Plant-Insect Interactions in Terrestrial Ecosystems - Biology 4571

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Also by appointment

Texts:
Insect-Plant Biology, Schoonhoven, Jermy and van Loon, 2nd Ed-Two copies of Ed. #1 are on reserve in Belk Library.
The Science of Entomology- Romoser and Stoffolano (on reserve in Belk Library)
The Insects- Gullan and Cranston (on reserve in Belk Library)

Course Objectives:
The diversity of plant-insect associations is truly remarkable, encompassing a wide array of biotic and abiotic interactions between insects and their host plants. From the smallest sucking insects to the largest leaf feeding herbivores, insects as a taxonomic group act as regulators of plant productivity and stimulators of evolutionary processes for both plants and animals. The very foundations of numerous terrestrial ecosystems are formed by a complex interconnecting network of plant-animal associations, with insects playing a primary role in many systems. The goal of this course is to examine this fascinating area of entomology and ecology through a combination of lectures, discussions of pertinent research, and laboratory exercises. The lectures are designed to build from a basic introduction of plant-insect interactions as a field of science to a more detailed look at the mechanisms underlying specific interactions. We will examine research articles to better understand the nature of plant-insect interactions from an experimental view. Rather than a course that covers lots of facts, the approach in this class is more conceptual and interpretive.

The laboratory is designed to expand on the lecture material, as well as expose you to the various aspects of plant-insect interactions we are studying through laboratory investigations (for more detail consult the laboratory syllabus). Some of the basic goals of the laboratory are: (1) provide a more detailed examination of the methods used to quantify plant-insect interactions via a series of mini field experiments, (2) use insects to set up experimental manipulations in the laboratory, and (3) allow you to choose a project of interest to develop, conduct, write up, and present before fellow students. Group effort is emphasized.

An important component in both the lecture and laboratory portions of this course is participation. This includes being prepared to discuss focus papers in lecture and to fully participate in prompted discussion in lecture and laboratory. I expect each student to be involved in discussing the subjects we cover in class. I will make relevant papers available for downloading by students.

For focus studies I present in class, I require you to summarize the study in a brief (1-2 page) paper (more details in lecture). This is not intended as a paper critique, rather a way for you to present more formally the relevance of the study within the context of our class material. Note: this assignment is not optional and is required to receive credit for this course.

Course Requirements:
Exam I 100 points
Exam II 100
Final Exam 100
Paper Summaries (3 @ 5 pts. each) 15
Class Participation 35
Laboratory 150

500 points

Grading Scale:
Based on a 10 percentage point scale-

A 470 - 500  D+ 330 - 349
A- 450 - 469  D 315 - 329
B+ 430 - 449  D- 300 - 314
B 415 - 429  F Below 314
B- 400 - 414
C+ 380 - 399
C 365 - 379
C- 350 - 364

Attendance:
It is your responsibility to attend class, realizing this will greatly improve your success in the course. More than two absences from the lecture will result in reductions in the class participation portion of your grade at my discretion. Attendance to each laboratory is mandatory. I reserve the right to subtract points from your participation grade for each laboratory you miss at my discretion. Also note that participation in laboratory activities (consult the lab syllabus) is considered in the class participation credit. Finally, lectures in which there are focus paper presentations and laboratories where there are Theme descriptions and student presentations will be weighed considerably more heavily than other days in terms of attendance and thus participation. Be aware that in summer school material comes out you fast and furious!

AsULearn Module:
This course relies heavily on the AsULearn site found as BIO4571101 (for lecture). Please consult the site often. This valuable resource has all of the figures we view and discuss in lecture, as well as review materials, example exam questions, etc. I also will post .pdf files for you to download of the focus papers we will discuss and you will summarize. For the lecture, having the figures available will be useful, especially for those not found in your text. Please be aware that the shows presented in class may have formatting that you will want to avoid (example, colors) if printing the show to follow in lecture. To save printer toner cost, perhaps convert all background to white! Resources posted to this site are not designed as a replacement for regular lecture attendance!

It is the student’s responsibility to ensure they have access to the website (asulearn.appstate.edu). The instructor is not responsible for the operation of the network system, access to network resources, or the performance of personal computers. As a precaution, accessing and uploading of material to the site using a Wi-Fi connection is not always reliable and should be avoided. Class materials, including lecture Power Point shows, will be posted in a timely manner. However, conditions may occur which prevent access to materials. It is the student’s responsibility to obtain class materials. Finally, you are responsible for checking your university email and the Moodle site for announcements. If you do not use the university system, configure your email so that it is forwarded to the account that you do use.

Interactions of the Day:
At the beginning of lecture we will have a very brief (5-10 minute) Power Point presentation on an insect-plant interaction chosen by each student. Guidelines for what to present will be presented in class. This is also a good way for everyone to learn something about interesting interactions we may not discuss in class. The order for presentations will be randomly determined early in the course.

Learning Outcomes for the Course:
The association between plants and insects encompasses many facets of ecology, physiology, and evolutionary processes. My expectation is that when you finish this course you should have gained valuable experience in: (1) collaborating on experimental designs and collecting data in manipulative experiments, (2) using quantitative skills to manage and statistically analyze data, (3) synthesizing results and presenting them in a research paper, (4) presenting experiments before others using digital technology, and (5) integrating information from a variety of sources to better understand the ecological basis of plant and insect associations.

Classroom Policies:
• Cell phones and pagers must be either turned OFF or on SILENT (vibrate) prior to entering the classroom. No personal phone calls will be permitted during lecture. To ensure access to the ASU emergency alert system, I will have a charged cell phone with me for each class period. Therefore, there is no situation where a cell phone or pager should be present on a desk top (or lap!) during lecture. Under no circumstances will the use of a phone for texting or any other purposes be tolerated in this class. If you need to put dates on your calendar, etc., this can be done once the class has ended. Devices needed for medical purposes or used by emergency response personnel are allowed so long as I am notified prior to class. Cell phones must be stored off the desk during exams.
• Recording devices are allowed with my prior approval but must not interfere with the class environment.
• Laptop computers used for following lectures or note taking are allowed so long as the volume is OFF. A student using a computer for purposes not associated with the class, such as surfing the web, playing games, etc. will be asked to turn the machine OFF at my discretion. Repeated violation of this request will result in the student not being allowed to bring a laptop to class.
• No food is allowed in the classroom. Please eat your breakfast prior to coming to class!

Academic Integrity:
All students who are enrolled in the introductory biology program agree to abide by the ASU Academic Integrity Code, which states
a. Students will not lie, cheat, or steal to gain academic advantage.
b. Students will oppose every instance of academic dishonesty.

By honoring this code a student commits to doing their own work- much more rewarding than depending on another! Please check the honor code website for a detailed description of expectations and penalties for violations- http://studentconduct.appstate.edu.

Office of Disability Services:
Appalachian State University is committed to making reasonable accommodations for individuals with documented qualifying disabilities in accordance with the Americans with Disabilities Act of 1990, and Section 504 of the Rehabilitation Act of 1973. Those seeking accommodations based on a substantially limiting disability must contact and register with The Office of Disability Services (ODS) at http://www.ods.appstate.edu, or 828.262-3056. Once registration is complete, individuals will meet with ODS staff to discuss eligibility and appropriate accommodations.
The lecture schedule below refers to readings in Schoonhoven, Edition 2 (this is not too much different than Edition 1 on reserve). I hope to keep to this schedule as closely as possible. Be aware that I will draw on numerous other resources besides this text so following the lectures will be important. Because it is difficult to gauge the progress of courses in summer sessions compared to the regular academic year, modifications to this schedule may be necessary—stay tuned. Exam dates are bolded.

Lecture Schedule:

W, 7/6-R, 7/7  Introduction and background  Chapter 1
Basics of plant-insect associations  Chapter 2
F, 7/8-T, 7/12  Plant phytochemistry- allelochemical constituents/constraints  Chapter 4
Induction concepts and evidence; Focus Paper #1 presented (T)
W, 7/13  Plant phytochemistry- nutritional constituents/constraints  Chapter 5
R, 7/14  Compensation and strategies to overcome constraints

F, 7/15  EXAM I (Introduction-Nutrition)

T, 7/19-W, 7/20  Unifying theories of chemical ecology; Begin host plant selection  Chapters 6,7
Plant/insect physiological considerations;
Variation in host plant selection by insects Focus Paper #2 presented (R)  Chapter 8
F, 7/22  Evolutionary Relationships  Chapter 11

T, 7/26  EXAM II (Compensation-Evolutionary Relationships)

W, 7/27-R, 7/28  Ecological Concepts- Abiotic Factors; Trophic level interactions,
bottom-up approach  Chapter 10
Carbon-nutrient balance hypothesis, top-down approach; Population
and community level interactions; theories and practice in understanding communities
F, 7/29  Climate Change and Interactions (Focus Paper #3-my work)
T, 8/2  Plant-insect mutualism concepts- pollination ecology, myrmecophily
and other mutualisms  Chapter 12
Using what we Know  Chapter 13

W, 8/3  EXAM III (Ecological concepts-Using what we know)

R, 8/4  Class open for Ray grading and lab project preparation

Biology 4571 Laboratory

The laboratory is designed to give you hands on experience in the ways plant-insect interaction experiments are conducted. We will use a variety of approaches to investigate plant-insect associations, including both field and laboratory-based mini-experiments. The laboratory consists of several “themes” from which groups of students will help design and conduct an experiment. The themes are:

Theme #1  Variation in insect community abundance and diversity across a landscape. We will collect and characterize the insect community in plots using diversity indices.

Theme #2  The role of intraspecific genetic variation on plant traits and insect colonization. We will focus on Solidago using plants growing at the ASU greenhouse.
Theme #3  The role of nutritional and defensive chemical constituents in insect performance. This will involve artificial diet studies using the tobacco hornworm, *Manduca sexta*.

Theme #4  The role of abiotic factors (specifically temperature) in mediating insect performance. This will involve studies using *M. sexta*.

In addition to these we collect data on a **Class Theme**: The role of vegetation type on ground-dwelling insects.

**Note**: for the Class Theme all students will be responsible for collecting and organizing the data. Ray will analyze the data and make an oral presentation before the class. This may serve as an example presentation, though variation on my approach is certainly acceptable.

For each of these themes handouts will be provided on basic concepts and discussions held. The lab group (see below) assigned to a theme will help design an experiment to address basic, yet relevant questions. In consultation with the class, a final design will be decided on and data collected by all members of the class on each experiment (see Laboratory Protocol below). An important aspect of these laboratory experiments is the analysis of data and its presentation. The laboratory exercises above are meant to lay a foundation for the development, implementation, and presentation of small group research projects.

Each student will be assigned to a group. You will work cooperatively with your classmates on one of the above projects. It is important that everyone **contribute equally**. This will be ascertained partially by an assigned group leader and partially by an evaluation instrument provided by each group member. Because of the limited amount of equipment in the laboratory, for some exercises groups will be asked to come to lab in a “time-staggered” fashion. Details will be presented where appropriate.

**NOTE**: Data generated in our laboratory exercises will be made available to all students via the Moodle module. It is important that you check the site **frequently** and this site is a valuable resource for this portion of the laboratory.

**NOTE**: Because this is a field-biology course you will be exposed to the elements! For local field trips you will need appropriate shoes (ex., hiking boots or tennis shoes (no sandals!)), long pants and water to drink. You may also get wet! Please be prepared when you come to lab.

Participation in all phases of the laboratory is considered when assigning the final participation points for the course.

**Laboratory Requirements:**

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<tr>
<th>Requirement</th>
<th>Points</th>
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<tbody>
<tr>
<td>Group Project Presentation/Summary</td>
<td>30</td>
</tr>
<tr>
<td>Research Project Paper and Presentation</td>
<td>100</td>
</tr>
<tr>
<td>Participation</td>
<td>20</td>
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<td><strong>Total</strong></td>
<td><strong>150</strong></td>
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**Group Project Presentation:**

Each laboratory group will present their theme project before the class. This Power Point Show will be provided for my evaluation based on a defined set of criteria. As an introduction, the show should be 15 minutes in length and have the following sections: Background, Objectives, Methods, Results and Conclusions. Every group member takes a section and orally presents it. Details will be discussed in
laboratory. The group presentations will be on Thursday, July 28. Each group will provide a summary for the evaluation/grading process (more details coming).

**Research Project- Paper and Presentation:**

The major component of the laboratory is the development, implementation and write-up of a project of interest. To facilitate this process the projects are done in pairs. At your discretion you may choose someone to develop a project with or request that I assign you a group. It is important that you develop your ideas for a project early enough to allow time for necessary supplies (this will be limited) to be acquired. I would like to discuss your project ideas on an individual basis. Your project idea needs to be submitted in writing and approved by me by Wednesday, July 27.

The requirements for the individual project paper follows. Your paper is due by 2:00 PM on Thursday, August 4.

The basic requirements for the paper are as follows:

1. Double-spaced text using a 12 point font with 1 inch margins all around.
2. All pages numbered (except title page).
3. The document should be created using Microsoft Word and uploaded to the proper place on the AsULearn site as .doc or .docx file.
4. Minimum eight pages in length.
5. Your paper should contain a Title Page.
6. Citation of at least 4 sources from the primary literature (peer review science articles). Your paper should contain references to literature directly pertinent to your project.
7. Your paper should have the following sections: Introduction, Methods, Results, Discussion (or Summary), and Literature Cited section.
8. Data collected from your project should be statistically analyzed and presented in either table and/or figure form. Tables should have captions and figures should have legends.

Your paper will be evaluated using criteria such as neatness, proper grammar/punctuation, effectiveness in setting up the background for the study, methods comprehension, proper analysis and presentation of data and the effectiveness of your conclusions.

Each project will be presented to fellow students in the form of a Power Point Show. The format will closely follow the presentations for the group projects above (more detail is provided in laboratory). All presentations will be held on Thursday, August 4.

**NOTE:** as mentioned above, much of the work in the laboratory is in a group setting. This allows for a cooperative and collaborative approach to science. While beneficial, it does require equal participation by all. Each student will have available an anonymous evaluation instrument for other members in your group. These comments will be considered when assigning participation grades in laboratory.

**CAUTION:** much like the lecture portion of the course, activities in laboratory will come at you quickly due to the summer school schedule. It is imperative that you stay on top of the lab work as the course progresses. Also, because of the limited number of days in the session, requirements in lecture and lab will overlap- be aware of this.

**Laboratory Protocol:**
The pedagogy we will use for the group projects in particular involves four stages, which are intended to illustrate and provide a practical experience in the scientific process for students. This “inquiry approach” will hopefully provide examples of how scientists investigate plant-insect interactions.

**Design:** this involves the presentation of a topic for investigation (one of the themes) by laboratory groups. This is supported by a brief oral presentation of the themes approach based on my brief description. Open discussion of experimental design and proposed hypotheses for each group’s project will foster discussion and feedback. Although each group is responsible for the initial design of a project, a discourse among fellow students will serve to illustrate an important component of the science inquiry process, that is, the role of sharing ideas and seeking input. This approach will allow students to develop skills in hypothesis testing as questions and predictions are centered on tangible factors. An important result of this learning approach will be an increased ability by students to design and conduct independent research projects. **Note:** I realize that the experimental design process comes early so the later modification of a research “plan” is both expected and acceptable.

**Technique:** largely provided in the lab, descriptions will concentrate on a variety of skills necessary for students to conduct experiments. Examples include the proper use of microbalances and growth chambers and formulation of artificial diets for insect feeding studies. The techniques will be presented and demonstrated at various times during the laboratory as appropriate.

**Data collection:** this requires participation by all students in the collection of data for each group project. Data collection for each group’s laboratory experiment follows the presentation of the questions or hypotheses on the topic (i.e. Design). Along with setting up and collecting samples, a primary goal for **Data Collection** is to give students practical experience in collecting and analyzing data. The group responsible for the theme, which will have ultimate responsibility to report the findings of that experiment, will report on data collected by all students. This portion of the laboratory exposes each student to the “hands on” nature of each project, allowing them to better understand the objectives, hypotheses and results when they hear the project presented.

As mentioned, each laboratory group will give an oral presentation. Pay particular attention how as a group you articulate the questions and hypotheses of the project and whether your data supports or rejects any hypotheses. It is my intent that the group project experience will provide the tools and experience for the research project. While this will primarily involve more independent thought, data collection and analysis and presentation of the project, I would hope that the above pedagogy will greatly assist students in designing and implementing a project of interest to them.

**Field Sites:**
The laboratory exercises will utilize three areas managed or owned by ASU:
- Environmental Studies Area (ESA): this is a tract of land behind the Broyhill Inn. Though mostly forest, other habitats are present.
- State Farm properties- athletic fields owned by ASU (also part of Boone greenway system)
- Greenhouse at State Farm

In addition to this we will take a trip to the Gilley Research Station (Ashe County) to examine research projects underway there. This is a 170+ ha site managed by the Biology Department for field research.

**Laboratory Schedule:**
The following schedule is tentative. Depending upon weather, plant and insect availability, and the expected pitfalls of plant-insect experimentation, it is subject to modification. Also, be aware that due to the nature of certain experiments (example, insect feeding trials over several days) you will need to
occasionally come to laboratory outside of the scheduled lab time. Dates pertinent to the lab pedagogy are **bolded**.

**W, 7/6**  Introduction to investigating interactions, overview of “themes”, discussion of laboratory protocol and projects; lab group meeting

**R, 7/7**  Collection and identification of insect morphospecies; Class Theme set up- ESA

**T, 7/12**  **Design**: Theme experimental design from lab groups; Introduction to statistical analysis and graphics using Excel (RSW 294 for this part of lab).

**W, 7/13**  Trip to Gilley Research Station

**R, 7/14**  Sample collection for Theme #1- State Farm

**T, 7/19**  **Data Collection** for Theme #1: Sample collection and **Data Collection** for Class Theme

**W, 7/20**  **Data Collection** for Theme #2- Greenhouse; making artificial diets (RSS 228)

**R, 7/21**  Themes #3 and #4 set up (RSS 228)- staggered attendance

**T, 7/26**  **Data Collection** for Themes #3 and #4 (RSS 228): staggered attendance

**W, 7/27**  Open for presentation/project work

**R, 7/28**  Group presentations

**T, 8/2**  Open for research project work

**W, 8/3**  Open for research project work

**R, 8/4**  Research **project presentations**; **papers due**