CIEE Monteverde, Costa Rica

Course title:	Tropical Diversity
Course code:	BIOL 3001 MVCR
Programs offering course:	Tropical Ecology and Conservation
Language of instruction:	English
U.S. semester credits:	4
Contact hours:	60
Term:	Fall 2020

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

By completing this course, 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.

Course Prerequisites

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

Methods of Instruction

Students will attend lectures and participate in classroom 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. Diversity activities will illustrate key concepts through hands-on experience.

Assessment and Final Grade

1.	Midterm exam	30%
2.	Final exam	30%
3.	Laboratory exams (2)	30%

4.	Problem Set	5%
5.	Participation	5%
	TOTAL	100%

Course Requirements

Midterm exam

Students will take a written midterm exam consisting of multiple choice and short-answer questions. Questions will be based on lectures, readings, classroom activities.

Final exam

Students will take a written midterm exam consisting of multiple choice and short-answer questions. Questions will be based on lectures, readings, classroom activities.

Laboratory exams (2)

Students will take one practical exam and one written exam. The practical consists of examining live or preserved materials or slides, and answering short questions. The written exam consists of short answer questions. Questions will be based on diversity activities.

Problem Set

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

Participation

Attendance to, and participation in, lectures, field trips/local walks, and delivery of species reports is mandatory and will be graded. Only students who attend all classes, field trips/local walks, and give complete species reports will obtain the maximum score (5% of 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.

Attendance

Full participation in field trips/ local walks includes attendance during the extensive, 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.

Full participation in traditional lectures and discussions includes attending all classes, actively engaging during discussions, and asking questions and offering responses as appropriate. Traditional-style lectures are complemented with activities/discussions to reinforce theoretical concepts.

N.B. Course schedule is subject to change due to study tours, excursions, or local holidays. Final schedules will be included in the final syllabus provided to students on site.

Weekly Schedule

Week 1

Class — Orientation to the program; Pacific Slope Field Trip. Plant, Insect, Mammal div

Lectures:

- "Plant Biology". Morphology and function of fruits, flowers, vegetative parts.
- "Natural History of Pacific Slope organisms".
- "Mangrove ecology and conservation".

Diversity Activities:

- Outings in Sierpe Mangroves

Readings:

CIEE Handbook of Plant and Animal Taxonomy

Tropical Diversity Laboratory Diversity Day Handouts.

Week 2

Class — Pacific Slope Field Trip. Plant, Insect, Mammal diversity.

Lectures:

- "Natural History of Corcovado National Park"
- "Natural History of Carara National Park"
- "Natural History of Tropical Dry Forest"

Diversity Activities:

- Outings in Corcovado National Park, Carara National Park, Santa Rosa National Park.

Readings:

CIEE Handbook of Plant and Animal Taxonomy

Tropical Diversity Laboratory Diversity Day Handouts.

Week 3

Class — Foundations of biodiversity studies

Including: taxonomic and geographic patterns; quantitative methods to describe and explore patterns; important species to Pacific Montane Forest (Monteverde).

Lectures:

“Concepts of Biodiversity”. History of the concept, ecologists’ definition of biodiversity, levels of biological organization, classification of living things, review of domains and kingdoms.

Diversity Activities

- Outings in Monteverde cloud forest

Readings:

Troudet et al. 2017.

Jones 2017.

Kerkhoff et al. 2014

Rapacciuolo et a. 2018.

Assignments:

Laboratory Practical (Exam)

Week 4

Class

Taxonomic and geographic patterns of biodiversity studies

Including quantitative methods to describe and explore patterns; important species to Pacific Montane Forest (Monteverde).

“Taxonomic and Geographic Distribution of Biodiversity”. 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.

“Species Richness, Diversity and Abundance”. 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.

Activity:

- Biodiversity assessment (for problem set assignment)

Readings:

Troudet et al. 2017.

Assessment:

Problem Set

Week 5

Class

Historical and evolutionary hypotheses for the creation of biological diversity

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:

Janicke et al. 2018.

Pennisi 2016.

Moser et al. 2018.

Polato et al. 2018.

Assignments:

Problem Set Due

Midterm Exam

Week 6

Class

Field Trip 2. Fungal, herp, bird diversity

Diversity Activities:

- Outings to the Children's Eternal Rainforest
- Basic taxonomy and biology of fungi, reptiles, amphibians, birds

Readings:

CIEE Handbook of Plant and Animal Taxonomy

Tropical Diversity Laboratory Diversity Day Handouts. Chapters on fungi, herps, birds and marine animal diversity.

Week 7

Class

Field Trip 2. Fungal, herp, bird diversity

Diversity Activities:

- Outings to Atlantic Slope Forest
- Basic taxonomy and biology of fungi, reptiles, amphibians, birds

Readings:

CIEE Handbook of Plant and Animal Taxonomy

Tropical Diversity Laboratory Diversity Day Handouts. Chapters on fungi, herps, birds and marine animal diversity.

Week 8

Class

Field Trip 2. Marine animal diversity

Diversity Activities:

- Outings to Caribbean coastal areas and coral reefs
- Basic taxonomy and biology of coral reef animals.

Readings:

CIEE Handbook of Plant and Animal Taxonomy

Tropical Diversity Laboratory Diversity Day Handouts. Chapters on fungi, herps, birds and marine animal diversity.

Week 9

Class

Ecological processes that maintain biological diversity

Lecture:

“Maintenance of Biodiversity, Part 1”. Importance of competition, predation, parasitism, and dispersal; frequency- and density-dependent selection.

Readings:

Johnson et al. 2018.

LaManna et al. 2017.

Usinowicz et al. 2017.

Assignment:

Laboratory Exam.

Week 10

Class

Evolutionary and historical processes that maintain biological diversity

Lecture:

“Maintenance of Biodiversity, Part 2”. Local communities and metacommunities; concept of niche, niche partitioning, productivity, Island Biogeography Theory, Hubbell’s Unified Theory of Biodiversity.

Readings:

Johnson et al. 2018.

LaManna et al. 2017.

Usinowicz et al. 2017.

Week 11

Class — Factors that contribute to the erosion of biodiversity

Lecture:

"Loss of Biodiversity, Part I"

Proximate and ultimate causes of extinction; tropical deforestation rates, invasive species, overexploitation, global warming, Allee effect,

Readings:

Fadrique et al. 2018.

Mendenhall et al. 2014.

Week 12

Class — Factors that contribute to the erosion of biodiversity

Lecture:

"Loss of Biodiversity, Part II"

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:

Régnier et al. 2015.

Scheffers et al. 2016.

Week 13

Class — Final Assessment

Final Exam

Course Materials

Readings

Textbook and Diversity Activity Handbooks

- Calderón, José C., et al. CIEE Handbook of Fungi and Animals. San José: printed by the authors. (2012) Print.
- CIEE Tropical Ecology and Conservation. 2013. Tropical Diversity Laboratory Diversity Day Handouts. San José: printed by the authors
- Ghazoul, Jaboury, and Douglas Sheil, eds. Tropical Rain Forest Ecology, Diversity, and Conservation. New York: Oxford University Press, 2010. Print.
- Janzen, Daniel. H, ed. Costa Rican Natural History. Chicago: The University of Chicago Press,1983. Print.
- Masters, Alan R., et al. 2012. CIEE Handbook of Plant and Animal Taxonomy. Costa Rica. San José: printed by the authors. Print.

Articles

- Fadrique, Belén, et al. “Widespread but heterogeneous responses of Andean forests to climate change”. Nature 564 (2018): 207–212.
- Janicke Tim, et al. “Sexual selection predicts species richness across the animal kingdom. Proc. R. Soc. B 285 (2018): 20180173. Print.
- Johnson, Daniel J., et al. “Abiotic niche partitioning and negative density dependence drive tree seedling survival in a tropical forest”. Proc. R. Soc. B 284 (2017): 20172210. Print.
- Jones, Benjamin. “A few bad scientists are threatening to topple taxonomy”. Smithsonian.com (2017): http://www.smithsonianmag.com/science-nature/the-big-ugly-problem-heart-of-taxonomy-1809646 Web.
- 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.
- LaManna, Joseph A., et al. "Plant diversity increases with the strength of negative density dependence at the global scale." Science 356 (2017): 1389–92. Print.
- Mendenhall, Chase D., et al. “Predicting biodiversity change and averting collapse in agricultural landscapes”. Nature 509 May (2014): 213217. Print.
- Moser Florian N., et al. “The onset of ecological diversification 50 years after colonization of a crater lake by haplochromine cichlid fishes”. Proc. R. Soc. B 285 (2018): 20180171. Print.
- Pennisi, Elizabeth. “Shaking up the Tree of Life”. Science 354 (2016): 817–21. Print.
- Polato, Nicholas R. “Narrow thermal tolerance and low dispersal drive higher speciation in tropical mountains”. PNAS 115 (2018): 12471-12476. Print.
- Rapacciuolo, Giovanni, et al. “Species diversity as a surrogate for conservation of phylogenetic and functional diversity in terrestrial vertebrates across the Americas” Nature Ecology & Evolution 3 (2019): 53–61. Web.
- Régnier, Claire, et al. “Mass extinction in poorly known taxa”. PNAS 112 (2015): 7761–66. Print.
- Scheffers, Brett R., et al. “The broad footprint of climate change from genes to biomes to people”. Science 354 (2016): aaf7671. Print.
- Troudet, Julien, et al. “Taxonomic bias in biodiversity data and societal preferences”. Scientific Reports 7 (2017): 9132. Web.
- Usinowicz, Jacob, et al. “Temporal coexistence mechanisms contribute to the latitudinal gradient in forest diversity”. Nature 550(2017):105-108. Print.