

Course syllabus: BIOL 373

Laboratory on the Evolution of Animal Behavior

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

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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 evolutionary origins of slow v. fast life history strategies; 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)

Cricket Module

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

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).

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](https://doi.org/10.1016/0022-5193(77)90061-3).

Damian O. Elias, Carlos A. Botero, Maydianne C. B. Andrade, Andrew C. Mason, Michael M. Kasumovic, High resource valuation fuels “desperado” fighting tactics in female jumping spiders, *Behavioral Ecology*, Volume 21, Issue 4, July-August 2010, Pages 868–875, <https://doi.org/10.1093/beheco/arg073>.

Green P. A. and Patek S. N. Mutual assessment during ritualized fighting in mantis shrimp (Stomatopoda). 2018. *Proc. R. Soc. B.* <http://doi.org/10.1098/rspb.2017.2542>.

Bergman M, Olofsson M and W Christer. 2010. Contest outcome in a territorial butterfly: the role of motivation. *Proc. R. Soc. B.* <http://doi.org/10.1098/rspb.2010.0646>.

Comparative Analyses Module

Joan van Baaren, Claire M.-S. Dufour, Jean-Sébastien Pierre, Véronique Martel, Philippe Louâpre, Evolution of life-history traits and mating strategy in males: a case study on two populations of a *Drosophila* parasitoid, *Biological Journal of the Linnean Society*, Volume 117, Issue 2, February 2016, Pages 231–240, <https://doi.org/10.1111/bij.12644>.

Kavanagh PH, Vilela B, Haynie HJ, Tuff T, Lima-Ribeiro M, Gray RD, Botero CA and MC Gavin. 2018. Hindcasting global population densities reveals forces enabling the origin of agriculture. *Nature Human Behavior.* [doi: 10.1038/s41562-018-0358-8](https://doi.org/10.1038/s41562-018-0358-8).

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).

Mauch M, MacCallum RM, Levy M, Leroi AM. 2015 The evolution of popular music: USA 1960–2010. *R. Soc. open sci.* 2: 150081. <http://dx.doi.org/10.1098/rsos.150081>.

Bielby, J., et al. “The Fast-Slow Continuum in Mammalian Life History: An Empirical Reevaluation.” *The American Naturalist*, vol. 169, no. 6, 2007, pp. 748–757. JSTOR, www.jstor.org/stable/10.1086/516847.

Simulation Modeling Module

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>.

Csilléry K, Michael G.B. Blum, Oscar E. Gaggiotti, Olivier François. 2010. Approximate Bayesian Computation (ABC) in practice. doi: <https://doi.org/10.1016/j.tree.2010.04.001>.

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; Randomization tests, Generalized Linear Regression 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)

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

Phylogenetic comparative methods (pGLS and correlated trait evolution models)

Evolution of life history (Life history traits, strategic decisions in life cycles, slow v. fast life history continuum)

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

Simulation modeling as tool for inference.

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 emailed to instructors prior to or on the designated dates listed in the schedule below.* **Assignments that are turned in 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.

*The instructors will provide feedback on the **content and writing style** of every lab report (other than the basic statistics module). Students will then have the opportunity to incorporate this feedback and may choose to turn in an updated version of their manuscripts for a maximum of 10 points of extra credit (up to a maximum final grade of 100 points per assignment). Unless otherwise stated by the head instructor, updated manuscripts **WILL ONLY BE ACCEPTED IF RETURNED WITHIN A WEEK OF RECEIVING FEEDBACK** (the new version must use “track changes” in Word to highlight differences with the old one). Written assignments 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);

Journal articles will be evaluated on the following criteria:

Presentation skills (100 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. How do the authors try to test it? (methods)
- c. What evidence does the manuscript give to support it? (results)
- d. Does the provided evidence support the theory?
- e. How important is it? (implications)

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: There are no official pre-requisites.

Office hours: By appointment only.

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
08/27/17	Introduction	<ul style="list-style-type: none">• Introductions & expectations• Generating and testing hypotheses about the

		adaptive value of animal behavior <ul style="list-style-type: none"> • Ultimate v proximate questions • Different approaches to the study of animal behavior • Reliability, replication, and healthy data practices
08/29/17	R computing and statistics	<ul style="list-style-type: none"> • Data management in R • Basic plotting commands • Pseudo code, loops and basic functions
09/03/17	R computing and statistics	<ul style="list-style-type: none"> • Sampling and probability distributions • Correlation • General Linear Models
09/05/17	R computing and statistics	<ul style="list-style-type: none"> • Random effects • Q&A on problem set
09/10/17	Observing and manipulating behavior	<ul style="list-style-type: none"> • LIGHTNING TALK (SESSION I) • Natural history of crickets • Resource holding potential, motivation, and information in the evolution of conflict resolution strategies
09/12/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data practices <p style="text-align: center;">Stats Assignments due TODAY</p>
09/17/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Workshop on scientific writing • Data collection and analysis
09/19/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis
09/24/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis
09/26/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis
10/01/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis
10/03/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data collection and analysis
10/08/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Data CURATION
10/10/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Statistical analyses
10/15/17	Fall Break	
10/17/17	Observing and manip. behavior	<ul style="list-style-type: none"> • Statistical analyses
10/22/17	Observing and manip. behavior	<ul style="list-style-type: none"> • LIGHTNING TALKS (SESSION II) • Report writing and final questions
10/24/17	Phylogenetic	<ul style="list-style-type: none"> • Life history theory

	comparative methods	<ul style="list-style-type: none"> • Building our hypotheses
10/29/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis <p style="text-align: center;">Cricket reports due TODAY</p>
10/31/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis • Introduction to pGLS
11/05/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Introduction to pGLS • Statistical analyses
11/07/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • Data collection and analysis <p style="text-align: center;">Carlos in Indiana</p>
11/12/17	Phylogenetic comparative methods	<ul style="list-style-type: none"> • LIGHTNING TALKS (SESSION III) • Report writing and final questions <p style="text-align: center;">Last day to turn in corrections for cricket lab</p>
11/14/17	Modeling behavior	<ul style="list-style-type: none"> • Introduction to evolutionary simulation modeling • Model building
11/19/17	Modeling behavior	<ul style="list-style-type: none"> • Model building <p style="text-align: center;">COMPARATIVE STUDY REPORTS due TODAY</p>
11/21/17	Modeling behavior	<ul style="list-style-type: none"> • Model building
11/26/17	Modeling behavior	<ul style="list-style-type: none"> • Data collection and analysis
11/28/17	Thanksgiving Break	
12/03/17	Modeling behavior	<ul style="list-style-type: none"> • Data collection and analysis <p style="text-align: center;">Last day to turn in corrections for Comparative Methods lab</p>
12/05/17	Modeling behavior	<ul style="list-style-type: none"> • Bio 373 Wrap-up Session
12/12/17		MODELING REPORTS due TODAY

* A link to important information regarding campus resources for students in the Danforth Campus on Sexual Assault Reporting, Academic Accommodations, Disability Resources, Bias Reporting, Mental Health, Center for Diversity & Inclusion, Preferred Name and Gender Inclusive Pronouns, Military Service Leave, and Important Dates, is available from the course's home page.