“HOW Do YOU Do?”

A Gardener’s Introduction to the Insect World

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...PEST ALERT...PEST ALERT...

https://www.youtube.com/watch?v=D0foMKAxCww
What will be “Bugging” us Today?

• What is an insect?
• How and why do we classify insects and their relatives?
• How do we use this information to manage pest insects?
• How do we protect the “good” bugs?
• Practice identifying common garden insects
What’s in a name?

- **Arthropoda**: jointed foot
- **Insecta** (or **hexapoda**): having six legs
Taxonomy Refresher...

KINGDOM
Animal

PHYLUM
Chordata (vertebrates)
Arthropoda

CLASS
Mammalia
Insecta (all insects!)
Arachnida (spiders, mites)
Crustacea (lobster, pillbugs)
Chilopoda (centipedes)
Diplopoda (millipedes)

ORDER
Primata
Lepidoptera
Coleoptera

More on orders, a little later!
Why are insects such a big deal?

• Estimated ratio on earth: 1 human to 200 million insects

• Estimated US biomass of insects: 400 pounds per acre

• Insects are the most successful animals on earth
What makes them so successful?

• Body architecture
  – Light and strong exoskeleton protects inner tissues, prevents water loss
  – Profusely and highly adapted body parts

• Small size
  – Facilitates dispersal, allows for hiding and escape

• Ability to fly (dispersal and escape, again)

• Reproductive capacity
What else do we know?

• We have identified and named over 900,000 species
• Estimated TWO to TEN TIMES that amount are yet to be discovered
• It is estimated that one in every four animals is a beetle
Ok, so we’re outnumbered...

• We often have an *uncomfortable* relationship with insects

• Yes, some insects pose a danger to human health, habitat and food supply
  – Parasites, disease vectors
  – Pests of home, timber
  – Pests of agricultural crops, livestock and stored food
But how do we benefit?

• Products like honey, silk and wax
• Pollination of major food crops
• As natural enemies of pests and parasites
• As scavengers and decomposers
• As food for wildlife and other animals, even us!
Entomophagy: the eating of…

• 80 percent of the world's population eats insects intentionally

• 100 percent eat them unintentionally!
  – Average of two pounds of insects annually
And good for you, too!

The nutritional content of edible insects and other animals based on a 100 gram serving are as follows:

<table>
<thead>
<tr>
<th>Animal (Scientific Name)</th>
<th>Energy (Kcal)</th>
<th>Protein (g)</th>
<th>Iron (mg)</th>
<th>Thiamine (mg)</th>
<th>Riboflavin (mg)</th>
<th>Niacin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termite <em>(Macrotermes subhyalinus)</em></td>
<td>613</td>
<td>14.2</td>
<td>0.75</td>
<td>0.13</td>
<td>1.15</td>
<td>0.95</td>
</tr>
<tr>
<td>Caterpillar <em>(Usata terpsichore)</em></td>
<td>370</td>
<td>28.2</td>
<td>35.5</td>
<td>3.67</td>
<td>1.91</td>
<td>5.2</td>
</tr>
<tr>
<td>Weevil <em>(Rhynchophorus phoenicis)</em></td>
<td>562</td>
<td>6.7</td>
<td>13.1</td>
<td>3.02</td>
<td>2.24</td>
<td>7.8</td>
</tr>
<tr>
<td>Beef <em>(Lean ground)</em></td>
<td>219</td>
<td>27.4</td>
<td>3.5</td>
<td>0.09</td>
<td>0.23</td>
<td>6.0</td>
</tr>
<tr>
<td>Fish <em>(Broiled cod)</em></td>
<td>170</td>
<td>28.5</td>
<td>1.0</td>
<td>0.08</td>
<td>0.11</td>
<td>3.0</td>
</tr>
</tbody>
</table>
In all seriousness, What is an insect, really?

• Like other arthropods, insects have:
  – A segmented body
  – An exoskeleton
  – Jointed appendages
• Unique to their class, insects have:
  – a body divided into three distinct regions, or segments:
    • Head, thorax, abdomen
    • Thorax bearing three pairs of legs and most often, two pairs of wings
  – A system for breathing composed of air tubes
Parts of an insect

- thorax
- wings
- head
- abdomen
- mouthparts
- antenna
- legs
Breathing system

- spiracle
- tracheae
Specialized structures: Mouthparts

• Often an identifying feature
• Tells a great deal about feeding
• Commonly encountered:
  - Chewing
  - Piercing-sucking
  - Siphoning
  - Sponging
  - Chewing-lapping
Growth and Development

It's a Jungle out there!

by HAGEN

Would you happen to have "Cocoon making for Dummies"?

Hagen Cartoons: http://www.hagencartoons.com
Insect Growth & Development

- Insects develop through **metamorphosis**
- Rate of development influenced by temperature
- Generations vary in length, number, and seasonal influence
- Most insects pass the winter in one life stage and in a state of dormancy
Complete Metamorphosis

Complete metamorphosis

- Adult
- Pupa
- Egg
- Larva
More Complete Metamorphosis
Insects with Complete Metamorphosis

- Beetles
- Flies
- Moths
- Butterflies
- Bees, wasps
- Ants
- Fleas
Incomplete Metamorphosis

Gradual or incomplete metamorphosis
More Incomplete Metamorphosis
Insects with Incomplete Metamorphosis

- Earwigs
- Stinkbugs
- Box Elder Bugs
- Aphids
- Termites
- Grasshoppers
- Mantids
- Cockroaches
How does this knowledge help us?

- Determine thresholds and time our management strategies
- Identify most damaging life stage
  - Ex: Larva of many insects is the most destructive.
- Identify most vulnerable life stage
  - Ex: Nymphs often more susceptible to contact insecticides
Insect Identification and Classification
Why identification is crucial

• Correctly assess cause of problem
• Use most effective and economical means of management
• Use pesticides in legal prescribed manner
• Avoid misuse of pesticides
Identification Strategies

• Experience
  – Hands on practice!

• Specimen approach
  – Use keys, drawings and descriptions along with a live or dead specimen

• Symptoms approach
  – Compare damage with what you know about an insect’s physical characteristics
• Host approach
  – Many insects have preferences...just like us!
  – Where is an insect likely to be found on a host?
  – Where is it *not* likely to be found?
Identification & Collection

• Start with a good specimen, carefully preserved

• When possible, identify to the order
  – Reference material will sort by order
  – Insects of the same order often share important characteristics
    • Type of mouthparts
    • Life cycle
    • Host and/or habitat

• Without special equipment it may be difficult to identify many beyond families
Let’s learn together!

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Coleoptera: the Beetles & Weevils

- Largest order of insects
- Adults and larva are pests of all parts of most plants, wood borers, pests of stored grain, natural fibers
- Significant pests of other insects
- Life cycle: complete metamorphosis
Identifying Beetles & Weevils

Chewing mouthparts (weevils have distinctive “snouts”)

Antennae usually have 11 segments

Thick, hard cover over wings, called “elytra,” meets in middle straight down back
Diptera: the Flies & Mosquitoes

• “True” flies
• Highly evolved
• Occur in every terrestrial and freshwater habitat
• Important parasites and disease transmitters of humans and livestock
• Pests of crop seeds and growing plants
• Can be beneficial predators and pollinators
• Life cycle: complete metamorphosis
Identifying Flies & Mosquitoes

Sponging or cutting-sponging mouthparts

One pair of membranous wings (unique to this order)

Hind wings are absent, having been reduced to form leg-like balancing organs called “halteres”

Piercing-sucking mouthparts
Hymenoptera: Bees, Wasps & Ants

• Major order considered by many to be the most beneficial to humans
  – Wax and honey production, pollination, pest predation
• However some, like sawflies or carpenter ants are destructive pests
• Life cycle: complete metamorphosis
• Larva can resemble caterpillars or grubs
• Highly evolved order, many families exhibit complex social structures
Identifying Bees, Wasps & Ants

Most species have two pairs of membranous wings, hind pair smaller.

Ovipositor may be modified into a stinger.

Highly modified sucking or lapping mouthparts.

Chewing mouthparts.

Often characterized by a thin “waist” where thorax is connected to the abdomen.
Lepidoptera: the Moths & Butterflies

• Very large order that contains some of the most beautiful known insects...
• And some of the most important pests
• Caterpillars are important pest crops (chewers, borers)
• Butterflies are important pollinators (nectar drinkers)
• Life cycle: complete metamorphosis
Identifying Moths & Butterflies

Butterflies are more active during the day
- Clubbed antennae

Siphoning mouthparts

Feathered antennae

Moths are more active at night
- Large, membranous wings covered with minute, overlapping scales, see-through in some clearwing moth species

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Distinguishing between larvae...

- Adult moths and adult beetles are easy to distinguish from each other, but their larvae are a little more difficult. Use a hand lens to examine the legs of the larvae.
- Moth larvae have three pairs of true legs, plus additional leg-like structures further down the abdomen.
- Beetle larvae are either grublike and legless or have only three pairs of legs, all located close to the head.
- Fly larvae are usually legless grubs.
Hemiptera: the True Bugs

• Known as the “true bugs”
• Plant feeders: suck sap
• Ecto-parasites: human, warm blooded animals
• Predators: feed on other insects
• Life cycle: incomplete metamorphosis
Identifying True Bugs

Piercing, sucking mouthparts

Usually a triangular plate between the bases of the wings called a “scutellum”

Somewhat flattened body, with an abdomen broadly joined to the thorax
Dermaptera: the Earwigs

- Medium size insects that can superficially resemble beetles
- Nocturnal
- Feed mostly on decaying organic matter, but will feed on plants or other insects
- Do not bite or crawl into ears, but may pinch when handled
- Incomplete metamorphosis
Identifying Earwigs

Chewing mouthparts

Front wings form short, leathery coverings for large, membranous hind wings (not all have wings)

Pincer-like “cerci” at tip of abdomen. Curved in males, straighter in females
Homoptera: the Aphids & Scales

• Very large, important group of insects
• So diverse that no one common name represents the whole order
• Includes aphids, scales, adelgids, mealybugs, leafhoppers, whiteflies and cicadas
• Plant pests: suck sap, vector diseases
Identifying Homopterans

When at rest, wings are held roof-like over the body.

Piercing-sucking mouthparts
Orthoptera: the Grasshoppers, Mantids and Roaches

- Diverse order containing grasshoppers, katydids, crickets, walking sticks, preying mantids, and roaches
- Major pests of crops, household pests, some are beneficial predators
- Sound production is common, particularly in grasshoppers and crickets
- Life cycle: incomplete metamorphosis
Identifying Orthoptera

- Hind legs modified for jumping
- Threadlike antennae
- Saber or lancelike "ovipositor"
- Chewing mouthparts and elongated, parchment-like wings
- Forelegs modified for grasping prey
- Flattened body, downward turned head
- Antennae longer than body
Odonata: the Dragon & Damselflies

- Ancient order of large, conspicuous insects
- Life cycle: incomplete metamorphosis
- Adults feed on insects caught in flight
- Immatures are aquatic, develop in 1-4 years
Identifying Odonatas

- Chewing mouthparts
- Large heads with protruding eyes
- Four net-veined, membranous wings
- Long, slender bodies