ECOLOGY AND EVOLUTIONARY BIOLOGY

Osborn Memorial Laboratories, 203.432.3837
http://eeb.yale.edu
M.S., Ph.D.
Chair
Thomas Near

Director of Graduate Studies
Carla Staver

Professors Richard Bribiescas (Anthropology), Craig Brodersen (School of the Environment), Nicholas Christakis (Sociology), Liza Comita (School of the Environment), Michael Donoghue, Casey Dunn, Erika Edwards, Vanessa Ezenwa, Vivian Irish (Molecular, Cellular, & Developmental Biology), Walter Jetz, Thomas Near, David Post, Jeffrey Powell, Richard Prum, Eric Sargis (Anthropology), Oswald Schmitz (School of the Environment), David Skelly (School of the Environment), Jeffrey Townsend (Public Health), Paul Turner

Associate Professors Forrest Crawford (Public Health), James Noonan (Genetics), Carla Staver, Alison Sweeney, David Vasseur

Assistant Professors Nathan Grubaugh (Public Health), Martha Munoz, C. Brandon Ogbunu, Alvaro Sanchez, Serena Tucci (Anthropology)

Senior Lecturer Marta Martinez Wells

Lecturers Adalgisa Caccone, Linda Puth

FIELDS OF STUDY
The Department of Ecology and Evolutionary Biology (E&EB) offers training programs in organismal biology, ecology, and evolutionary biology including molecular evolution, phylogenetics, molecular population genetics, developmental evolution, and evolutionary theory.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE
Each entering student, in consultation with the director of graduate studies (DGS), develops a specific program of courses, seminars, laboratory research, and independent reading tailored to the student's interests, background, and goals. There are normally no foreign language requirements. All first-year students carry out two research rotations. Students have the option of a rotation over their first summer. Students must participate in (1) E&EB 500 and E&EB 501, Advanced Topics in Ecology and Evolutionary Biology; (2) E&EB 545, a course on the responsible conduct of research; (3) weekly E&EB seminars; and (4) symposia of faculty and graduate student research. In addition, during their first two years of study, graduate students must enroll in a minimum of three additional graduate-level courses (numbered 500 and above); a grade of Honors (H) must be earned in two of these. Teaching experience is regarded as an integral part of the graduate training program. All students are required to teach three courses, typically during their first two years of study. Students who require additional support from the Graduate School must teach additional terms, if needed, after they have fulfilled the academic teaching requirement.

By the middle of the fourth term of study, each student organizes a formal preprospectus consultative meeting with the student's advisory committee to discuss the planned dissertation research. Before the beginning of the fifth term, students present and defend their planned dissertation research at a prospectus meeting, at which the department determines the viability and appropriateness of the student's Ph.D. proposal. A successful prospectus meeting and completion of course requirements results in admission to candidacy for the Ph.D. The remaining requirements include completion, presentation, and successful defense of the dissertation, and submission of copies of the dissertation to the Graduate School and to the Marx Science and Social Science Library.

In cases where the dissertation committee decides that preliminary field work during the summer after the fourth term is necessary prior to the prospectus, the prospectus meeting can be delayed by one term. A request for a delay must come from the dissertation committee adviser and must be approved by the DGS. In these exceptional cases, admission to candidacy may not be required for registration for the third year of graduate study.

HONORS REQUIREMENT
Students must meet the Graduate School's requirement of Honors in two courses by the end of the fourth term of study. The E&EB department also requires an average grade of at least High Pass in course work during the first two years of study.

MASTER'S DEGREE
M.S. (en route to the Ph.D.) Students must pass eight graduate-level courses. Required courses are: E&EB 500 and E&EB 501, Advanced Topics in Ecology and Evolutionary Biology; E&EB 545, Responsible Conduct of Research; E&EB 501, Research Rotation I; and E&EB 902, Research Rotation II. These courses are taken Sat/Unsat. A minimum of three additional graduate-level, elective courses are required and must be taken for a grade. Students must earn Honors in at least two courses and maintain an overall average of High Pass.
Additional information on the department, faculty, courses, and facilities is available from Deanna Brunson, Office of the Director of Graduate Studies, Department of Ecology and Evolutionary Biology, Yale University, PO Box 208106, New Haven CT 06520-8106; email, deanna.brunson@yale.edu; tel., 203.432.3837; fax, 203.432.2374; website, http://eeb.yale.edu.

COURSES

**E&EB 500a and E&EB 501b, Advanced Topics in Ecology and Evolutionary Biology**  Casey Dunn
Topics to be announced. Graded Satisfactory/Unsatisfactory.

**E&EB 510a / S&DS 501a, Introduction to Statistics: Life Sciences**  Walter Jetz and Jonathan Reuning-Scherer
Statistical and probabilistic analysis of biological problems, presented with a unified foundation in basic statistical theory. Problems are drawn from genetics, ecology, epidemiology, and bioinformatics.

**E&EB 520a, General Ecology**  David Vasseur and Carla Staver
A broad consideration of the theory and practice of ecology, including the ecology of individuals, population dynamics and regulation, community structure, ecosystem function, and ecological interactions on broad spatial and temporal scales. Topics such as climate change, fisheries management, and infectious disease are placed in an ecological context.

**E&EB 523Lb, Laboratory for Principles of Ecology, Evolutionary Biology, and the Tree of Life**  Marta Wells
Experimental approaches to organismal and population biology, including study of the diversity of life.

**E&EB 525b, Evolutionary Biology**  Alvaro Sanchez
An overview of evolutionary biology as the discipline uniting all of the life sciences. Evolution explains the origin of life and Earth's biodiversity, and how organisms acquire adaptations that improve survival and reproduction. This course uses reading and discussion of scientific papers to emphasize that evolutionary biology is a dynamic science, involving active research to better understand the mysteries of life. We discuss principles of population genetics, paleontology, and systematics; and application of evolutionary thinking in disciplines such as developmental biology, ecology, microbiology, molecular biology, and human medicine.

**E&EB 528b, Ecology and Evolution of Infectious Disease**  Paul Turner and Vanessa Ezenwa
Overview of the ecology and evolution of pathogens (bacteria, viruses, protozoa) and their impact on host populations. Topics include theoretical concepts, ecological and evolutionary dynamics, molecular biology, and epidemiology of ancient and emerging diseases.

**E&EB 545b, Responsible Conduct of Research**  Casey Dunn
This five-week discussion seminar considers issues related to the responsible conduct of research. Topics addressed include research misconduct, plagiarism, data acquisition and management, mentoring and collaboration, authorship and peer review, the use of animals and humans in scientific research, sexual harassment, diversity, and balancing professional and personal life. Graded Satisfactory/Unsatisfactory.

**E&EB 546a, Plant Diversity and Evolution**  Erika Edwards
Introduction to the major plant groups and their evolutionary relationships, with an emphasis on the diversification and global importance of flowering plants.

**E&EB 547La, Laboratory for Plant Diversity and Evolution**  Erika Edwards
Hands-on experience with the plant groups examined in the accompanying lectures; local field trips.

**E&EB 550a, Biology of Terrestrial Arthropods**  Marta Wells
Evolutionary history and diversity of terrestrial arthropods (body plan, phylogenetic relations, fossil record); physiology and functional morphology (water relations, thermo-regulation, energetics of flying and singing); reproduction (biology of reproduction, life cycles, metamorphosis, parental care); behavior (migration, communication, mating systems, evolution of sociality); ecology (parasitism, mutualism, predator-prey interactions, competition, plant-insect interactions).

**E&EB 551La, Laboratory for Biology of Terrestrial Arthropods**  Marta Wells
Comparative anatomy, dissections, identification, and classifications of terrestrial arthropods; specimen collection; field trips.

**E&EB 555a, Invertebrates**  Casey Dunn
An overview of animal diversity that explores themes including animal phylogenetics (evolutionary relationships), comparative studies of evolutionary patterns across species, organism structure and function, and the interaction of organisms with their environments. Most animal lineages are marine invertebrates, so marine invertebrates are the focus of most of the course. Concurrent enrollment in E&EB 556L is not required.

**E&EB 556La, Laboratory for Invertebrates**  Casey Dunn
The study of invertebrate anatomy and diversity in a laboratory and field setting. Activities include examination of live animals and museum specimens, as well as local field trips. Some field trips fall on weekends. Must be taken concurrently with E&EB 555.

**½ Course cr**

**E&EB 635a, Evolution and Medicine**  Brandon Ogbunu
Introduction to the ways in which evolutionary science informs medical research and clinical practice. Diseases of civilization and their relation to humans’ evolutionary past; the evolution of human defense mechanisms; antibiotic resistance and virulence in pathogens; cancer as an evolutionary process. Students view course lectures online; class time focuses on discussion of lecture topics and research papers. Prerequisites: BIOL 101–BIOL 104.
E&EB 729a, Microbial Ecology and Evolution  Alvaro Sanchez
This course examines various topics in the ecology and evolution of microbes, with an emphasis on prokaryotes (Eubacteria, Archaea) and viruses. Microbiology is an incredibly rich field, where microorganisms are studied from perspectives including the gene, genome, individual, population, community, and ecosystem levels. The course uses discussions of classic and contemporary journal articles to show how species interactions including competition, predation, parasitism, mutualism, and microbial communication influence these various levels of biological organization in particular, and evolutionary ecology of microbes in general. Sex and reproduction, genome architecture and reduction, novel evolutionary mechanisms, and challenges imposed by environmental change are examined from a microbial perspective. The result is an understanding of microbes in their natural habitats—whether air, soil, aquatic, or host environments—and of the power in using microbes to elucidate fundamental principles in ecology and evolution. Different discussion topics are emphasized in different years, and this year’s course focuses on the following three areas: studying microbial adaptation in laboratory and natural microcosms, evolutionary ecology of emerging infectious diseases, and the role of microbes in biogeochemical cycling especially in the oceans.

E&EB 830b, The Ecology of the Great Pandemics  Brandon Ogbunu
In this course we examine principles of the ecology of infectious disease in light of three pandemics: the 1918 influenza pandemic, the HIV/AIDS pandemic, and the COVID-19 pandemic. The course covers principles of zoonoses, disease emergence, herd immunity, basic vaccinology, and other fundamental concepts. It also focuses on social and cultural factors that fomented these pandemics.

E&EB 854a, The Behavioral Immune System  Vanessa Ezenwa
Behavior is the first line of defense against parasites and pathogens. Behavioral defenses allow organisms to minimize contact with infectious agents, and the concept of the “behavioral immune system” was developed to encompass a range of evolved behaviors that help minimize the fitness costs of infection. The COVID-19 pandemic has made the term “social distancing” a household term; however, distancing and many other avoidance strategies are employed by a wide range of organisms to combat infectious agents. In this seminar, we examine our current understanding of the behavioral immune system across the diversity of animals, including humans. Specifically, we explore: (1) the mechanisms of behavioral immunity; (2) the ecological, evolutionary, and epidemiological consequences of these behaviors; and (3) key costs of behavioral immunity that maintain intra- and interspecific variation. To do this, we discuss and synthesize the scientific literature on the behavioral immune system, drawing parallels to work on the physiological immune system. The first weeks of the course focus on instructor-selected papers, and subsequent weeks incorporate student-selected papers.

E&EB 862a, Ecosystem Dynamics of Nature-Based Climate Solutions  Carla Staver
Nature-based climate solutions have gained increasing attention in the past decade as possible contributors to reducing our net carbon emissions to the atmosphere, without necessarily reducing gross emissions. Prominent nature-based solutions include forestation (reforestation, afforestation, plantation forestry), avoided deforestation, and soil carbon sequestration. This seminar includes weekly readings and discussion around themes in the management of ecosystem carbon storage. This seminar is intended for Ph.D. students. It is open to master’s students and undergraduates by permission of the instructor only, based on a one- or two-paragraph description of interest in the course.

E&EB 901a, Research Rotation I  Casey Dunn
E&EB 902b, Research Rotation II  Casey Dunn
E&EB 930a or b / EPS 703a or b, Seminar in Systematics  Jacques Gauthier
Topics and class time are chosen by the participants, and have included reading books and/or a series of papers on particular topics (e.g., homology; morphological phylogenetics; evolution of egg colors and exposed nesting in dinosaurs/birds; origin of snake ecology; conflicts between morphology and molecules; role of fossils in phylogenetic inference).