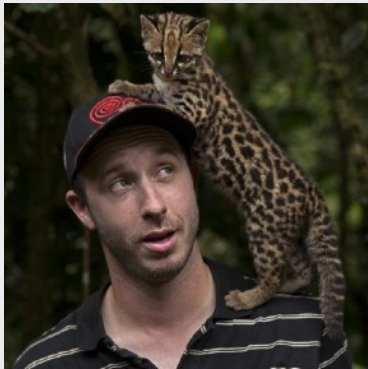


INTENSE ABOUT INSECTS

Tropical Entomology in the Peruvian Amazon

Instructor:

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Course Dates:

Session I: Dec. 11 - 23, 2017

Session II: Jun 3 - 16, 2018



Course Introduction

The overwhelming majority of Earth's known terrestrial animal species are invertebrates, mostly insects, that inhabit moist forests of the tropics. In the western Amazon, insects are a dominant component of microhabitats ranging from the canopies of towering emergent trees to the forest understory, into the leaf litter and even in aquatic habitats. Insects also occupy a bewildering variety of niches, straining the imagination of even the most thoughtful tropical naturalist. Although the number of known species is staggering, it is widely believed that most species remain to be described; proposed estimates of the total number of species globally do not agree even to within an order of magnitude. And despite their tremendous ecological importance, the basic biology and natural history of most species remain entirely unknown. This ignorance encumbers efforts to understand general patterns in the diversity, abundance, and distribution of biodiversity, a fact made especially urgent given the growing concern over human-caused global change.

Location:



Los Amigos Biological Station



Finca Las Piedras

Required Texts

Please obtain and read:

- *Forsyth, A. & K. Miyata. 1984. Tropical Nature. Touchstone, New York, NY
- Kricher, John. 2017. The new neotropical companion. Princeton University Press, Princeton
- Hanson, P.E. & K. Nishida. 2016. Insects and Other Arthropods of Tropical America. Cornell University Press, Ithaca

* To be read before class for first quiz of the field course

Due to its location at the intersection of the mega-diverse western Amazon and tropical Andes ecosystems, as well as vast expanses of roadless wilderness, Peru's Madre de Dios Department shelters more species of plants, insects, and other animals than almost anywhere else on earth. This course will be held between two sites in Madre de Dios. The course will begin at Finca Las Piedras, a research station located north of Puerto Maldonado, the regional capital, at the edge of the agricultural frontier that expanded following completion of the Interoceanic Highway several years ago. Finca Las Piedras is located in upland, 'terra firme' rainforest, and is surrounded by active and numerous Brazil nut concessions, where the region's leading non-timber forest product is gathered annually from natural forests. The second half of the course will take place at Los Amigos, a biological research station located approximately 5 hours northwest of Puerto Maldonado along the Madre de Dios river, the region's principal waterway. Los Amigos is also located in terra firme forest, but also provides access to floodplain forest of both the Madre de Dios and Los Amigos rivers, as well as several aquatic habitats.

will gain important practical skills used in field biology, and will related to insect diversity, form, function, and ecology in the extraordinary variety of tropical plants, insects, and other opportunity to observe and study a range of wildlife including as hundreds of species of birds, 5 cats including puma and jaguar, eagles, and countless reptiles and amphibians, among many

Course Objectives



The goals of this course are two-fold. First, participants will receive training in insect diversity, form, function, and ecology, with a particular emphasis on groups of special ecological importance in our area of the neotropics. Focal groups will range from butterflies to beetles, bees, and aquatic insects, among many others. We will also become familiar with an astonishing array of terrestrial and aquatic habitats that shelter a greater diversity of plant and animal species than anywhere else on the planet. Our job is to have students leave the course able to make sense of this diversity. Second, we will practice a variety of field techniques that facilitate entomological research and conservation studies in the tropics, including detailed note taking and natural history observation, off trail navigation, the use of GIS for managing spatial data, baiting insects, methods for the capture and/or survey of insects using a variety of tools, the storage of biological specimens, and canopy access techniques, among others.

Course Topics

Topic of Study	Activity	Description
I. Introduction		
> Field ethics, safety precautions, rules, and useful tips	Discussion	Staying safe in the rainforest environment, and conducting field research with a minimal environmental impact
> Introduction to backcountry/off-trail navigation	Activity	Participants will be introduced to the use of compass/map and GPS to safely navigate off-trail in the rainforest environment
> Habitat diversity at Finca Las Piedras	Group hike	We will explore the Finca Las Piedras trail system and examine Amazonian habitat types
> The Los Amigos Conservation Concession	Lecture	We will examine another rain forest site and explore additional Amazonian habitat diversity
II. Understanding the primary scientific literature		
> Synthesizing a research article	Discussion	As a group we will discuss a scientific paper covering a topic in tropical entomology, learning to critically evaluate methodology, results, interpret findings, and put the study into a broader context
> Survey of Neotropical entomological literature	Discussion	Participants will read several articles each day and discuss them as a group
Methods workshops	Discussion	Developing hypotheses, selecting appropriate methodology

Topic of Study	Activity	Description
III. Neotropical insect diversity		
> Survey of Neotropical insect diversity	Lecture	Learn to identify major insect orders and key Neotropical families
	Activity	Collect and correctly identify insects to the lowest taxonomic level possible
	Group hikes	Opportunistically observe and identify insects, and study their natural history and biology, in the field
IV. Insect ecology and natural history		
> Insect vertical stratification	Activity	Participants will conduct a group project investigating the stratification of butterfly species in the vertical forest column
> Ithomiine butterfly biology	Activity	We will use handnets and mark-release-recapture techniques to study clearwing butterfly behavior and ecology
> Amazon plant/insect host identification	Informal/ongoing	Descriptions of key Neotropical plant groups as they are encountered during field activities
V. Field techniques in tropical entomology		
> Surveys of field techniques in tropical entomology	Activities/informal discussions	Participants will be introduced the methods used for sampling a diversity variety of insect groups across different habitats
> Canopy access	Activity	Tree climbing—useful for sampling insects and studying ecology in the rain forest canopy
> Butterfly traps	Activity	Sampling butterflies along the vertical forest gradient
> Hand-net	Activity	Sampling flying insects in the forest understory/edge

Topic of Study	Activity	Description
> Mark-release-recapture	Activity	Population estimation and ecology
> Chemical attractants	Activity	Attracting insects using pheromones, fragrances, and other chemicals
IV. Different perspectives on the Amazon		
> Wildlife viewing along the Los Amigos River	Excursion	Safari in motorized dugout canoe up the Los Amigos River with opportunities to observe insects, birds, reptiles, and mammals
> Canopy tower	Excursion	Observe the rainforest canopy from a 60-m canopy tower
> Palm swamp	Excursion	Explore a <i>Mauritia</i> palm swamp and search for anaconda from a canoe
> Guest lectures	Lectures	Where available, students will learn about other topics in tropical biology from researchers and other guest lecturers

Daily Schedule

Below is the daily schedule of activities for the field course. Students should be aware that the timing of activities is subject to change due to weather or other unforeseen difficulties, or unanticipated opportunities. We will do our best to stick to the following schedule, but a good measure of flexibility will allow us to complete all of the planned activities while remaining adaptable to the constantly changing conditions in the field.

Date	Activities	Reading Discussion	Assignments Due
Day 1	<ul style="list-style-type: none"> -Depart Pto. Maldonado for Finca Las Piedras -Introductions -Brief tour of field site -Discussion: field ethics, safety precautions, rules, and useful tips -Course overview 		
Day 2	<p>Morning</p> <ul style="list-style-type: none"> -Introductory rain forest hike <p>Afternoon/evening</p> <ul style="list-style-type: none"> -Introduction to off trail navigation -Reading discussion 	<p>Erwin 1982</p> <p>How to read and evaluate a scientific article</p>	<p>Quiz #1</p> <p>Tropical Nature</p>
Day 3	<p>Morning</p> <ul style="list-style-type: none"> -Butterfly vertical stratification activity: trap placement <p>Afternoon/evening</p> <ul style="list-style-type: none"> -Check traps -Reading discussion -Nocturnal hike 	<p>DeVries 1988</p> <p>Rain forest butterfly vertical stratification</p>	
Day 4	<p>Morning</p> <ul style="list-style-type: none"> -Aguajal hike -Lecture: Neotropical insect diversity part I (hemimetabolous orders) <p>Afternoon/evening</p> <ul style="list-style-type: none"> -Check traps -Reading discussion 	<p>Molleman 2009</p> <p>Puddling</p>	

Date	Activities	Reading Discussion	Assignments Due
Day 5	Morning -Lecture: Neotropical insect diversity part II (holometabolous orders)	McCain & Grytnes 2010 Diversity gradients	
	Afternoon/evening -Check traps -Lecture: Elevational & latitudinal diversity gradients		
Day 6	Morning -Insect diversity activity		Quiz #2 Diversity gradients (AM)
	Afternoon/evening -Check & take down traps -Pack for Los Amigos		Insect diversity activity due (AM)
Day 7	Morning -Early departure for Los Amigos		
	Afternoon/evening -Lecture: Los Amigos Conservation Concession		
Day 8	Morning -Introductory hike	Ellwood & Foster 2004 Canopy invertebrate biomass	
	Afternoon/evening -Mark-release-recapture part I		
Day 9	Morning -Canopy access (group 1)		
	Afternoon/evening -Mark-release-recapture part II		
Day 10	Morning -Canopy access (group 2)		Butterfly trapping activity due
	Afternoon/evening -Los Amigos River wildlife spotting		
Day 11	Morning -Canopy tower & aguajal		Mark-release-recapture activity due
	Afternoon/evening -Study time & finish assignments		

Date	Activities	Reading Discussion	Assignments Due
Day 12	Morning -Final exam		Final exam (AM)
	Afternoon/evening -Explore floodplain forest & oxbow lake -Pack for early departure from Los Amigos		Field journals due for grading (AM)
Day 13	Morning -Boat from Los Amigos to Pto. Maldonado		

Course Work

Field Journal (100 pts)

The field journal is an integral part of the course, reflecting the importance of consistent, detailed note-taking in field biology—all scientists who conduct field research keep a journal in which they record everything they find, observe, and collect. Observations at all levels of organization, from the individual organism to the ecosystem, including behavior, natural history and life history traits, distribution, abundance, habitat, landscape, human dimensions, and how all of these things might be interrelated go into the field journal. The journal is a permanent record of observations and, no matter what the purpose of the field trip, the journal contains all the evidence on which subsequent work will be based. It is also a place where your observational skills are repeatedly and continuously tested and sharpened. We will introduce journal-writing style and expectations during the first few days of the course. Please note that FPI will provide students with a high-quality, waterproof field journal for use during the field course; journals will be graded but returned to students before completion of the course.

Requirements:

- i. Daily entries (10 total; 5 pts each):

The daily entry contains the who, what, where, why, and when of the day's activities. This should begin with the basics: site name/location, date, temperature and weather conditions (cloudy, sunny, windy, raining, cold, hot, and for what portion of the day/night, etc.), soil conditions (e.g., moist or dry, clay, sand, etc.), who you were with, etc. Then record your observations—keep in mind that you can never record too many details, no matter how trivial some might seem at the time. Every observation in the field journal will become valuable information later as you attempt to recall and synthesize your experiences. Things to note might be dominant trees or other plants in flower/fruit at the field site, any pollination or feeding activities observed, groups of conspicuous animals or behaviors, dominant vegetation types, patterns of human land use, condition of the local habitat (e.g., pristine, degraded/disturbed, etc.). Anything you think might be important goes in the journal, and remember, nothing is too trivial to be recorded; when in doubt, *write it down*.

2. Species descriptions (10 total; 5 pts each):

As part of your daily journaling, you will be noting many new species that you observe in the field. Each new species of plant, animal, or fungi that captures your attention should be recorded in the field journal, including details covering where and at what time the sighting occurred, the organism's scientific and common names, how far away it was, its size, etc.

Each day, you will also note at least one insect species that particularly stood out to you, and write a more detailed species description for it. This will be the daily 'species description,' which will be graded. Describe the species in detail: its size, form, appearance, behavior, microhabitat, interactions with other species, and anything else you found interesting about it. Remember to describe the organism, its habitat, and its behavior in detail—nothing is too trivial. An important part of a species description is a drawing of the organism, including important details about its habitat if relevant; the drawing will add information that cannot be easily expressed in words and will complement the written description. You won't be graded on the aesthetic quality of your drawing, but you will be expected to put effort into it such that it is a useful contribution to the species description. Species should be identified to the lowest taxonomic level possible; the course instructor will determine the required level, so if a subject is not identified to species then the student should enquire to what taxonomic level an identification will be required. The required identification level will depend on the material covered during field exercises, lectures, and formal and informal discussions. Misidentified or unidentified species will not count towards your points for the day's species description. However, don't shy away from writing about organisms you can't immediately classify—use the resources at your disposal, including the project reference library, resources at the field site, faculty, and your peers. A major part of the job of a field naturalist is species identification, and although sometimes difficult, this is an important and rewarding aspect of field biology.

Readings and reading discussions (10 total; 10 pts each)

Three texts are required for the field course; students should bring each with them to the field site. The first text, Forsyth & Miyata (1984), is a good (and highly readable) general introduction to the Neotropics. Students should read this book in its entirety before arriving in Puerto Maldonado; there will be a quiz on this material during the first day of the course at Finca Las Piedras. The second text, Kricher 2017, is an excellent general reference covering topics in Neotropical biology and ecology, as well as key groups of rainforest organisms that we are likely to encounter at the field site. This reference will be invaluable as students try to make sense of the flood of new plant and animal species they encounter in the field, as well as how they fit into the wider Amazonian ecosystem. The third book, Hanson & Nishida (2016), is perhaps the best general reference and field guide currently available for Neotropical insects, and you will use it heavily as you discover, study, and attempt to identify a flood of new insects at the field sites in Peru.

Group reading discussions are ongoing throughout the course and include discussions of each of the readings presented in the Reading List, incorporating selections from entomology, natural history, and ecology. Reading topics will mirror field activity themes, so that readings complement hands-on activities and learning in a logical fashion. We will cover the basics of reading and critically evaluating primary literature at the beginning of the course. Discussions will be led by the course instructor at the beginning of the course, but students will be expected to progressively lead discussions (with the instructor acting as moderator) as the course progresses. The reading discussion grade will be based on whether students participate in the discussions, as well as whether it is obvious that they have read and understand the article to a reasonable degree. We recommend that students read each paper carefully before arriving in Peru, and then re-read each one before the discussion—this method has been shown to increase understanding and retention of new, often challenging ideas.

Field activities (see table below for point values)

Throughout the field course we will conduct a number of group activities that will help students sharpen their skills in Neotropical insect identification and field techniques used in the study of insect diversity and ecology. Each assignment will require students to submit a final report of varying detail. Activities and associated assignments are described in detail in the Group Activities document, which will be distributed to students in electronic format before the start of the course. Point values for group activities are as follows:

Activity	Description	Points possible
1	Butterfly vertical stratification	200
2	Neotropical insect identification	100
3	Mark, release, and recapture	100

Please note that all group activity reports, including those for which data collection and analysis are required, will be completed by students individually, and turned in as electronic files on a portable USB drive/stick. Therefore, students should bring a laptop computer equipped with Microsoft Excel, as well as a small USB drive, with them to the field site. FPI maintains a small number of basic laptops at Los Amigos that are available for use by students. Please inform us in advance if you are unable to bring a personal computer with you.

Quizzes (2 total; 100 pts each)

Quizzes are designed to periodically test students' understanding and synthesis of specific course topics. Please note that the first quiz will cover the Forsyth and Miyata (1984) text, and will be given during the first day of the course at Finca Las Piedras. Therefore, students should read this text in its entirety before arriving in Puerto Maldonado.

Final exam (200 pts)

This is a written exam during the final days of the course. The exam format is a series of short essay questions designed to test students' synthesis of the course material, including field experiences, course lectures, reading material, and discussions. This will require an understanding of the course material, rather than only straightforward memorization. For example, while there may be simple questions regarding insect identification, students may also be asked to synthesize what they have learned about field research methods in entomology, as well as the flora, fauna, habitats, and conservation issues of the study region, by designing a study to investigate the biology of a focal group of insects. The final exam will take roughly 1-3 hours to complete.

Reading List

- Day 2: Erwin, T. 1982. Tropical forests: their richness in Coleoptera and other arthropod species. *The Coleopterists Bulletin* 36: 74-75.
- Day 3: DeVries, P.J. 1988. Stratification of fruit-feeding nymphalid butterflies in a Costa Rican rainforest. *Journal of Research on the Lepidoptera* 26: 98-108.
- Day 4: Molleman, F. 2010. Puddling: from natural history to understanding how it affects fitness. *Entomologia Experimentalis et Applicata* 134: 107-113.
- Day 5: McCain, C.M. & J.A. Grytnes. 2010. Elevational gradients in species richness. In: *Encyclopedia of Life Sciences*. John Wiley and Sons, Ltd., Chichester, U.K.
- Day 8: Ellwood, M.D.F. & W.A. Foster. 2004. Doubling the estimate of invertebrate biomass in a rainforest canopy. *Nature* 429: 549-551.

Grading Criteria

Individual and group assignments will be assessed according to the following point schedule:

Assessment Item	Date Due	Points Possible	Course Total Points Possible
Field journal	Day 12	100	1000
Reading discussion participation	ongoing	100	
Group activity #1: Butterfly vertical stratification	Day 10	200	
Group activity #2: Insect diversity	Day 6	100	
Group activity #3: Mark-release recapture	day 11	100	
Quiz #1	Day 2	100	
Quiz #2	Day 6	100	
Final exam	Day 12	200	

To convert final grade percentages to letter grades that will appear on the transcript, the following grading scheme will be applied:

Letter grade	Percentage	Letter grade	Percentage
A	$92.5 \leq \% < 100$	C+	$77.5 \leq \% < 80.0$
A-	$90.0 \leq \% < 92.5$	C	$72.5 \leq \% < 77.5$
B+	$87.5 \leq \% < 90.0$	C-	$70.0 \leq \% < 72.5$
B	$82.5 \leq \% < 87.5$	D+	$67.5 \leq \% < 70.0$
B-	$80.0 \leq \% < 82.5$	D	$62.5 \leq \% < 67.5$
		D-	$60.0 \leq \% < 62.5$
		F	$\% < 60.0$