Insect Systematics
ENTM 5300 / 6300

Instructor
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Office hours: 9-5 (drop on by).

Description
This is a survey of the biodiversity of insects, stressing taxon diagnostics and insect phylogeny.

Credit hours
5
1.5 contact hours of lecture and 4 contact hours of lab per week.

Prerequisites: General or Economic Entomology. These can be waived with permission.

Objectives:
1. You will be able to sample and preserve insect specimens.
2. You will be able to use diagnostic tools such as dichotomous keys, and identify on sight the common orders and families of insects that occur in the southeastern US.
3. You will know how to delimit, name and classify insect species.
4. You will be able to correctly interpret phylogenies, critically assess the phylogenetic literature, and use phylogenies in comparative research.
5. You will be able to estimate phylogenetic relationships among insect species.

Schedule for Fall 2018:

Week	**Lecture**	**Lab**
Aug 20-24	Overview of insect diversity and systematics	Insect sampling + preservation
Aug 27-31	The sense of phylogenetics	Insect diagnostics + Overview of insect orders
Sep 3-7	Species concepts + delimitation	Wingless hexapods + Palaeoptera
Sep 10-14	Classification + nomenclature	**Lab practical 1**
Sep 17-21	**Midterm exam**	Orthopteroids
Sep 24-28	Phylo 1: homology assessment	Hemipteroids
Oct 1-5	Phylo 2: estimation + **Archbold trip**	**Lab practical 2**
Oct 8-12	Phylo 3: estimation + **Fall Break**	Neuropterida + Coleoptera 1
Oct 15-19	Phylo 4: estimation + uncertainty	Coleoptera 3

Oct 22-26	Phylo 5: Comparative methods + **Midterm exam**	Mecoptera + Siphonaptera + Trichoptera
Oct 29- Nov 2	Start phylogeny projects	Lepidoptera + Hymenoptera 1
Nov 5-9	Paper discussions	Hymenoptera 2 + **Lab practical 3**
Nov 12-16	**ESA meeting**	
Nov 19-23	**Thanksgiving break**	
Nov 26-30	Paper discussions	Diptera
Dec 3-7	Paper discussions	Work on collections + **Final lab practical**

Evaluation:

- Insect collection (400 points). Each student will build an insect collection, and gain skills with specimen sampling, curation, and identification. See attached rubric for details.
- Lab practicals (125 points). Students' ability to identify insects that occur in the southeastern US (see attached list) will be assessed with 3 midterm practical exams (25 points each) and one cumulative final practical exam (50 points). Tests will involve a combination of sight identification and dichotomous keying.
- Midterm exams (150 points): There will be two midterm examinations, each of which will count for 75 points of the final grade. The second midterm is cumulative. There will be no final exam at the end of the semester.
- Phylogeny project (100 points). Each student will estimate phylogenetics relationships among a group of insects from published DNA sequence data. This project will be evaluated via a short written report due on the last day of classes. See attached rubric.
- In class exercises (100 points). In class, students will put what they learn into practice through a variety of active learning exercises.
- Research Paper discussions (45 points): Each student will lead the rest of us in a discussion of a paper that describes phylogeny-based research.
- Taxon diagnostics tips (25 points): Students will pair-up and become diagnostics experts for particular insect taxa. At the start of lab sessions, expert teams will share identification tips with the rest of the class, and help their peers gain that diagnostic expertise.

Final grading scale:
The sum of the above evaluations is 945 points. Your final grade will be determined by the percentage of these points you were able to earn.

90%-100% = A
80%-89% = B
70%-79% = C
60%-69% = D
<60% = F

Texts.

Johnson NF, Triplehorn CA. 2004. Borror and DeLong's Introduction the Study of Insects.

Course policies:
All quizzes will be announced. Attendance is required. Active participation is highly encouraged. If you do need to miss a class, let the instructor know ahead of time. Please see the Student Policy eHandbook for information about excused absences (http://www.auburn.edu/student_info/student_policies/). Arrangement to make up missed major examination (e.g. hour exams, mid-term exams) due to properly authorized excused absences must be initiated by the student within one week from the end of the period of the excused absences. Except in unusual circumstances, such as continued absence of the student or the advent of University holidays, a make-up exam will take place within two weeks from the time that the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins.

Academic honesty:
All portions of the Auburn University student academic honesty code (Title XII) found in the Student Policy eHandbook will apply to this class. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee. Don't cheat and don't plagiarize.

Disability accommodations:
Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e-mail. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096.

Insect Collection Grading Rubric.
This is slightly modified from the system Dr Mike Williams developed and used for his Insect Systematics course here at AU for decades.

700 points = D; 1100 points = C; 1500 points = B; 1800 points = A

Minimum Collection: 15 orders, 100 families = 700 points

Add

- 30 points for each additional order (more for a few — see below)
- 15 points for each additional family
- 5 points for each additional subfamily
- 2 points for each additional morphological kind within a family
- 5 points for each series (≥ 5 specimens of the same species)
- 10 points for each slide-mounted specimen
- 2 points for each pointed specimen
- 5 points for each ecological association (host plant, mutualist, natural enemy)
- 30 points for rare families (those bearing an asterisk in the text)
- 60 points each: Protura, Diplura, Zygentoma, Embioptera, Zoraptera, Strepsiptera
- 30 points for each specimen with a bounty on it — i.e., that are needed for the teaching collection
- Up to 50 points for tidy curation

Subtract

- 10 points for each incorrect, or unintelligible determination or data label
- 25 points for each misidentified family
- 75 points for each misidentified order
- 20 points for each improperly preserved specimen
- 400 points for false information

Note

- No more than 25% of collection can consist of traded material.
- Trades are only permitted between students currently taking this course. That is, no recycling of material from previous years is permitted.
- At least 85% off collection must be collected this term.
- Specimens in your collection may be be taken to replenish the teaching collection.

Insect taxa to be recognized.
Students should be able to site identify any taxon marked with asterisk.

PROTURA*
- Eosentomidae
- Protentomidae
- Acerentomidae

DIPLURA*
- Campodeidae
- Japygidae
- Anajapygidae

COLLEMBOLA*
- Sminthuridae
- Hypogastruidae
- Onychiuridae
- Entomobryiidae
- Isotomidae

THYSANURA / ZYGENTOMA *
- Lepismatidae

MICROCORYPHIA / ARCHAEOGNATHA*
- Machilidae

EPHEMEROPTERA*
- Baetidae
- Ephemeridae
- Heptageniidae

ODONATA*
- ANISOPTERA*
  - Aeshnidae*
  - Gomphidae*
  - Cordulegastridae*
  - Libelluloidea*
    - Libellulidae
    - Corduliidae
  - Macromiidae
- ZYGOPTERA*
  - Calopterygidae*
  - Coenagrionidae
  - Lestidae

PLECOPTERA*
- Taeniopterygidae

- Nemouridae
- Leuctridae
- Capniidae
- Pteronarcyidae
- Chloroperlidae
- Perlodidae
- Perlidae

ORTHOPTERA *
- CAELIFERA *
  - Romaleidae *
  - Acrididae *
    - Cyrticanthacridinae
    - Melanoplinae
    - Leptysminae
    - Oedipodinae
    - Gomphocerinae
  - Tettrigidae *
  - Tridactylidae
- ENSIFERA *
  - Tettigoniidae *
    - Phaneropterinae
    - Pseudophyllinae
    - Copiphorinae
    - Conocephalinae
    - Decticinae
  - Rhaphidophoridae *
  - Gryllidae *
    - Gryllinae
    - Oecanthinae
- Gryllotalpidae *

PHASMATODEA *
- Pseudophasmatidae
- Heteronemiidae

MANTODEA *
- Mantidae
- Thespidae
- Liturgusidae

BLATTODEA * (Paraphyletic with respect to Isoptera)
- Blattidae
- Blattellidae
- Blaberidae
- Polyphagidae

ISOPTERA *
- Rhinotermitidae
- Kalotermitidae

EMBIIDINA / EMBIOPTERA *

ZORAPTERA *
- Zorotypidae

DERMAPTERA *
- Forficulidae
- Anisolabididae
- Labiduridae
- Labiidae

STREPSIPTERA *

PSOCOPTERA * (Paraphyletic with respect to Phthiraptera)

PHTHIRAPTERA *
- AMBLYCERA
  - Menoponidae
- ISCHNOCERA
  - Philopteridae
  - Trichodectidae
- ANOPLURA
  - Pthiridae
  - Haematopinidae
  - Pediculidae

THYSANOPTERA *
- TUBULIFERA *
  - Phlaeothripidae
- TEREBRANTIA *
  - Thripidae

HEMIPTERA *
- STERNORRHYNCHA *
  - Psyllidae
  - Aleyrodidae
  - Aphididae
  - Adelgidae
  - Phylloxeridae
  - Coccidae
  - Diaspididae
  - Pseudococcidae
- AUCHENORRHYNCHA *

    - Cicadidae *
    - Membracidae *
    - Cercopidae *
    - Cicadellidae *
    - Fulgoridae
    - Derbidae
    - Cixiidae
    - Delphacidae
    - Acanaloniidae
    - Flatidae
    - Issidae
- HETEROPTERA *
    - Corixidae
    - Notonectidae
    - Nepidae
    - Belastomatidae *
    - Naucoridae
    - Gelastocoridae
    - Gerridae *
    - Veliidae
    - Saldidae
    - Cimicidae *
    - Miridae
    - Reduviidae
    - Nabidae
    - Tingidae *
    - Lygaeidae
    - Coreidae
    - Alydidae
    - Aradidae
    - Scutelleridae
    - Pentatomidae *
    - Cydnidae
    - Thyreocoridae

NEUROPTERIDA (Your book treats this a order Neuroptera, with suborders Megaloptera, Raphidioptera, and Planipenia)

- MEGALOPTERA *
    - Sialidae
    - Corydalidae
- RAPHIDIOPTERA *
    - Raphidiidae
- NEUROPTERA *
    - Mantispidae *
    - Chrysopidae
    - Berothidae
    - Hemerobiidae
    - Myrmeleontidae *

- Ascalaphidae *

COLEOPTERA *

- ADEPHAGA *
  - Carabidae *
  - Dytiscidae *
  - Gyrinidae *
- POLYPHAGA
  - Histeridae
  - Hydrophilidae
  - Silphidae *
  - Staphylinidae *
  - Cantharidae
  - Lycidae
  - Lampyridae *
  - Dermestidae
  - Cleridae
  - Elateridae *
  - Buprestidae *
  - Erotylidae
  - Silvanidae
  - Nitidulidae
  - Coccinellidae *
  - Meloidae
  - Mordellidae
  - Tenebrionidae *
  - Anobiidae
  - Bostrichidae
  - Lucanidae *
  - Passalidae *
  - Trogidae
  - Geotrupidae
  - Scarabaeidae *
    - Scarabaeinae
    - Aphodinae
    - Melolonthinae
    - Rutelinae
    - Cetoniinae
    - Dynastinae
  - Cerambycidae *
    - Parandrinae
    - Prioninae
    - Lamiinae
    - Lepturinae
    - Cerambycinae
  - Chrysomelidae *
    - Cassidinae

        - Hispinae
        - Donaciinae
        - Alticinae
        - Criocerinae
        - Chrysomelinae
        - Galerucinae
        - Bruchinae
        - Anthribidae
    - Brentidae
    - Curculionidae *
        - Entimiinae
        - Dryopthorinae
        - Curculioninae
        - Platypodinae
        - Scolytinae

TRICHOPTERA *
- Hydropsychidae
- Limnephilidae
- Leptoceridae

LEPIDOPTERA *
- Papilionidae *
- Pieridae *
- Nymphalidae *
    - Nymphalinae
    - Heliconinae
    - Satyrinae
    - Danainae
- Lycaenidae *
- Hesperiidae *
- Sphingidae *
- Saturniidae
- Arctiidae *
- Noctuidae
- Notodontidae
- Lasiocampidae
- Geometridae *
- Sesiidae
- Psychidae

MECOPTERA * (Paraphyletic with respect to Siphonaptera)
- Panorpidae
- Bittacidae

SIPHONAPTERA *
- Pulicidae

DIPTERA *

- NEMATOCERA (Paraphyletic with respect to other flies)
  - Tipulidae *
  - Psychodidae
  - Chironomidae *
  - Culicidae *
  - Bibionidae
  - Sciaridae
- BRACHYCERA
  - Tabanidae *
  - Stratiomyidae
  - Rhagionidae
  - Bombyliidae *
  - Asilidae *
- CYCLORRHAPHA
  - ASCHIZA
    - Syrphidae *
  - SCHIZOPHORA
    - ACALYPTRATAE
      - Ulidiiidae
      - Tephritidae
      - Drosophilidae
    - CALYPTRATAE
      - Tachinidae
      - Muscidae
      - Calliphoridae
      - Sarcophagidae
      - Anthomyiidae
      - Hippoboscidae

HYMENOPTERA *

- SYMPHYTA * (Paraphyletic with respect to Apocrita)
  - Argidae
  - Tenthredinidae
  - Siricidae
- APOCRITA *
  - Ichneumonidae
  - Brachonidae
  - Chalcididae
  - Evaniidae
  - Pelecinidae
  - Chrysididae *
  - Tiphiidae
  - Mutillidae *
  - Scoliidae
  - Formicidae *

- Vespidae *
- Pompilidae *
- Sphecidae
- Andrenidae
- Halictidae
- Megachilidae
- Apidae *
  - Apinae
  - Bombinae
  - Xylocopinae

Student Paper Discussion Rubric

Scientists needs to be good readers. Here's why:

- Science progresses. To keep pace, you need to keep learning. By the time you are in grad school, a large part of learning will be though reading. Once you leave grad school, even more of your learning will be through reading.
- Not all science is good science. And even the best science has flaws. Hence, critical reading is a critical skill. Skepticism is at the heart of the scientific approach. To filter out the good from the bad, you need to apply that skepticism to your reading. That takes practice. If you cannot read critically, you will be mislead. If you can read critically, you will recognize opportunities to keep science progressing.
- You'll be paid for it (in one way or another). We rely on peer review to assess the quality of science. Journal editors send manuscripts through peer review before deciding to publish something. Funding organizations send grant proposals through peer review before deciding to fund something. Grad students send drafts of their theses and dissertations through peer review before they can complete their graduate studies (in this case their peers are their committee members). Critical reading skills can earn you the good graces of journal editors and funding officers. They can also help you help others. Your comments as a peer reviewer of a scientific manuscript, grant proposal, or grad student research proposal can make the difference between bad science and good science.

To practice our critical reading skills, each graduate student will present a paper from the primary literature, that uses phylogenies to address questions about insect biology. Papers of any vintage are fine. To make it clear what is involved in critical thinking, each of these presentations will need to address a series of questions that the NSF asks reviewers to think about when they look at grant proposals:

1. What do the authors try and do? In other words, what is the research questions being addressed?
2. Why do they want to do it? Do they present a well-reasoned rationale? If so, what is it? If not, what went wrong?
3. How did they do it? Is their approach a reasonable way of addressing their questions. Using their approach, can they actually find what they are looking for?
4. Were they successful? Did they find what they were looking for?
5. What were the benefits? How does this work advance science? Is there anything transformative about it? That is, does this change our mindset in an important way, or give us new ways of doing science?

Grading (45 points total).
Twenty points of the total grade come from performance as a primary presenter. The remaining 25 points come from participation in the rest of the discussions.

Presenters – 20 pts.
When we meet to discuss a paper. Two students will be prime presenters. They will jointly choose a paper. But then each will independently read and evaluate the paper. When we meet, each prime presenter will provide a short answer to each of these five questions. By short, I mean no more than a few sentences. Each question is worth 4 points. As long as answers are logical you will earn all 4.

Participants – 5 pts.
After the primary presenters have finished, I will ask half of the rest of you to comment one one the 5 questions of your choosing. Any sensible response will get you 5 points. You just need to demonstrate that you have read the paper and are prepared to talk about it.
Bonus – 5pts.
At that stage we'll have an open discussion. I'll award 5 bonus points to all contributors.

Phylogeny Project Rubric

Each student will work independently. She (feminist choice of third nominative third person pronoun) must estimate phylogenetic relationships among at least 20 species with published DNA sequence data. To keep things simple, we will use data from just one locus (for example, COI, or Ef1a). She must also assess the confidence we should have in her estimate. The project will be presented via a short research report. This will take the form of a standard research paper. It should have an appropriate title, a 200 word abstract, and the other canonical sections of a research paper: Introduction, Methods, Results, Discussion, Conclusions, References. The manuscript should be ~1500 words (not including References cited, and captions). It should introduce and motivate a clear research question. It report should describe the methods in enough detail that someone else could replicate the work. It should accurately interpret the findings and explain their significance.

This project is worth 100 points. For a rubric, I will use a modified version of what ESA judges use to evaluate student presentations in competitions at annual society meetings.

The report will be due on the last day that we meet, April 26. But if you can get it to me by April 19, I will review it, and give you a chance to revise it before it is graded. I expect you'll get more out of your one round of review, if you have a relatively polished version to show me.

Scientific Content (60%)

- Introduction and background with pertinent literature cited (5 points)
- Title appropriate for presentation content (5 points)
- Objectives clearly stated (10 points)
- Methods appropriate for the problem, and reported in enough detail to be reproducible. (10 points)
- Results clearly stated (10 points)
- Interpretation justified (10 points)
- Significance of work clearly stated (10 points)

Presentation (40%)

- Appropriate length (10 points)
- Logical order, minimum redundancy (10 points)
- Grammatical writing; not excessively wordy (10 points)
- Effective use of figures and tables (10 points)

Rubric for evaluation of Diagnostic Expertise Team

Teams of two students each will provide diagnostic expertise and support for a particular taxon to their peers. At the start of a taxon-focused lab session, the responsible team will point out useful characters for sight identification, help to clarify ambiguities in dichotomous keys, and direct their peers to useful diagnostic resources. Then, for the rest of the lab, the team will be available to help their peers with their identifications. Throughout the semester, students should reach out to their peers in expert teams for help with diagnostics.

Teacher evaluation (60%)
Sight-ID characters (5 points)
Dichotomous key navigation (5 points)
Other diagnostic support (5 points)

Peer evaluation
Support* (10 points)

*Each student evaluates the performance of each student outside of their own expert team. Rate their availability, effort, and effectiveness. The default score should be a perfect 10. If a student did not seek help from an expert team, they should award students in that team a 10. Points should be deducted only if help was sought and was insufficient.