

**BSC 706/L: Principles of Biological Systematics
Fall 2008**

**Lecture: Mondays, Wednesdays, and Fridays, 9:00–9:50 A.M., TEC 340
Laboratory: Tuesdays 1:00–3:40 P.M., EHH (Nursing) 117-D**

Instructor

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Office Hours

(a) 3:15–4:00 P.M. Mondays and Wednesdays
(b) By appointment

Course Description

Lecture 3 hrs. Lab 1 hr. Theory and applications in the study of evolutionary relationships, including species concepts, nomenclature, homology assessment, phylogenetic inference, and classification. Prerequisites: None stated. BSC 305 (evolution) and BSC 370 (genetics) recommended.

Course Overview

This course focuses on theory and applications in the study of evolutionary relationships. Fundamental principles behind different methods will be studied, including character selection, homology, phylogenetic inference, confidence values, species concepts, classification, and nomenclature. The application of systematics to biogeography, conservation, comparative studies, and ecology will be discussed. Appropriate for graduate students and researchers in any subdiscipline of biology concerned with evolutionary relationships or comparative study, or in philosophy of science.

Course Objectives

Students will develop and demonstrate:

- Basic knowledge of the history and philosophy of systematics
- Ability to infer relationships among organisms (phylogenetic trees) and express confidence statistics
- Ability to judge between alternative methods of phylogenetic inference and support
- Broad understanding of the challenges and viewpoints regarding homology and species concepts
- Ability to determine or produce the correct name and an appropriate classification of an organism
- Apply systematic principles to biogeography, conservation, comparative studies, and ecology

Required Texts

Schuh, R. T. 2000. *Biological Systematics: Principles and Applications*. Ithaca, NY: Cornell UP.

Wheeler, Q. D. and R. Meier, eds. 2000. *Species Concepts and Phylogenetic Theory*. New York: Columbia UP.

Class Procedures and Requirements

Attendance in class and laboratory is expected. The indicated chapter(s) and required articles from the primary literature should be read before class, which will prepare you for the material presented in lecture. Sometimes the reading assignment may seem overwhelming, but immerse yourself and make sure that you understand the broader concepts. Assignments from the texts will be more general and should be read first, followed by selections from the primary literature. The exams may cover any of this material, plus applications learned in lab. Any changes to the syllabus will be announced *in class* at least one class period in advance.

Be prompt to class, and if you must leave early, please sit near the rear of the classroom. Questions and discussion are encouraged. Cellular phones, pagers, and other electronic devices should not disrupt class. Laptop computers may be used, but be aware of and eliminate noises or habits that may distract other students.

Evaluation Criteria (lecture and lab will be considered together for one final grade applied to both)

Exam 1	20%	(100 points)
Exam 2	20%	(100 points)
Final Exam	20%	(100 points)
Homework	20%	(100 points)
Project	20%	(100 points)

Grading Scale

90–100%	A	(450–500 points)
80–89%	B	(400–449 points)
70–79%	C	(350–399 points)
60–69%	D	(300–349 points)
0–59%	F	(0–299 points)

Make-Up Exams and Late Projects

Make-up exams are given **only** if written corroboration of a serious research conflict or disabling condition or situation is provided (doctor's note, advisor's note, parental note [with phone number] about funeral, police report). Contact professor immediately about re-scheduling. *Re-scheduling after one week is not possible*. Projects cannot be turned in late. A late project or an unscheduled make-up exam results in a grade of zero.

Academic Honesty

When cheating is discovered, the faculty member may give the student an F on the work involved or in the course. If further disciplinary action is deemed appropriate, the student will be reported to the Dean of Students. In addition to being a violation of academic honesty, cheating violates the Code of Student Conduct and may be grounds for probation, suspension, and/or expulsion. Students on disciplinary suspension may not enroll in any courses offered by the University of Southern Mississippi.

ADA Policy

If a student has a disability that qualifies under the Americans with Disabilities Act and requires accommodations, he/she should contact the Office for Disability Accommodations (ODA) for information on appropriate policies and procedures. Disabilities covered by the ADA may include learning, psychiatric, physical disabilities, or chronic health disorders. Students can contact ODA if they are not certain whether a medical condition/disability qualifies. Mailing address: 118 College Drive #8586, Hattiesburg, MS 39406-0001; Telephone: 601-266-5024; TTY: 1-800-582-2233; Fax: 601-266-6035; e-mail: suzanne.hebert@usm.edu.

Class Schedule*

Date	Topic	Reading Assignment (S = Schuh, W&M = Wheeler & Meier)
August 20	Introduction to Systematics	
22	Historical Context	S1, S3
25	What are the Units? Species	W&M Preface, 1
26	Species — Discussion and Exercise	W&M 2–4
27	Species	W&M 5–6
29	Species	W&M 7–9
29	Last day to register for class	
September 1	Labor Day holiday, no class	
2	Species — Discussion	W&M 10–11
3	Species	W&M 12–14
5	Species	W&M 15–16 Davis, 1997
8	Species	Luckow, 1995 Mishler & Donoghue, 1992
9	Species — Discussion and Presentations Guest Speaker	Boyd, 1999 Hull, 1975 Ruse, 1992
10	How Are These Units Related? Interpreting Trees	Farris, 1974
12	Characters	S5
15	Character Coding	Stevens, 1991
16	<i>Lab: Distance and Wagner Trees by Hand, Character State Optimization</i>	
17	Homology 1	S4 Patterson, 1982
19	Homology 2	Roth, 1988, 1991
22	Optimality Criteria 1	S6
23	<i>Lab: Binary, Additive, and Non-Additive Characters</i>	
24	Optimality Criteria 2	Felsenstein, 1978

26	EXAM 1 Dr. Alford out-of-town	
29	Consensus and Compromise Trees	S7 Nixon & Carpenter, 1996b
30	<i>Lab: Most Parsimonious Trees and Consensus and Compromise Trees</i>	
October 1	Tree Statistics 1	S7 (review) Farris, 1989
1	Last day to drop class without academic penalty; midpoint of the semester	
3	Tree Statistics 2	
6	Total Evidence and Congruence 1	de Queiroz et al., 1995 Huelsenbeck et al., 1996
7	<i>Lab: Tree Statistics</i>	
8	Total Evidence and Congruence 2	Nixon & Carpenter, 1996a Farris et al., 1995
10	Outgroups	Nixon & Carpenter, 1993 Maddison et al., 1984
13	Search Algorithms	Swofford et al., 1996
14	<i>Lab: Outgroups, Rooting, and Polarity</i>	
15	Missing Data, Inapplicable States, and Polymorphic Taxa	Maddison, 1993 Nixon & Davis, 1991
17	Fall Break, no class	
20	Clade Support: Bremer, Jackknife, Bootstrap	Farris et al., 1996 Felsenstein, 1985
21	<i>Lab: Missing Data</i>	
22	Clade Support: Skewness, DD, and Permutation	Huelsenbeck, 1991 Källersjö et al., 1992
24	Molecular Systematics	Doyle, 1992
27	DNA Alignment and Homology Assessment	
28	<i>Lab: Bootstrap and Jackknife</i>	
29	Gene Trees and Species Trees; Orthology and Paralogy	Doyle & Davis, 1998
31	Phenetics: NJ, UPGMA	handout
November 2	Daylight Savings Time ends; set clocks back one hour.	

3	Molecular Clocks	Graur & Martin, 2004
4	<i>Lab: DNA Data and Alignment</i>	
5	EXAM 2	
7	Maximum Likelihood 1	Felsenstein, 1981
10	Maximum Likelihood 2	Huelsenbeck & Crandall, 1997
11	<i>Lab: Maximum Likelihood and Bayesian Analysis</i>	
12	Bayesian Analysis	Huelsenbeck et al., 2002
14	How Does One Express Relationships? Classification	S8 Sokal & Sneath, 1963 Brummitt, 1997
17	What Does One Call the Units and Groups of Units? Nomenclature 1	S2
18	<i>Lab: Nomenclature Exercise</i>	
19	Nomenclature 2	de Queiroz & Gauthier, 1994
21	Nomenclature 3	Moore, 1998 Nixon & Carpenter, 2000 Dominguez & Wheeler, 1997
24	Applied Systematics: Biogeography and Host-Parasite Relationships	S9 Van Veller et al., 2003
25	Thanksgiving holiday, no class or laboratory	
26		
28		
December 1	Applied Systematics: Comparative Biology and Ecology	S10, S11
2	Project Talks Written Project Due	
3	Current Issues and Review	Wenzel & Carpenter, 1994 Luckow & Bruneau, 1997
Monday December 8 1:30–4:00 P.M.	Final Exam Comprehensive	

*Schedule may be revised if necessary. Students will be notified if this is the case.

Homework

Homework will consist of four activities, each valued at 25 points (5% of your grade): (1) a nomenclatural exercise, (2) a species circumscription exercise, (3) a character coding and phylogeny exercise, and (4) leading a discussion on an assigned paper.

Student Project

Each student will prepare a project using phylogenetic methods. The approximately 12-20 page report, which will include your phylogenetic trees, character matrices, and references, should address the history of the group concerned, previous studies, materials and methods, and your results and discussion. I expect a phylogeny of taxa (or genes), at least using parsimony but possibly using other methods, with appropriate statistics and a discussion using phylogenetic terms (monophyly, homology, character support, strict consensus, etc.). Results may be compared with maximum likelihood, distance, or Bayesian analyses. You may use any computer programs that you wish (WinClada, PAUP*, DNAML, MrBayes, etc.). I would prefer that you leave studies at the population level for Dr. Kreiser's course.

There are several options for the project:

- Re-do or modify an existing project and compare/contrast your results. For example, numerous studies have been conducted using only one kind of method, or you may be suspicious of someone's results. Re-create their matrix and download and align their DNA sequence data, and see if you get the same results. Science at work. Alternatively, find a study and perform an exhaustive set of analyses on it (distance, parsimony, maximum likelihood, Bayesian, etc.; separate versus combined data; molecular data as nucleotides versus amino acids; different alignments; etc.). Compare/contrast results and other factors (for example, calculating time).
- Augment an existing study. For example, some groups have phylogenies based on morphological data but have not been studied with molecular data. Find molecular data to add to their studies (you might have to work at the generic level; we'll talk about the problems associated with this in class), and compare/contrast your results.
- Create your own study based on publicly available data. Lots of things don't get published, but the data are out there.
- Create your own study based on *your* data. Do a good job here, and you might produce something worthy of publication.

During the last lab period of the course, your paper will be due, and you will be responsible for a 10-minute talk on your study.