BSC 706/L: Principles of Biological Systematics
Fall 2006

Instructor

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Office Hours

By appointment. E-mail, telephone, or see me in class in advance.

Course Description

Lecture 2 hrs. Lab 1 hr. The organized study of factors and processes causally responsible for patterns of organic diversity through phylogenetic evaluation, taxonomic hierarchical devices, and nomenclature. 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 statistics about them
- 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.

Kitching, I. J., P. L. Forey, C. J. Humphries, and D. M. Williams. 1998. *Cladistics: The Theory and Practice of Parsimony Analysis*. 2nd ed. Oxford, UK: Oxford UP. [The Systematics Assocation Publication No. 11]

Class Procedures and Requirements
Attendance in class is expected, but roll will not be taken. 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 daunting, but dive in and do your best. 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, but limited time is available in class; please respect the professor's need to move on. 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, K=Kitching)
August 23	Introduction to Systematics	S pp. 237–239
	Lab: WinClada and NONA	
28	Historical Context	S1, S3 Hennig, 1965 Mayr, 1984 Sokal & Sneath, 1963
30	Interpreting Trees	Bock, 1973 Cracraft, 1974 Gaffney, 1979
	Lab: Distance and Wagner Trees by Hand	
September 1	Last day to register for class	
4	Labor Day holiday, no lecture	
6	Characters	S5, K1 Farris, 1979 Pimentel & Riggins,1987
	Lab: Character State Optimization	
11	Homology	S4 Farris, 1974 Roth, 1988, 1991 Patterson, 1982
13	Character Coding	K2 Stevens, 1991
	Lab: Binary, Additive, and Non-Additive Characters	
18	Optimality Criteria	S6 Felsenstein, 1978
20	Consensus and Compromise Trees	S7, K7 Nixon & Carpenter, 1996b
	Lab: Most Parsimonious Trees and Consensus and Compromise Trees	
25	**EXAM 1**, Dr. Alford out-of-town	
27	Tree Statistics	K5 Farris, 1989
	Lab: Tree Statistics	
October 2	Total Evidence and Congruence	K8 de Queiroz et al., 1995 Huelsenbeck et al., 1996 Nixon & Carpenter, 1996a Farris et al., 1995

4	Outgroups	Nixon & Carpenter, 1993 Maddison et al., 1984
	Lab: Outgroups, Rooting, and Polarity	
	Last day to drop course without academic penalty; midpoint of semester	
9	Search Algorithms	K3 Swofford et al., 1996
11	Missing Data, Inapplicable States, and Polymorphic Taxa	K4.2 Maddison, 1993 Nixon & Davis, 1991
	Lab: Missing Data	
16	Clade Support: Bremer, Jackknife, Bootstrap	Farris et al., 1996 Felsenstein, 1985
18	Clade Support: Skewness, DD, and Permutation	K6 Huelsenbeck, 1991 Källersjö et al., 1992
	Lab: Bootstrap and Jackknife	
19–20	Fall Break	
23	Species Concepts – 1	Baum, 1992 Hull, 1975 Donoghue, 1985 Ruse, 1992 Templeton, 1989
25	Species Concepts – 2	Baum & Shaw, 1995 Davis, 1997 Luckow, 1995 Mishler & Donoghue, 1992 Nixon & Wheeler, 1990 (Davis & Nixon, 1992)
	Lab: Discussion of Species Concepts	
29	Daylight Savings Time ends. Set clocks back one hour.	
30	**EXAM 2**	
November 1	Molecular Systematics: Data Types and Alignment	Doyle, 1992
	Lab: DNA Alignment	
6	Gene Trees and Species Trees; Orthology and Paralogy	Doyle & Davis, 1998
8	Phenetics: NJ, UPGMA, Molecular Clocks	TBA
	*Lab: PAUP**	

13	Maximum Likelihood and Bayesian Analysis	Felsenstein, 1981 Huelsenbeck & Crandall, 1997
15	Applied Systematics: Biogeography and Host-Parasite Relationships	S9 Brooks, 1990 Van Veller et al., 2003
	Lab: Maximum Likelihood and Bayesian Analysis	
20	Applied Systematics: Comparative Biology and Ecology	S10, S11 Luckow & Bruneau, 1997 Wenzel & Carpenter, 1994
22	Thanksgiving holiday, no lecture or lab	
27	Classification	S8 Brummitt, 1997
29	Nomenclature – 1	S2
	Lab: Nomenclatural Stability	
December 4	Nomenclature – 2	de Queiroz & Gauthier, 1994 Dominguez & Wheeler, 1997 Moore, 1998 Nixon & Carpenter, 2000
6	Current Issues, Review	
	Lab: Project Talks ***Written Project Due***	
Friday, 8 December 8:00–10:30 A.M.	**Final Exam** **Comprehensive**	

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

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 upcoming course on phylogeography.

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 (perhaps less, if we have more students than I suspect) on your study.