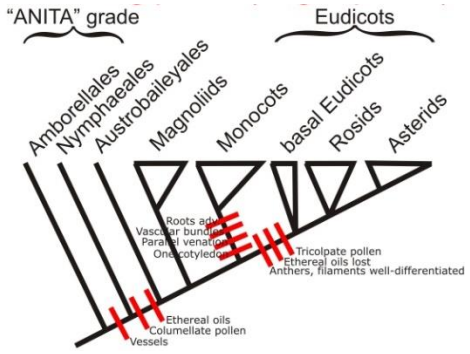
Biology 302 – Systematic Botany
CRN – 20505
Credit Hours: 4
Fall 2015



Instructor
Dr. Ross A. McCauley
Office: 447 Berndt Hall
Office phone: 970-247-7338
E-mail: mccauley_r@fortlewis.edu
Webpage: http://faculty.fortlewis.edu/mccauley_r/index.html
Office hours: M 9:00 AM – 12:10 PM; Th 11:15 AM – 12:10 PM; F 10:10 AM – 12:10 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/Lab TR 8:00-11:05 AM, 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.

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

Course 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.

Biology Program Learning Outcomes
1. Biology graduates will be able to explain key principles, assumptions, and criticisms of evolutionary theory and natural selection.
2. Biology graduates will be able to explain the relationship between form, function, and organization across biological systems.
3. Biology graduates will be able to effectively use laboratory and field techniques relevant to their area of specialization.
4. Biology graduates will be able to manage, explore, and analyze biological data.
5. Biology graduates will be able to read and interpret primary literature in the biological sciences in their area of specialization.
6. Biology graduates will be able to design, implement, and communicate an original research project in the biological sciences under the supervision of a faculty member.

Credit Hour Statement
One credit hour is equivalent to one hour of guided instruction (50 minute class) and a minimum of two hours of out-of-class student work each week for approximately 15 weeks for one semester. The typical student in this 4 credit course

should expect to spend at least 8 hours per week of concentrated attention on course-related work, including but not limited to time attending class, as well as out-of-class time spent reading, reviewing, organizing notes, preparing for upcoming quizzes/ exams, problem solving, developing and completing projects, and other activities that enhance learning.

Required texts

- Ackerfield, J. 2015. Flora of Colorado. Botanical Research Institute of Texas, Fort Worth, TX. ISBN: 978-1-889878-45-4.
- 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. This site hosts an interactive checklist of the Flora of the FLC Campus which will be an important resource for you. To access select the "Flora Projects" tab; under this select "Teaching Checklists"; in this listing select "Fort Lewis College Flora Project." An alternative is the direct link to the list: http://swbiodiversity.org/seinet/checklists/checklist.php?cl=3387&pid=4

Course Evaluation

Grades will be determined through a mix of tests, quizzes, and assignments and will ***roughly*** follow the point system below:

Keying Quizzes	10 pts each x 4	40 pts
Family ID Quizzes	10 pts each x 4	40 pts
First lecture exam		100 pts
Final exam		150 pts
Nomenclature Homework		20 pts
Herbarium Database Homework		20 pts
Plant Collection		100 pts
Group research project/Presentation		100 pts
Other assignments		~50 pts

Your grade will be a sum of the earned points you have accrued throughout the semester. Late submitted work will be subject to a penalty of 10% per day late, with a 0 for a week or later OR turning in after the instructor has already graded and returned the assignment to the rest of the class.

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.

Attendance Policy

While I do not take a daily role I expect you to attend all class meetings. If you know you are going to miss class please let me know beforehand. There will be NO make-up for quizzes or the class presentation for any circumstance. If you

miss another assignment or exam for a legitimate reason (absence with a letter documenting that absence from the appropriate college official, be a documented medical excuse, or be a documented religious observance) I will allow for a make-up of that assignment within a one-week time period. If you miss for an illegitimate reason then, well, sorry.

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.

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 leave or forfeit your device. Such activity is not only very disrespectful but also interferes with your ability to learn. Since our class meets in a laboratory 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. It also prohibits the wearing of open-toed shoes. Make sure to wear closed-toe shoes for all class meetings. (See Biology Laboratory Safety Rules and Procedures below)

Add/Drop policy
The last day to add the class is census date, Tuesday September 15 at 4:00 PM. 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 4:00 PM Friday, October 23. 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.

Course Structure
This class combines lecture and lab together into two three hour blocks per week. Much of what we will be doing this term in Plant Systematics involves limited lecture presented theory and more time performing analyses or making observations. The first two weeks of the class will be entirely focused on teaching you the basics of technical plant identification. We will be using the Flora of Fort Lewis with the addition of some preserved specimens to do this. During these two weeks expect to spend much of the class time outdoors, so dress appropriately. The next three weeks will continue this theme with some continued instruction on keying and coverage of other critical topics in systematics and taxonomy. The second portion of the class will be a collective investigation of a group of local plants which are confusing taxonomically. Working in groups you will apply a variety of systematic techniques to address various questions (See below for more detail). The final part of the course will be a phylogenetic survey of Angiosperm diversity with a focus on learning a select number of plant families important in temperate North America. Course time during this portion of the class will be a mixture of short lecture to present specific characters of the group being examined followed by an activity with living or preserved specimens.

Specific Requirements
Keying Quizzes: We will have four quizzes in which you use your flora to determine an unknown specimen to species. 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.

Family ID Quizzes: We will have four quizzes where you will be given a set of unknown plants for which you will need to identify the plant family without the assistance of a key. *I.e.* these will be sight id only. You will know prior to the quiz which required families could be covered on the quiz. The quizzes will be cumulative meaning that each quiz will cover material from the previous week and the required material from the previous quiz.

Exams: We will have two exams during the semester. The first will be at the end of the first section and will consist of a standard exam covering content and a second portion testing keying. The final will be partially a standard exam covering aspects of Angiosperm diversity, a portion on sight id of plant families, and a portion on keying.

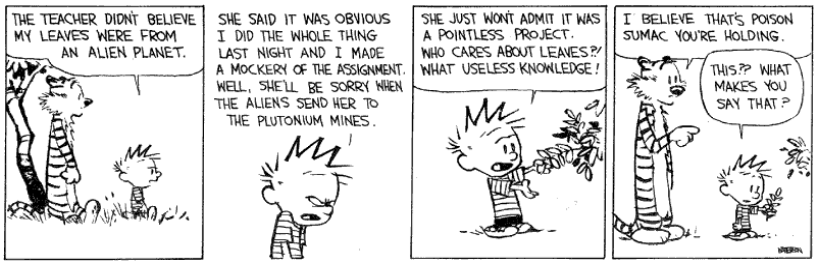
Nomenclature Homework: This assignment will review pertinent concepts in plant naming following the International Code of Botanical Nomenclature (ICBN) including Latin name formation, author citation, synonymy, priority of publication, typification, diagnosis, etc.

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 weeks four and five we will work on two exercises to understand the practical aspects of phylogeny reconstruction. We will use an imaginary group of plants in the imaginary family Dendrogrammaceae. We will use these "plants" to complete both a morphological and molecular phylogenetic analysis. You will need to turn in your generated phylogeny and associated questions for these two small class assignments.

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:

Tuesday September 29, all plants must be pressed and dried (identification at this point not required)
Thursday October 15, final collection with full identification and label documentation



The plant collection must include 10 identified and properly 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. (There is a Word template available on Canvas 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.
- 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.
- Do not collect cacti or any rare or endangered species. If not sure ask me or don't collect.
- You may use a Plant Collection Worksheet (available on Canvas) for each specimen to assist you in gathering the required information for completing your final specimen label.
- You will be able to sign out a plant press, hand clippers, spade and GPS unit to assist with your collecting (These must be returned or you will be charged for their replacement).
- Drying of plants can be performed in the dryer in the herbarium.
- All specimens must include fertile material unless our key does not require it to make an accurate determination.
- Plants must be turned in pressed and dried with each plant in separate folded newspaper. Each specimen must be accompanied by a properly formatted label. This should all be turned in in a large manila folder (available in the herbarium).
- I encourage you to find interesting places to collect – Interesting places = interesting plants.
- And lastly I hope that you will see this assignment as FUN and not work.

The collection will be graded based on the following requirements:

Identification: Specimens will require proper identification.

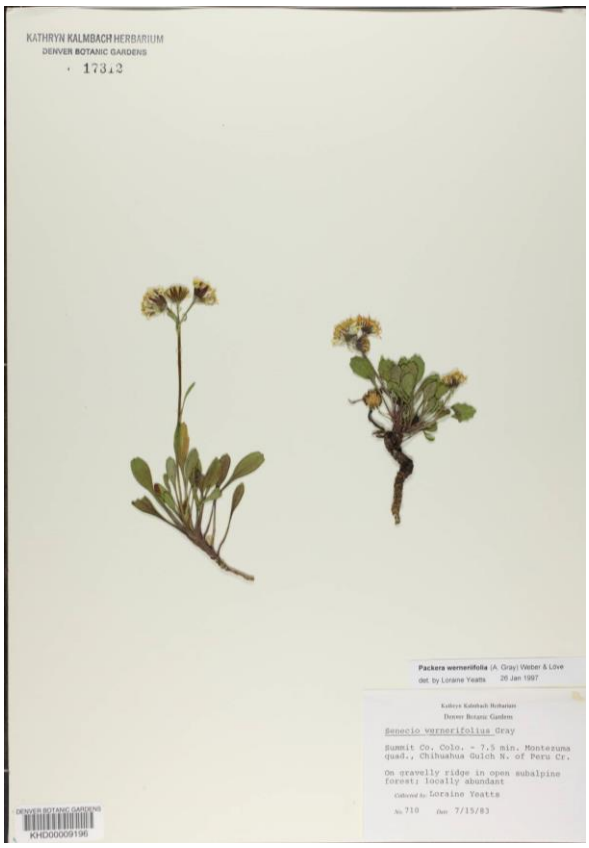
Specimen quality: All specimens must be dry and properly pressed and presented in folded newspaper cut to the proper size of a herbarium specimen.

Label data: Your labels must be complete – follow the Plant Collection Worksheet and sample label on the template for guidance. Metric units should be used for elevation and for describing any size data. The only English unit I will accept will be miles (ex. "5 miles West on Forest Rd. 200") since it is so widely used in the US. You may use either Latitude/Longitude or UTM for giving coordinates. Be sure to include the datum used.

Specific taxa: I will not accept as part of your collection any Gymnosperms unless your collection represents a new county record. You may collect Pteridophytes but you will be limited to one specimen.

Class Research Project: Systematics of *Packera*

This term we will be examining a couple taxonomic questions in local members of the genus *Packera*, a genus of Asteraceae which has typically been very difficult to identify. One specific question will be the validity of the endemic species *Packera mancosana* known from only one location north of Dolores, CO. The distinctiveness of this species could have important conservation ramifications. We will also examine the distinction of *Packera crocata*. This taxon has recently been placed in synonomy with *Packera dimorphophylla* in the most recent taxonomic treatment of Colorado plants however there is evidence that it may be distinct. Lastly we will try to investigate the correct application of the name *Packera werneriifolia*. This widespread species shows a tremendous amount of morphological variation and the application of names to this variation can be tricky. This is particularly true in reference to a common alpine and subalpine form from the local region which appears to not be properly named based on association with the original type material.



Packera werneriifolia

For this project you will work in small research teams to address a single question. Techniques for analysis can range from examination of digitized type material and historic documents, to measurements of morphological features from specimens, to measurements of traits on digitized herbarium specimens, to a molecular phylogenetic analysis based on gene sequence data. I collected some material for these analyses over the summer and those collections will be available to you. I would like one group to focus on a molecular analysis and I will assist with this analysis. Do be aware that any of these analyses may require you to invest some additional time outside of class. I will make time to assist you with these analyses and will make time outside of our regular class meeting. At the end of the research your team will need to give a presentation on the work done and the findings. I will provide more details later on the specific requirements of this presentation.

Course Expectations aka What do I need to do to get an A in this course?

Based on past experience, the following list compares student knowledge and skills versus their final class grade.

"F" students- We won't even go there.

"D" students- Are unclear about basic material. They are usually unwilling to admit this and ask for help and are unwilling to take the time to learn the material. They may also have a bad attitude exemplified by the comment "I hate plants" In a plant collection they turn in Gymnosperms collected on the day the assignment was due.

"C" students- Know most of the basics but are short on details. Such students usually memorize some material without really understanding it or putting it into context. They lack the ability to link names with structures and thus plant id and family id are almost impossible. Usually this is due to not investing the time both in and out of class to develop this skill.

"B" students- Know most basics and lots of details. They have good understanding in most areas but often lack confidence in their abilities. B students generally perform above average in putting together concepts from the course but they may be a little inconsistent.

"A" students- Know all the basics and most details. They have a global understanding of the big picture and can apply what they know. They are willing to take chances and be wrong. An A student has shown *excellent* understanding of how the ideas and information in the course fit into larger frameworks. A students have also figured out that 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 and they have invested that time to practice.

Biology Laboratory Safety Rules and Procedures:

- It has been said that "common sense isn't very common." Please use common sense to keep yourself and classmates safe, and the laboratory running smoothly. You are each responsible for maintaining the cleanliness and safety of the lab.
- No food or drinks are allowed during a lab session. The only exception is food or drink provided by the instructor as part of the laboratory.
- Only closed-toe shoes are to be worn in the lab. Open-toe sandals are not permitted.
- Keep hands and other objects away from your face, nose, eyes, ears, and mouth. Do not apply cosmetics while in the lab.
- When working with bacterial cell cultures, work areas/surfaces should be wiped down with disinfectant before and after lab use.
- Hands should be washed after handling bacteria and before leaving the laboratory.
- Laboratory coats are optional. They do protect your clothing from stains and reagents.
- When working around open flames from a Bunsen burner, long hair should be secured behind your head.
- Be careful around Bunsen burners. Flames cannot always be seen.
- All unnecessary books, purses, briefcases, etc., should be kept off the countertops during lab work.
- Never pipette anything by mouth (including water). Use pipetting devices.
- Label all materials with your name or initials, date, and any other applicable information (e.g., type of media, organism, etc.).
- When handling chemicals, note any hazard codes or warnings on the container and take the appropriate precautions indicated.
- Do not pour chemicals down the sink without first checking with your instructor.
- Do not pour culture media fluids with bacteria or agar down the sink.
- Return all chemicals, reagents, cultures, and glassware to their appropriate places.
- Flame transfer loops, wires, or needles (all made of metal) before and immediately after use when transferring biological material.
- Do not walk around the laboratory with transfer loops, wires, needles, or pipettes containing biological material.
- Report any broken equipment immediately to your instructor.
- Immediately report any broken glassware, especially those containing bacteria or biological material.
- Immediately report any chemical or biological fluid spills to your instructor.
- Follow all instructions given by your instructor for cleaning up any spills or broken glass.
- If you are injured in the laboratory, immediately inform your instructor.
- Always wipe and clean the lenses of your microscope before putting it away. Use the appropriate tissue paper and cleaning solution for this purpose.
- Do not remove any materials from the laboratory without permission from your instructor.
- Dispose of wastes in their proper container, <u>there are separate containers for sharps, broken glass, hazardous materials and biohazardous materials.</u>

<u>Waste Disposal</u>

- Dispose of items in special bags or receptacles as indicated. If you have a question regarding the proper disposal of an item, ask your instructor.
- Use a Biohazard (orange/red) bag for agar plates (plastic Petri plates) containing any biological material.
- Use a desktop plastic waste container for used plastic micropipette tips; these containers will be emptied into a Biohazard (orange/red) bag for autoclaving.
- Use a Biohazard "orange/red bag" container for contaminated cotton swabs.
- Use a Sharps container for needles, glass slides, syringes, pipettes, other types of sharps.
- Use a "Glass waste" container for broken glassware and for used microscope slides.
- Any glassware containing liquid culture medium in which bacteria have been grown must be autoclaved before disposal.
- In general, non-contaminated items that pose no threat can be disposed of by placing them in the regular trash. Any sharp object ("sharps"), contaminated or not, should be discarded into the sharps container.

(Biology department lab safety guidelines prepared by SH on August 29, 2014; adapted from: http://www.as.ysu.edu/%7Ecrcooper/LabRules.pdf)

Tentative Lecture/Lab Schedule

Readings are indicated as:

Baum & Smith = Baum, D. A. and S. D. Smith. 2013. Tree Thinking: an introduction to phylogenetic biology. (PDF on Canvas)
Carter = Carter et al., 2007. Preparation and use of voucher specimens for documenting research in weed science (PDF on Canvas)
Harrington = Harrington, H. D. 1977. How to identify grasses and grasslike plants. (PDF on Canvas)
Simpson = Simpson, M. G. 2010. Plant Systematics, 2nd Edition.

Wk	Date	Topics/Assignments	Reading
Taxonomy/Systematics Fundamentals/Plant Identification			
1	Sept. 1/3		
		T: Introduction: Course Overview. What is Systematic Botany? Introduction to keying **R:** Scavenger hunt – plant morphology review Plant Collection/Documentation Techniques	Simpson: Chap. 1, 15, 17 Carter
2	Sept. 8/10		
		T/R: Collection and Keying – Campus flora	
3	Sept. 15/17		
		T: Herbaria and tour of FLC Herbarium; Herbarium data information systems **Herbarium Database Homework (Due Sept. 22)** Keying Graminoids I - (Cyperaceae/Juncaceae) **R:** Botanical Nomenclature (ICBN) (**Be sure to have watched Botany: A Blooming History prior to Thursday's class – link on Canvas**) Keying Graminoids II - (Poaceae) **Keying Quiz #1**	Simpson Chap. 16, 18 Harrington Chap. 1-4, 6 &7 Video: Botany: A Blooming History – A confusion of names
4	Sept. 22/24		
		T: Naming/describing species **Nomenclature Homework (Due Sept. 29)** Keying Graminoids III - (continued Poaceae practice) **Keying Quiz #2** **R:** Phylogenetic Systematics – Dendrogrammaceae I	Simpson Chap. 16, 2 (skim) Baum & Smith Chap. 3 (part)
5	Sept. 29/Oct. 1		
		T: Phylogenetic Systematics: Molecular Phylogenetics – Dendrogrammaceae II **Plant Collection Deadline 1** **R: Exam 1 + Keying Quiz #3**	Simpson Chap. 14
Systematic Analysis of *Packera*			
6	Oct. 6/8		
		T: Exam Review Description of *Packera* problem Establish research teams Brainstorm methodology **Keying Quiz #4** **R:** *Packera* project For molecular work – DNA extraction	*Packera* papers – See Canvas

7	Oct. 13/15		
		T: *Packera* project For molecular project PCR amplification **R:** *Packera* project **Plant Collection Deadline 2**	
8	Oct. 20/22		
		T: *Packera* project For molecular project - PCR cleaning and sample submission **R:** *Packera* project For molecular work - sequence analysis	
9	Oct. 27/29		
		T: *Packera* project **R:** Group research presentations	
Evolution and Diversity			
10	Nov. 3/5		
		T: Review of land plant evolution (Bryophyta → Anthophyta) **R:** Basal Angiosperms (ANITA) and Magnoliids	Simpson Chap. 3, 4, 5, 6 (skim all), 7
11	Nov. 10/12		
		T: Monocots **Family Recognition Quiz** **R:** Basal Eudicots	Simpson Chap. 7, 8
12	Nov. 17/19		
		T: Rosids: Fabids **Family Recognition Quiz** **R:** Rosids: Malvids	Simpson Chap. 8
Thanksgiving Break!			
14	Dec. 1/3		
		T: Minor Core Eudicots - Caryophyllid Clade **Family Recognition Quiz** **R:** Asterids: Basal Groups	Simpson Chap. 8
15	Dec. 8/10		
		T: Asterids: Lamiids **Family Recognition Quiz** **R:** Asterids: Campanulids	Simpson Chap. 8
16	Thursday Dec. 17	**Final Exam 2:15 – 4:15 PM**	