

# Course: Biogeography

## Justification

Biogeography is a dynamic field that seeks to understand the role of historical factors in shaping biodiversity and to develop predictive capacities for gauging how biodiversity will respond to our rapidly changing world. Historically largely descriptive, it has become a rigorous science. The field synthesizes information from a broad range of fields, and the conceptual diversity of the field of biogeography is enormous, including basic sciences (historical biogeography, macroecology, physiological biogeography, remote sensing, paleobiogeography, ecoinformatics, evolutionary biology, ecosystem science, climatology) but also social sciences (linguistics, cultural biogeography), and applied disciplines (global change biology, invasion biogeography, disease ecology, environmental health).

Much of biogeography maintains a focus on the basic sciences, though there is an increasing necessity for relevance, especially in developing countries.

The course will provide a historical background for the field of biogeography and the ecological foundations needed to understand the distribution and abundance of species and their changes over time. It will also discuss developing technologies (including genomic tools and environmental models) together with the availability of big data and increasingly sophisticated analytical tools to examine the relevance of the field to global change biology, conservation, and invasion biology, as well as sustainable food systems and ecosystem services.

## Time and Place:

Lecture - WF 11-12:30 p.m.

Discussion – M 2-3 or W 2-3 p.m.

**Prerequisites:** Bio 1B or similar

**Brief Description:** 4 units. Three hours of lecture and one hour of discussion per week. Explores how biogeographic processes influence the ecology and evolution of species, communities, and ecosystems. Provides insights into the effects of global change on biota.

**More Details:** The goals of the course are to (a) examine how geographically-linked characteristics of populations and species influence their potential for evolution and extinction; and (b) provide an overview of the approaches for studying the interplay between geographic ranges, environment, evolution, and extinction. In general, lectures will focus on teaching key biogeographic principles and the relevance of biogeography in forecasting global change. Discussion sections will focus more on case studies and controversies.

## Text:

*Lomolino, M. V., Riddle, B. R., and Brown, J. H. 2006. Biogeography, 4<sup>th</sup> Edition. Sinaur.*  
*Some articles from the primary literature TBA*

**Grading:** 2 midterms and final (20% each), research paper written in a style acceptable for *Journal of Biogeography* (30%), participation in class and discussion section (10%).

## Tentative Syllabus

**Week 1 Jan 15-19: History of Biogeography - development of concepts** (Linnaeus, Humboldt, Darwin, Wallace, Wegener, Hennig, Brundin, Croizat)

Lecture 0 = First Day Info, Course Logistics, Scientific Method

Lecture 1 = Development of ideas and different components of biogeography

NO DISCUSSION SECTION FIRST WEEK

RELEVANT CHAPTERS: Chapter 1

REQUIRED READING: Crisci, J.V. and Katinas, L., 2009. Darwin, historical biogeography, and the importance of overcoming binary opposites. *Journal of Biogeography*, 36(6), pp.1027-1032.

**Week 2 Jan 22-26: Principles & Constraints on Geographic Ranges**

Lecture 2 = Species area relationship, neutral theory, equilibrium

Lecture 3 = Ecological Niche, Ecology vs. History; Species Interactions

DISCUSSION SECTION:

Lomolino, M.V., 2000. Ecology's most general, yet protean pattern: The species-area relationship. *Journal of Biogeography*, 27(1), pp.17-26.

Green, Jessica L., John Harte, and Annette Ostling. "Species richness, endemism, and abundance patterns: tests of two fractal models in a serpentine grassland." *Ecology Letters* 6, no. 10 (2003): 919-928.

Angert, A.L., Crozier, L.G., Rissler, L.J., Gilman, S.E., Tewksbury, J.J. and Chuncu, A.J., 2011. Do species' traits predict recent shifts at expanding range edges?. *Ecology letters*, 14(7), pp.677-689.

Wiens, J.J., 2011. The niche, biogeography and species interactions. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 366(1576), pp.2336-2350.

RELEVANT CHAPTERS: Chapter 2

**Week 3 Jan 29-Feb 2: Communities and patterns in biogeography**

Lecture 4 = Biomes and hotspots, biodiversity and extinction hotspots; alpha & beta diversity

Lecture 5 = Latitudinal gradient, altitude, etc

DISCUSSION SECTION:

Fine, Paul VA. "Ecological and evolutionary drivers of geographic variation in species diversity." *Annual Review of Ecology, Evolution, and Systematics* 46 (2015): 369-392.

Mittermeier, Russell A., Will R. Turner, Frank W. Larsen, Thomas M. Brooks, and Claude Gascon. "Global biodiversity conservation: the critical role of hotspots." In *Biodiversity hotspots*, pp. 3-22. Springer Berlin Heidelberg, 2011.

RELEVANT CHAPTERS: Chapter 4

**Week 4 Feb 5-9: Plate tectonics & Vicariance**

Lecture 6 = Plate tectonics

Lecture 7 = Dispersal & Vicariance

DISCUSSION SECTION,

Posadas, P., Crisci, J.V. and Katinas, L., 2006. Historical biogeography: a review of its basic concepts and critical issues. *Journal of Arid Environments*, 66(3), pp.389-403.

Morrone, Juan J. "Track analysis beyond panbiogeography." *Journal of Biogeography* 42, no. 3 (2015): 413-425.

RELEVANT CHAPTERS: Chapter 5

**Week 5 Feb 12-16: Speciation**

Lecture 8 = Speciation

1st midterm

DISCUSSION SECTION:

Fitzpatrick, B.M., Fordyce, J.A. and Gavrillets, S., 2009. Pattern, process and geographic modes of speciation. *Journal of evolutionary biology*, 22(11), pp.2342-2347.

RELEVANT CHAPTERS: Chapter 6

### **Week 6 Feb 19-23: Island biogeography**

Lecture 10= Islands, including sky islands, lakes, mountaintops; progression

Lecture 11 = Equilibrium theory

DISCUSSION SECTION:

Emerson, Brent C., and Rosemary G. Gillespie. "Phylogenetic analysis of community assembly and structure over space and time." *Trends in ecology & evolution* 23, no. 11 (2008): 619-630.

Rosindell, J., Hubbell, S.P. and Etienne, R.S., 2011. The unified neutral theory of biodiversity and biogeography at age ten. *Trends in ecology & evolution*, 26(7), pp.340-348.

Rosindell, James, and Albert B. Phillimore. "A unified model of island biogeography sheds light on the zone of radiation." *Ecology letters* 14, no. 6 (2011): 552-560.

RELEVANT CHAPTERS: Chapter 7

### **Week 7 Feb 26-Mar 2 Evolution on islands**

Lecture 12= Endemism, island phenomena; island rule, taxon cycles gigantism, plants

Lecture 13= Adaptive radiation; convergence

DISCUSSION SECTION:

Losos, Jonathan B., and Robert E. Ricklefs. "Adaptation and diversification on islands." *Nature* 457, no. 7231 (2009): 830.

Rundell, Rebecca J., and Trevor D. Price. "Adaptive radiation, nonadaptive radiation, ecological speciation and nonecological speciation." *Trends in Ecology & Evolution* 24, no. 7 (2009): 394-399.

RELEVANT CHAPTERS: Chapter 7

### **Week 8 Mar 5-9: Marine biogeography**

Lecture 14 = Open ocean

Lecture 15 = Marine lakes and shallow waters

DISCUSSION SECTION

Pinheiro, H.T., Bernardi, G., Simon, T., Joyeux, J.C., Macieira, R.M., Gasparini, J.L., Rocha, C. and Rocha, L.A., 2017. Island biogeography of marine organisms. *Nature*.

Dawson, Michael N. "Island and island-like marine environments." *Global Ecology and Biogeography* 25, no. 7 (2016): 831-846.

RELEVANT CHAPTERS: Chapter 9

### **Week 9 Mar 12-16: Paleobiogeography & fossils**

Lecture 16= Deep time - paleobiogeography & fossils (including the potential & limitations of fossils in biogeographic inference)

Lecture 17 = Quaternary and climate change

DISCUSSION SECTION

Butterfield, N.J., 2007. Macroevolution and macroecology through deep time. *Palaeontology*, 50(1), pp.41-55.

Smith, A.B. and Peterson, K.J., 2002. Dating the time of origin of major clades: molecular clocks and the fossil record. *Annual Review of Earth and Planetary Sciences*, 30(1), pp.65-88.

RELEVANT CHAPTERS: Chapter 10 & 12

### **Week 10 Mar 19-23: Phylogeography**

#### **Second midterm**

Lecture 18 = Phylogeography (ecology, evolution continuum)

DISCUSSION SECTION:

Avise, J.C., Bowen, B.W. and Ayala, F.J., 2016. In the light of evolution X: Comparative phylogeography. *Proceedings of the National Academy of Sciences*, 113(29), pp.7957-7961.

Papadopoulou, A. and Knowles, L.L., 2016. Toward a paradigm shift in comparative phylogeography driven by trait-based hypotheses. *Proceedings of the National Academy of Sciences*, 113(29), pp.8018-8024.

### **Week 11 Mar 26-30 SPRING BREAK**

### **Week 12 Apr 2-6 Biogeography of interactions & communities**

Lecture 18= Priority, progression

Lecture 19= Networks, nestedness, community dynamics

DISCUSSION SECTION

De Meester, L., Vanoverbeke, J., Kilsdonk, L.J. and Urban, M.C., 2016. Evolving perspectives on monopolization and priority effects. *Trends in ecology & evolution*, 31(2), pp.136-146.

Bascompte, Jordi, Pedro Jordano, and Jens M. Olesen. "Asymmetric coevolutionary networks facilitate biodiversity maintenance." *Science* 312, no. 5772 (2006): 431-433.

Rominger, A.J., Goodman, K.R., Lim, J.Y., Armstrong, E.E., Becking, L.E., Bennett, G.M., Brewer, M.S., Cotoras, D.D., Ewing, C.P., Harte, J. and Martinez, N.D., 2016.

Community assembly on isolated islands: macroecology meets evolution. *Global Ecology and Biogeography*, 25(7), pp.769-780.

RELEVANT CHAPTERS: -

### **Week 13 Apr 9-13 Human biogeography**

Lecture 20= **Biogeography of people and languages**

Lecture 21= **Biogeography of microbes and disease**

DISCUSSION SECTION

Novembre, J., Johnson, T., Bryc, K., Kutalik, Z., Boyko, A.R., Auton, A., Indap, A., King, K.S., Bergmann, S., Nelson, M.R. and Stephens, M., 2008. Genes mirror geography within Europe. *Nature*, 456(7218), p.98.

Gavin, M.C. and Sibanda, N., 2012. The island biogeography of languages. *Global Ecology and Biogeography*, 21(10), pp.958-967.

Gavin, Michael C., Carlos A. Botero, Claire Bower, Robert K. Colwell, Michael Dunn, Robert R. Dunn, Russell D. Gray et al. "Toward a mechanistic understanding of linguistic diversity." *BioScience* 63, no. 7 (2013): 524-535.

Weill, F.X., 2016. Global phylogeography and evolutionary history of *Shigella dysenteriae* type.

RELEVANT CHAPTERS: Chapter 13

### **Week 14 Apr 16-20 Human Impacts**

Lecture 22= **Domestication, agricultural origins**

Lecture 23= **Invasion biology**

DISCUSSION SECTION

- Daily, G.C., Ceballos, G., Pacheco, J., Suzán, G. and Sánchez-Azofeifa, A., 2003. Countryside biogeography of neotropical mammals: conservation opportunities in agricultural landscapes of Costa Rica. *Conservation biology*, 17(6), pp.1814-1826.
- Sax, D.F., Stachowicz, J.J., Brown, J.H., Bruno, J.F., Dawson, M.N., Gaines, S.D., Grosberg, R.K., Hastings, A., Holt, R.D., Mayfield, M.M. and O'Connor, M.I., 2007. Ecological and evolutionary insights from species invasions. *Trends in ecology & evolution*, 22(9), pp.465-471.

RELEVANT CHAPTERS: Chapter 13

**Week 15 Apr 23-27: Conservation biogeography**

Lecture 24= **Anthropocene and modified dynamics; extinction debts**

Lecture 25= **Modeling the future, concerns**

DISCUSSION SECTION

- Ackerly, D.D., Loarie, S.R., Cornwell, W.K., Weiss, S.B., Hamilton, H., Branciforte, R. and Kraft, N.J.B., 2010. The geography of climate change: implications for conservation biogeography. *Diversity and Distributions*, 16(3), pp.476-487.
- Richardson, D.M. and Whittaker, R.J., 2010. Conservation biogeography—foundations, concepts and challenges. *Diversity and Distributions*, 16(3), pp.313-320.

RELEVANT CHAPTERS: Chapter 14

**Week 16 Apr 30 -May 4: [REVIEW WEEK]**

**Week 17 May 7-May 11 FINAL EXAM AND PAPER DUE**

FINAL EXAMP GROUP XXX: