Entomology Basics

Chris Becker
Regional Extension Agent
Alabama Cooperative Extension System
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Fun Facts

• Over 750,000 described species
• Estimates run as high as 30-50 million species
• Less than 3% of insects are classified as pests
• 1/2-1/3 all species are insects
• The oceans and poles are the only habitats that insects have not been able to exploit
• In the typical backyard there are ~1000 insects at any given time
• An ant can pull 52 times its own weight - equal to a human pulling 4.5 tons!
• Honeybees communicate through dances
• Larvae eat 3-4 times their weight / day in food
• Aphids can process 100 times their weight in plant sap
• Some insects can survive being frozen solid
What is an insect?

Must have:

• Exoskeleton
• Segmented body
• Jointed appendages
• Three body regions (head, thorax, abdomen)
• Six legs (3 pair)
• One pair of antennae
• None, one, or two pair of wings
Are spiders insects?

No:

- **Class Arachnida**
- **2 body segments - head and abdomen**
- **8 legs**
- **Includes mites and ticks**
- **No wings**
Insect vs. Spider

- Antennae
- Three Segments
- Wings
- Six Legs

- Eight Legs
- Two Segments

Illustrations of insect and spider highlighting key differences in anatomy.
Growth and Development

- Molting – insects must shed their skin and produce a larger one in order to grow
- Period between molts is referred to as an instar
- Most insect life cycles have between 4 & 8 instars before the adult stage
- Insects can drastically change in shape and form during growth and development - called metamorphosis
Complete Metamorphosis

Metamorphosis – Change in shape and form

- Complete
  - Four, distinct life stages
  - Egg, Larvae, Pupa, Adult
  - Examples: butterflies, moths, bees, wasps, flies, beetles
Complete Metamorphosis

<table>
<thead>
<tr>
<th>Order/Common Name</th>
<th>Mouthparts</th>
<th>Wings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coleoptera</strong></td>
<td>adult: chewing</td>
<td>2 pair</td>
</tr>
<tr>
<td><em>Beetles</em></td>
<td>larva (grub): chewing</td>
<td>1st hardened wingcover (=elytra)</td>
</tr>
<tr>
<td><strong>Diptera</strong></td>
<td>adult: sucking, sponging, etc.</td>
<td>1 pair</td>
</tr>
<tr>
<td><em>Flies</em></td>
<td>larva (maggot): chewing</td>
<td></td>
</tr>
<tr>
<td><strong>Lepidoptera</strong></td>
<td>adult: siphoning</td>
<td>2 pair</td>
</tr>
<tr>
<td><em>Butterflies</em></td>
<td>larva (caterpillar): chewing</td>
<td>scales on wings</td>
</tr>
<tr>
<td><em>Moths</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neuroptera</strong></td>
<td>adult: chewing</td>
<td>2 pair</td>
</tr>
<tr>
<td><em>Lacewings</em></td>
<td>larva: chewing</td>
<td>net-like veins</td>
</tr>
<tr>
<td><em>Antlions</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hymenoptera</strong></td>
<td>adult: chewing</td>
<td>2 pair</td>
</tr>
<tr>
<td><em>Bees, ants</em></td>
<td>larva (grub): chewing</td>
<td>both membranous</td>
</tr>
<tr>
<td><em>wasps</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Incomplete Metamorphosis

- Incomplete
  - No distinct stages
  - Egg, Nymph, Adult
  - Nymph often appears as small version of adult
  - Adult often characterized by wings
  - Examples: grasshoppers, stink bugs, spiders
## Incomplete Metamorphosis

<table>
<thead>
<tr>
<th>Order/Common Name</th>
<th>Mouthparts</th>
<th>Wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthoptera</td>
<td>chewing</td>
<td>2 pair</td>
</tr>
<tr>
<td>Grasshoppers</td>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; leathery</td>
</tr>
<tr>
<td>Crickets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemiptera</td>
<td>piercing-sucking</td>
<td>2 pair</td>
</tr>
<tr>
<td>True bugs</td>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; halfwing</td>
</tr>
<tr>
<td>Homoptera</td>
<td>piercing-sucking</td>
<td>2 pair (some without)</td>
</tr>
<tr>
<td>Aphids, scales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mealybugs</td>
<td>both membranous</td>
<td></td>
</tr>
<tr>
<td>Thysanoptera</td>
<td>rasping-sucking</td>
<td>2 pair</td>
</tr>
<tr>
<td>Thrips</td>
<td></td>
<td>fringed/feathery</td>
</tr>
<tr>
<td>Dermaptera</td>
<td>chewing</td>
<td>2 pair</td>
</tr>
<tr>
<td>Earwigs</td>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; short wing cover</td>
</tr>
</tbody>
</table>
Molting

Insects are covered with a hard outer skeleton called the exoskeleton. The exoskeleton has many functions including:

• Protective coating for the insect
• Serves as a place for muscle attachment
• Water barrier
• Sensory interface with the environment

Periodically throughout an insect's life, the exoskeleton becomes too small and actually splits. This process is called molting.
Molting

METAMORPHOSIS

exuvium

instar III

MOLTING

instar IV
Molting

Split Exoskeleton (exuvium)
Life Cycle and Development

The life cycle of an insect can vary from species to species. Life cycles and development can be influenced by temperature, food availability, etc. Higher temperatures promote more active growth and development, whereas lower temperatures slow or hinder development. The majority of insects have either univoltine or multivoltine life cycles.
Voltinism

Indicate the number of broods or generations of an organism in a year
Univoltine

- One generation per year
- Don’t develop continuously throughout the year
- Enter into diapause (period of suspended development, overwinter) due to drought, temps high or low
- Example - Weevils
Multivoltine

- **Multiple generations per year**
- **Generally develop quite rapidly**
- **Some species only live for a matter of days** Example - fruit flies
Insect Orders

- Coleoptera
- Lepidoptera
- Hymenoptera
- Hemiptera
- Diptera
- Isoptera
- Orthoptera

- Dermaptera
- Dictyoptera
- Thysanoptera
- Homoptera
Coleoptera - Beetles

- Largest order of insects
- Complete metamorphosis - larvae are grubs
- Chewing mouthparts larvae and adults
- Two pairs of wings-first hardened into wing covers (elytra)
- Herbivores and carnivores

Colorado Potato Beetle
Lepidoptera – Butterflies, Moths

- Complete metamorphosis
- Larvae have chewing mouth parts
- Adults have sucking mouthparts (proboscis)

Two pairs of wings/ covered with scales
Hymenoptera – Ants, Bees, Wasps, Sawflies

- Complete metamorphosis - larvae are maggot like
- Chewing mouthparts in larvae
- Some adults have chewing (ants) some have sucking (bees)
- Two pairs of wings - both membranes hooked together to work as one
Hemiptera – True bugs, Stink bugs, Assassin bugs, Squash bugs

- Simple development
- Sucking mouthparts
- Front wings generally hemelytrous, (thickened at the base and membranous at the tip)
- Hind wings membranous and shorter than the front wings
Diptera – True Flies

- Complete metamorphosis larvae are maggots
- Chewing mouthparts in larvae and variable in adults
- Adults only have 1 pair of wings

Horse Fly
Isoptera - Termites

- Specialized life cycle that includes: egg, larvae, nymph, worker, soldier, king, and queen
- Chewing mouthparts in larvae and variable in adults
- Wings are variable
- Have complex caste system (soldiers, sterile workers, reproducers)
- Reproducers excrete hormone to suppress sexual development of the rest of the colony
Orthoptera – Grasshopper, Crickets

- Incomplete metamorphosis
- Chewing mouthparts
- One/two pair of wings, no wings, nubs
- Modified hind legs

Katydid
Dermaptera – Earwigs

- Incomplete metamorphosis
- Feed on animal and plant matter
- Chewing mouthparts
- Have pincers at the end of the abdomen
- Two pair of wings
Dictyoptera – Mantids and Roaches

- Incomplete metamorphosis
- Feed on animal and plant matter
- Chewing mouthparts
- Two pair of wings, no wings
Thysanoptera – Thrips

- **Incomplete metamorphosis**
- **Generally feed on plant matter, some are beneficial**
- **Chewing mouthparts**
- **Two pair of wings, some no wings**
Mouthparts

- **Chewing/biting**
- **Sucking**
- **Piercing sucking**
**Mouthparts**

**Labrum** - plate that serves as upper lip in insects with chewing mouthparts. Helps to pull food into the mouth.

**Mandible** – appendage that becomes the 1st pair of mouthparts, analogous to jaw. Used to chew, cut, and tear food, to carry things, to fight, and to mold wax. Move from side to side rather than up and down.

**Maxillae** - 2nd pair of feeding appendages, used for food handling and sensing. More complicated than the mandibles but working in the same manner.

**Labium** - fused, 3rd pair of feeding appendages, analogous to lower lip. They function to close the mouth below or behind. Evolved from paired maxillae-like structures that are fused along the center line.
Chewing and Biting
Feeding Styles

Chewing

• Chews external plant parts
• Most primitive
• Holes in foliage, stem
• Ragged leaf edges
• Larval stages are almost always chewing
• Examples: grasshoppers, Japanese beetle, armyworms
Sucking

Butterfly
mouth parts

labial palp
proboscis (maxillae)

cross-section
of the proboscis
Feeding Styles

- **Sucking**
  - Use proboscis to retrieve fluid from flowers and fruit.

- Majority of moths do not have a proboscis. Most moths live off fat reserves stored during the larval stage.
Piercing and Sucking

Mosquito

labrum
labium
proboscis
mandible
maxilla
hypopharynx
Feeding Styles

- **Piercing/Sucking**
  - Pierce plant tissue and suck plant juices (like needle)
  - Slender and sharp pointed mouthpart (stylet)
  - Injury often appears as minute spotting, wilting, deformed tissue, browning of tissue
  - Many of these insects produce honeydew/sooty mold
  - Vectors of plant disease
  - Examples: aphids, scale insects, plant bugs, mosquitoes
IPM

- IPM – Integrated Pest Management or Intelligent Pest Management, using a combination of biological, mechanical, cultural, and chemical means to control pests.
- Helps to reduce pesticide resistance
- Reduces chemical costs
- Limits chemical exposure
- Reduces environmental exposure to pesticides
IPM

• Prevention is the first step.
  • Location
  • Soil Preparation
  • Plant inspection and selection

• Mechanical & Cultural Control
  • Crop Rotation
  • Companion Plantings
  • Spacing
  • Clean/Decon equipment
  • Maintain equipment
  • Resistant varieties
  • Trap plants
  • Barriers and traps
  • Sanitation remove plant debris
  • Destroy alternate hosts (weeds)
Chemical

- Chemical
  - Insecticides
  - It is always necessary to read pesticide labels and follow all directions including PPE requirements and application guidelines.
  - Insecticide – any substance intended for preventing, repelling or destroying insect pests.
  - Always start with soft chemicals first then move up from there.
Pesticides

• Naming
  • Common name (active ingredient) – Carbaryl
  • Trade name – Sevin

• Classification
  • Contact (Kills on contact) vs. Systemic (Chemical is taken up by the plant and kills pests as they feed.)

• Mode of entry

• Chemical class (Organochlorines, Pyrethroids, Organophosphates, Carbamates, Botanicals)

• Formulation (Active ingredient, plus additional mat.)
Insecticides

- Formulation
  - Dusts
  - Oils
  - Soaps
  - Fumigants
  - Wettable powders
  - Emulsifiable (concentrated)
  - Granules
  - Sprays
Insecticides

• If there is any question on a chemical and its safety, contact the manufacturer and ask for the msds “Material safety data sheet”. These will tell you its chemical properties (flammability, reactivity, corrosiveness, etc.)
Insecticides

**Broad Spectrum**
- Wide range killers
- Used when several different kinds of insects are a problem
- Will not kill everything but very versatile

**Narrow Spectrum**
- Only kill specific insects, types, etc
- Pheromones
- Growth inhibitors
Break Time!!!!!!!
Common Garden Pests

Cecropia Moth Larvae
- Feeds on beans, peas, sweet corn, okra, tomatoes, cabbage, eggplant, and pepper
- Early planting
• Feed on cole crops, cucurbits, beans, peas, potatoes, tomatoes, lettuce, turnips, spinach

• Wash off plants with strong stream of water

Aphids

Insecticidal soaps
Biological control – Wasps, Lady beetles
• **Feed on garlic, onion, blueberry, ornamentals**
• **Remove weed hosts**
• **Biological control** – Lady beetles
Mealybug

- **Soft scale insects** that feed on foliage of various plants.
- **Produce** honeydew (sooty mold)
- **Biological control** – Lady beetles
Leafminer

- Larvae of flies, moths, and beetles that feed in between upper and lower leaf surfaces
- Feed on beans, lettuce, celery, broccoli, etc.
- Biological control – lady beetles
- Remove visible infestations
Spider Mites

- **Not an insect**
- **Feed on beans, corn, tomato, and eggplant, etc.**
- **Remove weeds**
- **Adequate soil moisture**
- **High pressure water spraying**
- **Miticides**
- **Insecticidal soaps**
Japanese Beetles

- Pest of turf, ornamentals, fruit, asparagus, soybean, corn, etc.
- Physical control
- Attractants, trapping (not recommended)
- Biological control - wasps
Slugs

- Feed on corn, lettuce, beans, ornamentals, etc.
- Optimum irrigation timing
- Manual removal
- Baits
- Traps
- Stale beer
• **Feed on**
  Tomatoes, peppers, cole crops, citrus, etc.

• **Prevention**

• **Biological control**
  – Lacewings, Bigeyed bugs

• **Remove heavily infested plants**
Tomato Horn Worm

- Feed on Tomato, eggplant, pepper, potato, etc.
- Bt (Bacillus thuringiensis)
- Physical removal
- Biological control – Wasps
Flea Beetles

- Feed on potato, spinach, tomatoes, peppers, cucumbers, etc.
- Remove weed hosts
- Traps
Corn Borers

- Feed on corn, peppers, potato, etc.
- Variety selection
- Planting date
- Early harvest
- Bt
- Biological – Lady beetles
Squash Bug

- Feed on cucurbits
- Hard to control
- Early detection of nymphs offers best control
- Maintain healthy plants
Cucumber Beetle

- Feed on cucurbits
- Vector of disease
- Select resistant crops
- Can be spotted, stripped, or banded
Black Cutworm

- Feed on corn, asparagus, bean, beet, etc
- Sever plants at the base of stem and soil line
- Generally no other damage present
- Use Bt products for control
- Avoid planting in areas that were formerly fields
Black Cutworm

- Feed on corn plants – leaves and corn
- Actively scout plants before silk appears
Leaf Hoppers

- **Feed on beans, lettuce, potato, etc**
- **Spread plant pathogens – bacterial, viral disease**
Curculios

- Feed on peas, plum, cotton, lima bean and many other fruit
- Late season crops are less susceptible
- Rotate crops
Squash Vine Borer

- Squash, zucchini, pumpkins, and gourds are attacked
- Scout for borer activity
- Look for visible frass
Tarnished Plant Bug

- Attacks some 50 species of plants
- Destroy favorable overwintering sites
- Remove all host plants
Leaf Roller

- Attacks lime beans, peas, soybean, cowpea etc
- Look for leaves rolled over attached with silk
- Shelters become larger when insects pupate
Leaffooted Bug

- Will attack cotton, peaches, and tomatoes, and seeds such as beans, black-eyed peas, and sorghum
- Damage similar to stinkbugs
Tomato Hornworm parasitized by the Braconid Wasp

Beneficial Insects
Braconid Wasp

- Adult wasp inserts eggs beneath the skin of caterpillar
- Larvae hatch and feed on caterpillar until they pupate and hatch out as seen in photo
- Will also parasitize other insects
Tiger Beetle

- Adults are opportunistic feeding on a wide variety of insects
- Larvae have burrows that they use as shelter and ambush prey as it passes by
- Tiger Beetles are also parasitized by Diptera sp.
Syrphid Fly

- Adult flies resemble bees or wasps
- Do not sting humans
- Prey on aphids
Predatory Stinkbug

- Most stinkbugs are pests
- Feed on beetles, caterpillars and other stinkbugs
Ladybird Beetle

- Larvae are voracious eaters of aphids, scale, mealy bugs
- Adults also feed on insects
- Multicolored Asian Beetles are also beneficial – THEY ARE NOT PESTS
Lacewing

- Adults and larvae feed primarily on aphids
- Larvae are often referred to as aphid lions
Assassin Bug

- Feed on aphids, leafhoppers, small caterpillars, and beetle eggs and larvae
- Can inflict a painful bite to humans
Soldier Beetle

- Adults feed mostly on nectar with the occasional aphid
- Larvae are found under logs debris and feed on aphids, maggots, grasshopper eggs
Damsel Bug

- **Feed on caterpillar eggs, small larvae, aphids, fleahoppers, lygus bugs, leafhoppers, treehoppers and spider mites**
Tree Cricket

- Feeds on aphids, scales
- May also feed on plant parts
- Not considered a pest
Predatory Mite

- Young mites are parasites on Orthoptera (grasshoppers, locusts and crickets)
- Utilized as a biocontrol agent against locusts
- Adults are voracious predators of various insects
Spiders

- Feed on insects and other spiders
- Some spin webs and some are roamers
- Crab spider, wolf spider, and jumping spider pictured to the right
Robber Fly

- Both adults and larvae feed on insects
- Larvae live in the soil and feed on insect larvae, eggs, and small insects
Praying Mantis

- Voracious insect predators
- Feed on anything they catch
- Will feed on pollinators