

SARAH R. CARRINO-KYKER

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EDUCATION

Ph.D., 2010 Biology, Case Western Reserve University

Dissertation: *Microbial Community Responses to Environmental Change: An Investigation in Vernal Pools.*

Advisor: Dr. David J. Burke

M.S., 2006 Biology, Case Western Reserve University

Thesis: *Eukaryotic and Cyanobacterial Diversity and Physicochemical Characterization of Northeastern Ohio Vernal Pools.*

Advisor: Dr. Andrew K. Swanson

B.A., 2003 Botany, Miami University, *Cum Laude*

B.S., 2003 Secondary Education, Earth and Life Science, Miami University, *Cum Laude*

PROFESSIONAL EXPERIENCE

Research Associate, 2012-present

Ecology of soil microorganisms and mycorrhizal fungi in deciduous forests

Research Department, The Holden Arboretum

Postdoctoral Scholar, 2010-2012

Soil microbial ecology in deciduous forests with acidic soils

NSF grant DEB-0918167; co-PI's Dr. David J. Burke and Dr. Kurt A. Smemo

Department of Biology, Case Western Reserve University and The Holden Arboretum

Graduate Research Assistant, 2008-2010

Microbial ecology of vernal pools

Department of Biology, Case Western Reserve University and The Holden Arboretum

Graduate Teaching Assistant, 2003-2007

Introductory biology, evolution, and molecular techniques

Department of Biology, Case Western Reserve University

Laboratory Assistant, 2003

Tissue engineering

Department of Biology, Case Western Reserve University

Howard Hughes Undergraduate Research Intern Summer 2002

Pollination biology

Department of Botany, Miami University

Summer Program of Undergraduate Research participant Summer 2001

Tissue engineering

Department of Biology, Case Western Reserve University

Undergraduate Researcher 2000-2002

Pollination biology

Department of Botany, Miami University

PUBLICATIONS

Peer Reviewed Publications

- Lance A.C., **Kyker S.R.**, Burke D.J., and Burns J.H. Soil legacy effects influence tree growth and rhizosphere fungal communities in a temperate forest restoration experiment. *Frontiers in Ecology and the Environment* (in revision).
- Carrino-Kyker S.R.**, Coyle K.P., Kluber L.A., and Burke D.J. (2020) Fungal and bacterial communities exhibit consistent responses to reversal of soil acidification and phosphorus limitation over time. *Microorganisms* 8: 1.
- Burke D.J., **Carrino-Kyker S.R.**, and Burns J.H. (2019) Is it climate or chemistry? Soil fungal communities respond to soil nutrients in a multi-year high resolution analysis. *Ecosphere* 10: e02896.
- Burke D.J., **Carrino-Kyker S.R.**, Hoke A., Cassidy S., Bialic-Murphy L., and Kalisz S. (2018) Deer and invasive plant removal alters mycorrhizal fungal communities and soil chemistry: Evidence from a long-term field experiment. *Soil Biology and Biochemistry* 128: 13-21.
- Monson M.L., Dennis P.M., Lukas, K.E., Krynak K.L., **Carrino-Kyker S.R.**, Burke D.J., and Schook M.W. (2018) The effects of increased hay-to-grain ratio on behavior, metabolic health measures, and fecal bacterial communities in four Masai giraffe (*Giraffa Camelopardalis tippelskirchi*) at Cleveland Metroparks Zoo. *Zoo Biology* 37: 320-331.
- Carrino-Kyker S.R.**, Kluber L.A., Coyle K.P., and Burke D.J. (2016) Regulation of arbuscular mycorrhizal fungi and their phosphate transporter genes in acidic forest soils following phosphorus addition. *Symbiosis* DOI 10.1007/s13199-016-0448-1.
- Carrino-Kyker S.R.**, Kluber L.A., Petersen S.M., Coyle K.P., Hewins C.R., DeForest J.L., Smemo K.A., and Burke D.J. (2016) Mycorrhizal fungal communities respond to experimental elevation of soil pH and P availability in temperate hardwood forests. *FEMS Microbiology Ecology* 92 DOI: 10.1093/femsec/fiw024.
- Hewins C.R., **Carrino-Kyker S.R.**, and Burke D.J. (2015) Seasonal variation in mycorrhizal fungi colonizing roots of *Allium tricoccum* (wild leek) in a mature hardwood forest. *Mycorrhiza* 25: 469-483. DOI: 10.1007/s00572-015-0628-5.
- Carrino-Kyker S.R.**, Smemo K.A., and Burke D.J. (2013) Shotgun metagenomic analysis of metabolic diversity and microbial community structure in experimental vernal pools subjected to nitrate pulse. *BMC Microbiology* 13: 78. (Highly accessed)
- Carrino-Kyker S.R.**, Smemo K.A., and Burke D.J. (2012) The effects of pH change and NO₃⁻ pulse on microbial community structure and function: a vernal pool microcosm study. *FEMS Microbiology Ecology* 81: 660-672.
- Kluber L.A., **Carrino-Kyker S.R.**, Coyle K.P., DeForest J.L., Hewins C.R., Shaw A.N., Smemo K.A., and Burke D.J. (2012) Mycorrhizal response to experimental pH and P manipulation in acidic hardwood forests. *PLoS ONE* 7: e48946.
- Carrino-Kyker S.R.**, Swanson A.K., and Burke, D.J. (2011) Changes in eukaryotic microbial communities of vernal pools along an urban-rural land use gradient. *Aquatic Microbial Ecology* 62: 13-24.
- Carrino-Kyker S.R.** and Swanson A.K. (2008) Temporal and spatial patterns of eukaryotic and bacterial communities found in vernal pools. *Applied and Environmental Microbiology* 74: 2554-2557.

Carrino-Kyker S.R. and Swanson A.K (2007) Seasonal physicochemical characteristics of thirty Northern Ohio temporary pools along gradients of GIS-delineated human land-use. *Wetlands* 27: 749-760.

Smith-Huerta N.L., **Carrino-Kyker S.R.**, and Huerta A.J. (2007) The effects of maternal and paternal nutrient status on pollen performance in the wildflower *Clarkia unguiculata* Lindley (Onagraceae). *Journal of the Torrey Botanical Society* 134: 451-457.

Other Publications

Kyker S., Krebs S., and Burke D. Microbes in soil: Just a part of the dirt or unseen heroes? *Leaves* Fall 2015, pp. 6-7

Kyker S.R. Getting by with a little help from a friend. How symbiotic root fungi help maple trees overcome phosphorus limitation. *Leaves* Spring 2013, pp.6-7.

Holden Research Scientists. The invisible world of soil and how we study it. *Leaves* Winter 2011-2012, pp.14-15.

Carrino-Kyker S.R. Sweating the small stuff: a study of microorganisms in vernal pools. *Leaves* Vol. 7, Spring 2009, pp. 4-5.

FUNDING

R. Henry Norweb, Jr. Fellowship (\$17,500)
Can Symbiotic Root Fungi Help Trees Overcome Phosphate Limitation in Forest Soils?
Awarded 2012

R. Henry Norweb, Jr. Fellowship (\$17,500)
Do Forest Microbes Help Plants Cope with Acid Rain-Induced Nutrient Limitation?
Awarded 2011

Phi Beta Kappa Grant for Student Research, Case Western Reserve University (\$300)
Awarded 2004

Undergraduate Research Grant, Miami University (\$400)
The Effects of Nutrient Levels on Seed Paternity in Clarkia unguiculata (Onagraceae)
Awarded 2002

TEACHING EXPERIENCE

Laboratory Instructor at Case Western Reserve University

Genes and Evolution (Spring 2007, Spring 2006, Spring 2004): Taught weekly laboratories and discussion sessions for an introductory undergraduate biology course. These laboratories and discussions were on topics ranging from DNA mutations to Hardy-Weinburg equilibrium.

Genes and Evolution laboratory co-coordinator (Spring 2005): Responsible for helping to coordinate all laboratory sections including providing additional material outside of the general course information. I was specifically responsible for organizing a relatively new lab on the evolution of complex traits, for which I created a series of four power point presentations to explain the theory behind the lab, provide step by step instructions on how to complete the lab, and give insight into graphing and analyzing the collected data.

Teaching Assistantships at Case Western Reserve University

Biotechnology (Fall 2007, Fall 2006, Fall 2005): Assisted with a semester-long exploration of genetic variability of underserved crops in developing countries and the development of

molecular markers for these plant species. This was an upper-level undergraduate and cross listed graduate course for biology students which focused on molecular techniques.

Evolution (Fall 2004, Fall 2003): Led weekly discussions on topics covered in lecture, assigned readings, and student presentations on primary literature. This class was cross listed between several subjects, including biology, geology, and philosophy.

SCHOLARLY ACTIVITIES

Co-creator and organizer of the SEARCH Symposium, an annual undergraduate summer research symposium for ecological research in the greater Cleveland area.

Manuscript reviewer for *Frontiers in Plant Science*, *Soil Use and Management*, *AOB Plants*, *PLoS ONE*, *Water Research*, *Soil Science Society of America Journal*, *Hydrobiologia*, *Marine Biotechnology*, and *Journal of Applied Microbiology*.

Guest editor for *AOB Plants*.

Organizer of an oral session at the 2019 Ecological Society of America meeting titled "The Role of Soil Microorganisms for Improving the Efficacy of Restoration." This session was held on Thursday, August 15, 2019.

HONORS/AWARDS

Soil Ecology Section Student Travel Award, Ecological Society of America, 2008

Endowment-Sponsored Mentorship Program Award, Case Western Reserve University, 2007

Mycological Section Student Travel Award, Botanical Society of America, 2007

America Student Profile participant, Botanical Society of America, 2007, website:

http://www.botany.org/students_corner/profiles/sarah_kyker/

Verhosek Fund for conference presentations, Case Western Reserve University, 2004

Young Botanist Award for Special Achievement, Botanical Society of America, 2003

Marcia E. Buck-Roll Memorial Scholarship, Botany Department, Miami University, 2002

National Society of Collegiate Scholars member, Miami University, 2001-2003

SERVICES

The Holden Arboretum

Co-organizer of the Research Renegades, a citizen science group based out of the Holden Arboretum.

Mentored a retired teacher through Holden Arboretum's volunteer program who was interested in learning more about molecular biology and laboratory techniques. January 2014- January 2016

Laboratory mentor for summer interns, Laboratory of David J. Burke, The Holden Arboretum, 2009-present

Case Western Reserve University

Developed a laboratory for an upper level undergraduate ecology class, Case Western Reserve University, November 2011. This laboratory involved analysis of microbial DNA sequences collected from vernal pools over time.

Developed a laboratory for an upper level undergraduate ecology class, Case Western Reserve University, November 2010. This laboratory investigated the bacterial community in a wetland invaded by the non-native cattail species, *Typha angustifolia*.

Mentoring Committee participant and co-author of two university-wide mentoring handbooks, one for faculty and one for students, and a survey report on mentoring at the university, Case Western Reserve University, 2007-2009.

Department Seminar Committee participant, Department of Biology, Case Western Reserve University, 2006-2008.

Graduate Student Seminar Series coordinator, Department of Biology, Case Western Reserve University, 2005-2008.

Graduate Student Social Hour coordinator, Department of Biology, Case Western Reserve University, 2006-2007; co-coordinator, 2005-2006.

Laboratory mentor for undergraduate research assistants, Laboratory of Andrew K. Swanson, Department of Biology, Case Western Reserve University, 2006-2007.

Other Service

Northeast Ohio Science and Engineering Fair judge. March 2011, 2012, 2014, 2015, 2016, 2017, 2018, 2019.

Interviewed two times on the Lake Effect Radio Station, Lakeland Community College, January-April 2012. The topics I discussed were microbial ecology, acid rain, mycorrhizal fungi, and graduate school.

OUTREACH

General Public

Prepared educational demonstrations as part of Women in Science Day at the Cleveland Museum of Natural History, February 2018, 2019. The demonstrations were displays of how soil is alive and included fungi, bacteria, and soil invertebrates.

Prepared educational demonstrations about the Boo-tiful Belowground for Goblins in the Garden at Holden Arboretum and Boo Bash at the Cleveland Botanical Garden, October 2018. These events were open to the public and the demonstrations included the diversity of soil fungi, including Dead Man's Fingers just in time for Halloween.

Prepared outreach materials on beech leaf disease for Sustainability in the Summit held in Mentor, OH. The materials included information on a current disease affecting American beech trees, as well as information on tree care and preventing the spread of tree diseases.

K-12 Teachers

Prepared two soil ecology modules for the Scholars Institute at The Holden Arboretum, October 18, 2012. The Scholars Institute was a continuing education program from high school teachers.

Mastin Teacher Workshop activity leader, The Holden Arboretum, June 2009. For this continuing education program for teachers, I led two modules on soil ecology: one on microbial diversity and the other on invertebrate diversity. The module on microbial diversity was incorporated into a laboratory by a middle school teacher at Hershey Montessori Farm School and I was invited to help the students with their analysis of this lab.

K-12 Students

Judge for the Northeast Ohio Science and Engineering Fair, March 2010-present.

Co-led modules on mycorrhizal fungi and sporocarp diversity at Hershey Montessori Farm School, September 2010, September 2012, February 2015, February 2016, February 2018, and February 2019.

Led a field trip for a Lake Metroparks biotechnology camp on molecular methods when they visited The Holden Arboretum. I performed a DNA extraction on mushrooms with the students, demonstrated how to load an agarose gel with PCR products, and went on a hike to collect sporocarps, August 2014

Developed and co-led modules on soil microbial diversity for middle school classes from Painseville City Schools when they visited The Holden Arboretum, February 2011, 2012, and 2014. One module involved plating soil microbes on nutrient agar and the other involved construction of a Winogradsky column. This was part of a program run through the Arthur Holden Leadership Institute.

Developed and led new modules on soil microbial diversity for middle school classes from Painseville City Schools, Chardon City Schools, and Madison City Schools when they visited The Holden Arboretum in 2016, 2017, 2018, and 2019. The modules involved plating soil microbes in the presence of kitchen spices and inhibitory compounds and investigation of root nodules. This was part of a program run through the Arthur Holden Leadership Institute.

Developed and led new modules on soil microbial diversity for middle school classes from Painseville City Schools, Chardon City Schools, and Madison City Schools when they visited The Holden Arboretum in 2019 and 2020. The modules involved plating soil microbes and talking about microbial diversity in soil. This was part of a program run through the Arthur Holden Leadership Institute.

PRESENTATIONS

Invited Talks

Carrino-Kyker S.R., Stuble K.L., Medeiros J.S., Watson M., and Burke D.J. Slow and steady: The intersection of long-term data collection and citizen science for ecological advancement. Ecological Society of America Conference. INSPIRE Session 16: Public Gardens in the Changing World: The Unique Position of Arboreta and Botanical Gardens to Address Today's Ecological Challenges. Louisville, KY. August 15.

Kyker S.R. and Burke D.J. (2016) What's P got to do with it? The effects of soil pH and P availability on mycorrhizal fungi in temperate hardwood forests. Environmental Science Program Seminar Series. Cleveland State University. September 30.

Kyker S.R. (2013) Getting by with a little help from a friend: How symbiotic root fungi help maple trees overcome phosphorus limitations. The Holden Arboretum's Scientist Lecture Series, Kirtland, OH. February 21.

Carrino-Kyker S.R. (2008) Little wetlands in the big city: the response of vernal pool microbial communities to environmental fluctuation and land use patterns. Cleveland Metroparks Second Annual Natural Resources Field Research Update, Cleveland, OH. May 8.

Oral Presentations

Carrino-Kyker S.R., Stuble K.L., Sabat Bonilla S.A., and Burke D.J. (2018) Soil biota shifts in response to land use history can influence aboveground plant community composition in a hardwood forest. Ecological Society of America Conference, New Orleans, LA. August 9.

Carrino-Kyker S.R., Hoke A.J., Chervenak C.F., Hewins C.R., and Burke D.J. (2017) Mycorrhizal fungi and extracellular enzyme activities associated with root mats in a temperate forest respond to changes in soil pH and phosphorus addition. Ecological Society of America Conference, Portland, OR. August 7.

- Carrino-Kyker S.R.**, Kluber L.A., Petersen S.M., Coyle K.P., Hewins C.R., DeForest J.L., Smemo K.A., and Burke D.J. (2014) Experimental pH and P manipulation alters root-associated fungal community structure in temperate hardwood forests. Ecological Society of America Conference, Sacramento, CA. August 14.
- Burke D.J., **Carrino-Kyker S.R.**, Kluber L.A., Petersen S.M., Coyle K.P., DeForest J.L., Smemo K.A., and Hewins C.R. (2013) Effects of soil pH and P availability on root associated fungal communities in a temperate hardwood forest. Botany 2013, New Orleans, LA. July 29.
- Carrino-Kyker S.R.**, Burke D.J., Smemo K.A., and López-Gutiérrez J.C. (2010) Vernal pool microbial community responses to environmental change: A microcosm study. Ecological Society of America Conference, Pittsburgh, PA. August 4.
- Carrino-Kyker S.R.** (2010) Microbial community responses to environmental change: An investigation in vernal pools. Department of Biology Seminar Series, Case Western Reserve University, April 20.
- Carrino-Kyker S.R.** (2008) Response and function of vernal pool microbial communities to environmental change. Department of Biology Seminar Series, Case Western Reserve University, May 5.
- Carrino-Kyker S.R.** and Swanson A.K. (2007) Little wetlands in the big city: microbial diversity of vernal pools in and around Cleveland, Ohio. Botany 2007, Chicago IL. July 11.
- Carrino-Kyker S.R.** and Swanson A.K. (2007) Little wetlands in the big city: microbial diversity of vernal pools in and around Cleveland, Ohio. Midwest Ecology and Evolution Conference, Kent State University, Kent, OH. March 11.
- Carrino S.R.** (2005) Diversity and physicochemical description of Northeastern Ohio vernal pools. Department of Biology Seminar Series, Case Western Reserve University, December 15.
- Carrino S.R.** and Swanson A.K. (2005) Little wetlands in the big city: Microbial molecular biodiversity among and within urban and non-urban GIS-characterized vernal pools of Northeastern Ohio. Northeast Algal Society, Rockport, ME. April 16.
- Carrino S.R.** and Swanson A.K. (2004) The utility of molecular genomics in assessing microorganismal ephemeral communities. Midwest Ecology and Evolution Conference, University of Notre Dame, South Bend, IN. March 6.

Posters

- Carrino-Kyker S.R.**, Stuble K.L., Sabat Bonilla S.A., and Burke, D.J. (2019) The legacy of agricultural land use can have a long-term impact on soil biota following reforestation. Natural Areas Conference, Pittsburgh, PA. October 8.
- Hoke A.J., Burke D.J., **Kyker S.**, Koch J., Martin D., and Carta L. (2019) Beech Leaf Disease: Investigating Ohio beech microbiome in search of a cause. Ecological Society of America Conference, Louisville, KY. August 15.
- Paolucci A.M., Rauschert E.S.J., Burke D.J., and **Carrino-Kyker S.R.** (2019) The relationship between endophytic root fungi and the success of the invasive plant, lesser celandine. Ohio Invasive Plant Council Research Conference, Columbus, OH. February 13.
- Dominguez A., Pietrasiak, N. Lehnhoff E., Burke D. and **Kyker S.** (2019) Revealing the rhizosphere microbial communities of the invasive *Eragrostis lehmanniana* and native *Bouteloua eriopoda* in a climate manipulations study. Soil Science Society of America International Soils Meeting. San Diego, CA. January 7.

- Paolucci A.M., Rauschert E.S.J., Burke D.J., and **Carrino-Kyker S.R.** (2018) The relationship between endophytic root fungi and the success of the invasive plant, lesser celandine. Ecological Society of America Conference, New Orleans, LA. August 8.
- Medeiros J.S., Mann M., Burns J.H., **Carrino-Kyker S.R.**, and Burke D.J. (2018) Ancestry and morphology determine leaf and root microbial communities of Rhododendrons, with implications for disease resistance. 21st Penn State Plant Biology Symposium: Wild and Tamed Phytobiomes. State College, PA. June 20.
- Dominguez A., Pietrasiak N., Lehnhoff E., and **Kyker S.** (2018) A comparison of the rhizosphere microbial communities of the invasive lovegrass and native black grama. New Mexico State University, College of Agricultural, Consumer, and Environmental Sciences Open House. April 14.
- Hoke A.J., **Carrino-Kyker S.R.**, and Burke D.J. (2017) Mycorrhizal fungal identification in surface root mats of *Fagus grandifolia*, *Quercus rubra*, and *Acer saccharum* in a mature forest. Ecological Society of America Conference, Portland, OR. August 10.
- Carrino-Kyker S.R.**, Coyle K.P., Kluber L.A., and Burke D.J. Do seasonal changes affect the soil microbial community response to ecosystem level acidification? (2016) International Society of Microbial Ecology Meeting, Montreal, QC. August 23.
- Carrino-Kyker S.R.**, Kluber L.A., Hewins C.R., Coyle K.P., Smemo K.A., and Burke D.J. (2012) Regulation of arbuscular mycorrhizal phosphate transporter genes in acidic forest soils. Soil Science Society of America Meeting, Cincinnati, OH. October 24.
- Carrino-Kyker S.R.**, Kluber L.A., Burke D.J., DeForest J.L., and Smemo K.A. (2012) Experimentally reversing soil acidification in NE hardwood forests: soil microbial and biogeochemical responses. 4th International EcoSummit, Columbus, OH. September 2.
- DeForest J.L., Shaw A.N., Kluber L.A., Burke D.J., **Carrino-Kyker S.R.**, and Smemo K.A. (2011) Phosphorus constrains accelerated nitrogen cycling in limed acidic forests. AGU Fall Meeting, San Francisco, CA. December 8.
- Carrino-Kyker S.R.**, Smemo K.A., and Burke D.J. (2011) Metagenomic analysis of microbial community structure and metabolic diversity in experimental vernal pools with and without NO₃⁻ addition. Ecological Society of America Conference, Austin, TX. August 3.
- Kluber L.A., Burke D.J., **Carrino-Kyker S.R.**, DeForest J.L., Hewins C.R., Shaw A.N., and Smemo K.A. (2011) What's P got to do with it? Mycorrhizal and biogeochemical response to experimental pH and P manipulation in acidic hardwood forests. Ecological Society of America Conference, Austin, TX. August 3.
- Smemo K.A., DeForest J.L., Burke D.J., Kluber L.A., **Carrino-Kyker S.R.**, and Elliott H. (2010) P limitation and microbial biogeochemistry in acidic forest soils of the Northeastern United States. AGU Fall Meeting, San Francisco, CA. December 14.
- Benard M.F., **Carrino-Kyker S.R.**, and Burke D.J. (2010) Effects of intraspecific genetic diversity on ecological communities are context-dependent. Ecological Society of America Conference, Pittsburgh, PA. August 4.
- Carrino-Kyker S.R.** and Burke D.J. (2008) The response of vernal pool microbial communities to environmental fluctuation and land use patterns. Ecological Society of America Conference, Milwaukee, WI. August 5.
- Cullis C.A., Ahmed S., Assar A., Babar A., Bentley D., Brady M., Butz L., Cantor A., Coutryman E., Imam K., Lavik A., Matires K., Michelson A., Molnar A., Neyman A., Nichols L., Patel M., Ponomareva O., Rich N., Schreiner A., Stofko E., Vijayvargiya N., Yang S., Yu

Y., **Carrino S.R.** (2007) Developing DNA markers for underserved crops important for the developing world. Research ShowCASE, Case Western Reserve University, Cleveland OH. April 12.

Cullis C.A., Aultman A., Bair E., Brandt E., Chang C., Chang J., Chen J., Cook D., Davis S., Hengenius J., Hua J., Kinsey R., Kramp D., Lake M., Lavik J.P., Mao M., Mehta P., Patel K., Predina J., Singh R., Moss T., Townsley E., Ueda M., Voss K., Warsch S., Wentzel S., Yan F., Wilson M., Zhao Y., Sutak V., **Carrino S.R.** (2006) Developing DNA markers for underserved crops important for the developing world. Research ShowCASE, Case Western Reserve University, Cleveland OH. April 6.

Carrino S.R. and Smith-Huerta N.L. (2002) Effects of nutrient supplementation on components of reproduction in the wildflower *Clarkia unguiculata* (Onagraceae). Botany 2002, University of Wisconsin, Madison, WI. August 3.