

PHYLOGEOGRAPHY AND SPECIES DISTRIBUTION MODELING

Description and goal: In this course we will explore basic concepts and theory relevant to the application of phylogeographic methods: rates of mtDNA and cpDNA evolution and their utility for genealogy reconstruction, gene trees vs. species trees, coalescent concepts and historical demography, molecular clock calibration, and the influence of life history and biogeography on patterns of relatedness. In the second half of the semester, we will focus on hypothesis testing with species distribution models and conservation: cryptic phylogenetic structure and conservation priorities, identifying critical habitat for threatened/endangered species or areas of concern for invasive species, sister species interactions or functional ecological group interactions, and modeling species responses to potential past or future climate.

Comments: Phylogeographic analyses underpin our understanding of historical demography and biogeography, genealogical relationships among populations, and the effect of current landscape and past geological events on speciation and population dynamics.

To explore the theory and application of phylogeographic methods in this seminar, we will read and discuss primary literature:

Tentative Schedule:

Week 1 Organizational Meeting

Phylogeography

Overview

Week 2 Avise, J. C. 2009. Phylogeography: retrospect and prospect. *Journal of Biogeography* 36: 3-15.

Martin, A.P. & S. R. Palumbi. 1993. Body size, metabolic rate, generation time, and the molecular clock. *Proceedings of the National Academy of Sciences of the USA* 90: 4087-4091.

Wolfe, K.H., W-H Li, & P.M. Sharp. 1987. Rates of nucleotide substitution vary greatly among plant mitochondrial, chloroplast, and nuclear DNAs. *Proceedings of the National Academy of Sciences of the USA* 84: 9054-9058.

Rogers, A.R. & H. Harpending. 1992. Population growth makes waves in the distribution of pairwise genetic differences. *Molecular Biology and Evolution* 9: 552-569.

Methods, Hypotheses, and Gene Tree/Species Tree Considerations

Week 3 Garrick, R.C., A. Caccone, & P. Sunnucks. 2010. Inference of population history by coupling exploratory and model-driven phylogeographic analyses. *International Journal of Molecular Sciences* 11: 1190-1227.

Degnan, J.H., & N.A. Rosenberg. 2006. Discordance of species trees with their most likely gene trees. *PLOS Genetics* 2, doi: 10.1371/journal.pgen.0020068

Historical Processes Shape Populations

Week 4 Wilson, J.S. & J.P. Pitts. 2010. Phylogeographic analysis of the nocturnal velvet ant genus *Dilophotopsis* (Hymenoptera: Mutillidae) provides insights into diversification in the Nearctic deserts. *Biological Journal of the Linnean Society* 101: 360-375.

Week 5 Spellman, G.M., B. Riddle, & J. Klicka. 2007. Phylogeography of the mountain chickadee (*Poecile gambeli*): diversification, introgression, and expansion in response to Quaternary climate change. *Molecular Ecology* 16: 1055-1068.

Carstens, B.C., & L.L. Knowles. 2007. Shifting distributions and speciation: species divergence during rapid climate change. *Molecular Ecology* 16: 619-627.

Week 6 Riddle, B.R., D.J. Hafner, L.F. Alexander, & J.R. Jaeger. 2000. Cryptic vicariance in the historical assembly of a Baja California Peninsular Desert biota. *Proceedings of the National Academy of the USA* 97: 14438-14443.

Overview of Molecular Dating

Week 7 Arbogast, B.S., S.V. Edwards, J. Wakeley, P. Beerli, J.B. Slowinski. 2002. Estimating divergence times from molecular data on phylogenetic and population genetic timescales. *Annual Reviews of Ecology and Systematics* 33: 707-740.

Species Distribution Modeling

Introduction and Niche Concepts

Week 8 Peterson, A.T., J. Soberon, R.G. Pearson, R.P. Anderson, E. Martinez-Meyer, M. Nakamura, & M.B. Araujo. 2011. *Ecological Niches and Geographic Distributions*. Princeton University Press, Princeton, NJ. 314 pp. Chapter 1: Introduction & Chapter 2: Concepts of Niches.

Week 9 Break

Methods and Hypotheses

Week 10 Richards, C.L., B.C. Carstens, L.L. Knowles. 2007. Distribution modelling and statistical phylogeography: an integrative framework for generating and testing alternative biogeographical hypotheses. *Journal of Biogeography* 34: 1833-1845.

Niche Evolution

Week 11 Kozak, K.H., & J.J. Wiens. 2006. Does niche conservatism promote speciation? A case study in North American salamanders. *Evolution* 60: 2604-2621.

Warren, D.L., R.E. Glor, & M. Turelli. 2008. Environmental niche equivalency versus conservatism: quantitative approaches to niche evolution. *Evolution* 62: 2868-2883.

Climate, Diversification, and Range Boundaries

Week 12 Carnaval, A. C., M. J. Hickerson, C. F. B. Haddad, M. T. Rodrigues, and C. Moritz. 2009. Stability predicts genetic diversity in the Brazilian Atlantic forest hotspot. *Science* 323: 785-789.

Glor, R.E., & D. Warren. 2011. Testing ecological explanations for biogeographic boundaries. *Evolution* 65: 673-683.

Modeling the Past, or Future

Week 13 Oberhauser, K. & A.T. Peterson. 2003. Modeling current and future potential wintering distributions of eastern North American monarch butterflies. *Proceedings of the National Academy of Sciences of the USA* 100: 14063-14068.

Premoli, A.C., P. Mathiasen, T. Kitzberger. 2010. Southern-most *Nothofagus* trees enduring ice ages: Genetic evidence and niche retrodiction reveal high latitude (54°S) glacial refugia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 298: 247-256.

Week 14 Break

Invasion

Week 15 Roura-Pascual, N., A.V. Suarez, C. Gomez, P. Pons, Y. Touyama, A.L. Wild, & A.T. Peterson. 2004. Geographical potential of Argentine ants (*Linepithema humile* Mayr) in the face of global climate change. *Proceedings of the Royal Society of London B* 271: 2527-2534.

Hinojosa-Diaz, I.A., O. Yanez-Ordóñez, G. Chen, A.T. Peterson, & M.S. Engel. 2005. The North American Invasion of the Giant Resin Bee (Hymenoptera: Megachilidae). *Journal of Hymenoptera Research* 14: 69-77.

GENERAL INFORMATION

Instructor: Robert Laport rob.laport@gmail.com
411 Manter Hall

Office hours: By Appointment

Course web site: Blackboard

Grading: Final grades will be based on presentation/leading discussion of weekly readings and contribution to group discussions. You are expected to be present for, and to participate in, all formal meetings/discussions. Please arrange for absences in advance.