Insect-plant interactions
- Why is the earth green?
- What is the importance of the evolutionary contest between insects & plants?
- Has this contributed to diversity of insects and angiosperms?
- What hypotheses explain variation in herbivory?

Plant apparency and agricultural crops: the alfalfa weevil (Hypera postica)
- What is apparency, and how does it explain susceptibility to herbivory?

Alfalfa weevil larvae skeletonize leaves

Alfalfa weevil damage in unsprayed strips.

Imported longhorned weevil on young soybean plants

Bean leaf beetle feeding on soybean pod
20 grasshoppers/plant is not uncommon in some fields

Nature and quantity of resources: Predictability and stress-related herbivory
- These hypotheses might also explain herbivory patterns and levels
- How?
- Might they also explain patterns of specificity?

Plant nutritional quality changes over time
- Nitrogen limits insect growth
- Phenological changes in N of oak leaves leads to evolution of spring-feeding herbivores?

Types of plant feeding
- Chewing insects
  - Caterpillars, beetles
  - Defoliators
- Leaf skeletonizers
  - Caterpillars, beetles
- Leaf miners
  - Flies, wasps, caterpillars
- Leaf tiers, rollers, & folders
  - Wasps, caterpillars, sawflies
- Borers
  - Beetles, caterpillars
- Sucking insects
  - Hemiptera
  - Honeydew
- Gall insects
  - Flies, wasps, caterpillars

Major orders of insect herbivores: the Coleoptera

Orthoptera
Lepidoptera: 90% are specialist herbivores

Gypsy moth, *Lymantria dispar*, is a generalist, often defoliating deciduous forests in eastern N.A.

Pale-striped flea beetle
*Systena blanda*

Borers: the Asian longhorn beetle (F. Cerambycidae)

Miners: O. Diptera; serpentine leafminer, *Liriomyza brassicae*

Suckers: O. Hemiptera; whiteflies
Suckers: Severe hopperburn and plant stunting

Typically, damage difficult to quantify

San Jose scale on apple
- Scale insects: O. Hemiptera, SF. Coccoidea (~ 20 families)
- Hosts: > 60 plants serve as hosts
- Insert stylets; withdraw liquid
- San Jose Scale feeds on fruit, foliage and bark
- Females: flat, circular, grayish
- Males: smaller, somewhat elongated
- Overwinter as immatures

http://www.caf.wvu.edu/kearneysville/pest_descriptions/pest_images/phot1-68.jpg

Hemlock woolly adelgid
- East coast, 1954, Richmond VA
- Expanding 3.5 km west/yr, 6 km N & S / yr

Mechanism of HWA feeding
- Adelges tsugae feeds at base of needles
- Needle mortality results
- HWA saliva can be toxic to susceptible trees
- 4-6 years to die
  - Other stresses hasten death
  - Especially chronic stresses

http://www.caf.wvu.edu/kearneysville/pest_descriptions/pest_images/phot1-68.jpg

Plant defenses against herbivory
- What defenses have evolved?
- Which are effective against insects?
Chemical defenses are similar within a plant family
- But different between families. Why?
- Stepwise chemical co-evolution

Plant evolves Chemical → Origin of Plant Family → Origin of Insect Family → Insect Breaks Defense

Milkweeds and cardenolides
- Widespread plants with milky sap
- Latex
- Digitalis is used to strengthen cardiac contractility and regulate heart rhythm

Milkweed specialists
- Monarch butterflies
- Milkweed bugs (*Oncopeltus fasciatus*)
- Aphid (*Aphis nerii*, others)
- Cardenolides
  - Sequestered by insects
  - Emetic to vertebrates
  - Causes regurgitation in mantids

Terpenoids in conifers can pass through membranes and are very toxic e.g. pinene in pines

Inducible defenses in tomato
- PI induction is rapid, systemic, and dose-dependent

[Graph showing damaged and undamaged leaves over time]