

Application for a New Course v9

Instructions:

The first four pages of this document provide instructions, example competencies, and a syllabus checklist. These four pages are for the course-developer's use, and do not need to be submitted along with the application.

Sequence:

- Consult with the Office of the Registrar to obtain course number.
- Consult with the Curriculum Office to discuss the degree plan and course number.
- Complete the New Course Application
- Create the course Syllabus – *See the associated Syllabus Checklist*
- Submit both paper and electronic versions of the Application and Syllabus to the Adams Center
- *Adams Center schedules review appointment within ten days of receipt of all items*
- Meet with Adams Center review team
- Make any necessary changes to application / syllabus
- Obtain the Library Review
- Obtain Preliminary Approval Signatures (Department Chair, Deans)
- Gather all attachments to application
- Submit to College Academic Council
- Submit to UUAC/UGAC

The course developer completes this application with supporting documentation (Section IV) and approval signatures of department chair and college dean (Section V) before the new course is reviewed by any academic council. **If the course is to be cross-listed, be certain to obtain signatures from all participating departments.**

Specific Instructions:

Before assigning a number (ID) for the course, consult the Office of the Registrar.

Section I. Systems and Catalog Information

Section II. Curriculum

Consult the Director of Curriculum, who will examine impact of new courses on university-wide programs. Curriculum director's signature on your degree plan attachment is required for confirmation.

1. **Degree Plan**

Explain how this course affects degree requirements. Attach a copy of the degree plan/s in Section IV-C

2. **Justification**

State the justification for adding this course to the current curriculum. Represent the need.

Attach any relevant documentation in Section IV-H. . (needs assessment, survey results, visiting committee report, market analysis, new government or accrediting body policy, exam scores, programs at other universities, etc.)

Section III. Course Design

III-2 - Competencies and Measurements

List the competencies that must be satisfied in order to pass the course, and indicate how each competency will be measured. *List in corresponding columns as indicated below. Add as many rows to the table as necessary. It is recommended that the identical table be presented in the syllabus, but the competencies and measures may be formatted differently in the syllabus as long as all elements are included in both documents. The wording for the competencies and measurements in the application should be identical to the syllabus.*

For **combined undergraduate/graduate** courses, make two tables and label them appropriately

Section IV. Supporting Documentation

Section V. Preliminary Approvals

Section VI. Approvals

VI-5 - University Budget Committee Action: (when applicable)

Any new or extensively revised program proposal (including new or extensively revised courses for the program) must be reviewed by the University Budget Committee (UBC) prior to the Application for a New Course being submitted to any academic council. Questions should be addressed to the college dean/director or associate provost. **The associate provost will submit materials to the UBC.**

Adams Center - Syllabus Checklist v9

Course ID _____ Developer _____

NOTE: It is not necessary to submit this checklist with New Course Applications. It is provided to assist the course developer in ensuring that all essential syllabus elements are addressed. The checklist is used by the Adams Center in syllabus review.

About the Course ☐ Title ☐ Course number and Section ☐ Credit hours ☐ Semester and Year ☐ Meeting time and Place About the Teacher ☐ Name and title or rank ☐ Office location ☐ Phone number(s) ☐ Email addresses ☐ Office hours / Contact expectations Course Content ☐ Catalog description (exact) ☐ Course Synopsis ☐ Outline ☐ Main topics Teaching/Learning Methods and Format of Class Sessions ☐ Description of the types of activities students should expect in the course Texts, Readings, and Supplements ☐ Required and Optional materials Evidence Concerning Christian Perspective ☐ Teaching philosophy ☐ Policy regarding questionable materials ☐ Scripture related to course content ☐ Faith / Learning resource	Overall Outcome & Competencies ☐ Specific competencies stated in measurable terms - o Appropriate learning level based upon Bloom's or Krathwohl's taxonomy ☐ Measurement Instrument - State which assignments or instruments will be used to assess the competencies. Grading Criteria ☐ Complete and accurate details of factors and Elements that will comprise the final grade. ☐ Weight or point value of all graded elements ☐ Grading scale with expectations for letter grades Course Policies ☐ Clear statement of expectations concerning penalties for non-compliance regarding: - o Attendance and Tardiness - o Participation - o Late assignment policy - o Late exam policy ☐ Special needs policy(ADA) ☐ Academic integrity policy ☐ Extra credit opportunities (optional) Course Calendar ☐ Exam dates ☐ Assignments ☐ Due dates and other deadlines ☐ Schedule of readings and topics ☐ Statement to reserve right to modify the calendar as necessary
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Writing Course Competencies

	Competency	Measurement Instrument
	<i>Instructions:</i> Competencies should be observable and measurable, and stated in terms of student performance. In some cases it might be valuable to complete the sentence “Students will be able to. ..” If the competencies are primarily cognitive, consider using Bloom’s Taxonomy to evaluate whether the competencies are at an appropriate level for the course. In the more rare instances where affective or psychomotor competencies are used, give careful attention to measurement techniques.	<i>Instructions:</i> Detail the instrument that will be used to gather the measurement. Examples might include: written papers, quizzes, tests, verbal presentations, video, audio, portfolio artifacts, demonstrations, performances, etc. This column should indicate where you will look for evidence of the type of student work that you expect. <i>Note that this is distinct from the Measurement Standard which provides some detail about what constitutes valid and acceptable student performance.</i>
Ex. 1	Defend dietary goals in light of current research.	Weekly Reading Journal, Research Paper
Ex. 2	Examine personal values, attitudes and expectations to enhance self-awareness for greater effectiveness as a social work professional. . .	Field Instructor Evaluation
Ex. 3	Integrate terminology from literary history into writing	Research Paper

Application for a New Course v9

Course ID <i>Subject and Number</i>	BIOL 481
Date APPROVED	
Date DENIED	

I. Systems and Catalog Information Complete each item.

1	Course Developer	Joshua M. Brokaw
2	Course Teacher	Joshua M. Brokaw
3	Course Title	Plant Systematics
4	Course Abbreviation (if title is over 30 characters)	
5	College	College of Arts & Sciences
6	Department	Department of Biology
7	Number of Credit Hours	4
8	Is the course Fixed Credit or Variable Credit?	Fixed Credit
9	Is the course repeatable?	no
10	Maximum number of times course may be repeated	
11	Maximum number of hours credit	
12	Explanation for variable credit	
13a	Course contact hours - LEC	3
13b	Course contact hours - Lab	3
13c	Course contact hours - Practicum	
13d	Course contact hours - Seminar	
13e	Course contact hours - Studio	
13f	Course contact hours - Online	
13g	Course contact hours - Colloquium	
13h	Course contact hours – Field Experience	
13j	Course contact hours - Internship	
13k	Course contact hours - Research	
13m	Course contact hours - Workshop	
13n	Course contact hours – Other (specify)	
14	Instructor Workload	Typical 4 credit hour course workload
15	Grade Mode (check all appropriate):	☒ Standard ☐ Credit/No Credit (undergrad only)
16	Maximum Enrollment	10
17	Catalog Description (50 words or less)	Introduction to the principles and methods of biological classification with emphasis on the local flora. Field and laboratory work consist of collection and identification of plant specimens

		and phylogenetic analysis of plant DNA. Laboratory graded and credited with the course.
18	List any prerequisites (course/s, test scores, class standing, major, etc.)	BIOL 112/114, BIOL 113/115
19	List any co-requisites	
20	If the course is cross listed, specify the Course ID(s) MUST have signature in Section V off all Department Chairs	
21	Does this course have any special student costs? Yes/No <i>Attach a <u>completed</u> "Request to Add or Change Course Fees" form. Describe in section IV-F.</i>	
22	How often will it be offered? Fall	
23a	How often will it be offered? Spring	Spring
23b	How often will it be offered? Summer	
23c	How often will it be offered? Fall	
24	Frequency?	Even years
25	First semester this course will be offered <i>New courses may not be taught under their approved course ID until they appear in the catalog, therefore, no earlier than the coming fall.</i>	Spring, 2014
26	List course/s that should be deleted, include the last semester for course/s being deleted <i>A course cannot be deleted when it is a requirement in a degree plan in any department.</i>	
27	Is this course required for a degree/s? Yes/No <i>If "Yes," attach a revised degree plan(s) reflecting the placement of the new course.</i>	No
28	Has this course been offered as a Special Topics course? Yes/No <i>If "Yes," specify the Course ID and enrollment for each term it was taught.</i>	Yes Spring 2010: 1020_BIOL44002, 5 students Spring 2012: 1220_BIOL44001, 6 students
29	List any courses in which content overlaps the proposed course. (Course ID and Name) <i>Attach statement from instructor/dept chair of existing course justifying the new offering in Section IV-D.</i>	No substantial overlap

II. Curriculum

1	Degree Plan Explanation of how this course affects degree requirements.	It fulfills requirements for advanced biology credits required by the Biology BS.
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2	Justification State the justification for adding this course to the current curriculum. Represent the need.	Plant Systematics will promote a more balanced biology curriculum as it is only the second plant biology course offered by the Biology Department at ACU. However, Plant Systematics also teaches fundamental skills and concepts widely applicable to modern biological classification, including phylogeny reconstruction, that are not thoroughly covered in other courses currently available at ACU. And, most importantly, the Plant Systematics Lab is designed to enable students to collect and analyze data for presentation of original research at scientific conferences and, potentially, for publication. Six pdf files have been attached to document student research facilitated by the most recent Plant Systematics special topics course in 2012. This course has been intentionally designed to strengthen the visibility of undergraduate research at ACU. All students in this spring-taught course are required at minimum to submit their research for presentation at the ACU Undergraduate Research Festival, but several students have also taken their presentations to the Meetings of the Texas Academy of Sciences and the Meetings of the Southwestern Association of Naturalists. In some cases, the class work has continued as extracurricular research, and work in continuation of the attached presentation by Gates and Brokaw is in preparation to be submitted for publication in the summer of 2013.
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III. Course Design

1. Audience and Course Goal

1	Describe the intended audience, including prerequisite skills.	This course is intended for Biology, Biochemistry, and Environmental Science majors interested in the application of molecular techniques to research questions about biological diversity. Students are expected to have basic knowledge and skills necessary to have completed a General Biology course for science majors.
2	State the overarching course goal(s) in performance terms.	I intend to provide students with the kind of experience that they can expect from a biology graduate level course. The content of this course will include the exploration of plant diversity as the context for presentation of the basic science of biological systematics. Students are expected to demonstrate sufficient knowledge and understanding of plant systematics (as measured by exams and presentations described in the syllabus) to enter a graduate level plant biology research program. Students will gain research experience equivalent to that of a first semester molecular systematics graduate program (as measure by performance at the ACU Undergraduate Research Festival).

2. Competencies and Measurements

	Competency	Measurement
1	Students will demonstrate basic understanding of modern biological classification techniques.	Short-answer midterm and final exams
2	Students will demonstrate basic knowledge and understanding of plant diversity and evolution.	Short-answer midterm and final exams
3	Students will demonstrate ability to interpret scientific literature.	Graded on participation and leadership of discussion groups
4	Students will demonstrate competence in molecular (DNA based) systematics lab techniques.	Graded on completion as part of semester research project requiring data collection
5	Students will demonstrate competence in phylogenetic and/or population genetic analyses of molecular data	Graded on completion as part of semester research project requiring data analysis
6	Students will demonstrate ability to make a research conference presentation.	Graded on performance as part of semester research project requiring poster or presentation
7	Students will demonstrate ability to collect, identify, and prepare plant voucher specimens.	Voucher collection graded for content, correct identification, and preparation for accession into the ACU herbarium
8		
9		

3. Text and Resources

1. Give the full publication information of the textbook/s and other required resources and outside readings.

Because this course covers a rapidly changing field of science and is offered only on even years, text resources will be subject to change from year to year. Here are the texts used in 2012 for course reading assignments.

Texts for lecture:

Simpson, M. G. 2010. *Plant Systematic*, 2nd Edition. Academic Press, Amsterdam.

Texts for lab:

Beatty, G. E. and Provan, J. 2010. Refugial persistence and postglacial recolonization of North America by the cold-tolerant herbaceous plant *Orthilia secunda*. *Molecular Ecology* 19:5009-5021.

Brokaw, J. M. and Hufford, L. 2010. Phylogeny, introgression, and character evolution of diploid species in *Mentzelia* section *Trachyphytum* (Loasaceae). *Systematic Botany* 35:601-617.

Omland, K. E., Cook, L. G., and Crisp, M. D. 2008. Tree thinking for all biology: the problem with reading phylogenies as ladders of progress. *BioEssays* 30:854-867.

Other journal articles are assigned on a student-by-student basis according to the topics of their research presentations to be included in the cited literature.

2. For **combined undergraduate/graduate** courses, make two lists:
 - a. full publication information; label **Undergraduate**.
 - b. full publication information; label **Graduate**. Indicate number of pages required.

IV. Supporting Documentation

Supporting documents must accompany proposal prior to preliminary approval by chair and dean.

1	Library — Submit new course application and syllabus to the Director of the Library. Consult with the director and establish a deadline for completion of the library report. Attach the signed copy of the library director's report.
2	Instructional Design — The application and syllabus must be reviewed by the Adams Center. Attach a copy of the Adams Center Review Letter.
3	Degree Plan — The impact of the course must be reviewed by the Director of Curriculum. Attach degree plan signed by the Director of Curriculum.
4	Content Overlap — Include one document for each course you listed in Section I-I. Attach statement from instructor/dept chair of existing course justifying the new offering.
5	Departmental Resources — List the resources that support the course and are available only through the department, if applicable. Attach the list of the holdings and the location/s.
6	Resources — List resources (other than library or departmental resources) that are needed to support this course (computers, lab equipment, other technology, etc.). Attach a complete list of all items and indicate possible sources or estimated cost of each. List the sources of any needed funds.
7	Expenses — List additional expenses needed to implement this course (full-time or part-time faculty, graduate or lab assistants, student employees, travel, special student costs, room renovation, storage facility, etc.). Attach a complete list of all items, the estimated cost of each and the source of the funds.
8	Justification — Attach all documents referred to in Section II-2
9	Syllabus — Attach the syllabus for the course based upon the anticipated first-semester offering.
10	Provide documentation for all additional attachments here

V. Preliminary Approvals

All supporting documentation has been assembled and attached to this application. I believe this course is ready to be presented to appropriate councils. We have a plan to fund this new course.

Primary Department

James R. Nichols

Department Chair

November 15, 2012

Date

[Signature]

Dean of the College

11/16/12

Date

Cross-listing Department *Add more lines if multiple departments are cross-listing*

Department Chair

Date

Dean of the College

Date

Cross-listing Department *Add more lines if multiple departments are cross-listing*

Department Chair

Date

Dean of the College

Date

VI. Approvals *Place all approvals on one page.*

A. Course ID: _____

Course Title: _____

1. College Academic Council Action: (for all courses)

Note: Insert additional lines for College Academic Council action for each college involved in cross-listed courses.

Approved ☒ Denied ☐ J. Hest 2-8-13
College Dean or Director Date

Approved ☐ Denied ☐ _____
College Dean or Director Date

2. Graduate Council Action: (for graduate level courses)

Approved ☐ Denied ☐ _____
Dean of Graduate School Date

3. University Undergraduate Academic Council Action:

For undergraduate level courses only

Approved ☐ Denied ☐ _____
Associate Provost Date

4. University General Education Council Action: (when applicable)

Approved ☐ Denied ☐ _____
Provost or designee Date

5. University Budget Committee Action: (when applicable)

When applicable – see New Course Application Instructions

Approved ☐ Denied ☐ _____
Chair, University Budget Committee Date

6. Academic Provost Action: (for all courses)

Approved ☐ Denied ☐ _____
Provost Date

7. President of the University Action: (for all courses)

Approved ☐ Denied ☐ _____
President Date

Attach notes, comments, or conditions from appropriate councils:

BS: Biology

BIOG: General Track

Name _____

Banner ID _____

Entering Term/Catalog Year _____

ACT/SAT Score _____

Transfer Hours/Dual Credit/AP _____

Math Placement _____

Required Biology (21 hours)			Term	Grade
_____ BIOL 112/114	General Biology I and Lab	4 hrs	_____	_____
_____ BIOL 113/115	General Biology II and Lab	4 hrs	_____	_____
_____ BIOL 221/223	Animal Biology and Lab			
_____ OR BIOL 222/224	Plant Biology and Lab	4 hrs	_____	_____
_____ BIOL 312	Cell Biology	3 hrs	_____	_____
_____ BIOL 362	Ecology	3 hrs	_____	_____
_____ BIOL 497	Seminar in Biology (Sr Yr)	3 hrs	_____	_____

Other Biology (21 hours) Any 300 or 400 Level Biology Course

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Chemistry (16 hours)

_____ CHEM 133/131	General Chemistry I and Lab	4 hrs	_____
_____ CHEM 134/132	General Chemistry II and Lab	4 hrs	_____
_____ CHEM 223/221	Organic Chemistry I and Lab	4 hrs	_____
_____ CHEM 324/322	Organic Chemistry II and Lab	4 hrs	_____

Physics (8 hours)

_____ PHYS 110/111	General Physics I and Lab	4 hrs	_____
_____ PHYS 112/113	General Physics II and Lab	4 hrs	_____

Electives (9 hours)

_____	3 hrs	_____
_____	3 hrs	_____
_____	3 hrs	_____

CORE (12 hours)

_____	CORE 110	The Question of Truth	3 hrs	_____
_____	CORE 120	The Question of Identity	3 hrs	_____
_____	CORE 220	The Question of Community	3 hrs	_____
_____	CORE 320	The Question of Transcendence	3 hrs	_____

Speech (3 hours)

_____	COMS 211	Foundations of Communication	3 hrs	_____
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Mathematics (3 hours)

_____	MATH 124	Precalculus II	3 hrs	_____
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OR

_____	MATH 185	Calculus		
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Bible (14 hours)

_____	BIBL 101	Life and Teachings of Jesus	3 hrs	_____
_____	BIBL 102	Acts - Revelation	3 hrs	_____
_____	BIBL 211	Message of the Old Testament	3 hrs	_____
_____	Adv. course (300-499) from BIBL, BIBD, BIBH, BMIS		3 hrs	_____
_____	BIBL 440	Christian Vocation & Mission (Sr. Yr.)	2 hrs	_____

English (12 hours)

_____	ENGL 111	Composition and Rhetoric	3 hrs	_____
_____	ENGL 112	Composition and Literature	3 hrs	_____
_____	ENGL _____	Literature (not including Engl 351)	3 hrs	_____
_____	ENGL _____	Literature (not including Engl 351)	3 hrs	_____

Exercise Science (3 hours)

_____	EXSC 100	Lifetime Wellness	1 hr	_____
_____	EXSC _____	Activity of your choice	1 hr	_____
_____	EXSC _____	Activity of your choice	1 hr	_____

Social Science (3 hours)

_____	3 hrs (100-299) of social science from Anthropology, Economics (incl. AGRB 261), Geography, History, Political Science, Psychology, Sociology	3 hrs	_____
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Social Science/Humanities/Fine Arts (3 hours)

_____	3 hours (100-299) of social science from a different area from the list above OR 3 hours from the following list: ART 101, ART 221, ART 222, MUSM 230, MUSM 231, MUSM 232, MUSM 233, THEA 220, THEA 250	3 hrs	_____
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Total Hours: 128

BS: Biology (BIOG: General Biology Track)

For Students Entering Fall 2011

This is a sample schedule to illustrate how long it will take to complete this degree plan. Additional semesters may be necessary if you are required to complete courses listed in the right-hand column or if you repeat courses. Consult with your academic advisor before changing the sequence of courses. Some courses are not offered every semester and some courses have prerequisites. Check the course description in the current catalog for details. Failure to complete courses in the recommended sequence may delay graduation.

FR Fall 17 hrs	† BIBL 101 Life & Teachings of Jesus 3 hrs	† ENGL 111 Composition & Rhetoric 3 hrs	BIOL 112/114 General Biology I/Lab 4 hrs	CHEM 131/133 General Chemistry I/Lab 4 hrs	† CORE 110 3 hrs			Required if condition of Admission:
FR Spring 17 hrs	† BIBL 102 Acts – Revelation 3 hrs	† ENGL 112 Composition & Literature 3 hrs	BIOL 113/115 General Biology II/Lab 4 hrs	CHEM 132/134 General Chemistry II/Lab 4 hrs	CORE 120 3 hrs			UNIV 011 Learning Strategies
Summer								May be required based on COMPASS tests MATH: MATW 019 MATH 109
SO Fall 17 hrs	• BIBL 211 Message of the Old Testament 3 hrs	• ENGL Literature 3 hrs	BIOL 221 /223 – Animal Biology/Lab OR BIOL 222/224 – Plant Biology/Lab 4 hrs		CHEM 221/223 Organic Chemistry I/Lab 4 hrs	MATH 124 Pre-Calculus II Or MATH 185 3 hrs		May be required based on ACT or SAT scores ENGLISH: ENGL 003 ENGL 004 ENGL 106 ENGL 006 ENGL 107 ENGL 007
SO Spring 16 or 17 hrs	CORE 220 3 hrs	CHEM 322/324 Organic Chemistry II/Lab 4 hrs	BIOL 312 – Cell Biology 3 hrs		• ENGL Literature 3 hrs	COMS 240 3 hrs	EXSC 100 1 hr	
Summer	Recommend Summer Study Abroad							
JR Fall 16 hrs	PHYS 110 / 111 General Physics I/Lab 4 hrs	BIOLOGY Advanced Elective 3 hrs	BIOL 362 – Ecology 3 hrs		•SOCIAL SCIENCE 3 hrs	CORE 320 3 hrs		*FOREIGN LANGUAGE Two semesters required if proficiency is not demonstrated by testing.
JR Spring 17 hrs	Advanced Bible 3 hrs	BIOLOGY Advanced Elective 3 hrs	BIOLOGY Advanced Elective 3 hrs	PHYS 112/113 General Physics II/Lab 4 hrs	•SOCIAL SCIENCE 3 hrs	EXSC (Activity) 1 hr		
Summer								
SR Fall 14 hrs	BIOLOGY Advanced Elective 3 hrs	BIOLOGY Advanced Elective 3 hrs	*Elective/Foreign Language 3 hrs	BIBL 440 2 hrs	ELECTIVE 3 hrs			ADVANCED MATH COMPASS REQUIRED FOR FINAL MATH PLACEMENT
SR Spring 13 hrs	*Elective/Foreign Language 3 hrs	BIOL 497 Biology Seminar 3 hrs	BIOLOGY Advanced Elective 3 hrs	BIOLOGY Advanced Elective 3 hrs	EXSC (Activity) 1 hr			Total Hours = 128 March 2011

Each block represents 3 hours unless otherwise noted. † Freshman Requirement. • This course or its equivalent is offered at one of ACU's semester-long Study Abroad sites. Those planning to study abroad should save these courses. See www.acu.edu/study-abroad for updated courses.

University Requirements for all Bachelor's Degrees

University Requirements, except advanced courses, should be completed by the end of the sophomore year.

University Requirements*

<i>Some courses may not be taken for university requirements credit (see course description)</i>	Required Credit
The Core CORE 110 – Cornerstone CORE 120 – Human Person and Identity CORE 220 – The Question of Community CORE 320 – The Question of Transcendence Capstone Course – (hours counted in the major)	12
Bible BIBL 101 - Life and Teachings of Jesus BIBL 102 - Acts-Revelations BIBL 211 - Message of the Old Testament Adv. course (300-499): BIBD, BIBH, BIBL, BMIS** BIBL 440 - Christian Vocation and Mission	4/4
English ENGL 111 - Composition and Rhetoric (<i>or</i> ENGL 106/006 and 107/007) ENGL 112 - Composition and Literature Sophomore (200-299) Literature (includes literature in foreign language)	9
Communication COMS 211 Speaking Well: Foundations of Rhetoric	3
Science Select two courses in different department areas from the following list: <i>Agriculture/Environmental Sciences</i> AENV 130 - Environmental and Technological Science ANSC 111 - General Animal Science	6

ANSC 235 - Companion Animal Management
 ENVR 112 - Plant Science

Biology

BIOL 101 – Biology: Human Perspective

Chemistry

CHEM 101 – Consumer Chemistry

Geology

GEOL 111 - Introduction to Geology

Nutrition

NUTR 120 - Nutrition and Wellness

Physics

PHYS 101 – Astronomy

PHYS 102 – Physical Science

PHYS 378 – History and Philosophy of Science

PHYS 379 – Philosophy, Religion, and Science

Or select courses from a two semester sequence below:

BIOL 112/113 – General Biology I & II

BIOL 291/291 – Anatomy & Physiology I & II

CHEM 113/114 – Introductory Chemistry/

Introductory Organic and Biological Chemistry

CHEM 133/134 – General Chemistry I & II

PHYS 110/112 – General Physics I & II

PHYS 120/122 – Engineering Physics I & II

Mathematics

MATW 120/020, MATH 120 or higher

Social Science

3 hours from the following list:

Economics

AGRB 261 – Principles of Agriculture and

Applied Economics

ECON 260 – Macroeconomics

ECON 261 – Microeconomics

History

HIST 117 – Civilization I

HIST 118 – Civilization II

HIST 221 – American History I

HIST 222 – American History II

Political Science

POLS 221 – Government and Business

POLS 225 – National Government

Sociology

SOCI 111 – Introduction to Sociology

Social Science/Humanities/Fine Arts

3 hours of social science from a different area from the list above or from the following list:

ART 101 – Introduction to Art

ART 221 – Art History: General Survey I

ART 222 – Art History: General Survey II

HUM 212 – Oxford Through the Ages

HUM 217 – Latin America and the Arts

MUSM 230 – Survey of Music in Western Culture

MUSM 231 – Survey of Jazz

MUSM 232 – Survey of Popular Music

MUSM 233 – Survey of World Music

THEA 220 – Introduction to Theatre

THEA 250 – Film Appreciation

Exercise Science

EXSC 100 - Lifetime Wellness

EXSC activity - 2 different activities

Foreign Language

If lacking two years of high school language (one language): 6 hours of college foreign language required (one language)

Total University Requirements Hours

56-62

BS: Biology

BIOO: Organismal Track

Name _____

Banner ID _____

Entering Term/Catalog Year _____

ACT/SAT Score _____

Transfer Hours/Dual Credit/AP _____

Math Placement _____

Required Biology (21 hours)

Term Grade

_____	BIOL 112/114	General Biology I and Lab	4 hrs	_____
_____	BIOL 113/115	General Biology II and Lab	4 hrs	_____
_____	BIOL 221/223	Animal Biology and Lab		
_____	OR BIOL 222/224	Plant Biology and Lab	4 hrs	_____
_____	BIOL 312	Cell Biology	3 hrs	_____
_____	BIOL 362	Ecology	3 hrs	_____
_____	BIOL 497	Seminar in Biology (Sr Yr)	3 hrs	_____

Other Biology (21 hours) 12 hrs. listed below plus 9 advanced hours of your choice

Choose two of the following courses:

BIOL 370 - Field, BIOL 380 - Mammalogy, BIOL 403 - Marine, BIOL 425 - Behavior

_____	BIOL _____	4 hrs	_____
_____	BIOL _____	4 hrs	_____
_____	BIOL 492/495	Physiology & Lab	4 hrs
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Chemistry (16 hours)

_____	CHEM 133/131	General Chemistry I and Lab	4 hrs	_____
_____	CHEM 134/132	General Chemistry II and Lab	4 hrs	_____
_____	CHEM 223/221	Organic Chemistry I and Lab	4 hrs	_____
_____	CHEM 324/322	Organic Chemistry II and Lab	4 hrs	_____

Physics (8 hours)

_____	PHYS 110/111	General Physics I and Lab	4 hrs	_____
_____	PHYS 112/113	General Physics II and Lab	4 hrs	_____

Electives (9 hours)

_____	_____	3 hrs	_____
_____	_____	3 hrs	_____
_____	_____	3 hrs	_____

CORE (12 hours)		
_____	CORE 110	The Question of Truth 3 hrs _____
_____	CORE 120	The Question of Identity 3 hrs _____
_____	CORE 220	The Question of Community 3 hrs _____
_____	CORE 320	The Question of Transcendence 3 hrs _____
Speech (3 hours)		
_____	COMS 211	Foundations of Communication 3 hrs _____
Mathematics (3 hours)		
_____	MATH 124	Precalculus II 3 hrs _____
OR		
_____	MATH 185	Calculus
Bible (14 hours)		
_____	BIBL 101	Life and Teachings of Jesus 3 hrs _____
_____	BIBL 102	Acts - Revelation 3 hrs _____
_____	BIBL 211	Message of the Old Testament 3 hrs _____
_____	Adv. course (300-499)	from BIBL, BIBD, BIBH, BMIS 3 hrs _____
_____	BIBL 440	Christian Vocation & Mission (Sr. Yr.) 2 hrs _____
English (12 hours)		
_____	ENGL 111	Composition and Rhetoric 3 hrs _____
_____	ENGL 112	Composition and Literature 3 hrs _____
_____	ENGL _____	Literature (not including Engl 351) 3 hrs _____
_____	ENGL _____	Literature (not including Engl 351) 3 hrs _____
Exercise Science (3 hours)		
_____	EXSC 100	Lifetime Wellness 1 hr _____
_____	EXSC _____	Activity of your choice 1 hr _____
_____	EXSC _____	Activity of your choice 1 hr _____
Social Science (3 hours)		
_____	3 hrs (100-299)	of social science from Anthropology, Economics (incl. AGRB 261), Geography, History, Political Science, Psychology, Sociology 3 hrs _____
Social Science/Humanities/Fine Arts (3 hours)		
_____	3 hours (100-299)	of social science from a different area from the list above OR 3 hours from the following list: 3 hrs _____
ART 101, ART 221, ART 222, MUSM 230, MUSM 231, MUSM 232, MUSM 233, THEA 220, THEA 250		

Total Hours: 128

BS: Biology (BIOO: Organismal Biology Track)

For Students Entering Fall 2011

This is a sample schedule to illustrate how long it will take to complete this degree plan. Additional semesters may be necessary if you are required to complete courses listed in the right-hand column or if you repeat courses. Consult with your academic advisor before changing the sequence of courses. Some courses are not offered every semester and some courses have prerequisites. Check the course description in the current catalog for details. Failure to complete courses in the recommended sequence may delay graduation.

FR Fall 17 hrs	† BIBL 101 Life & Teachings of Jesus 3 hrs	† ENGL 111 Composition & Rhetoric 3 hrs	BIOL 112/114 General Biology I/Lab 4 hrs	CHEM 131/133 General Chemistry I/Lab 4 hrs	† CORE 110 Cornerstone 3 hrs			Required if condition of Admission: UNIV 011 Learning Strategies
FR Spring 17 hrs	† BIBL 102 Acts – Revelation 3 hrs	† ENGL 112 Composition & Literature 3 hrs	BIOL 113/115 General Biology II/Lab 4 hrs	CHEM 132/134 General Chemistry II/Lab 4 hrs	CORE 120 Human Person and Identity 3 hrs			
Summer								
SO Fall 17 hrs	• BIBL 211 Message of the Old Testament 3 hrs	• ENGL Literature 3 hrs	BIOL 221 /223 – Animal Biology/Lab OR BIOL 222/224 – Plant Biology/Lab 4 hrs		CHEM 221/223 Organic Chemistry I/Lab 4 hrs	MATH 124 Pre-Calculus II Or MATH 185 Calculus I 3 hrs		May be required based on COMPASS tests: MATH: MATW 019 MATH 109
SO Spring 17 hrs	CORE 220 Community 3 hrs	CHEM 322/324 Organic Chemistry II/Lab 4 hrs	BIOL 312 – Cell Biology 3 hrs		• ENGL Literature 3 hrs	EXSC 100 1 hr	COMS 211 Speech and Rhetoric 3 hrs	May be required based on ACT or SAT scores ENGLISH: ENGL 003 ENGL 004 ENGL 106 ENGL 006 ENGL 107 ENGL 007
Summer	Recommend Summer Study Abroad							
JR Fall 17 hrs	PHYS 110 / 111 General Physics I/Lab 4 hrs	BIOL 492/495 Physiology/Lab 4 hrs	BIOL 362 – Ecology 3 hrs		•SOCIAL SCIENCE 3 hrs	CORE 320 Transcendence 3 hrs		*FOREIGN LANGUAGE Two semesters required if proficiency is not demonstrated by testing.
JR Spring 17 hrs	Advanced Bible 3 hrs	* BIOLOGY Advanced Elective 4 hrs	BIOLOGY Advanced Elective 3 hrs	PHYS 112/113 General Physics II/Lab 4 hrs	•SOCIAL SCIENCE 3 hrs			
Summer								
SR Fall 13 hrs	BIOLOGY Advanced Elective 3 hrs	BIOLOGY Advanced Elective 3 hrs	*Elective/Foreign Language 3 hrs	ELECTIVE 3 hrs	EXSC (Activity) 1 hr			ADVANCED MATH COMPASS REQUIRED FOR FINAL MATH PLACEMENT
SR Spring 13 hrs	*Elective/Foreign Language 3 hrs	BIOL 497 Biology Seminar 3 hrs	* BIOLOGY Advanced Elective 4 hrs	BIBL 440 2 hrs	EXSC (Activity) 1 hr			Total Hours = 128 April 2011

Each block represents 3 hours unless otherwise noted. † Freshman Requirement. • This course or its equivalent is offered at one of ACU's semester-long Study Abroad sites. Those planning to study abroad should save these courses. See www.acu.edu/study-abroad for updated courses. *8hrs from BIOL 370 – Field Biology, BIOL 380 – Mammalogy, BIOL 403 – Marine Biology, BIOL 425 – Behavioral Biology

Departmental Resources Used by Plant Systematics (BIOL 481.01)

The ACU Herbarium: an essential research collection of preserved plant specimens
-Foster Science, Room 485

The Clark Stevens Research Laboratory: and equipment therein

PCR

Centrifuge

Pipettes

Freezers and refrigerators

Electrophoresis equipment

Evolutionary potential of rare plant species: *Mentzelia jonesii* and *M. arizonica* (Loasaceae)

Tanner S. Agee and Joshua M. Brokaw – Abilene Christian University, Abilene, TX 79699

Introduction

Mentzelia jonesii (Urb. & Gilg) H.J. Thoms. & J.E. Roberts is an annual wildflower inhabiting deserts in southeastern California and western Arizona. *Mentzelia jonesii* is known to exist as tetraploid (four sets of chromosomes per cell) and hexaploid (six sets of chromosomes) populations. However, the hexaploids have not been officially described as a separate species due to the difficulty of distinguishing the different cytotypes. We informally will refer to these hexaploids as *M. 'arizonica'*. This study has been designed to test the hypotheses that: 1) the tetraploid and hexaploid populations of *M. jonesii* can be distinguished with chloroplast DNA and 2) the intergenic spacer *ndhF-rpl32R* can be used to differentiate these two cytotypes (i.e. as a genetic 'barcode'). We have extracted DNA from several populations of each cytotype and sequenced the *ndhF-rpl32R* region to identify genetic differences.

This work will be used to determine whether the hexaploid cytotype can be officially described as a new species.



Fig 1. *M. 'arizonica'*



Fig 2. *M. jonesii*

Results

Fig. 3. Haplotype network of chloroplast DNA in sampled *M. jonesii* and *M. 'arizonica'*

This graph shows the relationship of differences between haplotypes of *M. jonesii* and *M. 'arizonica'*. Most samples of *M. 'arizonica'* share a single haplotype, but 426 and 424 have unique haplotypes.

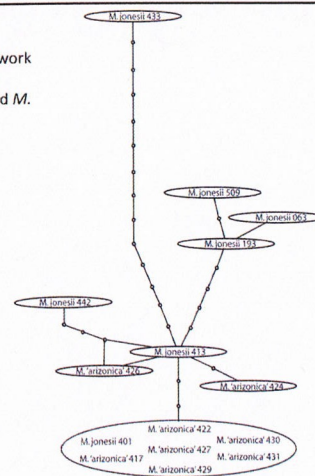
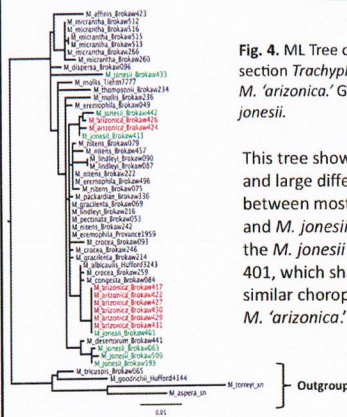


Fig. 4. ML Tree of *Mentzelia* section *Trachyphytum*. Red is *M. 'arizonica'*. Green is *M. jonesii*.

This tree shows a distinctive and large difference between most *M. 'arizonica'* and *M. jonesii* except for the *M. jonesii* haplotype 401, which shares very similar chloroplast DNA with *M. 'arizonica'*.



Discussion

The finding of shared haplotypes in the chloroplast data suggests that *M. 'arizonica'* was closely related to *M. jonesii*. Though there is a difference in ploidy level of the two, there is an overlap in the haplotypes exhibited by the two species based on the intergenic spacer *ndhF-rpl32R*, making it impossible to reliably differentiate these two cytotypes. Because of the similarity of the *ndhF-rpl32R* sequences in *M. jonesii* 401 and *M. 'arizonica'* 417, 422, 427, 429, 430, and 431, we have insufficient genetic data to assign a distinct 'barcode' of DNA to distinguish *M. 'arizonica'* from *M. jonesii*. However, the data may present some answers of the relationship between *M. jonesii* and *M. 'arizonica'*. Based on the chloroplast haplotypes there is reason to believe that *M. jonesii* and *M. 'arizonica'* have a shared ancestry, and this would also explain the similarity in chloroplast DNA but differing ploidy. Because *M. 'arizonica'* has a higher ploidy level than *M. jonesii*, it is expected that *M. 'arizonica'* is a subpopulation or subpopulations that diverged from *M. jonesii* in a polyploidization event as the plant spread east. Further, some of the distinct haplotypes exhibited in *M. 'arizonica'* could have been gained from a different progenitor during an allopolyploidization event involving the hybridization of *M. jonesii* and another unknown species in *Mentzelia* section *Trachyphytum* (Brokaw and Hufford 2010).

Conclusions

- The sharing of haplotypes by *M. 'arizonica'* and *M. jonesii* shows that this method of testing cannot serve as a reliable barcode that separates distinguishes the two species.
- However it is expected that *M. 'arizonica'* evolved from populations of *M. jonesii*, and this would explain the similarity in chloroplast DNA but differing ploidy.

Methods

Molecular Systematics. We sampled the following: *M. jonesii*: 7 populations from Southern California and Western Arizona; *M. 'arizonica'*: 8 populations from Arizona. Extraction and amplification for the cpDNA spacer *ndhF-rpl32R* were conducted using standard protocols (Marlowe and Hufford, 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University; sequences were edited using Sequencher version 4.10 (Gene Codes Corp., Ann Arbor, Michigan, USA) and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002). A haplotype network was constructed using TCS version 1.21 (Clement et al. 2000).

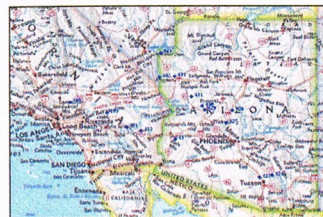


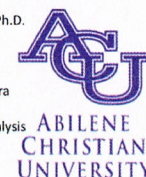
Fig. 5. Arizona and Southern California: Locations of *Mentzelia* collections. Collection numbers refer to those in figures 3 and 4.

Works Cited

- Brokaw, J. M. and Hufford, L. 2010. Origins and introgression of polyploid species in *Mentzelia* section *Trachyphytum* (Loasaceae). *American Journal of Botany* 97:1457-1473.
- Clement, M., D. Posada, and K. A. Crandall. 2000. TCS: A computer program to estimate gene genealogies. *Molecular Ecology* 9:1657-1659.
- Marlowe, K. 2007. Biogeography and evolution of flowering plants in the American West: *Gaillardia* (Asteraceae) and *Synthyris* (Plantaginaceae). Ph.D. dissertation. Pullman, WA: Washington State University.
- Rambaut, A. 1996-2002. Sequence Alignment Editor ver. 2.0a11. Oxford: Department of Zoology, University of Oxford.
- Stebbins, G. L. 1980. Rarity of plant species: a synthetic viewpoint. *Rhodora* 82:77-86.
- Zwickl, D. J. 2006. Genetic algorithm approaches for the phylogenetic analysis of large biological sequence data sets under the maximum likelihood criterion. Ph.D. dissertation, University of Texas, Austin, Texas, USA.

Acknowledgements

We thank Judith Glad, Larry Hufford, Rebecca Hunter, Qiang Xu, and the U.S. Bureau of Land Management for assistance. Tissue samples were provided by the University of Colorado Herbarium. Funding was provided by the Betty W. Hignbotham Trust, Hardman Foundation, and Abilene Christian University.



Testing the hypothesis of evolutionary origins of *Mentzelia micrantha* (Loasaceae)

Quincy Carroll and Joshua M. Brokaw – Abilene Christian University, Abilene, TX 79699



Fig 1. Habit of *M. micrantha* by L. Watson



Fig 2. Inflorescence of *M. micrantha* by L. Watson

Introduction

Mentzelia micrantha (Hook. & Arn.) Torr. & A. Gray is a native annual plant inhabiting coastal ranges in western California and Mexico. *Mentzelia micrantha* has previously been considered distantly related to all other species in *Mentzelia* section *Trachyphytum* due to several unique morphological characteristics. However, recent phylogenies based on DNA have suggested that *M. micrantha* is most closely related to *M. affinis* Greene despite remarkable physical dissimilarities. An alternative to this hypothesis is that the DNA similarities are artifacts of hybridization between *M. micrantha* and *M. affinis*. In this study we test the DNA-based hypothesis of evolutionary origins by sampling new populations of *M. micrantha*. The chloroplast intergenic spacer *ndhF-rpl32R* has previously been shown to be highly variable and useful for distinguishing closely related species. We have extracted DNA from several new populations of *M. micrantha*. We will analyze the *ndhF-rpl32R* sequences using phylogenetic reconstructions to test whether the new populations will be placed in distinct evolutionary groups, which would support a hypothesis of hybridization.



Fig 3. location of *M. micrantha* (plants.usda.gov)



Fig 4. Geographic location of *M. affinis* (plants.usda.gov)

Results

New sampling with the intergenic spacer *ndhF-rpl32R* did not provide evidence that *M. micrantha* occurs in any additional clades. All samples from *M. micrantha* form a monophyletic group. The *M. micrantha* clade is most closely related to *M. affinis*.

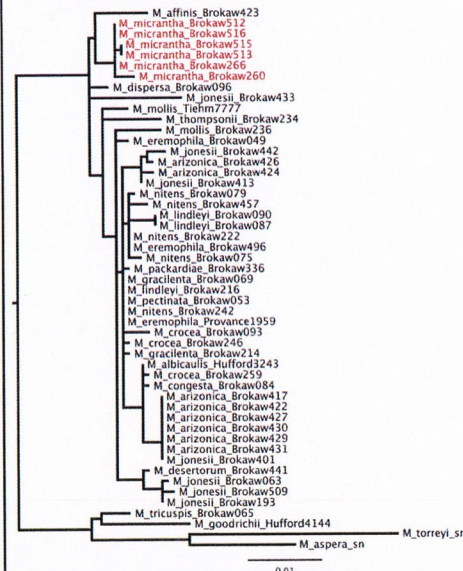


Fig. 5. Maximum likelihood tree of *Mentzelia* section *Trachyphytum* based on *ndhF-rpl32R*. Red labels represent samples from *M. micrantha*. Black labels are from other *Mentzelia* species. Some species are represented by multiple samples on the tree. Branch lengths represent mutation differences.

Discussion

The finding of only shared ancestry with *M. affinis* from the sampled chloroplast DNA data gives no new alternative hypothesis of the history of *M. micrantha*. *Mentzelia micrantha* is a sister species to *M. affinis*, with both coming from the same ancestor. Based on the phylogenetic branch lengths, *M. micrantha* has not had genetic contact with other species recently, and, if hybridization occurred, it must have occurred in the distant past in order for the *M. micrantha* and the *M. affinis* lineages to diverge from one another

A Possible reason for how they have different morphological characteristics is that they develop them differently to equate with their environment. Another possible cause could have been that that *M. micrantha* has gone through substantial mutations and that *M. affinis* has had less change and is more similar to the ancestor species and other species in section *Trachyphytum*.



Fig. 6. *M. affinis* flowers by N. Kramer



Fig. 7. *M. micrantha* flowers by L. Watson

Conclusion

• *M. micrantha* did not have any DNA sequences suggesting hybridization with other species of *Mentzelia*. The DNA supports the original evidence that *M. micrantha* and *M. affinis* are most closely related.

Methods

Sampling. We took six different samples of *M. micrantha* (Brokaw collections 260, 266, 512, 513, 515, 516) for DNA sequencing. This DNA was taken from the chloroplast and was prepared in our lab using a series of steps for DNA sequencing. We then sent our DNA off to Yale where it was run through their machines and the portion was returned to us for sequence editing. After editing we were able to view the chloroplast DNA strands and gather our information to determine the results of the project.

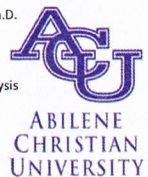
Molecular Systematics. We sampled the following: *M. micrantha*: 6 populations from California. Extraction and amplification for the cpDNA spacer *ndhF-rpl32R* were conducted using standard protocols (Marlowe and Hufford, 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University; sequences were edited using Sequencher version 4.10 (Gene Codes Corp., Ann Arbor, Michigan, USA) and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002). We conducted ML searches including all *M. micrantha* haplotypes and *Mentzelia ndhF-rpl32R* sequences available from Brokaw and Hufford (2010) using the program GARLI v. 0.95 (Zwickl, 2006).

Works Cited

- Brokaw, J. M. and Hufford, L. 2010. Origins and introgression of polyploid species in *Mentzelia* section *Trachyphytum* (Loasaceae). *American Journal of Botany* 97:1457-1473.
- Marlowe, K. 2007. Biogeography and evolution of flowering plants in the American West: *Gaillardia* (Asteraceae) and *Synthyris* (Plantaginaceae). Ph.D. dissertation. Pullman, WA: Washington State University.
- Rambaut, A. 1996-2002. Sequence Alignment Editor ver. 2.0a11. Oxford: Department of Zoology, University of Oxford.
- Zwickl, D. J. 2006. Genetic algorithm approaches for the phylogenetic analysis of large biological sequence data sets under the maximum likelihood criterion. Ph.D. dissertation, University of Texas, Austin, Texas, USA.

Acknowledgements

We thank Larry Hufford, Rebecca Hunter, Qiang Xu, and the U.S. Bureau of Land Management for assistance. Tissue samples were provided by the Abilene Christian Herbarium. Funding was provided by the Betty W. Higinbotham Trust, Hardman Foundation, and Abilene Christian University.



Testing *ndhF-rpl32R* as a Genetic Barcode to Distinguish *Mentzelia eremophila* and *M. nitens*. Jordan Dekeraty and Joshua M. Brokaw — Department of Biology, Abilene Christian University, Abilene, Texas 79699

Introduction

Mentzelia eremophila (Jeps.) H.J. Thoms. & J.E. Roberts and *M. nitens* Green are annual wildflowers inhabiting foothills in eastern California. These species are very similar morphologically, and both are diploid (having two sets of chromosomes). Therefore, it has been suggested that they are sister species (most closely related; Brokaw and Hufford 2010a). However, previous research has not clearly demonstrated that these species are genetically distinct. This study has been designed to test two hypotheses: 1) that *M. eremophila* and *M. nitens* are distinct sister species and 2) that the intergenic spacer *ndhF-rpl32R* can be used to differentiate these two species (i.e. as a genetic barcode). Here we extracted DNA from several populations of each species and sequenced the *ndhF-rpl32R* region to identify genetic differences, and those differences will be analyzed using phylogenetic reconstructions to test the sister relationship of *M. eremophila* and *M. nitens* and haplotype networks to test the effectiveness of *ndhF-rpl32R* as a genetic barcode.



Fig 1 *M. eremophila* by H. McAllister

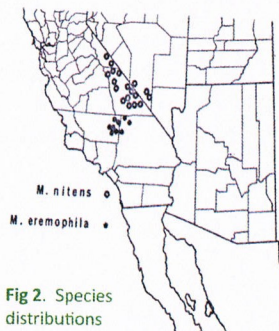


Fig 2. Species distributions



Fig 3. *M. nitens* by L. Blakely

Results

Both species displayed diverse haplotypes according to our edited data. Despite the genetic diversity between the sequences, some haplotypes occurred in both species as shown in figures 4 and 5. *Mentzelia nitens* had slightly greater diversity than *M. eremophila*. Most haplotypes from *M. nitens* were found in only one population, whereas many populations of *M. eremophila* shared the same haplotypes.

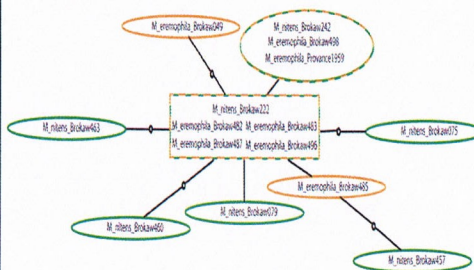


Fig. 5. Unrooted parsimony network of chloroplast haplotypes from *Mentzelia eremophila* and *Mentzelia nitens* on the basis of *ndhF-rpl32* sequence data. Black lines represent single mutational steps. Labels in haplotype ovals represent collection numbers for populations exhibiting the haplotype. Black dots represent inference of missing haplotypes. Haplotypes from only *M. eremophila* are colored green. Those from only *M. nitens* are colored orange, and haplotypes present in populations of both *M. eremophila* and *M. nitens* are dashed green and orange.

Discussion

Because of the excessive genetic overlap, we cannot use the intergenic spacer *ndhF-rpl32R* as a genetic barcode to differentiate *M. eremophila* and *M. nitens*. Since there are a number of identical sequences and they are both diploid and have the same numbers of chromosomes, it is definitely a possibility that they are able to interbreed, despite claims to the contrary (Zavortink 1965). Cross-pollination studies should be done in the future to test the viability and fertility of an F1 offspring. However, if shown that they are indeed the same species, due to the high diversity among populations, entire ranges should be preserved. Unfortunately *M. eremophila* is considered rare and concerns conservationists about its ability to stay in existence. Despite its narrow range, *M. eremophila* has remarkably high diversity, perhaps due to previous hybridizations (Brokaw and Hufford 2010a, 2010b). *Mentzelia nitens* has even higher diversity but samples were taken from a larger range.

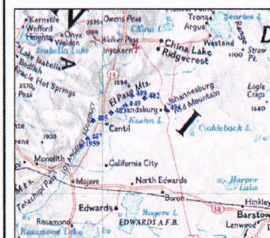


Fig. 6. Sampled *M. eremophila* populations



Fig. 7. Sampled *M. nitens* populations

Conclusions

- We cannot use the intergenic spacer *ndhF-rpl32R* as a genetic barcode to differentiate *M. eremophila* and *M. nitens*.
- Further research on cross pollination of the two species could answer the question as to whether or not the two are separate species at all.

Methods

Tissue samples were collected from populations of *M. eremophila* and *M. nitens* in mid-eastern California as well as a specimen from the herbarium of the University of California Riverside.

Molecular Data. We performed DNA extraction and PCR for the cpDNA spacer *ndhF-rpl32* using standard protocols (Marlowe 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University. Sequences were edited using Sequencher and aligned manually using SE-AL (v1.0a11; Rambaut 1996-2002). A haplotype network was constructed using TCS version 1.21 (Clement et al. 2000) under the criterion of a parsimony network in which connections have a probability of at least 95%.

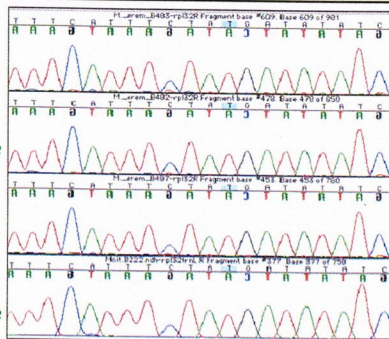


Fig. 4. Chromatograph of partial sequences as view in Sequencher from samples of both *M. eremophila* and *M. nitens* with identical haplotypes within the *ndhF-rpl32R* region. Peaks represent florescent bands of DNA visualized in an acrylamide gel during DNA sequencing.

Works Cited

- Brokaw, J. M. and Hufford, L. 2010a. Phylogeny, introgression, and character evolution of diploid species in *Mentzelia* section *Trachyphyllum* (Loasaceae). *Systematic Botany* 35:601-617.
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- Stebbins, G. L. and J. Major. 1965. Endemism and speciation in the California flora. *Ecological Monographs* 35:1-35.
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Acknowledgements

We thank Larry Hufford, Rebecca Hunter, Qiang Xu, and the U.S. Bureau of Land Management for assistance. Tissue samples were provided by the Abilene Christian Herbarium. Funding was provided by the Betty W. Higginbotham Trust, Hardman Foundation, and Abilene Christian University.



Introduction

Mentzelia section *Trachyphyllum* is a monophyletic group composed of approximately 20-30 annual plant species (Darlington 1934; Zavortink 1966; Hufford et al. 2003; Brokaw and Hufford 2010a; Brokaw and Hufford 2010b). This group includes rare, narrow endemics, several of which are polyploids that can be hard to distinguish. Populations of *M. monoensis* (hexaploid; Fig. 1) occur primarily on coarse pumice soils and disturbed sites near the Mono Craters (Figs. 5, 6) of Mono Co., California, at 2008–2482 m elevation (Brokaw and Hufford 2011). Although evolutionarily distinct (Brokaw 2009), *M. monoensis* is difficult to identify due to morphological characteristics shared among polyploid species in section *Trachyphyllum* (Darlington 1934; Zavortink 1966).

Most polyploid taxa in *Trachyphyllum* are morphologically intermediate to extant diploid species, suggesting that they have allopolyploid origins (Zavortink 1966). Recent molecular evidence has supported previous hypotheses of allopolyploid origins based on morphological data (Zavortink 1966; Brokaw 2009). However, analyses of nuclear genes suggest an unexpected unique allopolyploid origin of *M. monoensis* through the hybridization of *M. montana* (tetraploid; Fig. 2) and *M. dispersa* (diploid) (Brokaw and Hufford 2010b). Due to the complexity of identifying *M. monoensis* and its status as a narrow endemic, additional effort is needed to provide reliable characteristics for identification. This investigation involved comparative studies of morphological and molecular data that we collected from *M. monoensis* and the similar, widespread species, *M. montana*. The primary objective of this work is to construct a more precise approach to morphological identification of *M. monoensis* that concurs with genetic data.

The purpose of this study was to identify a molecular marker that can be used as a genetic 'barcode' for *M. monoensis* so that land managers can accurately determine the conservation status of this plant even when sufficient material for identification based on morphology is not available.



Fig 1. *M. monoensis*.



Fig 2. *M. montana*.

Methods

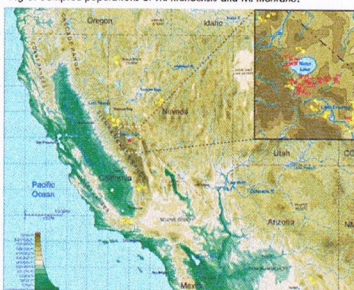
During a recent inventory, populations of *M. monoensis* were located throughout a range of approximately 1000 sq km in the vicinity of Mono Lake and other portions of the Mono Craters volcanic chain, often intermixed with those of *M. montana*. We took samples from 38 total populations, including 19 from *M. monoensis* and 19 from *M. montana* (Fig. 3). The samples that were collected were used for both morphological and molecular comparisons.

Molecular Data. We performed DNA extraction and amplification for the cpDNA spacers (*trnH-psbA*, *ndhF-rpl32*) using standard protocols (Marlowe 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University. Sequences were edited and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002).

In addition to the 19 specimens sampled for these analyses, two additional haplotypes from *M. monoensis* were taken from a previous study (Brokaw 2009), including one (Brokaw 367) sampled from the type locality (Fig. 3). Haplotype networks were constructed using TCS version 1.21 (Clement et al. 2000) under the criterion of a parsimony network in which connections have a probability of at least 95%.

Morphological Data. Four morphological characters, including bract color, bract shape, seed color, and seedcoat cell shape (Fig. 5), have been suggested to discriminate *M. monoensis* and *M. montana* (Brokaw and Hufford 2011). Herbarium specimens prepared from the sampled populations were used for observation.

Fig 3. Sampled populations of *M. monoensis* and *M. montana*.



Results

Molecular comparisons. No haplotypes were shared by *M. monoensis* and *M. montana* (Fig. 4). Using sequences from *trnH-psbA*, three *M. monoensis* specimens (Brokaw 367 and 547 and Zavortink 2640) shared an uncommon sequence, whereas all other *M. monoensis* and *M. montana* specimens had identical sequences. With *ndhF-rpl32* sequences, all *M. monoensis* specimens had identical sequences, but none were shared with *M. montana*. *Mentzelia montana* specimens exhibited one common *ndhF-rpl32* sequence and five unique sequences found in Brokaw 245, 291, 425, 568, and 575. Also one sequence was shared by two *M. montana* populations (Brokaw 564 and 565).

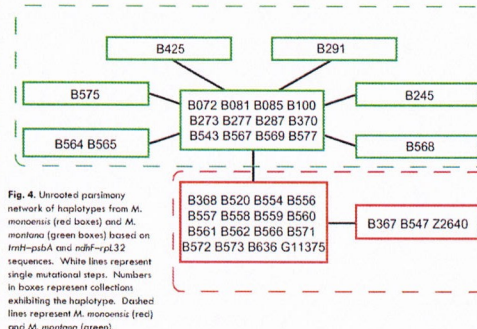


Fig. 4. Unrooted parsimony network of haplotypes from *M. monoensis* (red boxes) and *M. montana* (green boxes) based on *trnH-psbA* and *ndhF-rpl32* sequences. White lines represent single mutational steps. Numbers in boxes represent collections exhibiting the haplotype. Dashed lines represent *M. monoensis* (red) and *M. montana* (green).

Discussion

Through the use of molecular data, we will be able to further clarify the range of *M. monoensis* by identifying samples from herbaria in the surrounding counties. When there are not any seeds present in the herbarium specimens molecular data will allow us to determine the species. We have already determined that *M. monoensis* can be distinguished from *M. montana* in the field using a few morphological characteristics. The most easily visible characters are the color and shape of the bracts, whereas determining the shape and color of the seeds requires a hand lens or dissecting scope. Bract characteristics were important factors, but seed shape was most consistent in determining species. By providing land managers with a highly reliable method to recognize both taxa they can determine what the conservation status needs to be.

Mentzelia monoensis is narrowly endemic to the Mono Craters area in California. *Mentzelia monoensis* may be specialized to use volcanic substrates found in the region. However, this has not been confirmed. The term neoendemic refers to a species that has recently arisen. This could be a species that has diverged and become reproductively isolated or one that has formed following hybridization and is now classified as a separate species. Such hybrid speciation can be a common process in plants, especially those which exhibit polyploidy, such as *M. monoensis*. It is thought that neoendemicism best describes the evolution of *M. monoensis* because data produced by Brokaw and Hufford (2011b) suggest that *M. monoensis* is a relatively young species formed through an allopolyploidization event.

Because *M. monoensis* is likely a new species, it is possible that eventually it will spread throughout the western portion of the United States, as has *M. montana*. To determine how far it has spread we will begin obtaining specimens from herbariums in the counties around Mono county. We will then begin gathering their molecular data in order to confirm the species. The plastid spacer *ndhF-rpl32* can be used as a genetic 'barcode' to consistently distinguish this species when mature seeds are not available.

Conclusions

- Molecular and morphological data from new and wider sampling have supported earlier hypotheses that these species are distinct.
- Morphological characteristics discriminating *M. monoensis* and *M. montana* can be identified in the field, making distinction between these plants possible for taxonomists and land managers.
- The plastid intergenic spacer *ndhF-rpl32* can be used as a genetic 'barcode' to consistently distinguish *M. monoensis* and *M. montana* when mature seeds are not available.
- Molecular data will allow us to identify the range of *M. monoensis* from herbarium specimens in order to determine the conservation status of *M. monoensis*.



Fig 5. Mono Craters.



Fig 6. *M. monoensis*.

Works Cited

- Brokaw, J. M. 2009. Phylogeny Of *Mentzelia* section *Trachyphyllum*: origins and evolutionary ecology of polyploidy. Ph.D. dissertation. Pullman, WA: Washington State University.
- Brokaw, J. M. and Hufford, L. 2010a. Phylogeny, introgression, and character evolution of diploid species in *Mentzelia* section *Trachyphyllum* (Loasaceae). *Systematic Botany* 35:601-617.
- Brokaw, J. M. and Hufford, L. 2010b. Origins and introgression of polyploid species in *Mentzelia* section *Trachyphyllum* (Loasaceae). *American Journal of Botany* 97:1457-1473.
- Brokaw, J. M. and Hufford, L. 2011. A new species of *Mentzelia* (Loasaceae) from Mono County, California. *Madroño* 58:57-63.
- Clement, M., D. Posada, and K. A. Crandall. 2000. TCS: A computer program to estimate gene genealogies. *Molecular Ecology* 9:1657-1659.
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- Hufford, L., McMahon, M. M., Sherwood, A. M., Reeves, G., and Chase, M. W. 2003. The major clades of Loasaceae: phylogenetic analysis using the plastid *matK* and *trnL-trnF* regions. *American Journal of Botany* 90: 1215-1228.
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Acknowledgements

We thank Larry Hufford, Rebecca Hunter, Qiang Xu, and the U.S. Bureau of Land Management for assistance. Tissue samples were provided by the Abilene Christian Herbarium. Funding was provided by the Betty W. Higinbotham Trust, Hardman Foundation, and Abilene Christian University.



Fig. 1. Herbarium specimen of *M. lindheimeri*.



Fig. 2. Herbarium specimen of *M. oligosperma*.

Introduction

Mentzelia lindheimeri and *M. oligosperma* are herbaceous perennials native to the American Southwest. Both are members of the poorly understood section *Mentzelia* in the genus *Mentzelia*. *Mentzelia lindheimeri* and *M. oligosperma* have previously been distinguished morphologically based primarily on number of seeds and leaf characteristics; however, cursory examination of herbarium records shows that many collectors provide only tentative identifications when either of these species are collected in an area of overlapping ranges.

In this study our objective is to use DNA sequences to determine whether these two similar species are very genetically distinct. The intergenic spacer *ndhF-rpl32R* in chloroplast DNA has been previously shown to be highly variable in many plant species. Therefore this marker is a good candidate for use in distinguishing and identifying very similar species. Here we use phylogeny reconstructions based on sequences from *ndhF-rpl32R* to test the hypothesis that the taxa *Mentzelia lindheimeri* and *M. oligosperma* are distinct haplogroups.

Results

According to the best phylogenetic tree hypothesis, the sampled specimens form 2 major clades – one containing all the *M. oligosperma* specimens and the other containing the remaining specimens. In the “*oligosperma*” clade all the specimens are genetically identical at the *ndhF-rpl32R* region except for one insertion deletion event. In the “other” clade neither *M. lindheimeri* nor *M. aspera* form monophyletic groups.

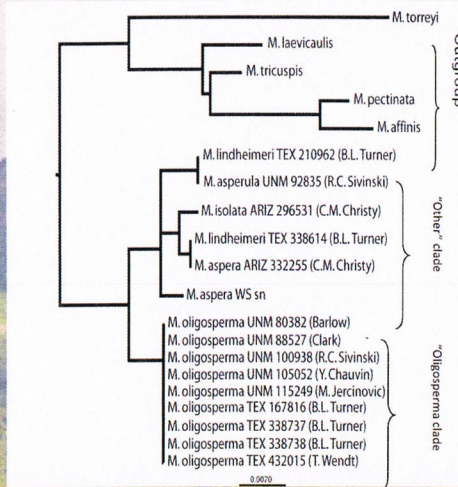


Fig. 3. ML Tree of *Mentzelia* section *Mentzelia*. Two major clades of *Mentzelia* spp. and outgroup labeled.

Discussion

According to the results, the finding of two major clades – one containing the majority of *M. oligosperma* specimens and the other containing the remaining specimens, indicates that *M. oligosperma* is not only a distinct haplogroup from *M. lindheimeri*, but it is also most distantly related to the other *Mentzelia* spp. This discovery supports our hypothesis based on current results.

Although the species exist in overlapping ranges, the results not only indicate that they have remained genetically distinct, but also that they have different proficiencies and ranges of dispersal. Based on the genetic similarity amongst the *M. oligosperma* compared to the greater genetic diversity amongst *M. lindheimeri* it can be inferred that dispersal occurs more easily in *M. oligosperma* than in *M. lindheimeri*. It is likely that the group with lower genetic diversity has populations that are easily dispersed over larger areas whereas the group with higher diversity probably contains populations that are more geographically isolated from one another.



Fig. 2. Flower of *M. oligosperma*.

Conclusions

- *M. lindheimeri* and *M. oligosperma* are distinct haplogroups.
- They are not closely related.
- In section *Mentzelia*, *M. oligosperma* is least closely related to all other *Mentzelia* spp. in section *Mentzelia*.
- *M. lindheimeri* contains greater genetic diversity and *M. oligosperma* contains little genetic diversity.

Methods

Molecular Systematics. We sampled 15 section *Mentzelia* specimens from herbariums of the University of New Mexico, the University of Texas, and Washington State University. Extraction and amplification for the cpDNA spacer *ndhF-rpl32R* were conducted using standard protocols (Marlowe and Hufford, 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University; sequences were edited using Sequencher version: 4.10 (Gene Codes Corp., Ann Arbor, Michigan, USA) and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002). We conducted maximum likelihood searches including all *M. lindheimeri* and *M. oligosperma* haplotypes and *Mentzelia* outgroup *ndhF-rpl32R* sequences available from Brokaw and Hufford (2010) using the program GARLI v. 0.95 (Zwickl, 2006).

Works Cited

- Brokaw, J. M. and Hufford, L. 2010. Origins and introgression of polyploid species in *Mentzelia* section *Trachyphylum* (Loasaceae). *American Journal of Botany* 97:1457-1473.
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- Zwickl, D. J. 2006. Genetic algorithm approaches for the phylogenetic analysis of large biological sequence data sets under the maximum likelihood criterion. Ph.D. dissertation, University of Texas, Austin, Texas, USA.

Acknowledgements

We thank Larry Hufford, Rebecca Hunter, and Qiang Xu for assistance. Tissue samples were provided from herbariums of the University of New Mexico, the University of Texas, and Washington State University. Funding was provided by the Betty W. Higinbotham Trust, Hardman Foundation, and Abilene Christian University.

Genetic Comparisons of *Mentzelia crocea* and *M. lindleyi* (Loasaceae)

Samantha Saldivar and Joshua M. Brokaw – Abilene Christian University, Abilene, TX 79699



Fig 1. Flower of *M. crocea*, by R.W. Brown



Fig 2. Flower of *M. lindleyi*, by B.A. Brousseau

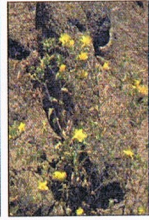


Fig 3. Habit of *M. lindleyi*, by B.A. Brousseau

Introduction

Mentzelia crocea Kellogg and *M. lindleyi* Torr. & A. Gray are large-flowered, annual plants inhabiting foothills in eastern and western California, respectively. These species have very similar flowers and overall morphology and are both tetraploids but inhabit distinct ranges separated by the Central Valley. Further, at least one of these species (*M. lindleyi*) has been dispersed commercially by seed and has an artificially increased range. Therefore, having a more effective technique for identification of these similar species is necessary.

Preliminary studies suggest that these species have genetically distinct chloroplast DNA (Brokaw and Hufford 2010). This study has been designed to test the hypothesis that the intergenic spacer *ndhF-rpl32R* can be used to differentiate these two species chloroplast region to provide a cost-effective method of identification of naturalized populations outside of the original species ranges.

While this study did not seek to establish a relationship between the two species, the data gathered can be used to support previous studies into the genetic histories of these two *Mentzelia* species.

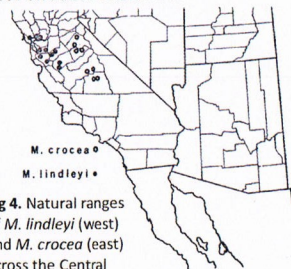


Fig 4. Natural ranges of *M. lindleyi* (west) and *M. crocea* (east) across the Central Valley

Results

With greater sampling, *M. lindleyi* and *M. crocea* still share no haplotypes. *Mentzelia lindleyi* and *M. crocea* have similar amounts of genetic diversity. Three haplotypes were recovered from *M. lindleyi*, and four were recovered from *M. crocea*. However, the *M. lindleyi* sequences exhibited the greatest mutational divergence.

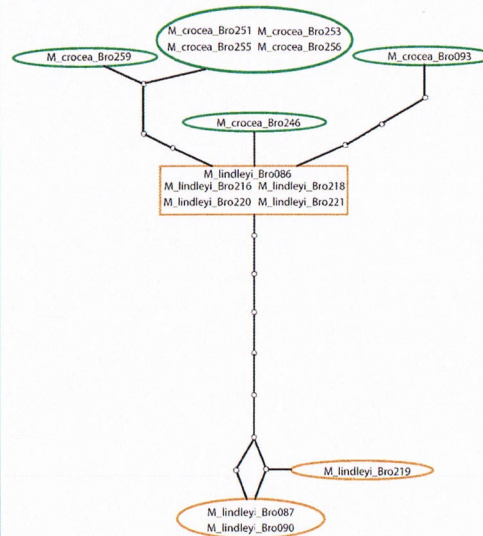


Fig. 5. Unrooted parsimony network of chloroplast haplotypes from *M. lindleyi* and *M. crocea* on the basis of *ndhF-rpl32* sequence data. Black lines represent single mutational steps. Labels in haplotype ovals represent collection numbers for populations exhibiting the haplotype. Black dots represent inference of missing haplotypes.

Discussion

The finding of distinctly different haplotypes in the chloroplast data supports previous findings that *M. crocea* and *M. lindleyi* are in fact different species although they have many similarities and are hard to tell apart by their morphological characters. It is fairly certain that the identity of the commercially available *M. lindleyi* seeds will be able to be deduced because of this clear separation and we will be able to tell if it is in fact *M. Lindleyi* that is being sold and introduced to new geographic ranges.

With further sampling it is possible that the distinctions between the two species may not be as apparent and signs of hybridization events between the two species may become known. While the 'rectangular' *M. lindleyi* haplotype has previously been found to be the most ancestral haplotype among our samples (Brokaw and Hufford 2010), it is not necessarily the ancestor of both species. A more likely explanation is that both species had a ancestor in common in less recent history and have undergone mutations separately or have hybridized but that the original haplotype has persisted in *M. lindleyi* only. However, the occurrence of this haplotype in *M. lindleyi* suggests that it could still occur in unsampled populations of *M. crocea*.

The finding of greater diversity in *M. crocea* is generally consistent with the larger geographic range of *M. crocea* (Fig 4), and it has been suggested that the very different haplotypes present in *M. lindleyi* may have been acquired through hybridization (Brokaw and Hufford 2010).

Conclusions

- The DNA supports the original evidence that *M. lindleyi* and *M. crocea* have distinctly different chloroplast DNA.
- The intergenic spacer *ndhF-rpl32R* can be used as a cost effective means to distinguish between the two species.

Methods

Sampling. We took five samples of chloroplast DNA from *M. lindleyi* (Brokaw collections 086, 218, 219, 220, 221) as well as five samples of *M. Crocea* (Brokaw collections 093, 246, 253, 256, 259) for DNA sequencing. Data from previously sequenced *M. lindleyi* and *M. crocea* samples (Brokaw and Hufford 2010) were compared to these sequences.

Molecular Systematics. We performed DNA extraction and PCR for the cpDNA spacer *ndhF-rpl32* using standard protocols (Marlowe 2007); amplified DNA was cycle sequenced and sequenced by the DNA Analysis Facility at Yale University. Sequences were edited using Sequencher and aligned manually using SE-AL (v2.0a11; Rambaut 1996-2002). A haplotype network was constructed using TCS version 1.21 (Clement et al. 2000) under the criterion of a parsimony network in which connections have a probability of at least 95%.



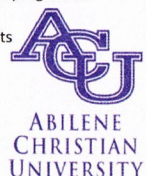
Fig 4. Samantha Saldivar preparing DNA for PCR

Works Cited

- Brokaw, J. M. and Hufford, L. 2010. Origins and introgression of polyploid species in *Mentzelia* section *Trachyphytum* (Loasaceae). *American Journal of Botany* 97:1457-1473.
- Clement, M., D Posada, and K. A. Crandall. 2000. TCS: A computer program to estimate gene genealogies. *Molecular Ecology* 9:1657-1659.
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Acknowledgements

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Course Syllabus for Plant Systematics

BIOL 481.01 Spring 2014

Lecture MWF 12:00-12:50 pm

Lab Thursday 2:00-4:50 pm

Foster Science Building Room 485

Mission Statements:

ACU: The mission of Abilene Christian University is to educate students for Christian service and leadership throughout the world.

College of Arts and Sciences: The mission of the College of Arts and Sciences is to educate students for worldwide Christian service and leadership through programs of study and other learning experiences that blend a liberal arts education with professional and career education.

Biology Department: The Department of Biology educates students for Christian service and leadership by preparing them to become biological scientists, pre-college teachers, and health care professionals.

Instructor: Dr. Joshua Brokaw, Assistant Professor

Office: Foster Science Building Room 479D

Office Hours: 9:30-10:30 am (MWF), 8:30-9:30 am (TR), 2-3 pm (MW), or appointment*

Phone: 325-674-2168

E-mail: josh.brokaw@acu.edu

*E-mails are welcome at any time and can be used to schedule appointments outside office hours.

Course Description:

BIOL 481.01 Plant Systematics (3-3-4), spring, even years. Introduction to the principles and methods of biological classification with emphasis on the local flora. Field and laboratory work consist of collection and identification of plant specimens and phylogenetic analysis of plant DNA. Laboratory graded and credited with the course.

Textbook: Plant Systematics, 2nd edition, by Simpson (2010)

Prerequisites: BIOL 112/114 & BIOL 113/115

Purpose: Plant Systematics is designed to introduce students to modern methods of plant classification, evolutionary biology, and molecular biotechnology in preparation for a career in scientific research. Part of this preparation for research includes teaching style, grading style, and types of assignments that are similar to what students will experience in early graduate level courses as described in the following sections.

Anticipated Outcomes and Competency Measures: This course provides the opportunity to learn foundational principles and methods of plant systematics with applications in careers in plant biology, ecology, natural resource management, and biotechnology. Students will demonstrate 1) basic understanding of modern biological **classification techniques**; 2) basic knowledge and understanding of **plant diversity and evolution**; 3) ability to interpret **scientific literature**; 4) competence in molecular (DNA based) systematics **lab techniques**; 5) competence in phylogenetic and/or population genetic **analyses** of molecular data; 6) ability to make a **research conference presentation**; and 7) ability to collect, identify, and prepare plant **voucher specimens**. Competency in these areas will be assessed by your performance on tests, class participation, and two class projects: a DNA sequencing project

presented at the ACU Undergraduate Research Festival graded for performance and completion and a plant voucher collection graded for content, correct identification, and preparation for accession into the ACU herbarium. Further information on each assessment method is given below.

Grade Assessment:

Grades	Points	
Lab Participation	100	(20%)
Conference Presentation	50	(10%)
Plant Collection	50	(10%)
2 Lab Practicals	100	(20%)
Midterm Exam	100	(20%)
Final Exam	100	(20%)
Total	500	(100%)

Grade Scale

A:	447.5-500.0 points (89.5%)
B:	397.5-447.5 points (79.5%)
C:	347.5-397.5 points (69.5%)
D:	297.5-347.5 points (59.5%)
F:	less than 297.5 points

Lab Participation: Lab participation is assessed by attendance, completion of research activities, and participation in discussions. Prior to labs scheduled for literature discussions, students will be assigned a recent publication with methods and topics relevant to the types of projects assigned to research teams in lab. Students should come prepared to lead discussion on the assigned reading. A discussion leader will be chosen randomly at the beginning of lab.

Lab Schedule:

Week	Date	Topic/Activity
1	TBD	Brief Lab Introduction and Molecular Data Collection
2	TBD	Tree Thinking Discussion and Data Collection
3	TBD	Molecular Data Collection
4	TBD	Molecular Method Discussion and Data Collection
5	TBD	Molecular Data Collection
6	TBD	Editing DNA Sequences
7	TBD	Phylogenetic Analysis Discussion and Data Analysis
8	TBD	Sequence Data Analysis
	TBD	Spring Break
9	TBD	Plant Diversity Specimens in Herbarium
10	TBD	Research Project Due , Field Collection/Identification
11	TBD	Lab Practical 1 , Specimens in Herbarium
12	TBD	Field Collection/Identification
13	TBD	Field Collection/Identification
14	TBD	Field Collection/Identification
15	TBD	Lab Practical 2, Collection Due , Specimen Mounting

Conference Presentation Project: Students have the opportunity/obligation to present original research in plant systematics using molecular data. Students may work in teams of 1 to 3 individuals (project size will be matched to team size). Each team will be assigned a unique research project that will be conducted under the supervision of and in collaboration with the instructor. Several of the early labs will be used to learn techniques and collect data for presentation at the ACU Undergraduate Research Festival in early April. **The application to the Festival is due in the first week of February.** Students should maintain regular contact with the instructor concerning progress in the project

throughout the first half of the semester. The poster or presentation is **due during the last lab in March and must be presented during the time listed in the ACU Research Festival program.**

Completion of data collection and data analysis will be graded as part of the lab participation grade. The conference presentation grade will be based on criteria including: 1) acceptance of abstract by the Research Festival committee [the committee will look for suitable research objectives, hypothesis, and originality], 2) presentation appearance/professionalism, 3) clarity of organization of presentation, 4) demonstration of understanding of concepts, and most importantly 5) demonstration of ability to explain research to Festival judges [some will not be scientists].

Plant Voucher Collection: This collection will consist of 25 specimens, which should be properly collected and identified. The collected specimens should represent at least 10 plant families, and at least half of the specimens must represent plants native to Taylor and adjacent counties. The collection will be graded for content, correct identification, and preparation for accession into the ACU herbarium. Extra credit will be given for specimens from Taylor and adjacent counties that represent species that are not already in the herbarium collection. The collection is **due on the last lab day.**

Late Project Assignments: Late work is always problematic. Because the conference presentation and plant collection are due at the latest possible dates during the semester, these assignments must be graded based on the level of completion at the due dates. Failure to submit any product must result in a grade of "0." There will be NO course incompletes given for failure to complete assignments. Students can make an appeal to the department chair for an exception. This appeal must be submitted in writing during the semester of the course. The appeal must include a written detailed plan of action to complete the course that outlines how each assignment will be completed. After the final day of class, no appeal can be made. There will be no exceptions to these rules. However, assignments can be turned in early for opportunities for review and revision in order obtain a higher grade.

Lab Practicals: Lab practicals will consist of short answer questions. Questions will require students to identify groups of plants presented during taxonomy/diversity labs and demonstrate knowledge of the terminology of plant identification.

Lecture: Lecture meetings will be led by the instructor and cover the topics listed below. Some lecture topics will consist of basic knowledge, such as plant diversity and nomenclature, whereas other topics, such as phylogenetic systematics and species concepts, will involve substantial classroom discussion.

Lecture Topics: * Any changes to schedule of topics will be communicated orally and/or in writing to students.

Topics	Assigned Chapters
Plant Systematics Overview	1
Classification History	
Phylogenetic Systematics	2
Plant Molecular Systematics	14
Other Systematic Evidence and Terminology	9-13
Species Concepts	19
Evolution of Plant Diversity	3-8
Plant Identification	15
Plant Nomenclature	16
Plant Collecting and Documentation	17
Herbaria	18

Midterm and Final Exams: The exams will consist of short answer questions based on material covered during lecture meetings. The Final Exam covers the second half of the semester and is not fully comprehensive. However, concepts covered will build upon topics from the first half of the semester.

Exam Schedule

Midterm Exam: 12:00-12:50 p.m., Wednesday, Week 8

Final Exam: TBD, Finals Week

All practicals and exams should be taken when scheduled. If an acceptable excuse (as stated below) for missing a quiz or test is given, you may take it within a week upon your return. According to university policy, if a student misses a final examination with permission, the teacher will record an "I" (incomplete) for the course grade. The final examination may be given at a later date (within the first six weeks of the following semester), with permission from the college dean.

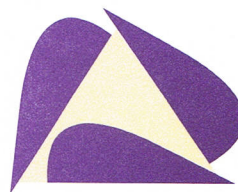
Attendance: Attendance is vital for success in this class. University policy states that students are allowed absences of no more than 9 MWF meetings. These include "approved absences" as well as other absences. The **only** acceptable excuses for missing class are 1) illness with doctor's letter (note: the school medical clinic **does not** provide excuse notes under most circumstances), 2) death in immediate family (parents, siblings, grandparents), 3) official school trips (with **advance** approvals).

Academic Integrity: Cheating on practicals or exams and plagiarism or dishonesty in research will automatically result in a grade of F. It will be reported to the department chair and the dean according to the procedures established by the university.

Learning Disabilities: If you have a documented disability and wish to discuss academic accommodations, you must contact the *ACU Student Disability Services Office* (part of *Alpha Academic Service*) at (325) 674-2667 to make an appointment with the Director of Disability Services. In order to receive accommodations, you must be registered with them for each class in which you need accommodations. They will make necessary arrangements in cooperation with instructors.

Behavior/Dress Code: Any behavior or dress that distracts other students from learning will receive one warning. If there is a second infringement, you will be asked to leave class.

Policy Regarding Questionable Materials: As with all worthy areas of academic inquiry, material in this course will likely challenge your understanding of the world (i.e. challenge worldviews). It is my objective as a mentor and a brother in Christ to provide the space for your questions and your personal development during this process because "Without any doubt, the mystery of our religion is great" (I Timothy 3:16a).



ADAMS CENTER

TEACHING • LEARNING • TECHNOLOGY

Abilene Christian University • ACU Box 29201
Abilene, Texas 79699-9201

November 12, 2012

Josh M. Brokaw, Ph.D., Assistant Professor
Department of Biology
Abilene Christian University
ACU Box 27868
Abilene, TX 79699-7868

Dear Dr. Brokaw,

Thank you for submitting Biology 481.01, Plant Systematics, to the Adams Center for review as a new course application. During our meeting on Friday, November 9, we reviewed the application.

In our meeting we reviewed the application and determined that it was thoroughly completed and has the support of the Adams Center. As we discussed the syllabus checklist, we identified several logistical adjustments that will assist you in satisfying all aspects of the checklist. You will not need to resubmit the application once you make those minor adjustments. We identified transferring the competencies from the application to the syllabus in addition to providing clarification on some minor issues such as questionable materials policy.

It was a pleasure to meet with you and on behalf of the Adams Center please let us know if there is any further way we can serve you.

Sincerely,

Scott E. Hamm, DEdMIN,
Director of Mobile Learning Research
The Adams Center for Teaching & Learning

Cc: James Nichols, Ph.D., Melinda Thompson, Ph.D.

ABILENE CHRISTIAN UNIVERSITY

LIBRARY

M E M O R A N D U M

DATE: November 13, 2012
TO: Dr. Josh Brokaw
FROM: Mark McCallon, Associate Dean for Library Services
RE: Course Application for BIOL 481 – Plant Systematics

After reviewing the course application, the library is able to support the proposed course. Thank you for letting the library review the course application.