CASTANEA 87(1): 12–19 January

Catillaria fungoides (Catillariaceae; Lecanoromycetes) an Inconspicuous Crustose Lichen Previously Overlooked in Eastern North America

Tomas Curtis[1]* and James C. Lendemer[2]
[1]The Tom S. and Miwako K. Cooperrider Herbarium, Department of Biological Sciences
Kent State University, Kent, OH 44242-0001
[2]Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126

ABSTRACT

Catillaria fungoides is newly reported for North America based on collections from the temperate eastern United States. A detailed description based on North American material is provided, the distribution is mapped, and images are provided. The species is likely widespread but overlooked due to its inconspicuous appearance.
Key words: Appalachian Mountains, biodiversity, corticolous, floristics, lichenized fungi, new record.

INTRODUCTION

In comparison to larger, more conspicuous macrolichens, crustose microlichens have generally been under-studied and under-collected due to their small size and the perception that they are difficult to identify (Tibell 1998). Historically this has been the case in temperate eastern North America, where, despite some recent advances, our understanding of the diversity, distribution, and conservation of many crustose lichens remains poor (Allen et al. 2019; Tripp and Lendemer 2019). Although crustose lichens have received little study overall in comparison to foliose and fruticose taxa, data gaps are pervasive for asexually reproducing species that do not typically produce the sexual reproductive structures routinely used for identification (Hodkinson and Lendemer 2012). That such knowledge gaps exist, is evidenced by the continued discovery of widely distributed and common asexually reproducing species, even from regions where crustose lichens have been considered well-known (e.g., Muscavitch et al. 2017; Anderson Stewart et al. 2018; Lendemer et al. 2019; Lendemer 2020).

Recently, we discovered material of an unusual sorediate crustose lichen during fieldwork in eastern North America. This species was not only inconspicuous and easily overlooked, but resembled a non-lichenized sporodochial fungus or even an alga, leading us to initially question whether it was even a lichen in the field. Subsequent study in the field and laboratory, and discovery of fertile material, led to the name *Catillaria fungoides* Etayo & van den Boom, described from the Iberian Peninsula of Europe nearly two decades ago (van den Boom and Etayo 2001). Here we provide the first reports of *C. fungoides* for North America, including a detailed description and illustrations, highlighting the existence of this easily overlooked species that we suspect is much more widespread than current records indicate.

MATERIALS AND METHODS

This study is based on specimens collected by the authors and deposited in the Tom S. and Miwako K. Cooperrider Herbarium at Kent State University (KE), and The New York Botanical Garden (NY).

*email address: tcurti12@kent.edu
Received 10 February 2021; Accepted 11 January 2022

Specimens at KE were examined dry using a Fisher Scientific Stereomaster dissecting microscope, and sections of the ascomata and thallus were examined using a Nikon Alphaphot YS2 compound microscope. Specimens at NY were examined dry with an Olympus SZ-STB dissecting microscope and mounted sections were examined with an Olympus BX53 compound microscope. Lichen substances were studied using standard spot tests (K, C, KC, P) following Brodo et al. (2001). Selected specimens were also studied with Thin Layer Chromatography (TLC) following Culberson and Kristinsson (1970) as modified by Lendemer (2011) and using Solvent C modified to a 200:30 ratio of toluene:glacial acetic acid.

TAXONOMIC SECTION

Catillaria fungoides **Etayo & van den Boom**, Lichenol. 33:107 (2001). TYPE: SPAIN. Navarra. Atallo, aliseda en parque, entrando por la minicentral eléctrica, on *Sambucus nigra*, 26 Nov. 1997, *J. Etayo 14194* (holotype, MA[n.v.]; isotype, hb. Etayo[n.v.]).

Description of North American specimens

Thallus thin, pale, greenish-gray, shiny, film-like, continuous to dispersed-areolate, sorediate; prothallus absent or an indistinct, stain-like white film; soralia punctiform, aggregated to scattered, orbicular to irregularly shaped in outline, initially distinct but quickly becoming diffuse, often formed along cracks in the thallus and areas of the thallus near fissures in the substrate, concentrated on central portions of the thallus; soredia distinctly darker than the thallus, dark greenish to brownish or blackish in color, small, globose, (11)–19–(25) µm in diameter; apothecia rare and sparse, biatorine, sessile, discoid, up to 0.4 mm in diameter, disc brown to black, epruinose, margins thin, concolorous with the disc; exciple thin, tapering from base, up to 35 µm thick at base, with a brown-pigmented outer margin formed from the pigmented caps of hyphal cells; hypothecium hyaline to light brown, pigment often more prevalent in upper portions, not inspersed with oil droplets or crystals, 55–100 µm tall; hymenium hyaline, not inspersed with oil droplets or crystals, 30–50 µm tall; epihymenium hyaline, appearing dark brown due to conspicuously brown pigmented apical cells of the paraphyses, 7–13 µm thick; asci cylindrical to clavate, *Catillaria*-type, 8-spored, (25.0)–28.4–(32.5) × (6.3)–7.9–(11.3) µm; ascospores hyaline, 1-septate, ellipsoid to nearly bacilliform, smooth, (6.3)–7.6–(8.8) × (2.3)–2.7–(3.3) µm; paraphyses slender, septate, with swollen and heavily brown pigmented apices, often branching near the apices; pycnidia not seen; photobiont green, chlorococcoid, globose, cells 7–13 µm in diameter.

Chemistry

No substances detected. Spot tests: K-, C-, KC-, P-, UV-.

Ecology and distribution

This species was described by van den Boom and Etayo (2001) based on material from the Iberian Peninsula (Portugal and Spain) in Europe. It has subsequently been reported from many areas of mainland Europe (van den Boom et al. 2007; Fačkovcová et al. 2014; Malíček et al. 2014; van den Boom 2015; Kukwa et al. 2017; Cezanne et al. 2020) and the British Isles (Hitch 2015) but appears to be unknown from other regions except for the Azores (van den Boom 2015). In North America, the known distribution of *Catillaria fungoides* is based on ecologically unrelated collections from the Erie Drift Plane and the southern Appalachian Mountains (Figure 3). It seems likely that *C. fungoides* is much more widespread in North America than current collections indicate.

Although additional data are required, it seems probable that this species either occurs throughout temperate eastern North America or has an Appalachian-Great Lakes distribution (see Brodo et al. 2001). The habitat preference in North American populations of *Catillaria fungoides* agrees well with the description given by Malíček et al. (2014) in that it has been observed mostly on smooth bark of branches and boles of relatively young hardwoods belonging to a diverse cohort of taxa (e.g., young *Acer rubrum* L., *A. saccharum* Marshall, *Populus grandidentata* Michx., and *Tilia americana* L.). Interestingly, the species has been observed several times in close association with *C. nigroclavata* (Nyl.) J. Steiner. In fact, it was this association that led us to believe the sorediate

crust may have belonged to the genus *Catillaria*. All the specimens from the Erie Drift Plain were collected from lowland sites, in either palustrine or riparian forests, while specimens from the southern Appalachian Mountains, where humidity and annual precipitation are higher, were collected in mesic forests.

DISCUSSION

While carrying out fieldwork independently in eastern North America, we both encountered this species, which we initially assumed it to be a non-lichenized sporodochial fungus that was growing intermixed with sterile and poorly developed thalli of crustose lichens (see Figure 1A-B). Eventually we collected well-developed material where it was clear that the asexual reproductive structures were soralia with dark pigmented soredia, and that these were directly associated with a crustose lichenized thallus (Figure 1C-F). Since our first collections were sterile, and the lichen did not produce any secondary compounds that were detectable with spot tests or TLC, we were unsure what genus the material might belong to. We then found fertile specimens (Figure 2) and initially assumed in the field that the apothecia were admixed from adjacent thalli of *Catillaria nigroclavata* or *Catinaria atropurpurea* (Schaer.) Vězda & Poelt, both of which frequently grow on the smooth bark of hardwoods in eastern North America (Lendemer et al. 2016; Lendemer and Noell 2018; Tripp and Lendemer 2020). Both of those species are however, esorediate. Subsequent examination in the laboratory revealed that the apothecia were clearly associated with the sorediate thallus, and this led the first author to the published accounts of *C. fungoides*.

Our specimens agree well with the original description of the thallus and soralia of *Catillaria fungoides*. Nonetheless apothecia associated with our material differ in that they have non-inspersed hymenia and the ascospores are smaller than reported by van den Boom and Etayo (2001). Those authors considered the presence of hymenial inspersion and larger ascospores to be additional characters that distinguished *C. fungoides* from *C. nigroclavata*. At the same time, they noted that they had examined material of *C. nigroclavata* in which the hymenium was inspersed, suggesting that the character was variable. While the ascospore size given in the original description of *C. fungoides* is larger than that found in our material, there is considerable variability in the ascospore size reported for *C. nigroclavata*, with ranges that overlap or include that in the protologue of *C. fungoides* (e.g., 8–12 × (2–)2.5–3.5(–4) µm (Hertel et al. 2007); 8–10 × (2–)2.5(–4) µm (Smith et al. 2009); 7.5–11 × 2.5–3 µm (Ren and Zheng 2018). Given the above, further study of fertile material from throughout the range of *C. fungoides* is needed, especially considering the lack of specific information such as presence of apothecia in most subsequent floristic reports. Evidently detailed quantitative comparison of ascospore size for *C. nigroclavata* is also needed. Nonetheless, our material appears almost identical to that illustrated by Malíček et al. (2014) for *C. fungoides*.

Catillaria fungoides can easily be recognized by its dark pigmented soralia and thallus that is pale, greenish-gray, thin, and shiny or film-like (Figure 1). In the regions where we have found *C. fungoides*, there are not any morphologically similar sorediate crustose lichens likely to be confused with it. As was discussed by van den Boom and Etayo (2001) the species is likely to be confused with *Buellia griseovirens* (Turner & Borrer ex Sm.) Almb. as it also has dark colored soredia and can be corticolous. Nonetheless, *B. griseovirens* typically has a more well-developed, white-gray thallus, produces lichen substances that can be detected with spot tests (typically atranorin and norstictic acid, though norstictic acid deficient populations are known; Allen and Lendemer 2013). *Buellia griseovirens* also appears to have a more northern, allopatric distribution with regard to *C. fungoides* in North America (Allen and Lendemer 2013). The species that is most likely to be confused with *C. fungoides* in the northern part of its range in North America is *Caloplaca ahtii* Søchting, as that species produces tiny dark soredia, has an almost imperceptible thallus, and grows on smooth bark of hardwoods (Søchting 1994; Wetmore 2004). That species differs from *C. fungoides* in having blue-gray, rather than brown-black soredia, and the thallus contains Sedifolia-gray (= Thalloidima-green, see Meyer and Printzen 2000), a pigment that reacts K+ purple in a water mount under the compound microscope (Wetmore 2004). When fertile, *C. ahtii* can also be easily distinguished by

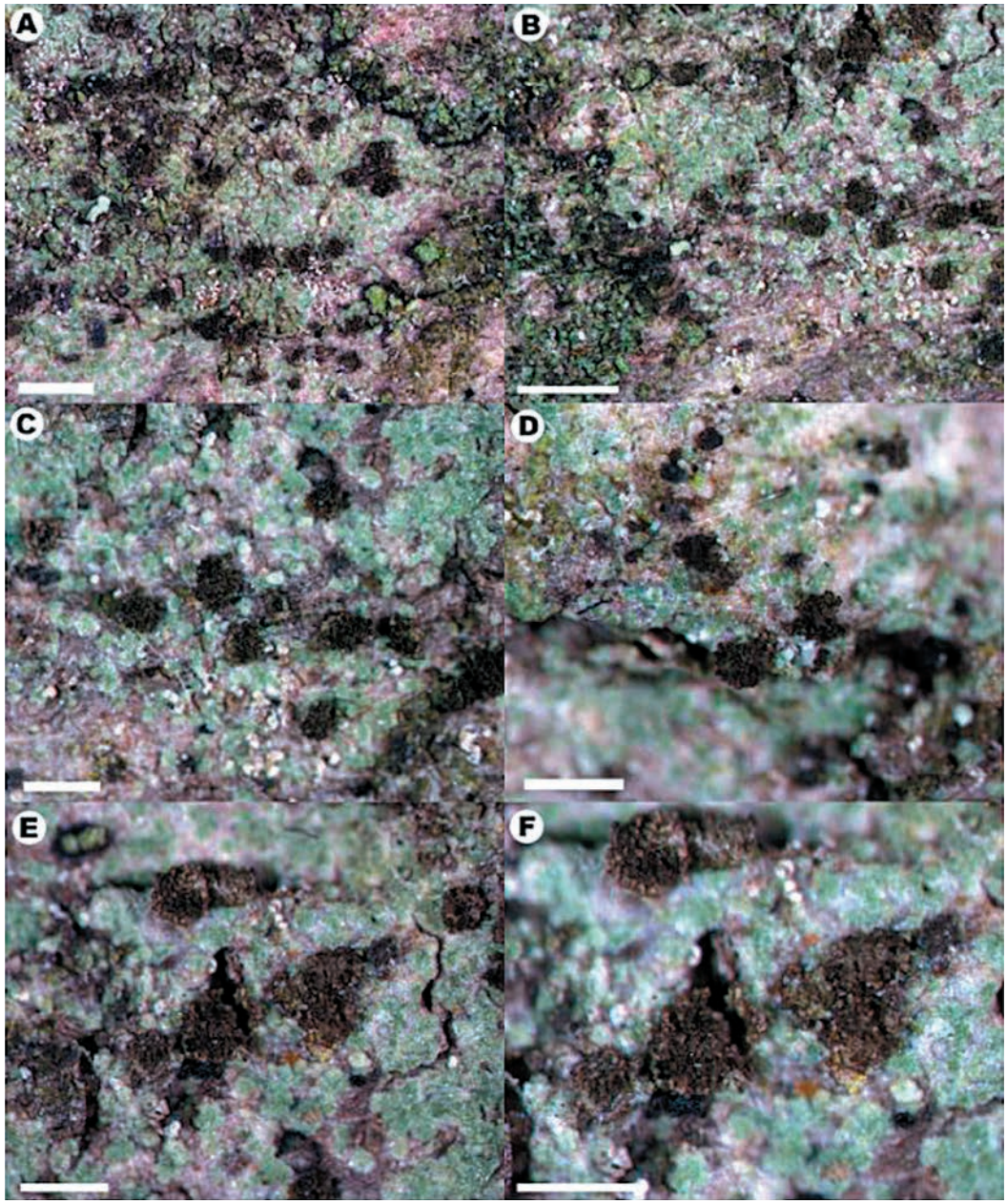

Figure 1. Morphology of thallus and asexual propagules in *Catillaria fungoides* (all from *Lendemer 58041*, NY). **A.** & **B.** Gross morphology of the thallus illustrating thin, flattened, areolate thallus and dispersed, somewhat punctiform soralia. **C.** Detail of dispersed areoles at edge of thallus. **D.** Young soralia with very dark soredia. **E.** & **F.** Detail of soralia varying from circular to irregular in outline. Scales=1.0 mm in A. & B., 0.5 mm in C.–F.

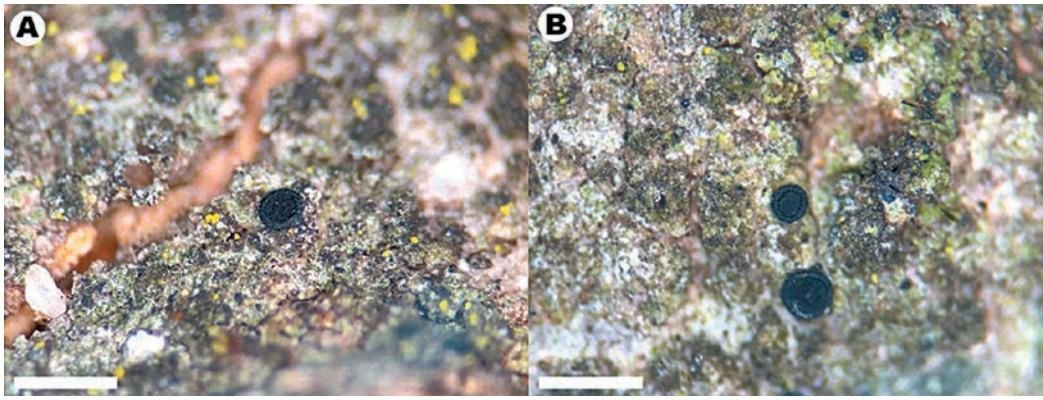

Figure 2. Fertile thalli of *Catillaria fungoides* illustrating dark blackish biatorine apothecia, thin continuous thallus and diffuse soralia with dark soredia (from *T.J. Curtis s.n.*, KE L5464). Scales=0.5 mm.

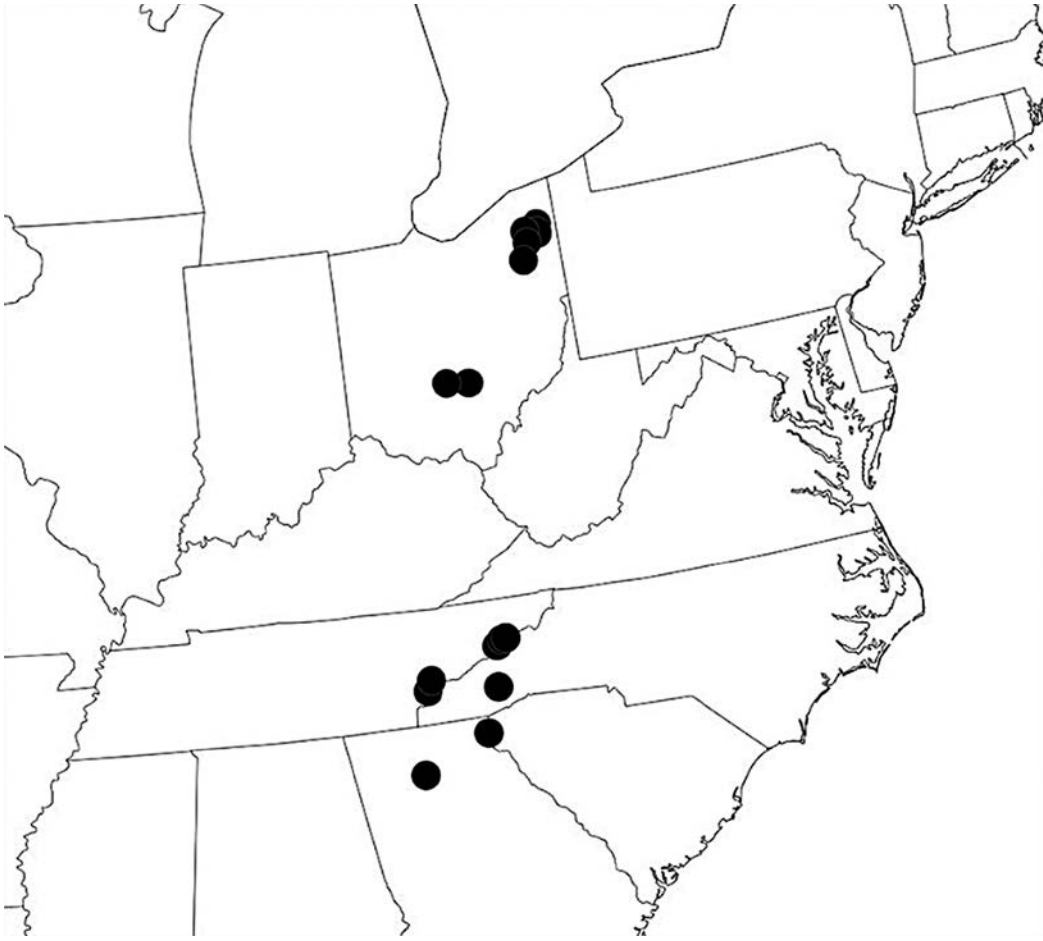

Figure 3. Geographic distribution of *Catillaria fungoides* in North America based on specimens examined for this study.

its orange apothecia that are K+ purple due to the presence of anthraquinones (Søchting 1994). In some respects *C. fungoides* resembles *Pseudothelomma ocellatum* (Flot. ex Körb.) M. Prieto & Wedin, which also has dark pigmented soralia and lacks lichen substances. However, that species typically occurs on wood, rather than living bark, has a well-developed white thallus, and has an allopatric distribution in western North America (Lendemer 2013).

Specimens examined

U.S.A. **GEORGIA: Fannin Co.:** Chattahoochee National Forest, S slopes of Green Mountain just E of Deep Gap and Aska Rd., 12 Jan. 2019, on *Acer saccharum*, *J.C. Lendemer 58041 & E. Tripp* (NY). **NORTH CAROLINA: Haywood Co.:** Pisgah National Forest, Balsam Mountains, Shining Rock Wilderness, Shining Rock Ledge, E slopes of Stairs Mountain summit, 24 Oct. 2019, on *Rhododendron catawbiense*, *J.C. Lendemer 62718 & A. Chandler* (NY, fertile). Madison Co., Pisgah National Forest, Bald Mountains, E-slopes of Spring Mountain, E of Appalachian Trial ~0.25 mi N of shelter, 17 Aug. 2020, on fallen branch, *J.C. Lendemer 69113* (NY); Pisgah National Forest, Bald Mountains, S-slopes of Spring Mountain, E of Appalachian Trial just S of Golden Ridge, 17 Aug. 2020, on *Liriodendron*, *J.C. Lendemer 69203* (NY); Pisgah National Forest, Bald Mountains, Baxter Cliff, ~0.3 mi S of Huckleberry Gap, 12 Aug. 2020, on *Ilex montana*, *J.C. Lendemer 68673* (NY); Pisgah National Forest, Bald Mountains, Green Ridge of Coldspring Mountain, N-slopes of Green Ridge Knob, 7 Aug. 2020, on *Amelanchier*, *J.C. Lendemer et al. 68367* (NY). **OHIO: Ashtabula Co.:** Hartsgrove Twp., Troyer property, approx. 1/3 mi NE of the Johnson Rd./Windsor-Mechanicsville Rd. jct., 27 Nov. 2019, on young *Acer rubrum*, *T.J. Curtis s.n.* (KE L4589); Morgan Twp., Cleveland Museum of Natural History – Schweitzer Tract of the Grand River Terraces, approx. 2 mi E of the Fobes Rd./Windsor-Mechanicsville Rd. jct., 12 Mar. 2020, on fallen *Populus grandidentata*, *T.J. Curtis s.n.* (KE L5295); Orwell Twp., Scali property, approx. 1.1 mi SW of the OH-45/Johnson Rd. jct., 27 Nov. 2019, on *Populus grandidentata*, *T.J. Curtis s.n.* (KE L4511); Rome Twp., Green property, approx. 4/3 mi SW of the US-6/OH-45 jct., 10 Dec. 2020, on *Acer rubrum*, *T.J. Curtis sn.* (KE L6071). Fairfield Co., Appalachia Ohio Alliance, approx. 4 mi S of Lancaster, 23 Nov. 2020, on *Juglans nigra* branches, *T.J. Curtis s.n.* (KE L5974). Geauga Co., Hambden Twp., Kitteridge property, approx. 0.6 mi ESE of the Bascom Rd./Rock Creek Rd. jct., 16 Nov. 2019, on *Tilia americana*, *T.J. Curtis s.n.* (KE L4330); LaDue Public Hunting Area, approx. 1.9 mi SSW of the Burton-Windsor Rd./OH-608 jct., 8 May 2019, on *Acer rubrum*, *T.J. Curtis s.n.* (KE L4140). Pickaway Co., Jahn property, approx. 6 mi N of Circleville, 5 Dec. 2020, on fallen *Populus deltoides* branches, *T.J. Curtis s.n.* (KE L6029). Portage Co., Shalersville Twp., Morgan Park, approx. 4/5 mi SE of the OH-44/Richfield Hudson Rd. jct., 28 Apr. 2020, on fallen *Populus grandidentata*, *T.J. Curtis s.n.* (KE L5464). **SOUTH CAROLINA: Oconee Co.:** Sumter National Forest, S-facing slopes of Poor Mountain, N of FSR7441 ~0.8 mi E of jct w/ FSR744/Rich Mountain Rd. 16 Apr. 2019, on *Acer saccharum*, *J.C. Lendemer 58623* (NY). **TENNESSEE: Monroe Co.:** Cherokee National Forest, Unicoi Mountains, Salt Spring Mountain, S-facing slopes above FS2659/Cold Spring Rd. 2 mi SW of Farr Gap, 1 Apr. 2020, on fallen *Acer saccharum*, *J.C. Lendemer 64628* (NY). Sevier Co., Great Smoky Mountains National Park, E-slopes of Chilhowee Mountain, above Foothills Parkway, 1.4 mi N of Cockspur Lead, 7 Apr. 2020, on *Acer saccharum, J.C. Lendemer 64849* (NY).

ACKNOWLEDGMENTS

The following organizations provided access, permitting and financial support to the first author for inventories leading to the discovery of new *Catillaria fungoides* populations: Portage Park District, Western Reserve Land Conservancy, Appalachia Ohio Alliance. This work was supported in part by NSF Dimensions Award #1542639 to the second author. The following organizations provided permission to the second author for inventory work that yielded collections of the species reported here: Cherokee National Forest, Chattahoochee National Forest, Great Smoky Mountains National Park, Pisgah National Forest, Sumter National Forest.

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