

Bulletin
of the
California Lichen Society



Volume 20 No. 1 Summer 2013

The California Lichen Society seeks to promote the appreciation, conservation, and study of lichens. The interests of the Society include the entire western part of the continent, although the focus is on California. Dues categories are (in \$US per year): Student and fixed income (eBulletin only) - \$10, Regular - \$20 (\$25 for foreign members, or \$20 foreign student memberships), Family - \$25, Sponsor and Libraries - \$35, Donor - \$50, Benefactor - \$100, and Life Members - \$500 (one time) payable to the California Lichen Society, PO Box 472, Fairfax, California 94978. Members receive the Bulletin (print and online access), the right to vote in society elections, and notices of meetings, field trips, lectures and workshops.

Board Members of the California Lichen Society:

President: Shelly Benson, President@californialichens.org
Vice President: Tom Carlberg, Vicepresident@californialichens.org
Secretary: Sarah Minnick, Secretary@californialichens.org
Treasurer: Kathy Faircloth, Treasurer@californialichens.org
Member At Large: Erin P. Martin, shastalichens@gmail.com

Editor: John Villella, johnvillella@yahoo.com
Production Editor: Erin P. Martin, shastalichens@gmail.com

Committees of the California Lichen Society:

Conservation: Eric Peterson, eric@landscapeecology.com, chairperson
Education: Erin P. Martin, shastalichens@gmail.com, chairperson
Poster/Mini Guides: Susan Crocker, cgwoodside@gmail.com, chairperson
Events/ Field trips/ Workshops: Christine Walker,
christinejwalker@gmail.com, chairperson
Outreach: Hanna Mesraty, hanna@californialichens.org, chairperson

The Bulletin of the California Lichen Society (ISSN 1093-9148) is edited by John Villella (johnvillella@yahoo.com) and is produced by Erin P. Martin (shastalichens@gmail.com). The Bulletin welcomes manuscripts on technical topics in lichenology relating to western North America and on conservation of lichens, as well as news of lichenologists and their activities. The best way to submit manuscripts is by e-mail attachments in the format of a major word processor (DOC or RTF preferred). Use italics for scientific names. Please submit figures in electronic formats with a resolution of 300 pixels per inch (600 minimum for line drawings). Email submissions are limited to 10MB per email, but large files may be split across several emails or other arrangements can be made. Contact the Production Editor: Erin P. Martin, at shastalichens@gmail.com, for details of submitting illustrations or other large files. A review process is followed. Nomenclature follows Esslinger's cumulative checklist online at <http://www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm>. The editors may substitute abbreviations of authors names, as appropriate from The International Plant Names Index - <http://www.ipni.org/index.html>. Style follows this issue. Electronic reprints in PDF format will be emailed to the lead author at no cost.

The deadline for submitting material for the Winter 2013 CALS Bulletin is 1 October 2013.

The California Lichen Society is online at: <http://californialichens.org/> and has email discussions through <http://tech.groups.yahoo.com/group/CaliforniaLichens/>.

Volume 20 (1) of the Bulletin was issued on 1 June 2013.

Front Cover: *Ramalina menziesii*. See article by Shrestha and St. Clair pg. 5. Photo by Kerry Heise.

Bulletin of the California Lichen Society

VOLUME 20 No. 1

Summer 2013

The Effects of Gaseous Ozone and Nitric Acid Deposition on Two Crustose Lichen Species from Joshua Tree National Park

Elizabeth C. Hessom
University of California, Riverside
Department of Environmental Sciences
Elizabethchessom@gmail.com

This study was funded by a CALS Educational Grant

My name is Elizabeth C. Hessom, and I recently completed my M.S. in Environmental Sciences at the University of California, Riverside. Towards the end of 2011, I received a student grant from CALS to support my thesis research looking at the effects of two common atmospheric pollutants on two crustose lichen species from Joshua Tree National Park. Here I present the summarized findings from this research.

When I started graduate school in 2010, I had a piqued interest in lichens; however I had little direct research experience with them, let alone with the crustose growth form. Preliminary studies helped increase my comfort level in working with crustose lichens, and I became more and more intrigued about lichens in general. At the time I was also working for the USDA Forest Service Pacific Southwest Research Station in Riverside, CA, under the supervision of Dr. Pamela Padgett. The Forest Service had used epiphytic lichens as passive bioindicators of atmospheric conditions, and was interested in expanding this use to crustose lichens. This interest shaped my research project

which looked at the effects of two common atmospheric pollutants on two common crustose species within southern California, specifically Joshua Tree National Park. I wanted to see if they could be used as passive bioindicators.

In order to gain insight on what crustose lichen species were present within the park, and which ones would be ideal for collecting, I contacted Kerry Knusden, from the UC Riverside Herbarium for his input. Kerry had been working in the park at the time doing an assessment of the lichen species present, and provided me with helpful information. We took our first field trip to the park in May 2011 to assess which lichens I should collect in areas where low atmospheric deposition was occurring. This helped ensure that the lichen samples I was working with would be fairly pristine before I exposed them to their lab fumigation trials of different atmospheric pollutants. After that first trip, Kerry and I decided that I should collect two fairly prevalent species for my study, *Lobothallia praeradiosa* (Nyl.) Hafellner, and *Acarospora socialis* H. Magn.. Both

of these species also happened to have unknown sensitivities to ozone (O_3) and the nitrogen compound nitric acid (HNO_3), which are prevalent atmospheric pollutants within the Los Angeles Basin. Westerly winds often cause these pollutants to deposit within Joshua Tree National Park, so we decided that these species would be tested for their sensitivities to O_3 and HNO_3 (Allen et al. 2006; Allen et al. 2009), to see if they could be used as passive indicators for the pollutants.

Kerry and I proceeded to return to Joshua Tree National Park multiple times within the next year to set-up passive samplers (to detect current atmospheric pollutant concentrations in the field), and to collect the lichen samples themselves. Since the lichens were crustose in nature, this made them more difficult to collect than epiphytic growth forms, because they need to remain attached to their rock

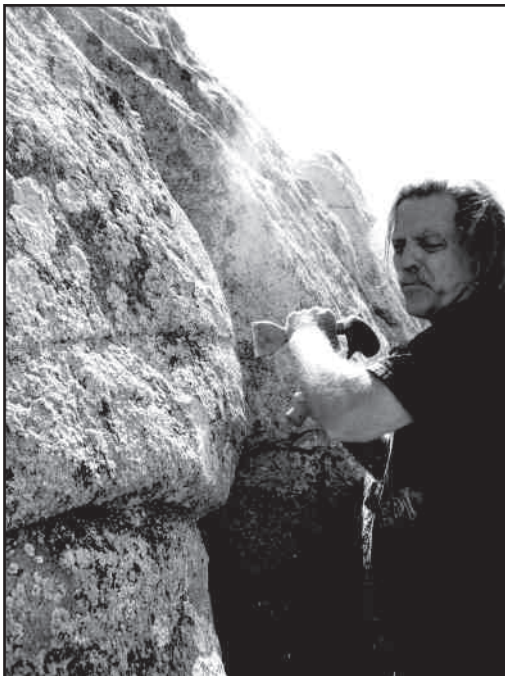


Figure 1. Kerry Knusden obtaining crustose lichen samples. Photo by Elizabeth Hessom.

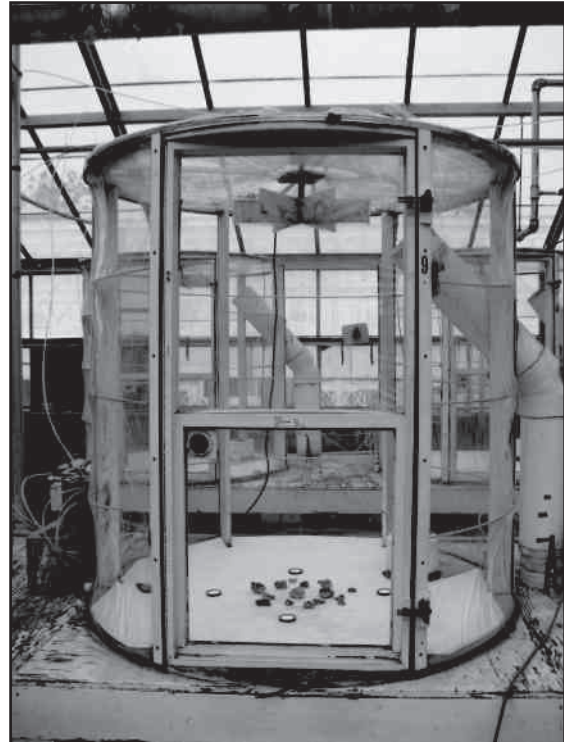


Figure 2. CSTR with lichens present at bottom of chamber. Photo by Elizabeth Hessom.

substrate. This resulted in hot days in Joshua Tree National Park, chipping away at rocks to get lichen samples (Fig. 1). Once collected, the samples were brought back to UC Riverside and prepped for fumigations in the CSTRs (continuously stirred tank reactors) (Fig. 2) with O_3 and HNO_3 separately.

The two lichen species underwent an O_3 fumigation, and a HNO_3 fumigation, both of which were 90 days long. Throughout the fumigations, physiological measures were taken on day 0, 30, 60, and 90 to assess the health of the lichen species in response to the pollutants. These measures included recording: 1) chlorophyll fluorescence to determine if damage occurred to photosystem II (PSII) or the algal component of the lichen, and 2) measuring ion loss to determine if thallus damage had occurred. In addition,

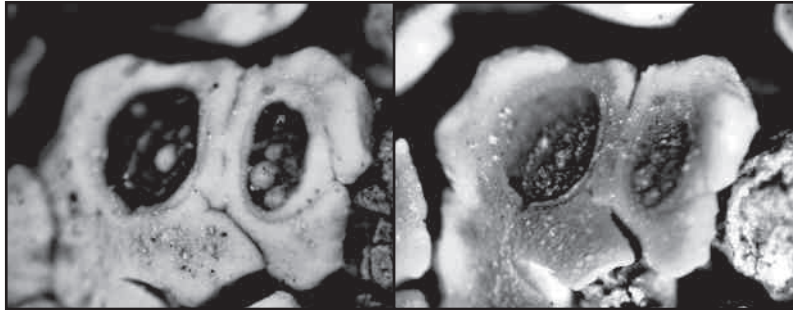


Figure 3. Imaging at 6.3x showing *Acarospora socialis* before O₃ on the left, and after on the right. Photo by Elizabeth Hessom.

microscopic imaging was performed during each sampling period to register if thallus damage or color change had occurred. A novel protocol was also developed to measure the dark respiration occurring from the lichens during each sampling period to see if the fungal component of the lichens was damaged, and changing the output of CO₂ being released. Previous protocols used in the literature involved more destructive methods, which removed the lichen from its substrate (Larson & Kershaw 1975). However, in order to avoid this destructive step with the crustose lichen, a protocol was developed by placing the lichen/rock substrate sample into a darkened mason jar, which was then hooked up to a Licor-7000 infrared gas analyzer (LI-COR Environmental, NE, USA) to measure the total released CO₂ during dark respiration from the lichen sample. With the results from these measures, we were able to determine the sensitivity of *Lobothallia praeradiosa* (Nyl.) Hafellner, and *Acarospora socialis* H. Magn. to O₃ and HNO₃.

Results indicated that both species had similar sensitivities to O₃ and HNO₃. Both species registered physical damage during the O₃ fumigation (as captured by the

imaging protocol, Fig.3), increased cation loss, as well as a decrease in dark respiration. Neither species showed major physical damage to HNO₃, but both manifested a decrease in chlorophyll fluorescence, suggesting damage to the photosynthetic systems of the algae symbiont. These results suggest that both species reacted negatively to the presence of O₃, and therefore could be used as passive bioindicators for O₃ in a field setting. The species however did not have a strong negative reaction to HNO₃ fumigation, indicating that it may not be feasible to use these species as bioindicators of HNO₃ pollution.

Findings from this research also suggested that the fungal component is more sensitive to the present atmospheric pollutants than the algal component. This may be due to the fact that the fungal component makes up the majority of the lichen structure, thus more of it is exposed to atmospheric deposition, whereas the algal component is more protected within the fungal structure (Purvis 2000).

Overall, this study expanded the background knowledge of these two unstudied crustose species, their susceptibilities to two different pollutants, and their potential use as passive

bioindicators for atmospheric pollution. This study also helped expand the current research on crustose lichen species, and illustrated that atmospheric deposition fumigation studies can be done on crustose lichens, despite the difficulties they present in needing to remain attached to their substrate. I hope that this research generates interest to work with crustose lichens, and use them as bioindicators in the future.

Acknowledgments

I would like to thank CALS for their support throughout this research project, and for helping make it possible. I would also like to thank my thesis committee, particularly Dr. Pamela Padgett, and Dr. David Parker. Lastly, I would like to thank Kerry Knusden for all of his help, guidance, and enduring hot days out in Joshua Tree National Park with me.

Literature Cited

Allen E. B., A. Bytnerowicz, M. E. Fenn, R. A. Minnich & M. F. Allen. 2006. Impacts of anthropogenic N deposition on weed invasion, biodiversity and the fire cycle at Joshua Tree National Park. Unpublished report. PMIS Number



One of the field sites for this study near Pine City, CA. Photo by Elizabeth Hessom.

72123: 1-35.

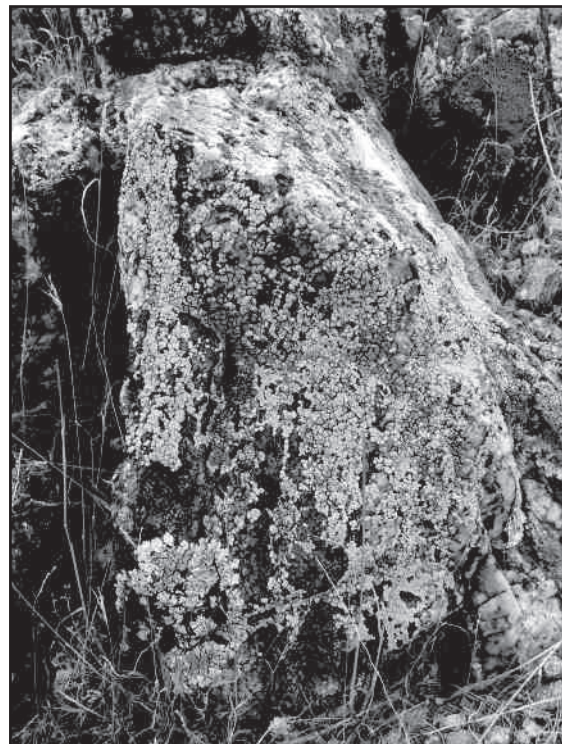
Allen E. B., L. E. Rao, R. J. Steers, A.

Bytnerowicz & M. E. Fenn. 2009. Impacts of atmospheric nitrogen deposition on vegetation and soils at Joshua Tree National Park. In R.H. Webb, L.F. Fenstermaker, J.S. Heaton, D.L. Hughson, E.V. McDonald, & D.M. Miller (Eds.), *The Mojave Desert: Ecosystem Processes and Sustainability* (78-100). Las Vegas: University of Nevada Press.

Larson, D. W. & K. A. Kershaw. 1975.

Measurement of CO₂ exchange in lichens – new method. *Canadian Journal of Botany-Revue Canadienne De Botanique* 53: 1535-1541.

Purvis, W. 2000. *Lichens*. London: The National History Museum, London. 112 pgs.



Typical Joshua Tree lichen mosaic. *Acarospora socialis* is dominant, mixed with *Candelariella citrina* and *Xanthoparmelia mexicana*, growing on monzogranite. There are several other smaller crustose lichens mixed among them including the endolithic *Lecidea laboriosa*, which are not visible. Photo by Jana Kocourková