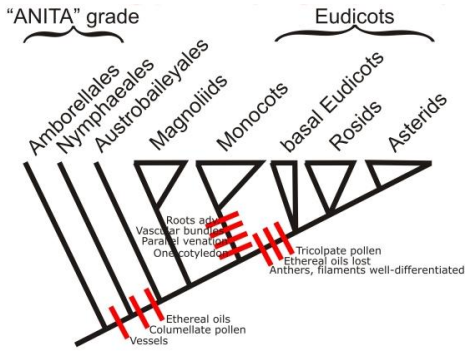
Biology 302 – Systematic Botany
CRN – 20553
Credit Hours: 4
Fall 2014



Instructor
Dr. Ross A. McCauley
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Webpage: http://faculty.fortlewis.edu/mccauley_r/index.html
Office hours: TR 11:15 am – 12:10 pm, MR 1:25 – 3:25 pm and by appointment

Outside of office hours the best way to contact me is via email. I will respond to your email within 24 hours. I do not carry around a smart phone or remain in constant email contact so do not expect an immediate response.

Course information
Meeting time and place: Lecture MWF 12:20-1:15 pm, 440 Berndt; Lab W 1:25-4:30 pm., 440 Berndt Hall

Course Description
This course provides an introduction to the principles and practice of contemporary plant systematics. The goals of this course are principally two-fold: 1) Introducing the principles and methodology of modern plant systematics, and 2) Learning the basics of plant identification and gaining a familiarity with important temperate vascular plant families.

Objectives

1. Be able to use the proper terminology for vegetative and reproductive features that are used in the identification of vascular plants.
2. Learn how to use published keys for the identification of flowering plants.
3. Learn to recognize some common plant families of SW Colorado.
4. Learn to use the proper scientific names for plant groups.
5. Gain an understanding of the relationships between evolutionary history and plant classifications.
6. Demonstrate basic knowledge and skill in using bioinformatics associated with biodiversity research.
7. Develop an ability to interpret research findings in Systematic Botany and understand how those findings contribute to the changes seen in nomenclature, the botanical classification systems, and for understanding evolutionary patterns.
8. Learn how to utilize the basic research methods used in modern systematic biology.

Prerequisites: BIO 206 (General Botany), BIO 260 (Genetics) (Minimum grade of C-)

Required texts:

- Ackerfield, J. 2013. The Flora of Colorado. Colorado State University Herbarium, Fort Collins, CO. (Pre-press manuscript – available for $34 at start of class)
- Harris, J. G. and M. W. Harris. 2001. Plant Identification Terminology, 2nd edition, Spring Lake Publishing, Spring Lake, UT. ISBN: 978-0-96402-216-4
- Simpson, M. G. 2010. Plant Systematics, 2nd Edition. Elsevier Inc, Burlington MA.. ISBN: 978-0-12-374380-0

Course Websites:

- Canvas: I will use Canvas as a repository for any lecture material, pertinent lab materials, review sheets and links to web-based tools, Herbarium databases, and image sites to assist with your learning of Systematic Botany.
- SEINet (Southwest Environmental Information Network): This is a tremendous resource for plant systematic data. I will be uploading an interactive checklist to accompany our development of the Flora of the FLC Campus which will be important for you to follow. This will be available under the "Teaching Checklists" option on the home page (http://swbiodiversity.org). The "Flash Card Quiz" under the

"Games" option is a great way to study plant recognition and your will help with your review of required taxa.

Course Evaluation
Grades will be determined through a mix of tests, quizzes, and assignments and will be distributed very ***roughly*** as:

Quizzes	6%
First lecture exam	16%
Final exam	16%
Practical/Diversity exam	16%
Campus flora project	20%
Independent research project	16%
Other assignments	10%

Your grade will mostly be a sum of the earned points you have accrued throughout the semester. There will be NO make-up quizzes for any circumstance. There will also be NO make up for the practical exam. If you miss another exam for a legitimate reason the score on the final exam will be substituted for the missed exam score. 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. If you miss for an illegitimate reason then, well, sorry.

Grading Scale by %

A	94-100	C+	77-79
A-	90-93	C-	70-72
B+	87-89	D+	67-69
B	83-86	D	63-66
B-	80-82	D-	60-62
C	73-76	F	0-59

The above grading scale will be followed however I will round your final percentage depending upon your class attendance.

Course Structure and Specific Requirements
Lecture:
Lecture will initially focus on learning plant identification and the tools to assist with identification and documentation including proper collection methods, nomenclature, and herbaria. Much of this will be in conjunction with our class project to document the flora of the natural areas of the FLC campus. We will then focus on a survey of diversity in the plant kingdom. This will start with a review of pertinent patterns in the Bryophytes, Pteridophytes, and Gymnosperms, much of which should be a review from General Botany. We will then proceed through the Angiosperm learning slected important families as we go. Following this we will shift to completing some exercises in analysis of systematic data and the development of your independent research projects.

Lab:
Lab will be used for a variety of functions. Most lab time will be used for our completion of the Campus Flora Project and your independent research projects. Lab is extremely important for your success in this class. Much of Systematic Botany, particularly learning to key and recognition of plant groups is best done in a hands-on manner and there is no replacing this hands-on time with plants with any other form of learning.

Specific Requirements
Keying Quizzes: We will have four quizzes in which you use your flora to determine an unknown specimen to species. These quizzes will be held at the beginning of a laboratory period. While I hope that you will all determine the correct species I will award partial credit for the correct family and/or genus determinations. To earn either full or partial credit on a keying quiz you must write out the number of each couplet you take starting with the Key to Families and ending with the specific epithet. If you're not sure what this means now you will very soon.

Exams: We will have three exams during the semester. Two of these will be a standard Midterm and Final based principally on the lecture material. These exams will be a mix of multiple choice, short answer, essay and case study type

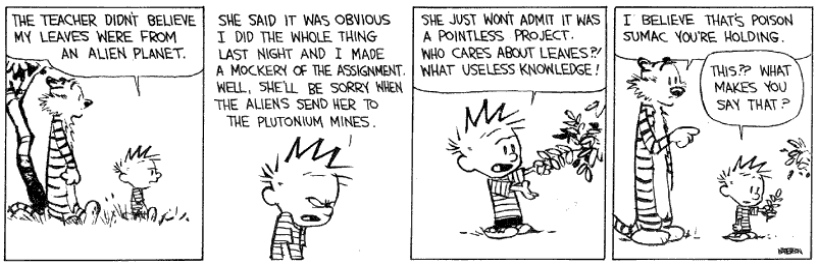
questions. The other exam (scheduled near mid-term) will be a combined written/practical based on our survey of Angiosperm diversity which will require your interpretation of specimens (either fresh, frozen, or herbarium).

Nomenclature Homework: This assignment will review pertinent concepts in plant naming following the International Code of Botanical Nomenclature (ICBN) including Latin name formation, author citation, synonymy, priority of publication, typification, diagnosis, etc.

Herbarium Database Homework: The availability of biodiversity information in electronic format is changing the way that scientists and resource managers use systematic data. This assignment will show you the types of information available and have you practice with specific applications of this data.

Plant Phylogenetic Exercises: During the last five weeks of the semester we will work on two exercises to understand the practical aspects of phylogeny reconstruction. One will use an imaginary group of plants in the imaginary family Dendrogrammaceae. We will use these "plants" to complete a morphological phylogenetic analysis. We will then use previously published molecular data to generate a phylogeny of the plant kingdom and then analyze the placement of specific important morphological traits. These will likely be completed during class time although their final write ups may require some homework time.

Campus Flora Project:



This class project will attempt to identify the naturally occurring flora of the FLC campus. You will need to survey various natural areas on campus and collect proper voucher specimens. These will then need to be identified. Once identified, these species will then be included on a master list of the flora. Following field work additional taxa will be identified using specimens previously collected and filed in the herbarium. Once a final list is generated students will take individual plant families and write up a short treatment which will allow future students to quickly determine the name of an unknown plant encountered on campus. These treatments will follow a standard format and will be compiled into a single document at the end of the project.

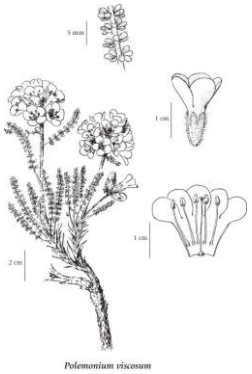
This project will give you extensive experience collecting plants, using taxonomic keys, and determining unknowns from limited material. It will also give you experience in the use of herbarium data. Your grade on this project will be based on the quality of your collected specimens, accuracy of your identification, and quality of your final

Independent Research Project:

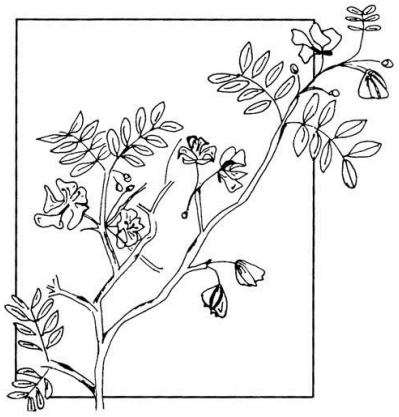
You will need to complete an original research project in systematics in a small group of 2-3 students. The following are some potential research projects which could be undertaken. If you have another feasible idea for research you may propose that. Due to limitations in time and resources, most research projects will use herbarium material or data currently available. We do not have the funding or time in this course to generate novel molecular systematic data or investigate reproductive biology.

<u>Potential projects</u>

1) Consistent segregation of *Mertensia* (Boraginaceae) species in SW Colorado.
Two species of *Mertensia* are common in the San Juan Mountains, *M. franciscana* and *M. ciliata*. While in theory these two species are distinguishable based on differences in leaf vestiture, in practice they are very difficult to distinguish and specimens in our herbarium collection are likely misassigned. This project would examine the literature to identify useful characters and then perform a detailed analysis of the specimens in the FLC herbarium to determine the consistent circumscription of these taxa in the area.

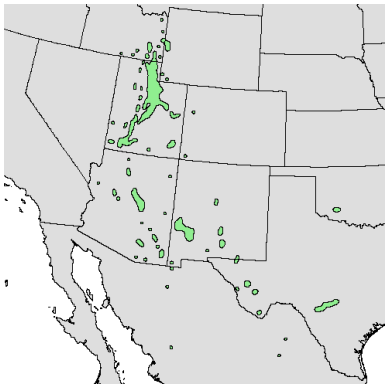


2) Consistent segregation of alpine *Polemonium* (Polemoniaceae)
Two species of *Polemonium*, *P. viscosum* and *P. confertum* supposedly inhabit the alpine areas of the San Juans. They are distinguished based on anther color and floral tube shape. There has been disagreement about the proper circumscription of these taxa, and some discussion that they may actually represent one variable taxon. Much like the *Mertensia* project this project would survey the literature and examine specimens from the FLC herbarium for consistent identifying features.



3) Leaf micromorphology of *Guiacum coulteri* (Zygophyllaceae) from western Mexico
This is an extension of a project I have been working on for some time. *Guiacum coulteri* is a species of hardwood tree native to the subtropical dry forest of western Mexico extending from Oaxaca in the south to Sonora in the north. A number of years ago I completed a conservation genetic and biogeographic study of the species. One thing this study turned up was a potential variation in chromosome number and genome size. While not visibly observed in the plant phenotype often these differences can be exhibited in micromorphological characters, particularly the length of the stomatal openings. This project would utilize herbarium collections I made from approximately 40 different populations. Leaf peels would be made from the specimens and analyzed under light microscopy. Pore size would be determined and then compared statistically for significant differences.

4) Community phylogeny of the FLC campus flora.
As an extension of the Campus Flora Project a molecular phylogeny of the species comprising the flora could be compiled. Many of the species likely have gene data already in Genbank for either the rbcL or ITS genes. This project would involve the generation of a large dataset from the publically available data followed by phylogenetic analysis. The phylogeny could give insights into the development of functional traits, life histories etc.



5) *Acer grandidentatum* (Sapindaceae)
This species of maple exhibits a discontinuous distribution extending from northern Mexico to SE Idaho. It occurs in mountain islands and likely represents a species which was more widespread at sometime in the past which has had its range reduced due to climatic changes.

a) The first project can look at morphological variation across the range of the species using geometric morphometrics. This technique measures specific structures and compares the shape of those structures across sampled individuals. This is well worked out for maples. Our herbarium has very little material of this species but with recent efforts to digitize herbarium collections we can use hi-resolution images of herbarium sheets from other herbaria. Measurements can be made on digital images using the program imageJ and transferred to a spreadsheet for analysis.

b) The second project involves the generation of an ecololgical niche model (ENM) for the species. This is particularly suited to a student with extensive GIS experience. ENMs seek to model the potential distribution based on a set of determining ecological factors. Once the parameters are set these models can then be used with historical climate data to estimate the species range in the past and with future climate models to model the future

distribution. This project would draw significantly on databased specimen data available from on-line databases including SEINet, iDigBio, and GBIF. Some georeferencing of these specimens might be necessary.

These are just a few ideas I had but you are also welcome to develop another idea based on plants you may know. For ideas and ways of approaching botanical research see http://www.botany.org/botany-without-borders.php (Contains video excerpts of research talks at the annual Botanical Society of America meetings. The poster interviews are the most useful)

Other Course policies

Academic Integrity: The Biology Department upholds College policy on Academic Integrity. Therefore, students who commit acts of academic dishonesty (a.k.a. cheating, copying, plagiarizing):

1) on homework or other less major assignments, will receive a ZERO on the assignment in question, and will be reported to Academic Affairs.

2) on exams, major papers or reports will earn a ZERO and be automatically removed from the COURSE, and will be reported to Academic Affairs.

Any student who accumulates two reported incidents of dishonesty with the Academic Affairs office will have a formal hearing with the Academic Standards Committee and faces academic dismissal from the College.

Attendance: While I do not take a daily role, regular attendance is expected – particularly if you want to do well. For much of the material in this class it is imperative that you view and work with specimens. No amount of book reading or reviewing lectures will help you with learning how to identify and recognize plant groups – only hands on practice will do that. If you know you are going to miss class please let me know beforehand. If your absence results in your missing a quiz or exam, and is legitimate, the aforementioned policy stands.

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 mobile phones, pagers, iPods, etc, at home or turn them off and keep them stowed during class. I will not allow texting or checking of messages on any electronic device during class time. If this becomes a problem you will be asked to forfeit your device. Such activity is not only very disrespectful but also interferes with your ability to learn. In labs FLC health and safety policies prohibit any food and beverage. Thus DO NOT bring any food or drink to lab. If you do you will be asked to finish it in the hall before coming back to class. I am aware that our lecture meeting time in a laboratory occurs during lunch for most people and thus this may be inconvenient. For this class you will have to eat either before or after class.

Add/Drop policy:

The last day to add the class is census date. Prior to this date you my drop the course at anytime with no grade being recorded. College policy states that not attending the first two class meetings will result in automatic disenrollment.

The last day to withdraw from FLC classes with a grade of "CW" (course withdrawal) is 4 pm Friday, October 24, 2014. This is a college-wide deadline that is not negotiable.

To withdraw from this course, go to the Registrar's Office, Room 160, Miller Student Services Building before the course withdrawal deadline. They will help you through the process. You do not need my signature on the course withdrawal request form.

Starting Fall 2013, students have a life-time limit of three individual course withdrawals from FLC courses. If you have withdrawn from classes before Fall 2013, these will not count towards your lifetime limit. Also, withdrawing entirely from a semester (all classes) does not count against your lifetime "CW" limit. Semester withdrawal is handled under a different policy and procedure. Please refer to the Academic Policies section of the Fort Lewis College Catalog of Courses for more information about course and semester withdrawal policies and procedures.

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

Readings are indicated as:

Harrington: Harrington, H. D. 1977. How to identify grasses and grasslike plants. (In course pack)
Simpson, M. G. 2010. Plant Systematics, 2nd Edition.
Baum & Smith = Baum, D. A. and S. D. Smith. 2013. Tree Thinking: an introduction to phylogenetic biology. Roberts and Company Publishers, Inc., Greenwood Village, CO. (PDF format on Canvas)

Wk	Date	Topics/Assignments	Reading
Fundamentals of Systematics and Taxonomy			
1	Sept. 1/3/5		
	Lecture	M: Introduction: Course Overview. What is Systematic Botany? W: Scavenger hunt – plant morphology review F: Plant morphology I: Description of vegetative variation	Simpson: Chap. 1, 15, Appendix 1
	Lab	Introduction to keying - Identification of woody plants in the mountain shrubland community Plant Collection/Documentation Techniques	Simpson: Chap. 17
2	Sept. 8/10/12		
	Lecture	M: No class – Dr. M. has Jury Duty W: Plant morphology II: Description of floral and fruit characters F: Plant morphology II: Description of floral and fruit characters cont.	Simpson: Appendix 1, Chap.18
	Lab	Collection and Keying – Campus flora	
3	Sept. 15/17/19		
	Lecture	M: Herbaria and tour of FLC Herbarium W: Herbarium data information systems **Herbarium Database Homework** F: Botanical Nomenclature (ICBN)	Simpson Chap. 18, 16
	Lab	Collection and Keying – Campus flora	
4	Sept. 22/23/26		
	Lecture	M: Naming/describing species **Nomenclature Homework** W/F: Basic Phylogenetic Principles/ Intro to Vascular Plant Phylogeny	Simpson Chap. 16, 2 (skim) Baum & Smith Chap. 3 (part)
	Lab	**Keying Quiz #1** Collection and Keying – Campus flora	
Evolution and Diversity			
5	Sept. 29/Oct. 1/3		
	Lecture	**M: Exam 1** W/F: Review of land plant evolution (Bryophyta → Coniferophyta)	Simpson Chap. 3, 4, 5, 6 (skim)
	Lab	**Keying Quiz #2** Keying grasses (Poaceae)	Harrington Chap. 1-4
6	Oct. 6/8/10		
	Lecture	M: Basal Angiosperms (ANITA) and Magnoliids W/F: Monocots	Simpson Chap. 7
	Lab	**Keying Quiz #3** Keying sedges/rushes (Cyperaceae/Juncaceae)	Harrington Chap. 6 &7
7	Oct. 13/15/17		
	Lecture	M: Eudicots - Basal groups W/F: Rosids	Simpson Chap. 8

	Lab	**Keying Quiz #4** Finish work on campus flora – Applying analysis of floristic quality, coefficient of conservatism	
8	Oct. 20/22/24		
	Lecture	M: Rosids W: Asterids: Basal Groups F: Caryophyllid Clade	Simpson Chap. 8
	Lab	Finish work on campus flora	
9	Oct. 27/29/31		
	Lecture	M/W/F: Euasterids	Simpson Chap. 8
	Lab	Finish work on campus flora	
10	Nov. 3/5/7		
	Lecture	M: Wrap-up & Review **W: Exam II** F: Identifying and analyzing systematic problems	
	Lab	**Practical Exam**	
Systematic Analysis			
11	Nov. 10/12/14		
	Lecture	M: Phylogenetic reconstruction (Dendrogrammaceae I – morphological exercise) **Turn in proposal for independent research** W: Extended lab time F: Phylogenetic reconstruction exercise cont.	
	Lab	Start Independent research	
12	Nov. 17/19/21		
	Lecture	M: Molecular data in systematics W: Extended lab time F: Molecular systematics	Simpson Chap. 14
	Lab	Independent research	
Thanksgiving Break!			
14	Dec. 1/3/5		
	Lecture	M: Molecular phylogeny of land plant evolution exercise W: Extended lab time F: Molecular phylogeny of land plant evolution exercise cont.	
	Lab	Independent research	
15	Dec. 8/10/12		
	Lecture	M: Dr. M research presentation W: Student Research Presentations F: Student Research Presentations **Research Project Report Due**	
	Lab	Student Research Presentations	
16	Dec. 15	**Final Exam 9:45 – 11:45 a.m**	