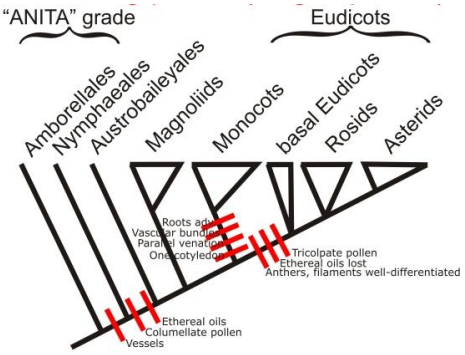
Biology 302 – Systematic Botany
Fall 2013



Instructor information
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Webpage: http://faculty.fortlewis.edu/mccauley_r/index.html
Office hours: R 10:10 a.m. – 12:10 p.m., T 12:20 p.m. – 1:15 p.m., MTR 1:25 p.m. – 2:20 p.m.

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
Required texts:

- 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
- Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens and M. J. Donoghue. 2008. Plant Systematics: A Phylogenetic Approach, 3rd Edition. Sinauer Associates, Inc., Sunderland, MA. ISBN: 978-0-87893-407-2
- Weber, W. A. and R. C. Wittmann. 2012. Colorado Flora: Western Slope, 4th edition. University Press of Colorado, Boulder, CO. ISBN: 978-1-60732-142-2

Course Website: http://moodle.fortlewis.edu
I will provide on Moodle copies of material from all lectures, pertinent lab materials, review sheets and links to web-based tools, Herbarium databases, and image sites to assist with your learning of Systematic Botany.

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

Course Description
This course provides an introduction to the principles and practice of contemporary plant systematics. The goals of this course are principally three-fold: 1) Introducing the principles and methodology of modern plant systematics, including phylogenetics, classification, and molecular systematics, 2) Learning the basics of plant identification and gaining a familiarity with important temperate vascular plant families in SW Colorado and, 3) Surveying the patterns and processes of speciation in modern plant groups.

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 and evolutionary biology.
9. Understand the life history and reproductive traits of plants which contribute to or limit gene exchange leading to plant speciation.

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

Quizzes	6%
First lecture exam	16%
Final lecture exam	16%
Practical/Diversity exam	16%
Plant collection	10%
Class Project participation/Short Report	16%
Other assignments	20%

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.

Expected prerequisite and background knowledge
Systematic Botany is an extension of some of the material you learned in General Botany. Due to that fact I will not take time to review specific concepts covered in General Botany. Be sure that you remember and understand the following concepts. Review your General Botany lecture and lab materials if you are not sure.

- General phylogenetic placement and broad characteristics of major plant groups including Lycophytes, Ferns, Gymnosperms, and Angiosperms.
- Flower structure – sepals, petals, stamens, carpels, zygomorphic, actinomorphic, hypogynous, epigynous. Be sure you know the difference between simple and compound ovaries and how to determine carpel number. Know the difference between ray (ligulate) and disc flowers in the heads of Asteraceae. Be able to differentiate dicots and monocots on basic floral structure.
- Vegetative features – be sure you understand phylotaxy, simple vs. compound leaves, stipules, basic venation patterns and leaf structure.

Lecture:
Lecture will initially focus on learning the terminology of traditional systematics, how to apply this to keys, nomenclature, and the history and development of different types of classifications. We will then focus on a survey of Angiosperm family diversity with families presented in a phylogenetic order covering their basic biology, evolutionary relationships, and identification. Following this we will shift to work in modern systematics including cladistics, phylogenetics, molecular systematics, and devote lecture time toward analyses required for completing our semester project (See below). We will also survey some of the patterns and processes involved in plant speciation.

Lab:
Lab will be used for a variety of functions. We will spend some time learning how to use published botanical keys, some time learning to recognize important temperate plant families and we will use that time for collecting data for our class research project (See below). 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 lab material and will require your sight identification of specimens (either fresh, frozen, or herbarium) to family.

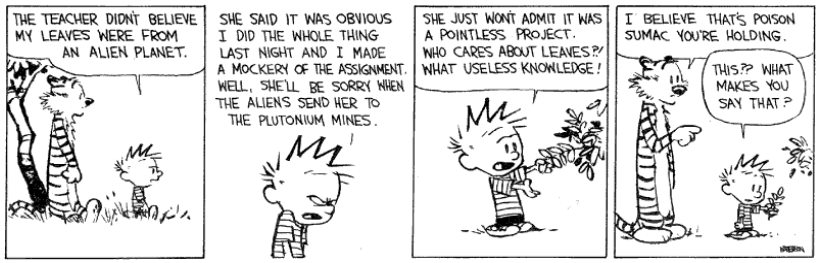
Nomenclature Homework: This assignment will review pertinent concepts in plant naming following the International Code of Botanical Nomenclature (ICBN) including Latin name formation, author citation, synonymy, priority of publication, typification, diagnosis, etc.

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.

Dendrogrammaceae Exercises: We will work during the last five weeks of the semester with an imaginary group of plants in the imaginary family Dendrogrammaceae. We will use these "plants" to help learn important aspects of systematic analysis. There will be three separate assignments using these, a morphological phylogenetic analysis, an exercise in molecular systematics/phylogenetics, and an exercise in inferring patterns of speciation. These will likely be completed during class time although their final write ups may require some homework time.

Plant Collection: The plant collection is designed to give you experience collecting, identifying, and documenting plant diversity. You will be required to collect a total of 10 different specimens. Due dates for this assignment will be as follows:

September 30, all plants must be pressed and dried (identification at this point not required)
October 14, final collection with full identification and label documentation



The plant collection must include 10 identified and labeled specimens representing different species (or infraspecific taxa). All specimens must be labeled with complete collection information (collector's name, collection number, family, genus, species, author citation, collection date, locality, and any additional information regarding ecology or plant form) and corresponding to the format used in the FLC Herbarium (I will provide a Word template to assist you with making your labels). When specimens are due they should be turned in with each specimen in folded newspaper inside of a large folder (available in the herbarium).

Things to keep in mind

- Your plants must be wild-collected and can come from any geographical location or environment. We have many keying resources available in the lab/herbarium for plant identification from different areas of North America.
- You cannot collect cultivated garden plants - they must be a part of the native flora!
- In making the collection you must remain aware of where you can legally collect and ask permission if necessary.
- You should complete a Plant Collection Worksheet (available on Moodle) for each specimen which will assist you in completing your final specimen label.
- You will be able to sign out a plant press and GPS to assist with your collecting (and these must be returned or you will be charged for replacing the equipment!).
- Drying of plants can be performed in the dryer in the herbarium.
- Specimens may be stored in a designated herbarium cabinet during processing and prior to turning in your collection.
- All specimens must include fertile material unless it is not required to make an accurate determination.
- I encourage you to find interesting places to collect – Interesting places = interesting plants.

The collection will be graded in the following manner:

Identification: Specimens will require proper identification. If an identification key other than our Colorado Flora is used for taxon identification, be sure to let me know via a note.
Specimen quality: Full credit will not be awarded to poor specimens.
Label data: Your labels must be complete. All units, including elevation, must be in metric (Hint: – if using a GPS unit just set it for metric units). The only English unit I will accept will be miles (ex. "5 miles West on Forest Rd. 200") You may use either Latitude/Longitude or UTM for giving coordinates. Be sure to include the datum used.
Specific taxa: All your taxa should be Angiosperms (no Pteridophytes or Gymnosperms). Your total collection will be required to have at least two specimens from the family Asteraceae and a minimum of one monocot specimen.

Class Project: We will work as a class the later part of the semester to understand the relationship of the species *Ipomopsis ramosa* (Polemoniaceae) within the genus and try to infer the processes that gave rise to it. The species is endemic to the Roaring Fork Canyon about 20 miles NE of Dolores, CO. It seems to be related to the common widespread *I. aggregata* although it is significantly different in terms of morphology, particularly flower color and floral tube architecture. We will be extracting DNA from the species and comparing it for two gene regions with a previously published phylogeny of *Ipomopsis* to infer the phylogenetic placement of this new species. We will also examine aspects of pollen viability and chromosome number to test the hypotheses of an origin through hybridization and/or polyploidy.

We will work on this project as a total group with students all participating in all aspects of analysis. At the end you will provide a short laboratory report describing our work and detail any conclusions. I'll provide more specifics on this later.

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 25, 2013. 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:
W&W = Weber, W. A. and R. C. Wittmann. 2012. Colorado Flora: Western Slope, 4th edition. University Press of Colorado, Boulder, CO.
Judd = Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens and M. J. Donoghue. 2008. Plant Systematics: A Phylogenetic Approach, 3rd Edition. Sinauer Associates, Inc., Sunderland, MA.
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 Moodle)

Wk	Date	Topics/Assignments	Reading
Fundamentals of Systematics and Taxonomy			
1	Sept. 2/4/6		
	Lecture	M: Introduction: Course Overview; What is Systematic Botany? W: Plant identification: Botanical key organization F: Plant morphology I: Variation of vegetative characters	W&W Intro Judd Chap. 1; Appendix 2; Chap. 4
	Lab	Identification of woody plants – Outside on Campus Plant Collection/Documentation Techniques	
2	Sept. 9/11/13		
	Lecture	M: Plant morphology II: Variation of floral and fruit characters W: Plant morphology II: Variation of floral and fruit characters cont. F: Herbaria and data information systems, herbarium tour **Herbarium Database Homework**	Judd Chap. 4; Appendix 2
	Lab	Group keying of flowering plant specimens	
3	Sept. 16/18/20		
	Lecture	M: History of Systematics/ Classification W: What's in a name?: Botanical Nomenclature (ICBN) F: Naming/describing species **Nomenclature Homework**	Judd Chap. 3; Appendix 1
	Lab	Continued keying practice	
4	Sept. 23/25/27		
	Lecture	M: Basic Phylogenetic Principles/ Intro to Vascular Plant Phylogeny W: Wrap-up & Review **F: Exam 1**	Baum & Smith Chap. 3 (part)
	Lab	**Keying Quiz #1** Continued keying practice – Intro to keying grasses	
Survey of Angiosperm Diversity			
5	Sept. 30/Oct. 2/4		
	Lecture	M: Basal Angiosperms (ANITA) and Magnoliids **Plant Collection First Deadline** W: Basal Eudicots F: Rosids I	Judd Chap. 9
	Lab	**Keying Quiz #2** Basal Angiosperms, Magnoliids, and Basal Eudicots	
6	Oct. 7/9/11		
	Lecture	M: Rosids I continued W: Rosids II F: Asterids: Basal Groups and Caryophyllid Clade	Judd Chap. 9
	Lab	**Keying Quiz #3** Rosids	

7	Oct. 14/16/18		
	Lecture	M: Euasterids I **Plant Collection Second Deadline** W: Euasterids II F: Monocots	Judd Chap. 9
	Lab	**Keying Quiz #4** Asterids: Basal Groups, Caryophyllid Clade and Euasterids	
8	Oct. 21/23/25		
	Lecture	M: Monocots W: Monocots F: Wrap-up & Review	Judd Chap. 9
	Lab	Monocots	
9	Oct. 28/30/Nov. 1		
	Lecture	M: In class review **W: Exam II** F: Introduction to *Ipomopsis* and Studies of Speciation	
	Lab	**Practical Exam**	
Systematic Analysis of Plant Speciation			
10	Nov. 4/6/8		
	Lecture	M: Molecular Systematics W: Extended lab time F: Phylogenetic reconstruction (Dendrogrammaceae I – morphological exercise)	Judd Chap. 5; 2
	Lab	DNA extraction and PCR amplification (ITS & trn*L-F*)	
11	Nov. 11/13/15		
	Lecture	M: Phylogenetic reconstruction exercise cont. W: Extended lab time F: Molecular phylogenetic reconstruction (Dendrogrammaceae II) (complete for homework)	
	Lab	PCR product visualization, Prep reactions for sequence analysis – Download GenBank data on *Ipomopsis*	
12	Nov. 18/20/22		
	Lecture	M: Plant breeding systems W: Extended lab time F: Isolation mechanisms	Judd Chap. 6
	Lab	Analyze *Ipomopsis* ITS & trn*L-F* data. Work on pollen stainability and somatic chromosome study	
Thanksgiving Break!			
14	Dec. 2/4/6		
	Lecture	M: Speciation models; Hybridization and introgression W: Polyploidy F: Dendrogrammaceae III – Speciation patterns	Judd Chap. 6
	Lab	Continue *Ipomopsis* data analysis.	
15	Dec. 9/11/13		
	Lecture	***Dr. M. at NSF-IDigBio meeting, Tallahassee, FL (M-Th.)*** M &W: No class F: Wrap-up and review **Final Project Lab Report Due**	
	Lab	No Lab	
16	Dec. 16	**Final Exam 9:45 – 11:45 a.m**	