

**Entomology 6210: Evolution and Diversity of Insects**  
Syllabus - Spring 2023

Lecture: Tuesday, Thursday, 10:05 - 11:25 am, 451 Kottman Hall  
Lab: Tuesday, 11:40 am - 1:30 pm, 451 Kottman Hall  
Mode of delivery: In-person

4 credits

Instructor:

Norman F. Johnson  
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Course prerequisites: Entomology 3000 or 4000 or equivalent, or permission of instructor.

Course description

Insects are one of, if not the most diverse groups of multicellular organisms. Estimates of numbers of species vary widely, from the millions to the hundreds of millions. Insects are critical elements of the ecosystem, functioning as herbivores, predators, parasites, detritivores and scavengers. The impact of the group on humans is immense in terms of health, the food we eat, and the structures we build. Insects are prominent as model systems for basic biology and have provided critical insights into fundamental questions of genetics, physiology, ecology and evolution. They are also conspicuous as cultural items and simply as creatures of beauty. It is impossible to ignore the diversity of insects and claim to have a balanced view of life on Earth.

The methods used to study insect diversity and evolution are widely applicable beyond the field of systematics. Evolution is the dominant paradigm of biology, and inference of patterns of evolutionary change are central to a wide range of disciplines. Tree-thinking, that is, finding and understanding patterns of change through time, is essential to fields as far from systematics as physiology, medicine and linguistics.

Systematics is a very broad field, essentially encompassing nearly all of comparative biology. The range of subjects to be explored is also quite broad, ranging from the philosophical underpinnings of the field to the practical day-to-day considerations of managing specimens and the data associated with them.

Learning Outcomes: Successful completion of this course the student will:

- Gain knowledge of the scale and makeup of insect diversity
- Understand the important events in the evolutionary history of insects, including the overall pattern of phylogeny, and the timing of major changes in structure and diversity through deep time
- Be able to identify insect orders and common families on sight and become adept in use of the tools and resources for insect identification
- Understand the underlying philosophy of the major analytical techniques used to infer phylogeny
- Be able to interpret branching tree diagrams and analyze patterns from a phylogenetic perspective.

## **Course Materials and Technologies**

### **Required Text**

Triplehorn, C.A. and N.F. Johnson. 2005. Borror and DeLong's introduction to the study of insects. 7<sup>th</sup> edition. Thomson Brooks/Cole. 864 pp.

Additional readings are posted on Carmen.

### **Required Equipment**

Computer: current Mac (MacOS) or PC (Windows 10) with high-speed internet connection.

## **How This Course Works**

This course will be delivered in-person. Lectures are Tuesdays and Thursdays at 10:05 - 11:25. The lab will be held on Tuesdays, from 11:40 am - 1:30 pm. Attendance is expected for all scheduled meetings. Videos of lecture material will be available in advance of class, and (other than the first meeting) you will be view this material before class. The “lecture” time will be used to review and discuss the content of the video and any assigned readings.

Should in-person classes be canceled, I will notify you as to which alternative methods of teaching will be offered to ensure continuity of instruction for this class. Communication will be via CarmenCanvas.

## **Assessment**

The course is conceptually divided into two sections. In the first the focus will be on the theoretical underpinnings of studies of diversity: species concepts and speciation, character analysis, phylogenetic analysis, dating of evolutionary events, detecting the signature of natural selection, etc. This section of the course will have two large graded items: a midterm exam and a term paper presenting the results of a phylogenetic analysis undertaken using real data extracted from Genbank.

The second portion of the course will focus on the major groups of insects, covering all 30-odd orders: their identifying characteristics, evolutionary history, biology, and ecological and social impact. This will be the subject of the second exam.

Phylogenetic Analysis Project (50 points): Students will work together in small groups focused on one set of species of their choice. Students will retrieve sequence data for the members of their study taxon from Genbank ([www.ncbi.nlm.nih.gov/genbank](http://www.ncbi.nlm.nih.gov/genbank)). These data will be aligned, assessed for phylogenetic signal, and the relationships among the species analyzed using a range of inference techniques. Each individual student will then write up the results of these analyses as a term paper. This paper should be 5 - 10 pages in length.

Exams (50 points each). The exams will cover material from readings and lecture. Questions will be in a variety of formats: short-answer, multiple-choice, as well as essays. Each exam will focus on the content of the two main sections of the course.

Quizzes (12 in lecture, 8 in lab @ 10 points each). In order to provide feedback on progress and learning, there will be a short quiz once each week in both lecture and lab. Each quiz will cover material from the previous week's lecture or lab, but information from readings for the day of the quiz is also fair game.

Phylogenetics Project:	50 points
Lecture Quizzes:	120 points
Lab Quizzes:	80 points
Midterm:	50 points
Final Exam:	50 points
Total:	350 points

#### Letter Grade Conversion Scale:

A: 93.0 - 100%	B+: 87.0 - 89.9%	C+: 77.0 - 77.9%	D+: 67.0 - 69.9%
A-: 90.0 - 92.9%	B: 83.0 - 86.9%	C: 73.0 - 76.9%	D: 60.0 - 66.9%
	B-: 80.0 - 82.9%	C-: 70.0 - 72.9%	E: < 59.9%

Posting of Grades: All grades will be posted on Carmen. You will have 10 class days from the day of posting to challenge or inquire about any posted grade. After that, the posted grades are final.

Academic Misconduct. It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct <http://studentlife.osu.edu/csc/>.

Disability Services. The University strives to make all learning experiences as accessible as

possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: [slds@osu.edu](mailto:slds@osu.edu); 614-292-3307; [slds.osu.edu](http://slds.osu.edu); 098 Baker Hall, 113 W. 12th Avenue.

**Mental Health.** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting [ccs.osu.edu](http://ccs.osu.edu) or calling 614- 292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766



and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273- TALK or at [suicidepreventionlifeline.org](http://suicidepreventionlifeline.org).

**Sexual Misconduct/Relationship Violence.** Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by

contacting the Ohio State Title IX Coordinator, Kellie Brennan, at [titleix@osu.edu](mailto:titleix@osu.edu).

Diversity. The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

#### Accessibility of Course Technology.

This course requires use of CarmenCanvas (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations as early as possible.

- CarmenCanvas accessibility: [go.osu.edu/canvas-accessibility](https://go.osu.edu/canvas-accessibility)
- CarmenZoom accessibility: [go.osu.edu/zoom-accessibility](https://go.osu.edu/zoom-accessibility)

Our inclusive environment allows for religious expression. Students requesting accommodations based on faith, religious or a spiritual belief system in regard to examinations, other academic requirements or absences, are required to provide the instructor with written notice of specific dates for which the student requests alternative accommodations at the earliest possible date. For more information about religious accommodations at Ohio State, visit [odi.osu.edu/religious-accommodations](https://odi.osu.edu/religious-accommodations).

## Lecture Schedule

Date	Topic	Readings
10 January	<i>Just how many species are there?</i> Class introduction, followed by an exploration of attempts to get a handle the number of different kinds of insects.	Erwin 1982 Stork et al. 2015
12 January	<i>What is a species?</i> A discussion of species concepts, how they have developed through time, and the many current opinions on the subject.	de Queiroz (2005) Wilkins essay (2006) Wilkins Species Concept Glossary
17 January	<i>Where do species come from?</i> Modes of speciation, from the classical allopatric model to magic traits. Lecture Quiz 1.	Turelli et al. (2001) Smadja & Butlin (2009) Hardy et al. (2016)
19 January	<i>Making sense of it all: classifications and taxonomy.</i> A review of the Linnean hierarchy, the goals of classification, the philosophical bases of classes and taxa, and an introduction to the major schools of taxonomy.	
24 January	<i>The Taxonomy Wars.</i> Evolutionary taxonomy and the rise of phenetics. Lecture Quiz 2.	Sokal (1986)
26 January	<i>The duck test.</i> Characters, homology, coding using molecular alignments as exemplars.	
31 January	<i>The Taxonomy Wars II.</i> Hennig and the rise of phylogenetic systematics; parsimony. Lecture Quiz 3.	
02 February	<i>The revolution will devour its children.</i> Model-based phylogenetic inference; maximum likelihood; Bayesian approaches.	
07 February	<i>What are the chances?</i> Support measures for trees: bootstrapping, jackknifing, Bremer support. Lecture Quiz 4.	
09 February	<i>The final frontier?</i> Phylogenomics; reduced genome representation: transcriptomes, targeted enrichment, ultraconserved elements; analytical challenges.	Kjer et al. (2016)
14 February	<i>When did that happen?</i> Classifications and dating. Lecture Quiz 5.	
16 February	<i>What's in a name?</i> The principles of zoological nomenclature and taxonomic descriptions.	
21 February	<i>Tricorder readings, Mr. Spock?</i> Tools for identification, from traditional keys to BugGuide to barcoding. Lecture Quiz 6.	Hebert et al. (2003) Hebert et al. (2004) Rubinoff et al. (2006)
23 February	<i>Big data.</i> Collections, primary species occurrence data, vouchers, biodiversity informatics, niche modeling.	
28 February	Midterm Exam (50 points)	
02 March	Paleoentomology, insects in deep time, extinct orders.	
07 March	Insect phylogeny: the 1KITE project. Lecture Quiz 7.	Misof et al. (2014)
09 March	The “apterygote” orders.	
21 March	Paleoptera: Odonata and Ephemeroptera. Lecture Quiz 8.	

23 March	Orthopteroids	Klaas (2002) Song et al. (2015)
28 March	Dictyoptera and remaining Polyneoptera. Lecture Quiz 9.	Inward et al. (2007)
30 March	Paraneoptera: the hemipteroid orders	Johnson et al. (2018)
04 April	Hymenoptera. Lecture Quiz 10.	Peters et al. (2017)
06 April	Neuropteroids	
11 April	Coleoptera and Strepsiptera. Lecture Quiz 11.	McKenna et al. (2015)
13 April	Amphiesmenoptera: Trichoptera and Lepidoptera	Regier et al. (2013)
18 April	Antliophora: Diptera, Siphonaptera and Mecoptera. Lecture Quiz 12.	Wiegmann et al. (2011) Tihelka et al. (2020)
20 April	Flex Day	
TBA	Final Exam	

### Lab Schedule

Date	Topic
10 January	Lab introduction
17 January	Phylogenetics project: introduction, group assignments, data download
24 January	Introduction to MEGA; multiple sequence alignment, model testing
31 January	Nexus files; neighbor-joining trees, maximum likelihood in MEGA, R; RaxML, MrBayes
7 February	Final analyses
14 February	Project paper due. Essentials of insect morphology for identification: tagmata, sclerites, sutures and sulci. The apterygote orders.
21 February	Insect morphology for identification: wing venation. The paleopterous orders. Lab Quiz 1.
28 February	Polyneopterous orders. Lab Quiz 2.
07 March	Paraneoptera: the hemipteroids. Lab Quiz 3.
21 March	Hymenoptera. Lab Quiz 4.
28 March	Neuropteroids. Lab Quiz 5.
04 April	Coleoptera and Strepsiptera. Lab Quiz 6.
11 April	Trichoptera and Lepidoptera. Lab Quiz 7.
18 April	Diptera, Siphonaptera and Mecoptera. Lab Quiz 8.