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Short title: New *Albomagister* from North America

Four new species of *Albomagister* (Agaricales) from eastern North America

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Abstract

Four new species of *Albomagister*, a genus of Tricholomataceae in the order Agaricales, are described and illustrated from eastern North America. All four are relatively rare or geographically restricted but two have a broad geographical distribution occurring in southeast Canada and in the southern Appalachians. This study increases the number of known species in the genus from three to seven, five of which occur in eastern North America. A broad concept for the genus is discussed. Illustrations and descriptions of the North American taxa are presented, along with a taxonomic key to the known seven species in the genus worldwide.

Abstrait

Quatre nouvelles espèces d'*Albomagister*, un genre de Tricholomataceae de l'ordre des Agaricales, sont décrites et illustrées de l'est de l'Amérique du Nord. Les quatre espèces sont relativement rares ou géographiquement restreintes, mais deux d'entre elles ont une large distribution géographique, se trouvant dans le sud-est du Canada et dans le sud des Appalaches. La présente étude fait passer de trois à sept le nombre d'espèces connues dans le genre, dont cinq présentes dans l'est de l'Amérique du Nord. Un concept général du genre est exposé. Des illustrations et des descriptions des taxons nord-américains sont présentées, ainsi qu'une clé taxonomique des sept espèces connues dans le monde.

Keywords

Agaricales, fungal diversity, Tricholomataceae, systematics, taxonomy

Introduction

The genus *Albomagister* Sánchez-García, Birkebak & Matheny was originally described to accommodate *Hygrophorus subaustralis* A.H. Sm. & Hesler, a white tricholomatoid species described from the southern Appalachians of the eastern United States. *Albomagister subaustralis* (Hesler & A.H. Sm.) Sánchez-García, Birkebak & Matheny is characterized in part by the presence of conspicuous cheilocystidia and pleurocystidia and smooth inamyloid basidiospores (Smith and Hesler 1942; Hesler and Smith 1963; Sánchez-García et al. 2014). The genus has been placed phylogenetically within the Tricholomataceae R. Heim ex Pouzar with strong phylogenetic support, rather than in the Hygrophoraceae Lotsy where it was originally placed (Sánchez-García et al. 2014). The latter work also suggested an ectomycorrhizal mode of nutrition for *A. subaustralis* based on stable carbon and nitrogen stable isotope signatures consistent with those from other ectomycorrhizal fungi (Sánchez-García et al. 2017). Since the description of *Albomagister*, two European species have been described in the genus: *A. alesandrii* P.-A. Moreau, Bellanger, Biancardini & F. Rich. and *A. virgineus* Corriol & P. Jargeat from Mediterranean (Corsica, France) and mainland France (Moreau et al. 2015; Corriol and Jargeat 2018), respectively, which allowed a more encompassing circumscription of the genus (Corriol and Jargeat 2018). However, four other species-level lineages from eastern North America were detected but not formally described in Sánchez-García et al. (2014, 2017) owing to the lack of sufficient morphological information about them. Since these studies, additional collections have been discovered or brought to our attention. Here, these four species are described as new. This study increases the number of species in *Albomagister* to seven from eastern North America and Europe, however, the ecology of the group will deserve more scrutiny.

Materials and Methods

Specimen-vouchers

Specimens were collected and studied from North Carolina, Tennessee, and Quebec. iNaturalist observations of sequenced (ITS barcode) specimens were also evaluated. Collecting permits were provided by the Great Smoky Mountains National Park (GRSM-2010-SCI-0078, GRSSM-2013-SCI-1048, GRSM-2015-SCI-1048). Notes of morphological features of specimens were made in fresh condition. Color codes are from Kornerup and Wanscher (1978). Specimens were preserved after dehydration in a food dehydrator, databased in MyCoPortal, and accessioned at the University of Tennessee Herbarium (TENN) and the Canadian National Mycological Herbarium – AAFC (DAOM). Use of the terms tricholomatoid, mycenoid, and inocyboid follow that of Corriol and Jargeat (2018).

Microscopic features were observed from sections of dried materials rehydrated in 5% KOH and/or Congo Red. Descriptive terms follow Vellinga (1998). Tissues were also examined in Melzer's reagent for any immediate amyloid or dextrinoid reactions, and then again after 30 minutes for any latent reactions (Vizzini et al. 2020). We also observed a drop of Melzer's reagent on spore deposits made on glass slides for any immediate color change and after 30 min. Mean basidiospore lengths and widths are italicized. Q-values are ratios of spore length to spore width. The number of collections and number of spores examined is placed in the following format as n=number of spores/from number of collections.

Phylogenetic analyses

We downloaded from TreeBASE (treebase.org) the 4-locus Tricholomataceae supermatrix produced by Sánchez-García et al. (2014) containing concatenated partial *rpb2*, 18S rDNA, 28S rDNA, and ITS1-5.8S-ITS2 sequences. To this we added multiple sequences from

Albomagister alesandrii and *A. virgineus* from Moreau et al. (2015) and Corriol and Jargeat (2018) and two previously unpublished ITS sequences (MT197009 and ON943297). Four of the seven ingroup taxa were represented by four loci (*A. alesandri*, *A. griseosquamosus* sp. nov., *A. parviniveus* sp. nov., and *A. subaustralis*); two (*A. leucoloma* sp. nov. and *A. luteifolius* sp. nov.) were represented by three loci and one (*A. virgineus*) by two loci. This dataset was pruned in Aliview 1.11 (Larsson 2014) to contain exemplar outgroups of *Tricholoma*, *Corneriella*, and *Leucopaxillus*, all of which were represented with four or three loci. All sites were included before phylogenetic analyses, except for *rpb2*-intron 4 and 47 ambiguously aligned sites of ITS1-ITS2. Phylogenetic analyses were conducted using maximum likelihood (ML) in RAxML 8.2.9 (Stamatakis 2014) and Bayesian inference (BI) with MrBayes 3.2.6 (Ronquist et al. 2012). The modified dataset is available online at figshare (DOI:10.6084/m9.figshare.25483612).

For both analyses the nucleotide data were partitioned by *rpb2* codon position (1st and 2nd codons combined and 3rd positions modeled separately) and a single partition containing the three linked rDNA regions. We applied GTRGAMMAI models for all partitions in both analyses following Sánchez-García et al. (2014). 1000 rapid bootstrap replicates were conducted in RAxML followed by a more thorough ML search for the best-scoring ML tree. For the BI analysis, we ran MrBayes for four million generations sampling trees and other parameters every 1000 steps. Two runs were conducted, and trees were combined after a 25% burn-in and inspection of measures of convergence between runs according to the user manual. Strongly supported nodes were recorded as such if they received more than 70% ML bootstrap and more than 0.95 Bayesian posterior probability (BPP). Trees were rooted along the branch leading to the clade containing *Tricholoma*, *Corneriella*, and *Leucopaxillus* following Sánchez-García and Matheny (2017). Midpoint rooting was also conducted to ensure consistency of results.

Results

Basidiospores of all sampled North American specimens were inamyloid and non-dextrinoid. The modified supermatrix contained 34 taxa and 4672 nucleotide sites. The *rpb2* portion contained 722 sites (exon only), the 18S 1772 sites, 28S 1391 sites, and the ITS 787 sites. RAxML output for preliminary analyses rejected a model of rate heterogeneity for the *rpb2*-codon 2 partition (the alpha parameter was estimated >10). Hence, codons 1 and 2 were merged into a single partition. BPP were calculated after a 25% burnin and sample of 6002 trees. Convergence diagnostics were met before one million generations.

Albomagister was recovered as monophyletic with strong support (Figure 1), and again as so when using the midpoint rooting option. Seven species-level lineages were recovered with strong support, four of which, all from eastern North America, are described as new species.

Albomagister subaustralis formed a strongly supported species pair with *A. luteifolius* sp. nov. This pair formed a strongly supported group with *A. leucoloma* sp. nov. The two European species, *A. alesandrii* and *A. virgineus*, formed a moderately supported clade together with *A. parviniveus* sp. nov. However, *A. parviniveus* was supported as sister to *A. virgineus* with strong support. In these latter two species, pleurocystidia were present only near the lamella edges or were absent altogether. This suite of six species was also recovered with strong support as sister to the gray-scaly *A. griseosquamosus*, which formed a lineage sister to the rest of the genus.

Taxonomy

Albomagister Sánchez-García, Birkebak & Matheny, Taxon 63(5): 1000. 2014.

TYPE: *Albomagister subaustralis* (A.H. Sm. & Hesler) Sánchez-García, Birkebak & Matheny

DESCRIPTION: Habit tricholomatoid, mycenoid, or inocyboid. Lamellae sinuate to adnexed, white, cream, yellowish, at times drying ocher-yellow. Basidiospores smooth, thin-walled (less often with thickened wall), inamyloid (less often weakly amyloid or dextrinoid). Pleurocystidia present and conspicuous in most species, thin-walled or with slightly thickened walls, hyaline. Cheilocystidia similar to pleurocystidia and present in all species. Pileipellis a cutis, often with ascending interwoven cylindric elements. Lamellar trama parallel. Clamp connections present, common, and easy to observe.

On soil. North American taxa occur in forests under ectomycorrhizal trees, but European taxa occur among non-ectomycorrhizal plants such as *Buxus*. Occurring in North America, Europe, and New Zealand.

TAXONOMIC NOTES: The genus is emended here to include at least one new species without pleurocystidia and other species with a mycenoid to inocyboid habit as first noted by Corriol and Jargeat (2018). Moreau et al. (2015) and Moyne and Moingeon (2018) reported faintly amyloid basidiospores in *A. alesandrii*, and Corril and Jargeat (2018) reported a small percentage of spores with a dextrinoid reaction in *A. virgineus*. In some species a small proportion of spores may be larger and display a thickened wall (Moreau et al. 2015; Corriol and Jargeat 2018; Moyne and Moingeon 2018). Stable isotope values of carbon and nitrogen support the ectomycorrhizal status of *A. subaustralis*, the type of the genus (Sánchez-García and Matheny 2017), but occurrence of the two European species with non-ectomycorrhizal plants, viz. *Buxus sempervirens*, suggests these are not ectomycorrhizal.

Albomagister griseosquamosus Lebeuf, Matheny & Vellinga, **sp. nov.** Figures 2A–F, 3A, 6A–C.

MycoBank: MB851399

Type: USA, Tennessee, Sevier County, Great Smoky Mountains National Park, Elmont, Jakes Creek Trail (35.6764 -83.3971), in humus in acidic cove hardwood forest under various hardwoods and *Tsuga canadensis*, 4 August 2009, *J. Lennie ECV4038* (holotype designated here, TENN-F-064609).

Diagnosis: Differs from the white species of *Albomagister* by the gray squarrose to appressed-scaly pileus and stipe.

Habit tricholomatoid. **Pileus** 25–50 mm wide, campanulate to plano-convex and at times with a low broad umbo, more flattened with age; margin decurved, occasionally torn or undulating; surface dry, initially with a whitish ground color, becoming gray and completely covered with dense small dark gray to blackish squamules, these squarrulose when young and more like fibrillose-scales in more-or-less concentric bands in age, not hygrophanous; context pale gray with dark gray areas, odor and taste indistinct, absent, or mild. **Lamellae** sinuate to adnate, close to crowded with ca. 55–60 L and 1–3 tiers of lamellulae, thick, narrow (3–5 mm), white to pale gray or gray with white edges that darken to gray, edges sometimes eroded. **Stipe** 35–70 × 4–7 mm, equal to slightly narrowed or slightly enlarged at the base; surface dry, veil absent, fibrillose at the apex but mostly with gray scaber-like squamules or with the squamules covering the entire length on a whitish or paler background, squamules smaller towards the base, becoming lacerate-scaly with age; context pale gray, becoming paler towards the nearly white base; hollow. **Basidiospores** 6–*7.1*–8 × (4)4.5–*5.6*–6.7 µm, Q 1.10–*1.28*–1.57 (n=65/4), smooth, elliptic to broadly so or subglobose, with a guttule, hyaline, inamyloid, with a distinct apiculus, white in

deposit. **Basidia** 25–37 × 7–9.5 µm, 4-spored, clavate to subcylindric, hyaline. **Pleurocystidia** 38–74 × 11–20 µm, obovate, sphaeropedunculate, broadly clavate, or fusiform-rostrate, with a long pedicel, with a rounded or mucronate apex, with thin or slightly thickened wall, brown pigmented. **Cheilocystidia** forming a sterile lamellar edge, 24–80 × 7–15 µm, often narrowly lageniform to abruptly fusiform, very long pedicellate, walls slightly thickened and brown pigmented. **Pileipellis** an irregular trichoderm with chained elements, these narrowed gradually, hyphae incrusted; terminal cells 45–115 × 9–18 µm, utriform to somewhat conical, less often narrowly lageniform, base generally broad, apices often with a moniliform excrescence, at times rostrate, brownish pigmented. **Stipitipellis** similar to pileipellis. **Clamp connections** present, large, and conspicuous.

TAXONOMIC NOTES: *Albomagister griseosquamosus* was previously reported as "undet gray scaly" in Sánchez-García et al. (2014, 2021). This species resembles *Tricholoma squarrulosum* Bres. and *T. atrosquamosum* Sacc., but in its outward appearance *A. griseosquamosus* differs from these by the more elongated non-bulbous stipe and non-farinaceous odor and taste. Microscopically, *A. griseosquamosus* differs readily from these by the presence of distinct pleuro- and cheilocystidia and the large conspicuous clamp connections found throughout the all tissues.

The basidiospores of the Quebec collections (6–*6.5*–7.5 × 4–*4.8*–5) µm, Q 1.09–*1.30*–1.63 are somewhat smaller than the type and ECV5690 from Tennessee. Although not analyzed here, an *rpb1* sequence was also produced from the type of *A. griseosquamosus* – KU139073 (Sánchez-García and Matheny 2017).

ETYMOLOGY: *griseosquamosus* (Latin), gray scaly, in reference to the gray scales on the pileus and stipe

DISTRIBUTION AND ECOLOGY: *Albomagister griseosquamosus* apparently is widely distributed in eastern North America, having been found in both Quebec and Tennessee, although there is a broad sampling gap between these regions. It occurs on acidic soils (where known) at relatively low elevations (<600 m), in mixed and cove hardwood forests containing some mixture of the following ectomycorrhizal trees: *Abies*, *Fagus*, *Betula*, *Tsuga* and/or *Tilia*. Basidiomes have been observed August to September.

OTHER SPECIMENS EXAMINED: Canada, Quebec, Saint-Stanislas, Parc de la rivière Batiscan, secteur Murphy, trial Le Buis (46.5891 -72.4125), solitary on ground in leaf litter in mixed forest under *Abies balsamea*, *Betula alleghaniensis*, 7 Sep. 2020, *R. Lebeuf & A. Paul HRL3282* (DAOM 984972); Saint-Alexis-des-Monts, chemin Yvon-Plante (46.5099 -73.1955), gregarious on soil in northern hardwood forest under *Fagus grandifolia*, *Abies balsamea*, *Acer*, 16 Aug. 2023, *R. Lebeuf & A. Paul HRL4268* (R.L. pers. fung., iNat178773906). USA, Tennessee, Sevier Co., Great Smoky Mountains National Park, Greenbrier, Ramsey Cascades Trail (35.7028 -83.3575), acidic cove hardwood forest including *Tsuga canadensis*, *Betula alleghaniensis*, *Tilia americana*, *Quercus*, 5 Sep. 2013, *E. C. Vellinga* ECV5690 (TENN-F-068763).

Albomagister leucoloma Matheny, Sánchez-García & Vellinga, **sp. nov.** Figures 3B, 6D–F

MYCOBANK: MB851400

TYPE: USA, Tennessee, Cocke County, Great Smoky Mountains National Park, Cosby, Maddron Bald Trail (35.7652 -83.2680), on soil and needle leaf litter in acidic cove hardwood forest under *Tsuga canadensis*, 10 Oct. 2010, *E.C. Vellinga ECV4202* (holotype designated here, TENN-F-065323).

DIAGNOSIS: Basidiomes with an inocyboid habit, white with underlying grayish drab ground color, in age with straw yellow to amber-yellow discolorations on the pileus and stipe, on acidic soil in a cove hardwood forest under *Tsuga canadensis*. Phylogenetically distinct and sister to the clade including *A. subaustralis* and *A. luteifolius*.

Habit small, inocyboid. **Pileus** 10–23 mm wide, obtusely conical, expanding with age, slightly umbonate and subcampanulate, margin decurved; surface dry but with some adhering soil particles, dull, innately white silky fibrillose, fibrils thinning at the center and revealing a grayish drab ground color, thicker and whitish or indistinctly straw yellow or grayish drab in places towards the margin; conext thick, odor and taste not remarkable. **Lamellae** sinuate, moderately close, thick, broad, whitish to pale grayish white, becoming buff or tinged cream with age, edges white and indistinctly fimbriate. **Stipe** 15–25 × 2–5 mm, terete, equal; dry, fibrillose white, in age revealing amber yellow discolored areas, base covered with soil and needle litter of *Tsuga canadensis*. **Basidiospores** 5–*6.0*–7 × (3.5–)4–*4.3*–5 µm, Q 1.16–*1.40*–1.68 (n=21/1), broadly elliptic to subovate, smooth, thin-walled, with a distinct apiculus, inamyloid and nondextrinoid. **Basidia** 29–40 × 6–7 µm, 4-spored, slenderly clavate, hyaline, thin-walled. **Pleurocystidia** 48–60(–86) × 14–16 µm, ventricose with a long slender pedicel, smooth, walls slightly thickened (ca. 1.0 µm thick), hyaline. **Cheilocystidia** 22–55 × 6–17 µm, many shorter than the pleurocystidia and thin-walled, also subfusiform, utriform, or clavate, some ventricose and long-pedicellate like the pleurocystidia, frequent on the lamellar edges but mixed with fertile basidia. **Pileipellis** a cutis, hyphae smooth, cylindric, mostly 5–12 µm wide. **Stipitipellis** without caulocystidia, surface hyphae cylindric, mostly 4–6 µm wide, smooth, thin-walled. **Clamp connections** abundant in all tissues.

TAXONOMIC NOTES: *Albomagister leucoloma* is described from a single collection made on acidic soil in a cove hardwood forest under *Tsuga canadensis* and various hardwoods in the Great Smoky Mountains. The species is phylogenetically distinct from, but most closely related to, the clade including *A. subaustralis* and *A. luteifolius*; indeed, all three species produce pleurocystidia. Based on the single gathering, we observed the pileus of *A. leucoloma* to reveal a grayish drab tone at the center, apparently as the thin white fibrillose vesture wears away. In age some yellow to amber-yellow discolorations were also noted on the pileus and stipe surfaces, but the dried specimens were off-white. The species may be distinguished from others by the grayish drab underlying tone to the pileus and somewhat larger spores, and, of course, with phylogenetic evidence. We have only recorded the species once despite years of collecting in the Great Smoky Mountains National Park, so it is comparatively rare or possibly overlooked or misidentified. *Albomagister leucoloma* equates to *Albomagister* sp. 3 in Sánchez-García et al. (2014, 2021). Although not analyzed here, an *rpb1* sequence was also produced from the type of *A. leucoloma* – KU139019 (Sánchez-García and Matheny 2017).

ETYMOLOGY: *leucoloma* (Greek), white fringe, in reference to the overall whitish basidiome coloration

DISTRIBUTION AND ECOLOGY: *Albomagister leucoloma* is known only from the type locality in east Tennessee in the Great Smoky Mountains. It occurred singly on acidic soil at relatively low elevations (<600 m) in a cove hardwood forest mixed with *Tsuga canadensis.* Basidiomes were recorded in October.

Albomagister luteifolius Lebeuf, Matheny & Sánchez-García, **sp. nov.** Figures 4A–B, 6G–I

MYCOBANK: MB851401

TYPE: Canada, Quebec, Saint-Thuribe, Rang Saint-Léon (42.3327 -72.9571), on soil in mixed forest including *Fagus grandifolia* with few *Abies balsamea*, 16 Sep. 2018, *R. Lebeuf HRL2773* (holotype designated here DAOM 984969, isotype TENN-F-074689).

DIAGNOSIS: Differs from other species of *Albomagister* by the habit similar to *Inocybe geophylla*, yellowing lamellae, and distinct phylogenetic position sister to *A. subaustralis*.

Habit inocyboid resembling *Inocybe geophylla* in outward appearance. **Pileus** 7–30 mm wide, campanulate, margin inflexed then deflexed; surface dry, with appressed radial fibrils, at times with watery drops near the margin; white, pale yellow over the center; context yellowish white to pale yellow (3A2, 3A3), thin; odor none, taste bitter. **Lamellae** adnexed to sinuate, distant to moderately so, 1.5–5 mm deep; white at first, becoming yellowish white (4A2) and darker yellow with age, light yellow (near 4A5) after drying, not waxy. **Stipe** 20–60 × 1–6 mm, equal, often curved; surface dry, veil not observed, pruinose to flocculose at the apex, fibrillose-striate below, when young with watery drops near the apex; white; context yellowish white to pale yellow. KOH negative on surfaces of the pileus and stipe and on the stipe context. **Basidiospores** 4.5–*5.0*–6 × (3–)3.5–*3.7*–4(–4.5) µm, Q 1.13–*1.37*–1.57(–1.71) (n=90/3), elliptic to broadly elliptic (more broadly so from less mature basidiomes), smooth, inamyloid, white in deposit. **Basidia** 21–27 × 6–7 µm, 4-spored, clavate. **Pleurocystidia** 38–66 × 8–14 µm, frequent, fusiform to subutriform or subcylindric or oblong, often short-pedicellate, thin-walled, hyaline. **Cheilocystidia** 48–75 × 8–14 µm, similar to pleurocystidia but at times long-pedicellate (pedicels up to 20 µm long). **Pileipellis** a cutis composed of cylindric hyphae 2–7 µm wide; tramal hyphae inflated, 5–20 µm wide. **Stipitipellis** without caulocystidia; hyphae cylindric, 3–9 µm wide. **Clamp connections** abundant in all tissues.

293 *TAXONOMIC NOTES*: *Albomagister luteifolius* and *A. subaustralis* are difficult to distinguish based
294 on morphology only. Indeed, both are sister taxa, but *A. luteifolius*, based on the proportion of
295 samples sequenced, appears to be the less frequently encountered of the two species. Based on
296 available data, *A. luteifolius* is best distinguished from *A. subaustralis* by the smaller *Inocybe*
297 *geophylla*-like habit. Comparison of dried materials of both species suggests neither can be
298 reliably distinguished by the yellowish to ocher-yellow color of the dried lamellae. *Albomagister*
299 *luteifolius* does not appear to be common but has been overlooked and misidentified as *A.*
300 *subaustralis* in the past (see AHS14872 cited under *Hygrophorus subaustralis* in Hesler and
301 Smith 1963). The species occurs in mixed hardwood forests and mixed forests including conifers
302 and has a wide geographic range having been confirmed by molecular data from Quebec and the
303 southern Appalachians during August and September. *Albomagister luteifolius* equates to
304 *Albomagister* sp. 2 in Sánchez-García et al. (2014, 2021).
305 ETYMOLOGY: *luteifolius* (Latin), yellow gills, in reference to the yellowish-tinged lamellae.
306 DISTRIBUTION AND ECOLOGY: *Albomagister luteifolius* is widely distributed across eastern North
307 America, having been found in Quebec, North Carolina, and Tennessee, but a broad sampling
308 gap occurs between those regions. It occurs singly to scattered or gregarious on acidic or
309 possibly more nutrient enriched soils at relatively low- to mid-elevations (<1200 m) in leaf litter
310 in mixed hardwood-*Tsuga canadensis* dominated forests, cove hardwood forests under *Quercus*,
311 northern hardwood forests, and in mixed forests containing *Fagus*, *Abies*, and/or *Betula.*
312 Basidiomes were recorded in August and September.
313 Sánchez-García and Matheny (2017) also produced an *rpb1* sequence (KU139018) for
314 MSG137 (TENN-F-068776).

OTHER SPECIMENS EXAMINED: Canada, Quebec, Saint-Thuribe, Rang Saint-Léon (42.3327 -72.0571), in beech-maple forest under *Fagus grandifolia*, 11 Sep. 2020, *R. Lebeuf & A. Paul HRL3286* (DAOM 984970); *ibid*., under *Fagus grandifolia*, *Betula alleghaniensis*, 11 Sep. 2020, *R. Lebeuf & A. Paul HRL3287* (DAOM 984971). USA, North Carolina, McDowell Co., Marion, Armstrong Creek (35.6830 -82.0058), in mixed hardwood forest with *Tsuga canadensis*, 21 Sep. 2012, *M. Sánchez-García MSG136* (TENN-F-068775); McDowell Co., Little Switzerland, Blue Ridge Parkway, Swofford Road near Table Rock Overlook (36.5186 -80.9358), in mixed hardwood forest along a gravel road, 21 Sep. 2012, *B.P. Looney MSG137* (TENN-F-068776); McDowell Co., near Marion, Pisgah National Forest, Victor Road (35.803 -82.162), in a swamp forest bog complex under *Betula*, *Tsuga*, *Quercus*, 22 Sep. 2023, *S.R. Warwick & P.B. Matheny PBM4797* (TENN-F-078516); Mitchell Co., Roses Creek, on acidic soil in cove hardwood forest, 22 Sep. 2023, *C.R. Noffsinger CRN92223A* (TENN-F-078620). Tennessee, Blount Co., Great Smoky Mountains National Park, Cades Cove (35.5942 -83.842), in rich cove hardwood forest with *Quercus*, 17 Aug. 1939, *A.H. Smith AHS14872* (MICH 58090 as "*Hygrophorus subaustralis*").

Albomagister parviniveus Matheny, Sánchez-García & Vellinga, **sp. nov.** Figure 6J–K.

MYCOBANK: MB851402

TYPE: USA, Tennessee, Sevier County, Great Smoky Mountains National Park, Cherokee Orchard, last turn-off before Rainbow Falls (36.1328 -83.8144), on acidic soil in cove hardwood forest near *Tsuga canadensis*, *Pinus*, *Quercus*, 31 August 2013, *E.C. Vellinga MSG144* (holotype designated here, TENN-F-071074).

DIAGNOSIS: Differs from other *Albomagister* by the absence of pleurocystidia, small basidiome size, and occurrence in eastern North America. Differs from *A. virgineus* by the slightly smaller spores, none of which are dextrinoid, and occurrence in acidic cove hardwood forests of eastern North America.

Habit small, mycenoid to inocyboid. **Pileus** up to 15 mm wide, convex, whitish, smooth, dry. **Lamellae** adnexed, close, whitish. **Stipe** 20 × 2 mm, slightly enlarged at the base; surface dry, fibrillose, off-white. **Basidiospores** 5–*5.3*–6(–6.5) × 4–*4.7*–5.5 µm, Q 1.08–*1.16*–1.28 (n=40/1), subglobose to broadly elliptic, with a guttule, hyaline, inamyloid and nondextrinoid, with a distinct apiculus, white in deposit. **Basidia** 24–29 × 6–8 µm, 4-spored, narrowly clavate to subcylindric, hyaline. **Pleurocystidia** absent. **Cheilocystidia** 24–52 × 5–7.5 µm, cylindric to narrowly utriform, at times narrowly clavate-flexuous, very long pedicellate, forming a sterile lamellar edge. **Pileipellis** hyphae slightly interwoven with some tips projecting upwards; terminal hyphae 55–98 × 6–9 µm, these narrowly cylindric to somewhat clavate-fusiform, hyaline, apices generally obtuse (rarely rostrate). **Stipitipellis** with scattered terminal cells 15–39 × 6–8 µm, these cylindric to clavate, smooth, thin-walled, hyaline. **Clamp connections** present in all tissues.

TAXONOMIC NOTES: *Albomagister parviniveus* is the same as "undet small white" in Sánchez-García et al. (2014, 2021). The species is distinguished from other American *Albomagister* most notably by the very small basidiomes and absence of pleurocystidia. We have only observed this species twice over a span of 15 years, but on both occasions at Cherokee Orchard in the Great Smoky Mountains National Park. The species is sister to the European *A. virgineus*, which also lacks pleurocystidia, however, it differs from *A. parviniveus* by the slightly larger spores with occasional dextrinoid walls and occurrence in a boxwood (*Buxus*) habitat in France.

ETYMOLOGY: *parviniveus* (Latin), small and white, in reference to the small white basidiomes.

DISTRIBUTION AND ECOLOGY: *Albomagister parviniveus* is known only from the type locality in the Great Smoky Mountains National Park where it has been collected in two different years. This species occurs singly on acidic soils in cove hardwood forests near *Tsuga*, *Quercus*, *Betula*, and *Pinus*. Basidiomes were observed in August.

ADDITIONAL SPECIMENS EXAMINED: USA, Tennessee, Sevier County, Great Smoky Mountains National Park, Cherokee Orchard Loop Road (36.1328, -83.8144), on ground in cove hardwood forest near *Tsuga canadensis*, *Quercus*, *Betula*, *Pinus*, 6 August 2009, *M.B. Pilkington* MBP6.VIII.09 (TENN-F-064359).

Albomagister subaustralis (A.H. Sm. & Hesler) Sánchez-García, Birkebak & Matheny, *Taxon* 63: 1000 (2014) Figures 5A–B, 7A–C.

= *Hygrophorus subaustralis* A.H. Sm. & Hesler, *Lloydia* 5: 46 (1942)

Habit tricholomatoid, resembling small forms of *Tricholoma columbetta*. **Pileus** 27–44 mm wide, bluntly conical with an inflexed margin when young, expanding to plano-convex or applanate with age, with a broad umbo; surface dull, matte, felted and slightly radially fibrillose towards the margin; white, at times yellowish at the center, not hygrophanous; context white and dull, odor mild or somewhat unpleasant, not farinaceous. **Lamellae** sinuate, close with several tiers of lamellulae, slightly yellowish white, broad (up to 7 mm deep), edges concolorous and entire in appearance. **Stipe** 45–55 × 5–10 mm, equal, at times somewhat flexuous, fragile; surface dry but on occasion with beads of moisture at the apex, tomentose on the lower part, veil absent; white; stuffed to hollow. **Basidiospores** 4–*4.6*–5(5.3) × 3.5–*3.8*–4(4.3) µm, Q 1.10–*1.25*–1.40 (n=61/3), broadly elliptic to subglobose, at times with a guttule, hyaline, thin-walled,

inamyloid and nondextrinoid, with a distinct apiculus, white in deposit. **Basidia** 20–28 × 5–6 µm, 4-spored, narrowly clavate to cylindric, hyaline, thin-walled. **Pleurocystidia** 26–56 × 8–15 µm, narrowly utriform or fusiform to utriform, rarely oblong to obovate, with rounded or obtuse apices, long pedicellate, thin-walled, hyaline; scattered, somewhat more frequent towards the fertile lamellar edges. **Cheilocystidia** similar to pleurocystidia, at times slenderly clavate, scattered and mixed with fertile basidia. **Pileipellis** a cutis giving rise to upright and constricted to flexuous cylindric hyphae, 3–9 µm wide, thin-walled, hyaline. **Stipitipellis** without caulocystidia, hyphae of stipe surface 3–5 µm wide, hyphae appressed or somewhat recurved, smooth, thin-walled, hyaline. **Clamp connections** present in all tissues.

TAXONOMIC NOTES: *Albomagister subaustralis* is the most commonly collected species of *Albomagister* in the southern Appalachians. It also produces the largest basidiomes among the white-colored species. *Albomagister luteifolius* is similar but is characterized by the smaller *Inocybe geophylla*-like basidiomes. *Albomagister leucoloma* differs from *A. subaustralis* by the pileus with grayish drab tints and unique phylogenetic position.

DISTRIBUTION AND ECOLOGY: *Albomagister subaustralis* is known only from the southern Appalachians (Georgia, North Carolina, South Carolina, Tennessee) in rich and poor (acidic) cove hardwood forests (<1000 m elev) mixed with hemlock and/or pine and also in oak-hickory-beech forests on karst topography. Potential ectomycorrhizal trees include *Tsuga*, *Betula*, *Carpinus*, *Carya*, *Fagus*, *Quercus*, *Pinus*, and *Tilia*. Reports from outside the southern Appalachians have not been confirmed with molecular annotations. Most basidiomes were observed from August to October.

ADDITIONAL SPECIMENS EXAMINED: USA, North Carolina, Swain County, Great Smoky Mountains National Park (GSMNP), Indian Creek, 23 August 1942, *L.R. Hesler & A.J. Sharp*

406 *LRH14423* (TENN-F-014423); *ibid*., 12 September 1947, *L.R. Hesler LRH17951* (TENN-F-
407 017951); *ibid.*, *L.R. Hesler & A.J. Sharp LRH18628* (TENN-F-018628); *ibid*., 14 August 1952,
408 *L.R. Hesler LRH020463* (TENN-F-020463); Martins Gap, GSMNP, beside the trail, 2 September
409 1938, *A.H. Smith AHS10844* (holotype, MICH 10951); South Carolina, Oconee County, Oconee
410 State Park, Mountain Rest, 22 September 2013, *J.M. Birkebak JMB092213-01* (TENN-F-
411 070997); Tennessee, Blount County, GSMNP, Cades Cove, 25 September 1957, *L.R. Hesler*
412 *LRH22663* (TENN-F-022663); *ibid.*, 26 August 1958, *L.R. Hesler LRH023195* (TENN-F-
413 023195); *ibid.*, campground area of Cades Cove, 6 August 1959, *L.R. Hesler LRH23221* (TENN-
414 F-023221); *ibid.*, 26 September 1973, *L.R. Hesler LRH39069* (TENN-F-039069); Cocke County,
415 GSMNP, Maddron Bald Trail, 4 August 2012, *S.A. Trudell SAT-12-217-02* (TENN-F-067343);
416 Monroe County, Tellico Plains, Bald River Falls, Cherokee National Forest, 1 October 2011, *W.*
417 *Burnette WBU11* (TENN-F-066902); Sevier County, GSMNP, Elkmont area, Jakes Creek Trail,
418 4 August 2009, *M.G. Wood MGW676* (TENN-F-064620); *ibid.*, *E.C. Vellinga ECV4049* (TENN-
419 F-064621); Sevier County, GSMNP, Greenbrier area at intersection of Greenbrier Road and
420 Ramsey Prong Road, Cemetery Trail, 2 September 2013, *M.G. Wood MGW1296* (TENN-F-
421 068710).
422
423 **Key to Species of *Albomagister* from North America and Europe**
424 1. Pleurocystidia present and conspicuous, basidiomes tricholomatoid or inocyboid.....2
425 1. Pleurocystidia absent, basdiomata inocyboid or nearly mycenoid and fragile.....6
426 2. Basidiomes with gray to blackish scales.....**A. griseosquamosus**
427 2. Basidiomes fibrillose, felty, or smooth, without scales; white 3

3. Basidiospores indistinctly amyloid or a small proportion dextrinoid, a small proportion thick-walled, known only from Europe (France, Corsica) ..... **A. alesandrii**

3. Basidiospores inamyloid, non-dextrinoid, and thin-walled; known only from eastern North America 4

4. Pileus with underlying grayish drab tones when fresh, basidiospores 5–7 × 4–5 µm ..... **A. leucoloma**

4. Pileus without grayish drab tones, spores 4–6 × 3.5–4 µm 5

5. Stipe 1–6 mm wide, habit inocyboid resembling *Inocybe geophylla* ..... **A. luteifolius**

5. Stipe 5–10 mm wide, habit tricholomatoid resembling small forms of *Tricholoma columbetta* ..... **A. subaustralis**

6. Basidiospores 5–6–× 4–5.5 µm, thin-walled, not dextrinoid; in acidic cove hardwood forests in eastern North America (southern Appalachians) ..... **A. parviniveus**

6. Basidiospores 6–6.5 × 4–6 µm, a small proportion with thickened dextrinoid walls, under *Buxus* in Europe (France) ..... **A. virgineus**

Discussion

Seven species of *Albomagister* can now be ascribed to the genus with five of them known only from localized and disparate areas of eastern North America based on sequenced materials. Of these five species, three are known only from the Southern Appalachians (*A. leucoloma*, *A. parviniveus*, *A. subaustralis*) in the Great Smoky Mountains National Park, along the Blue Ridge Parkway, and/or in surrounding areas of western North Carolina and Georgia. A record of *A. subaustralis* in western Virginia was found in MyCoPortal, but the identification was not verified with molecular data. Note that Hesler and Smith (1963) cited a collection identified as

Hygrophorus subaustralis by Dennis (1953) based on material from Trinidad, but this specimen lacks molecular confirmation as well. iNaturalist observations indicate occurrence of *A. subaustralis* in Eucador, but these specimens lack verification. Two other species of *Albomagister* are rarely collected but have wider disparate geographic distributions occurring in Quebec, Tennessee, and North Carolina (*A. griseosquamosus*, *A. luteifolius*). In Europe (mainland France and Corsica), the two *Albomagister* species there have thus far limited geographic distributions. Among current MyCoPortal records backed by vouchered specimens, one indicates an unidentified *Albomagister* from New Zealand supported by morphological analysis and ITS data [see also https://www.inaturalist.org/observations/29472072].

Of the seven species now recognized in *Albomagister*, five possess pleurocystidia. The two that lack pleurocystidia, *A. parviniveus* and *A. virgineus*, form a strongly supported monophyletic group. The absence of pleurocystidia in this clade, and their reduction in *A. alesandrii*, represents an evolutionary loss, thus the presence of pleurocystidia is ancestral for the genus. While faintly amyloid basidiospores were reported for *A. alesandrii* (Moreau et al. 2015; Corriol and Jargeat 2018), we did not observe amyloid reactions while studying lamellar fragments from North American samples under the microscope and spore deposits made on glass slides from North American samples. Similarly, a very small proportion of dextrinoid basidiospores was observed in *A. virgineus* (Corriol and Jargeat 2018), however, we did not observe any dextrinoid reactions in the North American species.

Albomagister was considered biotrophic (ectomycorrhizal) based on analysis of carbon and nitrogen stable isotope values sampled from three specimens of *A. subaustralis* (Sánchez-García et al. 2017), the generic type. However, none of the seven species now ascribed to the genus have been detected, performing blastn searches of the ITS, from environmental sampling

efforts on GenBank and the Unite database. This is probably due to the fact that species of *Albomagister* are rarely collected, and environmental sequencing studies have not occurred in regions where *Albomagister* is known to occur. However, European *Albomagister* have been reported from landscapes with *Buxus sempervirens*, implying a saprotrophic role for European species. Deciphering the ecological roles of *Albomagister* remains a subject for future research.

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Data availability statement: Nucleotide sequence data included in this study are referenced in Table 1 and available at the U.S. National Institute of Health (NIH) sequence database (GenBank; ncbi.nlm.nih.gov/genbank/). The DNA alignment analyzed for this study is available online at figshare 10.6084/m9.figshare.25483612. Specimen data are available at MyCoPortal (https://www.mycoportal.org/portal/index.php).

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Figure Captions

Fig. 1. ML phylogeny of *Albomagister* and selected outgroups based on a 4-locus supermatrix of *rpb2*, 18S, 28S, and ITS nucleotide data. Bootstrap values and Bayesian posterior probabilities are presented above branches.

Fig. 2. Basidiomes of *Albomagister griseosquamosus*. **A**–**B**. *ECV4038* (holotype, TENN-F-064609). **C–D.** *ECV5690* (TENN-F-068763). **E**–**F**. *HRL3282* (DAOM 984972). Bars = 1 cm. Photos **A–D** by M.G. Wood; photos **E–F** by R. Lebeuf.

Fig. 3. Basidiomes of *Albomagister*. **A**. *Albomagister griseosquamosus HRL4268* (R.L. pers. fung.). **B**. *Albomagister leucoloma ECV4202* (holotype, TENN-F-065323). Bars = 1 cm. Photo **A** by R. Lebeuf; photo **B** by E.C. Vellinga.

Fig. 4. Basidiomes of *Albomagister luteifolius*. **A**. *HRL2773* (holotype, DAOM 984969). **B**. *HRL3286* (DAOM 984970). Bars = 1 cm. Photos by R. Lebeuf.

Fig. 5. Basidiomes *Albomagister subaustralis*. **A**. *MGW1296* (TENN-F-068710). **B**. *SAT-12-217-02* (TENN-F-067343). Bars = 1 cm. Photo **A** by M.G. Wood; photo **B** by S.A. Trudell.

Fig. 6. Salient microscopic features of the new species of *Albomagister*. *Albomagister griseosquamosus* (*ECV4038*, holotype): **A**. Basidiospores. **B**. Pleurocystidia. **C**. Cheilocystidia.

565 *Albomagister leucoloma* (*ECV4202*, holotype): **D**. Basidiospores. **E**. Pleurocystidia. **F**.
566 Cheilocystidia. *Albomagister luteifolius* (*HRL2773*, holotype): **G**. Basidiospores. **H**.
567 Pleurocysidia. **I**. Cheilocystidia. *Albomagister parviniveus* (*MSG144*, holotpe). **J**. Basidiospores.
568 **K**. Cheilocystidia. Horizontal bars = 10 µm for basidiospores; vertical bars = 25 µm for cystidia.
569 **Fig. 7**. Salient microscopic features for *Albomagister subaustralis* (MGW676). **A.** Basidiospores.
570 **B.** Pleurocystidia. **C**. Cheilocystidia. Horizontal bar = 10 µm for basidiospores; vertical bar = 25
571 µm for cystidia. Line art by M.G. Grady.