Exercise 3: Research Project in Entomology

Goals of the project

Entomologists are almost as diverse as the critters they study, and may study insects in the context of everything from molecular biology to ecosystem ecology. As such, research on insects can occur in a wide variety of settings, using a variety of methods. You and a partner will conduct a research project on insects at the whole organism or above. You will develop a question, design and execute an experiment, analyze and present the results of the experiment in the form of a laboratory report, and put your findings into a broad context.

My objective for you is to develop a better understanding of the way in which biologists conduct scientific research by conducting an original project in biology that has insects or other arthropods as the subjects. The specific learning objectives that you will achieve include:

- gaining experience in planning and conducting original research,
- working on writing skills by writing a short grant proposal and a research report,
- studying particular species, populations, or communities in depth.

Assignment

You and your partner will design a short-term study to address your question. Decide on a topic, discuss that topic and proposed methods with me, and then write a short two page proposal. In an early meeting, each pair of students will brainstorm and discuss project ideas and plans with me. There is a form at the end of this document that you will cut and paste into an e-mail and send to me so that I have a record of your needs.

You will spend the equivalent of your laboratory time during each of several weeks gathering and analyzing your observational data. The amount of time you spend should be about 3 hours each week, although it may not occur during scheduled laboratory time. However, we will meet at the beginning of each laboratory session so that each team can check in with me to discuss progress and problems. Whatever you come up with as your project, it will at least take up the bulk the equivalent of four to five laboratory periods. Some experiments may require you to check something daily (e.g., take a temperature measurement every day); others may require field excursions.

Several project ideas are listed below, but you are encouraged to develop your own question and experiment. Be creative and ambitious. The syllabus contains a schedule of activities and you will see that projects ideas and designs are due early in the semester. This is for several reasons: 1) insects are active in the fall, but activity wanes as the semester proceeds for most species, and field research needs to be performed earlier in the semester, 2) it is important to plan for projects early so that support staff can gather supplies and materials – there will be multiple projects for this class and others, and 3) any flaws in research design can be spotted early in the planning process.

When choosing animal subjects and planning your project, there are several things to keep in mind. First, there may be constraints on accessing equipment. Even if we have it, if it is use by another class or research group, your access may be limited. Next, you must be able to complete your project within 4-5 weeks, so do not design a project that will take longer than that. Finally, plan your experiment so that you have sufficient statistical power to be able to avoid Type I statistical errors. That is, you want to be able to reject your null hypothesis if it is,

in fact, false. Lack of replication will result in low statistical power and the inability to correctly reject the null if false. Replication is balanced by resources, such as time, energy, equipment, availability of specimens, and cost. See section below for more information on experimental design and analysis.

You will write up the results in the form of a primary literature research report. I expect your project to be well planned, carefully conducted, and your paper to be carefully written. Attention to detail is vital. Not everyone is detail-oriented. If you are one of these people, please be as mindful as possible and communicate with me and your partner so that details or tasks do not get overlooked. I will be happy to help you with writing, including providing comments on short sections of your paper (I will not review drafts of the entire report) before it is due. The Davidson College Writing Center is also available for writing help. When writing in the sciences, preciseness is extremely important. Your work should have a logical sequence and should not be vague. I will provide details in class on how to write your paper. Please see instructions for your proposal below.

Proposal Instructions

View your proposal as a justification for what you plan to do, how you plan to do it, and how you plan to analyze your data. I will discuss analysis with each group prior to proposal submission, and we have a variety of statistical procedures written up by Dr. Peroni and available to us. Justification (i.e., why your project is important and how it relates to previous studies) for your project should be supported by citing primary literature.

Each pair of students will prepare one joint proposal. Many of the particulars of the assignment that follow apply to your research report as well. Proposals should be submitted electronically, as an e-mail attachment. Files should be named using the following convention: lastnames_proposal.docx

Proposals should be single-spaced, with a 12 point font and 6 pt spacing between paragraphs. They should not exceed two pages in length, excluding literature cited and any figures or tables. Use subheadings where appropriate and the active voice throughout. There should be no title page, but at the top of the first page include the title, authors and date. Carefully edit for grammar, spelling, and accuracy of ideas. I suggest you employ the spelling and grammar checkers of your word processing program as well as the Writing Center. You may ask a colleague to review your proposal. Follow a standard and consistent format for literature cited.

The proposal is due on the 14th or 16th of September, depending on which laboratory section you attend.

Animals we can possibly get - or you can get for laboratory experiments

- crickets
- caterpillars of several different species
- fruitflies
- mealworms, ladybird beetles, or other types of beetles and their larvae
- cockroaches
- mosquito larvae

- other options are available – catalogues will be available in lab to peruse

Some equipment we have:

- Standard entomological collecting equipment
- Temperature and light controlled environmental chambers
- Standard biological laboratory equipment (balances, water baths, dissecting equipment, pH meters, etc.)
- Aquaria, pumps, and other materials for aquatic insects
- Small cages of many types
- Chemicals and drugs (within reason, within budget, within the law)
- Other – ask and we will see what we can do

Possible project ideas for independent research project:

- investigate the impacts of urbanization on insect biodiversity
- stream insect ecology
- applied forensic entomology
- insect biodiversity on farms of different type
- behavioral studies of a particular species
- pollination studies
- honeybee behavior
- dietary preferences and growth rates of particular species
- designing educational curricula for elementary or middle schools

Experimental design and analysis

You will require a detailed experimental design. There are seven aspects to keep in mind whenever designing an experiment:

- Factors: what are the independent variables you will manipulate? These are the factors of your experiment.
- Treatments: the levels of the factors are the treatments you apply. For instance, if you choose to study predation on a population of herbivorous insects, predation is the factor, and presence or absence could be two treatments of the factor.
- Subjects: the individual species, populations, or communities you choose to study are the subjects. The choice should be made carefully, as poor choices may prevent you from accurately testing your hypothesis.
- Replication of experimental unit: the sample size, or how many subjects per treatment, is essential for statistical analysis. Statistics can rarely be applied when sample size is one, and larger sample sizes allow for more powerful detection of biological and statistical significance. The experimental unit is a physical entity that is exposed to a treatment. It could be an individual insect, or it could be an entire ecosystem; it depends on your question, but you should be careful not to inaccurately apply sample size estimates to individual insects when you are testing an entire community. Each experimental unit must be independent of other units.
- Constraints: cost, time (both weekly and the entire time-frame), and energy are all

constraints that will limit the number of factors, treatments, and samples you use.

- Control/blocking: you must control extraneous variables to be sure that you do not confound your factor with other factors. You may wish to use some kind of blocking design, which is a way to reduce the experimental error by making treatment comparisons solely within blocks, thereby taking advantage of the homogeneity of each block. The effect is similar to that obtained by controlling for a variable. A block may be a set of trials performed at a particular time, a particular researcher running a set of trials (used to determine any experimenter effects), or a set of repeated measurements made on the same experimental unit. Blocking isolates a systematic effect and prevents it from obscuring main effects.
- Statistical analysis: we will discuss this in more detail, and I will guide you in designing your experiment so that we can apply statistical analysis appropriately to your experiment. Most experiments will be able to employ a regression or analysis of variance approach, and these will be discussed in class.

Form to be sent along with Proposal: Copy this table to an email, fill it out carefully and completely, and email it to me ASAP.

Entomology Research Project Needs

Your Names:	
Proposed Title of Project:	
Insect species, populations, or communities with which you will be working:	
Number of insects needed that must be acquired by the biology department:	
Particular characteristics of insects you require (e.g., sex or instar):	
Date you need the animals:	
Materials needed for project (be specific and be complete) – if you omit something, we may not be able to acquire it later.	
Will you need to use temperature controlled environmental chambers?	
If so, describe temperature(s), light regime(s),, and number of chambers needed:	
Schedule of project (start date, end date, dates you need chambers, dates in the field, etc.) – give actual dates.	
Other things I should know about your project?	