Entomology and Genetics 606
Wildlife and Fisheries Sciences 646
Quantitative Phylogenetics
Spring 2020

Course Syllabus

Instructor:

Dr. Mariana Mateos
Dept. of Ecology and Conservation Biology
mmateos@tamu.edu
Office Hours at WFES 270 by appointment.

Purpose:

To provide students with hands-on experience in the inference of phylogenetic relationships using current computer applications.

Course information:

Class meets:

- Lecture on Monday and Wednesday, 12:40–1:30 pm, WFES 236

- Lab on Fri 9am–12 pm at WFES 406 [stay posted for changes]

Course Description:

This course provides the theory and tools that are used to infer phylogenetic relationships using morphological characters, and DNA and protein sequences. The course emphasizes a hands-on approach to molecular phylogenetics and combines lecture presentations with computer exercises, discussion of original scientific literature and peer review exercises.

Course credit:

3 semester hours, based on two 50 min lectures/discussion per week and one ~3h laboratory session per week.

Prerequisite:

A basic course in principles of systematic and comparative biology. Entomology 601 at Texas A&M University provides the necessary background, but equivalent courses are fine with the consent of the instructor.

Textbook (Optional):

-Lemey, Salemi and Vandamme (2009), *The Phylogenetic Handbook, Second Edition*, Cambridge University Press, 723 pp. (your instructor has a copy and the library has an electronic copy, but it probably allows a limited number of simultaneous users)
https://ebookcentral.proquest.com/lib/tamucs/detail.action?docID=431992

Course Web Site for Content and Grades: ecampus.tamu.edu

Communication with Instructor:
Please use my tamu email address (mmateos@tamu.edu) for electronic communications with me (**do not use eCampus for this**). In the subject line, include ENTO 606, GENE 606, or WFSC 646.

Grading:

Grades will be based on:
Final project proposal (5%)
Preliminary data set for final project (5%)
First draft of Final project (15%)
Written reviews of peers' first drafts (10%)
Final Paper (25%)
Homework/lab assignments (30%).
Class participation (includes leading paper discussions) (10%)

[91–100% = A; 81–90% = B; 71–80%= C; 61–70 = D; ≤60 = F]

Attendance:

Attendance to lectures and labs is compulsory. I will follow the student rule https://student-rules.tamu.edu/rule07/. You should inform me as soon as possible if you plan to miss (or have missed) a lecture or lab/discussion due to a university-excused reason. Assignments may be given during lectures. Students are responsible for assignments even if they did not attend lecture during which the assignment was given, unless other arrangements have been made with the instructor. Each student will be responsible for leading the discussion of several papers throughout the semester, which will be assigned by me.

Discussion participation:

Prior to the in-class Discussion session, you must submit in ecampus (under "Discussions") at least three discussion points/questions regarding each paper to be discussed. Questions that simply reflect ignorance, and/or lack of effort, concerning a topic are not acceptable. However, part of the discussion session can be used to clarify concepts.

Course outline (Subject to Change):

Week 1		**Introduction and Homology**
	Mon Jan 13	Introduction to the course
	Wed Jan 15	Homology and sequence alignment **Pre-lecture Reading**: Goldman and Yang 2008 (doi:10.1098/rstb.2008.0182)
	Fri Jan 17	Demonstration: Data file formats, tree file formats, data editing and file conversion tools. Consulting on final projects.
Week 2		**Homology continued**
	Mon Jan 20	No class (Martin Luther King Jr. Day)
	Wed Jan 22	Approaches to sequence alignment
	Fri Jan 24	**Lab 1:** BLAST, sequence alignment
Week 3		**Parsimony Analysis**
	Mon Jan 27	Basic parsimony analysis.
	Wed Jan 29	Character optimization and models of character state change
	Fri Jan 31	**Lab 2:** Parsimony analysis, character optimization
Week 4		**Advanced Parsimony Analysis**
	Mon Feb 3	Strategies and algorithms for heuristic parsimony analysis **Pre-lecture reading:** Goloboff 1999 **One-page proposal for Final project due** (please submit by email)
	Wed Feb 5	Resampling methods, Bremer Support **Discussion paper:** Lemmon and Lemmon 2013
	Fri Feb 7	**Lab 3:** Advanced parsimony analysis
Week 5		**Distance-Based Methods**
	Mon Feb 10	Measures of molecular distance.
	Wed Feb 12	Clustering algorithms. **Discussion paper:** Soltis and Soltis 2003
	Fri Feb 14	**Lab 4:** Phenetic analysis of molecular data, MEGA/PAUP*
Week 6		**Model-Based Methods: Maximum Likelihood Methods**
	Mon Feb 17	Substitution rate matrices, nucleotide frequencies, other model parameters.
	Wed Feb 19	Model Selection **Discussion:**
	Fri Feb 21	**Lab 5:** ModelTest **Preliminary, aligned data for final project due**
Week 7		**Model-Based Methods: Maximum Likelihood Methods continued**
	Mon Feb. 24	Implementing a Maximum Likelihood analysis
	Wed Feb. 26	Different algorithms and ML programs **Discussion:**
	Fri Mar. 28	**Lab 6:** Implementing a Maximum Likelihood analysis (PAUP*, PhyML, RAxML, IQTree and GARLI)
Week 8		**Model-Based Methods: Bayesian Analysis**

	Mon Mar 2	Bayesian inference methods in phylogenetics.
	Wed Mar 4	Analytical issues, convergence of chains **Discussion:**
	Fri Mar 6	**Lab 7:** Implementing a Bayesian analysis; MrBayes.
Spring Break	**Mar 9-13**	**Spring Break (NO CLASSES)**
Week 9		**Gene Trees vs. Species Tree**
	Mon Mar 16	Gene trees vs. species trees, deep coalescence and lineage sorting, the "anomaly zone" **Pre-lecture reading:** Degnan et al. 2009
	Wed Mar 18	Analytical approaches to gene tree discordance **Discussion**:
	Fri Mar 20	**Lab 8: Species tree analyses (*Beast, BUCKy)**
Week 10		**Rate heterogeneity and the molecular clock**
	Mon Mar 23	Tests of Molecular Clock
	Wed Mar 25	Calibration and relaxed clocks **Discussion**
	Fri Mar 27	**Lab 9:** Identifying Rate Heterogeneity among lineages, and divergence time estimation
Week 11		**Testing Hypotheses: Topology Comparisons**
	Mon Mar 30	Topology Comparisons: AU test and (SOWH test)
	Wed Apr 4	Parametric Bootstrap **Discussion:**
	Fri Apr 3	**No lab/class: EIS Symposium (theeis.tamu.edu)**
Week 12		**Data Partitions**
	Mon Apr 6	Strategies for analysis of heterogeneous data sets **First draft of final paper due (submit electronically)**
	Wed Apr 8	Partitioned Bremer Support, tests for data congruence **Pre-lecture reading**: Lambkin 2004 **Discussion:**
	Fri Apr 10	**No lab/class: Reading Day**
Week 13		**Testing Hypotheses: comparative analyses**
	Mon Apr 13	Use of phylogenetic frameworks for hypothesis testing **Pre-lecture reading**: Garland et al. 2005 **Written reviews of peer's papers due**
	Wed Apr 15	Independent Contrasts. **Discussion:**
	Fri Apr 17	**Lab 10: Hypothesis testing**
Week 14		**Open: unfinished topics or suggestions for additional topics (MM)**
	Mon Apr 20	**To be determined**. Some options: phylogenetic networks, detection of recombination, ancestral trait reconstruction, model averaging, next generation sequencing and phylogenomics, SVDquartets, etc.
	Wed Apr 22	TBD

	Fri Apr 24	**Open Lab**: I will be in the laboratory to help you with any final issues with the analyses for your projects, construction of figures, etc.
Week 15		
	Mon Apr 27	**Prep Day, classes meet**: Course Evaluations. Open discussion, critique of course, suggestions, problems encountered during course, etc. Last meeting of class.
	Tue Apr 28	**Redefined by TAMU as Friday**. No formal class, but instructor will be available in lab, upon request, for consultation on final projects. (If you would like to work with me, please send me an email to confirm so I will be sure to be there)
	Mon May 4	**Final Paper due.**

Class Participation.

I believe that participation in class is essential for graduate students to develop critical thinking and oral communication skills. It also allows me to gauge the level of understanding of covered topics, and the degree to which our teaching of various topics has been successful, or not. To obtain 100% in class participation, you should excel in all four of the following:

1- Participate with questions or comments during lectures.
2- You should lead discussions assigned to you. Come to class prepared to address major issues or questions with the paper.
3- Turn in your discussion points for each paper discussed in class, prior to class.
4- Participate actively in paper discussions, even if you are not the discussion leader.

Homework Assignments.

Weekly homework assignments provide practice with manipulating data and use of particular computer software relevant to each week's topics. In grading each assignment, I will use the following criteria:

1- Is each part of the assignment completed, and is an appropriate amount of output from programs, written discussion, or charts or figures provided so that I can determine that you have addressed all of the questions? When including computer output, be very selective in providing only what I ask for, or only what is essential to answer a question or address a particular point (60% of grade).

2- Are questions that require interpretation, analysis of results, or synthesis of results answered in sufficient detail, and in your own words (40% of grade)?

Americans with Disabilities Act (ADA) Policy Statement

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Academic Integrity Statement

"An Aggie does not lie, cheat, or steal or tolerate those who do."
Refer to the Honor Council Rules and Procedures on the web http://www.tamu.edu/aggiehonor. Pay special attention to what constitutes plagiarism, including examples (see https://library.tamu.edu/services/library_tutorials/academic_integrity/academic_integrity_3.html)

Student Support Services

A variety of student resources focused on health and safety are available to you should you need them
https://wfsc.tamu.edu/additional-info/student-support-resources/

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Guidelines for Lab Assignments

In all/most of the Friday lab sessions, we will discuss and distribute an assignment. Generally, I will distribute these electronically before class, along with any necessary data sets or other files needed to complete the work.

During the first part of a typical lab period, I will demonstrate the relevant software. During the remainder of the lab, you should try to complete the assignment. Because computer phylogenetics can be extremely CPU intensive, in some cases you will need to let the analyses run until they are completed, even if it takes a few days. In most cases, the assignments will be due electronically one week after the lab in which they are assigned. I'll do my best to set reasonable time limits for the assignments.

It is best to work in teams of 2-3 students. Please feel free to use your own personal laptops or computers in your office or lab to complete the assignments, as long as you are using licensed versions of the software. In some cases, you will find it necessary or useful to use other computing resources, such as the Brazos supercomputer at Texas A&M University, the CIPRES portal, or software served up on sites maintained by the developers of the programs.

Please submit by email to me one report as one single pdf file for each team and list the 2-3 team members that worked on the assignment. Please be as concise and efficient as possible in answering the questions posed in the assignment. Include in your report printouts or graphic results from your analyses, but if you do, please be sure that each item submitted is specifically used to answer a question or demonstrate a relevant point. I encourage you to use drawing programs (e.g. Adobe Illustrator or Inkscape to edit your figures; this will be handy when you do your final paper). Appending pages and pages of different trees or computer output without annotating or discussing them is not a good strategy.

Almost always, all members of the team will be assigned the same grade for the assignment, although I reserve the right to assign individualized grades if I believe it to be warranted. Assignments turned in from 1-7 days late will be graded, but points will be deducted due to lateness. After 7 days from the due date, assignments will no longer be accepted. If you have special circumstances that prevent you from completing an assignment on time, please discuss them with me.

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Requirements for Final Project

I require that each student design and complete an independent research project. The written report on this project will be your final paper.

The final paper is due in electronic copy no later than Monday, May 4. All deadlines are at 5 pm of the due date. Assignments not turned in by the deadline will receive a zero. If special circumstances prevent you from meeting a deadline, please discuss them with us. *Please submit all materials to me electronically.*

Deadlines:

Mon Feb 3: A one-page proposal for your final paper project is due in class. This should include brief descriptions of the topic, the data and methodologies to be used (5% of course grade). We strongly advise that you schedule a meeting with one (or both) of us to discuss your ideas for the final project BEFORE this deadline.

Fri Feb 21: An electronic copy of your preliminary data for final project is due. Submit this is as ONE SINGLE Nexus file. If multiple data partitions are included, please annotate them so that we can clearly sort them out. DNA sequence data should be ALIGNED. Indicate in comments in the data file how the data were aligned. If you are including morphological or behavioral data, please provide brief explanations of the character codings, and how the characters are to be treated (ordered, unordered, etc.) (5% of course grade)

Monday Apr 6: First draft of final paper (15% of course grade)

Monday Apr 13: Written reviews of peers' papers to instructors (10% of course grade)

Mon May 4: Final paper due (25% of course grade)

Objectives of the Final Project:

1. **obtain** expertise on the topics covered in the course
2. **practice** the development of original research projects
3. **practice** the preparation of manuscripts for peer-reviewed publication
4. **practice** peer-review of colleague's manuscripts

Topic Selection: The project should address an interesting or controversial question in your field. You may use published data or original data. We expect that you will employ a comprehensive and contemporary set of analytical methods appropriate to your data, and we expect critical discussion and interpretation of your results. You should plan to meet with one (or both) of us prior to submitting your proposal to discuss the idea for your project.

Format: The final paper (and the first draft) should be in the form of a journal article with the standard sections: Abstract, Introduction, Materials & Methods, Results, Discussion, and Literature Cited. In the Introduction you should provide sufficient background for your project so that we can understand the antecedents in the literature and their significance, and you should pose the major questions that will be addressed in the paper. Return to these questions in the Discussion section, and tell us how your results have helped to answer them. Literature citations should follow the format of any peer-reviewed journal of your choice.

Length: The paper should be no longer than 15-pages, at 12pt font, double-spaced type, including figures and tables, but not including Literature Cited. In a separate letter (not included in the 15-page limit), each student must explain how the reviewer's comments were addressed.

Review of peers's papers: Each student is expected to review the final paper drafts of two other students. We will give more specific guidelines later, but the expectation will be similar to what you would provide in reviewing a journal article for an editor.

Grading scheme of final paper (including first draft)

The following aspects of the final paper will be evaluated (each is equally weighted):

1- Are the evolutionary or biological questions underlying the study and the objectives of the paper clearly stated?

2- Is enough background provided for you to place the proposed project in the larger context of research in the field?

3- Is the proposed project likely to be an original contribution to the field?

4- Are the data proposed to be collected appropriate to answer the questions raised in the introduction?

5- Are the proposed methods appropriate to the data, and to address the proposed questions? Are they sufficiently rigorous and do they reflect the current state of the field?

6- Are the results of analyses or experiments clearly and completely presented, and do any conclusions or interpretations drawn from them appear to be sound?

7- Does the author return to the questions or objectives of the study in the discussion, and discuss them in terms of the results?

8- Is the paper well written and free of errors?

9- Are points in the text referenced appropriately, using a consistent format?

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Guidelines for Peer Review

In your review, you should address the following points. Don't just provide a YES or a NO, but explain why, particularly in the case of a "no" evaluation. You should provide the author with a clear and specific set of issues that you would want to see addressed in a revised paper. It is common practice for the reviewer to summarize the paper in his/her own words, so I recommend that you do this. This also helps to see how well the reviewer understood and/or paid attention. Your peer review will be graded based on whether you have addressed each of these points below professionally and appropriately (each weighed equally).

1- Are the evolutionary or biological questions underlying the study and the objectives of the paper clearly stated?
2- Is enough background provided for you to place the proposed project in the larger context of research in the field?
3- Is the proposed project likely to be an original contribution to the field?
4- Are the data proposed to be collected appropriate to answer the questions raised in the introduction?
5- Are the proposed methods appropriate to the data, and to address the proposed questions? Are they sufficiently rigorous and do they reflect the current state of the field?
6- Are the results of analyses or experiments clearly and completely presented, and do any conclusions or interpretations drawn from them appear to be sound?
7- Does the author return to the questions or objectives of the study in the discussion, and discuss them in terms of the results?
8- Is the paper well written and free of errors?
9- Are points in the text referenced appropriately, using a consistent format?

Please be constructive, cordial and professional in your comments. Most importantly, whenever possible, offer concise and specific suggestions for improving the manuscript or addressing problems that you find in it.

It is best to make your points as a series of individual, numbered suggestions, referencing if necessary, the location of the text in the manuscript. This makes it easier for the author and for me to be certain that (s)he has addressed all of your suggestions.