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
Casey Dunn

Professors Richard Bribiescas (Anthropology), Craig Brodersen (School of the Environment), Nicholas Christakis (Sociology), Liza Comita (School of the Environment), 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), Jeffery Townsend (Public Health), Paul Turner, David Vasseur

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

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

Senior Lecturer Marta Martínez Wells

Lecturers Adalgisa Caccone, Joshua Moyer, Linda Puth

Research Scientist Mary Beth Decker

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. The course requirements to advance to candidacy in E&EB are (1) E&EB 300* 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; (4) symposia of faculty and graduate student research; (5) two research rotations (E&EB 901*, Research Rotation I, and E&EB 902*, Research Rotation II) in the first two years; and (6) a minimum of three additional graduate-
level courses (numbered 500 and above) with a grade of Honors (H) in at least 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 three 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 pre-prospectus 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.

* This course is graded on a Satisfactory/Unsatisfactory basis.

**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.)** The course requirements for the M.S. are the same as for advancing to candidacy in the Ph.D. program: 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 901, 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 Kelly Pyers, Office of the Director of Graduate Studies, Department of Ecology and Evolutionary Biology, Yale University, PO Box 208106, New Haven CT 06520-8106; email, kelly.pyers@yale.edu; tel., 203.432.3837; http://eeb.yale.edu.
COURSES

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

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  
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 Evolution, Functional Traits, 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  Paul Turner  
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 542b, Behavioral Ecology  Vanessa Ezenwa  
An introduction to the study of animal behavior from an evolutionary and ecological perspective. Topics include decision-making, group living and cooperation, sexual selection and mating behavior, signaling and communication. In addition to lectures, in-class discussions and activities, students engage in the material by design and implement their own research projects. Prerequisite: Biology 104 or permission of instructor.

E&EB 545b, Responsible Conduct of Research  Staff  
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 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 551a, Laboratory for Biology of Terrestrial Arthropods  Marta Wells
Comparative anatomy, dissections, identification, and classifications of terrestrial arthropods; specimen collection; field trips.

E&EB 572b, Ornithology  Richard Prum
Structure, function, behavior, evolution, and diversity of birds. A general overview of avian biology and evolution. Topics include the evolutionary origin of birds, avian phylogeny, anatomy, physiology, neurobiology, behavior, breeding systems, and biogeography.

E&EB 573b, Lab for Ornithology  Richard Prum

E&EB 622a, Evolutionary Genetics  Jennifer Coughlan
Genetic variation is the currency by which natural selection is translated into evolutionary change. In this course we dissect patterns of genetic variation using an evolutionary mindset to ultimately understand what shapes genetic variation in nature and the potential for species to adapt to new and changing environments. This class unites two foundational fields of evolutionary genetics: quantitative genetics (the study of the genetic basis of complex traits) and population genetics (the study of gene variant frequencies across time and space), with an ultimate goal of understanding evolutionary change in nature. Although this course is lecture based, there is much opportunity for hands-on learning. Students use real-life and simulated genetic data to map the genetic basis of traits and investigate the evolutionary forces responsible for shaping genetic variation in nature. We also discuss how quantitative and population genetics theory are applied to the modern genomic era, particularly in the context of detecting genomic signatures of adaptation. Last, we discuss the application of evolutionary genetics to human populations, including the usefulness and missteps of these applications for science and society.

E&EB 636a / SOCY 636a, Biosocial Science  Nicholas Christakis
This seminar (with limited enrollment, but open to anyone) covers topics at the intersection of the natural and social sciences, including behavior genetics, gene-environment interactions, social epigenetics, and diverse other topics.

E&EB 654a, Phylogenetic Biology  Casey Dunn
Phylogenetic biology is the study of the evolutionary relationships between organisms, and the use of evolutionary relationships to understand other aspects of organism biology. This course surveys phylogenetic methods, providing a detailed picture of the statistical, mathematical, and computational tools for building phylogenies and using them to study evolution. We also examine the application of these tools to particular problems in the literature and emerging areas of study.

E&EB 713b, From Biodiversity Science to Conservation Impact  Walter Jetz
We dive into the scholarship and careers of E.O. Wilson and Thomas Lovejoy and explore how they succeeded in bringing scientific insights and evidence into the practice of conservation. We discuss examples of their primary research, recent studies following up on their ideas, and biographic work. We attempt to link their original contributions and ideas to the conservation actions and outcomes they inspired and hear from those who worked closely with them. In a final segment, we critically relate
their scientific legacy to the additional, new challenges and opportunities for equitable, fair and effective conservation solutions in the 21st century.

**E&EB 717a, Structuralism and Macroevolution**  Richard Prum  
A seminar course discussing the philosophical roots of and empirical research in structuralism and macroevolution. We read selected papers in philosophy of evolutionary biology, comparative phylogenetic methods, macroevolutionary studies, and the role of natural history in evolutionary thought. Each topic is paired with readings on empirical research that involves similar issues. The course concludes with a short writing assignment that analyzes a contemporary question in macroevolution or structural/organismic research.

**E&EB 725b, Scientific Writing for Ecology and Evolutionary Biology**  Carla Staver  
This course provides guidance and practice for graduate students in grant and manuscript writing in the fields of ecology and evolutionary biology. Students produce one grant application (NSF GRFP/DDIG or similar) and one manuscript for publication (on a topic of their choice, to contribute to their thesis or other ongoing work).

**E&EB 854b, 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 865b, Evolutionary Architects: Organisms as Targets and Agents of Natural Selection**  Martha Munoz  
Organisms are routinely faced with many abiotic and biotic pressures that impact their survivorship, growth, and reproductive success. For example, a lizard’s ability to perform fitness-based tasks (like foraging or predator evasion) is limited by the thermal dependence of its performance, its hydric and metabolic economy, and its morphological dimensions. Yet, organisms are not exclusively at the whim and mercy of their surroundings. Of key importance is the preeminent role that organisms exert on their own selective environments and, correspondingly, on their evolution. This course considers the diverse ways in which organisms engineer their own evolutionary trajectories. Some of the topics we cover include niche construction, extended phenotypes, behavioral drive, the Bogert effect, and adaptive virulence (particularly in the context of the COVID-19 pandemic). Open to upper-level undergraduates who have taken BIOL 103, BIOL 104, and E&EB 225 (or the equivalent).
Speciation and adaptation are two fundamental processes that generate the diversity of life seen on earth to date. This graduate-level seminar course will explore the evolutionary mechanisms responsible for these phenomena by delving into the primary literature to explore classic examples of adaptation and speciation using a genetics and genomics lens.

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).