Phytotaxa 662 (3): 271–278
https://www.mapress.com/pt/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.662.3.6

Arthromyces pulverulentus sp. nov. (Basidiomycota, Agaricales, Lyophyllaceae), a new insect associated conidia-producing species from the cloud forests of Colombia

ANA E. FRANCO-MOLANO[1], TIMOTHY J. BARONI[2*] & LENNART J. J. VAN DE PEPPEL[3]
[1]*Laboratorio de Taxonomía y Ecología de Hongos (TEHO), Instituto de Biología, Facultad de Ciencias Exactas y Naturales, Universidad de Antioquia UdeA, Calle 70 No. 52-21, Medellín, Colombia*
ana.franco@udea.edu.co; https://orcid.org/0000-0003-2600-5072
[2]*Department of Biological Sciences, State University of New York, College at Cortland, PO Box 2000, Cortland, New York 13045, USA*
tim.baroni@cortland.edu; https://orcid.org/0000-0002-3411-4175
[3]*Chair of Forest Entomology and Protection, Institute of Forestry, University of Freiburg, Fohrenbühl 27, 79252 Stegen-Wittental, Germany*
lennartvdpeppel@gmail.com; https://orcid.org/0000-0002-9851-6077
**Correspondence author: tim.baroni@cortland.edu*

Abstract

This is the third arthroconidial-producing agaric discovered for the genus *Arthromyces* found in the neotropics. *Arthromyces pulverulentus* from the cloud forests of Colombia is described and illustrated. The new species can be distinguished from other members of the genus *Arthromyces* by its thick mycelioid roll around the margin of the pileus that produces copious amounts of smooth phaeoarthrospores. This newly discovered species, like other members of the genus, is associated with insect-faecal pellet masses of an unidentified insect.

Key words: *Blastosporella*, phylogeny, taxonomy

Introduction

The neotropical genus *Arthromyces* T.J. Baroni & Lodge (2007: 574) currently contains three species (Baroni *et al.* 2007; van de Peppel *et al.* 2022a), this report adds a fourth taxon to the genus which was originally described in 2007 (Baroni *et al.* 2007). Species of *Arthromyces* are characterized by their collybioid habit with a typically long or sometimes short pseudorhizal stipe arising from insect faecal pellets, dark fuscous, grayish-fuscous or brown pigmented basidiomata with crowded, narrow often fimbriate edged lamellae bearing distinctive cylindrical or cylindrical-capitate cheilocystidia, basidia with cyanophilic/siderophilic bodies/granules content, basidiospores with cyanophilic walls and for the majority of the species in the genus the production of chains of dark-colored arthroconidia. Molecular investigations recently identified one species of *Arthromyces* that does not produce arthroconidia on the basidiomata, *A. glabriceps* M. C. Aime & V. Coimbra (2022:10), described from Brazil and Guyana (van de Peppel *et al.* 2022a). We report here a new phaeoarthroconidia producing agaric that grows on insect faecal pellets that has been found several times in different localities in the cloud forests proximal to Medellin, Colombia. The undescribed taxon produces powdery arthroconidia on a thick pulverulent roll around the pileus margin. Numerous images of this new species, originally misidentified as *Blastosporella zonata* T. J. Baroni & Franco-Mol. (2007:579) (Baroni *et al.* 2007), have been posted on iNaturalist (2023) by various citizen naturalists in Colombia. Both morphological and molecular analysis confirm this is a new taxon and its placement in the genus *Arthromyces*.

Accepted by Carlos Salvador: 30 Jul. 2024; published: 13 Aug. 2024

Material & Methods

Taxon sampling

The specimens for this study were collected at different locations in the department of Antioquia, Colombia. The collection sites were well above 2,000 metres of elevation associated with *Quercus humboldtii* Bonpl. (1809:155) or mixtures of *Quercus* and *Pinus* sp.

Morphological methods

Collections were imaged in the field under natural settings when possible. Field notes were recorded on freshly collected samples using general colour terms or the OAC colour charts (Online Auction Colour Chart Company—Online Colour Charts for Mycologists and Botanists, www.nhbs.com), and then the basidiomata were slowly air dried using low warm air heat. Thin sections of the dried pileus and stipe tissues and small lamella edge fragments were prepared for microscopic examination of structures by rehydrating tissues in clear liquid mounts of either 14% NH_4OH or 5% KOH solutions or in solutions of Congo Red in 14 % NH_4OH. Tests for chemical reactions to hyphae and basidiospore walls were examined in Melzer's Reagent and Cotton Blue dye, the latter to determine cyanophilic reactions of basidiospore walls and internal cyanophilic/siderophilic bodies in basidia typical of members of the family Lyophyllaceae Jülich (1982:378) (Baroni *et al.* 2007).

In the description of the basidiospores, n = number of individual spores measured, L = mean length, W = mean width, Q = length divided by the width of an individual spore and given in a range, Qm = mean for all Q values, and ± is for standard deviation of measurements presented. Ranges for all other microscopic structures are based on a minimum of 10 measurements. All measurements were made at 1000x magnifications under an oil immersion lens. Image capture of microscopic structures was also made at 1000x magnification with a Spot Insight 3 colour, 2 megapixel camera (Diagnostic Instruments) on an Olympus BX50 light microscope using bright field and differential interference contrast (DIC) lens systems.

DNA extraction, PCR and phylogenetic analysis

A small piece of dried tissue was used for DNA extraction. The tissue was placed in a 1.5ml Eppendorf tube and was disrupted by freezing it in liquid nitrogen and grinding it using a sterile pestle. DNA extraction was carried out using a Qiagen QIAamp DNA Micro Kit using the manufacturer's protocol except that the incubation step at 56°C with proteinase K was carried out overnight.

A total of three regions were amplified using conventional polymerase chain reaction (PCR); the nuclear ribosomal region containing the internal transcribed spacer 1 (ITS1), 5.8S and the internal transcribed spacer 2 (ITS2), a partial sequence of the nuclear ribosomal large subunit (LSU, 28S) and a partial sequence of the transcription elongation factor 1-α (*TEF1α*) gene. The following primer pairs were used; ITS1f/ITS4 for ITS (White *et al.* 1990; Gardes & Bruns 1993), LR0R/LR5 for LSU (Vilgalys & Hester 1990) and 983F and 1567R for *TEF1α* (Rehner and Buckley 2005). The PCR conditions were as follows: initial denaturation at 94°C for five minutes, followed by 35 cycles of denaturation at 94°C for one minute, annealing at 53°C for ITS, 49°C for LSU and 56°C for *TEF1α* for one minute, and extension at 72°C for one minute. Amplification was completed with a final extension step at 72°C for 10 minutes. Sanger sequencing was performed by StarSEQ (Mainz, Germany) using both the forward and reverse primer. The assembly of the forward and reverse sequence was done using Geneious 10.0.9 (Kearse *et al.* 2012).

Sequences of closely related species from other studies were obtained from NCBI Genbank and added to the alignment (Hofstetter *et al.* 2014; van de Peppel *et al.* 2022a; 2022b). A complete overview of all the sequences that were used can be found in Supplementary Table 1. For the phylogenetic analysis, individual alignments were made for each marker. Sequences were aligned using MAFFT v7.505 online alignment software with default settings (Katoh *et al.* 2019). After alignment and trimming, the three alignments were concatenated using Geneious 10.0.9. A maximum-likelihood tree was reconstructed using the webserver of IQ-tree with default settings and 1000 ultrafast bootstrap replicates (Trifinopoulos *et al.* 2016). Branches with UFBS > 90 were considered significantly supported, branches with UFBS < 90 were collapsed into polytomies. *Australocybe olivacea* T.J. Baroni, N. Fechner & van de Peppel (2022:3) was used as an outgroup to root the tree (van de Peppel *et al.* 2022a).

TABLE 1. List of Taxa analyzed in Fig. 1 and Genbank accession numbers.

Species	Voucher ID	ITS	LSU	EF1α	Collector(s)	Collection date	Country	Reference
Arthromyces claviformis	TJB8258		EU708334		S.A. Cantrell & T.J. Baroni	9/11/1996	Puerto Rico	Baroni *et al.* 2007
Arthromyces claviformis	DR-2983	OM905928	OM905980	OM974115	M. Quirico, O. Perdomo, M. Marmolejo & R. Concepción	30/08/2003	Dominican Republic	van de Peppel *et al.* 2022b
Arthromyces glabriceps	PUL F29134 pt1	OM905936	OM905988	OM974120	M.C. Aime	3/06/2002	Guyana	van de Peppel *et al.* 2022b
Arthromyces glabriceps	PUL F29136	OM905939	OM905991	OM974123	M.C. Aime	27/05/2010	Guyana	van de Peppel *et al.* 2022b
Arthromyces glabriceps	PUL F29138	OM905941	OM905993	OM974128	M.C. Aime	31/05/2012	Guyana	van de Peppel *et al.* 2022b
Arthromyces glabriceps	CORT014857	OM905943	OM905995	OM974125	V.R.M. Coimbra	25/04/2012	Brazil	van de Peppel *et al.* 2022b
Arthromyces matolae	FLAS:F-62778	MN945962			J. Rogers	22/06/2018	USA: Florida, Gainesville	Unpublished
Arthromyces matolae	DLC04-170	EU708339	EU708336		D.L. Lindner	17/08/2004	Belize	Baroni *et al.* 2007
Arthromyces matolae	TJB9912	EU708338	EU708335		T.J. Baroni	18/08/2004	Belize	Baroni *et al.* 2007
Arthromyces matolae	CORT014601	OM905931	OM905983	OM974118	T.J. Baroni	25/08/2007	Belize	van de Peppel *et al.* 2022b
Arthromyces matolae	FLAS:F-62734	OM905929	OM905981	OM974116	M.E. Smith	28/06/2018	USA: Florida, Gainesville	van de Peppel *et al.* 2022b
Arthromyces matolae	TJB10171	OM905930	OM905982	OM974117	T.J. Baroni	24/08/2007	Belize	van de Peppel *et al.* 2022b
Arthromyces pulverulentus	**Velez 37**	**PP294861**	**PP294859**	**PP278606**	**J.L. Velez**	**28/06/2022**	**Colombia**	**This study**
Arthromyces pulverulentus	**HUA233518**	**PP294860**	**PP294858**	**PP278605**	**J.C. Quiroz Mejía**	**15/12/2023**	**Colombia**	**This study**
Arthromyces sp.	LIP:RC/Guy12.019	KP208751			R. Courtecuisse	18/06/2012	French Guiana	Unpublished
Australocybe olivacea	BRI1030081	OM905944	OM905996	OM974129	T.J. Baroni	25/05/2011	Australia	van de Peppel *et al.* 2022b
Blastosporella zonata	TJB8371	EU708340	EU708337	MZ574160	T.J. Baroni & O.P. Perdomo	5/01/1997	Dominican Republic	van de Peppel *et al.* 2022a
Blastosporella zonata	Bzo01 (type 2)	MZ566499	MZ566495	MZ574147	L.J.J. van de Peppel	31/10/2016	Colombia	van de Peppel *et al.* 2022a
Blastosporella zonata	Bzo04 (type 1)	MZ566498	MZ566494	MZ574150	L.J.J. van de Peppel	1/11/2016	Colombia	van de Peppel *et al.* 2022a
Nigrocarnea radicata	HNL501043	OM905946	OM905998	OM974131	O.S. Pedersen & T. Læssøe	21/08/2015	Laos	van de Peppel *et al.* 2022b
Phaeotephrocybe leucophylla	CORT014602	OM905945	OM905997	OM974130	T.J. Baroni	13/08/2001	Belize	van de Peppel *et al.* 2022b
Praearthromyces corneri	CORT014856	OM905948	OM906000	OM974133	D. Stubbe	9/10/2006	Malaysia	van de Peppel *et al.* 2022b
Praearthromyces griseus	CORT014481	OM905947	OM905999	OM974132	R. Zhao	3/06/2006	Thailand	van de Peppel *et al.* 2022b
Tephrocybe rancida	CORT012399	OM905965	OM906003	OM974135	T.J. Baroni	24/11/1987	USA: California, Healdsburg	van de Peppel *et al.* 2022b
Tephrocybe rancida	CORT012400	OM905966	OM906004		T.J. Baroni	14/10/1997	USA: California, Hyampom	van de Peppel *et al.* 2022b
Tephrocybe rancida	TR2017	OM905967	OM906005	OM974137	L.J.J. van de Peppel	18/10/2017	The Netherlands: Breukelen	van de Peppel *et al.* 2022b
Termitomyces microcarpus	DUKE-PRU3900	AF357023	AF042587	EF421077				Hofstetter *et al.* 2014
Termitomyces sp.	IE-BSG-BSIsp.1	AF357024	AF223174	EF421078				Hofstetter *et al.* 2014

Results

Phylogenetic analysis

After concatenation of the individual alignments, the final alignment consisted of 2,195 base pairs of which 1,595 were invariant and 438 were parsimony informative. Our phylogenetic analysis significantly supports the monophyly of the genus *Arthromyces* (UFBS 100) and places *A. pulverulentus* as the early-branching lineage of this clade (Fig. 1). The *Arthromyces* clade is sister to termite-cultivated genus *Termitomyces* (UFBS 100), which is in accordance with earlier studies (van de Peppel *et al.* 2021; 2022a). Within the *Arthromyces* clade there are some branches that are not significantly supported, most notably, the large polytomy which contains the species *A. matolae* T.J. Baroni, Lodge & D.L. Lindner (2007:576) and *A. claviformis* T.J. Baroni & Lodge (2007:574).

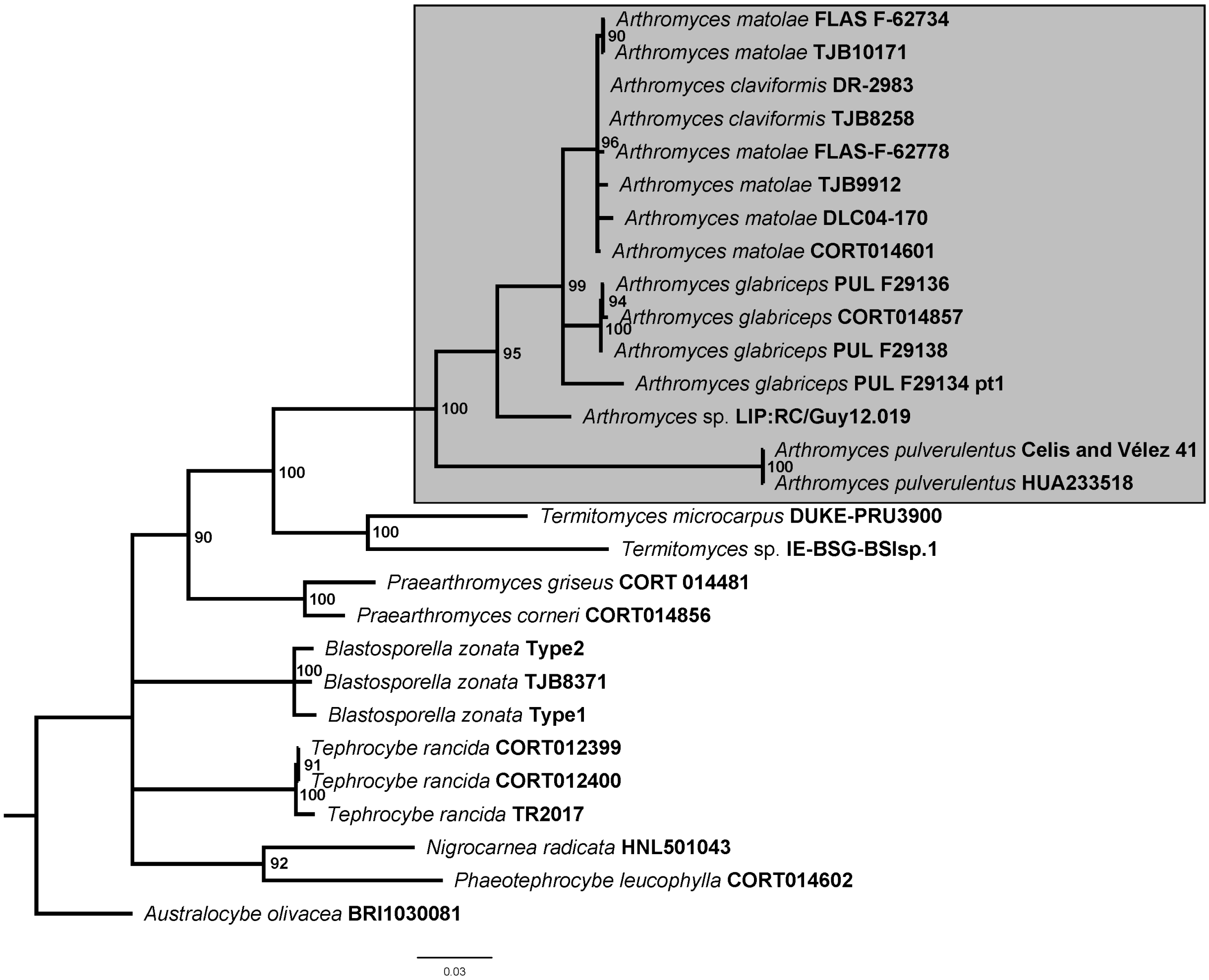

FIGURE 1. Maximum-likelihood tree based on concatenated ITS, LSU and TEF1α sequences. Support values at the nodes indicate ultrafast-bootstrap replicates. The genus *Arthromyces* is highlighted in gray.

Taxonomy

Arthromyces pulverulentus A.E. Franco-Molano, T.J. Baroni & L.J.J. van de Peppel, *sp. nov.* Fig. 2 A–F
Mycobank—MB851622

Etymology—from the powdery pulverulent pileus margin

Type—COLOMBIA. Antioquia: Municipio de Envigado, El Salado, sector de las Cuevas del Higuerón, 2400 m asl. 15 December 2023. Juan Carlos Quiroz Mejía s.n. (holotype HUA233518!, isotype NY04285950!). Genbank: ITS (PP294860), LSU (PP294858), *TEF1α* (PP278605).

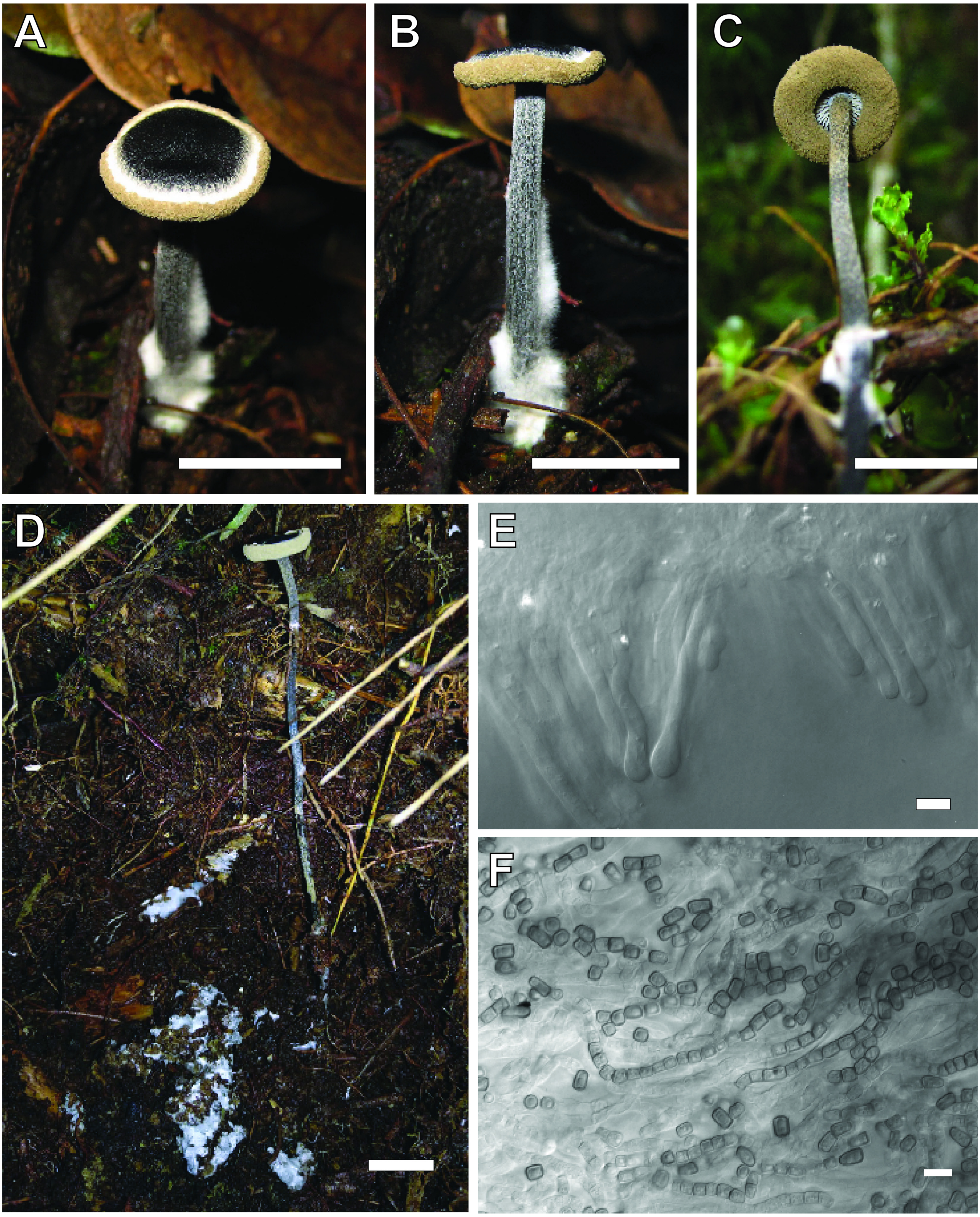

FIGURE 2. *Arthromyces pulverulentus* A–C Holotype (HUA233518) basidiome in situ showing the thickened pileus margin covered with brown pulverulent arthroconidia. D (HUA 227833), a basidiome showing connections to a faecal pellet substrate covered with white mycelium. E–F Isotype (NY04285950). E, cheilocystidia F, arthroconidia. Images A–C by J. C. Quiroz Mejía, image D by B. Zora Vergara (HUA 227833), images E–F by T.J. Baroni. Scales bars, A–D 10 mm, E–F 5 µm.

Diagnosis—*Arthromyces pulverulentus* differs from *A. claviformis*, *A. glabriceps* and *A. matolae*, by the thick, white mycelioid roll around the margin of the pileus, producing dense brown pulverulent masses of arthroconidia in long chains, the arthroconidia surfaces are smooth and not ornamented as found in the other arthroconidia producing species *A. claviformis* and *A. matolae*, and the cheilocystidia are not encrusted in *A. pulverulentus*.

Description—Pileus 7–12 mm broad, plano-convex or slightly and broadly depressed, some become convex-campanulate, always with thickened rounded margin covered with dense cream gray (oac801) to cream (oac816) mycelioid roll at first, the thickened roll incurved and covering lamellae from margin or to mid pileus, then eventually covering the lamellae completely to the stipe, the marginal roll becoming pulverulent-powdery and turning olivaceous brown from arthroconidia production, disc surface black (oac908) to margin, glabrous, shiny or matte, smooth or becoming rugulose, solid and glass-like as dried. Context 1 mm thick, solid, dark gray (aoc901). Lamellae adnate with a decurrent tooth, close to subdistant, narrow (1 mm) white to grayish (oac909-893) at first, edges olivaceous and granulate-floccose. Stipe 35–70 mm long, 1.5–2 mm broad at apex, central, cylindrical, equal above ground, but gradually tapered to a long pseudorhizal base below ground level, surface fuscous-black but mostly covered over the upper portions at first or the entire above ground surface with fine white (oac909) velutinous pubescence that eventually turns olivaceous brown over the upper apical regions like the pileus marginal roll, pseudorhiza attached to ball shaped masses of insect faecal pellets composed of masticated plant materials, these faecal pellets bound together by white mycelium that produced the basidiomata.

Basidiospores 4–5 × (2–) 3–4 µm, (n= 23, L=4.6 ± 0.44, W=2.95 ± 0.45, Q = 1.25–2, QM = 1.6 ± 0.2), ellipsoid in profile and face views, round in polar view, smooth, walls thin cyanophilic. Basidia not abundant, (12–) 15–19 × 4–5 µm, cylindrical, 4-sterigmate, filled with small cyanophilic bodies when mounted in Cotton Blue and Congo Red droplets when mounted in Congo Red ammonia solution. Basidioles similar in dimensions to basidia, cylindrical or quite often fusoid, filled with cyanophilic bodies. Cheilocystidia 25–52 × 4–6 µm, narrowly clavate or more frequently cylindrical-capitate (capitulum 5–8 um broad), hyaline in NH_4OH, with abundant, large shiny lipoidal bodies in Cotton Blue. Pleurocystidia absent. Lamella trama composed of parallel, cylindric hyphae, 2–6 (–10) µm broad. Pileipellis a dark brown layer in NH_4OH, of repent cylindrical hyphae, 3–6 µm in diam, walls of hyphae fainty but distinctly encrusted with brown pigment, separating and producing a zebra like pattern on individual hyphae.

Clamp connections absent.

Arthroconidia on pileus margin dark olivaceous in NH_4OH, often in long chains of 10–20 cells, individual conidia, thick-walled, mostly short or elongate rectangular, some curved, smooth, 3–6.5 (–7) × 3–3.5 (–4) µm.

Habit and habitat—solitary, on soil among pine needles, on insect pellet frass masses, apparently associated with an insect in its life cycle. April through December.

Additional material examined—COLOMBIA. Antioquia, municipio de Medellín, Corregimiento de San Antonio de Prado, Vereda Astilleros, Reserva Natural Astillera; bosque de niebla, 2500–2800 m asl (6.25425, -75.66986), 28 June 2022, Laura Vélez Jaramillo #37 (HUA 233492; CORT 014891); Antioquia, municipio de Medellín, Corregimiento de San Antonio de Prado, Vereda Astilleros, Reserva Limona-Manguala, cuchilla del Romeral. 2441.95 m asl, (6.171650, -75.756765), 15 November 2023, Juan Jose Celis #2 (HUA 233519); Antioquia, municipio de Envigado, El Salado, camino ancentral a Cuevas del Higueron, (6.12364612, -75.561523), 12 September 2021, Brayan Zora Vergara s.n. (HUA 227833); Antioquia, municipio de Medellin, Corregimiento de Santa Elena, vereda El Rosario, (6.245319, -75.493642237535), 26 May 2024, Juan Jose Celis #88 (HUA 237535).

Comments—*Arthromyces pulverulentus* differs from other species in the genus by its distinctive thick cottony-pulverulent roll producing olivaceous-brown chains of arthroconidia around the pileus margin, and not on the disc of the pileus as typical for *A. matolae* and *A. claviformis*, the two other arthroconidia producing taxa in this genus (Baroni *et al.* 2007). *Arthromyces glabriceps* does not produce arthroconidia on its basidiomata (van de Peppel 2022a). The cheilocystidia of *A. pulverulentus* are also distinctive by lacking encrusting exudates that are found on the cheilocystidia of all the other species of *Arthromyces* described so far. Also, the arthroconidia produced by *A. pulverulentus* are smooth, not ornamented as is typical for the other arthroconidial producing taxa, *A. matolae* and *A. claviformis*. A final, and not insignificant difference, is that the basidiospores of *A. pulverulentus* are smaller than the other three taxa in this genus (i.e. *A. claviformis*—4.5–6.5 x 3–4 µm; *A. glabriceps*—5–7.5 x 3–4 µm; *A. matolae*—5.5–7.5 x 3.4–4.5 µm: Baroni *et al.* 2007, van de Peppel *et al.* 2022a).

Discussion

This new species of *Arthromyces* brings the total number of described species in this genus up to four. Besides the specimens that we document here, *A. pulverulentus* has been observed several times in the area around Medellín by several different citizen scientists (iNaturalist observations: 22385899, 45028477, 62608759, 139593278, 164732235, 190826074, 191304916, 194479499). Some of these observations were originally identified as *Blastosporella* *zonata*, but the distinctive thick pulverulent pileus margin definitively identifies these images as specimens of *A. pulverulentus*.

Although *A. pulverulentus* is well supported as a species, both morphologically as well phylogenetically, our phylogenetic analysis could not recover *A. matolae* and *A. claviformis* as distinct phylogenetic species, however see Key to species below. Whether these two morphospecies represent the same phylogenetic species should be investigated in a future study. Our analysis does not include enough sequence data for *A. claviformis* and additional sequence data from the type specimen could help in solving this question.

Interestingly, *A. pulverulentus* co-occurs in the same general area as some recently documented collections of *B. zonata* from near Medellín (iNaturalist: 180843715 and 108363038), another insect-associated member of the termitomycetoid clade (Baroni *et al.* 2007; van de Peppel *et al.* 2022b) and possibly also *A. claviformis*, as it was found at two other locations in Colombia (van de Peppel *et al.* 2022a). This overlap in geographic range between these three insect-associated species shows that there are potentially different niches available and indicates a possible specialization of each species towards a distinct insect host. Previous studies were not able to identify the insect host of the known *Arthromyces* species or *B. zonata* (van de Peppel *et al.* 2021; van de Peppel *et al.* 2022a), however for the latter, an association to Coleopteran larvae has been suggested (van de Peppel *et al.* 2021). Although insect faecal pellets were observed for all collections of *A. pulverulentus* documented in this paper, an insect host could not be identified. The function of the conidia and their role in the dispersal of the fungus are not completely understood, although they could play a role in the short-range dispersal of the fungus and may facilitate rapid colonization of the masses of insect faecal pellet substrates (van de Peppel *et al.* 2022b). More detailed studies are required to unravel the life cycle and biology of these peculiar fungi and to detect the degree of specialization towards specific insect host(s).

Key to ***Arthromyces*** and ***Blastosporella*** in the Neotropics, insect associated taxa arising from aggregated masses of insect faecal pellets

1. Pileus mostly plane, up to 40 mm broad, brown, translucent-striate, hygrophanous, glabrous and not producing arthroconidia on the pileus or stipe (currently known only from Brazil and Guyana) .... *A. glabriceps*
- Pileus variously shaped, but always producing dark brown or fuscous black powdery conidia 2
2. Pileus truncate-convex and strongly zonate at first with gray and dark brown bands, soon deeply depressed over disc producing a well-defined rim around the disc with the depression filled with powdery soot-brown blastospores produced by inflated hyphal end cells on the pileus, blastospores globose and strongly tuberculate ornamented (Colombia and Dominican Republic) .... *Blastosporella zonata*
- Pileus not strongly zonate nor depressed with well-defined rim around the disc, pileus variously shaped and producing dark gray or grayish-brown arthroconidia in chains of disarticulating end cells on the pileus and in one species also the stipe 3
3. Pileus with well-developed, thick, pale grayish-cream colored marginal roll at first, which turns olivaceous-brown and powdery-pulverulent from production of long chains (10–20 cells) of smooth walled, dark brown arthroconidia, cheilocystidia narrowly clavate or cylindrical-capitate and not encrusted (Colombia) .... *Arthromyces pulverulentus*
- Pileus lacking well-developed, thick marginal roll, arthroconidia verrucose or punctate roughened, typically in chains of less than 10 cells, cheilocystidia with resin-encrusted apices .... 4.
4. Pileus up to 55 mm broad, convex and grayish-yellow to clay color, margin translucent-striate at first, pileus disc area soon developing dark grayish-brown powdery arthroconidia and production of arthroconidia spreading towards the margin, arthroconidia dark brown and finely punctate ornamented over the outer walls (Belize and Florida, USA) .... *Arthromyces matolae*
- Pileus up to 15 mm broad, ± convex, typically with broadly truncate disc which is strongly depressed with age, pileus margin strongly inrolled, entire pileus opaque; pileus and stipe densely covered with short chains of powdery dark brown verrucose ornamented arthroconidia (Dominican Republic, Puerto Rico) .... *Arthromyces claviformis*

Acknowledgements

LJJvdP was supported by the Netherlands Organization for Scientific Research (NWO-Rubicon grant no. 019.211EN.031). Juan Carlos Quiroz Mejía collected a specimen which he gave to AEFM and gave the authors of this paper permission to use his images originally posted on iNaturalist (inaturalist.org/observations/161919895). We also thank Bryan Zora for providing an image and his collection to our research. We are grateful to Maria Lopera Martinez for help with obtaining collections and the iNaturalist community of Colombia for sharing their observations of *A. pulverulentus*. Laura Vélez Jaramillo and Juan Jose Celis in AEFM's laboratory provided collections and valuable help with this project as well. The biological material used in this work was collected under the permission given to the University of Antioquia according to resolution 0524 of May 27, 2014, issued by the National Environmental Licensing Authority—ANLA.

Literature Cited

Baroni, T.J., Franco-Molano, A.E., Lodge, D.J., Lindner,, D.L., Horak E. & Hofstetter, V. (2007) *Arthromyces* and *Blastosporella*, two new genera of conidia-producing lyophylloid agarics (Agaricales, Basidiomycota) from the neotropics. *Mycological Research* 111 (5): 572–580.
https://doi.org/10.1016/j.mycres.2007.03.007

Gardes, M. & Bruns, T.D. (1993) ITS primers with enhanced specificity for basidiomycetes—application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2 (2): 113–118.
https://doi.org/10.1111/j.1365-294X.1993.tb00005.x

Hofstetter, V., Redhead, S.A., Kauff, F., Moncalvo, J.M., Matheny, P.B. & Vilgalys, R. (2014) Taxonomic revision and examination of ecological transitions of the Lyophyllaceae (Basidiomycota, Agaricales) based on a multigene phylogeny. *Cryptogamie Mycologie* 35 (4): 399–425.
https://doi.org/10.7872/crym.v35.iss4.2014.399

iNaturalist (2023) iNaturalist. *iNaturalist Database*. Available from: https://www.inaturalist.org (accessed 1 July 2023)

Katoh, K., Rozewicki, J. & Yamada, K.D. (2019) MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in Bioinformatics* 20 (4): 1160–1166.
https://doi.org/10.1093/bib/bbx108

Kearse, M., Moir, R., Wilson, A., Stones-Havas, S., Cheung, M., Sturrock, S., Buxton, S., Cooper, A., Markowitz, S., Duran, C., Thierer, T., Ashton, B., Meintjes, P. & Drummond, A. (2012) Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* 28 (12): 1647–1649.
https://doi.org/10.1093/bioinformatics/bts199

Rehner, S.A. & Buckley, E. (2005) A *Beauveria* phylogeny inferred from nuclear ITS and EF1-alpha sequences: evidence for cryptic diversification and links to *Cordyceps* teleomorphs. *Mycologia* 97 (1): 84–98.
https://doi.org/10.3852/mycologia.97.1.84

Trifinopoulos, J., Nguyen, L.T., von Haeseler, A. & Minh, B.Q. (2016) W-IQ-TREE: a fast online phylogenetic tool for maximum likelihood analysis. *Nucleic Acids Research* 44 (W1): W232–235.
https://doi.org/10.1093/nar/gkw256

van de Peppel, L.J.J., Aime, M.C., Læssøe, T., Pedersen, O.S., Coimbra, V.R., Kuyper, T.W., Stubbe, D., Aanen, D.K. & Baroni, T.J. (2022a) Four new genera and six new species of lyophylloid agarics (Agaricales, Basidiomycota) from three different continents. *Mycological Progress* 21 (10): 1–14.
https://doi.org/10.1007/s11557-022-01836-7

van de Peppel, L.J.J., Baroni, T.J., Franco-Molano, A.E. & Aanen, D.K. (2022b) Genetic population structure of the agaric *Blastosporella zonata* (Lyophyllaceae) reveals cryptic species and different roles for sexual and asexual spores in dispersal. *Persoonia* 49: 195–200.
https://doi.org/10.3767/persoonia.2022.49.06

van de Peppel, L.J.J., Nieuwenhuis, M., Auxier, B., Grum-Grzhimaylo, A.A., Cardenas, M.E., de Beer, Z.W., Lodge, D.J., Smith, M.E., Kuyper, T.W., Franco-Molano, A.E., Baroni, T.J. & Aanen, D.K. (2021) Ancestral predisposition toward a domesticated lifestyle in the termite-cultivated fungus *Termitomyces*. *Current Biology* 31 (19): 4413–4421.
https://doi.org/10.1016/j.cub.2021.07.070

Vilgalys, R. & Hester, M. (1990) Rapid Genetic Identification and Mapping of Enzymatically Amplified Ribosomal DNA from Several *Cryptococcus* Species. *Journal of Bacteriology* 172 (8): 4238–4246.
https://doi.org/10.1128/jb.172.8.4238-4246.1990

White, T.J., Bruns, T.D., Lee, S.J.W.T. & Taylor, J.L. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *PCR protocols: a guide to methods and applications* 18 (1): 315–322.
https://doi.org/10.1016/B978-0-12-372180-8.50042-1