabulary is intended as a contribution of preventing ‘lingual erosion’ in the languages aside from English. Regarding the 18 languages actually included in *LIAS light*, it becomes apparent that several ones (like French, German, Polish, Russian, Spanish etc.) easily cover all general and specific terminologies, while others (like Kyrgyz or Chinese) are only capable of providing the general terms but not or much less the specific ones, (e.g. the scientific names of secondary metabolites). In such cases, supplementation of the respective character state list by terms from English or Russian (in the case of Kyrgyz) or another widely spoken language is required. The use of a native language is desired, especially by students as well as amateur communities, who are involved in monitoring projects in many countries of the world. The translation of the *LIAS light* character list and the *NaviKey* web interface contents into the various languages have been achieved by colleagues in biology or lichenology (<http://liaslight.lias.net/About/Impressum.html>).

LIAS light content is provided via *NaviKey*, a Java applet and application for accessing descriptive data (<http://www.navikey.net/>). It provides quite a range of possibilities to modify the queries for obtaining improved results. One of the most important options is ‘*Retain items unrecorded for the selected characters*’ being a switch between a ‘data query mode’ (checkbox “set off”, as the default) and an ‘identification mode’ (checkbox “set on”). While the query mode is strict and only provides the directly



Submission of pdf files with descriptions of missing taxa is highly appreciated. If your language is not yet supported, you are very welcome to create that translation. Please contact us for obtaining relevant template files.

Աշխարհի բարաքուների տեսակների որոշում

(Տարածների փորձական դուրս բերում աշխարհի տարբեր տարածաշրջաններին)

Java Երազիրը գործարկելու համար անհրաժեշտ է ներբերեն Java™ Runtime Environment Երազրի վերջին տարբերակը և կատարել տեղադրում: Կանոնառ սինյուն օգտագործելու համար պետք է Java v. 6.0 կամ ավելի նոր տարբերակ: Հետևյալ կայքի հասցեն (http://ias.net) պետք է տեղադրել վեբ բրաուզերի pop-up blocker կարգավորումների թույլտրտրելի կայքերի ցանկում: Մանրամասն տեղեկություններ կարող եք գտնել տարբեր:

Եթե LNU լայն տվյալների բազան օգտագործվել է Ձեր աշխատանքում, այսու կատարել հղում, ինչպես խորհուրդ է տրվում այստեղ: Մենք գնահատում ենք Ձեր կարծիքը:

Figure 1. LIAS light web interface NaviKey in Armenian language.

matching data according to the selection, the identification mode is more tolerant in the way that it matches positively also in the case, that a respective character state is not specified in the respective data record. During identification, the option to simultaneously select more than one character state, either with OR (*‘Retain matching at least one selected state’* checkbox “set on”, as the default) or with AND (checkbox “set off”) selection criteria, facilitates one making decisions when specifying states of categorical characters. For instance, the decision to select certain colour nuances may be relatively difficult. However, switching between the two modes is not yet possible during one and the same identification procedure, but will be implemented in the future.

The *LIAS light* database with its *NaviKey* web interface still exhibits certain shortcomings and does not fully provide satisfactory results in all cases. Nevertheless, it is foreseeable that by continued data entry and revision and with some improvements of the user interface, *LIAS light* will become a feasible tool for lichen identification. Especially the intended inclusion of country checklist information from reliable original sources (e.g., the original checklists of Austria, Australia, France, Germany, or North America), will entail improved resolution of data and therefore more reliable identification results, especially for countries with a more or less saturated knowledge of taxon occurrence. The use of checklist information as a prefilter function also beneath country level is being considered. Since October 2013, GBIF offers the option of user-defined filter creation for dynamically generating spatially defined species lists. By implementing access to this service *LIAS light* will be enabled to use this additional option of taxon preselection. For the next future, functionality of the *NaviKey* software will be extended by enabling the dynamic generation of taxon description web pages. *LIAS metabolites* will be optimized and new languages will be added on request.

All contents of the lingual versions are downloadable under a Creative Commons Attribution-Non-Commercial-No Derivative Works 3.0 Unported License as archive data files from the respective *LIAS light* language version page (e.g., http://liaslight.lias.net/Identification/Navkey/data/download/LIASlightDataFilesWorld.pl_PL.zip for the data set in the Polish language). The data may be evoked by a local installation of *NaviKey* and be even used offline, which, for instance, may be of value for work in remote areas with low bandwidth internet. Server logs indicate an increasing acceptance of *LIAS light*. The relative number of re-visitors or users, respectively, is steadily growing and is a clear argument in favour of internationalizing the project – there is a striking correlation between visitor location at the country level and the language version being selected. A citation of *LIAS light* by users in their publications is highly appreciated and should be in accordance with the imprint page (<http://liaslight.lias.net/About/Impressum.html>).

Acknowledgements

For translating the *LIAS light* database schema and user interface into the various languages, we would like to thank Martin Brüggemeier, Ahaus, Germany (Esperanto), Tiziana Cossu, Sassari, Italy (Italian), Evgeny A. Davydov, Barnaul, Russia (Russian), Decebal-Radu Ciurchea, Cluj-Napoca, Romania (Romanian), Estelle Enaud, Louvain-la-Neuve, Belgium (French), Arsen Gasparyan, Yerevan, Armenia (Armenian), Iris Gonzáles, Managua, Nicaragua (Portuguese), Yongdoo Kim, Gwangju, South Korea (Korean), Tamar Kis-Papo, Haifa, Israel (Hebrew), Nathalie Moske, Bayreuth, Germany (Turkish), Gulnara A. Muhambetalieva, Karakol, Kyrgyzstan, (Kyrgyz, Uzbek), Nicole Nöske, Berlin, Germany (German), Piotr Jan Osyczka, Krakow, Poland (Polish), Claude Roux, Mirabeau, France (Esperanto, French), Veronica Sanz, Barcelona, Spain (Spanish), Ayhan Şenkardeşler, Izmir, Turkey (Turkish), Sameh Mohammad Shaddad, Sassari, Italy (Arabic), Mohammad Sohrabi, Helsinki, Finland and Tehran, Iran (Arme-

nian, Farsi, Turkish), Ileana Téllez, Managua, Nicaragua (Portuguese), Reinaldo Vargas Castillo, Concepción, Chile (Spanish), Jiang-Chun Wei, Beijing, China (Chinese), and Xin Li Wei, Beijing, China (Chinese).

The work was supported in part by the Federal Ministry of Education and Research, Germany (BMBF) under project ID 01 LI 1001 B ‘GBIF-D’ and by the German Research Foundation (DFG) as a project of the LIS infrastructure program grants (project IDs INST 747/1-1, RA 731/11-2, and TR 290/5-1) and in the context of the funding initiative DFG/CNPq: German-Brasílian consultative visits under DFG project ID 444 BRA – 113 / 58 / 0-1. Support was also granted by the European Union’s 7 Framework Programme (project ID FP7/2007-2013) in the 4D4Life project context (grant agreement ID 238988).

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Two new species of *Ramaria* from Arkansas

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Academic editor: S. Redhead | Received 22 February 2014 | Accepted 29 May 2014 | Published 25 July 2014

Citation: Petersen RH, Hughes KW, Justice J (2014) Two new species of *Ramaria* from Arkansas. MycoKeys 8: 17–29. doi: 10.3897/mycokeys.8.7356

Abstract

Two species of *Ramaria* from the Ozark region of Arkansas, USA, *R. admiratia* and *R. calvodistalis*, are proposed as new. They are described morphologically and placed molecularly within a large clade including taxa of ramarioid and cantharelloid fungi.

Key words

Ozark Plateau, dendrophysoid hyphae, *Laeticolora*, taxonomy

Introduction

The annual national foray of the North American Mycological Association was held in northern Arkansas in 2013, specifically in the lower Boston Mountains of the Ozark Ecoregion. Among collections of fleshy fungi were several species of *Ramaria* (Gomphaceae, Gomphales, Agaricomycotina), of which two appear to be new to science and are described below.

American literature dealing with the modern genus *Ramaria* may have begun with the treatment by Burt (1922), followed by that of Coker (1923), both of whom used an expansive concept of *Clavaria* to shelter taxa of the modern *Ramaria*. Maxwell Doty (1944) dealt with some taxa of *Ramaria* in his thesis on *Clavaria* (s.l.) from Oregon and the Pacific Northwest. Corner (1950, 1970) greatly expanded the concept of *Ramaria* and treated the genus worldwide. The genus in Washington State was taken up

by Currie D. Marr in his PhD dissertation, published jointly with his major professor, Daniel E. Stuntz (Marr and Stuntz 1973). Their coverage centered in the Pacific Northwest and not only revealed that region to be unusually speciose, but divided *Ramaria* species into four subgenera, of which the largest was subg. *Laeticolora*, which took in the largest, fleshiest, most brightly colored basidiomata theretofore known. The same geographical region was summarized by Exeter (2001) and Exeter et al. (2006). Over the years, Petersen (see bibliography by Exeter et al. 2006) published shorter papers attempting to bring order to the genus and describing some new taxa, chiefly from eastern North America. As a result, although the temperate rain-forests of western North America and, to a lesser extent the temperate forests of eastern North America have been treated scientifically, almost no scientific literature exists for *Ramaria* in the mid-United States, and this appears especially true of the Ozark Plateau in northern Arkansas.

Pine et al. (1999) were the first to explore the clavarioid and cantharelloid fungi using molecular techniques. Among several discoveries, *Ramaria* was linked to significantly different morphological genera (i.e. *Clavariadelphus*, *Lentaria*, *Gomphus*, *Sphaerobolus*, *Pseudocolus*, etc.) in the “gomphoid-phalloid clade,” an alliance which has appeared repeatedly in other phylogenies since its discovery. Humpert et al. (2001) dissected the Gomphales in further detail in an attempt to ascertain relationships of and within the genera. At the resolution of nuclear nrLSU, some traditional infrageneric groups (i.e. *Laeticolora*, *Lentoramaria*) were found to be polyphyletic, while *Echinoramaria* seemed to segregate as a discrete clade. Morphologically discordant elements (i.e. *Gomphus*, *Gautieria*) were found within the large *Ramaria* clade. Although Humpert et al. (2001) revealed the considerable heterogeneity within *Ramaria*, many *Ramaria* LSU sequences were deposited in GenBank, forming a nucleus for ongoing comparison.

In two seminal publications, Christan (2008) and Christan and Hahn (2005) summarized several previous systematic schemes involving the entire genus. Dealing with the group traditionally referred to as subg. *Laeticolora*, it was accepted that *Laeticolora* was best subsumed into subg. *Ramaria*, which included section *Ramaria* [with typus generis *Clavaria* (*Ramaria*) *botrytis*] and section *Formosae*, typified by *R. formosa* (see Franchi and Marchetti 2001; Christan and Hahn 2005). In the latter section most of the fleshy, coralloid, brightly colored basidiomata could be placed, and according to this outline, the two species described here as new belong in sect. *Formosae*. A third section, *Fennicae* (type, *R. fennica*, see Schild 1995) was reserved for certain species with violaceous coloration and hymenial color change in KOH. Christan and Hahn (2005) detailed further infrageneric taxonomic characters, among them the anatomy of rhizomorphic strands and/or basidiomatal basal mycelium. Several types and complexities of acanthodendroid hyphae were described and illustrated, as well as crystal formation and morphology. Again, with these hyphal characters in mind, the two species described below belong in section *Formosae*, but are not to be found in the keys by Christan (2008; for European taxa) or Exeter et al. (2006; for Pacific Northwest United States).

Methods

Microscopic observations employed an Olympus BX60 microscope fitted for bright field (BF) and phase contrast (PhC) microscopy. Typical mountant was 3% aqueous KOH, with Melzer's reagent and lactic acid-Cotton blue occasionally used as stains. TFB = Tennessee Fieldbook number, assigned in the field to track notes and photos; TENN = Herbarium, University of Tennessee, permanent accession number; Q = spore length divided by spore width; Q^m = mean Q value of number of spores measured; L^m = mean length of all spores measured. Colors within quotation marks are from Ridgway (1912) and those within parentheses are from Kornerup and Wanscher (1967).

The term "firm-walled" is intended to describe hyphal walls which are thick enough so that hyphal crumpling or collapse is not observed in microscopic mounts, but there is no measurable distance between inner and outer wall surfaces. "Thick-walled," conversely, describes a hyphal wall thick enough that the inner and outer surface are sufficiently distinct and that the wall thickness can be measured and reported.

Procedures for DNA extraction, PCR and DNA sequencing of the ribosomal ITS and LSU regions was performed as described in Hughes et al. (2013). Initial blast searches of the NCBI database were performed to identify related taxa for which sequences were available. In order to place collections from Arkansas in a larger context, the ribosomal LSU region was selected for analysis. Related sequences were downloaded, combined with similar sequences in our unpublished sequence database, aligned manually and trimmed to 905bp containing D1-D3 variable regions using GCG (2000). Three small areas (4–5bp) of ambiguously aligned sequence were not excluded from the dataset because they were informative in species delineation. The alignment was imported into GENEIOUS (2005). PhyML using the general time reversible model of substitution with parameters estimated and 100 bootstrap replicates was performed within GENEIOUS and the resulting tree exported to FIGTREE (Rambaut 2006). This model requires the fewest assumptions of the data set. The likelihood of the best tree was -2745.59. ITS and LSU sequences were deposited in GenBank (KJ416132-KJ416135). Alignments and the PhyML tree were deposited in TreeBASE (<http://purl.org/phylo/treebase/phyloids/study/TB2:S15885>).

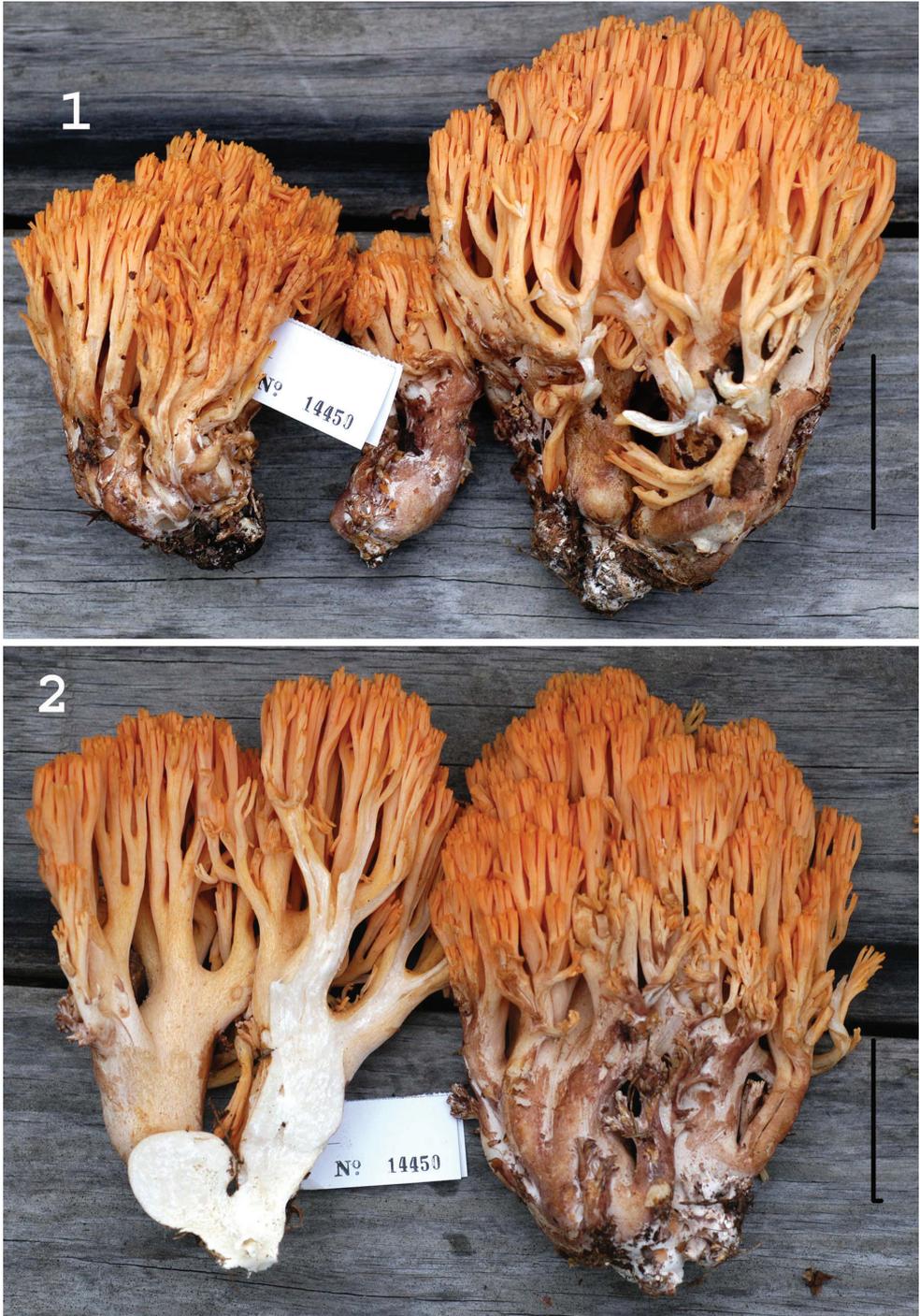
Results

Ramaria admiratia R.H. Petersen sp. nov.

Mycobank no. 807954

Figs 1–5

Holotype. United States, Arkansas, Searcy Co., grounds of Shepherd of the Ozarks, 36°00'10"N, 92°28'28"W, 24.X.2013, coll. Carl Davis and Therese Martin (NAMA), TFB 14450 (TENN 69114).



Figures 1, 2. Basidiomata of *Ramaria admiratia*. **1** Exterior of two mature basidiomata and one immature **2** Left. Exposed stipe and lower branch trama. Right. Exterior of mature basidioma. Standard lines = 5 cm. Holotype.

Etymology. admiratia = surprise, astonish, referring to the acanthodendroid hyphae in the outer stipe context.

Diagnosis. 1) Member of *Ramaria* subg. *Laeticolora* sect. *Formosae*; 2) clamp connections absent from all tissues; 3) acanthodendroid hyphae common in outer stipe flesh and surface; 4) stipe large, pruinose, white but easily staining to brown where handled or rubbed; 5) branch apices bright orange red; 6) type locality, northern Arkansas; 7) ITS sequence unique in the subgenus; (GenBank ITS accession KJ416133).

Basidiomata (Figs 1–4) robust, fleshy, -16×14 cm, repeatedly branched, coral-loid. **Stipe** portion massive (Fig. 3), from discrete to 2–3 large conjunct stipes, fleshy, rounded, with minimum external mycelium, superficially white-pruinose where undisturbed, extensively “Mikado brown” (7C6) where rubbed; flesh off-white, solid, moist (not slippery), very finely marbled, very slowly becoming tan where sliced; abortive branchlets in small, vertical clusters, easily brown. **Lower branches** “light ochraceous buff” (5A4), upward “capucine orange” (5A6) to “Mikado orange” (6A6), in age “ochraceous salmon” (6A6) to “light ochraceous salmon” (6A4); internodes diminishing gradually; **branch apices** (Fig. 4) (ultimate 3–4 mm) rounded, ultimately dentate, “Grenadine red” (8A8), becoming concolorous to “capucine yellow” (5A8). **Odor** none. **Taste** none. 5% aqueous FeSO₄ on stipe flesh = no color change.

Habitat and phenology. Generally second-growth hardwood forest of *Quercus* with scattered *Carpinus*, *Carya* and *Acer*; sole specimen from late autumn.

Surface of lower stipe covered with felty white tomentum; **tomentum hyphae** 3–4 μm diam, clampless, firm- to thick-walled (wall -0.5 μm thick), hyaline; acanthodendroid hyphae (Fig. 5B) common, refringent (PhC), strongly cyanophilous, 3–4 μm diam, thick-walled (wall -0.7 μm thick), appearing thorny. Hyphal construction of stipe medulla monomitic (with gloeoplerous hyphae), liberating significant debris in squash mounts; hyphae 4–14 μm diam, firm- to thick-walled (wall -0.5 μm thick), hyaline, clampless; ampulliform septa 7–17 μm diam, ampulliform to subspherical, thick-walled (wall -1 μm thick), delicately ornamented; gloeoplerous system represented by short lengths of cyanophilous hyphae with occasionally swellings. Hyphae of upper branch trama strictly parallel, tightly packed, thin-walled, clampless; cells filamentous to keg-shaped; occasionally slender (3–4 μm diam), non-refringent hyphae meandering through trama. Gloeoplerous system represent by occasional short lengths of strongly cyanophilous hyphae without septa. **Basidia** (Fig. 5A) 45–57 \times 11–13 μm , clavate (not significantly bulbous), clampless, 4-sterigmate; contents multiguttulate (guttules refringent, apparently scattered throughout; PhC). Basidioles filamentous, digitate, uninformative. **Basidiospores** (Fig. 5B) 12–14.5 \times 4.5–5.5(–6) μm ($Q = 2.27$ – 2.80 ; $Q^m = 2.52$; $L^m = 13.20$ μm), ellipsoid, distinctly roughened in profile but ornamentation indistinct (PhC); contents heterogeneous with one or more non-refringent vacuoles (vacuoles amorphous, appearing empty on slightly darker background; PhC); ornamentation moderately cyanophilous, of narrow, axially oriented, meandering low ridges, appearing scattered, small and low in profile.

Commentary. Superficially, basidiomata of *R. admiratia* resemble those of *R. cokeri* through sordid yellow branches with reddish apices and brunnescent stipe. *Ramaria cok-*



Figures 3, 4. Basidiomata of *Ramaria admiratia*. **3** Stipe exteriors showing extensive brown bruising **4** Upper branches and branch apices. Standard lines = 5 cm. Holotype.

eri belongs in *Phaeoclavulina* (Giachini 2004; Giachini and Castellano 2011; Giachini et al. 2001, 2010 = *Ramaria* subg. *Echinoramaria*) with echinulate basidiospores, clamped tramal hyphae and basidia, and rubribrunnescent (not brunnescent) stipe surface.

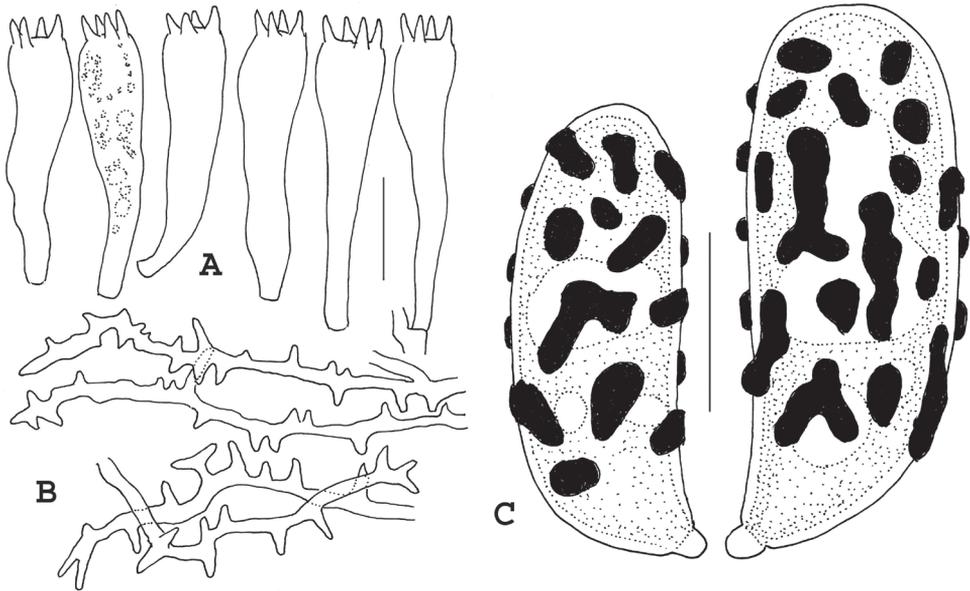


Figure 5. Microstructures of *Ramaria admiratia*. **A** Basidia **B** Acanthodendroidal hyphae of outer stipe tissue **C** Basidiospores showing cyanophilous ornamentation. Standard line for **A**, **B** = 20 μ m; for **C** = 5 μ m. Holotype.

As noted by Christan (2008) taxa with cyanophilous dendrohyphidioid stipe tomentum hyphae are more common than originally envisioned (Marr and Stuntz 1973). Most common among them are taxa with yellow branches and apices and rather small stipes. In taxa resembling *R. admiratia*, centering around *R. cystidiophora*, varieties have been described based largely on odors (vars. *anisata*, *fabiolens*) and rubribrunnescent stipe (var. *maculans*) (see Marr and Stuntz 1973; Exeter et al. 2006). Conversely, *R. admiratia* basidiomata exhibit a large, strongly brunnescent stipe and orange to red-orange branches and apices.

The terms “monomitic,” “dimitic”, etc. were coined by E.J.H. Corner (1932) to describe the anatomy of various polypore basidiomata and have proven useful in subsequent, widely used taxonomic schemes. Dimitic referred only to presence of two hyphal types, specifically generative and skeletal, definition of the latter being philosophically augmented over some decades. Donk (1971) and Petersen (1975), conversely, while accepting the anatomical observations, linguistically considered dimitic to describe any tissue in which two hyphal types were found, whether generative and skeletal, generative and gloeoplerous, generative and acanthanophysoid, etc., as long as the hyphal types were accurately described. In the case of *Ramaria admiratia* (and other fleshy fungi with various second hyphal types), one is confronted with Cornerian terminology in which “monomitic” actually includes two hyphal types: generative plus cyanophilous, characteristically branched acanthophysoid hyphae.

***Ramaria calvodistalis* R.H. Petersen, sp. nov.**

Mycobank no. 807955

Figs 6, 7

Holotype. United States, Arkansas, Baxter Co., vic. Big Flat, Rte 341, Moccasin Creek Trailhead, Ozark National Forest, 36°02'N, 92°21'W, 24.X.2013, coll. RHP, TFB 14431 (TENN 69095).

Etymology. Calvus = bald; distalis = referring to the spore wall opposite the hilar appendage.

Diagnosis. 1) Member of *Ramaria* subg. *Laeticolora*; 2) clamp connections absent from all tissues; 3) acanthodendroid hyphae absent; 4) stipe small, pruinose, white, without color change where handled or rubbed; 5) branches and apices yellow; 6) type locality northern Arkansas; 7) ITS sequence unique in the subgenus; (GenBank accession KJ416132).

Adult **basidiomata** (Fig. 6) –15 × 12 cm, repeatedly branched, coralloid; young basidioma with discrete base, white, hardly canescent or pruinose; adult basidiome base falsely fasciculate (i.e. discrete but with narrow grooves and crevices giving the appearance of several stipes strongly compressed), snow white, finely canescent where free of soil particles; abortive branchlets common, white; stipe flesh white, solid, firm, gelatinous only in areas of degeneration or maggot-infestation, without brown bands or patches; lower branches “orange buff” (5A5), upward becoming “warm buff” (5A4) to “antimony yellow” (4B6); apices rounded, concolorous. **Odor** none. **Taste** none; consistency mealy. No bruising reactions on surface or flesh.

Habitat and phenology. Possibly associated with deciduous trees from local forests of *Quercus*, *Carya*, *Carpinus* and occasional *Pinus*, solitary to gregarious, often in troops or rings; fruiting in late autumn.

Hyphae of stipe canescence 2–4 µm diam, relatively brittle and straight, firm-walled, rarely septate, without clamp connections, non-refracting; **acanthodendroid hyphae** absent; in non-gelatinous areas of stipe flesh hyphae 3–12 µm diam, tortuous, frequently branched, thick-walled (wall –0.7 µm thick), often refracting (PhC), without clamp connections; rare ampulliform swellings (without clamp connection) –16 µm diam, delicately ornamented internally, not unusually thick-walled. **Hyphae of upper branch trama** appearing subgelatinous under low magnification, but when squashed in KOH shown to be free, 3.5–12 µm diam, without clamp connections, firm-walled (wall –0.5 µm thick); cells filamentous to elongate-barrel-shaped. Basidioles often misshapen, paraphysoid, with various small lobes or sinuate shapes. **Basidia** (Fig. 7A) 55–72 × 12–13 µm, clavate with somewhat bulbous apex, 4-sterigmate, occasionally with an asymmetric lobe, without clamp connections; contents usually with proximal and distal refracting guttules. **Basidiospores** (Fig. 7B) (12–)14–15 × 4.5–5.0(–5.5) µm ($Q = 2.67–3.33$; $Q^m = 3.03$; $L^m = 14.05$ µm), generally boletoid, with scattered small cyanophilous warts and patches through midsection of the spore but absent from the distal end which appears bald; contents with amorphous deposits (PhC); wall slightly thickened through midsection (wall –0.5 µm thick).



Figure 6. Basidiomata of *Ramaria calvodistalis*. Standard line = 5 cm. Holotype.

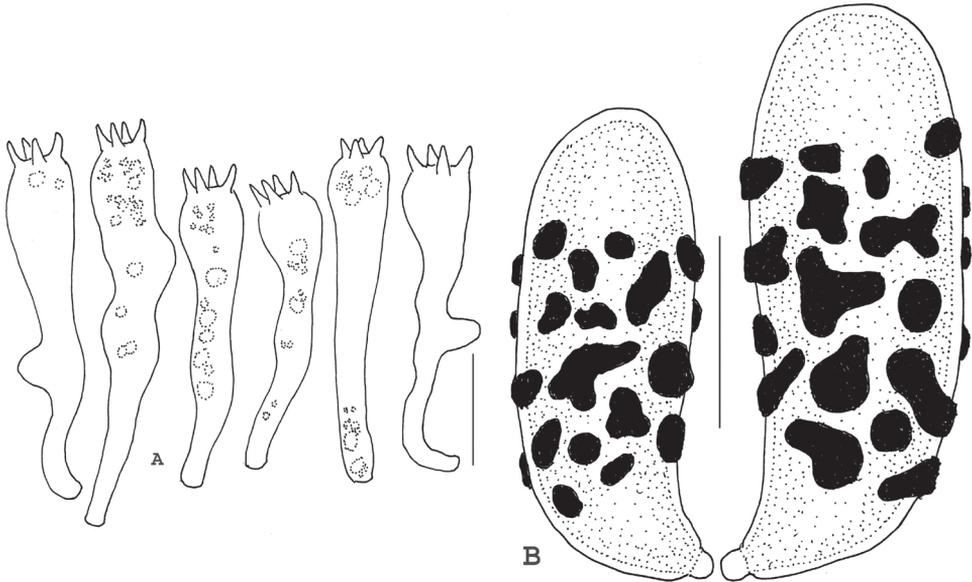


Figure 7. Basidia and basidiospores of *Ramaria calvodistalis*. **A** Basidia **B** Basidiospores. Standard line for **A** = 20 μm ; for **B** = 5 μm . Holotype.

Commentary. Care must be taken to ascertain the condition of basidial septa. In clamped basidia, subsequent basidioles arise through the subtending clamp. In clampless basidia (as above), subsequent basidioles arise in precisely the same fashion, arising

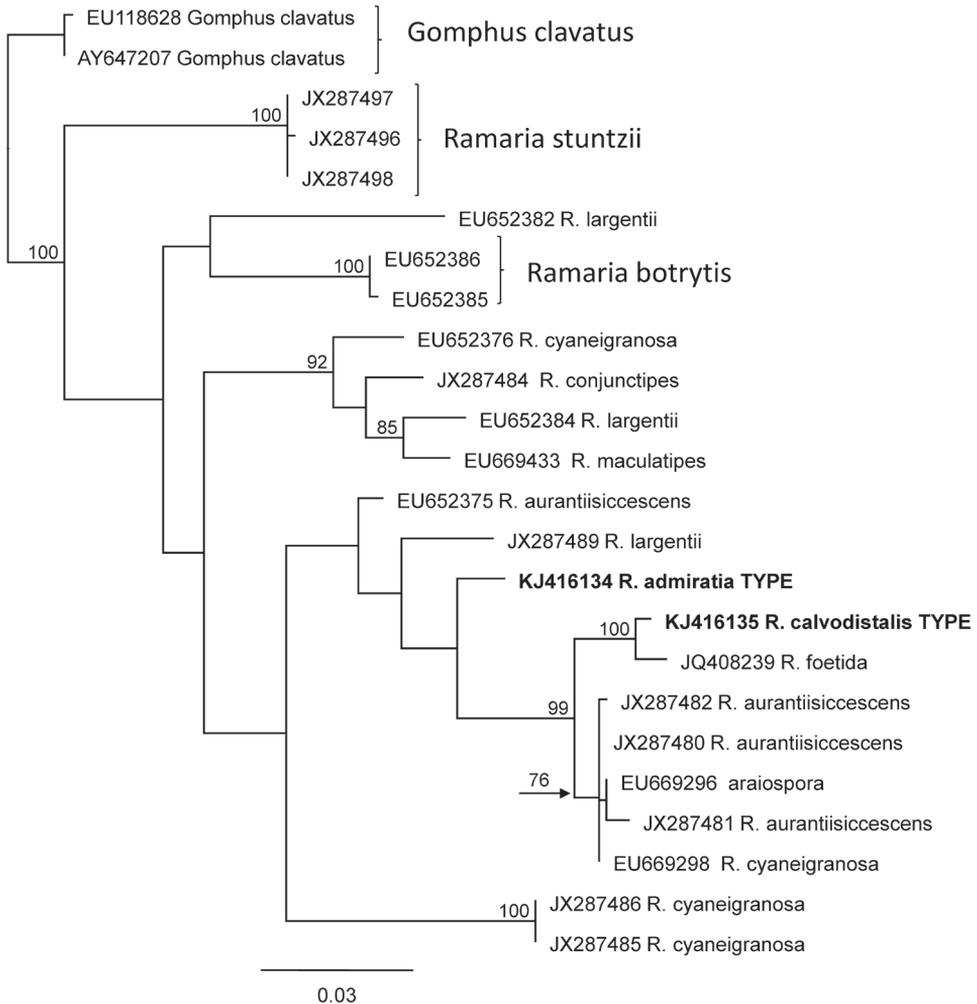


Figure 8. PhyML Phylogeny of proposed new species of *Ramaria* based on nrLSU sequences. Bootstrap support equal or greater than 70% is given to the left of the supported node. GenBank accession numbers are given at the end of each twig.

just below the subtending septum, but without the telltale evidence of a clamp connection. Additional care is required to ascertain that both tramal hyphae and basidia are without clamps. Spores are among the longest in the subgenus and largely as a result, Q^m value is high. Spore outline is distinctly boletoid with slight suprahilar depression. First impression was of delicately marbled stipe flesh (i.e. with small, scattered areas of hyphae with gelatinized walls), but closer examination revealed scattered degeneration of inner stipe flesh through maggot infestation. Lower and middle branches as well as apices are essentially unicolorous, straw yellow or dull ochraceous yellow. Juvenile branches exhibit a slight blush of pale pinkish buff, but this soon fades and slowly turns to the adult yellow shades.

In the three days of the NAMA foray, numerous collections of this species were made. Basidiomata seem to occur in troops and “fairy rings” under deciduous trees and are often somewhat bulky. Stipes are not deeply rooted and are easily dislodged, but adult stipes seem consistently maggot-ridden. Because a new taxon was not anticipated, only the type collection was preserved. Although the literature dealing with *Ramaria* of the Pacific Northwest has been summarized at least twice over the decades (Marr and Stuntz 1973; Exeter et al. 2006), modern literature is unavailable for *Ramaria* east of the Rocky Mountains except in fragments. Even less adequate is coverage of central United States, including the Ozark Mountains of Arkansas.

Marr and Stuntz (1973) described a small group of *Ramaria* taxa which exhibited cyanophilous “acantho-dendroid” hyphae in the outer stipe flesh, using *R. cystidiophora* as the focal taxon, but including several infraspecific taxa. In all cases, stipes are white and pruinose and all upper basidiome parts are some shade of yellow. Exeter et al. (2006) illustrated basidiomata of several of the infraspecific taxa in the *R. cystidiophora* complex, which macroscopically are reminiscent of *R. calvodistalis*, so a special search was made for acanthodendroidal hyphae. Not only were no such hyphae found, but *R. calvodistalis* lacks clamp connections, also a violation of the *R. cystidiophora* complex.

If the key to clampless taxa in Exeter et al. (2006) is employed, no adequate match is found. *Ramaria longispora* produces spores of appropriate dimensions, but while upper branches and apices are yellow, lower branches are cantaloupe or pinkish salmon. In the working key of one of us (RHP), no match is found because the combination of yellow basidiome coloration, lack of clamp connections and long spores eliminates all candidates.

Ramaria admiratia and *R. calvodistalis* LSU sequences place them near sequences representing brightly colored *Ramaria* species (*R. aurantiiscescens* and *R. araiospora*) in subgenus *Laeticolora* (Fig. 8). ITS divergence within this subgenus is large, however, and *Ramaria admiratia* and *R. calvodistalis* ITS sequences are only 86% similar to each other. *Ramaria calvodistalis* ITS sequences are most closely related (>97%) to two unnamed collections from Mexico (GenBank KC152173 and KC152176). These three collections differ from each other predominantly in the number of bases in repeat areas and probably represent the same lineage. We have previously noted that Mexico may have served as a glacial refugium for taxa now found further north (Hughes et al. 1999; Lickey et al. 2002; Hughes and Petersen 2004). There are no close blast matches to *Ramaria admiratia* in GenBank or in our sequence data set. A number of taxa in Fig. 8, based on assigned names, appear to be polyphyletic suggesting that morphological species concepts harbor more than one cryptic species or that misidentifications are common.

Acknowledgements

Sincere thanks are extended to Carl Davis and Therese Martin of Louisiana who collected *Ramaria admiratia*. Work was partially supported by NSF DEB1144974 to RHP and KWH.

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Tremella rhizocarpicola sp. nov. and other interesting lichenicolous Tremellales and Filobasidiales in the Nordic countries

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Academic editor: Pradeep Divakar | Received 26 July 2014 | Accepted 29 August 2014 | Published 16 September 2014

Citation: Millanes AM, Diederich P, Westberg M, Knutsson T, Wedin M (2014) *Tremella rhizocarpicola* sp. nov. and other interesting lichenicolous Tremellales and Filobasidiales in the Nordic countries. MycoKeys 8: 31–41. doi: 10.3897/mycokeys.8.8176

Abstract

New data on the diversity and geographical distribution of lichenicolous Tremellales and Filobasidiales in the Nordic countries is presented. One new species, *Tremella rhizocarpicola*, is formally described. *Tremella pertusariae* and *T. protoparmeliae* are reported as new to the Nordic countries, *Syzygospora physciacearum* is new to Iceland, *Tremella rinodinae* is new to Sweden, and *T. caloplacae* is new to Norway. Nine species are reported as new to a number of Swedish provinces, including *Biatoropsis usnearum*, *Syzygospora bachmannii*, *S. physciacearum*, *Tremella caloplacae*, *T. cetrariicola*, *T. cladoniae*, *T. coppinsii*, *T. diploschistina*, and *T. hypogymniae*.

Key words

Basidiomycota, *Biatoropsis*, new species, new records, Scandinavia, *Syzygospora*

Introduction

Fungal mycoparasites, including lichen-parasites, are common among the Tremellomycetes (Basidiomycota, Fungi). Lichen-inhabiting species belong to the genera *Biatoropsis*,

Tremella (both Tremellales) and *Syzygospora* (Filobasidiales). There are currently 50 lichenicolous species described in the group (Diederich 1986, 1996, 2003, Sérusiaux et al. 2003, Diederich 2007, Zamora et al. 2011, Millanes et al. 2012), and an additional five are known but have not yet been formally named (Diederich 1996, 2007). The actual diversity and distribution of lichen-inhabiting species is still largely unknown, as comparatively few mycologists and lichenologists collect lichenicolous fungi. Some tremellalean species are relatively easy to spot in the field as they induce the formation of conspicuous galls on the hosts, whereas others grow only inside the host hymenium producing few or no external symptoms. In these cases, study of host herbarium material is extremely useful for diversity surveys, and also improves our knowledge on the geographical distribution of taxa that are otherwise much overlooked in the field. In the Nordic countries, 15 tremellalean lichenicolous species have been reported so far (Nordin et al. 2014). During fieldwork in Sweden and Norway, and herbarium surveys undertaken in BG, S, and UPS, during 2012–2014, we found material allowing one new species to be formally described and several species to be newly reported to the Nordic countries, Iceland, Norway or Sweden.

Methods

Macromorphological traits were observed using a Zeiss Stemi 2000-C dissecting microscope. Microscopic structures were studied using handmade sections stained with Phloxin (1% in water) after pre-treatment with KOH (5%), following the methods of Diederich (1996), and observed with a Zeiss Axioscope-2 microscope. Macro- and microscopic photographs were taken with a Nikon Coolpix 995 camera fitted to both microscopes. The apiculus is not included in basidiospore measurements. Sizes in parentheses represent minimum and maximum observed values.

Results

Tremella rhizocarpicola Diederich, Millanes & Wedin, sp. nov.

Mycobank No: MB809897

Description. Basidiomata inside the hymenium of the host, resulting in blackish swellings of the host apothecia; context hyphae difficult to observe, 2.5–3.5 mm thick, thin walled, with clamp connections; haustorial branches not observed. Hymenium hyaline, containing numerous probasidia, intermixed with the hymenium of the host; probasidial initials clavate, proliferations occurring through the basal clamp; hyphidia and cystidia absent. Basidia, when mature, narrowly ellipsoid to subcylindrical, with one transverse septum (never oblique or longitudinal), slightly constricted at the septum, the lower cell elongate, with an attenuated stalk-like base, (14–)17–44 × 7–12(–13) μm (incl. stalk); epibasidia 3–3.5 mm thick, up to 65 μm long. Basidiospores

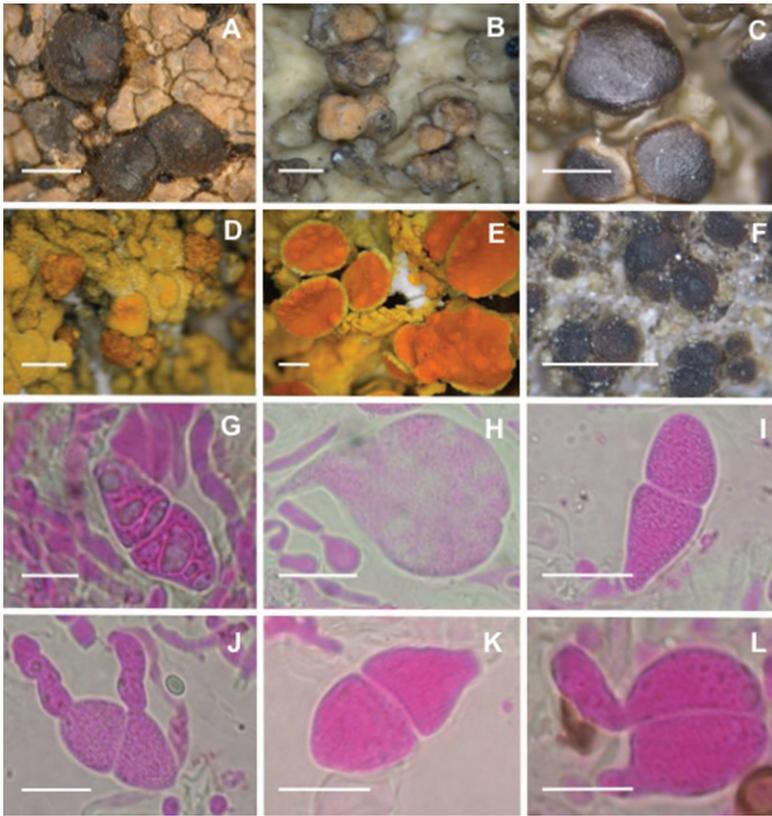


Figure 1. Photographs of new species or records for the Nordic countries, Norway, and Sweden. Macroscopic habit of *Tremella rhizocarpicola* on *Rhizocarpon lavatum* (holotype, BG: L-68612) (**A**), *T. pertusariae* on *Pertusaria hymenea* (S: F-131626) (**B**), *T. protoparmeliae*, asymptomatic on *Protoparmelia badia* (S: F-255342) (**C**), *T. caloplacae* on *Caloplaca decipiens* (S: F-253110) (**D**), *T. caloplacae* on *Xanthoria parietina* (S: F-253109) (**E**), and *T. rinodinae* on *Rinodina gennarii* (S: F-255341) (**F**). Basidium morphology in *Tremella rhizocarpicola* (**G**), *T. pertusariae* (**H**), *T. protoparmeliae* (**I**), *T. caloplacae* (S: F-255314) (**J**), and *T. rinodinae* (**K–L**). Scale bars: 1 mm (**A–F**) and 10 mm (**G–L**).

subglobose, with a large apiculus, 7.5–9.5 × 6–8.5 mm. Anamorph: conidial chains sometimes present in the hymenium. Individual conidia 3–5 × 3–5 mm.

Type. NORWAY, Rogaland, Suldal, on the N side of lake Stranddalsvatnet. On N facing phylitic rock, 59°26.26'N, 6°43.48'E, ca. 1000 m, 18 Aug 1999, P.G. Ihlen 957 (BG: L-68612).

Distribution, ecology and host. The new species is known from one locality in Denmark, two localities in Norway, and nine in Sweden, all growing inside the hymenium of *Rhizocarpon lavatum* on siliceous rocks, often along shorelines or near water.

Discussion. The species was tentatively described by Diederich (1996: 170) as *Tremella* sp. 3. The single specimen known at that time was very small, but the discovery of 12 additional collections from Denmark, Sweden and Norway (Fig. 1A) is now

enough for a formal description. There is little to add to the description and illustrations given by Diederich (1996), however. The only novelties are the wider range of basidium width and length (Fig. 1G) and the presence, occasionally, of an anamorph consisting of catenulate conidia. A sequence of the ITS barcode region is not provided, since recently collected specimens were too reduced for DNA extraction, and old specimens could not be amplified by PCR. Diederich (1996) indicated that this species was microscopically very similar to *Tremella protoparmeliae*, but *T. rhizocarpicola* could be distinguished by the formation of dark brown swellings on the host apothecia and by small differences in the size of the basidia. The additional specimens studied here show that there is an anamorph formed by catenulate conidia in *T. rhizocarpicola*, and the basidia of this species can be comparatively shorter and wider than those of *T. protoparmeliae*.

Additional specimens examined (all on *Rhizocarpon lavatum*): DENMARK. Faroe Islands: Nordoya, Bordö, Klaksvig, N end of Bordö Vig, rivulet Gravarå, 4 Sept 1956, G. Degelius (UPS: L-662460). – NORWAY. Oslo: Ekeberg, 13 May 1886, N.G. Moe (BG: L-58000). Rogaland: Suldal, on the north side of lake Strandalsvatnet, 59°26.26'N, 6°43.48'E, ca. 1000 m, 18 Aug 1999, P.G. Ihlen 957 (BG: L-68612). – SWEDEN. Bohuslän: Foss, 1851, M.M. Floderus (UPS: L-662426). Bohuslän: Solberga, Rörtången, 10 June 1928, A.H. Magnusson 11329 (UPS: L-662425). Bohuslän: Ödsmål, Korsgården, 1 Aug 1931, A.H. Magnusson 12851b (UPS: L-662448). Bohuslän: Spekeröd, Groland, 28 Aug 1955, A.H. Magnusson 24616b (UPS: L-662457). Halland: Övraby, Sperlingsholm, 3 July 1851, T.M. Fries (UPS: L-132524). Halland: Tölö, Skårby, Valåsberget, 24 May 1925, A.H. Magnusson 9384b (UPS: L-662453). Halland: Karup par., SE of Båstad, on boulder in the river Kågleån, 10 Oct 1970, M. S. Christiansen 6498 (C). Härjedalen: Tännäs, Tännfallet waterfall in Tännån, 11 km NW of Tännäs, 62°29.04'N, 12°29.19'E, 6 July 2012, J. Hermansson 18827 (UPS: L-597926). Småland: Malmbäck, Älgaryd, 1875, P.G.E. Theorin (UPS: L-131500). Uppland: Danmark par., Linnés Hammarby, 2.4–2.5 km SE of Danmark church, the hill NE of the houses, 59°49.02'N, 17°46.59' E, 25 m. 15 Sept 2007, G. Thor 22045 (UPS: L-167626).

New records to the Nordic countries

Tremella pertusariae Diederich

Note. This species was previously recorded in Europe (Belgium, France, Germany, Great Britain, Ireland, Italy, and Spain), where it is very common in the western Pyrenees, and in America (Mexico and U.S.A) (Diederich 1996). Knutsson and Johansson (2011) reported it from Sweden, but with some hesitation since the material could not be identified microscopically. The five additional specimens reported here confirm the presence of the species in the Nordic countries. The fungus forms pale to dark brown or blackish galls, generally on the apothecia of *Pertusaria hymenea* (Fig. 1B), but also on the thallus of both *P. hymenea* and *P. pertusa*, and bears characteristic stalked basidia (Fig. 1H).

Specimens examined (all on *P. hymenea*). DENMARK. Jylland: Fredrikshavn, W of Pikkerbakken, 20 June 1947, A.H. Magnusson 20958b (UPS: F-661189). – SWEDEN. Småland: Femsjö par., Femsjö, 1859, T.M. Fries (UPS: F-661180). Småland: Växjö par., Växjö, Jan 1880, E. Köhler (UPS: L-661177). Skåne: Oppmanna par., Bokenäset, July 1916, E.P. Vrang (S: F-131626). Skåne: Oppmanna par., Bokenäset, 19 July 1943, G. Degelius (UPS: L-661197). Öland: Ås par., Södra Ottenby lund, "Skogsudden", on ancient *Quercus robur*, in oak-dominated deciduous forest. 56°12.98'N 16°24.80'E 16 Feb 1999, T. Knutsson 99-092 (private herb.)

Tremella protoparmeliae Diederich & Coppins

Note. This species was previously only recorded in England (Diederich 1996). The fungus grows intrahyemially on *Protoparmelia badia*, without producing any external symptoms, which suggests that this species could in reality be common, but much overlooked as it is not visible macroscopically (Figs. 1C and 1I).

Specimens examined (all in the hymenium of *Protoparmelia badia*). SWEDEN. Torne Lappmark: Jukkasjärvi par., Åbeskosuolo, south-eastern part to the island, facing the shore of the lake, 68°21.88'N, 18°50.17'E, 29 July 2013, A. Millanes 915 & M. Méndez (S: F-255342). Uppland: Djurö par., Runmarö, Small hill at the NW end of the Lake Viträsket, 59°16.44'N, 18°45.91'E, 27 Aug 2011, A. Millanes, S. Klopstein & M. Westberg (S: F-255343).

New records to Iceland, Norway or Sweden

Syzygospora physciacearum Diederich

Note. New to Iceland and to the Swedish provinces Öland, Södermanland, and Västergötland.

This species is widely distributed, with numerous records in Africa, America, Asia, and Europe (Diederich 1996, van den Boom and Alstrup 1996, van den Boom et al. 1998, Motiejūnaitė 1999, van den Boom and Giralt 1999, Halonen et al. 2000, Kukwa et al. 2002, Himelbrant et al. 2013, Urbanachivene et al. 2013). In the Nordic countries it has been recorded in Finland, Norway, Sweden and Denmark (Diederich 1996, Puolasmaa et al. 2008, Hemberg 2014).

Specimens examined. ICELAND. W of Reyðarfjörður, lake Lagarfjót, SW of Hallormsstaður, Atlavík cove, W of Atlavík camping, siliceous rock outcrops in native *Betula* forest, on *Physcia tenella* subsp. *marina*, 4 Aug 2013, P. Diederich 17521 (private herb.). SWEDEN. Södermanland: Tyresö par., before the entrance of Tyresta National Park, on dead *Populus*, on *Physcia adscendens*, 56°10.26'N, 18°14.2'E, 3 m, 5 Apr 2014, A. Millanes 1028, S. Fernández-Brime & M. Westberg (S: F-255317).

Västergötland: Österplana par., Mt. Kinnekulle, Österplana hed, E of Nyängarna, 58°33.83 N, 13°24.5'E, 140 m, on *Fraxinus*, on *Physcia tenella*, 4 May 2009, M. Wedin 8392 (S: F-255318). Öland: Smedby par., Nedra Västerstad, garden in the N. part of the village., on old *Syringa* sp., on *Physcia tenella*, 56°25'27 N, 16°24'47 E, 29 Jan 2011, T. Knutsson 2011-002 (private herb.).

***Tremella caloplacae* (Zahlbr.) Diederich**

Note. New to Norway and to the Swedish province Torne Lappmark.

The species was at first tentatively described as *Tremella* sp. 1 by Diederich (1996) and eventually formally described by Sérusiaux et al. (2003). It has been reported from Austria, Canada, France, Great Britain, Greece, Greenland, and Spain (Diederich 1996, 2007, Sérusiaux et al. 2003), growing inside the hymenia, or exceptionally on the thallus, of different *Caloplaca* species, viz. *C. arenaria*, *C. arnoldii*, *C. aurantia*, *C. carphinea* and *C. saxicola* (Diederich 1996, Sérusiaux et al. 2003), and on the thallus of *Xanthoria soreliata* (Diederich 2007). It was recently reported as new to the Nordic countries (Thell et al. 2014) from two Swedish collections, growing on new hosts: *Caloplaca decipiens* (on the thallus; Fig. 1D) and *Xanthoria parietina* (inside the hymenium; Fig. 1E). Here it is reported on a new host (*Xanthoria elegans*), in Sweden. All samples below are on *X. elegans*, growing inside the hymenium or on the thallus. All specimens bear two-celled basidia (Fig. 1J) and are very similar microscopically. Further investigations are needed, however, to check if all specimens growing on Teloschistaceae belong to a single species.

Specimens examined (all on *Xanthoria elegans*): NORWAY. Oppland: Lom municipality, Runningsgrende, Kleive, 61°42.95'N, 8°14.05'E, 720–850 m, 29 June 2013, A. Millanes 808 (S: F-255312). – SWEDEN. Torne Lappmark: Jukkasjärvi par., Paddos, 68°19.16'N, 18°51.93'E, 625 m, 28 Aug 2013, A. Millanes 904 & M. Méndez (S: F-255313). Torne Lappmark: Jukkasjärvi par., Paddos, 68°19.13'N, 18°51.89'E, 596 m, 28 Aug 2013, A. Millanes 908 & M. Méndez (S: F-255314).

***Tremella rinodinae* Diederich & M. S. Christ.**

Note. New to Sweden.

This fungus was previously known only from Denmark (Diederich 1996). It grows in the hymenium of *Rinodina gennarii*, forming distinct brown swellings on the host apothecia (Fig. 1F). The basidia have one transverse (Fig. 1K), or exceptionally longitudinal (Fig. 1L), septum.

Specimens examined (all in the hymenium of *Rinodina gennarii*): SWEDEN. Bohuslän: Skaftö par., Östersida, 3 Aug 1928, G. Degelius (UPS: L-87926). Skåne: Oppmanna par., Arkelstrop, July 1916, E.P. Vrang (S: F-255341).

Records new to some provinces in Sweden

Biatoropsis usnearum Räsänen

Note. New to Bohuslän.

This species has a wide distribution and has been recorded in all Nordic countries except Iceland (i.e., Denmark, Finland, Norway, and Sweden) (Diederich and Christiansen 1994, Nordin et al. 2014).

New specimen examined. SWEDEN. Bohuslän, Kville/Tanum pars., following Torsbo stream, low part of the cliff, mixed forest with *Alnus*, *Betula*, *Corylus*, *Picea* and *Salix*, on *Usnea* sp., 58°47.55'N, 11°8,4'E, 14 Apr 2013, A. Millanes 695 (S: F-255315).

Syzygospora bachmannii Diederich & M.S. Christ.

Note. New to Gotland and Medelpad.

This material had been placed in S long ago, but as the specimens have apparently not been published or otherwise recorded elsewhere, we report them here. The species had been previously recorded in the Nordic countries, particularly in Sweden and Finland (Diederich 1996).

New specimens examined. SWEDEN. Gotland: Sundre par., ca 1 km SE of Sundre church, along small track 500 m S Muskmyr, open limestone pavement ('alvar'), on the ground, on *Cladonia macroceras*, 56°55'N, 18°12'E, M. Wedin 6802 (S: F-102481). Gotland: Klinte, on alvar ground, on *C. macroceras*, 7 May 1937, T.E. Hasselrot (S: F-255268). Medelpad: Selånger par., on rests of rotten plants on the surface of a small stone, next to the ground, in forest, on *C. cornuta*, 60 m, 25 Nov 1928, E. Eriksson (S: F-161742).

Tremella cetrariicola Diederich & Coppins

Note. New to Dalarna, Norrbotten, and Ångermanland.

In the Nordic countries this species has been recorded in Finland, Norway and Sweden (Diederich 1996, Pippola and Kotiranta 2008).

New specimens examined (all on *Tuckermanopsis chlorophylla*). SWEDEN. Dalarna: Mockfjärd par., ca. 1.2 km WNW Bastberget, 60°22.64'N, 14°55.73'E, 220 m, 28 Sept 2010, M. Westberg 10-116 (S: F-255319). Norrbotten: Norrfjärden par., Lustgården Nature Reserve, 65°32.76'N, 21°26.41'E, 25 Aug 2009, M. Wedin 8491 (S: F-255320). Norrbotten: Norrfjärden par., ca. 5.5 km NNW of Sjulsmark, along a forest road to the lake Hällträsket close to the beginning of the road Abborrtjärnvägen, 65°34.19'N, 21°27.35'E, 28 Aug 2009, M. Wedin 8566 (S: F-255333). Ångermanland: Örnköldsvik, Västanåhöjden, at turnoff towards Västanåbodarna, old *Picea*-dominated forest, 63°10.42'N, 18°14.33'E, 21 July 2010, M. Wedin 8763 (S: F-255322).

***Tremella cladoniae* Diederich & M.S. Christ.**

Note. New to Öland.

In the Nordic countries this species has been reported from Denmark, Finland, and Sweden (Diederich 1996, Pippola and Kotiranta 2008, Westberg and Thor 2014).

New specimen examined. SWEDEN. Öland: Böda par., Trollskogen, Norra Uddändan, between Hjerteskeppet and Grankullavik, on semi-dead *Juniperus*, on *Cladonia polydactyla* and *C. coniocraea*, 57°21.38'N, 17°6.91'E, 24 Jan 1998, T. Knutsson 98-013 (private herb.).

***Tremella coppinsii* Diederich & G. Marson**

Note. New to Bohuslän, Dalsland, Dalarna and Västergötland.

The species has previously been recorded in the Scandinavian Peninsula, i.e., Norway and Sweden (Holien and Tønsberg 1994, Diederich 1996).

New specimens examined (all on *Platismatia glauca*). SWEDEN. Bohuslän: Kville/Tanum pars., following Torsbo stream, low part of a cliff, mixed forest with *Alnus*, *Betula*, *Corylus*, *Picea* and *Salix*, on *Alnus*, 58°47.55'N, 11°8.4'E, 14 Apr 2013, A. Millanes 694 (S: F-255266). Dalarna: Mockfjärd par., ca. 1.2 km WNW Bastberget, 60°22.73'N, 14°55.96'E, 240 m, 28 Sept 2010, M. Westberg 10-114 (S: F-255324). Dalsland: Dals-Ed par., Torstorp, 1.6 km NW Knä sjö, on *Sorbus aucuparia* at the edge of mixed forest 58°50.55'N, 12°5.9'E, 28 Nov 2013, T. Knutsson (private herb.). Västergötland: Trollhättan par., S of Lake Åkersjö, close to the lock, *Picea* dominated forest with *Quercus*, *Acer* and *Corylus*, on *Picea*, 58°28.74'N, 11°36.19'E, 15 Apr 2013, A. Millanes 710 (S: F-255325). Västergötland: Trollhättan par., Brandsbo Nature Reserve, mixed forest with *Alnus*, *Corylus*, *Quercus*, *Picea*, and *Salix*, along a stream (very humid area), 58°28.64'N, 11°35.33'E, 11 m, 15 Apr 2013, A. Millanes 725 (S: F-255326).

***Tremella diploschistina* Millanes, M. Westb., Wedin & Diederich**

Note. New to Öland.

In the Nordic countries the species has been so far only reported from Sweden (Millanes et al. 2012).

New specimens examined (all on *Diploschistes muscorum*): SWEDEN. Öland: Stenåsa par., Stenåsa alvar, SSW of lake Möckelmossen, 56°40.28'N, 16°23.02'E, 27 Apr 2013, T. Knutsson 2013-018 (S: F-255327). Öland: Resmo par., Gyngelvarv, ca. 2.0 km E of Resmo church, 56°32.52'N, 16°28.6'E, 6 May 2014, M. Westberg 14-001 (S: F-255349).

***Tremella hypogymniae* Diederich & M.S. Christ.**

Note. New to Bohuslän, Dalarna, Norrbotten, Pite Lappmark, and Torne Lappmark.

This is a widely distributed species. In the Nordic countries it has been reported from Denmark, Finland, Norway, and Sweden (Diederich 1996, Alstrup et al. 2004, 2008, Pippola and Kotiranta 2008).

New specimens examined (all on *Hypogymnia physodes*). SWEDEN. Bohuslän: Tanum par., Lammön, on the way to Lammön, mixed forest with *Pinus* and *Quercus*, on dead branch of *Quercus*, 58°59.63'N, 11°5.39'E, 13 Apr 2013, A. Millanes 664 (S: F-255328). Dalarna: Mockfjärd par., ca. 1.2 km WNW Bastberget, 60°22.72'N, 14°55.94'E, 28 Sept 2010, M. Westberg 10-115 (S: F-255348). Dalarna: Älvdalen par., Gummas Nature Reserve, 61°19.2'N, 13°31.7'E, 29 Sept 2010, M. Wedin 8778 (S: F-255329). Dalarna: Orsa par., Mt. Stora Tunturiberget, 61°22.66'N, 14°49.44'E, 30 Sept 2010, M. Wedin 8796 (S: F-255331). Dalarna: Rättvik par., N of the village Västberg, at the parking lot ca. 50 m S of the E end of Lake Ammtjärnen, on *Picea*, 60°94'N, 15°08'E, 21 Apr 2012, A. Millanes 610 (S: F-255330). Norrbotten: Norrfjärden par., ca. 5.5 km NNW of Sjulsmark, along a forest road to the lake Hällträsket close to the beginning of the road Abborrtjärnvägen, 65°34.19'N, 21°27.35'E, 28 Aug 2009, M. Wedin 8564 (S: F-255321). Pite Lappmark: Arvidsjaur par., ca. 19 km NE of Moskosel, NE slope of N Granberget, 65°57.76'N, 19°48.83'E, 27 Aug 2009, M. Wedin 8544 (S: F-255332). Torne Lappmark: Jukkasjärvi par., Kungsleden, way to Abiskojaure, after 'Tältlägret' on a dead trunk of *Betula*, 68°19.05'N, 18°44.25'E, 453m. 31 Aug 2013, A. Millanes 946 (S: F-255334).

Acknowledgements

This study is part of the research project "Tremellales in Sweden" funded by the Swedish Taxonomy Initiative (Svenska artprojektet) administered by the Swedish Species Information Center (ArtDatabanken). Mika Bendiksby, Astri Botnen, Reidar Haugan, Einar Timdal and Tor Tønsberg are warmly thanked for organizing and funding fieldwork in Norway. Marcos Méndez and Jan Olsson provided excellent field guiding in Torne Lappmark and Bohuslän, respectively. We are grateful to the staff of BG, S, and UPS for making collections available and arranging loans, and to Laura Williams who very kindly revised the English of this manuscript.

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Pycnopulvinus aurantiacus gen. et sp. nov., a new sporocarp-forming member of Pucciniomycotina

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Academic editor: D. Begerow | Received 15 April 2014 | Accepted 29 October 2014 | Published 3 November 2014

Citation: Toome M, Aime MC (2014) *Pycnopulvinus aurantiacus* gen. et sp. nov., a new sporocarp-forming member of Pucciniomycotina. MycoKeys 8: 43–50. doi: 10.3897/mycokeys.8.7676

Abstract

An unusual fungus producing minute orange stilboid sporocarps was found on a palm leaf mid-rib in a Neotropical forest. Morphological observations could not place this collection into any previously described species or genus and, due to an absence of sexual structures, even higher level placement was uncertain. Phylogenetic analysis of a portion of the large subunit and the internal transcribed spacer of the nuclear ribosomal DNA indicated that this fungus is related to *Heterogastridium pycnidioideum* and belongs to Heterogastridiales, Microbotryomycetes (Pucciniomycotina). A new genus and species, *Pycnopulvinus aurantiacus*, are proposed here to accommodate this fungus.

Key words

Ceratocystis, Fungal biodiversity, litter fungi, palm fungi, *Pycnobasidium*, tropical mycology

Introduction

The majority of Pucciniomycotina (Basidiomycota) species have life cycles that include the production of microscopic fruiting structures (e.g., spermogonia of rust fungi), but only a few species within the subphylum form macroscopic fruiting bodies (Swann et al. 2001; Aime et al. 2014). Although these sporocarps vary in form (e.g., see Aime et al. 2014), many are stilboid or pycnidoid with spore masses produced at the base of the sporocarp and exiting through the tip of the neck. Fungi with such fruiting bodies can be found mostly in Atractiellomycetes (Oberwinkler and Bandoni 1982) and, as is true for many other members of Pucciniomycotina, little is known about their biology or biodiversity.

Heterogastridium pycnidioideum Oberw. & R. Bauer (anamorph *Hyalopycnis blepharistoma* (Berk.) Seeler) is one such fungus that produces stilboid fruiting bodies. It is a strictly filamentous species with simple septal pores and specialized organelles—colacosomes—associated with mycoparasitism (Oberwinkler et al. 1990). *Heterogastridium* is placed in Heterogastridiaceae and Heterogastridiales (Oberwinkler et al. 1990), which are now placed in Microbotryomycetes (Weiss et al. 2004). Bauer et al. (2006) placed three genera in Heterogastridiaceae in addition to *Heterogastridium*—*Atractocolax* R. Kirschner, R. Bauer & Oberw., *Colacogloea* Oberw. & R. Bauer, and *Krieglsteinera* Pouzar. Of these, neither sequence data nor reference cultures are available for two of the genera, *Atractocolax* and *Krieglsteinera*, both of which are monotypic. *Colacogloea*, on the other hand, has been demonstrated several times to form a separate clade of Microbotryomycetes, distant from Heterogastridiales (e.g. Aime et al. 2006; Kurtzman et al. 2011). Thus, at present, only *Heterogastridium* and its sole species, *H. pycnidioideum*, can be confidently assigned to Heterogastridiales with molecular data.

An unusual stilboid fungus was discovered on the mid-rib of a palm leaf in litter that could not be confidently assigned to any previously described genus. DNA sequence data and phylogenetic analyses indicated that the collection represents a new member of Heterogastridiales. Herein we describe and illustrate *Pycnopulvinus aurantiacus* gen. et sp. nov. and provide a phylogenetic analysis of Heterogastridiales.

Methods

The specimen (PUL F2679) was collected near Bilsa Biological Station in Ecuador, in the vicinity of N0.350444, W79.732075, on 3 May 2004, where it was growing on the mid-rib of a dead palm leaf in the litter. The fungus was photographed and described in the field after which small pieces of substrate bearing the fruiting bodies were dried on an herbarium drier. Color designations refer to Kornerup and Wanscher (1978). Duplicates are deposited in the Kriebel Herbarium at Purdue University (PUL) and the herbarium of the Pontificia Universidad Católica del Ecuador (QCA).

Morphological characters of the fruiting bodies were observed first with an Olympus SZ61 dissecting microscope. With the aid of the dissecting microscope, a few fruiting bodies were carefully removed from the substrate and placed in a sterile water droplet on a microscope slide, permitting five minutes of rehydration before further preparation. Thereafter microscopic characters were examined with a Nikon Eclipse 80i microscope with standard differential interference contrast (DIC) settings and with 10×, 20×, 40× and 100× objectives. The length and width of 20 spores was measured from three different fruiting bodies with an ocular micrometer using 100× oil-immersion objective. Images were taken with Nikon Digital Sight DS-Fi1 camera setup and measurements were calibrated with a stage micrometer.

For molecular characterization, five dry fruiting bodies were carefully removed from the leaf surface to avoid the inclusion of leaf material and potential contaminants. These were used for DNA extraction with the E.Z.N.A. High Performance

DNA Kit (Omega Bio-Tek Inc., Norcross, GA, USA), following the manufacturers' instructions for samples with lower DNA content (protocol 3). PCR reactions were carried out in 25 μ L reactions that contained 12.5 μ L of Apex Taq RED Master Mix (Genesee Scientific, San Diego, CA, USA), 1.25 μ L of each primer (10 μ M), 5 μ L of molecular grade water and 5 μ L of template DNA. Amplification of the ITS region was conducted with primer pair ITS1F (Gardes and Bruns 1993) and ITS4 (White et al. 1990), and the LSU region was amplified with LR0R and LR5 (Vilgalys and Hester 1990). Amplification conditions followed Toome et al. (2013). Sequencing of amplified fragments was performed by Beckman Coulter, Inc. (Danvers, MA), using the same primers that were used for amplification. Sequences were edited with Sequencher 5.2.3 (Gene Codes Corporation, Ann Arbor, MI, USA) and are deposited in GenBank.

A BLASTn analysis in GenBank (<http://www.ncbi.nlm.nih.gov>) was used to locate similar sequences for phylogenetic analyses. For the LSU dataset, sequences sharing >92% identity with PUL F2679 were selected and for the ITS dataset sequences sharing >85% identity with PUL F2679 were included. Sequences from *Rhodotorula hylophila* and *R. javanica* were added based on their relatedness according to the analyses of Kurtzman et al. (2011) and *R. yarrowii* was included for rooting purposes. Only the sequences from type strains were retained for previously described species. Accession numbers for sequences used are indicated on Figure 1.

Both datasets were aligned separately using the Muscle algorithm in MEGA 5.2 (Kumar et al. 2008), yielding 695 bp and 605 bp alignments for the ITS and the partial LSU region, respectively. These two alignments were subsequently concatenated for phylogenetic analyses. The final alignment is available in TreeBASE (<http://treebase.org>) under accession number 15679.

Phylogenetic analyses were performed via the CIPRES Science Gateway (Miller et al. 2010). The maximum likelihood (ML) analyses were conducted in RAxML-HPC2 7.6.3 using the -k option for bootstrap analysis. Bayesian posterior probability analyses were conducted with MrBayes 3.2.2 with parameters set to 10 000 000 generations, two runs and four chains. The resulting phylogenetic tree was edited in Inkscape (<http://www.inkscape.org>).

Results

Sporocarps of PUL F2679 had a swollen cushion-like basal region, measuring 0.2 to 1 mm in diameter after drying. The basal region was pigmented, ranging from light to dark orange when fresh and appearing orange-brown after drying. This base supports a narrow synnemata-like structure with a 1 to 2 mm long neck. At the apex of the neck, a light yellow to orange mucous droplet of spores is formed (Figure 2 a–f). While the size of sporocarps was variable, all of them produced a spore-containing droplet. Although it could not be definitely determined, the spores appear to be asexually produced. Also, despite numerous attempts to isolate the fungus into pure culture from revived

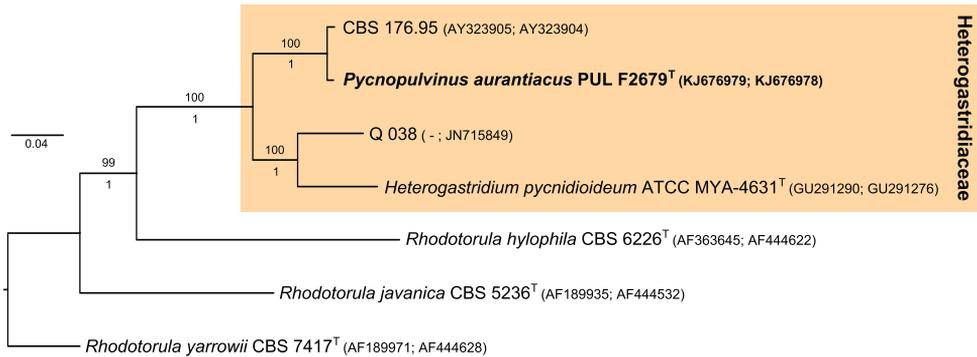


Figure 1. Maximum likelihood tree illustrating the placement of *Pycnopulvinus aurantiacus* in relation to other known members of Heterogastridiaceae. The analysis was performed with combined LSU and ITS sequence data and the topology was rooted with *Rhodotorula yarrowii*. The numbers above and below branches show the bootstrap and posterior probability values, respectively. LSU and ITS GenBank accession numbers of each used strain are given in the brackets. Superscript letter T indicates sequence data that originate from the type.

spores, no isolate was obtained. Only an isolate of *Ceratocystis paradoxa* (deposited in GenBank as AY821864; CBS 116770) was frequently recovered during these attempts.

Of previously sequenced species, PUL F2679 shared the most sequence identity with *H. pycnidioideum* (= *H. blepharistoma*) at 92% (414 bp of 452 bp) in the LSU region and 86% (515 bp of 596 bp) in the ITS region. The only other close match was to a previously sequenced but undescribed isolate, CBS 196.95 (GenBank no. LSU–AY323905; ITS–AY323904), which shared 98% identity (446 bp of 453 bp) in the LSU region and 99% identity (609 bp of 616 bp) in the ITS region. Results of phylogenetic analyses are presented in Figure 1.

Taxonomy

Pycnopulvinus Toome & Aime, gen. nov.

Mycobank MB808523

Diagnosis. Member of Heterogastridiaceae, Heterogastridiales, Microbotryomycetes, Pucciniomycotina. *Pycnopulvinus* is similar to *Heterogastridium*, but differs in possessing a distinct basal cushion, segmented spores, and pigmented sporocarps. *Pycnopulvinus* can also be distinguished with rDNA sequence data.

Type. *Pycnopulvinus aurantiacus* Toome & Aime

Description. Minute, pigmented stilboid sporocarps with a swollen basal region and long tubular neck bearing a mucoid droplet of spores at the tip.

Ecology and distribution. On palm litter in South America (Ecuador); known from sequence data in Central America (Costa Rica).

Etymology. *pycno-* = dense, compact, and *pulvinus* = cushion, for the distinctive cushion-like base of the sporocarp.

Discussion. The genus is closely related to *Heterogastridium*, but has orange-colored fruiting bodies that are larger and form a distinct basal cushion. Of the other three genera currently recognized in Heterogastridiales (Kirk et al. 2008, Bauer et al. 2006), *Pycnopulvinus* can be readily separated from *Colacogloea* on the basis of DNA sequence data (Aime et al. 2006), and the absence of stilboid fructifications or septate spores in the latter, from *Krieglsteinera* which does not form fruiting bodies or multicelled spores and parasitizes ascocarps, and from *Atractocolax* which forms smaller (140 µm diam.), gelatinous, hyaline sporocarps, produces unicellular spores and is associated with bark beetles. Currently, *Pycnopulvinus* is a monotypic genus. A previously undescribed isolate, CBS 176.95 (isolated from the tropical forest of Costa Rica and accessioned in the GenBank as "*Pycnobasidium* sp." – a generic name that has not been validly published – appears to represent a member of this genus. In the absence of morphological or other additional data, it cannot be determined whether CBS 176.95 is conspecific with *P. aurantiacus* or represents a second species of *Pycnopulvinus*. Despite the rapid accumulation of environmental sequencing data, no studies thus far have published sequences referable to *Pycnopulvinus*, indicating that members of the genus are probably not widely dispersed in commonly sampled habitats.

***Pycnopulvinus aurantiacus* Toome & Aime, sp. nov.**

Mycobank MB808524

Figure 2

Diagnosis. Sporocarps minute, orange, with a swollen basal cushion (up to 3 mm wide) and long narrow neck (up to 3 mm long) subtended by a light yellow to orange mucous droplet (up to 1.5 mm diam.) of hyaline, 2–4 celled spores, averaging 3.25×11.8 µm. Found on palm leaf litter.

Type. ECUADOR. Manabi Division, near Bilsa Biological Station, in the vicinity of N0.350444, W79.732075, on palm leaf mid-rib in the litter, 3 May 2004, M.C. Aime, MCA 2548 (holotype PUL F2679; isotype QCA). GenBank no. KJ676978 (ITS), KJ676979 (LSU).

Description. Gregarious, light to dark orange (ca. 5A6–7), superficial, stilboid sporocarps with swollen globose base (0.5–3 mm wide in fresh specimen, drying to 0.2–1 mm), surrounded by hyphae with globular apical cells, 20–30 µm wide and 45–55 µm long. Sporocarp necks erect, long (0.5–2 mm), narrow (up to 110 µm at base, 50–70 µm at middle and widening up to 130 µm at tip), tubular, light yellow to orange, smooth. Hyphae on the outer layer of the neck 5 µm wide, septate; hyphae at the base and inside the neck 2–2.5 µm wide, septate. Ostiolar hyphae extend from the outer layer of the neck cells, hyaline, non-septate, 10–12 µm wide, narrowing at the tip. Clamp connections not observed. Spores accumulate in pale to orange mucous droplets at tips

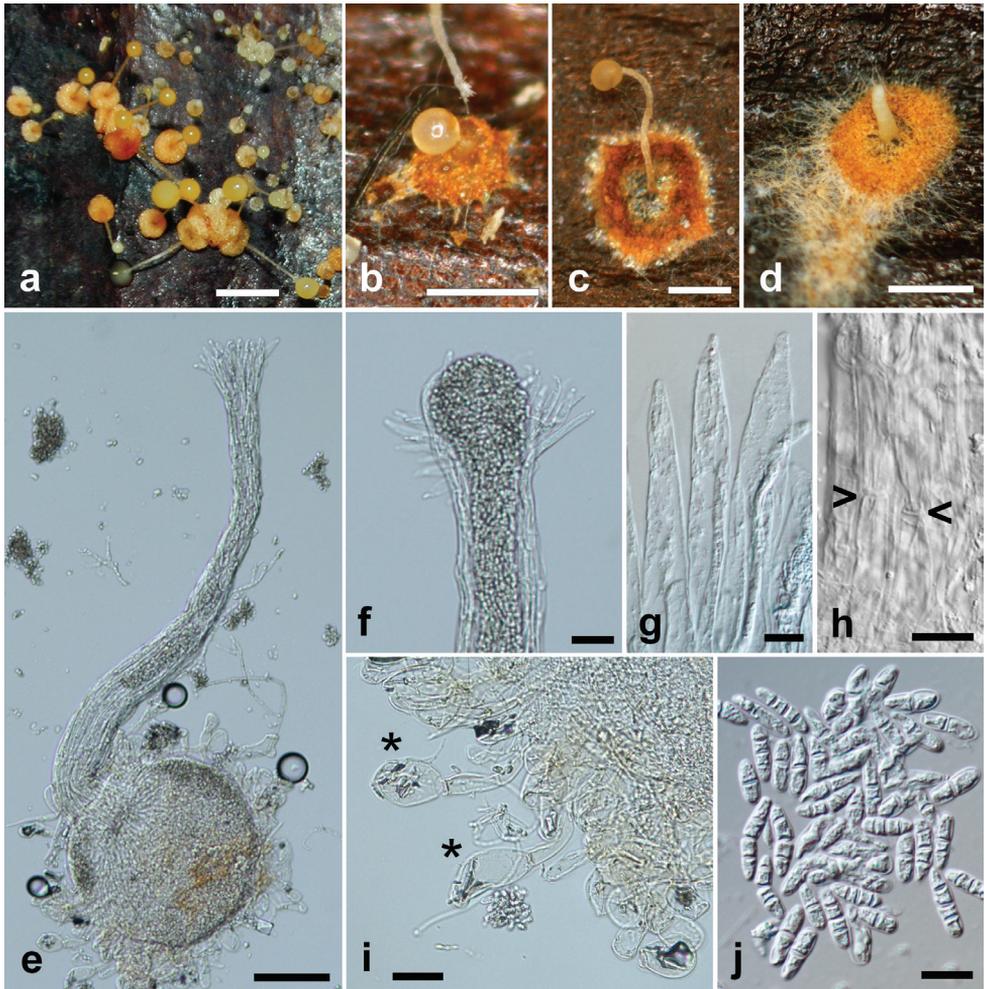


Figure 2. *Pycnopulvinus aurantiacus* (holotype PUL F2679). **a** Field photo of fresh sporocarps on palm leaf. Note the variable size and color of the sporocarps. Bar = 2 mm **b–d** Sporocarps of various stages and sizes after drying. Bars = 0.5 mm **e** Sporocarp as seen under the light microscope. Note the swollen pigmented base with surrounding large globose cells and the long tubular neck with a widening tip. Bar = 200 μ m **f** Tip of the neck with spore mass exiting the sporocarp. Bar = 25 μ m **g** Ostiolar hyphae at the tip of the neck. Bar = 10 μ m **h** Outer surface of the neck, wide hyphae are visible, septa are marked with arrows. Bar = 10 μ m **i** Globose cells (marked with asterisk) surrounding the base of the sporocarp. Bar = 25 μ m **j** Multicellular spores produced inside the sporocarps. Note the four-celled spores on the left breaking into smaller compartments. Bar = 10 μ m.

of sporocarp necks, approximately half of the size of the basal cushion in diam. (up to 1.5 mm diam. in fresh material). Spores hyaline, mostly 2–4 celled and cylindrical or somewhat fusiform, measuring 3–4 \times 7–18 μ m (average 3.25 \times 11.8 μ m), breaking into smaller compartments. No sporogenous cells were detected at the interior of the sporocarp, but the spores are likely asexually produced. Basidia not observed.

Ecology and distribution. On palm leaf litter in tropical forest of Ecuador. Possibly occurring in association with other fungi. Known only from the type locale.

Etymology. *aurantiacus* = orange, for the color of fresh sporocarps.

Specimens examined. PUL F2679.

Discussion. The sporocarps most likely represent an asexual stage of *P. aurantiacus*. Anamorphic stilboid conidiomata have been described for other members of Pucciniomycotina, especially in Atractiellomycetes (e.g. Oberwinkler et al. 2006). However, multicellular spores have not previously been described for any sporocarp-forming member of Atractiellomycetes or Microbotryomycetes. The organic matter of palm trees is not a common substrate among Pucciniomycotina and only one other basidiocarp-forming genus, *Agaricostilbum* Wright, is known to specifically inhabit palm litter (Wright et al. 1981). The recovery of *C. paradoxa* from the material might hint on a possible mycoparasitic strategy for *P. aurantiacus*.

Acknowledgements

We are grateful to Prof. Rosario Briones of Pontificia Universidad Catolica del Ecuador, Quito for facilitating specimen deposition and exchanges at Pontificia Universidad Catolica del Ecuador (QCA), to Drs. Harry Evans and Gary Samuels for facilitating permitting and collecting logistics in Ecuador and companionship in the field, and the staff and volunteers at Bilsa. Cindy Park is gratefully acknowledged for laboratory assistance at the USDA. We are thankful to Tom Creswell, Gail Ruhl and Anna Meier from the Purdue University Plant and Pest Diagnostic Laboratory for use of microscopy facilities and to Mehrdad Abbasi assisting with submission to Kriebel Herbarium at Purdue. We are also thankful to the two anonymous reviewers for constructive comments and suggestions on an earlier version of this manuscript.

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