

HANNAH J. BROADLEY, PhD

Postdoctoral Research Associate
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EDUCATION

- Ph.D. Organismic and Evolutionary Biology** 2018
University of Massachusetts, Amherst, MA
Dissertation: *Impact of native natural enemies on populations of the invasive winter moth (Operophtera brumata L) in the northeast United States*
Advisor: Dr. Joseph S. Elkinton, Department of Environmental Conservation
- M.S. Organismic and Evolutionary Biology** 2016
University of Massachusetts, Amherst, MA
- B.S. Environmental Studies, Cum Laude** 2010
Bates College, Lewiston, ME

CURRENT APPOINTMENT

Postdoctoral Research Associate 2018- Present
Cooperative agreement
Department of Environmental Conservation, University of Massachusetts, Amherst, Massachusetts & USDA APHIS, Plant Protection and Quarantine, Science and Technology, Buzzards Bay, Massachusetts

My current projects include:

- Studying the general ecology and biology of a host-specific, parasitic wasp of the invasive insect Spotted lanternfly (*Lycorma delicatula*)
- Developing research to determine the distribution and natural enemy complex of the Roseau cane scale (*Nipponaclerda biwakoensis*)

HONORS AND AWARDS

Plant Pest and Disease Management and Disaster Prevention Program (Farm Bill), FY2019 \$97,873.00
Title: *Determining the distribution and natural enemy complex of the Roseau Cane Scale in Asia*

1st Place, Gerald N. Lanier Student Forum, Northeast Forest Pest Council, 2018 \$225.00

Society of Invertebrate Pathology, Virus Division Travel Award, 2017 \$750.00

Irwin Martin Award, Research in Organismic and Evolutionary Biology, 2017 \$2500.00

Natural History Collections Summer Scholarship, 2017 \$3500.00

NSF GRFP Learning Community Outreach Grant, Individual Professional Development \$1000.00

Graduate School Fieldwork Grant, 2017 \$3300.00

College of Natural Sciences Teaching Fellowship, 2015, 2016 \$6000.00

Graduate School Dissertation Research Grant, 2015 \$1000.00

Organismal and Evolutionary Biology Travel Grant, 2013-2015 \$1500.00

2nd Place, Gerald N. Lanier Student Forum, Northeast Forest Pest Council, 2014, 2015 \$440.00

Honorable Mention, NSF Graduate Research Fellowship, 2014

Cum Laude (GPA: 3.72), Bates College, ME. 2010

PUBLICATIONS

(Manuscripts in preparation)

- Broadley, H.J.**, G.H. Boettner, J.C. Andersen, T. Klemola, J.P. Burand, and J.S. Elkinton. Comparative population ecology of an introduced geometrid (*Operophtera brumata*, L.) and its native congener (*Operophtera bruceata*, Hulst). In Prep.
- Broadley, H.J.**, B. Schneider, G.J. Boettner, and J.S. Elkinton. The role of native natural enemies of pupae and the biological control agent *Cyzenis albicans* in the population regulation of an invasive geometrid, winter moth (*Operophtera brumata*, L.). In Prep.
- Elkinton, J.S., G.J. Boettner, and **H.J. Broadley**. Converting a serious invasive defoliator to a non-pest: winter moth, *Operophtera brumata* L., in the northeastern United States. In Prep.
- Malek, R., J.M. Kaser, J. Gould, **H.J. Broadley**, G. Anfora, K.A. Hoelmer. Footprints and ootheca of *Lycorma delicatula* influence host-searching and -acceptance of the egg-parasitoid *Anastatus orientalis*. In Prep.
- Elkinton, J.S., T.D. Bittner, V.J. Pasquarella, G.H. Boettner, A.M. Liebhold, J.R. Gould, H. Faubert, L. Tewksbury, **H.J. Broadley**, N.P. Havill, and A.E. Hajek. Relating Aerial Deposition of *Entomophaga maimaiga* Conidia to Mortality of Gypsy Moth (Lepidoptera: Erebidiae) Larvae and Nearby Defoliation. In Prep.

(Manuscripts in review)

- Broadley, H.J.**, J.S. Elkinton, R. Kula, G.J. Boettner, B. Griffin, and J.C. Andersen. Recruitment of native parasitic wasps to populations of the invasive winter moth in the Northeastern United States. Biological Invasions. Accepted with minor revisions.
- Broadley, H.J.**, K.L. Cottingham, N.A. Baer, K.C. Weathers, H.A. Ewing, R. Chaves-Ulloa, J. Chickering, A.M. Wilson, J. Shrestha, and C.Y. Chen. Factors affecting MeHg bioaccumulation in stream biota: the role of dissolved organic carbon and diet. Ecotoxicology. Accepted with revisions.
- Andersen, J.C., N.P. Havill, **H.J. Broadley**, G.H. Boettner, A. Caccone, and J.S. Elkinton. Widespread hybridization among native and invasive species of *Operophtera* moths (Lepidoptera: Geometridae) in Europe and North America. Biological Invasions. In Review.

(Published)

- Donahue, K., **H.J. Broadley**, J.S. Elkinton, J.P. Burand, W. Huang, and J.C. Andersen. Using the SSU, ITS, and Ribosomal DNA Operon Arrangement to Characterize Two Microsporidia Infecting Bruce spanworm, *Operophtera bruceata* (Lepidoptera: Geometridae). Journal of Eukaryotic Microbiology. In Press. DOI 10.1111/jeu.12685.
- Broadley, H.J.**, E.A. Kelly, J.S. Elkinton, R. Kula, and G.J. Boettner. 2018. Identification and impact of hyperparasitoids and predators affecting *Cyzenis albicans* (Tachinidae), a recently introduced biological control agent of winter moth (*Operophtera brumata*, L.) in the northeastern U.S.A. Biological Control, 121:99-108. DOI 10.1016/j.biocontrol.2018.01.011
- Buckman, K.L., V.F. Taylor, **H.J. Broadley**, D. Hocking, P. Balcom, R. Mason, K. Nislow, and C.Y. Chen. 2017. Methylmercury bioaccumulation in an urban estuary: Delaware River USA. Estuaries and Coasts. DOI 10.1007/s12237-017-0232-3.
- Broadley, H.J.**, M. Boucher, J.P. Burand, and J.S. Elkinton. 2016. The phylogenetic relationship and cross-infection of nucleopolyhedroviruses between the invasive winter moth (*Operophtera brumata*) and its native congener, Bruce spanworm (*O. bruceata*). Journal of Invertebrate Pathology, 143:61-68. DOI: 10.1016/j.jip.2016.11.016

- Havill, N.P., J.S. Elkinton, J.C. Andersen, S.B. Hagen, **H.J. Broadley**, G.J. Boettner, A. Caccone. 2016. Asymmetric hybridization between non-native winter moth, *Operophtera brumata* (Lepidoptera: Geometridae), and native Bruce spanworm, *O. bruceata*, in the northeastern United States, assessed with novel microsatellites and SNPs. *Bulletin of Entomological Research*. DOI:10.1017/S0007485316000857
- Pepi, A.A., **H.J. Broadley**, and J.S. Elkinton. Density-dependent effects of larval dispersal mediated by host plant quality on population of an invasive insect. 2016. *Oecologia*, 182:499 – 509. DOI: 10.1007/s00442-016-3689-z
- Chaves-Ulloa, R., B.W. Taylor, **H.J. Broadley**, K.L. Cottingham, N.A. Baer, K.C. Weathers, H.A. Ewing, C.Y. Chen. 2016. Dissolved organic carbon modulates mercury concentrations in insect subsidies from streams to terrestrial consumers. *Ecological Applications*, 26(6):1771-1784. DOI:10.1890/15-0025.1
- Buckman, K.L., M. Marvin-DiPasquale, V.F. Taylor, A. Chalmers, **H.J. Broadley**, J. Agee, B.P. Jackson, C.Y. Chen. 2015. Influence of a chlor-alkali superfund site on mercury bioaccumulation in periphyton and low-trophic level fauna. *Environmental Toxicology*. DOI: 10.1002/etc.2964
- Broadley, H.J.**, K.L. Buckman, D.M. Bugge, and C.Y. Chen. 2013. Spatial variability of metal bioaccumulation in estuarine killifish (*Fundulus heteroclitus*) at the Callahan mine superfund site, Brooksville, ME. *Archives of Environmental Contamination and Toxicology*, 65:765–78. DOI 10.1007/s00244-013-9952-y.

SELECTED ORAL PRESENTATIONS

- Gould, J.R., K. Hoelmer, **H.J. Broadley**, X.Y. Wang, R. Malek. Biocontrol of spotted lanternfly: Two promising agents discovered in China. Eastern Branch Entomological Society of America, 9 - 12 March 2019. Blacksburg, Virginia
- Elkinton, J.S., **H.J. Broadley**, and G.H. Boettner. Winter moth in the northeast and its associated parasitoids, pathogens, and predators. 17 -19 March 2018. Eastern Branch Entomology Society of America, 89th Annual Meeting. Annapolis, MD.
- Broadley, H.J.**, J.S. Elkinton, and G.H. Boettner. The Role of Native Natural Enemies in the Biological Control of Winter moth (*Operophtera brumata* L) in the Northeast U.S. 13 – 15 March 2018. Northeast Forest Pest Council, 80th Annual Meeting. Burlington, VT.
- Elkinton, J.S., **H.J. Broadley**, and G.H. Boettner. Biological control of winter moth and the role of native natural enemies. 9 – 12 January 2018. XXIX USDA Interagency Research Forum on Invasive Species. Annapolis, MD.
- Broadley, H.J.**, J.S. Elkinton, and G.H. Boettner. Friend or Foe: The Role of Native, Natural Enemies in the Biological Control of Winter Moth. 11 – 15 September 2017. International Symposium on Biological Control of Arthropods. Langkawi, Malaysia.
- Elkinton, J.S., G.H. Boettner, and **H.J. Broadley**. Ecology and Biological Control of Outbreak Populations of Winter Moth in the Northeastern United States. 11 – 15 September 2017. International Symposium on Biological Control of Arthropods. Langkawi, Malaysia.
- Broadley, H.J.**, W. Kim, J.P. Burand, and J.S. Elkinton. Tracing the Origin of Nucleopolyhedrovirus from an Invasive Species, Winter Moth *Operophtera brumata* L. (Lepidoptera: Geometridae). 14 – 18 August 2017. Society of Invertebrate Pathology. San Diego, CA.
- Broadley, H.J.**, and Valerie Pasquarella. Update on the gypsy moth outbreak in New England. 18 – 21 March 2017. Entomological Society of America – Eastern Branch Meeting. Newport, RI.
- Broadley, H.J.**, J.S. Elkinton, G.H. Boettner, and J.P. Burand. Why are Bruce spanworm, *Operophtera bruceata*, outbreaks in North America so infrequent and short-lived? 25 – 30 September 2016. International Congress of Entomology. Orlando, FL.

- Broadley, H.J.,** G. Boettner, and J.S. Elkinton. Comparative population ecology of winter moth and Bruce spanworm in North America. 13-15 Jan 2016. USDA Interagency Forum on Invasive Species.
- Broadley, H.J.,** G. Boettner, and J.S. Elkinton. Winter moth in the northeast and its associated parasitoids, pathogens, and predators. 3 – 7 January 2016. The Northeastern Plant, Pest, and Soils Conference. Philadelphia, PA.
- Broadley, H.J.,** J.P. Burand, M. Boucher, L.F. Solter, and J.S. Elkinton. Nucleopolyhedrovirus and microsporidia in winter moth (*Operophtera brumata*) and Bruce spanworm (*O. bruceata*) populations. August 2015. Society of Invertebrate Pathology, Vancouver, Canada.
- Broadley, H.J.,** B. Fleming, and J.S. Elkinton. Cold tolerance of winter moth overwintering eggs may limit range expansion. Northeast Forest Pest Council. 10 – 13 March 2015. Hanover, NH.
- Broadley, H.J.,** J.S. Elkinton, J.P. Burand, M. Boucher, K. Donahue, L.Tian, and L.F. Solter. Nucleopolyhedrovirus and microsporidia in winter moth (*Operophtera brumata*) and Bruce spanworm (*O. bruceata*) populations in the northeastern U.S. Gerald N. Lanier Student Forum. Northeast Forest Pest Council. 10 – 13 March 2015. Hanover, NH.
- Broadley, H. J.** and J.S. Elkinton. Biological Control of Winter Moth (*Operophtera brumata*) in Northeastern U.S.: Interaction between Predators and *Cyzenis albicans*. Northeast Forest Pest Council's Gerald N. Lanier Student Forum. 27 January 2014. Quebec, Canada.
- Broadley, H. J.** and J.S. Elkinton. Interactions Between Native Predators and in the Control of Winter Moth (*Operophtera brumata*) in Northeastern U.S.. 25th USDA *Cyzenis albicans* Interagency Forum on Invasive Species. 1 – 10 January 2014. Loews Annapolis, MD.

SELECTED POSTER PRESENTATIONS

- Broadley, H.J.,** J.S. Elkinton, and G.H. Boettner. Specialist and generalist natural enemies interact to suppress population outbreaks of the invasive winter moth. Eastern Branch Entomological Society of America, 9 - 12 March 2019. Blacksburg, Virginia
- Broadley, H.J.,** J.S. Elkinton, and G.H. Boettner. Interactions Between Native Predators and an Introduced Parasitoid in the Control of the Invasive Geometrid Winter Moth (*Operophtera brumata*). USDA Interagency Forum on Invasive Species. 13 - 16 January 2015. Annapolis, MD
- Broadley, H.J.,** J.S. Elkinton, J.P. Burand, M. Boucher, K. Donahue, L.Tian, and L.F. Solter. Nucleopolyhedrovirus and Microsporidia in Winter Moth (*Operophtera brumata*) and Bruce Spanworm (*O. bruceata*) populations in the Northeast US. 26th USDA Interagency Forum on Invasive Species. 13 - 16 January 2015. Annapolis, MD.
- Broadley, H.J.,** J.S. Elkinton, and G.H. Boettner. Interactions Between Native Predators and an Introduced Parasitoid in the Control of the Invasive Geometrid Winter Moth (*Operophtera brumata*). Annual Meeting of Entomological Society of America. 16 - 19 Nov. 2014, Portland, OR
- Broadley, H.J.,** J.S. Elkinton, J.P. Burand, L.Tian, and L.F. Solter. Nucleopolyhedrovirus and Microsporidia in Winter Moth (*Operophtera brumata* (L.)) and Bruce Spanworm (*O. bruceata* (Hurst)) populations in the Northeast US. 47th Annual Meeting of the Society of Invertebrate Pathology, Mainz, Germany, 3 – 7 August 2014

TEACHING

Instructor **University of Massachusetts, Amherst**
 Phylogenetic Analyses, Organizer for Independent Study (BIO 496, 1 credit), Spring 2017
 Boom and Bust: Population Ecology, First year seminar (NATSCI 191, 1 credit), 2 sections, Fall 2016
 Putting the Pop in Population Ecology, First year seminar (NATSCI 191, 1 credit), 2 sections, Fall 2015

Teaching Assistant**University of Massachusetts, Amherst**

Animal Communication (BIO 551, 3 credits), Fall 2016

Introductory Biology 2 (BIO 152, 3 credits), Fall 2015

Biology of Social Issues (BIO 105, 4 credits), UMass, Amherst, Spring 2014, 2015

Guest Lecturer**UMass Amherst/Bay Path University**

- “The Hungry Caterpillar in Real Life” Bay Path Women in STEM Honors (WiSH) Seminar, Spring 2017
- “Insect Orders Lab” Insects and Diseases of Forests and Shade Trees (NRC 572), Spring 2017
- “Insect Zoo Day” Insects and Human Society (NCR 126), Spring 2014, 2015, 2016, and 2017
- “Day in the life of a Graduate Student” Honors Experimental Methods in Ecology (BIO 422H), Spring 2016, 2017

Supervisor/Mentor**UMass Amherst/Dartmouth College**

I have supervised two honors biology thesis students:

- Katelyn Donahue (2015 – 2016), Title: *Identification and Characterization of Microsporidia in Bruce Spanworm (Operophtera bruceata)*
- Emily Kelly (2016 – 2017), Title: *Are native hyperparasitoids undermining the winter moth biological control effort?*

Both studies are published!

I have provided mentorship for 7 thesis and undergraduate research projects.

- Brian Griffin, Undergraduate honors thesis student, 2017 – 2018
- Gennifer Greenberg, Grant Hespeler, and Julia Cox, undergraduate research projects, 2016 - 2017
- Quentin Dupupet, Emma Lutz, undergraduate research projects, 2015 – 2016.
- Kaitlyn O’Donnell, a UMaine grad student, I trained to identify winter moth virus via DNA extraction and analysis.

I have supervised and mentored 16 research technicians and research assistance and 5 volunteers who have assisted in my field and laboratory research. This mentorship of general laboratory, field techniques, and career development.

Environmental Educator**Montshire Museum of Science, Norwich, VT**

Preschool Nature Camp, Kindergarten, Summer 2006

TEACHING CERTIFICATES

Practitioner certificate, Center for the Integration of Research, Teaching and Learning (CIRTL),
Practitioner project: “The Role of Self-Directed Learning for an Outgoing and a Reserved Classroom Environment” April 2016

Associate certificate, Center for the Integration of Res., Teaching and Learning (CIRTL), Fall 2015

PREVIOUS RESEARCH APPOINTMENTS

Graduate Research Assistant, April 2013–August 2018

Department of Environmental Conservation, University of Massachusetts Amherst

Research Assistant, Heavy Metals Research, Chen Lab, Department of Biological Sciences,
Dartmouth College, Hanover, NH, Spring 2010 - 2013

Research Assistant, Water Chemistry Research, Ewing Lab, Environmental Studies Program,
Bates College, Lewiston, ME, Spring 2009 - 2010

EXTENSION AND OUTREACH

Blog Co-founder, Chair of Managing Editors, and Writer, That's Life [Science], 2015 – 2018

- Interdepartmental Life Science Outreach Blog, available at thatslifesci.com
- Awarded Most Helpful Editor, 2016, 2017 and Most Surprising Post, 2016

Local Advertising and Vice Treasurer, Science Café, 2015 – 2018

- Grad. student initiative hosting evening seminars that engage the community in science discourse
- Managed advertising and supported the treasury

Invited Panelist, Center of Excellence for Women in STEM, Bay Path University, Fall 2015, 2016

- Contributed to two half day, professional development and networking workshop for students and professional women in the STEM fields

Secretary and member, Fernald Club, Entomological Outreach Initiative, 2013 – 2015

- Secretary and active member of student organization that promotes entomology through scientific innovation, insect conservation, and outreach education for the western Mass. Community.

Co-author of US Forest Service brochure

- Describes success of winter moth biological control
https://www.fs.fed.us/foresthealth/technology/pdfs/FHAAST-2018-03_Biology_Control_Winter-Moth.pdf

PROFESSIONAL SERVICE AND ASSOCIATIONS

College, University, and Department Service:

- Bates Alumni in Admissions, Prospective Student Interviewer (18 interviews), 2010 – present
- Charles Paul Alexander Speaker Committee, Prominent speakers in Entomology, 2013 – 2018
- Organismic and Evolutionary Biology Grad. Student Program Steering Committee, 2015 – 2017
- New Student Mentoring Committee, Organismic and Evolutionary Biology, 2015 – 2017
- Sinauer Speaker Committee, Prominent speakers in Biology and Neurobiology, 2014 – 2016
- Organismic and Evolutionary Biology, Seminar Committee, 2014 – 2015

Journal referee:

- Science of the Total Environment (2)
- Archives of Environmental Contamination and Toxicology (1)
- African Journal of Environmental Science and Technology (1)
- Drug and Chemical Toxicology (1)

Professional Membership:

- Entomological Society of America, 2014 – present
- Society of Insect Pathology, 2015 – present

- Sigma Xi, 2010 – present
- Lepidopterists' Society 2018 – present

ANALYTICAL SKILLS

Microscopy, DNA extraction, polymerase chain reaction, gel electrophoresis, sequencing techniques, Geneious, substitution model selection, phylogenetic analyses (Bayesian, Maximum Likelihood, Parsimony, and Neighbor joining)
R and JMP statistical programs, data management, MS Word, Excel, and PowerPoint
ArcGIS mapping and analysis