

Catillaria fungoides (Catillariaceae; Lecanoromycetes) an inconspicuous crustose lichen
previously overlooked in eastern North America

Tomas Curtis¹ & James C. Lendemer²

¹The Tom S. and Miwako K. Cooperrider Herbarium, Department of Biological Sciences, Kent
State University, Kent, OH 44242-0001, U.S.A.

- tcurtil2@kent.edu

²Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126,
U.S.A. - e-mail: jlendemer@nybg.org

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 color illustrations of the morphology are provided. The species is likely widespread, but overlooked due to its inconspicuous appearance.

Key words. - corticolous, eastern North America, lichenized fungi, new record, sorediate crustose lichen

Introduction

In comparison to larger, more conspicuous macrolichens, crustose microlichens have generally been understudied 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 major data gaps for crustose lichens that have hindered understanding of diversity, distributions and conservation are beginning to be overcome (Allen et al. 2019, Tripp & Lendemer 2019a). 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 & 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., Anderson Stewart et al. 2018, Lendemer 2020, Lendemer et al. 2019, Muscavitch et al. 2017).

Recently, we discovered material of an unusual sorediate crustose lichen during fieldwork in eastern North America. This species was not only inconspicuous and well camouflaged, 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 & 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 & 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). 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 a Olympus SZ-STB dissecting microscope and mounted sections were examined with a 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**, Lichenologist 33(2): 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.]).

Figures 1 and 2.

Description. - Thallus thin, pale, greenish-gray, shiny, film-like, continuous to dispersed-areolate, sorediate; prothallus absent an indistinct, stain-like white filmt; soralia punctiform and aggregated, or scattered and 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, typically absent, biatorine, sessile, discoid, up to 0.4 mm in diameter, disc brown to black, epruinose, margins thin, concolorous with the disc; exciple relatively thin, tapering from base, up to 35 µm thick at base, with a brow-pigmented outer margin formed from the pigmented caps of hyphal cells; hypothecium hyaline to lightly brown pigmented, pigment often more prevalent in upper portions, not interspersed with oil droplets or crystals, 55-100 µm tall; hymenium hyaline, not interspersed 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) x (6.3)-7.9-(11.3) µm; ascospores hyaline, 1-septate, ellipsoid to nearly bacilliform, smooth, (6.3)-7.6-(8.8) x (2.3)-2.7-(3.3) µm; paraphyses filamentous, 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 (Fačkovcová et al. 2014, Kukwa et al. 2017, Malíček et al. 2014, van den Boom 2015, van den Boom et al. 2007) and the British Isles (Hitch 2015) but so far appears to be unknown from other regions with the exception of the Azores (van den Boom 2015). In North America, the known distribution of *Catillaria fungoides* is based on ecologically distant collections from the Erie Drift Plane and the southern Appalachian Mountains

(Fig. 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 relatively young hardwoods (young *Acer rubrum*, *Populus grandidentata*, and *Tilia americana*) and 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 of 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 atmospheric moisture is more prevalent, were collected in mesic forests.

Discussion. - When both of us independently first encountered this species, we initially assumed it to be a non-lichenized sporodochial fungus that was growing intermixed sterile and poorly developed thalli of crustose lichens (see Figs. 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 (Fig. 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 located fertile specimens (Fig. 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 with the species on the smooth bark of hardwoods in eastern North America (Lendemer & Noell 2018, Lendemer et al. 2016, Tripp & Lendemer 2020). 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* in the literature.

Our specimens agree well with both the original description, and the material illustrated subsequently by Malíček et al. (2014). *Catillaria fungoides* can easily be recognized by its dark pigmented soralia and thallus that is pale, greenish-gray, thin, and shiny or film-like (Fig. 1). In the regions where we have found *C. fungoides* to date, there are not any morphologically similar sorediate crustose lichens that it is likely to be confused with. 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 and produces lichen substances that can be detected with spot tests (typically atranorin and norstictic acid, though norstictic acid deficient populations are known; Allen & 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* Söchting, as that species produces tiny dark soredia, has an almost imperceptible thallus, and grows on smooth bark of hardwoods (Söchting 1994, Wetmore 2004). That species differs from *C. fungoides* in having blue-gray, rather than brown-black soredia, and the thallus contains Thalloidima-green, 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 its orange apothecia that are K⁺ purple due to the presence of anthraquinones (Söchting 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, and has a well-developed white thallus (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 Trail ~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 Trail 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). xxxx **OHIO. ASHTABULA CO.**: Hartsgrove Twp., Troyer property, approx 1/3 mi NE of the Johnson Rd/Windsor-Mechanicsville Rd; 41.580649, -80.909486, 27 November 2019, mature floodplain forest w/ mixed hardwoods (*Quercus*, *Nyssa*, *Acer*, *Carya*, *Ulmus*, *Prunus*, *Populus*, *Fraxinus*), w/ small, scattered scrub-shrub and emergent wetlands and a nearby oil road w/ surrounding successional woody species (*Frangula*, *Rhus*, *Populus*), on bark of a young maple (*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; 41.6968, -80.8671, 12 March 2020, in a flat, 2nd-growth swamp forest w/ mixed hardwoods (*Acer*, *Populus*, *Quercus*, *Ulmus*, *Nyssa*, *Carpinus*, *Malus*), on bark of a fallen aspen (*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; 41.567177, -80.883359, 27 November 2019, in a mature lowland forest w/ mixed hardwoods (*Populus*, *Quercus*, *Acer*, *Fraxinus*, *Ulmus*, *Carya*, *Carpinus*), w/ an influential stream and adjacent marsh and farmland, on bark of aspen (*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; 41.5919, -80.8832, 10 December 2020, bottomland swamp forest merging with floodplain forest, w/ mixed hardwoods (*Quercus*, *Fraxinus*, *Acer*, *Tilia*, *Nyssa*, *Betula*, *Carya*, *Ulmus*, *Fagus*, *Salix*, *Populus*, *Carpinus*), forest ranging from mature to seral, some scattered, planted conifers (*Pinus sylvestris*), on bark of red maple (*Acer rubrum*), T. J. Curtis s. n. (KE L6071). **FAIRFIELD CO.**: Appalachia Ohio Alliance, approx 4 mi S of Lancaster; 39.651, -82.5743, 23 November 2020, in a mature forest w/ sandstone bedrock outcroppings, w/ upland oak forest above and mixed mesophytic forest (some floodplain forest) below (*Acer*, *Quercus*, *Liriodendron*, *Betula*), on branches of walnut (*Juglans nigra*), 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; 41.622549, -81.109822, 16 November 2019, in a forested floodplain of Bates Creek w/ mature hardwoods (*Fagus*, *Quercus*, *Carpinus*, *Crataegus*, *Tilia*, *Liriodendron*, *Ulmus*, *Acer*, *Carya*, *Fraxinus*, *Ostrya*, *Betula*), creek bed consisting mostly of sand and granite/shale/sandstone cobble, on bark of basswood (*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; 41.466413, -81.104626, 8 May 2019, in a disturbed, 2nd-growth lowland forest w/ *Acer* and *Fraxinus* dominant, w/ scattered *Ulmus*, *Pinus* (planted), *Populus*, *Liriodendron*, and *Quercus*, w/ *Cornus* and *Frangula* in the understory, on bark of red maple (*Acer rubrum*), T. J. Curtis s. n. (KE L4140). **PICKAWAY**

CO.: Jahn property, approx 6 mi N of Circleville; 39.6917, -82.9742, 5 December 2020, mature floodplain forest (of Walnut Creek) w/ mixed hardwoods (*Populus*, *Acer*, *Celtis*, *Juglans*, *Salix*, *Platanus*, *Fraxinus*, *Ulmus*), w/ a disturbed understory dominated by invasive shrubs (*Lonicera*, *Ligustrum*, *Rosa*), w/ adjacent agriculture, old field, and other disturbances, on fallen branches of poplar (*Populus deltoides*), *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; 41.2304, -81.2211, 28 April 2020, at transition b/w a wet, disturbed forest w/ mixed hardwoods and a rich riparian swamp forest, on bark of a fallen aspen (*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).

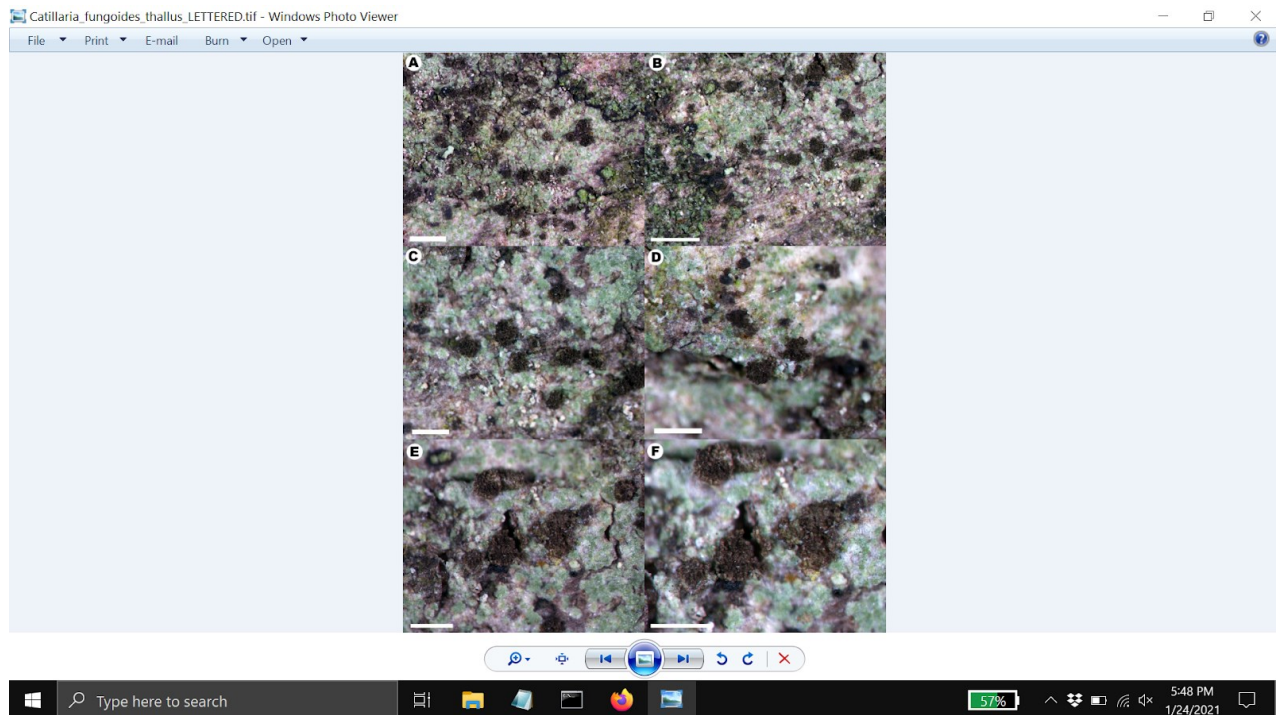
Acknowledgements

For the first author, the following organizations provided access, permitting and financial support 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.

Literature Cited

- Allen**, J. L./ J. C. Lendemer 2013: Uncovering chemical variability: Molecular data reveal the identity of a sterile crustose lichen from the Yukon and affirm an expanded circumscription for *Buellia griseovirens*. - *North American Fungi* **8(12)**: 1-14. [RLL List # 232 / Rec.# 34956]
- Allen**, J.L./ McMullin, R.T./ Tripp, E.A./ Lendemer, J.C. 2019: Lichen conservation in North America: A review of current practices and research in Canada and the United States. - *Biodiversity and Conservation* **28**: 3103–3138. [RLL List # 258 / Rec.# 41541]
- Anderson Stewart, C.R./ **Lendemer**, J.C./ Keepers, K.G./ Pogoda, C.S./ Kane, N.C./ McCain, C.M./ Tripp, E.A. 2018: *Lecanora markjohnstonii* (Lecanoraceae, lichenized Ascomycetes), a new sorediate crustose lichen from the southeastern United States. - *The Bryologist* **121(4)**: 498-512. [RLL List # 256 / Rec.# 40794]
- Brodo, I.M., S.D. Sharnoff and S. Sharnoff. 2001. *Lichens of North America*. Yale University Press, New Haven & London.
- Culberson**, CF/ Kristinsson, H 1970: A standardized method for the identification of lichen products. - *Jour. Chromatogr.* **46**: 85-93. [RLL List # 75 / Rec.# 3758]
- Fačkovcová, Z./ Palice, Z./ Vondrák, J./ Liška, J./ Guttová, A. 2014: The lichens of Cerová vrchovina Mts (southern Slovakia) [Lišajníky cerovej vrchoviny (južné Slovensko)]. - *Bryonora* **54**: 22–42. [RLL List # 245 / Rec.# 38557]

- Hodkinson, B. P./ J. C. **Lendemer** 2012: Phylogeny and taxonomy of an enigmatic sterile lichen. - *Systematic Botany* **37(4)**: 835-844. [RLL List # 228 / Rec.# 34064]
- Hitch**, C. 2015: New, rare and interesting lichens. - *British Lichen Society Bulletin* **117**: 61-72. [RLL List # 242 / Rec.# 37159]
- Kukwa, M./ Czarnota, P./ Lubek, A. 2017: Three lichen species in Buellia, Catillaria, and Cheiromycina, new to Poland. - *Mycotaxon* **132(1)**: 177-182. [RLL List # 249 / Rec.# 39375]
- Lendemer**, J.C. 2020: Leprocaulon beechingii (Leprocaulaceae), a new species from the southern Appalachian Mountains of eastern North America. - *The Bryologist* **123(1)**: 1-10. [RLL List # 260 / Rec.# 41944]
- Lendemer**, J. C. 2013: *Thelomma ocellatum*, a range extension to the Yukon Territory and case study in the use of molecular data to recognize asexually reproducing crustose lichens. - *North American Fungi* **8(13)**: 1-13. [RLL List # 233 / Rec.# 35066]
- Lendemer**, J. C. 2011: A review of the morphologically similar species Fuscidea pusilla and Ropalospora viridis in eastern North America. - *Opuscula Philolichenum* **9**: 11-20. [RLL List # 223 / Rec.# 32914]
- Lendemer, J.C./ **Noell**, N. 2018: Delmarva Lichens: An illustrated manual. - *Memoirs of the Torrey Botanical Society* **28**: 1-386. [RLL List # 256 / Rec.# 40771]
- Lendemer, J.C./ Buck, W.R./ Harris, R.C. 2016: Two new host-specific hepaticolous species of *Catinaria* (Ramalinaceae). - *The Lichenologist* **48(5)**: 441-449. [RLL List # 245 / Rec.# 38208]
- Lendemer**, J.C./ Hoffman, J.R./ Sheard, J.W. 2019: Rinodina brauniana (Physciaceae, Teloschistales), a new species with pseudoisidia from the southern Appalachian Mountains of eastern North America. - *The Bryologist* **122(1)**: 111-121. [RLL List # 257 / Rec.# 41113]
- Malíček, J./ Palice, Z./ Vondrák, J. 2014: New lichen records and rediscoveries from the Czech Republic and Slovakia [Neu- und wiederfunde von flechten aus der Tschechischen Republik und der Slowakei]. - *Herzogia* **27**: 257-284. [RLL List # 245 / Rec.# 38553]
- Muscavitch, Z.M./ **Lendemer**, J.C./ Harris, R.C. 2017: A review of the lichen genus Phlyctis in North America (Phlyctidaceae) including the description of a new widespread saxicolous species from eastern North America. - *The Bryologist* **120(4)**: 388-417. [RLL List # 250 / Rec.# 39601]
- Søchting, U 1994: Caloplaca ahtii Søchting spec. nova and other Caloplaca species with greenish-bluish soredia from the northern hemisphere. - *Acta Botanica Fennica* **150**: 173-178. [RLL List # 156 / Rec.# 17663]
- Tibell, L. 1998. Crustose mazaediate lichens and the Mycocaliciaceae in temperate-South America
- Tripp**, E.A./ Lendemer, J.C. 2019a: Highlights from 10+ years of lichenological research in Great Smoky Mountains National Park: Celebrating the United States National Park Service Centennial. - *Systematic Botany* **44(4)**: 943-980. [RLL List # 259 / Rec.# 41655]
- Tripp, E.A./ **Lendemer**, J.C. 2019b: *Field Guide to the Lichens of Great Smoky Mountains National Park*. - University of Tennessee Press, Knoxville. 569 pp. [RLL List # 261 / Rec.# 42051]
- van den Boom, P.P.G. 2015: *Contribution to the flora of Portugal*: Lichens and lichenicolous fungi 5. - *Österreichische Zeitschrift für Pilzkunde* **15**: 11-19.
- van den Boom, PPG/ Etayo, J 2001: Two new sorediate species of lichens in the Catillariaceae from the Iberian Peninsula. - *Lichenologist* **33(2)**: 103-110. [RLL List # 183 / Rec.# 22057]
- van den Boom, P./ van den Boom, B./ Yazıcı, K. 2007: *Catillaria fungoides* found in Cape Verde, The Netherlands and Turkey, with notes on accompanying species. - *Österreichische Zeitschrift für Pilzkunde* **16**: 1-3. [RLL List # 261 / Rec.# 42048]
- Wetmore**, CM 2004: The sorediate corticolous species of Caloplaca in North and Central America. - *The Bryologist* **107(4)**: 505-520. [RLL List # 198 / Rec.# 26663]



[screenshot inserted; not actual figure file] 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 soresidia. 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.

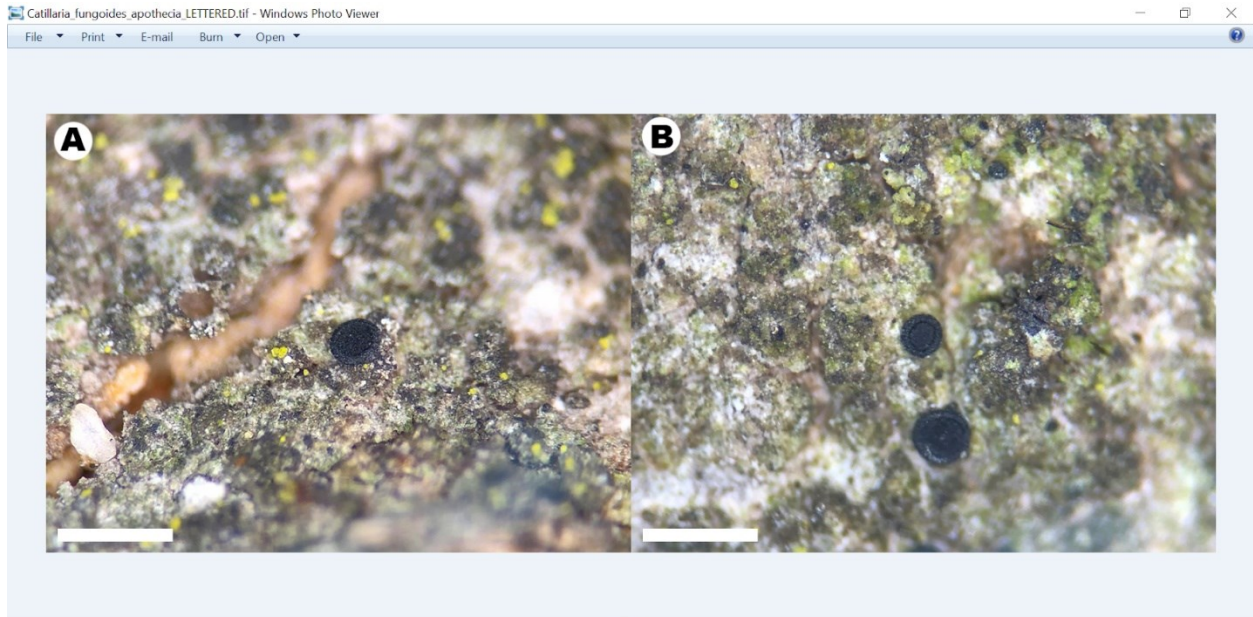


Figure 2. Fertile thalli of *Catillaria fungoides* illustrating dark blackish biatorine apothecia, thin continuous thallus and diffuse soralia with dark soredia (from T. J. Curtis s. n., KE L5464). Scales = 0.5 mm.

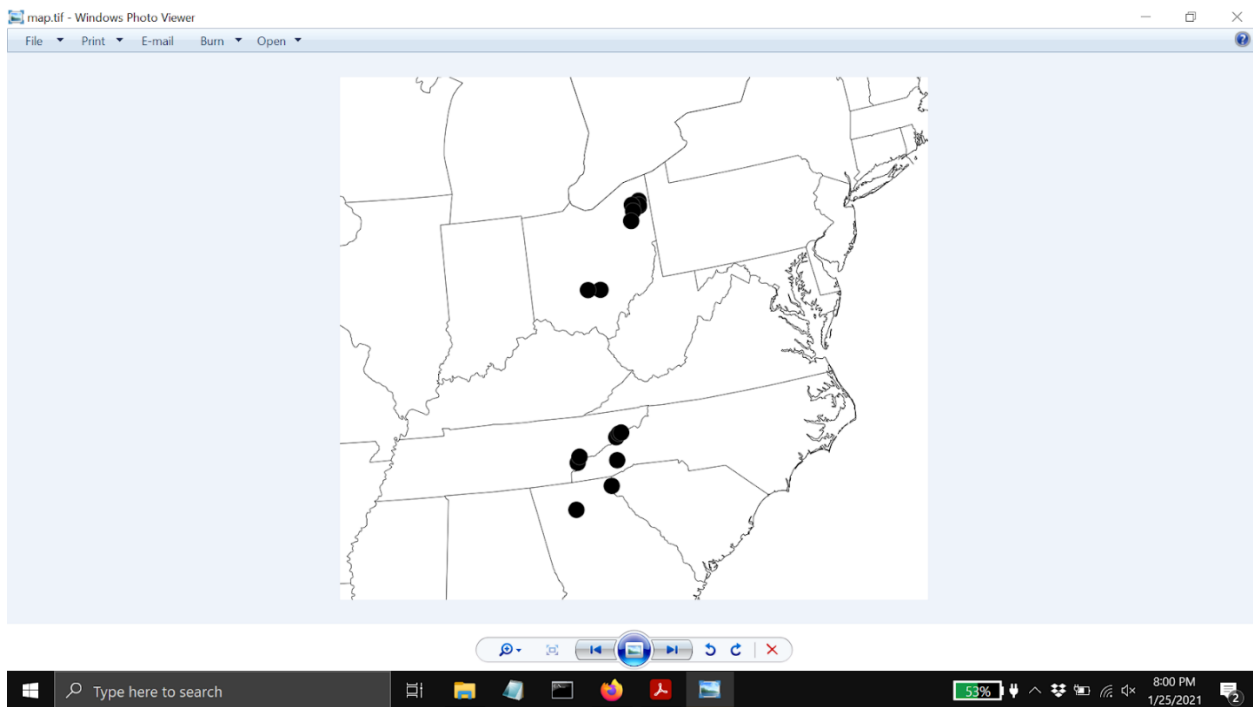


Figure 3. Geographic distribution of *Catillaria fungoides* in North America based on specimens examined for this study.