

## Lecture 4 Selected Components of Insect Behavior and Reproduction

Topics:

Mechanoreception: touch, gravity, and sound (and sound production)

Thermoreception (and thermoregulation)

Chemoreception (and production)

Semiochemicals: chemicals that carry messages

Vision / light reception (and light production)

Reproduction

Sperm storage

Sex determination

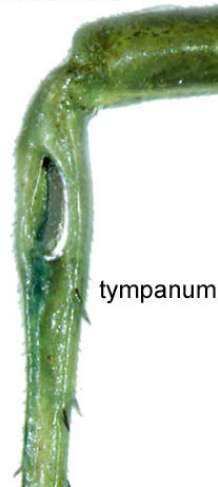
Parthenogenesis

Polyembryony

**Mechanical stimuli**, detection and processing:

- Tactile receptors: cuticular projections called hairs, bristles, setae, or more technical terms. Projections connected to a nerve-connected socket are called “trichoid sensillae” (hair-like little sense organs)
  - Cockroaches use mechanoreceptors on their antennae and cuticle to remain in contact with the surfaces beside and above them (so where would you place a sticky roach trap?)
- Position / orientation receptors (in relation to gravity)
  - In the cuticle, on halteres, etc.
    - (why pulling a haltere off a fly causes erratic flight)
- Sound reception
  - Thin cuticular membranes are called **tympanae**; locations on the body vary among groups
    - **Mantids:**
    - **Noctuid moths:**
    - **Orthoptera:**
    - **Cicadas:**
    - Wing bases of lacewings and some moths
    - Prosternum of some flies

Tettigoniidae male

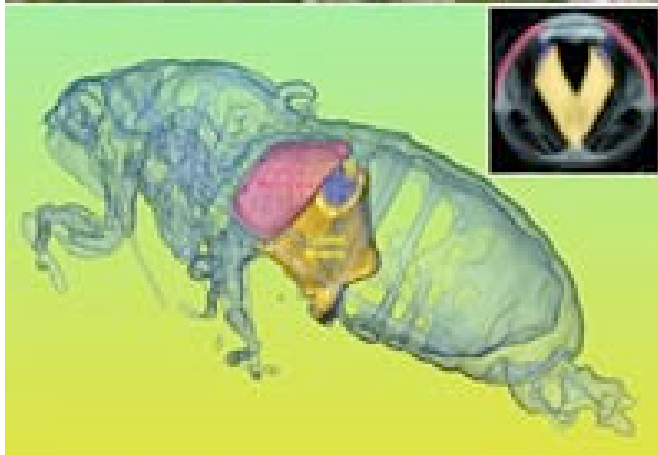


tympanum

Tympanum on the foreleg of a longhorned grasshopper (Univ. of Minnesota).

- Sound production

- : “scraper” is rubbed against “file” (grasshoppers and crickets)
- Vibration of an elastic area of cuticle called a tymbal (cicadas)



Tymbal chamber and muscles. [Nahirney et al 2007, NIH.](http://www.niams.nih.gov/News_and_Events/Spotlight_on_Research/2007/cicada_muscle.asp)

([http://www.niams.nih.gov/News\\_and\\_Events/Spotlight\\_on\\_Research/2007/cicada\\_muscle.asp](http://www.niams.nih.gov/News_and_Events/Spotlight_on_Research/2007/cicada_muscle.asp))

## Thermoreception and thermoregulation

- Heat receptors may be located on antennae, tarsi, and ?
- Regulation of body temperature
  - Behavioral: “Basking” ... exposure and orientation to sunlight
  - Physiological: Heart rate, wing muscle activity (to warm or cool)

## Chemoreception (and production)

- Taste (aqueous chemicals) and smell (airborne chemicals)
  - “Taste” (contact) receptors located on mouthparts, ovipositor, legs (tarsi)
  - “Smell” receptors are concentrated in the antennae
- Semiochemicals = chemicals that carry a message
  - Pheromones are intraspecific ... produced and released externally by one individual to communicate with and elicit a response from another individual of the same species
    - A.
    - B.
    - C.
    - D.
    - E.
  - Allelochemicals ... carry a message between species
    - Kairomones:
    - Allomones:
    - Synomones:

## Vision / Light Reception (and production)

- Light reception for vision
  - Compound eyes – comprised of hundreds or thousands of ommatidia (facets) may give 360-degree field of vision  
([http://www.daviddarling.info/encyclopedia/C/compound\\_eye.html](http://www.daviddarling.info/encyclopedia/C/compound_eye.html))
  - Simple eyes (ocelli) – not for high-resolution vision; more for horizon detection, perception of changes in light intensity related with daily behavior rhythms
  - Stemmata (larval eyes) – single to multiple lenses

- Dermal light reception – no focusing for vision, but receptors are sensitive to light; day length (photoperiod) determines cycles of dormancy (diapauses) and reproduction (sexual versus parthenogenesis)
- Light production
  - In some Collembola (springtails), a lanternfly (Hemiptera: Fulgoridae), a few Diptera (fungus gnats), and several beetles (especially the families Phengodidae and Lampyridae – the fireflies or lightningbugs).
    - Luciferin is oxidized in the presence of ATP to produce oxy-luciferin, carbon dioxide, and light ... highly efficient, with little heat.
    - **Primary purpose:**

## Reproduction

Most insects are “oviparous” ... females lay eggs. The act of egg-laying is called **oviposition**. Eggs may be laid singly or in masses; often they are coated with a sticky substance secreted from the female accessory gland to glue them to each other and a plant surface (or other substrate). In most insect groups, eggs are laid shortly after fertilization; egg development does not occur in the mother.

Exceptions to the general rule summarized above include

- Ovovivipary: Eggs are incubated in the female until nearly ready to hatch, and hatching occurs almost immediately after oviposition; this occurs in some cockroaches, aphids, scales, beetles, thrips, and flies (but is not the “rule in any of these groups).
- Pseudoplacental vivipary: Egg develops in maternal tissue where nutrients are transferred to the developing embryo; offspring is “born” immediately upon hatching from the egg. Common in many aphids; also occurs in some earwigs, Psocoptera, and one family of Hemiptera.



Aphid female giving birth to nymph ([Krister Hall, http://photo.net/photodb/photo?photo\\_id=3137372&size=lg](http://photo.net/photodb/photo?photo_id=3137372&size=lg)).

- In a few fly families, larval development occurs entirely within the mother, and the fully grown larva pupates immediately after “birth.” This occurs in the tsetse fly, the louse flies or keds, and the bat flies.

**Sperm storage** in the spermatheca allows females to store sperm to fertilize eggs later, in the absence of males (sperm remain viable in the spermatheca of queen honey bees for up to 3 years).

#### **Sex determination**

- Most insects are diploid, with one set of chromosomes from each parent. XX individuals usually are female; XO are male.
- Haploid – diploid sex determination occurs when unfertilized eggs develop into haploid individuals and are male; fertilized eggs develop into diploid females ... occurs in Hymenoptera.

(Sex determination can be considerably more complicated than this in some groups, but that’s for a follow-up course to address.)

**Parthenogenesis:** Reproduction via development of unfertilized eggs

- Eggs may be all female (thelytokous parthenogenesis) ... aphids
- Eggs may be all male (arhenotokous parthenogenesis) ... many Hymenoptera

**Polyembryony:** Two or more embryos develop from one egg; common in Hymenoptera.



Pupae of a Hymenopteran parasite on a hornworm, *Manduca* sp. An adult wasp inserted one egg into this larva, and multiple embryos developed. Larvae of the wasp fed inside the hornworm and have exited the body and spun cocoons in which they have pupated. (Eric Burkness, Univ. of Minnesota, <http://www.vegedge.umn.edu/vegpest/hornworm.htm>)