

Dr. Nate B. Hardy

Assistant Professor

Department of Entomology and Plant Pathology

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Education

- 2008 PhD, University of California, Davis, Department of Entomology
- 2002 BS, Cornell University, Department of Entomology

Employment

- 2013- Assistant Professor, Auburn University (AU), Department of Entomology and Plant Pathology
- 2012-2013 Postdoc, Cleveland Museum of Natural History
- 2011-2012 Postdoc, University of New Mexico
- 2008-2011 Research Entomologist, Queensland Department of Primary Industries and Fisheries, Brisbane, Queensland, Australia
- 2008 Postdoc, University of California, Davis

Teaching

Courses

- 2013- Insect Systematics (ENTM 5300/6300), taught three times
- 2013- Insect Morphology (ENTM 5440/6440), taught twice

Graduate students

As major professor

- 2015- MS student Nick Christodoulides studies the genetic architecture of host-use adaptation in plant-eating insects.
- 2015- PhD student Ricki Hamilton studies the species diversity of hickory-galling phyloxerans.
- 2014-2016 MS Mayrolin García Morales upgraded ScaleNet and studied the role of natural enemy pressure in driving plant-eating insect speciation. She was awarded an NSF Graduate Research Fellowship and began her PhD at the University of Massachusetts in the fall of 2016.

As committee member

- 2013-2015 MS Zi Ye studied mosquito olfaction in Nannan Liu's lab at AU. He began his PhD at Vanderbilt University in 2015.
- 2014- MS student Xinmi Zhang studies arthropod-transmitted diseases in Derrick Mathias's lab at AU.

As host

2016 PhD student Linda Oforika came from the University of Lagos, Nigeria, to work on the biodiversity of the blackflies that transmit River Blindness.

Grants and Awards

Funded

2016-2018 PI, Hatch Seed Grant: How do sap-sucking bugs overcome plant defenses? (\$50,000)
 2014-2017 PI, USDA Specific Cooperative Research Agreement: Rebuilding ScaleNet. (\$75,000)
 2014-2016 PI, Hatch New Investigator Award: Evolution of polyphagy in plant-feeding insects. (\$30,000)
 2009-2011 PI, Australian Biological Resources Study, National Taxonomy Research Grant: Describing Australia's armored scales. (\$30,000)
 2008 Winner, Kinsella Memorial Prize for the Outstanding Graduate Student in the UC Davis College of Agricultural Sciences. (\$3,000)

Pending

2017-2020 PI, NSF, DEB: What drives speciation in Nearctic aphids? (\$150,000)

Publications

<http://scholar.google.com/citations?user=KxXQV14AAAAJ&hl=en>

Students in my group denoted with an asterisk.

1. Hardy NB, Peterson DA, Normark BB. 2016. Nonadaptive Radiation: Pervasive diet specialization by drift in scale insects? bioRxiv, p.064220. (accepted by *Evolution*)
2. Peterson D, Hardy NB, Normark BB. 2016. Micro-and macroevolutionary trade-offs in plant-feeding insects. bioRxiv, p.040311. (accepted by *The American Naturalist*)
3. García Morales M*, Denno B, Miller DR, Miller GA, Ben-Dov Y, Hardy NB. 2016. ScaleNet: A literature-based model of scale insect biology and systematics. *Database*, 2016, p.bav118.
4. Hardy NB, Peterson DA, Normark BB. 2015. Scale insect host ranges are broader in the tropics. *Biology Letters*, 11, 20150924; DOI: 10.1098/rsbl.2015.0924
5. Blackmon H, Hardy NB, Ross L. 2015. The evolutionary dynamics of haplodiploidy: genome architecture and haploid viability. *Evolution*, 69, 2971-2978.
6. Winterton SL, Hardy NB, Gaimari SD, Hauser M, Hill HN, Holston KC, Irwin ME, Lambkin CL, Metz MA, Turco F, Webb D, Yang L, Yeates DK, Wiegmann BM. 2015. The phylogeny of stiletto flies (Diptera Therevidae). *Systematic Entomology*, DOI: 10.1111/syen.12147
7. Peterson DA, Hardy NB, Morse GE, Stocks IC, Okusu A, Normark BB. 2015. Phylogenetic analysis reveals positive correlations between adaptations to diverse hosts in a group of pathogen-like herbivores. *Evolution*, 69, DOI: 10.1111/evo.12772
8. Svenson GJ, Hardy NB, Whiteman HMC, Wieland F. 2015. Of flowers and twigs: phylogenetic revision of the plant-mimicking praying mantises (Mantodea: Empusidae and Hymenopodidae) with a new suprageneric classification. *Systematic Entomology*, online early (DOI: 10.1111/syen.12134).
9. Hardy NB, Peterson DA, von Dohlen CD. 2015. The evolution of life cycle complexity in aphids: ecological optimization or historical constraint? *Evolution*. 69, 1423-1432.
10. Semple T, Gullan P, Hodgson C, Hardy NB, Cook LG. 2015. Systematic review of the Australian "bush coconut" genus (Hemiptera: Eriococcus: Cystococcus) uncovers a new species from Queensland. *Invertebrate Systematics*, 29, 287-312

11. Ross L, Blackmon H, Lorite P, Gokhman VE, Hardy NB. 2015. Recombination, chromosome number and eusociality in the Hymenoptera. *Journal of Evolutionary Biology*, 28, 105-116.
12. Hardy NB, Otto SP. 2014. Specialization and generalization in the diversification of phytophagous insects: tests of the musical chairs and oscillation hypotheses. *Proceedings of the Royal Society B* 281, 20132960.
13. Cook LG, Hardy NB, Crisp MD. 2014. Three explanations for biodiversity hotspots: small range size, geographic overlap and time for species accumulation. An Australian case study. *New Phytologist*. 207, 390-400.
14. Crisp MD, Hardy NB, Cook LG. 2014. Clock model makes a large difference to age estimates of long-stemmed clades with no internal calibration: A test using Australian grass trees. *BMC Evolutionary Biology*. 14, 263.
15. Ross L, Gardner A, Hardy N, West SA. 2013. Ecology, not the genetics of sex determination, determines who helps in eusocial populations. *Current Biology* 23, 2382-2387.
16. Miller K, Jean A, Alariae Y, Hardy N, Gibson R. 2013. Phylogenetic placement of North American subterranean diving beetles (Insecta: Coleoptera: Dytiscidae). *Arthropod Systematics and Phylogeny* 71, 75-90.
17. Hodgson CJ, Hardy NB. 2013. The phylogeny of the superfamily Coccoidea (Hemiptera: Sternorrhyncha) based on the morphology of extant and extinct macropterous males. *Systematic Entomology* 38, 794-804.
18. Hardy NB. 2013. The status and future of scale insects (Coccoidea) systematics. *Systematic Entomology* 38, 453-458.
19. Ross L, Hardy NB, Okusu A, Normark BB. 2013. Large population size predicts the distribution of asexuality in scale insects. *Evolution* 67, 196-206.
20. Hardy NB, Cook LG. 2012. Testing for ecological limitation of diversification: a case study using parasitic plants. *The American Naturalist* 180, 438-449.
21. Cranston PS, Hardy NB, Morse GE. 2012. A dated molecular phylogeny for the Chironomidae (Diptera). *Systematic Entomology* 37, 172-188.
22. Hardy NB, Henderson RC. 2011. Revision of *Poliaspis* (Hemiptera: Coccoidea: Diaspididae), with descriptions of eight new species from Australia. *Zookeys* 137, 1-40.
23. Hardy NB, Beardsley JW, Gullan PJ. 2011. Uncovering diversity of Australian *Eucalyptus*-constrained felt scales (Hemiptera: Coccoidea: Eriococcidae). *Systematic Entomology* 36, 497-528.
24. Gruwell ME, Hardy NB, Gullan PJ, Dittmar K. 2010. Evolutionary relationships among primary endosymbionts in the mealybug subfamily Phenacoccinae (Hemiptera: Coccoidea: Pseudococcidae). *Applied and Environmental Microbiology* 76, 7521-7525.
25. Hardy NB, Gullan PJ. 2010. Australian gall-inducing scale insects on *Eucalyptus*: revision of *Opisthoscelis* Schrader (Coccoidea, Eriococcidae) and descriptions of a new genus and nine new species. *Zookeys* 58, 1-74.
26. Cook LG, Edwards RD, Crisp M, Hardy NB. 2010. Need morphology always be required for new species descriptions? *Invertebrate Systematics* 24, 322-326.
27. Hardy NB, Cook LG. 2010. Gall-induction in insects: evolutionary dead-end or speciation driver? *BMC Evolutionary Biology* 10, 257.
28. Cranston PS, Hardy NB, Morse GE, Puslednick L, McCluen SR. 2010. When molecules and morphology concur: the 'gondwanan' midges (Diptera: Chironomidae). *Systematic Entomology* 35, 636-648.
29. Winterton SL, Hardy NB, Wiegmann BM. 2010. On wings of lace: phylogeny and Bayesian divergence time estimates of Neuropterida (Insecta) based on morphological and molecular data. *Systematic Entomology* 35, 349-378.

30. Gullan PJ, Kaydan MB, Hardy NB. 2010. Molecular phylogeny and species recognition in the mealybug genus *Ferrisia* (Hemiptera: Pseudococcidae). *Systematic Entomology* 35, 329-339.
31. Hardy NB, Gullan PJ. 2009. *Opisthoscelis nigra* Froggatt (Eriococcidae) is an armoured scale *Maskellia nigra* (Froggatt) (Diaspididae). pp. 59–62. In: Branco, M., Franco, J.C. & Hodgson, C. (Eds) *Proceedings of the XI International Symposium of Scale Insect Studies*, Oeiras, Portugal, 24–27 September 2007. ISA Press, Lisbon, Portugal.
32. Kondo T, Hardy NB. 2008. Redescription of *Inglesia vitrea* Cockerell (Hemiptera, Coccidae) and its transfer to the genus *Pseudokermes* Cockerell. *Zookeys* 3, 11-21.
33. Hardy NB, Gullan PJ, Henderson RC, Cook LG. 2008. Relationships among scale insects (Hemiptera: Coccoidea: Eriococcidae) of southern beech, *Nothofagus* (Nothofagaceae), with the first descriptions of Australian species of the *Nothofagus*-feeding genus *Madarococcus* Hoy. *Invertebrate Systematics* 22, 365-405.
34. Kondo T, Hardy NB. 2008. Synonymy of *Etiennea* Matile-Ferrero with *Hemilecanium* Newstead (Hemiptera: Coccidae), based on morphology of adult females, adult males and first-instar nymphs, and description of a new species from Okinawa, Japan. *Entomological Science* 11, 189-213.
35. Hardy NB, Gullan PJ. 2008. Pseudococcini Cockerell, 1905: proposed precedence over Sphaerococcini Cockerell, 1899. Case number 3424. *The Bulletin of Zoological Nomenclature* 65, 24-64.
36. Hardy NB, Gullan PJ, Hodgson CJ. 2008. A classification of mealybugs (Hemiptera: Pseudococcidae) based on integrated molecular and morphological data. *Systematic Entomology* 33, 51-71.
37. Hardy NB. 2007. A new mealybug species (Hemiptera: Coccoidea: Pseudococcidae) from the ant-plant *Hydnophytum* (Rubiaceae) in Fiji. *Fiji Arthropods In: Evenhuis NL & Bickel DJ (eds). Fiji Arthropods IX. Bishop Museum Occasional Papers.* 94, 35-40.
38. Hardy NB, Gullan PJ. 2007. A new species of *Phacelococcus* Miller (Hemiptera: Coccoidea: Eriococcidae) on *Bursaria* (Pittosporaceae). *The Australian Entomologist* 34, 85-91.
39. Hardy NB. 2007. Phylogenetic utility of dynamin and triose phosphate isomerase. *Systematic Entomology* 32, 396-403.
40. Hardy NB, Gullan PJ. 2007. A new genus and four new species of felt scales on *Eucalyptus* (Hemiptera: Coccoidea: Eriococcidae) in south-eastern Australia. *Australian Journal of Entomology* 46, 106-120.
41. Kondo T, Hardy NB, Cook LG, Gullan PJ. 2006. Description of two new genera and species of Eriococcidae (Hemiptera: Coccoidea) from southern South America. *Zootaxa* 1349, 19-36.

Presentations

Invited talks

1. Hardy NB. 2016. Musical chairs and dead ends: The macroevolution of diet diversity in plant-eating insects. International Congress of Entomology, Orlando, Florida, 15 minute talk in Symposium: From diet breadth to diversification: Understanding host shifts in phytophagous insects.
2. Hardy NB. 2015. Evolution of life cycle complexity and phenotypic plasticity in plant-feeding insects. Santa Fe Institute, Evolutionary Ecology of Complex Investment Strategies Workshop.
3. Hardy NB. 2015. Host-use evolution in plant-feeding insects: comparative analyses of bugs, butterflies and moths. University of Georgia, Department of Entomology seminar.

4. Hardy NB, Normark BB. 2015. We should do Sternorrhyncha systematics! Illinois Natural History Survey, NSF Assembling the Hemipteroid Tree of Life workshop.
5. Hardy NB. 2014. Jack of all trades makes no tradeoffs: host breadth evolution in plant feeding insects. Florida State University, Department of Biological Sciences, Evolution and Ecology seminar.
6. Hardy NB. 2014. Jack of all trades makes no tradeoffs: host breadth evolution in plant feeding insects. University of Florida, Department of Entomology and Nematology seminar.

Conference talks

Students in my group denoted with an asterisk.

1. García Morales M*, Hardy NB. 2016. Diversification of plant-feeding insects is positively correlated with natural enemy pressure. International Congress of Entomology, Orlando, 15 minute talk.
2. Christodoulides N*, Hardy NB. 2016. The role of gene expression evolution in scale insect host use adaptation. International Congress of Entomology, Orlando, 15 minute talk.
3. Hamilton R*, Hardy NB. 2016. New species of armored scale insects (Hemiptera: Diaspididae) described from New Caledonia. International Congress of Entomology, Orlando, 15 minute talk.
4. Hardy NB, Peterson DA, Normark BB. 2016. Geographic and phylogenetic patterns in scale insect diversity and diet breadth. International Symposium on Scale Insect Studies, Catania, Italy, 15 minute talk.
5. Hardy NB. 2015. Non-adaptive host-plant specialization in plant-feeding insects. Entomological Society of America Annual Meeting, Minneapolis, MN, 10 minute talk.
6. Hardy NB, Peterson D, Normark BB. 2014. Effects of plant species-richness of host breadth evolution in armored scales. Entomological Society of America Annual Meeting, Portland, OR, 10 minute talk.
7. Hardy NB. 2013. Testing the adaptiveness of complex life cycles in aphids. Entomological Society of America Annual Meeting, Austin, TX, 10 minute talk.
8. Hardy NB. 2013. The status and future of scale insect (Coccoidea) systematics. International Symposium on Scale Insect Studies, Sofia, Bulgaria, 15 minute talk.
9. Hardy NB. 2012. Large population size predicts the distribution of asexuality in scale insects. Annual Meeting of the Entomological Society of America, Knoxville, TN, 10 minute talk.
10. Hardy NB. 2012. Species diversification of evolutionary oddballs. Cleveland Museum of Natural History, Explorer Lecture Series, Cleveland, OH, 45 minute talk.
11. Hardy NB, Svenson GJ, Cook LG. 2011. Biogeography of Southern Hemisphere arthropods. Annual Meeting of the Entomological Society of America, Reno, NV, 10 minute talk.
12. Hardy NB. 2010. Rebuilding ScaleNet: new architecture, administration, and access. XII International Symposium on Scale Insect Studies, Xania, Crete, 15 minute talk.
13. Hardy NB, Trewick S, Cook LG. 2010. Biogeography of Austral arthropods: a comparative molecular phylogenetics approach. Southern Connections Congress, Bariloche, Argentina, 15 minute talk.
14. Hardy NB. 2009. Is gall-induction a key innovation in insects? Darwin 200: Evolution and Biodiversity, Darwin, Australia, 15 minute talk.
15. Hardy NB, Gullan PJ, Hodgson CJ. 2007. A subfamily classification of mealybugs (Hemiptera: Pseudococcidae) based on integrated molecular and morphological data. Annual Meeting of the Entomological Society of America, San Diego, CA, 10 minute talk.
16. Hardy NB, Gullan PJ, Hodgson CJ. 2007. Mealybug phylogeny and classification revisited (Hemiptera: Coccoidea: Pseudococcidae). International Symposium of Scale Insect Studies,

Oeiras, Portugal, 15 minute talk.

17. Hardy NB. 2005. Evolution of gall-induction within the Australian felt scales (Hemiptera: Coccoidea: Eriococcidae). Annual Meeting of the Entomological Society of America, Ft Lauderdale, FL, 10 minute student talk.

Web

- <http://scalenet.info>: An online catalog of scale insect biology and systematics.
- <http://specimens.mantodearesearch.com/mantispp/default/species>: A database of high-resolution images of mantis type specimens.

Service

Professional community

- 2008- Manuscript referee for more than twenty journals, including: *Evolution*, *Proceeding of the Royal Society B*, *Systematic Entomology*, *Molecular Phylogenetics and Evolution*, *Molecular Ecology*, *Oecologia*, and the *Journal of Biogeography*.
- 2013- Editorial Board Member of *Systematic Entomology*.
- 2016 NSF, DEB *ad hoc* reviewer
- 2015 NSF, DEB *ad hoc* reviewer, and panelist
- 2014 NSF, DEB panelist
- 2013 NSF, DEB *ad hoc* reviewer

University and department committees

- 2014- AU Department of Entomology and Plant Pathology Web Committee
- 2015- AU Department of Entomology and Plant Pathology Curriculum Committee
- 2016 Director of the AU Museum of Natural History Search Committee
- 2016 Co-chair of Assistant Professor in Apiculture and Pollination Biology Search Committee
- 2016 External Reader, Dissertation of Milton Tan, AU Biology
- 2016 External Reader, Dissertation of Raphael Orelis-Ribeiro, AU Fisheries
- 2014-2016 AU Department of Entomology and Plant Pathology Executive Committee
- 2015 AU Distinguished Dissertation Award Committee
- 2015 External Reader, Dissertation of Chris Hamilton, AU Biology
- 2014 Assistant Professor in Mycology Search Committee