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Lepraria friabilis, a New Species from Eastern North America

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ABSTRACT. – *Lepraria friabilis* is described as new to science based on scattered collections from the coastal plain of southeastern North America and disjunct populations from western North America (California).

INTRODUCTION

While collecting in the southern United States in recent years the first author has occasionally encountered a *Lepraria* taxon morphologically similar to *Lepraria caesiella* R.C. Harris but differing most markedly in chemistry. While surveying sites with high relative humidity in montane forests in the coastal peninsular ranges of southern California, the second author also discovered two small populations of the same taxon. As part of the continuing taxonomic studies of North American *Lepraria* (Knudsen et al. 2006, 2007; Knudsen & Elix 2007, Lendemer 2005, Lendemer & Harris 2007, Tønsberg 2007) we describe this new species as *L. friabilis*.

METHODS

The methods used in this study follow those of Lendemer & Harris (2007). The chemistry of specimens has been studied with thin layer chromatography (TLC) using solvents C and G following the standardized methods of Culberson & Kristisson (1970). Additionally representative specimens of each chemotype have been studied by the third author with HPLC. Specimens have been examined using standard light microscopy and measurements were obtained from hand cut sections of the thallus mounted in water. Illustrations were prepared using a Nikon CoolPix 950 digital camera with the aid Adobe Photoshop CS2.

Several collections were also examined using a Scanning Electron Microscope (SEM). Samples were removed from herbarium specimens with a razor and not subjected to fixation, rinsing, or dehydration. They were mounted on stainless steel stubs using conductive carbon adhesive tabs and sputter coated for 2 minutes at 10 mA, which resulted in a coating of ~20nm of gold. Following coating with gold the samples were examined with a scanning electron microscope (Hitachi S-2700) with a tungsten filament operating with an accelerating voltage of 20kV. Digital images were captured using Quartz PCI Image Management System and Adobe Photoshop 4.0 was used to improve contrast.

As our descriptions of *Lepraria* species (Knudsen et al. 2007, Lendemer & Harris 2007) differ somewhat from those produced by other authors we feel some discussion is warranted here.

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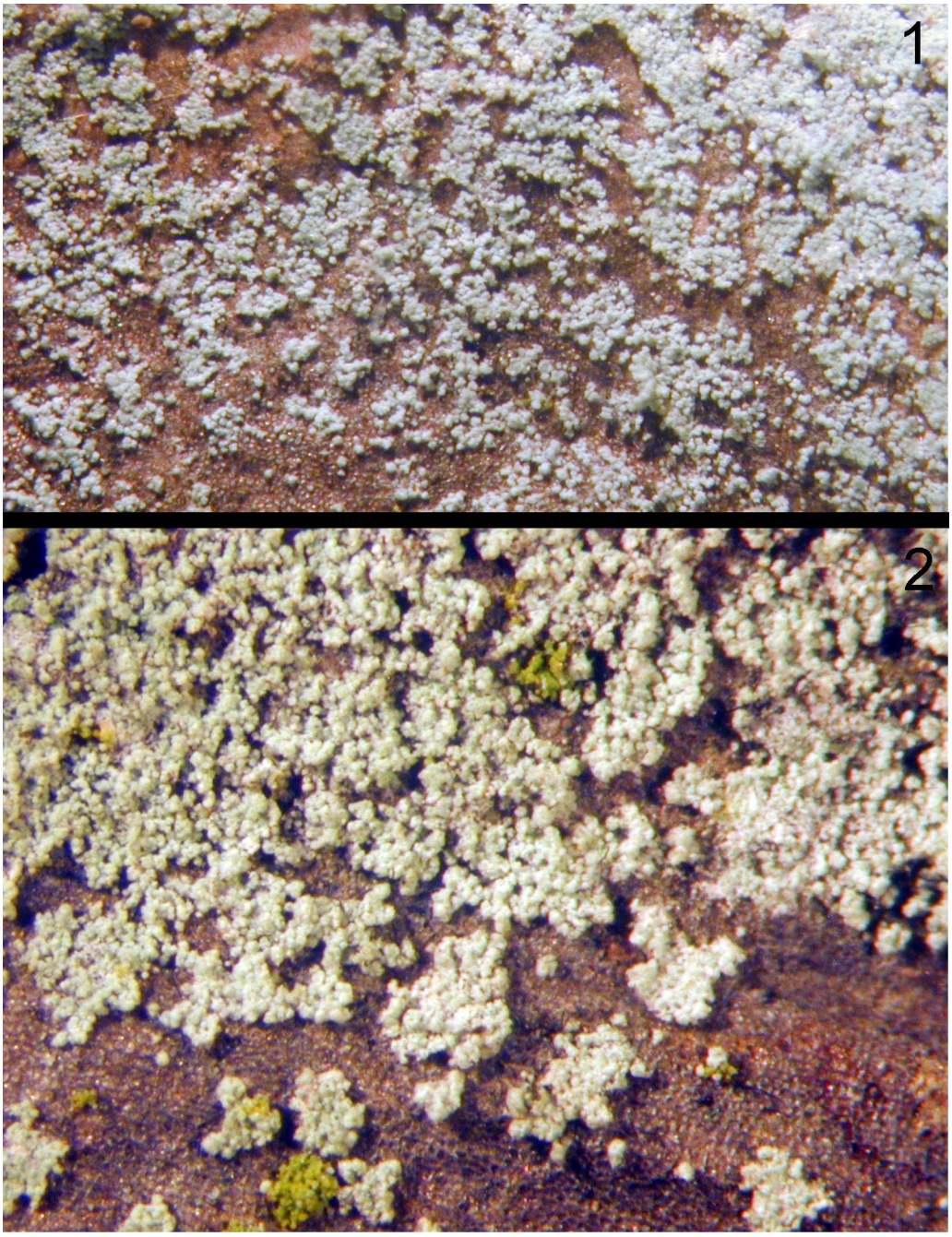

Plate 1. Figures 1-2, thallus of *Lepraria friabilis* (*Lendemer 9063*, NY), magnification 8x and 12x respectively.

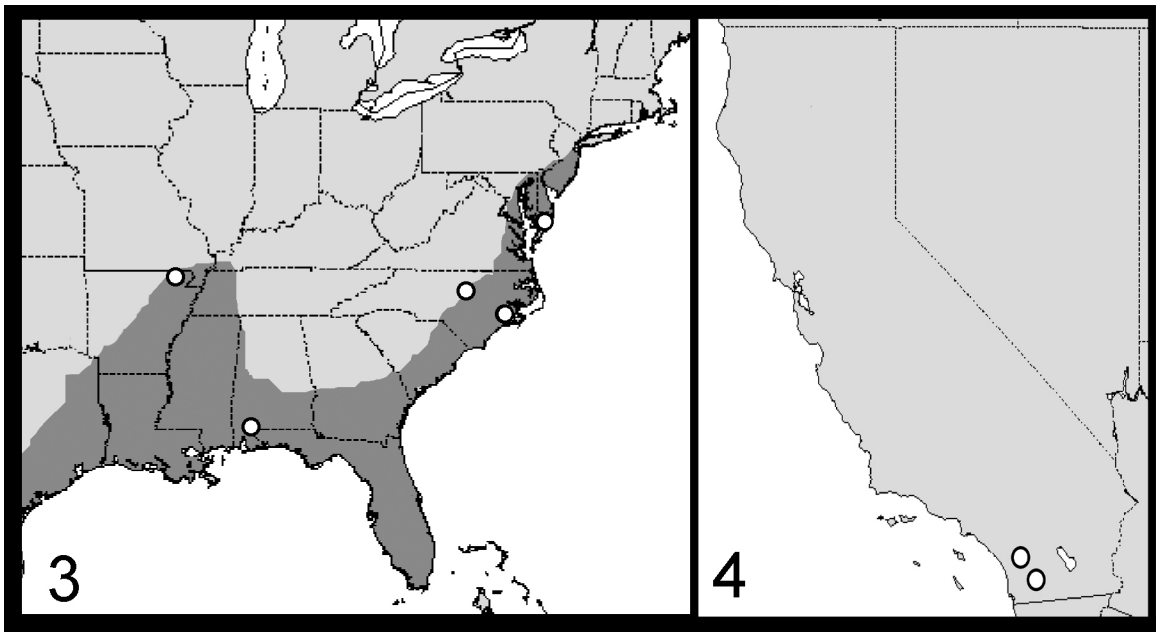

Plate 2. Figure 3, geographic distribution of *Lepraria friabilis* in eastern North America, shaded portion represents rough approximation of the coastal plain. **Figure 4**, geographic distribution of *L. fraibilis* in western North America.

Recently, it has been common practice in the description of *Lepraria* species to refer to individual lichenized thalline units as "soredia" and aggregations of these units as "consoredia" (see Tønsberg 1992). We feel that this terminology is misleading. Kirk et al. (2001)[4] describe a "soredium" in such a manner that it may apply to the thalline units found in the genus *Lepraria*. However, the illustrations (Kirk et al. 2001, fig. 25, j-l) accompanying their description show structures arising from the breakdown of the thallus and contained in structures universally referred to as "soralia". Since the vegetative units in *Lepraria* form the actual thallus rather than arise from a breakdown of distinct stratified layers (e.g. cortex or medulla) it seems best to restrict the term "soredia" to the structures formed in the latter manner. We prefer to refer to the primary lichenized thalline units of *Lepraria*, and other lichen species with leprose thalli, as "granules". In fact, it should be noted that the first major modern study of *Lepraria* (Laundon 1992) referred to the thalline units of *Lepraria* as granules rather than soredia. Similarly, the use of the term "soredia" has not been universal (e.g. Sipman 2004).

As used here, granules are structures that have distinct hyphal walls encasing a lichenized alga. These hyphal walls can be considered ecorticate where the layer consists of gelatinized hyphae or corticate where distinct prosoplectenchyma or paraplectenchyma can be distinguished in one or more layers. But it is probably best to jettison the use of the terms corticate and ecorticate in *Lepraria* because gelatinized layers may be derived from either hyphal form and the forms may represent stages in the development of the granules.

All granules, as well as hyphae, in the leprose thallus of *Lepraria*, through division or fragmentation, can act as propagating units.

The hyphae found in *Lepraria friabilis,* and other *Lepraria* species, present another problem in describing the morphology of *Lepraria* thalli. They are the non-lichenized component of the thallus, and could be referred to as a mycelium. In mature thalli they either form the matrix in which the lichenized granules are situated and/or they originate from the surface of the granules and lace throughout the thallus. They can act as rhizohyphae or anchors attaching the thallus to the substrate and/or binding the thallus together. They may also be adventitious, lichenizing new alga. Fragments probably act as propagules, and

[4] "a non-corticate combination of phyciobiont cells and fungal hyphae having the appearance of a powdery granule, and capable of reproducing a lichen vegetatively"

possibly could be found non-lichenized on a suitable substrate. We have not definitively seen the hyphae in these species anastomosing but it could be expected to occur. These non-lichenized hyphae form a distinct lower layer beneath a necral layer of gelatinized granules in *L. friabilis* and in this paper we refer to this layer as the "hypothallus"

The term "projecting hyphae" has been used for long thick hyphae originating from the granules that are easily seen at lower magnifications. This term is imprecise because all *Lepraria* species we have studied have hyphae attached to the surface of at least some granules, whether easily visible at low magnifications (dissecting microscope) or at higher magnifications (compound microscope, SEM). These hyphae do not differ in size or structure from those discussed in the previous paragraph. Since "projecting hyphae" are present in all species studied, and do not differ significantly in form or function from the rest of the hyphae comprising the thallus, we do not use the term here.

Generally it can be said that the hyphae of a *Lepraria* thallus are of the same type whether adventitious, or forming rhizohyphae or anchors, or a hypothallus, or arising from the granules to bind the thallus together.

Taxonomic Section

***Lepraria friabilis* Lendemer, K. Knudsen & Elix, sp. nov.**

Mycobank #511603.

Ab *Lepraria caesiella* acido fumarprotocetrarico continens et acido atranorico et zeorinicum nullo differt.

TYPE: U.S.A. Alabama. Baldwin Co.: Splinter Hill Bog Preserve, south of CR 47, 0.9 miles west-northwest of Dyas Creek, 1.3 miles west-northwest of I-65, Perdido Quad., elev. 250 ft., *Sarracenia* bog with adjacent hardwood swamp and bottomlands along stream, on *Pinus*, 12.iv.2007, *J.C. Lendemer et al. 9063* (ny, holotype; b, canb, ucr, udga, hb. lendemer, isotypes)

Description. – Thallus corticolous, crustose, leprose, without lobes, diffuse, patchy to convergent and continuous, with granules sparsely distributed at first, eventually overlapping and accumulating, very thin (usually less than 0.5 mm thick), greenish to blue-white in color; hypothallus a thin network of hyphae underneath the granules and extending outward from edge of the thallus; granules (10-)20-30 µm in diameter, ecorticate, round, readily dividing, with usually one layer of gelatinized hyaline hyphae surrounding an algal core; hyphae 2-4 µm wide, hyaline, thin walled, obscurely septate, anchoring the granules to each other and to the substrate; photobiont green, coccoid, globose, 7-10 µm in diameter.

Etymology. – The epithet "friabilis" refers to the fragile, almost friable, appearance of the thallus, especially when it occurs as small dispersed heaps of granules.

Chemistry. – CHEMOTYPE I: fumarprotocetraric acid (major), protocetraric acid (minor), succinprotocetraric acid (minor), confumarprotocetraric acid (minor); spot tests: K-, C-, KC-, PD+ orange/red. CHEMOTYPE II: fumarprotocetraric acid (only substance detected); spot tests as in chemotype I.

Distribution. – *Lepraria friabilis* is known only from the coastal plain and piedmont of the southeastern USA, with disjunction populations in the peninsular ranges of southern California (Palomar Mountains and Cuyamaca Mountains), USA.

Ecology. – *Lepraria friabilis* is ecologically distinctive in occurring on the bark of conifers (*Pinus, Pseudotsuga, Taxodium*) in humid habitats (swamps, stream valleys, high elevation north slopes). It has not yet been found on the bark of hardwoods or on rocks which occur in similar habitats.

Discussion. – Among North American species of *Lepraria*, *L. friabilis* is most likely to be confused with *L. caesiella* R.C. Harris (which is not known western North America), but the granules in *L. caesiella* tend to be larger (30-50 µm) and readily accrete into larger masses that may be hard to delimit, accumulating to form a thicker contoured thallus. The hyphae comprising the hypothallus of *L. friabilis* appear more abundant and thinner (usually 2-4 µm) than those of *L. caesiella* (usually 4-5 µm) and this species is more common on rough, older bark rather than smooth bark. The two species are readily distinguished by chemistry as *L. friabilis* contains fumarprotocetraric acid rather than atranorin, zeorin.

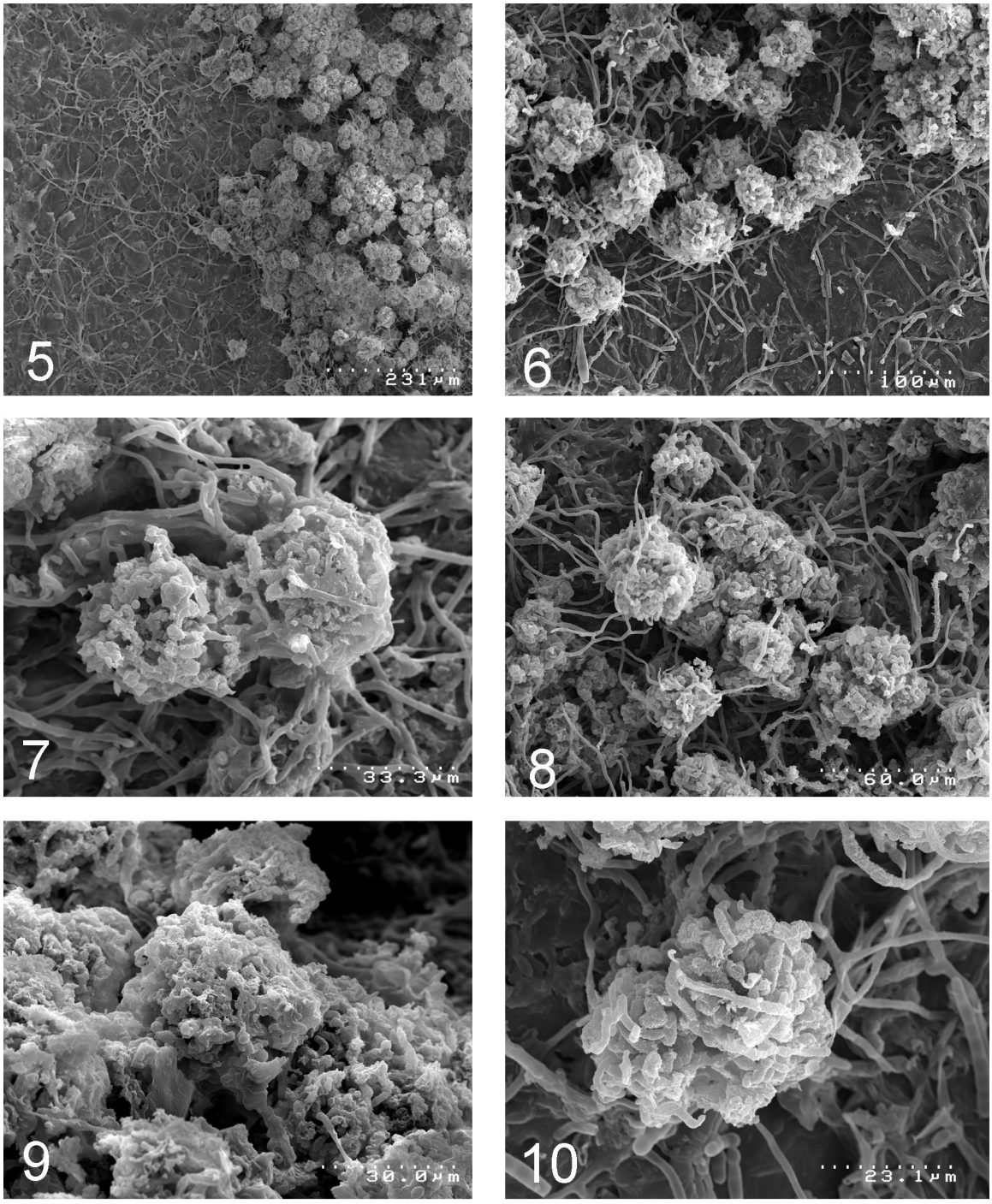

Plate 3. Scanning electron micrographs of thallus and thallus development of *Lepraria friabilis*. **Figure 5**, thallus margin with extensive network of non-lichenized adventitious hyphae extending outward onto the surrounding substrate (*Lendemer 8308*, NY). **Figure 6**, detail of thallus edge and hypothallus (*Lendemer 8308*, NY). **Figure 7**, granules in early stages of development with hyphae anchoring the granules to the substrate and connecting them to the hypothallus (*Lendemer 9603*, NY). **Figure 8**, aggregation of granules, several with abundant attachment hyphae (*Lendemer 8308*, NY). **Figure 9**, fully gelatinized granules in central portion of thallus (*Lendemer 9063*, NY). **Figure 10**, granule in early stage of development with attachement hyphae (*Lendemer 8303*, NY). Scale bars as indicated.

The crystals coating the hyphae of *L. frabilis* are smaller and more concentrated than those of *L. caesiella* and represent fumarprotocetraric acid (dissolving in P, and P+ orange-red) whereas the crystals found in thallus of *L. caesiella* represent atranorin (dissolving in K, and K+ yellow). These crystals should not be confused with the calcium oxalate crystals found in other *Lepraria* species (e.g. *L. normandinoides* Lendemer & R.C. Harris) which are also POL+ but do not dissolve in KOH (Lendemer & Harris 2007).

While *L. friabilis* and *L. caesiella* are ecologically similar in being corticolous, the substrate range of *L. friabilis* appears to be much more restricted (conifers) when compared to *L. caesiella* (bark of conifers and hardwoods as well as acidic rock). In eastern North America *L. friabilis* is also phytogeographically distinct from *L. caesiella* in having a Coastal Plain-Piedmont distribution rather than an Appalachian-Great Lakes distribution (sensu Brodo et al. 2001). It should be noted that the geographic distribution of *L. friabilis* in eastern North America is similar to that of other species belonging to the "southern" element of the Coastal Plain (*cf.* Lendemer 2006, Lendemer & Knapp 2007).

The disjunct populations of *L. friabilis* in southern California in western North America were not as well developed as the eastern populations which have higher relative annual humidity and they only contained fumarprotocetraric acid, but otherwise were morphologically identical. The current geographic distribution of *L. friabilis* likely represents the collecting bias of the first two authors (JCL and KK). Further field work in the southeastern Coastal Plain and Piedmont, as well as southern California, will almost certainly reveal additional populations of this species.

ADDITIONAL SPECIMENS EXAMINED. – ***CHEMOTYPE I:*** U.S.A. ARKANSAS. CLAY CO.: Black River State Wildlife Area, at boat launch along north side of Black River, ca. 3.2 miles southeast of Reyno, 13.viii.1997, *D. Ladd 20905 & B. Heumann* (NY). MARYLAND. WORCESTER CO.: Pocomoke State Forest, along Corber Branch, 19.iv.2006, *J.C. Lendemer et al. 6415* (NY). NORTH CAROLINA. CRAVEN CO.: Croatan National Forest, north of Havelock, west of SR#70, west of Flanners Beach Campground, 13.xii.2004, *J.C. Lendemer 4217 & E. Tripp* (NY, UCR). WAKE CO.: William B. Umstead State Park, vicinity of lower Sycamore Lake, ~1 mi SW of Ebenezer Church, 14.i.2007, *J.C. Lendemer et al. 8398* (NY, UCR). ***CHEMOTYPE II:*** U.S.A. CALIFORNIA. SAN DIEGO CO.: Palomar Mountain, Palomar State Park, steep N-facing slope, 20.iv.2005, *K. Knudsen 2719 & L. Glacy* (CANB, NY, SDNHM, UCR); Cuyamaca Mountains, Cuyamaca State Park, near Stonewall Mine along Minshall Trail, in sight of lake, 12.x.2007, *K. Knudsen 9205* (B, CANB, FH, H, NY, SBBG, PRM, SDNHM, UCR).

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