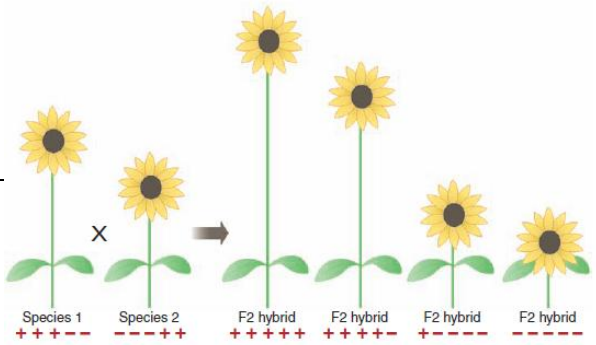
Biology 390 – Plant Speciation and Evolution
Winter 2010



Instructor information
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Course information
Meeting time and place: Lecture MWF 12:20-1:15 PM Berndt Hall 755; Lab M 1:30-4:30 PM Berndt Hall 3020 or 755

Required text:
There is no required text but selected readings will be provided from the scientific literature and selected books.

Course Website: http://moodle.fortlewis.edu
The course website contains all of the course lecture materials, copies of most readings, copies of lab protocols as well as updates to the schedule. I will also upload at the appropriate time review sheets for all exams approximately one week in anticipation.

Prerequisite: BIO 113, Intro. to Molecular and Cellular Biology; BIO 206, General Botany

Course Description:
A survey of the patterns and processes of speciation in modern plant groups. Includes a review of evolutionary principles, the genetic processes involved in evolution, the generation of heritable variation, phylogeny and phylogeography, breeding systems and the maintenance of discrete forms. Laboratory will include an original investigation of speciation in plants of SW Colorado.

Objectives:
1. Understand the basic conceptual development of evolutionary theory.
2. Link population genetic changes with population level patterns of divergence.
3. Understand the basic premise of the Hardy-Weinberg Equilibrium and how deviation from this can be analyzed.
4. Learn how to utilize the basic research methods used in modern evolutionary biology including DNA sequencing and phylogeny reconstruction, flow cytometry, and morphometric analysis.
5. Understand the life history and reproductive traits of plants which contribute to or limit gene exchange.
6. Understand how the understanding of evolutionary processes can contribute to our understanding of plant biology from the physiological to ecological levels of complexity.
7. Develop an ability to interpret and discuss original research in the area of plant evolutionary biology.

Course Evaluation
Grades will be determined through a mix of exams, a term paper/presentation, and participation in discussion sessions and laboratories. There will be no small assignments or a large number of individual grades in this course. I do however expect each student to participate in the class activities. Part of your grade will be based on an evaluation of your in-class presentation by your peers (more on this later). There will be a total of 400 possible points divided into 200 pts for exams, 160 points associated with the term paper and presentation, and 40 points for discussion session and laboratory participation.

Specific Requirements

Tests:

We will have two exams, a midterm and a comprehensive final, each worth a total of 100 pts. Most exam questions will be short answer or essay in format. Some questions will involve the interpretation of data.

Term Paper and Presentation:

Your single largest assignment will be the completion of a written review paper and oral presentation on a topic you choose related to plant speciation or evolution. This review could be over the evolution of a particular group of plants, a summary of a specific type of evolutionary mechanism, the review and application of a new experimental technique in evolutionary biology, etc. Use your imagination to select a topic – but make sure it is something both feasible and interesting to you.

The first part of the assignment will be your submission of a topic proposal at the end of the fourth week of class (February 5). This will be worth 10 pts toward the overall grade and should include a rough idea of your topic and 1-2 listed bibliographic sources. I will evaluate your proposal and make suggestions for how to circumscribe the topic (particularly if it appears too unwieldy).

The written paper will be expected to be 8-10 pages in length with standard 1 in. margins and 10-12 pt font. You will be expected to cite at lest 5 published journal articles and/or book sources. **General web sources will not be permitted.** Your paper should be organized with a specific title, a summary paragraph in the form of an abstract, the body of the text divided into appropriate sections with subtitles, and a literature cited section which lists only the sources you refer to in the text and should follow a commonly used citation method in biology. Within the text you should follow the "Author, date" style of citation [eg. "…as was shown by the brilliant experiments of McCauley and What's-his-name (2008)..." or "…the evidence for a successful plant-animal hybrid was deemed inconclusive (McCauley and What's-his-name, 2009)]. You should not include page numbers within this in-text citation. A first draft of your paper will be due on March 22 and will be worth a total of 40 pts. I will review this draft and make suggestions before returning it. The final draft of the paper will be due April 16 and will be worth an additional 60 pts. You should turn in to me both the final and rough drafts of the papers at this time.

The second part of the assignment will be your preparation of an in-class lecture on your selected review topic. The lectures will be scheduled for the class periods between March 22 and April 12. The order of presentations will be determined through a lottery. The lecture should be prepared as a power-point presentation which you have practiced and should extend for approximately 40 minutes leaving time for questions and/or discussion. **You will be required to submit to me a copy of your presentation two days before the date of your presentation so I can review it for content.** You should include pictures, graphs and diagrams in your presentation to help illustrate key points. These figures must be cited on the presentation and presented in a literature cited slide. Your grade on the presentation will be largely determined through a peer evaluation following a standard critique sheet. I too will critique the presentation and average my grade in with those of your peers and will be worth a total of 50 pts. As your presentations will be part of the lecture sequence and since some questions on the final exam will be derived from the student presentations, you will also be required to submit to me a digital copy of your final presentation for posting on the course Moodle site.

Lab Information:

We will use the lab time to learn some of the techniques used in modern evolutionary plant biology while collaborating on original research. Many of the labs will focus on the use of basic molecular techniques and we will go over the basics of these methodologies and their application in organismal biology.

The first research project we will work on will be to determine the phylogenetic relationship of the new species *Gutierrezia elegans*, recently described from SW Colorado. This species is restricted only to a single small outcrop of Mancos Shale and is allied with the more common and widespread species, *G. sarothrae* and *G. microcephala* but we don't understand how. We will be extracting DNA from a few species of the genus *Gutierrezia*, performing PCR amplification, and generating DNA sequence data which we will then combine with other published data to generate a molecular phylogeny to better understand the relationship and evolutionary history of this restricted species.

A second project we will work on is a hypothesized case of cryptic speciation in the genus *Guaiacum* in southwestern Mexico. I have been working with this group for some time and have amassed a set of data which indicates a potential

instance of early speciation within the species *G. coulteri* due to apparent changes in genome size within a set geographical area of the state of Oaxaca. To verify these changes we will be applying the technique of flow cytometry for determining chromosome numbers of plants in various populations (that I collected about two years ago – sorry no mid-winter field trips to southern Mexico!). We can then apply a powerful morphological and multivariate statistical analysis of leaf form to determine if there is any consistent morphological evidence for this hypothesized pattern.

While we will not have specific lab quizzes or laboratory reports it is imperative that you attend all laboratories. I will be teaching various topics in the laboratory particularly those related to data interpretation. Some of this will be included on the exams.

Lecture:
While the content of lecture is principally decided by me, thus making it our own little dictatorship, I am not opposed to constructive deviations away from the course timetable. Ultimately this is "your" class and as this is a small upper-level class we can be free to explore items of particular interest to the group as a whole.

Discussion Sessions:
Many Wednesdays we will discuss a research paper from the scientific literature. The paper will be posted on Moodle prior to the class meeting and it will be your responsibility to have read the article prior to the class discussion. We will discuss the background of the paper, techniques used in the research, and the findings. Some of the papers will be linked with the general evolutionary principles we are discussing in lecture while others will be used to illustrate new topics and ideas. It will be your responsibility for understanding the papers since some of the information will be on the exams; therefore if you do not understand a finding you should bring that up in the discussion.

Other Course policies (The boring stuff that just has to be here)
Academic Integrity:
I expect all students to uphold the highest standards of academic honesty in all exams and assignments. Plagiarism in any form will not be accepted and will at the least result in the loss of credit for the assignment in question and may result in course failure and the filing of a formal report to the proper college authority (Remember, I know how to Google too - so no cut-and-paste from the internet).

Attendance:
While I do not take a daily role, regular attendance is expected – particularly if you want to do well. If you know you are going to miss class please let me know beforehand. If your absence results in your missing an exam, and is legitimate, you will be allowed to make it up within 5 days of the original exam date. If you miss an exam for a legitimate reason and are unable to make up the exam within 5 days the score on the final exam will be substituted for the missed exam score. If you miss for an illegitimate reason than you will receive a zero for that particular exam. Legitimate absences will include any absence with a letter documenting that absence from the appropriate college official, be a documented medical excuse, or be a documented religious observance.

Classroom conduct:
While I hope it goes without saying, please respect the rights of myself and your fellow classmates. If you are late try not to disturb everyone else. Additionally please leave cell phones, pagers, iPods, etc, at home or turn them off during class. Lastly there will be no use of tobacco products during lecture or lab.

Drops:
The college deadline for dropping this class with a "W" is census date, Tuesday January 26. Without exceptional circumstances, I will not assign a grade of "W" on a drop slip after this date unless you are currently passing the course with a C or better.

Accommodations:
Students with disabilities who require reasonable accommodations to fully participate in course activities or meet course requirements must register with the Disability Services Office. If you qualify for services through the Disability office, bring your letter of accommodations to me as soon as possible so I can make the appropriate arrangements. Letters are available through Dian Jenkins, Coordinator of Disability Services, 280 Noble Hall, 247-7459.

Tentative Lecture/Lab Schedule

Wk	Date	Topics	Supplemental Readings
1	Jan. 11/13/15		
	Lecture	• Introduction • Brief History of Evolutionary Theory • Sources/control of genetic variation	Freeman & Herron Chapt. 4
	Lab	No lab	
2	Jan. 18/20/22		
	Lecture	• Population genetics I: Hardy-Weinberg Principle • Discussion Clausen, J. 1962. The Evolution of Ecological Races. Ch. 4 *in* Stages in the Evolution of Plant Species. Hafner Publishing Co., New York. • Population genetics II: Stochastic processes/Gene flow and population subdivision	Freeman & Herron Chapt. 5 & 6
	Lab	Start DNA extraction - *Gutierrezia*	
3	Jan. 25/27/29		
	Lecture	• Techniques for assessing gene flow and expression • Discusison Morjan, C. L. and L. H. Rieseberg. 2004. How species evolve collectively: implications of gene flow and selection for the spread of advantageous alleles. *Molecular Ecology* 13: 1341-1356. • Phylogenetic inference	
	Lab	Finish DNA extraction	
4	Feb. 1/3/5		
	Lecture	**Term paper topic proposal due – Fri. Feb. 5** • Plant breeding systems • Discusison Schemske, D. W. and H. D. Bradshaw, Jr. 1999. Pollinator preference and the evolution of floral traits in monkeyflowers (*Mimulus*). *Proceedings of the National Academy of the United States* 96: 11910-11915. • Isolation mechanisms	Charlesworth, D., 2006.
	Lab	PCR Amplification	
5	Feb. 8/10/12		
	Lecture	• Speciation models and pathways • Discussion Mayer, M.S., P. S. Soltis and D. E. Soltis. 1994. The evolution of the *Streptanthus glandulosus* complex (Cruciferae): Genetic divergence and gene flow in serpentine endemics. *American Journal of Botany* 81: 1288-1299. • Hybridization and introgression I	Briggs & Walters, 1997; Grant, 1981.
	Lab	Verification of amplification products. Gel electrophoresis.	
6	Feb. 15/17/19		
	Lecture	• Hybridization and introgression II –historical processes - refugia • Discussion Rieseberg, et al. 2003. Major ecological transitions in wild sunflowers facilitated by hybridization. *Science* 301: 1211-1216. • Key innovations	
	Lab	Compile/align DNA sequence data; using GenBank data	
7	Feb. 22/24/26		
	Lecture	• Wrap-up	

		• In-class review **Midterm Exam**	
	Lab	Molecular phylogenetic analysis	
8	Mar. 1/3/5		
	Lecture	• Radiations – adaptive and non-adaptive I • Discussion Hughes, C. and R. Eastwood. 2006. Island radiation on a continental scale: exceptional rates of plant diversification after uplift of the Andes. *Proceedings of the National Academy of the United States* 103: 10334-10339. • Radiations – Island evolution	Rundell, R. J. and T. D. Price, 2009.
	Lab	Intro to plant chromosome studies – manual root tip squashes.	
9		**Spring Break**	
10	Mar. 15/17/19		
	Lecture	• Polyploidy • Discussion Soltis, D. E. et al. 2004. Recent and recurrent polyploidy in *Tragopogon* (Asteraceae): cytogenetic, genomic and genetic comparisons. *Biological Journal of the Linnean Society* 82: 485-501. • Polyploidy II	Briggs & Walters, 1997; Stebbins, 1971.
	Lab	Flow cytometry in *G. coulteri*	
11	Mar. 22/24/26		
	Lecture	**First draft of term paper due – Mon. Mar. 22.** • Student lecture • Student lecture • Student lecture	
	Lab	Flow cytometry in *G. coulteri*	
12	Mar. 29/31/Apr. 2		
	Lecture	• Student lecture • Student lecture • Student lecture	
	Lab	Flow cytometry in *G. coulteri*	
13	Apr. 5/7/9		
	Lecture	• Student lecture • Student lecture • Student lecture	
	Lab	Morphometric analysis in *G. coulteri*	
14	Apr. 12/14/16		
	Lecture	**Final version of term paper due – Fri. Apr. 16** • Student lecture • Application of evolutionary theory to plant conservation • Discussion Newman, D. and D. Pilson. 1997. Increased probability of extinction due to decreased genetic effective population size: experimental populations of *Clarkia pulchella*. *Evolution* 51: 354-362.	
	Lab	Morphometric analysis in *G. coulteri*	
15	Apr. 19/21/23		
	Lecture	• Evolution, plant introductions, and genetic engineering • Discussion	

		Zalapa, J. E., J. Brunet and R. P. Guries. 2009. Patterns of hybridization and introgression between invasive *Ulmus pumila* (Ulmaceae) and native *U. rubra*. *American Journal of Botany* 96: 1116-1128. • Wrap-up	
	Lab	Final analysis of *G. coulteri* data	
16	Apr. 26 (Monday)	**Final Exam 9:45 – 11:45 a.m.**	

Supplemental Reading Sources (Articles or relevant book chapters will be provided in .pdf form on Moodle)

- Briggs, D. and S. M. Walters. 1997. Plant Variation and Evolution, 3rd edition. Cambridge University Press, Cambridge.
- Charlesworth, D. 2006. Evolution of plant breeding systems. *Current Biology* 16: R726-R735.
- Freeman, S. and J. C Herron. 2001. Evolutionary Analysis, 2nd edition. Prentice Hall, Upper Saddle River, New Jersey.
- Grant, V. 1981. Plant Speciation, 2nd edition. Columbia University Press, New York.
- Rundell, R. J. and T. D. Price. 2009. Adaptive radiation, nonadaptive radiation, ecological speciation and nonecological speciation. *Trends in Ecology and Evolution* 24: 394-399.
- Stebbins, G.L. 1971. Chromosomal Evolution in Higher Plants. Edward Arnold, London.