

Course syllabus: BIOL 373

Laboratory on the Evolution of Animal Behavior

URL: <https://boterolab.weebly.com/bio-373.html>

Instructor: Carlos A. Botero, Ph. D. (cbotero@wustl.edu)

MTE: Trey Scott (tjscott@wustl.edu)

AI: Savannah Fuqua (savannah.fuqua@wustl.edu)

Description: This course explores the evolution of animal behavior through hands-on modules that emphasize a range of analytical approaches commonly used in modern evolutionary biology. It is intended as a practical introduction to these tools and therefore requires no prior experience with any of the topics covered. The course includes a brief overview of scientific computing and statistics in R; (2) *an experimental lab module* that explores the adaptive value of agonistic behavior in crickets; (3) *a lab module on phylogenetic comparative methods* that explores the evolution of sexual dichromatism; and (4) *a computer simulation lab* where students will use evolutionary simulation modeling to explore questions on the effect of rare selection events on the evolution of behavior. Most of our class time will be spent actively designing experiments, collecting data or analyzing results. Each of our lab modules will be complemented by student-driven discussions of relevant primary literature that either exemplify the techniques being used or place the work we are doing in a broader conceptual framework.

Readings: All readings for this course come from the primary literature. Each student will present one of the following articles to the class (see guidelines for “lightning talks” below)

D. A. Luther, J. Phillips, & E. P. Derryberry. 2016 Not so sexy in the city: urban birds adjust songs to noise but compromise vocal performance. *Behavioral Ecology* 27(1): 332–340, doi.org/10.1093/beheco/arv162.

J. Maynard-Smith & G.R. Price 1973. The Logic of Animal Conflict. *Nature* 246: 15–18
doi: <https://doi.org/10.1038/246015a0>.

D. L. Morina, S. Demarais, B. K. Strickland, J. E. Larson. 2018. While males fight, females choose: male phenotypic quality informs female mate choice in mammals. *Animal Behaviour*. 138: 69-74. <https://doi.org/10.1016/j.anbehav.2018.02.004>.

- C. N. Templeton, E. Greene, K. Davis. 2005. Allometry of Alarm Calls: Black-Capped Chickadees Encode Information About Predator Size. *Science* 308(5730): 1934-1937. doi: [10.1126/science.1108841](https://doi.org/10.1126/science.1108841).
- J. C. Wingfield. 2013. The comparative biology of environmental stress: Behavioural endocrinology and variation in ability to cope with novel, changing environments. *Animal Behaviour*. 85(5): 1127-1133. <https://doi.org/10.1016/j.anbehav.2013.02.018>.
- A. Zahavi. 1977. The cost of honesty: Further Remarks on the Handicap Principle. *Journal of Theoretical Biology* 67(3): 603-605. doi.org/10.1016/0022-5193(77)90061-3.
- B. Ballentine, J. Hyman, S. Nowicki. 2004. Vocal performance influences female response to male bird song: an experimental test. *Behavioral Ecology* 15:163–168. <https://doi.org/10.1093/beheco/arg090>.
- M. J. Fernandes-Martins, T. M. Puckett, R. Lockwood, J. P. Swaddle & G. Hunt. 2018. High male sexual investment as a driver of extinction in fossil ostracods. *Nature* 556: 366–369. <https://doi.org/10.1038/s41586-018-0020-7>.
- T. Fristoe, Iwaniuk A, & CA Botero. 2017. Big brains stabilize population dynamics in birds. *Nature Ecology & Evolution* <https://doi.org/10.1038/s41559-017-0316-2>.
- R. D. Gray, A. J. Drummond, S. J. Greenhill. 2009. Language Phylogenies Reveal Expansion Pulses and Pauses in Pacific Settlement. *Science* 323(5913) : 479-483. doi: [10.1126/science.1166858](https://doi.org/10.1126/science.1166858).
- B. Kempnaers, GR Verheyen, AA Dhondi. 1997. Extrapair paternity in the blue tit (*Parus caeruleus*): female choice, male characteristics, and offspring quality. *Behavioral Ecology* 8:481–492. <https://doi.org/10.1093/beheco/8.5.481>.
- D. L. Morina, S. Demarais, B. K. Strickland, J. E. Larson. 2018. While males fight, females choose: male phenotypic quality informs female mate choice in mammals. *Animal Behaviour*. 138: 69-74. <https://doi.org/10.1016/j.anbehav.2018.02.004>.
- Botero, CA, I. Pen, J. Komdeur, and F.J. Weissing. 2010. The evolution of individual variation in communication strategies. *Evolution*. 64: 3123-3133. doi: [10.1111/j.1558-5646.2010.01065.x](https://doi.org/10.1111/j.1558-5646.2010.01065.x).
- L. Fromhage, M. Jennions, H. Kokko. 2016. The evolution of sex roles in mate searching. *Evolution* 70(3): 617-624. <https://doi.org/10.1111/evo.12874>.
- S. Gandon, M. J. Mackinnon, S. Nee & A. F. Read. 2001. Imperfect vaccines and the evolution of pathogen virulence. *Nature* 414: 751–756. <https://doi.org/10.1038/414751a>.

S. Mitri, D. Floreano, and L. Keller. 2009. The evolution of information suppression in communicating robots with conflicting interests. *Proceedings of the National Academy of Sciences* 106 (37) 15786-15790. <https://doi.org/10.1073/pnas.0903152106>.

Reeve HK Emlen ST Keller L . 1998. Reproductive sharing in animal societies: reproductive incentives or incomplete control by dominant breeders? *Behavioral Ecology* 9:267–278. <https://doi.org/10.1093/beheco/9.3.267>.

M. Wolf, G. S. van Doorn, O. Leimar & F. J. Weissing. 2007. Life-history trade-offs favour the evolution of animal personalities. *Nature* 447: 581–584. [doi:10.1038/nature05835](https://doi.org/10.1038/nature05835).

Topics to be covered:

Observing and quantifying behavior (Sampling and recording rules; Reliability, replication, and healthy data practices; Formulating and testing Hypothesis; Experimental design; Pseudoreplication)

Basic statistics (Sampling and probability distributions; How and when to apply contingency tables, goodness of fit tests, correlation, regression and General Linear Models)

Scientific writing (Standard manuscript format; Basic elements of scientific writing style; active voice; avoiding unnecessary redundancy and digression)

Evolution of animal conflicts (Resource holding potential, motivation, and access to information as drivers of agonistic behavior; The evolution of ritualization; Social hierarchies)

Evolution of animal communication (What is communication? The evolution of honesty; Costs and constraints on signal evolution; Co-evolution of senders and receivers; Emergent properties of individual variation within populations)

Sexual selection and female choice (Anisogamy and the competition for mates; Measures of sexual selection; Costs and constraints on mating preferences)

Game theory (Hawk and Dove game, Sequential Assessment Game, Cumulative Assessment Game)

Phylogenetic comparative methods (pGLS and correlated trait evolution models)

Cultural evolution (Phylolinguistics, Macroecology and macroevolution of human culture)

Electronics policy: Electronics will be essential for the collection and analysis of data in the active learning portion of this course. During lecture times, the use of electronics will be strictly prohibited unless otherwise stated by the instructor.

Schedule of major assignments and exams: The course is designed to meet in 2x 3hr blocks per week. It will be evaluated on the basis of participation in class and written reports (no exams). *Reports should be uploaded to blackboard prior to or on the designated dates listed in the schedule below. Students that upload their assignments late will be deducted 5 points per day past the due date. No lab will be accepted later than 7 calendar days from the due date.*

Criteria for evaluating student work: Students can achieve a maximum of 500 points in this course: Basic statistics (100 points), Aggression Lab (100 points), Phylogenetic Comparative Methods Lab (100 points), Evolutionary Simulation Lab (100 points), and class participation (100 points). The statistics module will be evaluated through a problem set, whereas the lab modules will be evaluated through written reports in the form of scientific manuscripts.

Written reports (other than the basic statistics module) will be evaluated based on the following criteria:

(a) Title and Abstract (5 points): Both of these are different types of summaries of what you did and why it matters. Your title should be informative and accurate, and your abstract should follow the following general format:

- 1-2 sentences describing what the problem or the observation you are interested in is.
- 1-2 sentences very broadly saying what you did to address this issue
- 1-3 sentences stating what you found
- 1-2 sentences interpreting what your results mean
- 1 closing sentence saying why this work matters

(b) Introduction: Has the relevant background been provided and have the ideas described been properly referenced (10 points)? Have the questions you will address been clear stated (5 points)?

(c) Methods and Results: Were trials scored and the resulting data made available to the rest of the class on time (10 points)? Are the procedures and study design clearly described (5 points)? Are results clearly described and summarized (10 points)? Are statistical tests appropriate (5 points)? Are figures clear and informative (5 points)?

(d) Discussion:

Results are properly interpreted (10 points), discussed (25 points) and placed in the context of earlier literature (10 points);

Class participation will be evaluated on the following criteria:

Presentation skills (60 points): Each student will present a primary literature paper to the class in the format of a “lightning talk” (10 min talk; 5 min questions). Students will choose a paper on the topic they are assigned and will clear their selection with the AI or MTE. The lightning talk should be clear but brief and should cover the following aspects of the chosen paper:

- a. What is the main idea? (questions/background)
- b. What evidence does the speaker give to support it? (methods/results)
- c. What do you think about it? (discussion)
- d. How important is it? (implications)
- e. Do you agree that the evidence supports the theory?

Feedback (40 points): Students are expected to participate in their peers’ presentations by asking engaging questions after the talk and providing constructive feedback on presentation style and content. The instructor will facilitate these feedback sessions at the end of each lightning talk and will promote a respectful, positive, and constructive environment.

Grading scale:

The following scale will be used to assign final grades based on the total amount of points a student accumulates over the duration of the course.

A+: 485-500	B+: 435-450	C+: 385-400	D+: 335-350
A: 468-484	B: 418-434	C: 368-384	D: 318-334
A-: 451-467	B-: 401-417	C-: 351-367	D-: 301-317
F: 0-300			

Prerequisites: Bio 2970 or permission of instructor.

Schedule: The class will meet on Tuesdays and Thursdays from 9 AM to noon (NB: check schedule for room number). Please contact the instructors ahead of time (at least two weeks prior) for religious holidays accommodations.

Date	Course module	Topics covered	Room
08/28/17	Introduction	<ul style="list-style-type: none">• Introductions & expectations• Generating and testing hypotheses about the adaptive value of animal behavior• Ultimate v proximate questions	LS 117

		<ul style="list-style-type: none"> • Different approaches to the study of animal behavior • Reliability, replication, and healthy data practices 	
08/30/17	R computing and statistics	<ul style="list-style-type: none"> • Data management in R • Basic plotting commands • Pseudo code, loops and basic functions 	LS 117
09/04/17	R computing and statistics	<ul style="list-style-type: none"> • Sampling and probability distributions • Correlation • General Linear Models 	LS 117
09/06/17	R computing and statistics	<ul style="list-style-type: none"> • Random effects • Q&A on problem set • Demo of "lightning talks" 	LS 117
09/11/17	Observing and manipulating behavior	<ul style="list-style-type: none"> • LIGHTNING TALKS • Natural history of crickets • Resource holding potential, motivation, and information in the evolution of conflict resolution strategies 	LS 117
09/13/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Discuss project proposals <p style="text-align: center;">Stats Assignments due TODAY</p>	LS 202
09/18/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Workshop on scientific writing • Data collection and analysis 	LS 202
09/20/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 202
09/25/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 202
09/27/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 202
10/02/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 202
10/04/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 202
10/9/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data CURATION 	LS 202
10/11/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Statistical analyses 	LS 117
10/16/17	Fall Break		
10/18/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Statistical analyses 	LS 117
10/23/17	Observing and	<ul style="list-style-type: none"> • LIGHTNING TALKS (sessions II and III) 	LS 117

	manip. behavior	<ul style="list-style-type: none"> • Report writing and final questions <p style="text-align: center;">Carlos in Tucson AZ</p>	
10/25/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Sexual selection and ornamentation • Sexual dimorphism • Tree thinking: uncovering broad patterns in the evolution of behavior using molecular phylogenies. • {colorZapper} in R • Handbook of the Birds of the World 	LS 117
10/30/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis <p style="text-align: center;">CRICKET REPORTS due TODAY</p>	LS 117
11/01/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis • Introduction to pGLS 	LS 117
11/06/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis 	LS 117
11/08/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Introduction to pGLS • Statistical analyses 	LS 117
11/13/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Report writing and final questions 	LS 117
11/15/17	Modeling behavior	<ul style="list-style-type: none"> • Introduction to evolutionary simulation modeling • Model building 	LS 117
11/20/17	Modeling behavior	<ul style="list-style-type: none"> • Model building <p style="text-align: center;">COMPARATIVE STUDY REPORTS due TODAY</p>	LS 117
11/22/17	Thanksgiving Break		
11/27/17	Modeling behavior	<ul style="list-style-type: none"> • Model building 	LS 117
11/29/17	Modeling behavior	<ul style="list-style-type: none"> • Data collection and analysis <p style="text-align: center;">Carlos in Chicago</p>	LS 117
12/04/17	Modeling behavior	<ul style="list-style-type: none"> • Data collection and analysis 	LS 117
12/06/17	Modeling behavior	<ul style="list-style-type: none"> • Bio 373 Wrap-up Session 	LS 117
12/15/17		MODELING REPORTS due TODAY	