Evolutionary Ecology

Biology 652-01 / Winter 2008

INSTRUCTORS

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GENERAL DESCRIPTION

Class Meeting Times: Monday and Wednesday 10:00 – 11:45 am 142 WIDB
3.0 credit hours

Evolutionary Ecology is an advanced course in our graduate curriculum focused on the interplay between population ecology and adaptation. We approach this topic from four angles.

1. **Population growth.** We first examine the regulation of population growth, a topic of great interest to both Malthus and Darwin. This framework serves as the foundation for understanding a variety of problems in evolutionary ecology, several of which we will consider here.
2. **Life history evolution.** We next consider the evolution of life history traits. We build upon the population matrix modeling tools used in population dynamic studies to understand how selection favors the evolution of reproductive traits that most affect population growth.
3. **Species interactions and evolutionary adaptation.** Here we explore patterns of natural selection in the wild. We consider the role of contingency and determinism in evolution, emphasizing predation and competitions as drivers of evolutionary change. We return to our theme of population regulation by modeling population dynamics in predator-prey and competitive interactions.
4. **Behavior.** Finally, we wrap things up by considering the evolution of behavior and its ecological consequences. We consider sexual selection, cooperation and altruism, optimal foraging, and speciation.

This course covers a broad set of topics that fall under the umbrella of 'evolutionary ecology'. Our goal in this class is for you to become familiar with the state of the field in each of the areas that we cover. Our approach is to offer a historical perspective, including the development of mathematical models where appropriate, and to demonstrate through empirical work important milestones in these fields. We hope to leave each topic by discussing a set of current problems in each field where future research would pay off.

LEARNING OBJECTIVES

Upon successfully completing this course, you should be able to:

1. Discuss historical development of population growth equations. Derive population growth equations from first principles and modify these to include density dependence. Define equilibrium, and explain global and local stability relative to population growth models. Explain factors that determine growth rates and stability. Calculate growth rates and population sizes given starting conditions.
2. Generate life cycle diagrams for any life history strategy. Show the link between this diagram and a matrix model, and sue this information to populate a matrix model. Use the tools of population matrix modeling to determine growth rate, stable age distribution, and reproductive value. Demonstrate the use of elasticity and sensitivity analysis.
3. Discuss historical development of life history theory. Explain trade-off models and optimality analyses. Discuss the relationship between theoretical life history analyses and empirical studies.
4. Explain how natural selection in the wild is studied. Calculate selection gradients and coefficients. Discuss the ideas of contingency versus determinism in driving evolutionary change.
5. Explore the study of phenotypic plasticity from a historical and current perspective. Explain why plasticity evolves in some cases but not in others; offer your perspective in light of the 'costs of plasticity' arguments. Show how to generate reaction norms.
6. Describe differences and similarities among several kinds of tight species interactions (host-parasite, plant-pollinator, plant-herbivore, predator-prey, mutualisms, etc.). Describe several ways that these interactions are studied. Link these ideas to the study of co-evolution.
7. Describe character displacement. List the criteria required to demonstrate character displacement; what alternative hypotheses exist to explain phenotypic differences among co-occuring species.
8. Discuss historical development of competition equations and the concept of completion in ecology and evolution. Derive classical competition models as an extension of population growth models. Derive and explain potential outcomes with the use of zero-growth isoclines analysis. Discuss the relationship between theoretical analyses of competition and empirical studies.
9. Discuss historical development of predator-prey equations and the concept of predation in ecology and evolution. Derive classical predator-prey models as an extension of population growth models. Derive and explain potential outcomes with the use of zero-growth isoclines analysis. Discuss the relationship between theoretical analyses of predation and empirical studies.
10. Explain how different mating systems have evolved. Explore the interaction between sexual selection and natural selection.
11. Describe historic and current problems in the study of cooperation and altruism.
12. Explain the evolution of animal movement, particularly as it relates to foraging strategies.
13. Explain possible mechanisms of speciation; describe features common / necessary to all models of speciation as well as unique elements. Explore the possibility of generating a unified framework for understanding speciation.

14. Complete your own research project in evolutionary ecology. Write up your results as a publishable manuscript for a journal of your choice.
15. Present your research findings as a scientific talk in our class symposium at the end of the semester.

INCORPORATING ELEMENTS OF THE *OXFORD TUTORIAL* APPROACH TO LEARNING

What distinguishes a graduate course from an undergraduate course? Is it just that the problems are harder, or the course material is covered more in-depth, or perhaps we expect you to write better? Although each of these may be so, what truly distinguishes your graduate education from a *typical* undergraduate one is that we expect you to think independently. This means that you must not only master content, but you must come to your own understanding and conclusions about it. Sequestering facts alone is not enough; you must also grasp how such ideas have come about, why they matter, and what their implications are for the future. This expectation has a long tradition in some European undergraduate universities, most notably at Oxford and Cambridge.

In this course we will adopt elements of the Oxford Tutorial philosophy. If you are not familiar with this approach, please read over the *pdf* entitled *The Oxford Tutorial*. Pay special attention to chapters 1, 2, 5, 7, 12, and 14. As your instructors we will provide you with *starting* material for understanding topics in evolutionary ecology; note the emphasis on *starting*. An in-depth appreciation and independent assessment will require your further exploration. The responsibility for mastering content lies with you. Come to class prepared. As your instructors we will treat some of our class time in a lecture format—professors professing—but we expect most of our time together will be spent in a format that more closely approximates the Oxford tutorial. We will ask you to present your understanding and insights about a topic, lead you with questions to help further clarify your ideas, and ask you to project where you see the field going. Any one of you could be asked to stand before the class to discuss the topic. Come to class prepared.

COURSE MATERIALS

Case, Ted J. 2000. An illustrated guide to theoretical ecology. Oxford University Press, New York, 449 pp.

Fox, Charles W., Derek A. Roff, and Daphne J. Fairbairn. 2001. Evolutionary ecology: concepts and case studies. Oxford University Press, New York. 424 pp.

ADDITIONAL READING

In addition to chapters from the two primary sources, we will also point you to select readings on specific topics. When possible, these papers will be made available to you in *pdf* format. Also note that in this syllabus we have put together a list of books and journals that could help you as you explore various topics.

PARTICIPATION AND ASSIGNMENTS

Participation: Employing a tutorial style of learning demands careful preparation by each course participant prior to attending class. With a small class size there is an exceptional opportunity for very personalized learning. For this model to be successful, you must of course be in class and then please plan on being the center of attention. You will be asked to present and defend your ideas.

Turning in assignments: Deadlines, unless otherwise stated, are at the **beginning of class** on the due date.

Late Policy and Absences: Extra-curricular activities, travel, or work in other courses, are not justifications for late work here. If you know anticipate that you will be absent for class discuss this with your professors *before* your absence. We will try to come up with some alternative direction for you to explore those topics.

Description of assignments:

1. Research Paper – To put it simply, we expect an original manuscript similar to what we would receive to review from a journal. You choose a mutually agreeable topic (come up with an idea and run it by us), do the research, and write the manuscript in the format of your chosen journal. We will review it when you turn it in the first time as if we had received it from a journal and we will assign a grade. You have the option of accepting that grade or revising the manuscript for a final review and possible grade change at the end of the semester.

2. Class Presentation – A twenty-minute presentation like you would present at a scientific meeting. The last three days will be used for presentations and we will grade the presentation based on the criteria for judging for student awards at a national meeting. The best presentation wins lunch on the professors. There will be an extended period for questions after each presentation and we will be looking for insightful questions from class members as part of the participation score detailed below.

3. Take Home Final Exam – The final exam will be a take-home exam given at the end of regular instruction (before class presentations). The exam will be open-source with the exception of other people. In other words, you can access any written material required, but you cannot email or otherwise ask another person to help with questions. The exam must be turned in as a written response in hard copy.

4. Participation- Because of the design of the class, individual participation is required. We will assign participation points depending on your readiness in class when called upon (see Oxford Tutorial), and your voluntary efforts especially during class presentations.

COURSE GRADING

		Letter grades will be assigned as follows:					
Research Paper	100			A	93%	A-	90%
Class Presentation	50	B+	87%	B	83%	B-	80%
Take Home Final Exam	100	C+	77%	C	73%	C-	70%
Participation	50	D+	67%	D	63%	D-	60%
Total	**300**						

BLACKBOARD

We plan to use *Blackboard* as a way to post material for you to read. However, the most important use of *BB* will be as a way for you to communicate with each other in posting questions and exchanging information. Please use this as a way of generating reading material for each other, for sharing questions and answers, and for developing your own independent ideas on various topics.

JOURNALS and BOOKS THAT YOU MIGHT FIND USEFUL

Animal Behavior
Behavioral Ecology
The American Naturalist
Ecology
Evolution
Evolutionary Ecology
Evolutionary Ecology Research
Trends in Ecology and Evolution

Coyne, Jerry and Alan Orr. Speciation. 2004. Sinauer Associates, Inc. Sunderland, MA.

Endler, John A. 1986. Natural selection in the wild. Princeton Univ. Monographs, Princeton, NJ.

Futuyma, Douglas J. 1998. Evolutionary Biology. Sinauer Associates, Inc. Sunderland, MA.

Kingsland, Sharon. Modeling nature: episodes in the history of population ecology (science and its conceptual foundations)

Mayhew, Peter. 2006. Discovering evolutionary ecology. Oxford University Press, Oxford, UK.

Mitton, Jeffry B. 1997. Selection in natural populations. Oxford University Press, Oxford, UK.

Pianka, Eric R. 1988. Evolutionary ecology. Harper and Row, Publisher, Inc., New York.

Real, Leslie A. (editor). 1994. Behavioral mechanisms in evolutionary ecology. University of Chicago Press, Chicago.

Real, Leslie A. and James H. Brown (eds.). 1991. Foundations of ecology: classic papers with commentaries. University of Chicago Press, Chicago.

Roff, Derek A. The evolution of life histories: theory and analysis. Chapman and Hall, New York.

Date	Prof.	Class Topic	Reading Assignment	Assignment due
Jan 07	MB / JJ	Course overview The *Oxford Tutorial* model of learning	*The Oxford Tutorial*	
Population dynamics				
09	MB	Exponential population growth	Case: Chapters 1	
14	MB	Density dependent population growth	Case: Chapter 5	
16	JJ	Population equilibrium and stability Introduction to matrix models	Case: Chapters 3 & 4	
21	University Holiday – no class			
23	JJ	Matrix models / elasticity analysis and links to fitness	Case: Chapters 3 & 4 Ecology papers or Caswell	
Life history evolution				
28	MB	Life history evolution – Cole's paradox	Case: Chapter 7 & 8	
30	MB	Life history trade-offs	Case: Chapter 7 &8 and Fox et al., Chapters 8 & 9	
Feb 04	MB	More life history	Case: Chapter 7 &8 and Fox et al., Chapters 8 & 9	

Date	Prof.	Class Topic	Reading Assignment	Assignment due
06	MB	More life history	Case: Chapter 7 &8 and Fox et al., Chapters 8 & 9	
Evolutionary adaptation and species interactions				
11	JJ	Natural selection & adaptation	Fox: Chapter 3 & 4	
13	JJ	Phenotypic plasticity	Fox: Chapter 5	
18	University Holiday – no class			
20	JJ	Species interactions: parasite / host, plant / herbivore, mutualisms	Fox: Chapter 22, 23, 24	
25	JJ	Species interactions: parasite / host, plant / herbivore, mutualisms (cont.)		
27	JJ	Ecological character displacement	Fox: Chapter 20	
Mar 03	MB	Competition	Case: Chapter 14	

Date	Prof.	Class Topic	Reading Assignment	Assignment due
05	MB	Competition		
10	MB	Predator / prey	Case: Chapter 12, Fox: Chapter 21	
	Behavioral Ecology			
12	JJ	Mating systems & sexual selection	Fox: Chapters 15 & 16	
17	JJ	Cooperation and altruism	Fox: Chapter 17	
19	JJ	Foraging behavior	Fox: Chapter 18	Research Paper Due
24	JJ	Speciation	Coyne and Orr 2004	
26	-	Work on take home exam	-	
31	-	Work on take home exam	-	
Apr 02	-	Prepare class presentations	-	Return Research Paper Take Home Exam Due
07	MB / JJ	Class Presentations	-	Class presentation
09	MB / JJ	Class Presentations	-	Class presentation
14	MB / JJ	Class presentations	-	Class presentation

Date	Prof.	Class Topic	Reading Assignment	Assignment due
19	Revised Paper Due (in lieu of final exam; submit two copies) - Friday, 18 April 2008, 4:00 pm 153 WIDB			

MISCELLANEOUS

Sexual Harassment Statement. Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity. Title IX covers faculty-student, student-faculty and student-to-student sexual harassment. BYU's policy against sexual harassment extends not only to employees of the university but to students as well. If you encounter unlawful sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment office (378-5895); or contact the Honor Code Office at 378-2847.

Honor Code Standards. In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact **be** your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Students with Disabilities. If you have a disability that may affect your performance in this course, you should get in touch with the office of Services for Students with Disabilities (1520 WSC). This office can evaluate your disability and assist the professor in arranging for reasonable accommodations.