BioOne RESEARCH EVOLVED

Sarcogyne mitziae (Acarosporaceae), a new species from biotic soil crusts in western North America

Author(s): Kerry Knudsen , Jana Kocourková and Bruce McCune
Source: The Bryologist, 116(2):122-126. 2013.
Published By: The American Bryological and Lichenological Society, Inc.
DOI: http://dx.doi.org/10.1639/0007-2745-116.2.122
URL: http://www.bioone.org/doi/full/10.1639/0007-2745-116.2.122

BioOne (www.bioone.org) is a nonprofit, online aggregation of core research in the biological, ecological, and environmental sciences. BioOne provides a sustainable online platform for over 170 journals and books published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Web site, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/page/terms_of_use.

Usage of BioOne content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Sarcogyne mitziae (Acarosporaceae), a new species from biotic soil crusts in western North America

Kerry Knudsen[1,2], Jana Kocourková[3] and Bruce McCune[4]

[2] *Herbarium, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521–0124, U.S.A.;* [3] *Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Prague, Kamýcká 129, Praha 6 - Suchdol, CZ–165 21, Czech Republic;* [4] *Department of Botany and Plant Pathology, Oregon State University, 2082 Cordley Hall, Corvallis, OR 97333, U.S.A.*

Abstract. A new species with a corticated brown thallus, *Sarcogyne mitziae,* is described from biotic soil crusts in California, Idaho, and Washington. The species is considered rare and occurs in habitat that is threatened by anthropogenic factors such as development, grazing, and fire, throughout western North America. Seventeen species of *Sarcogyne* are currently recognized for North America.

Keywords. Conservation, Joshua Tree National Park, taxonomy, terricolous lichens.

◆ ◆ ◆

Biotic or biological soil crusts are communities of phylogenetically and functionally diverse organisms including archaea, bacteria, cyanobacteria, microfungi, and green algae, as well as lichens and bryophytes (Belnap & Lange 2001; Soule et al. 2009). In three recent studies a total of 148 lichen species were reported from biotic soil crusts in coastal southern California, Oregon, and Washington (Hernandez & Knudsen 2012; Root et al. 2011; Root & McCune 2012). Many species had a scattered pattern of distribution in biotic soil crusts and new discoveries were expected (Root et al. 2011). Many species were rare, either naturally or through loss of biotic soil crust habitat (Knudsen 2010). In this paper we describe one of these discoveries from biotic soil crusts in western North America, a new species of terricolous *Sarcogyne, S. mitziae,* which has a scattered pattern of distribution and is rare.

The genus *Sarcogyne* Flot. is characterized by polyspory, simple, hyaline spores, lecideine apothecia, and bitunicate but non-fissitunicate asci with a non-amyloid tholus (Knudsen & Standley 2007; Magnusson 1935a,b). The exciple is formed of pigmented or melanized hyphae, which may even be carbonized, but the apothecia lack the intricate epihymenial accretions of those species currently included in *Polysporina* Vězda. *Sarcogyne* species predominately occur on rocks, both calcareous and non-calcareous. The type of the genus is *S. corrugata* Flot. (Jørgensen & Santesson 1993), a synonym of *Sarcogyne clavus* (DC.) Kremp. (Magnusson 1935a), a species often found on hard granite boulders along rivers, washes, and waterfalls. Three species are terricolous (Knudsen & Kocourková 2010; Knudsen et al. 2012). The genus has a world-wide distribution with over 50 species by our estimation (CABI Bioscience *et al.* 2011).

Materials and Methods

Specimens from the herbarium of the University of California in Riverside (UCR) and Oregon State University (OSC) were prepared with hand sections and studied using standard light microscopy. Measurements were made in water, amyloid reactions tested with Lugol's Solution (IKI), with or without pretreatment with KOH (K), and the structures were studied in 10% KOH. Ascospore measurements were made in water with an accuracy of 0.5 µm. Macrophotographs were taken with a digital camera Olympus DP72 mounted with QuickPhoto Camera 2.3 on an Olympus SZX 7 stereomicroscope or with Nikon Coolpix 995 on Olympus SZ.

Taxonomy

Sarcogyne mitziae K. Knudsen, Kocourk. & McCune, *sp. nov.* **Fig. 1D**

Mycobank MB 516797

Similar to Sarcogyne novomexicana but with a corticated brown thallus and smaller apothecia.

[1] Corresponding author's email: knudsen@ucr.edu

DOI: 10.1639/0007-2745-116.2.122

Copyright ©2013 by The American Bryological and Lichenological Society, Inc.

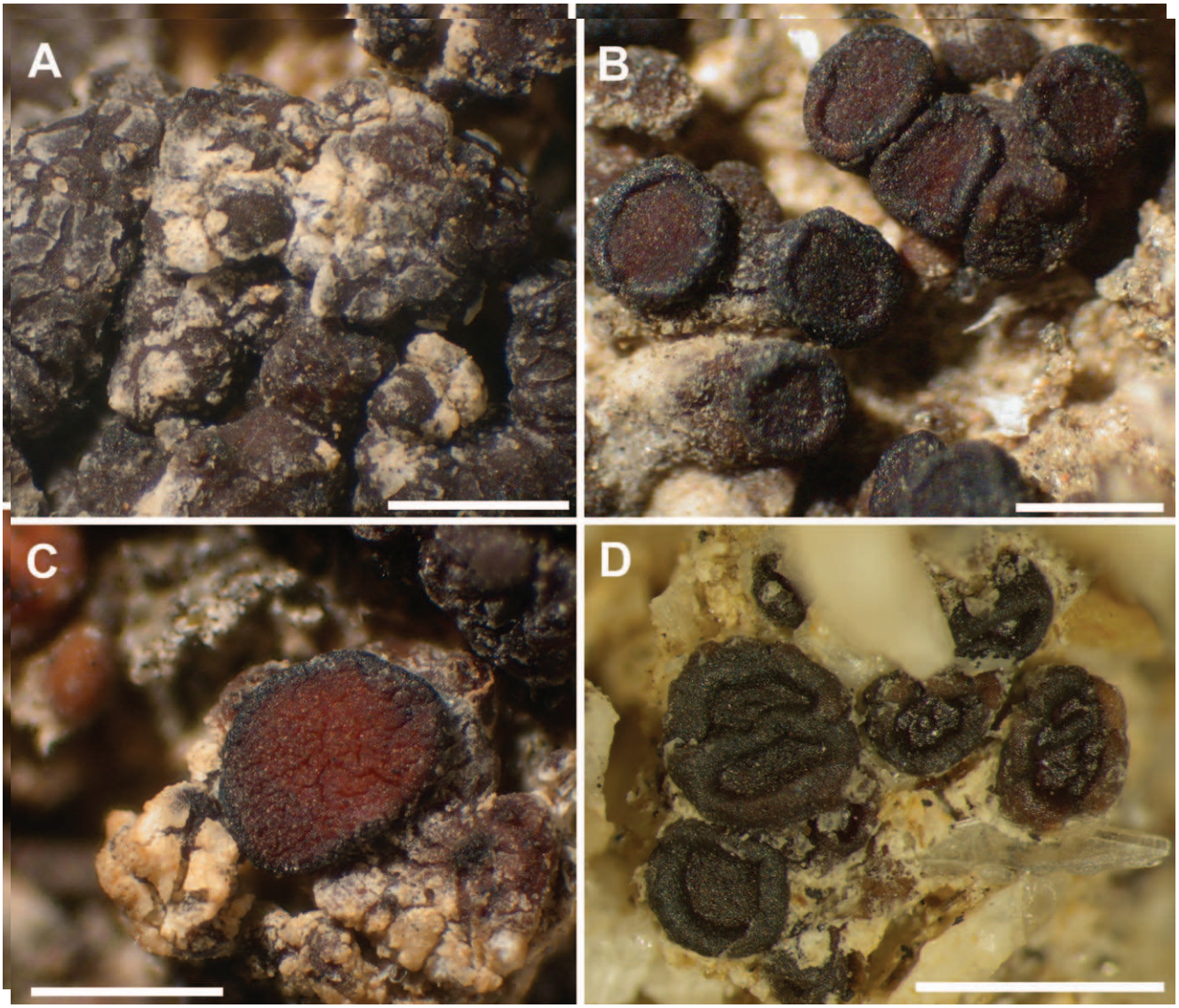

Figure 1. *Sarcogyne mitziae.* **A.** Poorly differentiated thallus, *B. McCune 31907.* **B.** Apothecia, *J. Ponzetti 1312.* **C.** Apothecia, *B. McCune 31907.* **D.** Apothecia, *K. Knudsen 13688.* A–C = 0.5 mm; D = 1 mm.

TYPE: U.S.A. CALIFORNIA: San Bernardino Co., Joshua Tree National Park, Little San Bernardino Mountains, east of Long Canyon on hillside, 34°04′31″ N, 116°26′31″ W, 1316 m, on gravelly soil of decomposed granite, *Oct. 4, 2011, Knudsen 13688* w/ *M. Harding* (holotype: UCR; isotypes: UCR).

Description. Hypothallus of abundant endosubstratal rhizohyphae, binding the soil and rock particles in a continuous biological soil crust to several cm in diam. Thallus epilithic, crustose, poorly differentiated, becoming areolate at edges, or of distinct areoles, dispersed or contiguous, 0.2–0.3 (−0.6) mm in diam., 0.2–0.3 mm thick, round to irregular, light to dark brown on upper surface, epruinose, smooth or fissured, broadly to narrowly attached, with usually pale lower surface. Upper, lateral, and lower cortices 10–20 (–40) µm thick, paraplectenchymatous, cells globose to irregular, mostly 2–4 µm diam., hyaline, with a thin brown pigmented upper layer mostly one or two cells thick, with or without a thin epicortex of gelatinized hyphae. Algal layer mostly 200 µm thick, upper and lower strata uneven, uninterrupted by hyphal bundles, continuous below apothecia, algal cells mostly 10 µm in diam. Medulla 40–60 µm thick, of gelatinized hyphae mixed with substrate particles, or distinct hyphae continuous with abundant rhizohyphae, hyaline, thin-walled, branching, 2.5–5 µm wide, IKI–. One apothecium per areole, erumpent, the areoles sometimes becoming reduced, forming the base of the apothecium, until only the apothecia are visible and the thallus appears endolithic. Apothecia scattered or sometimes in dense clusters, mostly round, small, 0.2–0.5 mm in diam., margin thin, brown, raised above the disc,

smooth or rough, sometimes undulate. Disc reddish-brown to dull brown, reddish orange when wetted, epruinose, smooth or scabrid. Exciple to 120 μm wide, hyaline within, outer layer dark pigmented, c. 10–20 μm thick. Hymenium usually 80–100 μm tall, IKI+ unstable, blue, yellow-green, or red, K/IKI+ blue, epihymenium c. 10 μm high, with reddish-brown diffuse pigment, hymenium inspersed with oil drops, paraphyses not branching, conglutinate, 2–3 μm wide, cells 5–10 μm, often with oil drops, apices unexpanded or expanded to 4 μm with dark pigmented cap. Asci clavate, *Acarospora*-type stain in K/IKI, mostly 50–65 ×15–20 μm, 100+ ascospores per ascus. Ascospores simple, hyaline, ellipsoid, mostly 4–5 × 2 μm. Subhymenium to 20 μm thick, IKI+ blue. Hypothecium prosoplentenchymatous, 10–15 μm wide, expanding into excipular margin. Pycnidia absent to frequent, conidia simple, hyaline, 2–2.5 × 1.5–2 μm, mostly broadly ellipsoid to subglobose. Spot tests negative.

Other specimens examined. U.S.A. IDAHO: Ada County, Snake River Plain, south of Kuna, *B. McCune 31907* (OSC). WASHINGTON: Benton County, Horse Heaven Hills, Plot 304, May 21, 1999, *J. Ponzetti* (OSC).

Etymology. The species is named in honor of the NPS botanist Mitzi Harding, who discovered the lichen forming extensive soil crusts in the Mojave Desert in Joshua Tree National Park in California.

Distribution. Western North America (California, Idaho, Washington) from 497–1316 m. We found no more populations of *S. mitziae* in Joshua Tree National Park (California) in over 70 days of fieldwork, suggesting that it is part of the Pleistocene relictual element of the lichen biota in the northwest region of the park (Knudsen et al. 2013). The Idaho and Washington populations also suggest it is not a desert species. It has not been discovered in coastal southern California or in the Sierra Nevada Mountains by the authors.

Ecology. *Sarcogyne mitziae* is an obligate terricolous lichen based on the extensive rhizohyphae of the hypothallus and the biological soil crusts it forms. In the type collection from the Mojave Desert, *S. mitziae* was not associated with other lichens. Biotic soil crusts with one or two lichen species are common in the southwestern Mojave Desert in Joshua Tree National Park, probably due to climatic restraints (Knudsen et al. 2013; Pietrasiak et al. 2011). In Idaho, *S. mitziae* grew with the yellow *Acarospora schleicheri* (Ach.) A. Massal, within extensive, nearly continuous, species-rich lichen-bryophyte soil crusts in relatively old *Artemisia* shrub steppe on the Snake River Plain. In southern Washington the species was found in a species-rich plot with *Arthonia glebosa* Tuck., crustose *Aspicilia* taxa, *Buellia punctata* A. Massal., *Cladonia pocillum* (Ach.) Grognot, *Diploschistes muscorum* (Scop.) R. Sant., *Lecanora zosterae* (Ach.) Nyl., *Leptogium* sp., *Massalongia carnosa* (Dicks.) Körb., *Trapeliopsis bisorediata* McCune & Camacho, the large moss *Syntrichia ruralis* (Hedwig) F. Weber & D. Mohr, and extensive short mosses. *Sarcogyne mitziae* was growing with *Pseudoroegneria spicata* (Pursh.) Á. Löve without *Artemisia*, which in this area implies that it had burned in recent decades (Ponzetti et al. 2007). The type collection has some bleached areoles infected by *Lichenothelia convexa* Henssen, a common saxicolous and lichenicolous micro-fungus in the Mojave Desert that attacks a wide range of lichens (Kocourková & Knudsen 2011; Muggia et al. 2012), while no lichenicolous fungi occurred on the specimens from Idaho and Washington.

Differentiation. Because of the apothecia with brown margins and discs that turn orange when wetted, *Sarcogyne mitziae* resembles the more robust *Sarcogyne novomexicana* H. Magn., but has smaller apothecia (0.2.–0.5 mm vs. 0.8–2.0 mm), an inspersed hymenium, and a terricolous habit with a corticate thallus. The latter species is saxicolous, endolithic, and prefers limestone or calcareous drainages on granite. Both species occur in Joshua Tree National Park in California.

Only two species of *Sarcogyne* are known to have corticate epilithic thalli and both are terricolous but differ significantly from *S. mitziae*. *Sarcogyne crustacea* K. Knudsen & Kocourk. from the lower coastal elevations of the mountains of southern California differs from *S. mitziae* in usually forming a non-areolate thallus, having reddish-black apothecia with a black margin, non-inspersed hymenium, and longer narrow conidia (Knudsen & Kocourková 2010). *Sarcogyne brunnea* K. Knudsen & Flakus from the Andes in South America (Bolivia, Ecuador) differs from *S. mitziae* in having pruinose brown areoles, black discs not changing color when wetted, a higher non-inspersed hymenium, and an algal layer interrupted by hyphal bundles (Knudsen et al. 2012). The only other terricolous species in the genus is *S. terrena* H. Magn. from Brazil, which is currently only known from a historic collection (Knudsen et al. 2012). Like *S. mitziae, S. terrena* has an extensive hypothallus of rhizohyphae, but differs in lacking an episubstratic thallus and possessing consistently smaller apothecia with a punctiform disc and a higher non-inspersed hymenium with branching paraphyses. Though inspersion is an informative character, all the material of *S. mitziae* we have seen was relatively recent. Inspersion in the hymenium had decreased in the oldest collection from 1999.

Sarcogyne crustacea and *S. mitziae* are the only terricolous species from the genus reported from

North America. *Sarcogyne arenosa* (Herre) K. Knudsen & Standl. and *S. similis* H. Magn. are saxicolous species which have occasionally been found in biological soil crusts in southern California (Hernandez & Knudsen 2012; Knudsen et al. 2013). It is common, especially on consolidated granite alluvium, for saxicolous lichens to occasionally occur in biological soil crusts with obligate terricolous species. *Sarcogyne arenosa* differs from *S. mitziae* in usually having a very thin ecorticate white or dun-colored thallus or a white rim subtending the margin and a non-inspersed hymenium while *S. similis* has larger black apothecia with a black margin, a non-inspersed hymenium, and an endolithic thallus.

Discussion

Sarcogyne is a surprisingly diverse crustose genus in North America. This paper is the latest installment in a continuing revision of North American *Sarcogyne* that builds on the foundation of A. H. Magnusson's pioneering work (Magnusson 1935b). Including *S. mitziae*, in North America we currently recognize 17 species in the genus: *S. arenosa* (Knudsen & Standley 2007), *S. athroocarpa* H. Magn. (Magnusson 1935b), *S. clavus* (Knudsen & Standley 2007; Magnusson 1935a,b), *S. crustacea* (Knudsen & Kocourková 2010a), *S. dakotensis* H. Magn. (Knudsen & Standley 2007; Magnusson 1935b), *S. desolata* (H. Magn.) K. Knudsen & Standl. (Knudsen & Standley 2007), *S. integra* B. de Lesd. *ex* H. Magn. (Magnusson 1935b), *S. magnussonii* B. de Lesd. (Knudsen & Kocourková 2012; Magnusson 1935b), *S. novomexicana* (Knudsen & Lendemer 2005; Knudsen & Standley 2007), *S. plicata* H. Magn. (Knudsen & Kocourková 2011; Magnusson 1935b), *S. regularis* Körb. (Knudsen & Standley 2007; Magnusson 1935a,b), *S.* "*privigna*" auct., non (Ach.) A. Massal. (Knudsen & Standley 2007; Knudsen & Kocourková 2011; Magnusson 1935a,b), *S. reebiae* K. Knudsen (Knudsen & Standley 2007; Knudsen et al. 2011), *S. regularis* Körb. (Knudsen and Standley 2007; Magnusson 1935a,b), *S. sphaerospora* J. Steiner (Lendemer et al. 2009), and *S. similis* (Knudsen & Standley 2007; Magnusson 1935b). Some North American specimens of *Sarcogyne* are still impossible to determine. The delimitation of several species is still problematic. There are probably several undescribed taxa. The key by Knudsen and Standley (2007) is useful for identifying many specimens, but lacks *S. crustacea, S. magnussonii, S. mitziae, S. plicata*, and *S. sphaerospora* as well as the "unknown" species *S. athroocarpa* and *S. integra* whose types are lost and identities are unresolved (Knudsen & Kocourková 2012; Magnusson 1935b). *Sarcogyne mitziae* is easy to identify because it is the only North American terricolous species with a brown corticated thallus, an inspersed hymenium, and short subglobose to ellipsoid conidia.

Biotic soil crusts contain many apparently rare species (Knudsen 2010; Root et al. 2011; Hernandez & Knudsen 2012). "Assessing the conservation status of individual soil crust species across the landscape is challenging because the distribution of the species is poorly known due to a lack of studies, and many species are difficult to identify" (Root et al. 2011). Based on our extensive field work at 238 sites, *Sarcogyne mitziae* is naturally rare in Joshua Tree National Park in California, known only from its type locality in the Little San Bernardino Mountains (Knudsen et al. 2013). We know of only one location for *S. mitziae* in each of the three states in which it has been found. Although additional field work may discover other populations, at present the species appears to be truly rare, not just under collected. Furthermore, biotic soil crust habitat is threatened by development, overgrazing, invasive species, and increased fire frequency. Because of the rarity of *S. mitziae,* it should be considered for listing under state programs for rare, threatened, and endangered species.

Acknowledgements

We thank our reviewers. We especially thank NPS botanist Mitzi Harding for often accompanying us in the field and for acting as our liaison with Joshua Tree National Park. Kerry Knudsen was funded by a co-operative agreement between the University of California at Riverside and Joshua Tree National Park. The work of Jana Kocourková was supported financially by the KONTAKT II, Program of International Cooperation in Research and Development for scientific cooperation between the CR and USA, LH 11057 from Ministry of Education, Youth and Sports. Field work at Horse Heaven Hills was supported by the Forest and Rangeland Ecosystem Science Center of the U.S. Department of the Interior and the Bureau of Land Management.

Literature Cited

Belnap, J. & O. L. Lange. 2001. Biological soil crusts: structure, function, and management. Springer-Verlag, Berlin.

CABI. 2011. Index Fungorum. http://www.indexfungorum.org [Accessed Feb. 2011].

Hernandez, R. R. & K. Knudsen. 2012. Late-successional biological soil crusts in a biodiversity hotspot: an example of congruency in species richness. Biodiversity and Conservation 21: 1015–1031.

Jørgensen, P. M. & R. Santesson. 1993. Nine proposals to conserve generic names of lichenized fungi. Taxon 42: 881–887.

Knudsen, K. 2010. *Acarospora orcuttii* (Acarosporaceae), a rare terricolous lichen from southern California. The Bryologist 113: 713–716.

Knudsen, K., A. Flakus & M. Kukwa. 2012. A contribution to the study of Acarosporaceae in South America. The Lichenologist 44: 253–262.

Knudsen, K., J. Hoines & M. Harding. 2013. The Lichen Flora of Joshua Tree National Park: an annotated checklist. Natural Resource Technical Report NPS/SFAN/NRTR—2013/xxx. National Park Service, Fort Collins, Colorado.

Knudsen, K. & J. Kocourková. 2010. Lichenological notes 1: *Acarosporaceae*. Mycotaxon 12: 361–366.

Knudsen, K. & J. Kocourková. 2011. Lichenological Notes 3: *Sarcogyne plicata* in California. Mycotaxon 118: 423–431.

Knudsen, K. & J. Kocourková. 2012. Lichenological Notes 5: The Neotypification of *Sarcogyne magnussonii*. Mycotaxon 121: 139–145.

Knudsen, K. & J. C. Lendemer. 2005. Changes and additions to the checklist of North American lichens - III. Mycotaxon 93: 277–281.

Knudsen, K., J. C. Lendemer & R. C. Harris. 2011. Studies in lichens and lichenicolous fungi – no 8: miscellaneous notes on species eastern North America. Opuscula Philolichenum 9: 45–75.

Knudsen, K. & S. M. Standley. 2007. *Sarcogyne*. Pages 289–296. In: T. H. Nash III, C. Gries & F. Bungartz: Lichen Flora of the Greater Sonoran Desert Region. Volume 3. Lichens Unlimited, Arizona State University, Tempe, AZ.

Kocourková, J. & K. Knudsen. 2011. Lichenological notes 2: *Lichenothelia convexa*, little-known rock-inhabiting lichenicolous fungus. Mycotaxon 115: 345–351.

Lendemer, J. C., J. Kocourková & K. Knudsen. 2009. Studies in lichens and lichenicolous fungi: more notes on some taxa from North America. Mycotaxon 108: 491–497.

Magnusson, A. H. 1935a. *Acarosporaceae, Thelocarpaceae*. Pages 1–318. In: A. Zahlbruckner (ed.), L. Rabenhorst. Kryptogamen-Flora von Deutschland, Österreich, und der Schweiz. 2nd IX. Die Flechten. Abt. 5 (1). Borntraeger/Leipzig.

Magnusson, A. H. 1935b. On the species of *Biatorella* and *Sarcogyne* in America. Annales de Cryptogamie Exotique 7: 115–145.

Muggia, L., C. Gueidan, K. Knudsen, G. Perlmutter & M. Grube. 2012 (online publication). The Lichen Connections of Black Fungi. Mycopathologia. DOI 10.1007/s11046-012-9598-8

Pietrasiak, N., R. J. Johansen, T. LaDoux & R. C. Graham. 2011. Comparison of Disturbance Impacts to and Spatial Distribution of Biological Soil Crusts in the Little San Bernardino Mountains of Joshua Tree National Park, California. Western North American Naturalist 71: 539–552.

Ponzetti, J., B. McCune & D. A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. The Bryologist 110: 706–722.

Root, H. T. & B. McCune. 2012. Regional patterns of biological soil crust lichen species composition related to vegetation, soils, and climate in Oregon, USA. Journal of Arid Environments 79: 93–100.

Root, H. T., J. E. D. Miller & B. McCune. 2011. Biotic soil crust lichen diversity and conservation in shrub-steppe habitats of Oregon and Washington. The Bryologist 114: 796–812.

Soule, T., I. J. Anderson, S. L. Johnson, S. T. Bates & F. Garcia-Pichel. 2009. Archaeal populations in biological soil crusts from arid lands in North America. Soil Biology and Biochemistry 41: 2069–2074.

manuscript received January 3, 2013; accepted April 17, 2013.