BRYAN NICHOLAS DANFORTH

ACADEMIC RANK: Professor

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TRAINING: **BS zoology**, Duke University, Durham, NC, 1983.

MS entomology, University of Kansas, Lawrence, KS, 1987.

Advisor: C.D. Michener.

PhD entomology, University of Kansas, Lawrence, KS, May, 1991. Advisor: C.D. Michener.

FIELD OF SPECIALIZATION

Research/Teaching: Insect phylogeny, social evolution, behavioral ecology, systematics, pollination biology. Specialization: phylogeny, ecology, and social evolution of bees.

PROFESSIONAL EXPERIENCE

1982 Teaching assistant, Department of Zoology, Duke University, Durham, NC (Animal Diversity)

1985 Teaching assistant, Department of Entomology, University of Kansas, Lawrence, KS (Introductory Biology).

1985-1986 Teaching assistant, Department of Entomology, University of Kansas, Lawrence, KS (Introductory Entomology).

1987-1989 Research assistant, Department of Entomology, University of Kansas, Lawrence, KS. Supervisor: C.D. Michener.

1989-1991 Pre-doctoral Fellow. Department of Entomology, Smithsonian Institution. Supervisor: Ronald J. McGinley.

1991-1992 Research Assistant, Department of Entomology, Smithsonian Institution. Supervisor: Ronald J. McGinley.

1992 Post-doc, Department of Entomology, University of California, Riverside. Advisor: P. Kirk Visscher

1993-1995 Post-doc, Department of Entomology, Cornell University, Ithaca, NY. Advisor: G.C. Eickwort.

1993 Lecturer, Genome Variation Analysis Facility, Cornell University, Ithaca, NY; Analysis of Genomic Variation (Instructor: Bernie May)

1995 Lecturer, Insect Morphology, Cornell University, Ithaca, NY

1996-2002 Assistant Professor, Cornell University, Ithaca, NY

2002-2008 Associate Professor, Cornell University, Ithaca, NY

2008-Present Professor, Cornell University, Ithaca, NY

PROFESSIONAL AWARDS

Cum Laude, Duke University, 1983.

Fulbright Scholarship Finalist, 1983.

H.B. Hungerford Award for an outstanding thesis, University of Kansas, 1987.

United States Department of Agriculture, Unit Award for Superior Service, 1993.

Thomas Say Award, Entomological Society of America, 2014

CALS Outstanding Accomplishments in Extension and Outreach (group award), 2017

PROFESSIONAL ACITIVITIES (1990 to present)

A. Professional societies

American Association for the Advancement of Science

Entomological Society of America

Journal of the Kansas Entomological Society

Pan-Pacific Entomological Society

Society of Systematic Biologists

Society for the Study of Evolution

Society for Molecular Biology and Evolution

B. Professional Assignments

Reviewer for the following journals:

American Museum Novitates

American Naturalist

Animal Behaviour

Annals of the Entomological Society of America

Annals of the South African Museum

Apidologie

Behavioral Ecology

Behavioral Ecology and Sociobiology

Biological Journal of the Linnean Society

Canadian Entomologist

Canadian Journal of Zoology

Cladistics

Current Biology

Ecology

Ecological Entomology

Environmental Entomology

Entomological News

Entomological Society of Washington
Ethology
Evolutionary Biology
Gene
Heredity
Insectes Sociaux
Journal of Animal Ecology
Journal of Apicultural Research
Journal of Applied Ecology
Journal of Biogeography
Journal of Insect Behavior
Journal of the Kansas Entomological Society
Journal of Zoology
Molecular Ecology
Molecular Phylogenetics and Evolution
Oecologia
Pan-Pacific Entomologist
Proceedings Royal Society of London
Proceedings of the National Academy of Sciences (PNAS)
Science (AAAS)
Systematic Biology
Systematic Entomology
Zoologica Scripta

Ad hoc grant reviewer for:
Australian National Research Council
National Geographic Society
National Science Foundation (USA)
National Sciences and Engineering Research Council (Canada)

C. Invited Lectures/Seminars

University of Maryland, Department of Entomology, 10 November, 1991

Harvard University, Department of Organismal and Evolutionary Biology, 20 February, 1992

York University, Department of Biology, 7 March, 1994

University of Kansas, Department of Entomology, 20 November, 1997

State University of New York, Stonybrook, 15 October, 1998

University of Maryland, Department of Entomology, 12 March, 2001

Ithaca College, Department of Biology, 26 February, 2004

Cornell University,Department of Ecology and Evolutionary Biology, 24 January, 2005

American Museum of Natural History, Department of Invertebrate Zoology, 15 April, 2005

University of Illinois, Urbana-Champagne, Apr. 17, 2006

Harvard University, Cambridge, MA, Oct. 5, 2006

Dresden meeting on insect phylogeny September 21-23, 2007

International Pollination Symposium June 24-28, 2007

Evolution Joint Annual Meeting, July 1-3, 2008

XXIII International Congress of Entomology, July 6-12, 2008

Society for Integrative and Comparative Biology, January 3-7, 2009

56th Annual Systematics Symposium, Missouri Botanical Garden, October 9-11, 2009

Department of Entomology, Cornell Experiment Station, Geneva, NY, November 2, 2009

UC Davis Entomology, Davis, CA, September 20, 2012, “The new view of bee phylogeny”

Rutgers University, Rutgers, NJ, November 29, 2012, “The new view of bee phylogeny”

Eastern Branch, Entomological Society of America, "How molecular data have altered our understanding of bee phylogeny and evolution", Lancaster, PA, March 16-19, 2013

Pennsylvania State University, State College, PA, February 27, 2014, “The new view of bee phylogeny”

University of Rochester, Rochester, NY, November 7, 2014, “The new view of bee phylogeny”

University of Kansas, Lawrence, KS, February 9, 2015, “The new view of bee phylogeny”

D. Invited Symposia

ESA Symposium on the Biology of Native Bees, 20 December, 1992

ESA Symposium on Phylogenomics, 26 October, 2003

ESA Symposium on Bee Phylogeny, 15 November, 2004

International IUSSI meeting; Symposium on Bee Phylogeny, Aug. 2006

Dresden meeting on insect phylogeny, 21 September 2007

ESA Symposium on fossil-calibrated phylogenies. 15 December, 2010

E. University, College, and Departmental Committees

Faculty Representative to the Career Development Office (1998-2002)

Cornell University Insect Collection Committee/Bradley Committee (1996-present)

Department of Entomology representative to the CALS Faculty Senate (1998-2000)

Chair, Department of Entomology Curriculum Committee (2005-2011)

CALS Curriculum Committee representative for Entomology (2005-2011)

Department of Entomology Graduate Admissions Committee (1998-2002)

CALS Committee on Teaching and Learning (2008-2011)

Department of Entomology Griswold Committee Chair (2011-2012)

CUIC Collections Manager Search Committee (Fall 2011)

Honeybee Extension Associate Search Committee (Fall 2015)

CUIC Collections Committee (2000-present)

University Faculty Senate, Entomology representative (2012-2015)

Chair, Department of Entomology (2017-present)

EvoDay organizer May 11, 2017. Organized a one-day event at the Lab of Ornithology on "Phylogenomics". Hosted the Harrison Lecturer, Brant Faircloth.

F. Outside activities

Advisory Panel, Southwestern Research Station, Portal, AZ. (Three year term: 1997-1999)

Doctoral Dissertation Improvement Grant Panel, National Science Foundation (24-25 Feb., 2000). Reviewed 25 grants.

Research Associate, Division of Invertebrate Biology, American Museum of Natural History, Central Park west @ 79th St., New York, NY

Editor, Special Issue of Apidologie [vol. 39(1)], "Insights into Bee Evolution: A tribute to Charles D. Michener" (co-editor: Eduardo Almeida)

International Scientific Board of Apidologie (January 2012-December 2015). INRA Centre PACA/ Dept SPE, 400 route des Chappes, 06903 Sophia-Antipolis Cedex, FRANCE [http://www.apidologie.org/]

NYS DEC advisory panel on surveying the bees of NY. Meetings and conference calls starting in Fall, 2016 and extending to Spring, 2019

The Bee Course

"The Bee Course" has been taught annually for over twenty years at the Southwestern Research Station in Portal, AZ. I have contributed to the course since its inception in 1999. In 2018, I took over as lead instructor for the course (from Jerry Rozen) and am now organizing the course on an annual basis. The course is limited to 24 students and we typically receive between 50 and 100 applicants for each offering. The Bee Course provides instruction in bee identification (to the generic level) for all genera collected in North and Central America (using the following text book: Michener, C.D., R.J. McGinley & B.N. Danforth.1994. The Bee Genera of North and Central America (Hymenoptera: Apoidea). Smithsonian Institution Press, Washington, DC. vii+209pp.).

More information can be found on the website: https://www.thebeecourse.org/

Invited public lectures

Museum of the Earth, Ithaca, NY 19 March, 2005 [Public lecture on bees]

Finger Lakes Native Plant Society, 17 Oct., 2006 [Public lecture on bees]

Tompkins County Beekeepers Association, 19 Nov., 2006 [Public lecture on bees]

Jupiter Island Club, West Palm Beach, FL 19 Jan., 2008 [Public lecture on bees]

Taft School, Watertown, CT 16 Nov., 2012 [Lecture to AP Biology class]

Finger Lakes Beekeeping club, 21 April, 2013 [Public lecture on apple pollination]

Tompkins County Environmental Management Council, 12 March, 2015 [Public lecture entitled “Honey bees, colony collapse disorder, and the importance of wild bees in crop pollination”]

Science Cabaret, 21 April, 2015 [Public lecture on the importance of wild bees for crop pollination]

GRANT FUNDING

Current grant funding:

National Science Foundation (DEB: Systematic Biology): ($850,500; Jan. 5, 2016 to Jan. 4, 2020). Title: title: Phylogeny and diversification of the stinging Hymenoptera (Aculeata) using targeted enrichment of ultra-conserved elements. Lead PI: Bryan Danforth (Sean Brady, James Pitts, Robert Ross, co-PIs)

NYS-DEC grant: ($120,197; Sept 1, 2018 to Aug 31, 2021) – Title: Implementing the Empire State Native Pollinator Survey (ESNPS).

USDA-NIFA grant: ($545,212?; April 1, 2019 to March 31, 2022) – Title: Bee-microbe symbioses and their impact on pollinator health. Shawn Steffan (Univ Wisconsin), co-PI

USDA-NIFA grant: ($499,185; April 1, 2019 to March 31, 2022) – Title: Fungicides and pollinator health: quantifying mechanisms of stress to inform real world solutions. Scott McArt PI, Danforth co-PI

Hatch Multistate grant: ($35,000/year; Oct. 1, 2019 to Sept 30, 2022) – Title: The brood cell microbiome of bees – diversity, vulnerability and the importance to pollinator health.

National Science Foundation (DEB: Systematic Biology): ($612,961; Sept 1 2019 to Aug 31 2022) – Title: Collaborative Research: The brood cell microbiome of solitary bees: origin, diversity, function, vulnerability. Shawn Steffan (Univ Wisconsin), Rachel Vannette (UC Davis), and Quinn McFrederick (UC Riverside), co-PIs

Pending grant funding:

USDA-NIFA grant: ($650,000; Feb 1, 2020 to January 31, 2025) – Title: National Native Bee Monitoring Plan for the U.S. Lead PI: Hollis Woodard, Bryan Danforth co-PI (along with many others)

Past grant funding (in reverse chronological order):

USDA Hatch grant: ($88,500) (Oct. 1, 2015 to Sept 30, 2018). Title: The interacting effects of pesticides, pathogens, and symbionts on the squash bee: Peponapis pruinosa.

USDA-AFRI grant: ($495,925) (Feb. 1, 2011 to January 31, 2016). Title: Quantifying and enhancing pollination services provided by native bees for sustainable apple production.

USDA-Specialty Crop Research Initiative (SCRI) grant: ($129,488) (Jan. 2, 2012 to Dec. 31, 2016). Title: Pollination and Security for Fruit and Vegetable crops in the Northeast. Lead PI: Anne Averill, Umass, Amherst. Cornell subcontract. $2M grant

Apple Research and Development Program (ARDP), New York Farm and Markets grant: ($54,686) (March 1, 2015 - Feb. 28, 2016). Title: Mason bees as pesticide biomonitors in apple orchard habitats. Co-PIs: Katja Poveda, Brian Eitzer

New York Farm Viability Institute (NYFVI): ($100,000) (April 1, 2015 to March 31, 2017). Title: Northeast Pollinator Partnership: developing cost-effective pollinator management for New York apple growers

Atkinson Center for a Sustainable Future (Cornell University): ($99,581) (Sept. 1, 2012 to August 31, 2013) Title: Impacts of Pathogens and Pesticides on Wild Pollinators in Eastern Apple Orchards. Collaborators: Motoko Mukai (VTPMD), Eric Nelson (PLPA), and Andre Kessler (EEB)

USDA Hatch Grant: ($85,200) (Oct. 1, 2012 to Sept. 30 2015). Title: Pesticide and Pathogen Screening of the Alternative Pollinator Osmia cornifrons. Collaborators: EJ Blitzer, Shannon Hedtke.

National Science Foundation Improvements to Biological Research Collections (NSF-BRC) Program: ($150,314) (May 1, 2010 to April 30, 2014). Title: Collaborative databasing of North American bee collections within a global informatics network. Collaborative grant with John Ascher and Jerome Rozen (AMNH) and Douglas Yanega (UC Riverside). $3M grant

NSF (Systematics Program): ($370,000) [DEB-0742998] (February 15, 2008 to May 31, 2013). Title: REVSYS: Phylogeny and systematics of megachilid bees. Collaborative grant with Dr. Terry Griswold, USDA Bee Biology and Systematics Laboratory, Logan Utah

NSF (Systematics Program): ($393,736 + $7,500 REU supplement) [DEB-0814544] (September 1, 2008 to August 30, 2012). Title: Phylogeny of Apidae (Hymenoptera) with an emphasis on the evolution and antiquity of eusociality

USDA Hatch Grant: ($57,900) (Oct. 1, 2008 to Sept. 30 2011). Title: Diversity and Pollination Biology of Native and Managed Bees in Apple Orchards in New York

National Geographic Society (Fideliini) ($10,000). (Oct. 1, 2008 to Oct. 14, 2009) Title: Phylogeny, historical biogeography, and host-plant evolution of the Fideliini (Hymenoptera: Apoidea).

NSF (Doctoral Dissertation Improvement Grant Program): ($11,992) [DEB-0709956] (July 1, 2007 to June 30, 2008). Title: DISSERTATION RESEARCH: Evolution of cleptoparasitism in apid bees (Hymenoptera: Apidae).

NSF (Systematics Program): ($286,681) [DEB-0412176] (September 1, 2004 to August 31, 2008). Title: Phylogeny and historical biogeography of the primitive bee family Colletidae.

NSF (Systematics Program): ($185,745) [DEB-0211701] (July 15, 2002 to June 30, 2005 Title: Collaborative Research: Reconstructing the early evolution of the bees and the history of bee/angiosperm relationships.

NSF (Multi-user Equipment and Instrumentation Resources for Biological Sciences): ($123,745) [DBI-0400433] (July 1, 2004 to June 30, 2005). Title: A new capillary sequencer for the evolutionary genomics core facility at Cornell University (with K. Zamudio [project director], R. Harrison, J.J. Doyle, C.D. Hopkins).

NSF (Systematics Program): ($7,300) [DEB-0211701] (July 15, 2002 to June 30, 2005). REU supplement to DEB-0211701.

National Geographic Society: ($18,574, September 1, 2001 to July 31, 2003). Title: Historical biogeography and sociality of African halictine bees (NGS grant no. 6946-01)

NSF (Doctoral Dissertation Improvement Grant Program): ($9,383) [DDIG-0104893] (July 1, 2001 to June 30, 2003) Title: DISSERTATION RESEARCH: Phylogeny and evolution of subsocial behavior in the New World Treehopper family Membracinae (Homoptera: Membracidae).

NSF (Doctoral Dissertation Improvement Grant Program): ($7,000) [DDIG-0206096] (May 1, 2002 to April 31 2004). Title: DISSERTATION RESEARCH: Native Hawaiian bees (Hylaeus): phylogenetics and pollen usage.

NSF (Doctoral Dissertation Improvement Grant Program): ($9,880) [DDIG-0206093] (June 1 2002 to November 30 2003). Title: DISSERTATION RESEARCH: Phylogeny and evolution of host associations and fighting behavior in Neotropical derelomine weevils (Coleoptera: Curculionidae).

NSF (Systematics Program): ($150,000) [DEB-9815236] (April 15, 1999 to March 31, 2003). Title: Phylogenetic analysis of the subfamily Halictinae (Hymenoptera: Halictidae) with an analysis of social evolution.

Smithsonian Scholarly Studies Grant ($35,000; Jan. 2000- Dec. 2002). Title: Comparative population genetic structure and within-group genetic relatedness of solitary and social neotropical sweat bees (Lasioglossum, Halictidae) (in collaboration with William Wcislo, Smithsonian Insturition).

NATO Collaborative Research Grant. In collaboration with Prof. F. Andrietti in Milan, Italy ($6,000 for travel and per diem related expenses to study solitary ground-nesting bees)

NSF (Systematics Program): ($189,000) [DEB-9508647] (April 15, 1996 to March 31 1999). Title: Phylogenetic systematics and social evolution in the bee genus Lasioglossum (Hymenoptera: Halictidae).

NSF (Multi-user Equipment and Instrumentation Resources for Biological Sciences): ($120,234) [DBI-9970113] (April 1, 1999 to May 31 2001). Title: An Automated DNA sequencing and genotyping facility for studies of ecology, systematics, evolution, and behavior (with K. Zamudio [project director], R. Harrison, J.J. Doyle, H.K. Reeve).

USDA Hatch Grant: ($40,000) (July 1 1997 to June 31 2002). Title: Phylogenetic analysis, faunal studies, and social behavior of halictine bees in New York State.

PUBLICATIONS

Refereed publications (in reverse chronological order; n=109):

In prep:

Erin's Ascosphaera paper

Kristen's paper on Peponapis brood cell microbiome

Elizabeth's masarine paper

Encyclopedia of Social Insects – book chapter with Silas

111. Woodard, H.S. et al. (2019). Toward a national program for monitoring native bees. PNAS (submitted).

110. Centrella, M., L. Russo, N. Moreno-Ramirez, B. Eitzer, M. Van Dyke, B.N. Danforth, K. Poveda (2019). Landscape simplification reduces solitary bee performance in agroecosystems via increased pesticide exposure, reduced floral diet diversity, and their interaction. Journal of Applied Ecology [in review]

109. Steffan, S.A., H.R. Gaines-Day, P.S. Dharampal, Y. Chikaraishi, Y. Takizawa, B.N. Danforth (2019). Omnivory in bees: Elevated trophic positions among all major bee families. American Naturalist [in press]

108. Rozen, J.G., Jr., B.N. Danforth, C.S. Smith, B.L. Decker, N.N. Dorian, D. Dority, S.K. Kilpatrick, E. Krichilsky, A.N. Laws, K. Urban-Mead. 2019. Early nesting biology of the bee Caupolicana yarrowi (Cresson) (Colletidae: Diphaglossinae) and its cleptoparasite Triepeolus grandis (Friese) (Apidae: Nomadinae). American Museum Novitates 3931: 1-20 [published online June 28, 2019]

107. Minckley, R.L. & B.N. Danforth (2019). Sources and frequency of brood loss in solitary bees. Apidologie [published online June 20, 2019; DOI: 10.1007/s13592-019-00663-2]

106. Grab, H., M.G. Branstetter, N. Amon, K.R. Urban-Mead, M.G. Park, J. Gibbs, E.J. Blitzer, K. Poveda, G. Loeb, and B.N. Danforth (2019). Agriculturally dominated landscapes reduce bee phylogenetic diversity and pollination services. Science 363: 282-284 [published Jan. 18, 2019]

105. Murray, E.A., J. Burand, N. Trikoz, J. Schnabel, H. Grab, B.N. Danforth (2018). Viral transmission in honey bees and native bees, supported by a global black queen cell virus phylogeny. Environmental Microbiology 21(3): 972-983 [published online 10 December 2018; https://doi-org.proxy.library.cornell.edu/10.1111/1462-2920.14501]

104. Almeida, E.A.B, L. Packer, G.A.R. Melo, B.N. Danforth, S. Cardinal, F.B. Quinteiro, and M.R. Pie (2018). The diversification of neopasiphaeine bees during the Cenozoic (Hymenoptera: Colletidae). Zoologica Scripta [available online 18 December. DOI: 10.1111/zsc.12333]

103. Murray, E.A., S. Bossert, B.N. Danforth (2018). Pollenivory and the diversification dynamics of bees. Biology Letters 20180530 [available online 15 November; http://dx.doi.org/10.1098/rsbl.2018.0530]

102. Bossert, S., E. Murray, E.A.B. Almeida, S. Brady, B. Blaimer, B.N. Danforth (2018). Combining transcriptomes and ultraconserved elements to illuminate the phylogeny of Apidae. Molecular Phylogenetics and Evolution 130 (2019): 121–131 [available online 14 October]

101. Grab, H. K. Poveda, B.N. Danforth, G. Loeb (2018). Landscape context shifts the balance of costs and benefits from wildflower borders on multiple ecosystem services. Proceedings of the Royal Society of London B (Biological Sciences). [available online 1 August 2018.DOI: 10.1098/rspb.2018.1102]

100. Dorchin, A., B.N. Danforth, T. Griswold (2018). A new genus of eucerine bees endemic to southwestern North America revealed in phylogenetic analyses of the Eucera complex (Hymenoptera: Apidae: Eucerini). Arthropod Systematics and Phylogeny 76(2): 215-234 [open access: http://www.senckenberg.de/root/index.php?page_id=8057; available online 29 June, 2018]

99. Park, M.G., N.K. Joshi, E.G. Rajotte, D.J. Biddinger, J.E. Losey, B.N. Danforth (2018). Apple grower pollination practices and perceptions of alternative pollinators in New York and Pennsylvania. Renewable Agriculture and Food Systems 1–14. https://doi.org/10.1017/S1742170518000145

98. Bossert, S. and B.N. Danforth (2018). On the universality of target enrichment baits for phylogenomic research. Methods in Ecology and Evolution 00:1-8. https://doi.org/ 10.1111/2041-210X.12988.

97. Dorchin, A., M.M. López-Uribe, C.J. Praz, T. Griswold, B.N. Danforth (2018). Phylogeny, new generic-level classification, and historical biogeography of the Eucera complex (Hymenoptera: Apidae). Molecular Phylogenetics and Evolution 119: 81-92.

96. Grab, H., K. Poveda, B.N. Danforth, G. Loeb (2018). Landscape simplification reduces classical biological control and crop yield. Ecological Applications 28(2): 348–355 [published online 18 January 2018]

95. Pauw, A., B. Kahnt, M. Kuhlmann, D. Michez, G.A. Montgomery, E. Murray, B.N. Danforth (2017). Long-legged bees make adaptive leaps: linking adaptation to coevolution in a plant-pollinator network. Proceedings of the Royal Society of London, B 284 (1862), 20171707. [published online ## August, 2017, DOI: http://dx.doi.org/10.1098/rspb.2017.1707]

94. Kahnt, B., G.A. Montgomery, E. Murray, M. Kuhlmann, A. Pauw, D. Michez, R.J. Paxton, B.N. Danforth (2017). Playing with extremes: origins and evolution of exaggerated forelegs in South African Rediviva bees. Molecular Phylogenetics and Evolution 115: 95-105.

93. Russo, L. & B.N. Danforth (2017). Pollen preferences among the bee species visiting apple (Malus domesticus) in eastern New York. Apidologie 48(6): 806-820 [published online 3 July, 2017, DOI: 10.1007/s13592-017-0525-3]

92. Glastad, K.M. S.V. Arsenault, K.L. Vertacnik, S.M. Geib, S.Kay, B.N. Danforth, S.M. Rehan, C.R. Linnen, S.D. Kocher, B.G. Hunt (2017). Variation in DNA methylation is not consistently reflected by sociality in Hymenoptera. Genome Biol. Evol. 9(6):1687-1698.

91. Russo, L., E.J. Blitzer, M.L. Park, & B.N. Danforth (2017). Flower handling behavior and abundance determine the relative contribution of pollinators to seed set in apple orchards. Agriculture, Ecosystems and Environment 246: 102-108.

90. Lichtenberg, E.M., C.M. Kennedy, C. Kremen, et al. (2017). A global synthesis of the effects of diversified farming systems on arthropod diversity at field and landscape scales. Global Change Biology 6 [DOI: 10.1111/gcb.13714]

89. Grab, H., E.J. Blitzer, B.N. Danforth, G. Loeb, & K. Poveda (2017). Temporally dependent pollinator competition and facilitation with mass flowering crops affects yield in co-blooming crops. Nature Scientific Reports 7:45296 [DOI: 10.1038/srep45296]

88. Bossert, S., E.A. Murray, B.B. Blaimer, & B.N. Danforth (2017). The impact of GC bias on phylogenetic accuracy using targeted enrichment phylogenomic data. Molecular Phylogenetics and Evolution 111: 149-157.

87. Branstetter, M.G., B.N. Danforth, J.P. Pitts, B.C. Faircloth, P.S. Ward, M.L. Buffington, M.W. Gates, R.R. Kula. & S.G. Brady (2017). Phylogenomics and improved taxon sampling resolve relationships among ants, bees, and stinging wasps. Current Biology 27(7):1019-1024. [See commentary published in same issue of Current Biology: http://www.sciencedirect.com/science/article/pii/S0960982217303536]

86. López-Uribe, M. J. Cane, R. Minckley, B.N. Danforth (2016). Crop domestication facilitated rapid geographic expansion of a specialist pollinator, the squash bee Peponapis pruinosa. Proc. Royal Soc. Lond. (B) 283: 20160443

85. Litman, J.R., T. Griswold, B.N. Danforth (2016). Phylogenetic systematics and a revised generic classification of anthidiine bees (Hymenoptera: Megachilidae). Molecular Phylogenetics and Evolution 100: 183-198. [DOI: 10.1016/j.ympev.2016.03.018]

84. Blitzer, E.J., J. Gibbs, M.G. Park, B.N. Danforth (2016). Pollination services for apple depend on functionally diverse wild bee communities. Agriculture, Ecosystems, and Environment 221: 1-7

83. Park, M.G., R.A. Raguso, J.E. Losey, B.N. Danforth (2016). Per-visit pollinator performance and regional importance of wild Bombus and Andrena (Melandrena) compared to the managed honey bee in New York apple orchards. Apidologie 47:145–160 [published online 25 August 2015, 10.1007/s13592-015-0383-9]

82. Russo, L., M.G. Park, J. Gibbs, B.N. Danforth (2015). The challenge of accurately documenting bee species richness in agroecosystems: bee diversity in eastern apple orchards. Ecology and Evolution 5(17): 3531–3540 [published online 5 August 2015, doi: 10.1002/ece3.1582]

81. Hedtke S.M., E.J. Blitzer, G.A. Montgomery, B.N. Danforth (2015). Introduction of non-native pollinators can lead to trans-continental movement of bee-associated fungi. PLoS ONE 10(6): e0130560 [published online 23 June 2015, doi:10.1371/journal.pone.0130560]

80. Kleijn, D., R. Winfree, I. Bartomeus, L. Cavalheiro, et al. (2015). Managing for pollinators or pollination: conflicts between biodiversity conservation and ecosystem service delivery. Nature Communications 6:7414 [published online 16 June, 2015, DOI: 10.1038/ncomms8414]

79. Park, M.G., E.J. Blitzer, J. Gibbs, J.E. Losey, B.N. Danforth (2015). Combined effect of pesticides and landscape simplification compromises wild pollinators. Proc. Royal Soc. Lond. (B) 282: 20150299 [published online 3 June 2015, DOI: 10.1098/rspb.2015.0299]

78. López-Uribe, M,M,, S.J. Morreale, C.K. Santiago, B.N. Danforth (2015) Nest suitability, fine-scale population structure and male-mediated dispersal of a solitary ground nesting bee in an urban landscape. PLoS ONE 10(5): e0125719. doi:10.1371/journal.pone.0125719

77. López-Uribe, M.M., K.R. Zamudio, C.F. Cardoso and B.N. Danforth (2014). Climate, physiological tolerance, and sex-biased dispersal shape genetic structure of Neotropical orchid bees. Molecular Ecology 23(7): 1874-1890 [published online 7 February, 2014, DOI: 10.1111/mec.12689]

76. Bartomeus, I., M.G. Park, J. Gibbs, B.N. Danforth, A.N. Lakso, & R. Winfree (2013). Biodiversity as insurance against plant-pollinator phenological asynchrony. Ecology Letters 16:1331-1338 [published online 23 August, 2013, doi: 10.1111/ele.12170]

75. Hedtke, S., S. Patiny, B.N. Danforth (2013). Resolving the Bee Tree of Life : bioinformatic approaches to apoid phylogeny. BMC Evolutionary Biology 13:138 http://www.biomedcentral.com/1471-2148/13/138

74. Gibbs, J., L. Packer, S. Dumesh, and B.N. Danforth (2013). Revision and reclassification of Lasioglossum (Evylaeus), L. (Hemihalictus) and L. (Sphecodogastra) in eastern North America (Hymenoptera: Apoidea: Halictidae). Zootaxa 3672 (1): 1-117

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Abstracts, Posters and Presented Papers (in reverse chronological order):

Urban-Mead, K., S. McArt, B.N. Danforth (2018). Bees in the trees: Early spring forest canopy resources support orchard pollinators. Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Bossert, S., E.A. Murray, E.A. Almeida, S. Brady, B. Blaimer, S. Cardinal, B.N. Danforth (2018). Combining transcriptomes and ultraconserved elements to illuminate the phylogeny of Apidae. Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Centrella, M., K. Poveda, B.N. Danforth, A. Fersch, N. Baert, B.D. Eitzer, M. VanDyke, K. Böröczky, and S. McArt (2018). Do solitary and social bees respond in the same way to stressors in agroecosystems? Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Brochu, K. & B.N. Danforth (2018). Love it or leave it: Digestive adaptations of specialist and generalist bees on cucurbits. Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Danforth, B.N. (2018). New insights into bee phylogeny -- Charles Michener was (almost) always right. Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Murray, E.A., Bossert, S., B.N. Danforth (2018). Pollinivory and the diversification dynamics of bees. Joint Entomological Society of America and Entomological Society of Canada meeting, Vancouver, BC, Canada (November 10-14, 2018).

Murray, E., Bossert, S., Blaimer, B.B., and B.N. Danforth (2017). Origins and antiquity of pollen-feeding in the vespid wasps, based on phylogenomic analysis of ultraconserved elements. Entomological Society of America, Denver, CO (November 4-8, 2017).

Urban-Mead K., McArt S., & B.N. Danforth (2017). Bees in the Treetops: A new spatial dimension to pollinator visitation networks. Entomological Society of America, Denver, CO (November 5, 2017).

Bossert, S., Murray E.A., Blaimer B.B. & B.N. Danforth (2017). The impact of GC bias on phylogenetic accuracy using ultraconserved phylogenomic data: A case study on the corbiculate bees. Oral presentation, Entomological Society of America, Denver, CO (November 4-8, 2017).

Mary Centrella, Brian D. Eitzer, Heather Grab, Katja Poveda and B.N. Danforth (2017). Fitness responses of wild bees (Osmia cornifrons) to their environment: The interactive effects of landscape complexity, pesticide exposure and pollen diet diversity, Entomological Society of America, Denver, CO (November 4-8, 2017).

Erin Krichilsky, Mary Centrella, Brian Eitzer, B.N. Danforth, Heather Grab (2017). Taking Inventory: Drivers of the bee associated fungi (Genus: Ascosphaera) in the solitary mason bee, Osmia cornifrons. Entomological Society of America. Denver, CO. November 6, 2017.

Brochu, K.; and Danforth, B.N. (2017). Microbial communities in ground-nesting bee brood cells: diverse, stable, and unique. Annual Meeting of the Entomological Society of America. Denver, CO (November 4-8, 2017)

Lemnian, I., A. Soro, M. Bonn, M. Lopez-Uribe, B.N. Danforth, I. Grosse, R.J. Paxton. The genetic underpinning of eusociality in a socially polymorphic sweat bee Halictus rubicundus. European Society of Evolutionary Biology, Groningen, The Netherlands (Aug. 20-25, 2017).

Brochu, K.* & B.N. Danforth (2016). Microbial ecology of the bee brood cell. Entomological Society of America and International Congress of Entomology, Miami, FL (Sept 25-30, 2016)

Centrella, M., K. Poveda, B.N. Danforth (2016). Landscape effects on mason bee fitness mediated by diet diversity and pesticide exposure. Entomological Society of America and International Congress of Entomology, Miami, FL (Sept 25-30, 2016)

Grab, H., J. Brokaw, B.N. Danforth, J. Gibbs, A. Hutchinson, R. Isaacs, K. Poveda, M. Renauld, and G.M. Loeb (2016). Landscape simplification constrains adult body size in native bees. Entomological Society of America and International Congress of Entomology, Miami, FL (Sept 25-30, 2016)

Brokaw, J.N., M.G. Park, B.N. Danforth (2016). The dirt on apple pollinators: incorporating soil survey data to predict ground-nesting bee distributions in central New York orchards. Entomological Society of America and International Congress of Entomology, Miami, FL (Sept 25-30, 2016) [poster]

vanDyke, M. & B.N. Danforth (2016). The Northeast Pollinator Partnership.International Conference on Pollinator Biology, Health and Policy, Pennsylvania State University, State College, PA (July 18-20, 2016)

Russo, L., M. Park, J. Gibbs, E.J. Blitzer, B.N. Danforth* (2015). A novel approach to quantifying the importance of wild bees in apple pollination. Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Centrella, M.*, B.N. Danforth, K. Poveda, E.J. Blitzer (2015). You are what you eat: the effects of pesticides and diet diversity on mason bees in apple. Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Park, M.*, N.K. Joshi, E. Rajotte, D.J. Biddinger, J. Losey, & B.N. Danforth (2015). A regional assessment of eastern apple grower knowledge, perceptions, and attitudes of alternative pollinators. Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Branstetter, M., B.N. Danforth, J.P. Pitts, & S. Brady* (2015). Phylogeny of the stinging Hymenoptera (Aculeata) using targeted enrichment of ultra-conserved elements. Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Connelly, H.*, N. Amon, B.N. Danforth, K. Poveda, & G.M. Loeb (2015). Does landscape mediate wild bee health and phylodiversity? Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Brochu, K*., A. Kessler, B.N. Danforth (2015). Chemical and microbial ecology of the bee brood cell: insights from the hoary squash bee, Peponapis pruinosa (Eucerini, Apidae). Entomological Society of America, Minneapolis, MN (Nov. 15-18, 2015)

Burand, J.P., S. Zheng, B.N. Danforth (2015). Virus prevalence in bee populations in apple orchards in New York, USA. Society of Invertebrate Pathology, Vancouver, BC, Canada (August 9-13, 2015).

Branstetter, M., B. Faircloth, B.N. Danforth, J. Pitts, & S. Brady (2014). Ultraconserved elements provide new insights into the phylogeny and evolution of Hymenoptera. ESA meeting, Portland, OR (November 16-19, 2014)

Park, M.G., R.A. Raguso, E.J. Blitzer, J. Gibbs, J. Losey, & B.N. Danforth (2014). Filling the pollination gap: Assessing the potential for wild bees to maintain adequate apple pollination as

honey bee colonies decline. Ecological Society of America meeting, Sacramento CA, Aug. 10-15, 2014

Russo, L., M.G., Park, B.N. Danforth (2014). Host specialization in a wild bee community: Variation in the composition of pollen collected by apple pollinators. Ecological Society of America meeting, Sacramento CA, Aug. 10-15, 2014

Park, M.G., R. Raguso, J.E. Losey, & B.N. Danforth. Effectiveness and importance of wild bees for apple pollination. ESA meeting, Austin, TX (November 10-14, 2013)

Hedtke, S., S. Patiny, & B.N. Danforth. The bee tree of life: Insights from a supermatrix approach to apoid phylogeny. ESA meeting, Austin, TX (November 10-14, 2013) [Invited symposium]

López-Uribe, M. & B.N. Danforth. The successful biological invasion of the specialist bee Peponapis pruinosa. ESA meeting, Austin, TX (November 10-14, 2013) [Invited symposium]

Park, M.G., E.J. Blitzer, J. Gibbs, J. Losey, and B.N. Danforth. Natural areas buffer the impact of pesticides on wild pollinators of a perennial crop, International Student Conference on Conservation Science, New York, NY (October 9-11, 2013).

López-Uribe, M.M. & B.N. Danforth. Integrative taxonomy of orchid bee species in the genus Eulaema (Apidae: Euglossini). VIII Congreso Mesoamericano de abejas nativas, San José, Costa Rica (Aug 30-31, 2013).

Park, M.G., E.J. Blitzer, J. Gibbs, J. Losey, & B.N. Danforth. Natural areas buffer impact of pesticides on wild pollinators of a perennial crop. International Conference on Pollinator Biology, Health and Policy, State College, PA (July 11-14, 2013)

Hedtke, S.H. & B.N. Danforth. The pleasures and pitfalls of bee phylogenetics. Evolution meeting, Snowbird, UT (June 21-25, 2013).

Debevec, A., S.C. Cardinal, B.N. Danforth, & J.W. Whitfield. Investigating outgroup taxon sampling: empirical examples from Noctuoidea (Lepidoptera) and bees (Hymenoptera: Apoidea). North Central Branch ESA meeting, Rapid City, South Dakota (June 16-19, 2013).

Blitzer, E.J., M.G. Park, B.N. Danforth. Native and managed bees of New York apple orchards: Connecting biodiversity, pollination services, and production. Eastern Branch ESA meeting, Lancaster, PN (March 16-19, 2013).

Danforth, B.N. How molecular data have altered our understanding of bee phylogeny and evolution. Eastern Branch ESA meeting, Lancaster, PN (March 16-19, 2013). [Invited symposium: Natural History and Diversity of Arthropods]

Blitzer, E.J., M.G. Park, B.N. Danforth. Connecting native and managed pollinators to apple production in New York orchards. ESA meeting, Knoxville, TN (November 11-14, 2012). [Invited symposium]

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RESEARCH INTERESTS

1. **Bee Phylogeny**

A major focus of my work over the past 20 years has been on resolving higher-level relationships in bees. Bees include over 20,000 described species currently placed into 7 families and 23 subfamilies. Bees arose sometime between 140 and 100 million years ago and bee diversification almost certainly influenced the explosive diversification of the angiosperms (flowering plants) in the early to mid Cretaceous. Understanding the evolutionary history of bees can therefore help provide insights into the diversification of the angiosperms, or what Darwin called the "abominable mystery."

My lab has worked on all seven extant bee families, as well as relationships among closely-related apoid wasps (Debevec, et al. 2012). Our approach has been heavily focused on single-copy nuclear gene data, but some studies combine morphological and molecular data, and some studies are based entirely on morphology. Single-copy nuclear genes provide excellent data sets for resolving deep divergences in bees because (1) alignments of protein-coding regions are unambiguous, (2) the bee genome consists of over 12,000 protein-coding genes, making these data readily available for phylogenetic analysis, and (3) these genes have been shown to perform more effectively than mitochondrial (Lin & Danforth 2004) and ribosomal genes (Danforth et al. 2005) in comparative studies. My laboratory pioneered the use of single-copy nuclear genes as phylogenetic markers in bees and closely related wasps.

Insights that have been gained from these studies include the following areas:

a. Bee antiquity – I have been involved in a number of studies focused on both fossils and fossil-calibrated phylogenies. In collaboration with George Poinar (Oregon State), I helped described the morphology and phylogenetic significance of Melittosphex burmensis – the oldest known bee fossil (Poinar & Danforth 2006, Danforth & Poinar 2011). In collaboration with my students and post-docs, I have published fossil-calibrated phylogenies for Colletidae (Almeida et al. 2012), Halictidae (Gibbs et al. 2013), Apidae (Cardinal et al. 2010), Megachilidae (Litman et al. 2011) and bees as a whole (Cardinal & Danforth 2013).

b. Family-level phylogeny – A major focus of my lab over the past 10 years has been to establish a robust phylogeny for the bee families, subfamilies, and tribes. We have used a variety of approaches, including large, multigene, nucleotide data sets (Danforth et al. 2006a), nucleotide data sets in combination with morphology (Danforth et al. 2006b), patterns of unique intron gains and losses (Brady & Danforth 2004), and analysis of gene duplications (Brady et al. 2011). Our results have provided important new insights into where the root node of bees falls. Previous studies supported a root node near or within Colletidae. However, all our molecular studies have indicated a root node at or within the family Melittidae, a small, enigmatic, relictual, host-plant specialist family with greatest diversity in southern Africa. Subsequent studies, based on both expanded gene and expanded taxon sampling that continues to support this hypothesis (Cardinal & Danforth 2013.; Hedtke et al. in review).

c. Social behavior – Bees are fascinating creatures for many reasons, but one of the most important is that they exhibit multiple origins of complex forms of eusociality. The families Halictidae and Apidae include species that range from solitary nesting to advanced eusociality. My laboratory has made heavy use of phylogenetic analysis to investigate the patterns of social evolution in both Halictidae (Danforth 1999, 2002; Danforth et al. 1999, 2003, 2008; Soucy & Danforth 2002; Brady et al. 2006) and Apidae (Cardinal & Danforth 2011). Our results have revealed an unforseen pattern: eusociality in bees has had relatively few origins while within eusocial clades one can see multiple reversals to solitary nesting. Our current estimate is as few as four origins of eusociality in bees: (1) corbiculate Apidae, (2) Xylocopinae, (3) Augochlorini, (4) Halictini (Halictus+Lasioglossum).

d. Cleptoparasitism – Approximately 10% of all bee species are cleptoparasitic (brood parasitic), meaning they enter the nests of other bees and lay an egg without actually collecting either pollen or nectar provisions. Cleptoparasitism has been reported from all bee families except Andrenidae, Melittidae, and Stenotritidae. Phylogenetic studies in my lab have provided a comparative framework for examining the evolution of cleptoparasitism in Halictidae, Megachilidae, and, most recently, in Apidae. My student and former post-doc Sophie Cardinal used a comprehensive phylogeny of the Apidae and Bayesian, ancestral state reconstruction methods to show that, what had previously been regarded as multiple origins of cleptoparasitism were, in fact, more likely a single, ancient origin of cleptoparasitism in Apidae (Cardinal et al. 2010). This result has significant implications for understanding the evolution of cleptoparasitism in bees because nearly 20% of apid bees are cleptoparasites.

e. Historical biogeography – Phylogenies play an important role in understanding how the current distribution of organisms on earth came to be. Research in my laboratory has made use of phylogenies for Halictidae (Danforth et al. 2004, Patiny et al. 2007), Melittidae (Michez et al. 2009), Megachilidae (Litman et al. 2011), and especially Colletidae (Almeida & Danforth 2009, Almeida et al. 2012) to analyze biogeographic patterns with both parsimony and model-based methods. Work by my former student, Eduardo Almeida on colletid bees has demonstrated a series of repeated interchanges between Australia and South America via Antarctica over the past 90 million years (Almeida et al. 2012). Australia's bee fauna was therefore composed entirely of colletid bees up until the Oligocene, when additional bee families arrived via Asia.

In summary, the phylogenetic work in my laboratory has provided significant new insights into the evolution of bees, including their historical biogeography, social behavior, antiquity, and life history evolution. Future work will focus on expanding the range of genes and data sets we use to reconstruct bee phylogeny. Currently, we are exploring two avenues of research: (1) next-generation (Illumina) sequencing of bee transcriptomes as a way to greatly expand the range of genes we can use and (2) super-matrix approaches to bee phylogeny in which we extract data from Genbank using automated, bioinformatics approaches to downloading, aligning, and analyzing large nucleotide data sets (in collaboration with Shannon Hedtke).

2. **Pollination biology**

I have recently expanded my research into the area of applied pollination biology. Starting in 2007, my laboratory has been surveying and characterizing native bee diversity in NY State apple orchards with the goal of understanding the role of native bees in apple pollination. We recently obtained a USDA-AFRI grant to expand this study and to relate bee diversity and abundance to fruit set in commercial apple orchards. To date, we have identified over 100 native bee species that are potentially contributing to apple pollination in central New York (Park, et al., in prep.). In addition, we have used careful experimental approaches to determine per-visit pollen deposition in a number of native bee species. Our data indicate that native bees deposit two to three times more pollen grains per visit than honey bees (Park, et al., in prep.). Finally, we have demonstrated that in central New York apple orchards, there is clear evidence of pollen limitation, as indicated by comparison of hand vs. open-pollinated flowers. This study has allowed me to use my expertise in bee taxonomy to develop more sustainable management practices in commercial apple orchards.

3. **Bee biodiversity**

I am currently involved in an NSF-funded, multi-institutional effort to database major bee collections across the US. The Cornell University Insect Collection is one of the 12 collections being databased for the purpose of examining long-term trends in bee distribution and phenology. This is a highly collaborative effort led by John Ascher (AMNH) and Douglas Yanega (UC Riverside). Our study has already yielded two published papers (Bartolomeus et al., 2011, 2013) documenting shifts in native bee flight phenology and geographic distribution over the past 140 years in eastern North America. Over the first two years of the grant we have databased over 30,000 bee specimens from Cornell alone.

I also continue to conduct field work in areas of high bee diversity, including Australia, South Africa, Kenya, and Mediterranean Europe.

Future directions:

1. Next-gen sequencing and bioinformatics: the field of molecular systematics is moving incredibly fast and new technologies are transforming how we approach DNA sequencing. Next-gen sequencing (Illumina and 454) technologies now allow us to generate massive transcriptome and genome datasets. These data sets require new skills, in particular bioinformatic skills, to make effective use of the data. I would like to explore the use of transcriptome data sets across multiple bee and wasp species in order to greatly expand the range of genes we are currently using for phylogenetic analysis. We already have a pilot experiment underway using Illumina RNA-seq data from 12 bee and wasp species and there is clearly a lot of overlap in the genes sequenced across these species. However, distinguishing paralogs and orthologs is not trivial in the absence of closely related reference genomes.

2. The transition from carnivory to pollenivory – gut transcriptomics: One of the “key innovations” in the evolution of bees from predatory wasps was the transition from larval carnivory to larval pollenivory. From a nutritional standpoint, arthropod prey and pollen are similar in that both provide a diet rich in proteins and amino acids (Roulston and Cane 2000). However, extraction of these nutrients requires significant alteration in larval digestive physiology. The external layer of the pollen grain, the pollenkitt, contains nutritive lipids. There are one or two additional layers which must be broken down before the cytoplasm of the pollen can be released and the nutrients absorbed (or further digested): the exine (present in most flowering plants, but not all monocots), which is made up of a tough complex carbohydrate called sporopollenin, and the intine, which is made up of cellulose and pectin. Digestion appears to occur through a combination of osmotic and enzymatic processes as pollen passes through the midgut of the bee, and thus requires both morphological changes in the structure of the intestine and in the enzymes that contribute to the breakdown of these pollen walls (reviewed in Roulston and Cane 2000). I propose to examine the evolutionary changes associated with pollen-feeding by comparing the gut transcriptomes of larval crabronid wasps and bees. My prediction is that we will find significant alterations in the expressed genes and that there will be an increase in genes

associated with (1) carbohydrate metabolism, and (2) detoxification of plant secondary compounds.

3. Chemical ecology and phylogeny of bee-plant interactions: One aspect of bee evolution that has received surprisingly little attention is the co-evolutionary interactions between bees and their host-plants. Bees vary widely in their host plant preferences. Polylectic (generalist) bees collect pollen and nectar from a wide variety of host-plants while oligolectic (specialist) bees collect pollen and nectar from a much more narrow range of host-plants, usually resctricted to a family, tribe, genus or even species of host plant. Specialization in bees involves both behavioral preference for certain host plants as well as morphological adaptations to host-plant flower and pollen morphology. We know very little about the evolution of both host plant range (oligolecty and polylecty) and host plant preference in bees. Two previous studies have used phylogenies and character mapping to examine the evolution of host-plant preferences in bees (Sipes & Tepedino 2005, Sedivy et al. 2008). We have learned from these studies that (1) polylecty is often derived from within oligolectic clades and (2) host-switching, when it occurs, often involves switches to phylogenetically unrelated host-plants. Whether host switching is driven by floral morphology or floral chemistry remains to be seen. I propose to examine the evolution of host-plant associations within one or more bee genera in which a mixture of polylectic and oligolectic species occur (e.g., Andrena, Perdita, Dufourea, Dasypoda, Hesperapis). The goal of such studies would be to reconstruct species-level relationships based on multi-gene data sets and to use ancestral state reconstruction methods to trace the evolution of host-plant range and preference. When closely-related bee are on unrelated host-plants I would like to examine whether the host plants share similar morphological or chemical attributes. My prediction is that the either host-plant chemistry or host plant floral morphology drives such switches. I am actively seeking a collaborator with expertise in chemical ecology for this project.

4. Bees and microbes – does “defensive mutualism” exist in mass-provisioning bees: A number of insect species have been shown to have associations with beneficial microbes, primarly bacteria, that have been described as “defensive mutualisms” (Kaltenpoth 2009). These defensive mutualists can provide a variety of functions, but they are often involved in protecting valuable resources (for example, the fungal gardens in leaf-cutting ants) from invasion by pathogenic microbes. The pollen/nectar provisions of bees are rich in carbohydrates and proteins and are stored in harsh environments (soil, wood, stems) where attack by microbes would appear to be easy. I would like to explore the possible microbial symbionts of bees using metagenomic methods based on high-throughput next generation sequencing.

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Michez, D., S. Patiny & B.N. Danforth (2009). Phylogeny of the bee family Melittidae (Hymenoptera: Anthophila) based on combined molecular and morphological data. Syst. Entom. 34: 574-597

Park, M.G., M.C. Orr, & B.N. Danforth (2010). The role of native bees in apple pollination. New York State Fruit Quarterly 18(1): 21-25.

Patiny, S., D. Michez, & B.N. Danforth (2007). Phylogenetic relationships and host-plant associations within the basal clade of Halictidae (Hymenoptera: Apoidea). Cladistics online: 8-Nov-2007 doi: 10.1111/j.1096-0031.2007.00182.x

Poinar, G.O., Jr. & B.N. Danforth (2006). A fossil bee from Early Cretaceous Burmese amber. Science 314: 614.

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Sipes, S.D. & V.J. Tepedino (2005). Pollen-host specificity and evolutionary patterns of host switching in a clade of specialist bees (Apoidea: Diadasia). Biol. J. Linn. Soc. 86: 487-505.

Soucy, S.L. & B.N. Danforth (2002). Phylogeography of the socially polymorphic sweat bee Halictus rubicundus (Hymenoptera: Halictidae). Evolution 56 (2): 330-341.

MENTORING

1. **Post-docs**

Current: Dr. Jessica Gillung

Past:

Dr. Elizabeth Murray

Department of Entomology

National Museum of Natural History

Smithsonian Institution

10th St. & Constitution Ave. NW

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2. **Graduate students**

Current:

Mary Centrella (co-advised with Katja Poveda)
Silas Bossert (currently at the Smithsonian Institution)

Katherine Urban-Mead (co-advised with Scott McArt)

Past:

Kristen Brochu
Department of Entomology
Pennsylvania State University
University Park, PA 16802
E-mail: kb532@cornell.edu

Dr. Chung-Ping Lin (PhD 2002)
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Dr. John S. Ascher (PhD 2003)
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Dr. Karl N. Magnacca (PhD 2004)
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Dr. Eduardo A. B. Almeida (PhD 2006)
Departamento de Biologia
FFCLRP - Universidade de São Paulo
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Dr. Sophie Cardinal (PhD 2010)
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email: mmlopezu@ncsu.edu

Dr. Mia Park (PhD 2014)
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3. **Undergraduate students**

Undergraduate research students:

Current:
Peter Lannoo (Biology, 2017)
Erin Krichilsky (Entomology, 2017)

Past:
Chris Desjardins (Entomology, 1997 [2 years])
Luke Ballard (Biology, 1999 [3 years; Cornell Presidential Research Scholar Program])
Lindsay Conway (Animal Science, 2000 [2 years])
Adam Pearson (Biology, 2002 [3 years; Cornell Presidential Research Scholar Program])
Alison Novick (Biology, 2003[2 years])
Stephanie Johnson (Entomology, 2005[1 semester])
Alex Swanson (Biology, 2006[1 years])
Allison Meisner (Entomology, 2006[1 years])

Kojun Kanda (Entomology, 2007[2 years])

Neha Botapati (Biology, 2009[1 semester])

Chris Castorena (Engineering, 2009 [1 semester])

Michael Orr (Entomology, 2009 [2 years])

Andrew Debevec (Entomology, 2011 [2 years; Hughes Undergraduate Research Scholars Program])

Jamer Bellis (Biology, 2011[1 semester])

Yang Zhang (Biology, 2011 [1 year]

Lori Moshmann (Plant Biology, 2012 [4 years])

Kyle Rossner (Continuing Education, 2012 [1 year])

Isa Betancourt (Entomology, 2013 [1 year])

Patrick Brown (Entomology, 2013 [1 year])

Christine Santiago (Human Ecology, 2013 [3 years; Undergraduate Minority Student Fellowship])

Michelle Jennifer Rogals (Biology, 2014 [1 year])

Corey Jack Keane (Biology, 2014 [1 year])

Christina Harden (Biology, 2015 [1 year])

Julia Brokaw (Natural Resources, 2013 [3 year])

Graham Montgomery (Entomology, 2015 [2 years])

Nolan Amon (Entomology, 2015 [2 years])

Undergraduate advisees:

Elia Andrea Garcia (Entomology, 1998)

Susan Margaret Packard (Entomology, 2001)

Peter Michael Fisk (Entomology, 2004)

Megan Vidler (Entomology, 2005)

Phil Torres (Entomology; 2008)

Taro Eldredge (Entomology; 2009)

Keith Ciccaglione (Entomology; 2011)

Lori Moshmann (Entomology; 2012)

Patrick Brown (Entomology; 2013)

Dan Pearlstein (Entomology; 2013)

Leah Buchmann (Entomology; 2016)

Clifton Stacy (Entomology; 2017)

Undergraduate publications (1999 to present):

Papers with undergraduate co-authors (in bold) are listed below.

Danforth, B.N. & C. A. Desjardins (1999). Male dimorphism in Perdita portalis (Hymenoptera: Andrenidae) has arisen from preexisting allometric patterns. Insectes Sociaux 46:18-28.

Danforth, B.N., S. Ji, & L.J. Ballard (2003a). Gene flow and population structure in an oligolectic desert bee, Macrotera (Macroteropsis) portalis (Hymenoptera: Andrenidae). J. Kansas Entomological Society 76(2): 221-235.

Danforth, B.N., L.Conway, & S. Ji (2003b). Phylogeny of eusocial Lasioglossum reveals multiple losses of eusociality within a primitively eusocial clade of bees (Hymenoptera: Halictidae). Syst. Biol. 52(1): 23-36.

Danforth, B.N., S.G. Brady, S.D. Sipes & A. Pearson (2004). Single copy nuclear genes recover Cretaceous age divergences in bees. Syst. Biol. 53(2): 309-326.

Brady, S.G., S.D. Sipes, A. Pearson, B.N. Danforth (2006). Recent and simultaneous origins of eusociality in halictid bees. Proc. Royal Soc. London, Series B (Biological Sciences) 273:1643-1649.

Debevec, A.H., S. Cardinal, & B.N. Danforth (2012). Identifying the sister group to the bees: a molecular phylogeny of aculeata with an emphasis on the superfamily Apoidea. Zoologica Scripta [published ahead of print 14 June 2012, DOI: 10.1111/j.1463-6409.2012.00549.x]

Gibbs, J., S. Brady, K. Kanda, & B.N. Danforth (2012).Phylogeny of halictine bees supports a shared origin of eusociality for Halictus and Lasioglossum (Apoidea: Anthophila: Halictidae). Mol. Phylogen. Evol. 65: 926-939.

López-Uribe, C.K. Santiago, S.M. Bogdanowicz, B.N. Danforth (2012). Discovery and characterization of microsatellites for the solitary bee Colletes inaequalis using Sanger and 454 pyrosequencing. Apidologie 44(2): 163-172.

Hedtke S.M., E.J. Blitzer, G.A. Montgomery, B.N. Danforth (2015). Introduction of non-native pollinators can lead to trans-continental movement of bee-associated fungi. PLoS ONE 10(6): e0130560

Pauw, A., B. Kahnt, M. Kuhlmann, D. Michez, G.A. Montgomery, E. Murray, B.N. Danforth (2017). Long-legged bees make adaptive leaps: linking adaptation to coevolution in a plant-pollinator network. Proceedings of the Royal Society of London, B 284 (1862), 20171707. [published online ## August, 2017, DOI: http://dx.doi.org/10.1098/rspb.2017.1707]

Kahnt, B., G.A. Montgomery, E. Murray, M. Kuhlmann, A. Pauw, D. Michez, R.J. Paxton, B.N. Danforth (2017). Playing with extremes: origins and evolution of exaggerated forelegs in South African Rediviva bees. Molecular Phylogenetics and Evolution 115: 95-105.

TEACHING

a. Accomplishments

Over the past 20 years I have taught 19 courses (Entom 2010 [Alien Empire: Bizarre Biology of Bugs], Entom 3220 [Insect Comparative Morphology], Entom. 3310/3311 [Insect Phylogeny and Evolution], and Entom. 6350 [Insect Molecular Systematics] to a total of 863 students. Course evaluations for all these classes were high (4.0 or above on most questions; see attached course evaluations, below).

Entom. 2010/2011 is an elective, non-majors class that is meant to introduce undergraduate students to the bizarre and fascinating world of insects. This course emphasizes insect evolution, behavior, natural history, and ecology, but also covers topics related to the interaction between humans and insects. I have worked very hard in Alien Empire to captivate the students with the bizarre and interesting lives of insects. I make heavy use of color photographs to illustrate the diversity of insect form and anatomy. I use audio recordings to introduce students to the world of insect acoustic communication. I place short films (~5 mins.) throughout the lectures to show live insects in action. I also try to keep things entertaining with occasional segments from popular movies such as “Joe’s Apartment” and “Bugs Life”.

Alien Empire is one of my favorite courses to teach and I think the students react well to my enthusiasm. I have been told by some students that Entom 2010/2011 is the best course they have had at Cornell. Other student comments included: “I have never had a more enthusiastic instructor since I have been at Cornell,” “Bryan is an enthusiastic teacher -- he loves the subject and transferred this excitement well,” “I really enjoyed this class... Bugs are really neat!”, “I loved this course and would recommend it to all my friends.”

Entom 3310/3311 is a graduate/undergraduate level course in insect phylogeny and evolution. I taught this class for the first time in Spring, 2007 and am currently teaching it in Fall, 2011. This course provides students with a broad overview of insect diversity, phylogeny, evolution and fossil history. This is an important course for our undergraduate and graduate program because insects are one of the largest and most diverse groups of organisms on the planet. Phylogeny provides the comparative and evolutionary framework for investigating insect biology and this course strives to develop a solid understanding of both the methods we use to reconstruct phylogeny as well as our current estimate of insect evolutionary relationships. I emphasize that phylogenies are hypotheses that are constantly changing as new data and new methods are applied. The course also investigates how phylogenies can be used to investigate evolutionary questions, such as host-plant evolution, co-evolution of hosts and symbionts, and the evolution of eusociality. Students give presentations at the end of the semester on independent research they have done on one group of insects. The laboratory portion of the course (Entom. 3311; 1 credit) involves field collections and identification to the family level.

I have also taught other courses at Cornell. Two courses (Entom 3220, Insect Comparative Morphology and Entom 6350, Insect Molecular Systematics) are no longer offered.

b. **Courses taught** (1997-2019)

Course number		Time	Semeste	Enroll
Entom. 3220	Insect Comparative Morphology	Sp., 1997		22
Entom. 2010	Alien Empire: Bizarre Bio Bugs	Sp., 1998		65
Entom. 3220	Insect Comparative Morphology	Sp., 1999		22
Entom. 2010	Alien Empire: Bizarre Bio Bugs	Sp., 2000		55
Entom. 3220	Insect Comparative Morphology	Sp., 2001		24
Sabbatical leave (Jan.-July 2002)				
Entom. 3220	Insect Comparative Morphology	Sp., 2003*		20

Entom. 2010	Alien Empire: Bizarre Bio Bugs	Sp., 2004*	65
Entom. 6350	Insect Molecular Systematics	Sp., 2004	8
Entom. 3220	Insect Comparative Morphology	Sp., 2005*	18
Entom. 2010	Alien Empire: Bizarre Bio Bugs	Sp., 2006*	98
Entom. 6350	Insect Molecular Systematics	Sp., 2006*	6
Entom. 3310/3311	Insect Phylogeny and Evolution	Sp., 2007*	14
Entom. 2010	Alien Empire: Bizarre Bio Bugs	Sp., 2008*	140
Entom. 2010/2011	Alien Empire: Bizarre Bio Bugs	Sp., 2009*	140
Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2009*	16

Sabbatical leave (Jan.-July 2010)

Entom. 2010/2011	Alien Empire: Bizarre Bio Bugs	Sp., 2011*	136
Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2011*	18
Entom. 2010/2011	Alien Empire: Bizarre Bio Bugs	Sp., 2013	130
Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2013	12
Entom 3340	Tropical Field Entomology	Wn., 2015	10
Entom 4610	Model-based Phylogenetics	Sp., 2015	22

and Hypothesis Testing

Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2015	10
Entom. 2010/2011	Alien Empire: Bizarre Bio Bugs	Sp., 2016	100
Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2017	16
Entom. 2010/2011	Alien Empire: Bizarre Bio Bugs	Sp., 2018	125
Entom 2500	Insect-plant Interactions in the Desert Southwest	Sp., 2019	5
Entom 7670	Professional Development for Graduate students	Fa. 2019	##
Entom. 3310/3311	Insect Phylogeny and Evolution	Fa., 2019	##

* Please see attached spreadsheet that summarizes course evaluations for these semesters.

c. **Course descriptions**:

ENTOM 2010 - Alien Empire: Bizarre Biology of Bugs

Spring. 2 credits. S-U or letter grade option. B.N. Danforth

Insects are the most abundant and diverse animals on earth. This course explores the bizarre biology of insects and their interaction with humans. It examines both the detrimental roles insects play (e.g., pests and vectors of disease) as well as their beneficial roles (e.g., pollination, edible insects, insect products such as waxes, dyes, and silk). The course also explores the symbolic representation of insects in art, literature, and religion.

ENTOM 2011 - Alien Empire: Bizarre Biology of Bugs

Spring. 3 credits. S-U or letter grade option. B.N. Danforth

Insects are the most abundant and diverse animals on earth. This course explores the bizarre biology of insects and their interaction with humans. It examines both the detrimental roles insects play (e.g., pests and vectors of disease) as well as their beneficial roles (e.g., pollination, edible insects, insect products such as waxes, dyes, and silk). The course also explores the symbolic representation of insects in art, literature, and religion. Students taking the course for 3 credits meet once per week for small group discussions, debates, demonstrations, and documentary films on the biology of insects.

ENTOM 3220 Comparative Insect Morphology [NO LONGER OFFERED]

Spring. 4 credits. Prerequisite: ENTOM 2120 or 2410. Lec, lab. B.N. Danforth.

Provides a detailed introduction to the external and internal anatomy of insects. Lectures introduce basic concepts in insect morphology, such as the organization of the insect body plan and organ systems, functional morphology, homology, phylogeny, modularity, and development. The lab introduces students to the basic methods of insect microdissection, specimen preparation, and scientific illustration. High-quality, publishable illustrations are produced based on student artwork.

ENTOM 3310 - Insect Diversity and Evolution

Fall. 3 credits. Prerequisite: ENTOM 2120. Co-requisite: ENTOM 3311. Offered alternate years.

B. N. Danforth.

Insects are the dominant terrestrial organisms on planet earth both in terms of the number of species as well as in biomass. This course will provide a detailed look at insect diversity, phylogeny, natural history, and the insect fossil record. We will examine what is known about insect higher level relationships based on morphology and DNA sequence data and explore how phylogenies can be used to examine the evolution of behavior, life history, ecology, and natural history. Students will come away from the class with a deeper understanding of insect biodiversity, evolution, natural history, and phylogeny.

ENTOM 3311 - Insect Diversity and Evolution Laboratory

Fall. (Offered alternate years) 1 credit. Prerequisite: ENTOM 2120. Co-requisite: ENTOM 3310. Course fee: Lab fee $40. B.N. Danforth.

This laboratory will introduce students to the diversity of insects and their identification. Collections will be made in the early part of the semester. Labs will introduce students to insect collecting techniques and insect identification to the family level. Optional weekend field trips to natural areas will take place early in the semester. Entomology undergraduates wishing to count

Insect Phylogeny and Evolution toward their Group A requirement should take the laboratory as well as the lecture for a total of 4 credits.

ENTOM 3340 - Tropical Field Entomology

Winter. 4 credits. Prerequisite: ENTOM 2120 or BIOEE 1610.

This course will give students hands-on exposure to insect biodiversity, ecology, and behavior in a neotropical rainforest environment. Students will gain experience in insect sampling and survey methods, insect identification to the family level, insect natural history, experimental design and data collection in a field setting, basic statistics, interpretation and evaluation of scientific literature, and scientific writing. Course takes place over a two-week period for approximately 12 hr/day. The course takes place at the La Selva Field Station in Costa Rica from January 4-18, 2015. Applications are due to Professor Danforth by October 1, 2014.

ENTOM 4610 - Model-Based Phylogenetics and Hypothesis Testing

Spring. 3 credits. Prerequisite: BIOEE 1780 or BIOMG 2800 or equivalent, or permission of instructor. E. Murray, B. Danforth

A variety of disciplines in biological research address questions that rely on a phylogenetic framework for hypothesis-testing, including the fields of ecology, epidemiology, behavior, physiology, evolution, and genomics. This course will provide an advanced undergraduate/graduate level introduction to model-based methods of phylogenetic analysis including maximum likelihood and Bayesian methods. The emphasis will be on DNA sequence data and issues associated with reconstructing phylogenetic trees from multiple gene loci. In addition, the course will cover how phylogenies can be used in the context of evolutionary hypothesis testing (including fossil-calibrated phylogenies, character mapping, ancestral state reconstruction, community ecology, and historical biogeography) using rigorous statistical methods. The course will include a computer laboratory for performing analyses using real data sets. Beginning skills in R programming will be introduced, and students will build an independent dataset to analyze using the techniques introduced in class.

ENTOM 6350 - Insect Molecular Systematics [NO LONGER OFFERED]

Spring. 2 credits. Prerequisite: permission of instructor. B.N. Danforth

Analysis of DNA sequence variation can provide a powerful tool for resolving problems in insect systematics, from species-level taxonomic decisions to higher-level (ordinal) relationships. This course introduces students, through readings of the primary literature, to the basic methods of insect molecular systematics, including DNA extraction, gel electrophoresis, PCR, DNA purification, and DNA sequencing (manual and automated). Results are analyzed using available computer programs. Students are encouraged to collect preliminary data for thesis or post-doctoral research.

d. **Student Evaluations**

I have summarized the student evaluations over the past 11 semesters in the spreadsheet on the following page and have provided the most recent course evaluations for two classes: Entom 2010/2011, Alien Empire, Spring 2011 and Entom 3310/3311, Insect Phylogeny and Evolution, Fall 2009. Overall, my teaching evaluations are good. Out of a total of 5 points, the students evaluated my overall teaching between 4.06 and 4.86. Similarly, the courses I have taught are ranked between 3.96 and 4.86. Entom 2010/2011 (Alien Empire: Bizarre Biology of Bugs) has the largest enrollment of undergraduate students (between 60 and 140 students since inception) and the students ranked this class between 4.1 and 4.48 over the past four offereings. The graduate-level courses (Entom 3220, 3310/3311, and 6350) have similarly high ratings. My teaching skills receive some of the highest scores: between 4.31 and 4.75. There do not appear to be obvious changes in the ratings my classes receive over time.

Recent student evaluations of Entom 2010/2011, Alien Empire, Spring 2011 were overall extremely positive. Students gave the course an overall rating of 4.34 and scored my teaching skills as 4.69. One student commented: “Danforth was AWESOME! Unbelievably caring, nice, and a great teacher. By far one of the best professors I've had at Cornell. The class was incredibly enjoyable, and I'd recommend it to anyone. His organization (i.e. the website) was great, and truly wanted us to learn. A+” Another student commented: “I really loved this class. I wish I had time to take more entomology courses because they are so interesting, but it will probably be a while before I can if I ever can. This is a good course for anyone, no matter their interest. Professor Danforth is also a really effective lecturer and I never had trouble paying attention, which has been the case in some of my other classes.”

Recent student evaluations of Entom 3310/3311, Insect Phylogeny and Evolution, Fall 2011 were very high. The course was given an overall rating of 4.75 and my teaching skills were rated 4.75. Recent student comments included: “Professor Danforth was particularly good at explaining methodology, and treating it as a variable tool which must be considered along with results. His explanation of molecular phylogenetic modeling and analysis was the most clear and easiest to grasp of many that I have been exposed to.” and “I loved the lecture course!”

EXTENSION

I do not have a formal extension appointment at Cornell, but I am a strong believer that scientific results, including studies of biodiversity, phylogeny, and pollination ecology, be made readily accessible to the general public. As part of our USDA-funded apple pollination project (see Research section), we are making a serious effort to disseminate our findings to the apple growers, orchard managers and anyone who can make effective use of our findings. We do this in a number of ways. First, a number of people in my lab (Mia Park, EJ Blitzer, Laura Russo myself) have given extension talks at regional meetings of New York apple growers. We have developed recommendations for managing and maintaining native bee diversity in and around apple orchards in central NY. We have also recent published one extension publication (Park, M.G., et al. 2010) and and one extension booklet based on funding from the Northeast IPM program (Park, M.G., et al. 2012)

My lab is also heavily involved in the annual open house sponsored by the Department of Entomology at Cornell. This one-day event (Insectapalooza!) attracts over 3000 visitors to our department every fall semester. My lab presents displays and posters about bee biodiversity, bee biology and ecology, and the importance of conserving native pollinators. We have

developed a powerpoint template that allows anyone in my lab to develop a high-quality, professional-style display on any topic. Our displays include photos, text, pinned insects, and other biological specimens relevant to the topic (see figure at right). We have prepared over 12 such displays over the past three years.

Finally, I have been involved with a local elementary school (Cayuga Heights Elementary) in developing a 5th grade project on the biology of mason bees. This project was initially developed in 2010 with the help of a fifth grade teacher, Connie Patterson. The program is now run every year by Cayuga Heights instructors.

Extension publications:

Danforth, B.N. & C.M. Marshall. 2003. Insect morphology meets the WWW. Amer. Entomol. 48(4): 197-199.

Danforth, B.N. & K.N. Magnacca (2002). Bees of New York State. NY State Biodiversity Clearinghouse, New York State Biodiversity Project and New York State Biodiversity Research Institute. [http://www.nybiodiversity.org/]

Danforth, B.N., J. Fang, S. Sipes, S.G. Brady, & E.A.B. Almeida (2005). Phylogeny and molecular systematics of bees (Hymenoptera: Apoidea). Cornell University, Ithaca, NY [http://www.entomology.cornell.edu/BeePhylogeny/]

Park, M.G., M.C. Orr, & B.N. Danforth (2010). The role of native bees in apple pollination. New York State Fruit Quarterly 18(1): 21-25.

Park, M.G., B.N. Danforth, J. Losey, D. Biddinger, Mace Vaughan, J. Dollar, E. Rajotte, & A. Agnello (2012). Wild Pollinators of Eastern Apple Orchards and How to Conserve Them. Cornell University, Penn State University, and The Xerces Society. URL: http://www.northeastipm.org/park2012

Danforth, B.N., M. T. van Dyke (2015) The wild bees of New York: Our insurance policy against honey bee decline. New York Fruit Quarterly 23(4): 17-22.

Extension talks to apple growers:

New York Pollinator Conservation Planning Short Course. September 23, 2010, Big Flats Plant Materials Center, Big Flats, NY, “The role and importance of native bees in apple pollination” [extension talk]

Fruit EXPO, Syracuse, NY, Jan. 22, 2014, “Honeybees, CCD, and the importance of wild pollinators for orchard pollination” [extension talk]

NY State IPM advisory council meeting, Syracuse, NY, Feb. 25, 2014, “Honeybees, CCD, and the importance of wild pollinators for orchard pollination” [extension talk]

Lake Ontario Winter Fruit School, Lockport, NY, Feb. 1, 2016. “Pollinator Management: The Importance of Wild Bees”. [extension talk]

Lake Ontario Winter Fruit School, Newark, NY, Feb. 2, 2016. “Pollinator Management: The Importance of Wild Bees”. [extension talk]

Red Tomato Annual Growers Meeting, The Henry A. Wallace Center at the FDR Presidential Library and Home, Hyde Park, NY, March 15, 2016. “Wild pollinator diversity and ecology in NY orchards”. [extension talk]

New York Pollinator Protection Plan Meeting, NY, November 1, 2017. “Wild bee research in the Danforth lab”

Extension workshops:

NYS DEC pollinator workshop May 23-26, 2017. Four-day pollinator identification workshop held at Huyck Preserve in Rensselaerville, NY.

NYS DEC pollinator workshop June 5-8, 2019. Three-day pollinator identification workshop held at Cornell University, Ithaca, NY

Extension websites:

The Northeast Pollinator Partnership Project: Bee Abundance Assessment Tool. http://northeastpollinatorpartnership.org

Date modified: 22 July, 2019