

Biology 488/588
Evolutionary
Processes Fall 2016

Instructor: Matt Streisfeld

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Meeting Times: M/W 4:00-5:20

Location: Esslinger 199

Course Description: A major goal of evolutionary biology is to understand the processes that generate and maintain patterns of variation in nature. In addition, it is well-known that organisms routinely show a remarkable fit with their environments, suggesting that these phenotypes are adaptive. However, there are several ecological and evolutionary processes that can operate to produce similar patterns of phenotypic variation in nature. So what are the tools that we - as evolutionary biologists - use to determine whether a phenotypic trait is adaptive in nature? The main goal of this course is to learn how evolutionary biologists experimentally study adaptation. Such a course is interdisciplinary, in that it unites several areas of biology, including ecology, genetics, statistics, molecular biology, and genomics. By the end of the term, you will have an appreciation for the different techniques and skills that are required to understand the evolutionary process.

Learning outcomes:

- Demonstrate how the evolutionary process is used to understand the process of adaptation
- Proficiency in critical thinking based on evaluation of data from primary literature
- Analyze data from primary literature using statistical and population genetic approaches
- Develop verbal and written communication skills through in-class discussion and assignments

Prerequisite: BI 380, Evolution; or Instructor approval

Details: This is an advanced, upper-level biology course. It should be challenging, but fun. Our meetings will be mostly discussion-based, but I will lecture as well. **I expect that you will come prepared to each class for a lively discussion.** This is an advanced course in evolutionary biology. As such, I expect that you are comfortable with basic evolutionary theory, such as population genetics. To make sure that we are on the same page, during the first week, I will provide you with an overview of the basic concepts that you will need to understand to be successful in this class. However, if these topics are not familiar to you or if you would like a better foundation in basic evolutionary theory, I strongly recommend that you do some additional background reading. If you would like information on appropriate reading, please see me.

Because the statistics, techniques, and advances in this area are ever-changing, there is no textbook that covers all of the relevant topics. Therefore, we will use the primary literature as our guide to the approaches that currently are being used in the field. Starting in week 2, we will begin each class period with a discussion about one or two papers. We will focus on the merits of the methods used and the major implications of the results identified by the investigators. To make sure that you have the appropriate background to critically evaluate each paper, I will end the previous class with an approximately 30- minute lecture on the upcoming topic.

Readings: Papers from the primary literature constitute all of the reading for the course. All papers are available on Canvas as pdfs for download. Readings must be completed by the time of the class meeting in which they will be discussed. **Class participation is essential to an intellectually lively course; it will also contribute to your grade.**

I have chosen these papers because they are either technical descriptions of a relevant approach in the field or because they represent exemplar cases that experimentally use these approaches. Many of the papers will contain lots of technical information. It is OK if you don't understand everything when you read the paper. The purpose of the discussion is for the entire class to work through the papers to gain a better understanding of the material. **You should come to class prepared with questions about what you didn't understand.** Some questions to ask yourself when you read each paper:

- What is the purpose of this paper?
- What is the main question that the authors ask?
- What are the main findings? Can I explain what each figure represents?
- Do the findings support the conclusions that the authors draw?

Quizzes: There will be a series of 5 short pop-quizzes spread throughout the course. The quizzes will test your careful reading of the papers. Their purpose is to ensure that you come prepared to class each day and have critically read and evaluated the papers. If you read the papers carefully and come to class each day, the quizzes will be easy. Each quiz should take no more than 5-7 minutes to complete. I will drop the lowest score from your final grade. There will be no make-up quizzes without medical justification.

Problem Sets: There will be two problem sets that you will need to complete. I will provide you with a data-set and you will be required to analyze and interpret the data using methods that we learn about in the class. These will be due in weeks 5 and 8.

Term Paper: Each student will submit a 5 page term paper that critically examines one of five different case studies of adaptive evolution. Each paper should be double spaced, with 1-inch margins and be fully referenced. I provide you with a list of case studies (see below) – currently, these are recognized as some of the most complete studies of adaptive evolution. It is your job to select one and determine how well the investigators have done characterizing the different aspects of the evolutionary process. The paper has three parts that should be integrated into a single, comprehensive essay (1-2 pages each): 1) an introduction, defining adaptation and how

you test for it, 2) a literature review of the relevant studies, and 3) your assessment of whether the authors have identified adaptation (ie. a conclusion). This final area requires that you defend your point using specific examples. Typically, the study of adaptive evolution is a long-term research objective. Therefore, you should not expect to find all of the relevant information in a single paper. I expect that you will read and present a summary of the background literature on the study system, and then critically interpret the significance of these results for the study of adaptation. Your grade will be determined by the clarity of your writing - both in terms of its flow, style, etc, as well as the arguments that you make.

I do not want you to simply repeat the results from these studies, but instead, I am looking for you to synthesize the findings related to potential adaptation. Then, I want you to use what you have learned throughout the class to make a **coherent and evidence-based argument** about the various components of the adaptive process in the system you choose. There is no right or wrong answer to this ... what I want is to see you critically think about the topic and clearly describe your perspective of the case study you have chosen.

Writing is an iterative process - no paper can ever be written in just one sitting. Instead, it takes many drafts and sets of eyes to create a solid piece of work. Therefore, you will have an opportunity to read each other's papers and provide critical feedback that can be used during revision before the final draft is turned in at the end of the term. At the end of week 7 (Nov 9), each student will turn in a draft of their introduction, which should be roughly 1-2 double spaced pages. Remember, the purpose of the introduction is to provide a critical assessment of adaptation and what is necessary to document it. In addition to sending me a copy, you will also send a copy to one of the other students in the class. Each student will then have 1 week to provide critical feedback on the paper, which will help to improve the final version of the introduction. You will be graded on the quality of your initial draft as well as the level of detail you provide on the review. I will provide more detail on what a good peer review entails later in the term. I encourage you to carefully proof-read your papers, and consider the style and flow of the information during your writing. The quality of the writing will be an essential component to your grade. The final version of the introduction, along with the other two sections of the paper will be due during final's week.

As far as references are concerned, there are probably three places that are the best to look: PubMed Central (<http://www.ncbi.nlm.nih.gov/pubmed>), ISI Web of Science (<http://www.isiknowledge.com>), and Google Scholar. Pubmed and Google Scholar can be accessed from any computer; web of science requires a UO IP address. To be able to download many of the papers, however, you also will need a UO IP address. Alternatively, you can download the UO VPN to connect your off campus computer to the UO servers and access the online articles through the library.

Case Studies

1) Coat color variation in *Peromyscus* mice. The lead author on much of this work is Hopi Hoekstra. Be sure that you are examining similar systems, as there have been two sets of populations studied for coat coloration in *Peromyscus* (alternatively, you can compare and contrast the two studies if you wish).

- 2) Physiological changes associated with survival at high altitudes in *Peromyscus* mice. The lead author on much of this work is Jay Storz.
- 3) Lateral plate reduction associated with the recent colonization of freshwater habitats in threespine stickleback (*Gasterosteus aculeatus*). The lead authors on much of this work include Dolph Schluter, David Kingsley, and Bill Cresko.
- 4) The evolution of mimicry in South American *Heliconius* butterflies. The lead authors on much of this work are: W. Owen McMillan, James Mallet, and Chris Jiggins.
- 5) Ecological speciation in monkeyflowers (*Mimulus cardinalis* and *M. lewisii*). The lead authors on this work are Doug Schemske, HD Bradshaw, Jr., and Amy Angert.

Email as a word (or text) document by 5pm on the due date.

Research Proposal (Graduate students only): One of the main parts of graduate work in the natural and life sciences is independent research. The way research is conducted is by securing funding from granting agencies. This is a critical aspect of any career in research. Therefore, your assignment will be to choose a trait or traits from any organism you like and design a research proposal describing how you would study whether that trait is adaptive in nature. The traits can come directly from your own research or they can be traits that we discussed in class. By the end of week 6, I require that you set up a time to meet with me to discuss your trait/system and for me to answer any questions that you have.

The format of the proposal follows that of the National Science Foundation Graduate Research Fellowship, which some or many of you have or will be applying for. This is a 2-page (single space, 11-point, minimum) proposal including references (they can be numbered, with 10-point literature cited). No broader impacts section is required. The proposal should give the background to the problem, state the research objectives, describe the study system, and conclude with the research methods/experimental design. The methods can be things that we talked about in class or other methods that you are familiar with from your own research. The main goal is that you demonstrate how your experimental design will address the research objectives that you put forth. You should have at least 2 research objectives and describe the experiments in sufficient detail so that I (as a reviewer) can determine whether the project appears feasible. Compiling this information into only 2 pages is a challenge; therefore, I highly recommend that you do not wait until the last minute to start working on this project. This project will be due the beginning of week 10. **This assignment is due via email as a word (or text) document by 5pm the day it is due.**

Evaluation: Your final grade will be determined as follows:

	Undergraduate Percent of Final Grade	Graduate Percent of Final Grade
Term Paper	30%	25%
Problem sets (2)	25%	20%
Introduction	15%	10%
Peer Review	10%	10%
Quizzes	10%	10%
Participation	10%	10%
Research Proposal (Grad only)	----	15%

Please note that late assignments will incur a 5% penalty per day.

Academic Integrity: I have a zero tolerance policy for cheating, plagiarism, or any other form of academic dishonesty. For this course, that means your paper and assignments must be your work, and all references to others' scholarship should be properly cited. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures.

Students with Disabilities: The University of Oregon is working to create inclusive learning environments. Please notify me during the first week of the term if there are aspects of the instruction or design of this course that result in barriers to your participation. You may also wish to contact Disability Services in 164 Oregon Hall at 346-1155 or disabsrv@uoregon.edu.

Date	Discussion Topic (I will present lectures on each discussion topic in the class period before they are discussed)	Readings (Discussed on this day of class)
26-Sept	Course introduction, review of genetic and evolution terms	None
28-Sept	Population genetics: review; selection vs. drift	Schemske and Bierzychudek 2001
3-Oct	Quantitative genetics: introduction	Conner 2002
5-Oct	First discussion: What is (and is not) adaptation?	Gould and Lewontin 1979
10-Oct	Phenotypic selection: direct vs indirect; univariate/ multivariate	--
12-Oct	<i>No class</i>	--
17-Oct	Phenotypic selection: direct vs indirect; univariate/ multivariate (discussion)	Campbell et al. 1997
19-Oct	Experimental evolution – mode and tempo of adaptation	Lenski and Travisano 1994
24-Oct	Population differentiation – Fst 1st Problem Set Due	Lowry et al. 2008
26-Oct	Clines – selection vs. drift	Stankowski et al. 2015
31-Oct	Molecular population genetics – introduction	Sabeti et al. 2006
2-Nov	Molecular population genetics – single genes	Wang et al. 1999
7-Nov	Population genomic scans for selection	Hohenlohe et al 2010
9-Nov	Finding the genes – QTL mapping (lecture) Paper introduction Due	--
14-Nov	Finding the genes – QTL mapping (discussion)	Steiner et al. 2007
16-Nov	What is the origin of adaptive alleles? New mutations? Peer review due	Linnen et al. 2009
21-Nov	What is the origin of adaptive alleles? Standing variation? 2nd Problem Set Due	Barrett et al. 2008
23-Nov	<i>Thanksgiving – No Class</i>	--
28-Nov	What is the origin of adaptive alleles? Introgression? Graduate Student Research Proposal Due	Stankowski and Streisfeld 2015
30-Nov	Final Synthesis	Nielsen 2009; Barrett and Hoekstra 2011
8-Dec Thurs Final's Week	Term Paper Due 5pm	