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
Erika Edwards

Professors Richard Bribiescas (Anthropology), Nicholas Christakis (Sociology), Michael Donoghue, Casey Dunn, Erika Edwards, Alison Galvani (Public Health), Vivian Irish (Molecular, Cellular, & Developmental Biology), Walter Jetz, Thomas Near, David Post, Jeffrey Powell, Richard Prum, Eric Sargis (Anthropology), Oswald Schmitz (Forestry & Environmental Studies), David Skelly (Forestry & Environmental Studies), Stephen Stearns, Jeffrey Townsend (Public Health), Paul Turner, J. Rimas Vaisnys (Electrical Engineering), Günter Wagner

Associate Professors Liza Comita (Forestry & Environmental Studies), Forrest Crawford (Public Health), James Noonan (Genetics), David Vasseur

Assistant Professors Craig Brodersen (Forestry & Environmental Studies), Alvaro Sanchez, Carla Staver

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, phylogeny, molecular population genetics, developmental evolution, and evolutionary theory.

SPECIAL ADMISSIONS REQUIREMENTS
Applicants should have had training in one of the following fields: biology, mathematics, chemistry, physics, statistics, and/or geology. Candidates are selected, regardless of their major, based on overall preparation for a career in research in ecology and evolutionary biology. Some, planning for careers in applied fields, may have prepared with courses in public policy, economics, and agriculture.

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, normally at a level 20, typically during their first two years of study. Students whose advisers experience disruption in funding may require additional support from the Graduate School. In such cases, students will be required to 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 Center for Science and Social Science Information.

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.
MASTERS DEGREE

M.S. (en route to the Ph.D.) Students must pass ten graduate-level courses. At least four courses must be taken for a grade, and students must earn Honors in two courses and maintain an overall average of High Pass. Required courses are: E&EB 500 and E&EB 501, Advanced Topics in Ecology and Evolutionary Biology; E&EB 445, Responsible Conduct of Research; E&EB 901, Research Rotation I; and E&EB 902, Research Rotation II. A minimum of five additional graduate-level courses (four taken for a grade) are required.

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; e-mail, 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 Erika Edwards
Topics to be announced. Graded Satisfactory/Unsatisfactory.

E&EB 510a, Introduction to Statistics: Life Sciences 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 515a, Conservation Biology Linda Puth
An introduction to ecological and evolutionary principles underpinning efforts to conserve Earth's biodiversity. Efforts to halt the rapid increase in disappearance of both plants and animals. Discussion of sociological and economic issues.

E&EB 520a, General Ecology David Vasseur and Ann 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 523b, Laboratory for Principles of Evolution, Ecology, and Behavior 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 535a, Evolution and Medicine Stephen Stearns
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.

E&EB 545b, Responsible Conduct of Research Erika Edwards
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. o Course cr

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 556a, 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 610b, Evolutionary Functional Genomics, Cell Types, and Homology**  
Jeffrey Powell  
Functional genomics has opened the opportunity to assess the activity state of all genes in the genomes in a largely scalable way. Many cell types, tissues, and characters can readily be assessed across many species, leading to a new field of evolutionary or comparative functional genomics. At the same time this new field of data analysis can be used to address many deep issues in organismic evolution, like the evolution of cell types, the homology among cell types, etc. In this seminar we review the current state of published literature as it pertains to the evolutionary analysis of transcriptsomes and epigenetic marks and their bearing on issues of cell and tissue evolution and homology.

**E&EB 621a, Philosophy of Biology**  
Casey Dunn and Günter Wagner  
An introduction to the philosophy of biology, with application to specific current problems. The course focuses on two major strands of thinking seeking answers to two fundamental and to some extent complementary questions: “How do we know?” [epistemology] and “What things really exist in the world?” [ontology]. These two themes have the most important impact on the practice of science, as they pertain to the nature of the scientific enterprise and how it works [epistemology and philosophy of science], as well as what scientists consider part of reality [science-related ontology: unicorns and phlogiston, NO; atoms, electrons, YES; but what about species and genes? Do they have the same status as atoms?]. In each of these fields of philosophy we outline the main positions and discuss how they apply to past and current debates in biology — in particular, but not exclusively, evolutionary biology.

**E&EB 625a, Limnology**  
David Post  
Limnology, the study of the physical, chemical, and biological properties of inland waters, focuses on lakes where physical (light, temperature, and mixing) and chemical (dissolved elements and compounds) properties interact with the ecology and evolution of organisms. Topics include origins and morphology of inland waters; physical and chemical properties; diversity and interactions among the organisms found in lakes; historical perspectives; and understanding conservation and management in the context of global change. Frequent field trips to local freshwater ecosystems.

**E&EB 680b, Life History Evolution**  
Stephen Stearns  
Life history evolution studies how the phenotypic traits directly involved in reproductive success are shaped by evolution to solve ecological problems. The intimate interplay between evolution and ecology.

**E&EB 717b, 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 725a, Scientific Writing for Ecology and Evolutionary Biology**  
Ann 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 729a, Microbial Ecology and Evolution**  
Alvaro Sanchez De Andres  
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 800a / GENE 800a, Seminar in Molecular Evolution**  
Jeffrey Powell and Bluma Lesch  
This weekly seminar, a continuation of the highly successful Colloquium on Molecular Evolution, covers topics in the general area of molecular evolution. Past topics have included evolution of transcription factors, the role of epigenetics in evolutionary processes, and detecting selection in DNA sequences. Speakers generally come from Yale: faculty, postdocs, and graduate students. We solicit speakers as the term progresses, and we invite volunteers to let us know if they want to present ongoing research for input from other participants.
Graduate students may take the course for credit, but it is not graded. Credit is given for attendance at at least two-thirds of meetings; sign-in for students taking the course for credit is held at each session.

**E&EB 810b, Dynamics of Evolving Systems**  J. Rimas Vaišnys
An introduction to the ways evolving biological systems can be described, modeled, and analyzed by using a dynamical systems approach. To use currently fashionable terminology, we develop an individual-based model of the behavior of biological populations, which leads to evolution as an emergent property. In this approach it is possible to construct populations of varying individuals, which can then be combined into larger assemblages, and to modify both the overall environment and the environments at the lower levels, so that aspects often neglected in modeling evolution can be explored and related to any available observational data. Extensive use of the software package Mathematica, but prior experience with the program is not required.

**E&EB 901a, Research Rotation I**  Erika Edwards

**E&EB 902b, Research Rotation II**  Erika Edwards

**E&EB 930a / G&G 703a, 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).