University of Illinois
CPSC 270, Introduction to Applied Entomology
Fall, 2008

Lecture 3
Insect Growth and Development

Because they are enclosed in an exoskeleton, insects must "shed their skins", or molt, to grow larger. The molting process in immatures and the transformation from larva to pupa to adult is regulated by hormones.

- One is **ecdysone (molting hormone)** secreted by the prothoracic gland; it stimulates shedding of the cuticle.
- Another is **juvenile hormone (JH)**. JH is secreted from the corpora allata; it suppresses adult characteristics.

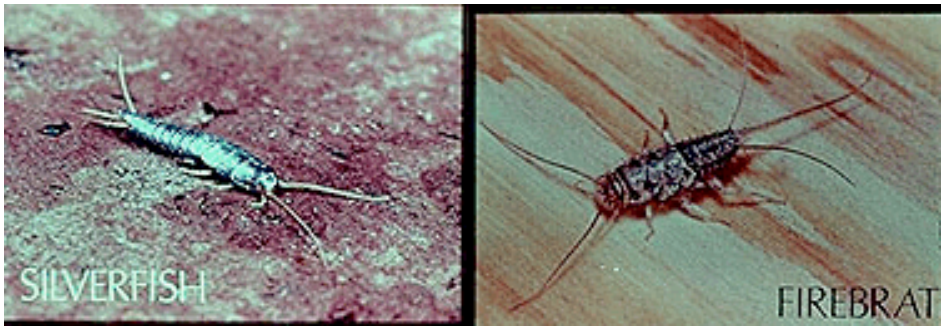
As growth during each stage triggers secretion of ecdysone, if juvenile hormone is present, the cuticle is shed and replaced, and the insect reaches its next juvenile stage.

As the immature insect grows and eventually discontinues production of juvenile hormone, secretion of ecdysone in the absence of JH triggers pupation and subsequent development of adult form.

Synthetic juvenile hormones have been developed for use as insecticides that disrupt insect development and cause death.

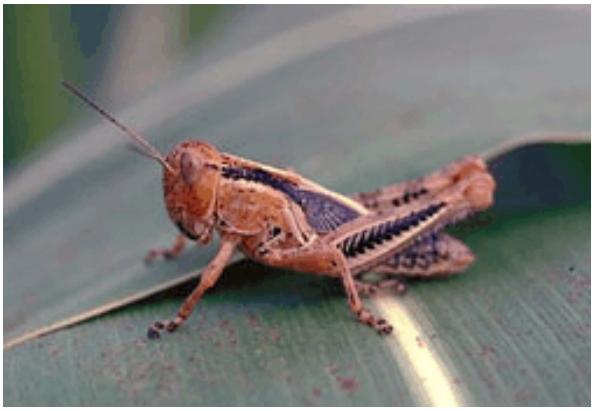
Metamorphosis ... change in form. Four types of metamorphosis are recognized for insects: ametamorphosis, gradual metamorphosis, incomplete metamorphosis, and complete metamorphosis.

Ametamorphosis ... "without metamorphosis"



Immatures are called juveniles. Ametamorphosis is exhibited by springtails, silverfish, and firebrats (and more). Changes in form during growth are minor; all immature stages resemble adults.

Gradual metamorphosis

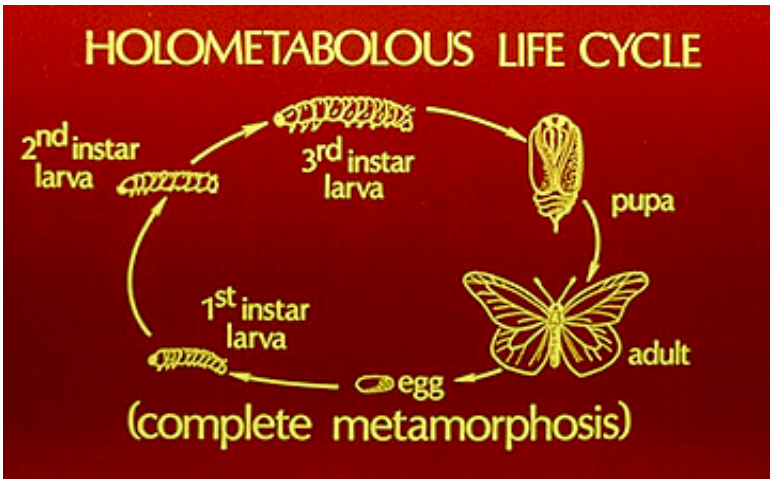


- Immatures are called **nymphs**. Gradual metamorphosis is exhibited by grasshoppers, crickets, true bugs, etc. Change in form is gradual, with the most obvious changes involving the development of external wing pads and differences in color or markings. Nymphs and adults generally share the same habitat.

Incomplete metamorphosis

- Immatures are called **naiads**. Incomplete metamorphosis is exhibited by mayflies, dragonflies, damselflies, and stoneflies. Immatures do not closely resemble adults ... naiads have tracheal gills. However, transition to adult form is gradual ... external wing pads develop in later instars. Nymphs and adults dwell in different habitats.

Complete metamorphosis



- Immatures are called **larvae** and **pupae**. Complete metamorphosis is exhibited by butterflies, moths, beetles, flies, ants, bees, wasps, etc. Larvae do not resemble adults. Wings and other adult features develop during an immobile pupal stage. Immatures and adults may or may not share habitats. Immatures are adapted for feeding; adults are adapted for reproduction and dispersal.

    - **Instar**: The insect itself between molts ... "third instar (larva)"

Surviving adverse conditions

- **Quiescence**: Immediate inactivity in response to unfavorable conditions.
- **Dormancy**: Seasonally recurring suppression of growth, development, and/or reproduction.
- **Diapause**: Dormancy (sometimes delayed) invoked by "token stimuli" (often day length [photoperiod]). Once invoked, usually continues for predetermined period.

In temperate climates, dormancy and diapause are often accompanied by overwintering adaptations ... One is survival by supercooling, often as a result of secretion of trehalose or similar sugars that act as freezing depressants (antifreeze).

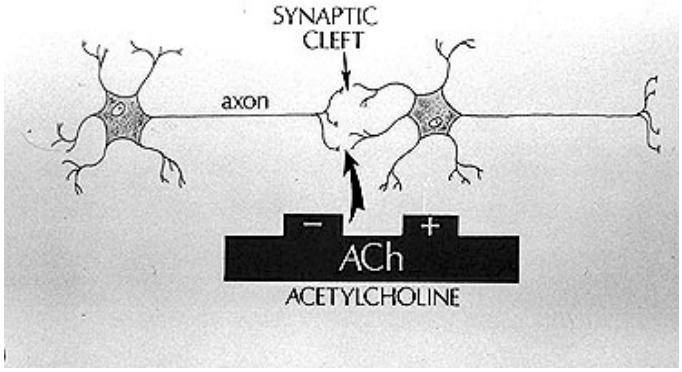
Reproduction: A couple of noteworthy ways in which insects are different than vertebrate animals ...

- **Parthenogenesis**: Reproduction in the absence of male gametes (facultative or obligative); common in aphids and some groups of Hymenoptera
- Haplo-diplo sex determination:
  - Unfertilized eggs become males; fertilized eggs become females. (Particularly common in the Hymenoptera)

Univoltine: A single generation per year.
Multivoltine: Multiple generations per year.

Nerve impulse transmission:

- **Axonic** transmission: Along a nerve fiber.
  - By electrical impulse, created by movement of sodium (Na) and potassium (K) ions through Na-K channels of axon membranes.



- **Synaptic** transmission: Across a gap between neurons and muscle cells (or other neurons)
  - Mediated by neurotransmitters (acetylcholine and others)
  - Acetylcholinesterase prevents repeated "firing" of nerve cells at synapses. Organophosphate and carbamate insecticides are (acetyl)cholinesterase inhibitors. Several other insecticides inhibit other neurotransmitters.

For more information ...
- Check "An Introduction to Insect Anatomy" at the Wonderful World of Insects.