Insect Ecology, Fall 2013
(ENT 105, 4 units, T/TH 12:10-1:30, Briggs 122)

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Course Objectives

This is an undergraduate course for students interested in the ecology of insects. This course will cover fundamental questions in ecology, with an emphasis on ideas, hypotheses, and insights related to the ecology of insects. I hope that this course will provide a firm foundation in both basic ecological concepts and the remarkable biology of insects. However, the core objective of this course is to teach the *process* of insect ecology, including the skills required to: a) observe nature in the context of existing knowledge and ideas, b) read and understand scientific figures and writing, c) ask and investigate questions in insect ecology, and d) effectively and concisely communicate scientific ideas with others.

Course Description

> *"We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."* E.O. Wilson

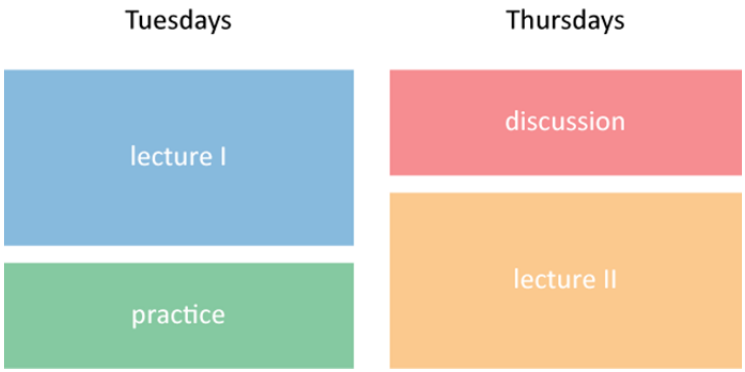
This course is about insect ecology. Each week will be structured around a question which we will use to guide our investigations. This course does not use the traditional organization of many introductory ecology courses (i.e. individuals, populations, communities and ecosystems) because I hope to emphasize the conceptual links between these levels of organization, rather than highlight their differences. Similarly, this course is not primarily focused on the diversity and natural history of insects, though I find both topics fascinating. Instead, this course attempts to teach fundamental concepts that are related to the ecology of insects. We will cover several fundamental and current ideas in ecology: evolution, direct and indirect species interactions, population regulation, ecosystem services, co-evolutionary ecology, temporal variability and community dynamics, mechanisms of coexistence, phenological shifts and climate change, ecological stoichiometry, symbioses and mutualisms, chemical ecology, and ecosystem engineering, among others. This course is focused on insects, but we will readily include other creatures in our discussion to illustrate key concepts and ecological relationships.

This course is structured around ecological questions. Science is a process of answering questions about nature, and learning to *ask* and *answer* questions is the crux of the scientific endeavor. The structure of this course is intended to encourage you to consider several concepts at once, and combine them in

unexpected ways. From this, I hope you will learn key concepts and ideas, supported by data and examples, as well as some insight into the curious process of scientific inquiry.

I recognize that most of you do not intend to become insect ecologists. Nonetheless, I think there is value in learning to think like a scientist in general, and like an insect ecologist in particular. This course is an attempt to teach how ecologists think, and to help you make your own links between specific knowledge and general understanding, sparked by your intellectual curiosity about the amazing world of the insects.

We will establish several traditions for the duration of this quarter. There are 10 weeks in the quarter, and this class meets for 80 minutes on Tuesdays and Thursdays. In general, our Tuesday meetings will include about 50 minutes of lecture, followed by approximately 30 minutes of practice and discussion. The Thursday meetings will usually begin with about 30 minutes of practice and discussion, followed by 50 minutes of lecture. The reality will be more improvisational, but this is a rough approximation of what we're aiming for:



During the lecture parts of the class, I will aim to present organized ideas about insect ecology. This will be a more-or-less traditional lecture format, where your participation is encouraged, but I will take the lead in structuring this part of the class.

In the practice and discussion parts of the class, we will have a discussion, and some practice in the art of observing nature, asking questions, understanding models, etc. The discussion will often be set up like a friendly debate, where we will discuss a question from the week's lectures and readings. This format will encourage you to develop an opinion, and an informed opinion might require you to do some outside research. I would encourage you to be engaged participants in this part of the class. To keep things interesting, you'll be expected to research both the affirmative and negative side of each question, and a subset of students will be randomly selected to represent each side. Remember, strong arguments emerge from concrete examples and clear communication, and those things emerge from thoughtful preparation. Although a subset of students will be selected each week, there will be opportunities for everyone to ask and answer questions. Everyone participates in their own way, and I would like to give everyone an opportunity to contribute to the discussion.

Textbook

The required textbook for this course is:

> Price, P. W., R. F. Denno, M. D. Eubanks, D. L. Finke, and I. Kaplan. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press.

I will also draw resources from a variety of other sources, including both scientific and popular literature.

For each course meeting after the first, there will be a few required readings checkmarked (✓) at the bottom of the lecture outline. These readings will be posted to the course website by the preceding Friday. You will be expected to a) look over the lecture outline, and b) read these materials *before* coming to class, in preparation for the class meeting.

Teaching Philosophy

1. I believe that nearly all students are honest, respectful, intelligent, curious, independent and creative thinkers. As a result, I believe that university courses should be designed to allow students to develop according to their own individual interests and abilities without being coercive or authoritarian.

2. I believe that the world of facts and knowledge has never been greater or more accessible in all of human history. As a result, my goal is to teach you how to teach yourself. I would like you to be able to use the tools at your disposal in the pursuit of self-motivated discovery. In this course, we will be applying the philosophy of "deliberate practice", which emphasizes the acquisition of core knowledge outside of class, followed by practice and refinement in class.

3. I believe that the process of science requires a mixture of curiosity, knowledge and understanding. The science of ecology is rooted in our urge to connect specific examples with general concepts. In order to do insect ecology, you need to be intellectually motivated enough to learn facts and combine them with conceptual understanding in new and interesting ways.

4. I believe that quality is more important than quantity, and that concise communication is an essential part of science.

Class Schedule

week	question
10/1	Insect adaptations: How have insect adaptations shaped their ecology (and vice versa)?
10/8	The sensory world of insects: How do insects perceive the world?
10/15	Population regulation: What factors regulate insect populations?
10/22	Insect diversity and coexistence: Why are there so many kinds of insects?
10/29	Insects in food webs: Bottom-up or top-down population regulation?
11/5	Insects as predators and prey: Who eats who?
11/12	Other kinds of species interactions: Are we missing the real story?
11/19	Nutrient cycling and stoichiometry: Are you what you eat (less what you excrete)?

11/26	Ecosystem services and disservices: How do insects help and harm humans?
12/3	The future of insect ecology: How will insect ecology change in the coming century?

Evaluations

date	evaluation
October 21-24	Oral Exam, 15-minute slots by appointment
November 5	Term paper prospectus due at the beginning of class
November 19	Term paper draft due at the beginning of class
December 3	Term paper due at the beginning of class
December 11	Final Exam - Wednesday, December 11, 6 pm, Briggs 122

There will be three primary graded components to this course, *worth a total of 1200 points*. Letter grades will be assigned on the basis of your point total, but this course will not be graded on a strict quantile basis (i.e. on a "curve"). Instead, I will seek to assign letter grade thresholds to reflect a common-sense assessment of your performance throughout the course.

I. The first graded component will be a 15-minute oral exam. During each exam, I will ask a series of three questions selected from a list of 10 possible questions provided below; I will ask follow-up questions as necessary. You may be asked questions that build upon what you have learned in unexpected ways – in this exam, as in science, you will be best served by honing your understanding of the key concepts without rote memorization. I encourage you to discuss these prompts with your friends and classmates outside of class in order to practice discussing these topics in depth. Top scores will go to responses that are clear, concise, thoughtful, and correct. Exams may be recorded to facilitate grading. This exam will be conducted by appointment in Briggs 380. Appointments are available on a first-come basis, and should be scheduled online at least 1 week in advance. In order to be fair to all exam-takers, time limits will be strictly enforced; students are encouraged to arrive 5-10 minutes early for their exams. *The maximum credit for this component is 400 points.*

    a. George Bartholomew (1982) advised biologists not to try to mimic physicists, especially "not to seek general answers to specific questions… but to seek many different special answers to each general question." Discuss this proposition.

    b. What are "levels of causation" and how do they relate to Tinbergen's "Four Questions"? How are "levels of causation" useful in science?

    c. Discuss the origin of insect wings as it relates to the "the dilemma of incipient stages" (i.e., how can complex adaptations arise if they must pass through several gradual evolutionary steps before they are able to function efficiently?).

d. Why is olfaction particularly important for the ecology of insects? What are some ecological implications of this chemosensory ability? What are other sensory modalities of insects that are different from our own?

e. Explain the exponential and logistic population growth curves. What causes exponential growth? What limits exponential growth?

f. Why are there so many species of insects? Southwood and others have proposed that the combination of small size, flight, and metamorphosis has permitted insects to finely subdivide the environment and to link small evolutionary opportunities, "fractional niches", into diverse, viable ways of life. Why do you think these three attributes of insects are responsible for their diversity? Are there other attributes that are also important?

g. How does insect morphology affect the capacity for movement among insects? Are there any patterns that may be generalized across species? How is movement constrained by or facilitated by the biomechanics of small size?

h. Explain the Hutchinsonian niche concept, by comparison to the Eltonian and Grinnellian niche concepts.

i. Can density-independent factors regulate populations? If so, explain how. If not, explain why not.

j. What is a metapopulation? What are some counter-intuitive predictions that arise from thinking about metapopulation dynamics?

II. The second graded component will be a substantive, concise project proposal (< 2000 words, excluding references) addressing a question in insect ecology. This proposal will be similar in form and content to a research description for the National Science Foundation Graduate Research Fellowship Program[1]. Each project proposal must contain a) a clearly stated and testable question, b) the intellectual context of your question, c) specific hypotheses you would like to explore, and d) a very brief description of an experimental method you would use to evaluate the question and hypotheses. These projects should describe experimental (not observational) studies that could be carried out within 5 miles of Davis during the winter and spring quarters; after the class, these proposals will be considered as the basis for potential group projects in course Experimental Ecology and Evolution in the Field (EVE/ENT 180)[2]. Proposals will be evaluated on the basis of four criteria: 1) *originality*: creative research ideas

[1] If you are thinking about graduate school, you should consider applying for this 3-year fellowship as an undergraduate: http://www.nsfgrfp.org/

[2] Several of these projects have turned into published papers in the past. If your proposal is chosen as the basis for a group project, you will be a co-author on any publications that arise from this project, and would be welcome to participate in the ensuing research. If you would not like your proposal to be considered as a potential group project, please let me know.

that extend existing knowledge, 2) *importance*: relevant research ideas that contribute to scientific discourse, 3) *feasibility*: a good research question must be testable within the described parameters, and 4) *communication*: research ideas much be communicated clearly and concisely to be effective. Note that the *maximum* length of this paper is 2000 words; you will need to be clear, organized and concise. I'd encourage you to begin thinking about ideas for this proposal soon after the first class meeting; one good way to begin is though conversations with your colleagues inside and outside the class; another good way to start is to sit quietly without distractions for 30-45 minutes, while you let your thoughts wander. The final proposal should present a clearly stated experimental question, and describe a well-organized and clearly reasoned experiment to answer this question. Because it's difficult to write a clear term paper from scratch, this paper will progress through three stages of review:

a. A short prospectus of your proposal. The prospectus sub-assignment is designed to get you started thinking about possible topics for your proposal. It will consist of a short (< 500 word) summary that describes a) a clearly stated and testable question, b) the context of your paper topic, c) the specific hypotheses you would like to explore, and d) the experiment you propose to answer this question and/or test the hypothesis. I would encourage you to discuss your term paper topic with me along the way; Lao-Tzu wisely said, *"A journey of a thousand miles begins with a single step."*, but it helps if your first steps are in the right direction, and you don't have lots of time to wander. Each student will post their prospectus as a separate topic to the forum on the course website. In addition, each student will submit four constructive comments as separate threads to four separate prospectus topics within 48 hours of the prospectus deadline. These comments should help each writer judge whether the proposed topic has the potential to become an interesting and novel proposal. Each topic should have no more than four comment threads associated with it. Unconstructive comments are not acceptable in this forum. Peer review is an important part of the scientific process, and this component of the term paper is intended to give you experience on both sides of peer review. In this assignment (as in science) the most valuable comments are polite, constructive, thoughtful and specific. Your grade for this component will be based on a combination of your prospectus and your comments. *The maximum credit for this sub-assignment is 100 points.*
b. A full-length draft (< 2000 words, excluding references) of your term paper will be due by the beginning of class on the deadline day. This draft should <u>not</u> be considered a rough draft; instead, it should be carefully considered and well-organized. Citations should be in a standard form, suitable for publication in a professional journal like *Ecology*, *Ecology Letters* or *The American Naturalist*. This draft will be read and evaluated for its logic and its clarity of conceptual development and communication. Write simply; avoid complex sentences. Consider using the online writing resources on the course website. Written comments will be returned to each author, along with a grade for this draft. *The maximum credit for this sub-assignment is 200 points.*

c. A final draft of this term paper will be due at the beginning of class on the deadline day. Written comments and a grade for this final draft will be returned to each student. *The maximum credit for this sub-assignment is 100 points.*

III. The third graded component of this course will be a standard written exam during our finals exam slot. This exam will be evaluated for concise, complete answers in a short-answer format. See the final exam study guides on the SmartSite. *The maximum credit for this component is 400 points.*

Extra credit assignments

In addition to the 1200 points that are in the three primary graded components to this course, a total of 100 points will be available in extra credit assignments.

1. Collect and prepare up to 20 insect specimens each representing a family of insects. Learning to collect, prepare and identify insect specimens is a tried and true way to learn about the ecology and morphology of insects. For this assignment, each specimen must be collected, pinned, prepared, identified and labeled in accordance with standard entomological methods as outlined in the USDA Insect Handbook (available on our course website). Insect pins, label-making paper and other supplies will be provided on request. Specimens must be submitted to Briggs 380K by appointment, before the final lecture. One point for each correctly prepared and identified specimen; *the maximum extra credit for this assignment is 20 points.*

2. Attend the Entomology seminar series or the Ecology and Evolution seminar series. Attending seminars is a good way to learn about current issues and ideas in science, and it's also a good way to get to know your scientific colleagues. Check the internet for times and locations. Write a concise (< 300 words) description of each seminar, including the name of the seminar speaker, the seminar date, the key question investigated by the speaker, and the most important findings presented. All descriptions must be submitted as a single document by the day after the final seminar. *Two points for each seminar; the maximum extra credit for this assignment is 20 points.*

3. Scavenger hunt. For credit, take a clear and identifiable photo of yourself with the following items:

    a. A subterranean insect
    b. A soapberry bug
    c. A library copy of Hairston, Smith and Slobodkin (1960)
    d. An insect in the act of eating another insect
    e. A vertebrate in the act of eating an insect
    f. An insect in the act of eating a vertebrate
    g. Insects in the act of mating
    h. An oak gall
    i. A buprestid
    j. Lerps
    k. A leaf-miner insect
    l. An insect in flight

m. A parasitoid insect
n. A molting insect
o. The aquatic lifestage of an insect
p. A blue insect
q. A peanut-head bug
r. A live praying mantis
s. A trapnest
t. A jumping gall

All items can be found on the UC Davis campus, but items found off campus are also fair game. All photos must be submitted before the final lecture as a single ZIP file that includes a typed list of each image and the item that it represents. Each photo can only count for one item. *One point for each item; the maximum extra credit for this assignment is 20 points.*

4. Explore a local field site. Take an identifiable photo of yourself with an insect at these locations:

    a. 38° 34.181'N 121° 45.684'W
    b. 38° 34.459'N 121° 42.795'W
    c. 38° 32.598'N 121° 42.053'W
    d. 38° 33.503'N 121° 46.929'W
    e. 38° 31.758'N 121° 45.814'W
    f. 38° 32.523'N 121° 45.987'W
    g. 38° 33.345'N 121° 43.318'W

    The location should be clearly identifiable in your photo. All photos must be submitted before the final lecture as a single ZIP file that includes a typed list of each image and a one-sentence ecological description of the location. *Four points for each item; the maximum extra credit for this assignment is 20 points.*

5. Communicate an ecological concept using multimedia. It's often more intuitive for us to learn complex concepts through means other than writing. In this assignment, you will be challenged to communicate a complex ecological concept using alternative means of communication. This assignment could consist of illustrations, photographs, videos, sounds, or interactive media. There are few restrictions on this assignment, but students are encouraged to discuss possible projects before starting. Completed projects must be submitted by the final lecture. Projects will be scored on the basis of clarity and creativity; *the maximum extra credit for this assignment is 20 points.*

Expectations, Responsibilities and Policies

It has become the norm to include a section on the syllabus that outlines certain rules and guidelines for responsible academic conduct. I suspect that most these rules and guidelines are obvious to most of you, but I've learned that they may not all be obvious to all of you. So, here goes:

1. Conduct yourself as a professional, with honesty, integrity and respect. This is part of being a good colleague, and it's nice.
2. Deadlines for graded components are firm, except under the most extreme circumstances.

3. Take responsibility for your grades before the evaluations; I will not change your grades except under the most extreme circumstances. If you have not scored as well as you would like to, consider doing one (or several) of the extra credit assignments.
4. Seek help when you need it. We all need help at some point, and it's why we're here.

A Note about Learning Differences

Everyone learns differently. In this course, I attempt to evaluate students in three different ways, where each mode of evaluation represents an important, separate component of the scientific process. Likewise, each class meeting will include aspects of traditional lecturing, interactive discussion and group learning. While this approach might be somewhat unusual, I think it provides a better approximation of the skills and activities that comprise the scientific process.

Especially given the structure of this course, I would like to encourage students with special needs to contact me and the UC Davis Student Disability Center to make any necessary accommodations for the course as soon as possible.

A Note to Graduate Students

There may be a few folks taking this course as graduate students. Welcome! While this course is primarily intended for undergraduate students, there are two main reasons why graduate students might be interested in taking this course. First, this course could be useful to you if you are starting grad school in a related field, and you don't have a particularly strong background in insect ecology. Second, this course could be useful to you if you are nearing the end of graduate school, and you are starting to think about teaching an insect ecology course of your own. In either case, my only requirement is that you are a full participant in all aspects of the course.

A Note about Taking Notes

Yup, I think it's important to learn to take good notes. As a result, there are intentional gaps in the course outline, where I don't provide all the material that will be presented in lecture. There will also be unintentional gaps, where our discussion veers into unexpected territory, and of course, this material won't be represented on the outline either.

Course Resources, Email and Links

I expect you to use all the resources at your disposal to complete this course. In some cases, we may suggest resources that become part of your toolbox. In other cases, you may be asked to draw upon your own unique skills and background to get you through. Don't be shy about asking for help, or using unconventional means to learn the material. If you discover any particularly useful resources, please let me know! The following course resources will be posted or linked on the course website (and more may be added):

1. USDA Insect Collection and Preparation Handbook (pdf)
2. Insect label template (docx)

3. Zotero and Mendeley
4. Purdue University's Online Writing Lab (OWL)
5. UC Davis Student Academic Success Center
6. UC Davis Student Disability Center
7. Health Education & Promotion Wellness: Napping & Sleeping Resources
8. Web of Science
9. Google Scholar
10. Tuft University's VUE
11. eFabre

If you want to email the entire course, you can email *insectecology2013@smartsite.ucdavis.edu*.

Acknowledgements

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