ECOLOGY AND EVOLUTIONARY BIOLOGY

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

Chair
Paul Turner

Director of Graduate Studies
David Vasseur

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

Associate Professors Forrest Crawford (Public Health), Walter Jetz, James Noonan (Genetics), Jeffrey Townsend (Public Health), David Vasseur

Assistant Professors Liza Comita (Forestry & Environmental Studies), Alvaro Sanchez, Carla Staver

Senior Lecturer Marta Martínez 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 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.

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.
MASTER’S 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, Advanced Topics in Ecology and Evolutionary Biology; 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. 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**  David Vasseur
Topics to be announced. Graded Satisfactory/Unsatisfactory.

**E&EB 510a / S&DS 501a, 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 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**  Jeffrey Powell and 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; 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
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**  David Vasseur
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 575b, Biological Oceanography**  Staff
Exploration of a range of coastal and pelagic ecosystems. Relationships between biological systems and the physical processes that control the movements of water and productivity of marine systems. Anthropogenic impacts on oceans, such as the effects of fishing and climate change. Includes three Friday field trips.

**E&EB 608a, Biology of Feathers**  Richard Prum

**E&EB 610a, Evolutionary Functional Genomics, Cell Types, and Homology**  Günter Wagner
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 transcriptomes and epigenetic marks and their bearing on issues of cell and tissue evolution and homology.

**E&EB 620a, Evolutionary and Ecological Genetics**  Jeffrey Powell
Topics related to analyzing molecular genetic data to answer questions in evolution and ecology. Methods to detect selection in DNA sequences and other molecular data, and landscape genetics, overlaying genetic data on ecological maps from global imaging. Other topics will be determined by interests of participants.

**E&EB 672b, Ornithology**  Richard Prum
An overview of avian biology and evolution, including the structure, function, behavior, and diversity of birds. The evolutionary origin of birds, avian phylogeny, anatomy, physiology, neurobiology, breeding systems, and biogeography.

**E&EB 673b, Laboratory for Ornithology**  Richard Prum
Laboratory and field studies of avian morphology, diversity, phylogeny, classification, identification, and behavior. Must be taken concurrently with E&EB 672.
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 705b, Plant Ecology  Ann Staver
Plant ecology is the study of plant interactions with their environment, at the level of individuals, and of how plant-plant interactions mediate environmental interactions at the level of populations, communities, and ecosystems. The course incorporates empirical and theoretical perspectives, emphasizing the empirical origins of concepts in plant ecology and effective empirical tests of conceptual and mathematical predictions. Students read the primary scientific literature extensively, both for content and to build familiarity with methodological standards and the scientific writing.

E&EB 713b, Spatial and Environmental Data Analysis in Conservation and Biodiversity Science  Walter Jetz
The course provides an introduction and hands-on exposure to computational and statistical approaches for the analysis of biodiversity data in a geographical, environmental, and conservation context. After a general overview of relevant hot topics and questions in conservation and ecology and their associated methodological and data sources, we introduce a set of example questions that we then address with a variety of datasets and methods. A particular focus is the analysis of species distributions and abundances in changing landscapes using remotely sensed environmental information. Beyond broadly available data and methods, students explore new biodiversity-relevant remote-sensing products under development with NASA and prototype tools available through the Yale-based Map of Life project and its partnership with the Google Earth Engine team. Participants gain hands-on experience in spatial analysis and modeling relevant for biodiversity and conservation science and learn about key associated concepts and potential pitfalls. Case studies from forestry, species distribution modeling, biodiversity, and remote sensing data processing. The course meets weekly for 2–3 hours, day and time to be determined. The first organizational meeting takes place on January 20 at 2 pm in OML 201; if you are interested in the course but unable to attend the organizational meeting, please contact the instructor at walter.jetz@yale.edu. Prerequisite: open to advanced undergraduates and graduate students (postdocs also welcome) with an interest in advancing their data analysis and modeling skill set and at least some experience in GIS and statistical analysis in R (or willingness to acquire it).

E&EB 810a or b, Dynamics of Evolving Systems  J. Rimas Vašišys
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 ecological 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 842b / ANTH 835b, Primate Diversity and Evolution  Eric Sargis
The diversity and evolutionary history of living and extinct primates. Focus on major controversies in primate systematics and evolution, including the origins and relationships of several groups. Consideration of both morphological and molecular studies. Morphological diversity and adaptations explored through museum specimens and fossil casts.

E&EB 900a or b, First-Year Introduction to Research and Rotations  David Vasseur

E&EB 901a, Research Rotation I  David Vasseur

E&EB 902b, Research Rotation II  David Vasseur

E&EB 903b, Independent Study  David Vasseur
By arrangement with faculty. Approval of DGS required.

E&EB 930a or b / G&G 703a or b, Seminar in Systematics  Jacques Gauthier
A seminar on using molecular evolutionary models in Bayesian phylogenetic analyses. Topics are chosen by the participants but may include "models" in phylogenetics, understanding and comparison of model selection criteria, effects of model under- and overparameterization on parameter value estimates and phylogenetic inferences, and accommodating model uncertainty and model-averaging.

E&EB 950a, Second-Year Research  David Vasseur
By arrangement with faculty.

E&EB 960b, Studies in Evolutionary Medicine I  Stephen Stearns
The first term of a two-term course that begins in January. Students learn the major principles of evolutionary biology and apply them to issues in medical research and practice by presenting and discussing original papers from the current research literature. Such issues include lactose and alcohol tolerance; the hygiene hypothesis and autoimmune disease; human genetic variation in drug response and pathogen resistance; spontaneous abortions, immune genes, and mate choice; parental conflicts over reproductive investment mediated by genetic imprinting; life history trade-offs and the evolution of aging; the evolution of virulence and drug resistance in pathogens; the evolutionary genetics of humans and their pathogens; the ecology and evolution of disease; the evolutionary origin of diseases; and the emergence of new diseases. Students develop a research proposal based on one of their own questions in the spring term, spend the summer on a research project related to their research proposal, and write a paper based on the results of their research in the fall term.
Credit and grades are awarded for each term. Only students who have engaged in summer research projects may enroll in the fall term. Admission is by competitive application only. Forms are available on the E&EB department website.