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Study Center in Monteverde, Costa Rica

Course name:	Tropical Diversity
Course number:	BIOL 3001 MVCR
Programs offering course:	Costa Rica: Monteverde - Tropical Ecology and Conservation
Language of instruction:	English
U.S. Semester Credits:	4 semester/6 quarter hours
Contact Hours:	60 hours
Term:	Spring 2018
Course meeting times:	Monday and Friday 8AM- 12PM and scheduled fieldtrips
Course meeting place:	Classroom, Monteverde Biological Station
Professor:	Johel Chaves-Campos, PhD
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Office hours:	Thursdays 1-3 pm

Course Description

The origin, maintenance, and loss of tropical diversity are the focus of this course. The current theoretical understanding of diversity will be explored in lectures, and students will read primary literature related to lecture themes. Laboratories and field trips will emphasize taxonomy, basic biology, and natural history. Field trips throughout Costa Rica will closely examine the biodiversity of each community type. In addition, marine diversity will be explored along Costa Rica's coasts and on Panamanian coral reefs.

Learning Objectives

Upon completion of the course the students will:

- Know several definitions of species.
- Understand basic taxonomy and systematics.
- Be able to identify and know the taxonomy and natural history of over 200 species.
- Have sound theoretical grounding in the origin of tropical diversity.
- Understand natural selection, evolution, models of speciation, and genetic divergence.
- Be able to calculate standard indices of ecological diversity, richness, and community similarity.
- Comprehend current ecological theories of how tropical diversity is maintained, including stochastic and deterministic models.
- Know the proximate and ultimate drivers of species loss in the Tropics, which species are most prone to extinction, and examples of contemporary extinction.
- Explore and come to some conclusions about the fate of tropical biodiversity and how best to conserve it.

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Course Prerequisites

One year of Introductory Biology and one elective in whole organismic biology or conservation.

Methods of Instruction

Students will attend lectures and diversity activities. Lectures will emphasize theory, analytical (including quantitative) skills. Students will read and analyze current literature. In addition, students will travel and spend extensive time in the field learning key taxa and characteristic species. There will be one assignment to calculate and interpret diversity indices, reports on species in the field, visits to local sites to emphasize key taxonomic groups. Additional diversity activities will illustrate key concepts through hands-on experience.

Assessment and Final Grade

1.	Midterm exam	30%
2.	Final exam	30%
3.	Laboratory	20% (2 laboratory practicals)
4.	Diversity Activities	10%
5.	Problem Set	5%
6.	Participation	5%

Course Requirements

Field Trips / Local Walks

There is extensive time in the field learning the biodiversity of all major life zones in Costa Rica. The course includes two 15-day field trips to learn representative species of the most important life zones. In addition, there are walks to explore the local diversity of Monteverde. Trips to rescue centers, butterfly gardens and other attractions are used to learn about select taxonomic groups during the field trips and in Monteverde. Field trips and local walks constitute the majority of the laboratory component of the course.

Basic information on the natural history, identification and taxonomic classification of 80 to 100 species is given during each field trip. The students are graded on their ability to identify and provide basic taxonomic and natural history information of the learned species in two practical exams conducted in the field and laboratory in Monteverde approximately one week after each field trip ends.

Field Textbook: Janzen, Daniel. H, ed. *Costa Rican Natural History*. Chicago: The University of Chicago Press,1983. Print.

Diversity Lectures

Diversity Lectures highlight a major taxon and explore its basic biology and taxonomy. Lectures and classroom and field activities are used to teach the basic characteristics and biology of each taxon. Major taxa include plants (including mangrove plants, coastal plants, fruit and flower morphology), mammals, insects, fungi, birds, amphibian, reptiles, and marine animals. Diversity lectures complement the field trips/local walks and provide background to the laboratory component of the course. These lectures are not directly evaluated but some information provided in them could be part of the basic natural history of species encountered in field trips.

Lectures

Traditional lectures are complemented with activities/discussions to reinforce theoretical concepts. Specific topics include: biodiversity concepts, how biodiversity is distributed both taxonomically and geographically, how biodiversity is measured, created, maintained and lost. Students will be graded on a midterm and final exam through multiple choice and short-answer questions.

Reference textbook: Ghazoul, Jaboury, and Douglas Sheil, eds. *Tropical Rain Forest Ecology, Diversity, and Conservation*. New York: Oxford University Press, 2010. Print.

Problem Set Assignment

Students are asked to collect biodiversity data in the field and calculate diversity and similarity indices. Students will be graded on the accuracy of their calculations and their answers to specific questions regarding their results.

Diversity Activities

Students will conduct hands-on activities that would help them clarify difficult concepts covered in lectures. Some activities will include short-answer questions that will be graded.

Readings

The students read current primary literature, mostly research articles, relevant to topics covered in lecture. The students should synthesize the rationale of each paper, major findings and conclusions. Questions about these specific aspects are part of the midterm and final exam.

Attendance and Class Participation

Attendance to lectures and field trips is mandatory and participation during lectures and discussion sessions will be graded. The quality of the species reports given by students will be also graded as part of participation. Only students that do not miss classes and give complete species reports will obtain the maximum grade (5% of the final grade). A complete species report includes the geographic distribution of a species, its basic natural history (pollinator and disperser for plants, diet and predators for animals) and any special aspect of their biology that makes them distinct to most other species (e.g. mutualistic interactions, mimicry, breeding system, etc.). Late assignments will be marked down 5% after the first day and 1% every day afterwards. No coursework will be accepted after the last day of class.

Weekly Schedule

Weeks 1-3 Feb 9-Feb 25	Orientation, Pacific Slope Field Trip. Plant, Insect, Mammal diversity. Introduction, fruit and flower morphology. Important species to Lowland Pacific Wet, Moist and Dry Forest, Coastal Forests and Mangroves (Sierpe Mangroves, Corcovado National Park, Carara National Park, Santa Rosa National Park). Basic taxonomy and biology of plants (additional information on mangroves), insects and other arthropods, and mammals. Readings: CIEE Handbooks of Plants, Fungi and Animals, CIEE Tropical Diversity Day Laboratory Reader: chapters on mangroves, flowers, fruits, plants, insects, and mammals.
Weeks 3-4 Feb 26-Mar 8	Important species to Pacific Montane Forest (Monteverde). Lectures: "Concepts of Biodiversity", "Taxonomic and Geographic Distribution of Biodiversity","Species Richness, Diversity and Abundance". History of the concept, ecologists' definition of biodiversity, levels of biological organization, classification of living things, review of domains and kingdoms, taxonomic expansion in geological history, importance of these concepts to conservation. Rules of taxonomy, basics of systematics; morphological, biological and phylogenetic species concepts, species richness for major phyla, methods to estimate numbers of undescribed species. Latitudinal trends in biodiversity; endemism, hotspots. Quantitative methods to describe diversity, richness, and community similarity and turnover; alpha, beta gamma richness, species-area curves, dominance-diversity curves. Readings: Scholl and Wiens 2016. Scheffers et al. 2012. Stuart-Smith 2013. Wittebolle, L. 2009. **First Practical Exam.**

Week 5 Mar 9-Mar 15	Lecture: “Creation of Biodiversity”. Centers of speciation, natural selection, sexual selection, fitness, adaptation, and evolution, models of speciation, radiation, isolating mechanisms, genetic differentiation, Pleistocene Refugia Theory, ecotones. Readings: Heinen-Kay et al. 2015. Lamichhaney et al. 2016. Kerkhoff et al. 2014 Cadena et al. 2012. **Problem Set Due. Midterm Exam.**
Weeks 6-8 Mar 16-Apr 5	Atlantic slope field trip. Fungal, herp, bird and marine animal diversity. Important species to mid and lowland elevation tropical rainforest (Children’s Eternal Rainforest, La Selva Biological Station), Caribbean coastal areas and coral reefs (Tortuguero/Parismina turtle nesting, Bocas del Toro, Panamá). Basic taxonomy and biology of fungi, reptiles, amphibians, birds, and coral reef animals. Readings: CIEE Handbooks of Plant, Fungi and Animals, CIEE Diversity Lab Reader: chapters on fungi, herps, birds and marine animal diversity.
Week 9-10 Apr 6-Apr 19	Lecture: “Maintenance of Biodiversity”. Importance of competition, predation, parasitism, and dispersal; frequency- and density-dependent selection; local communities and metacommunities; concept of niche, niche partitioning, productivity, Island Biogeography Theory, Hubbell’s Unified Theory of Biodiversity. Readings: Condit et al. 2012. Emerson and Kolm. 2005. **Second Practical Exam.**
Weeks 11-12 Apr 20- May 3	Lectures: “Loss of Biodiversity, Part I and II”. Proximate and ultimate causes of extinction; tropical deforestation rates, invasive species, overexploitation, global warming, Allee effect, genetic and ecological consequences of population declines; attributes of species that make them more or less extinction prone; case studies of species extinctions; amphibian declines and pathogens. Readings: Feeley et al. 2013. Jetz et al. 2014.

Mendenhall et al. 2014.
Régnier et al. 2015.
Scriven et al. 2015.

Diversity Activity Due

Weeks 13-14 Ofice hours. **Final Exam.**
May 4-May 17

Readings

1. Cadena, Carlos D., et al. "Latitude, elevational climatic zonation and speciation in New World Vertebrates." *Proc. R. Soc. B* 279 (2012): 194–201. Print.
2. Calderón, José C., et al. *CIEE Handbook of Fungi and Animals.* San José: printed by the authors, 2012. Print.
3. Condit, Richard, et al. "Thirty years of forest census at barro colorado and the importance of immigration in maintaining diversity". *PLoS ONE* 7 (2012): e49826. Print.
4. CIEE Tropical Ecology and Conservation. *Tropical Diversity Laboratory Diversity Day Handouts*. San José: printed by the authors, 2013.
5. Emerson, Brent C., and Niclas Kolm. "Species diversity can drive speciation". *Nature* 434 Apr (2005): 1015-7. Print.
6. Feeley, Kenneth J., et al. "Compositional shifts in Costa Rican forests due to climate-driven species migrations". *Global Change Biology* 19 (2013): 3472–80. Print.
7. Heinen-Kay, Justa L., et al. "A trade-off between natural and sexual selection underlies diversification of a sexual signal". *Behavioral Ecology* (2015): 26, 533–42. Print.
8. Jetz Walter, et al. "Global Distribution and Conservation of Evolutionary Distinctness in Birds". Current Biology 24 (2014): 919–30. Print.
9. Kerkhoff, Andrew J., et al. "The latitudinal species richness gradient in New World woody angiosperms is consistent with the tropical conservatism hypothesis". *PNAS* 111 (2014): 8125–30. Print.
10. Lamichhaney, Sangeet, et al. "A beak size locus in Darwin's finches facilitated character displacement during a drought". *Science* (2016): 352, 470-74. Print.
11. Masters, Alan R., et al. *CIEE Handbook of Plant Taxonomy*. Costa Rica. San José: printed by the authors, 2012. Print.
12. Mendenhall, Chase D., et al. "Predicting biodiversity change and averting collapse in agricultural landscapes". *Nature* 509 May (2014): 213-217. Print.
13. Régnier, Claire, et al. "Mass extinction in poorly known taxa". *PNAS* 112 (2015): 7761–7766. Print.
14. Scheffers, Brett R., et al. "What we know and don't know about Earth's missing biodiversity". *TREE* 27.9 (2012.): 501-10. Print.
15. Scholl, Joshua P., and John J. Wiens. "Diversification rates and species richness across the Tree of Life". Proc. R. Soc. B 283 (2016): in press.
16. Scriven, Sarah A., et al. "Protected areas in Borneo may fail to conserve tropical forest biodiversity under climate change". *Biological Conservation* 184 (2015): 414–23. Print.

17. Stuart-Smith, Rick D., et al. “Integrating abundance and functional traits reveals new global hotspots of fish diversity”. *Nature* 501(2013): 539-42. Print.
18. Wittebolle, Lieven, et al. “Initial community evenness favours functionality under selective stress”. *Nature* Apr 458 (2009): 623-6. Print.