Culicidae: Mosquitoes

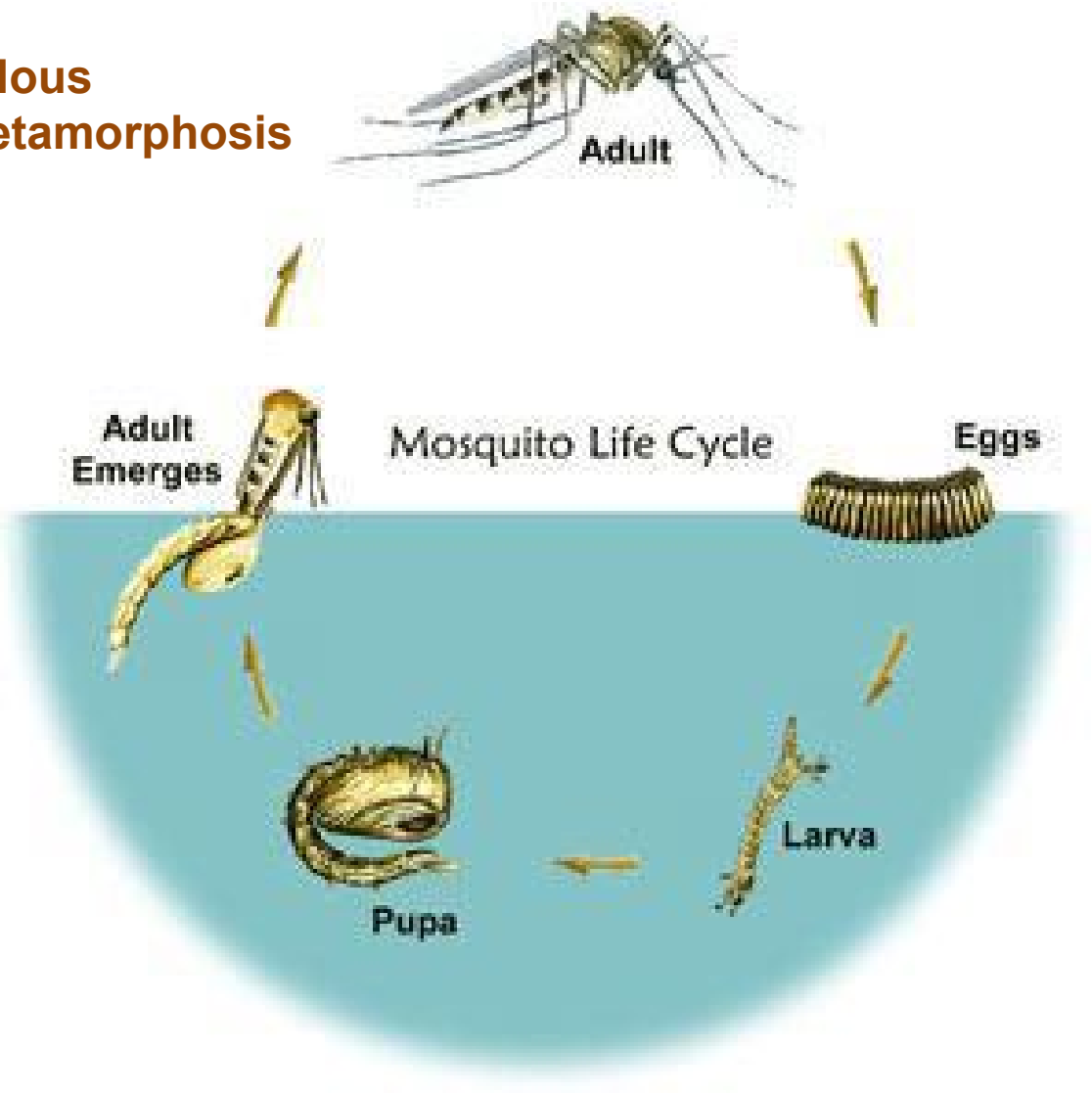
- Domain- Eukarya
- Kingdom- Animalia
- Phylum- Arthropoda
  - exoskeleton, segmented body & jointed limbs
- Class- Insecta (insects)
  - 3 body parts, 6 legs, 2 antenna, compound eyes
- Order- Diptera (all flies)
  - 2 wings total (hind wings are halteres)
- Family - Culicidae
  - Wings are covered in scales
  - Modified mouthparts for blood feeding

Many Mosquito Species

- >3,500 species world-wide
- >175 in North America
- 50 – 60 species in Tennessee
- Each species has its own biology, behavior, ecology
- Implications
  - No single control can be expected to work for all mosquitoes
  - Need to understand which species that you're facing

Generic Mosquito Lifecycle

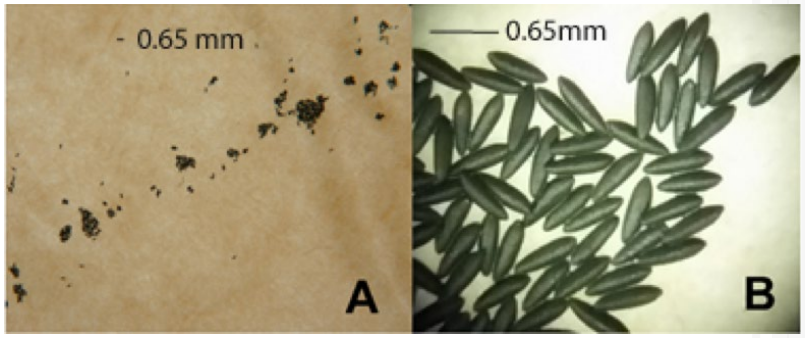
Holometabolous
complete metamorphosis



Hatch from egg & Emerge from pupa

www.youtube.com/watch?v=wFfO7f8Vr9c

(1) Eggs



- Oviposition – female lays eggs
- Eggs vary by genus
  - *Anopheles* mosquitoes lay them singly on top of the water with floats
  - *Aedes* mosquitoes lay them clustered
  - *Culex* mosquitoes lay them as rafts

https://www.youtube.com/watch?v=VwlqGbhq4T8

Anopheles

Aedes

Culex

(2) Larvae (Wigglers)

- All larvae are aquatic & most use a siphon to breathe
  - https://www.youtube.com/watch?v=CoPCXKwANb8
  - *Anopheles* do not have siphons and lay 'flat' on surface
- Most filter feed on algae and bacteria
  - *Toxorhynchites* is a mosquito predator
  - https://www.youtube.com/watch?v=tYOMbTizqKA

Anopheles

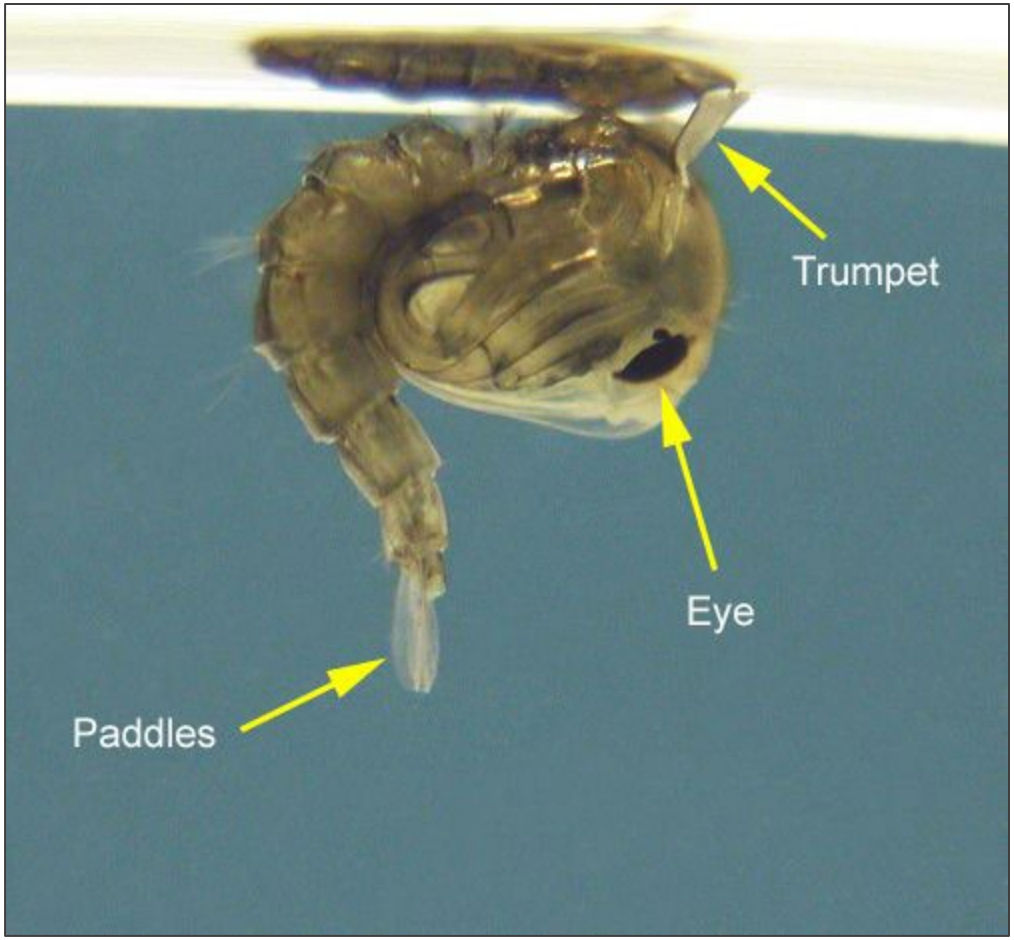
Aedes

Culex

Toxorhynchites

(3) Pupae (tumblers)

- After 4 larval instars mosquitoes molt into a pupa
- All pupae are aquatic & use trumpets to breathe
- Active life stage, but no feeding
  - https://www.youtube.com/watch?v=K8kmgRKX12E

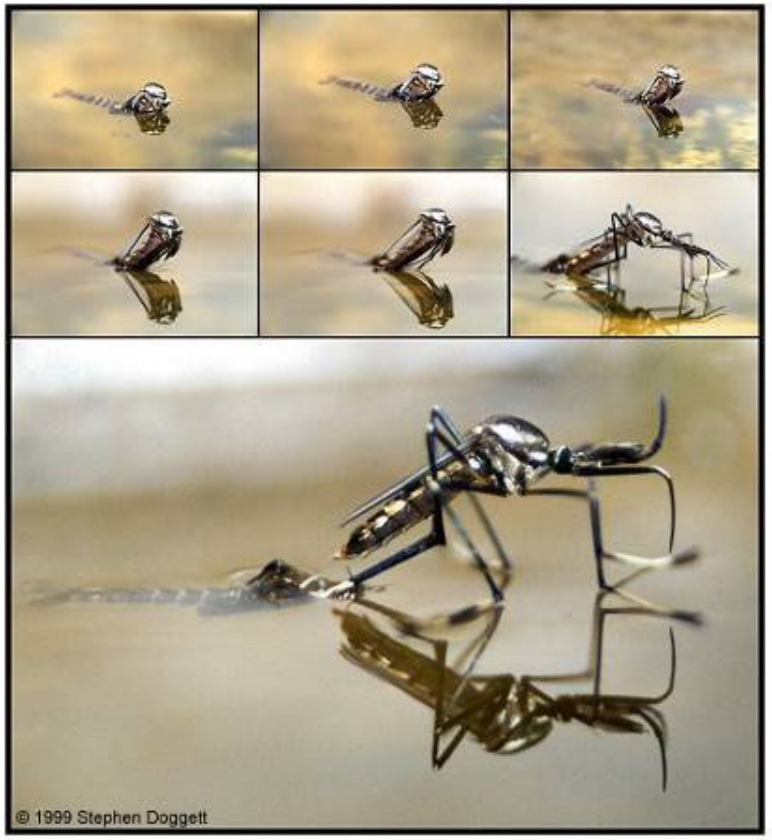


(4) Adult

- All are terrestrial with wings
  - Sugar feed (both males & females)
  - Blood feed (females)
  - Mate (both males & females)
  - Repeat 2xs

- D1 – Rest
- D2 – sugar feed
- D3 – First blood meal
- D4 – First egg clutch
- D5/6- Second blood feed

- Typical adult lives 7 – 10 days



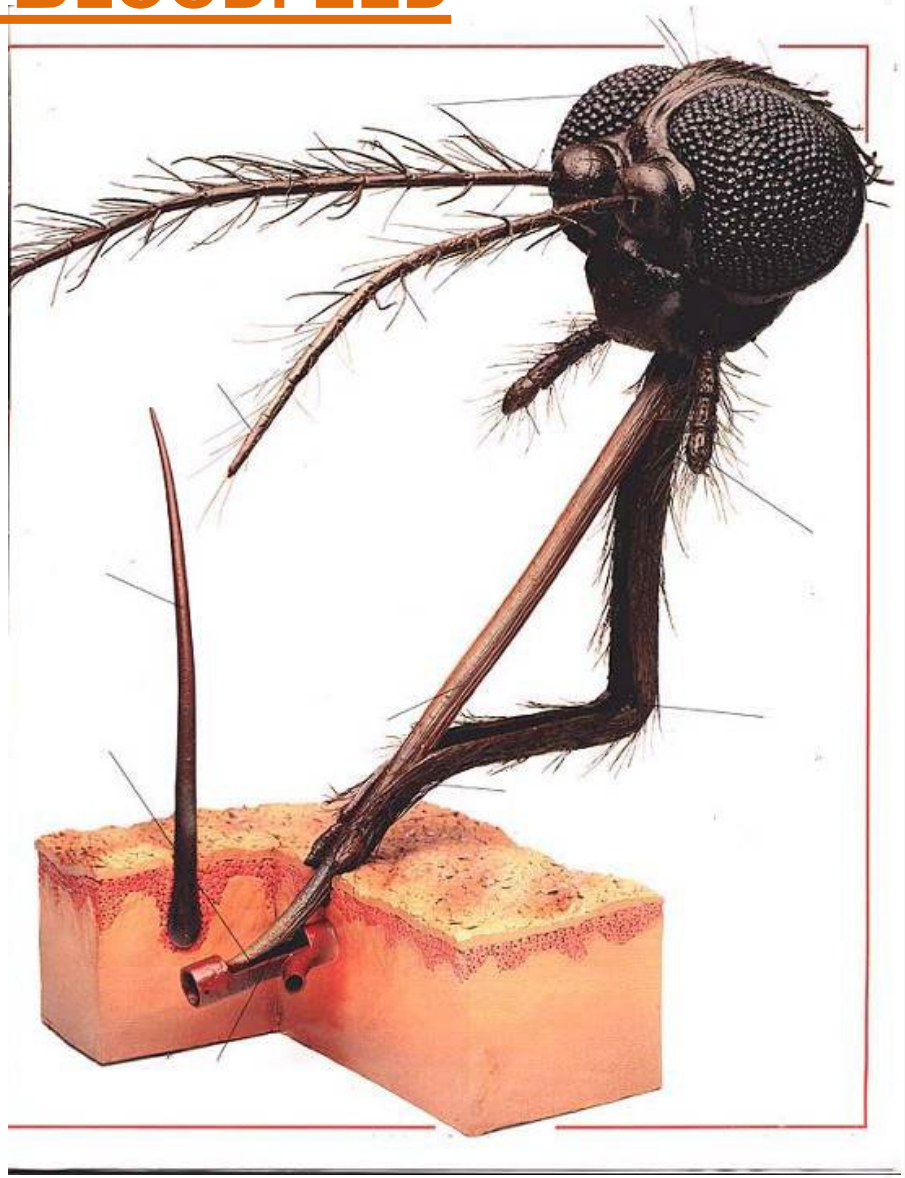
Adult:
Female Searches for a Bloodmeal

Off Host

- Long distance (eye & antennae)
  - Vision with 2 compound eyes
  - Johnston's organ located at base of pedicel on antenna
- At 1-2 m (eyes, palps, & anteannae)
  - odor, carbon dioxide, heat, humidity
    - http://www.youtube.com/watch?v=ndwY6NKIlmY

Adult:
Female Starts to Bloodfeed

- Once the mosquito lands, she must confirm host with sensors on tarsi (feet)
- Proboscis (6 stylets)
  - outer sheath slides back, exposing the mandibles & maxillae
  - stylets stab skin
  - Sensors on the tip of the stylets confirm capillary location



Adult: Female Feeding Behavior

- Female has found her host
  - Exploration
  - Penetration & Vessel seeking
  - Imbibing
  - Withdrawal
    - Injects saliva with digestive enzymes & anticoagulants (piercing-sucking flies)
    - https://www.youtube.com/watch?v=rD8SmacBUcU
- In Mosquito
  - Blood accumulates in midgut
  - Peritrophic membrane (=matrix) encases blood
  - Water is excreted

Adult: Mating Behavior

- Differ by species
- Males swarm (form leks) & females are attracted to a frequency based on wing size & beats & patterns
  - Plays an important role in speciation
- During copulation
  - male inserts a plug that 'traps' semen in seminal bursa
  - plug dissolves, semen travels to spermatheca

http://www.youtube.com/watch?v=vnwdd1L-b4g

LIFECYCLE
DEPENDENT ON THE ENVIRONMENT

Egg - Larva1 – Larva2 – Larva3- Larva4- Pupa- Adult

Genus	*Days to Emergence*					*Optimal Temperature*
	16℃ (60.8F)	20℃ (68F)	24℃ (75.2F)	28℃ (82.4F)	32℃ (89.6F)	
Culex	20-30d	15-20d	10-15d	10d	<10d	16-24℃ (60.8-75.2F)

City	*Average Temperature Hi/Low in F*											
	Jan	Feb.	Mar.	Apr.	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Knox.	47 30	52 33	61 40	71 48	78 57	85 65	88 69	87 68	81 62	71 49	60 41	50 34
Chatt.	50 31	55 34	64 41	71 48	80 57	87 66	90 70	90 69	83 62	73 50	62 40	52 33

https://www.youtube.com/watch?v=VXiQPRmb_Zw

Mosquito "Fun Facts"

- Mosquitoes are known from as far back as the Triassic Period – 400 million years ago. They are known from North America from the Cretaceous – 100 million years ago.
- There are about 2,700 species of mosquito. There are 176 species in the United States.
- The average mosquito weighs about 2.5 milligrams.
- The average mosquito takes in about 5-millionths of a liter of blood during feeding.
- Mosquitoes find hosts by sight (they observe movement); by detecting infra-red radiation emitted by warm bodies; and by chemical signals (mosquitoes are attracted to carbon dioxide and lactic acid, among other chemicals) at distances of 25 to 35 meters.
- Mosquitoes fly an estimated 1 to 1.5 miles per hour.
- Salt marsh mosquitoes can migrate up to 40 miles for a meal.
- Bigger people are often more attractive to mosquitoes because they are larger targets and they produce more mosquito attractants, namely CO2 and lactic acid.
- Active or fidgety people also produce more CO2 and lactic acid.
- Smelly feet are attractive to certain species of mosquitoes – as is Limburger Cheese.
- Dark clothing has been shown to attract some species of mosquitoes more than lighter colored clothing.
  Movement increased mosquito biting up to 50% in some research tests.
- A full moon increased mosquito activity 500% in one study