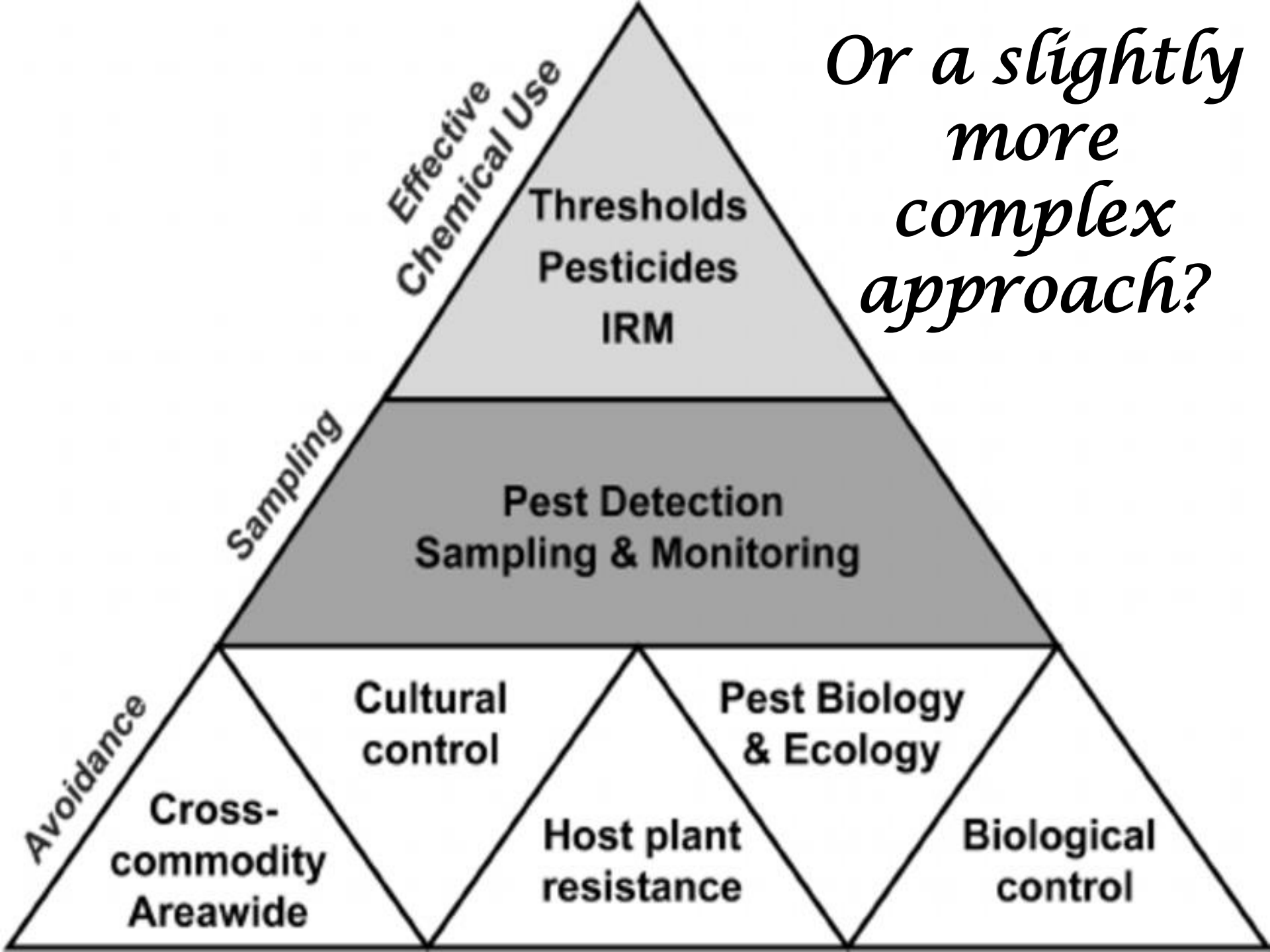


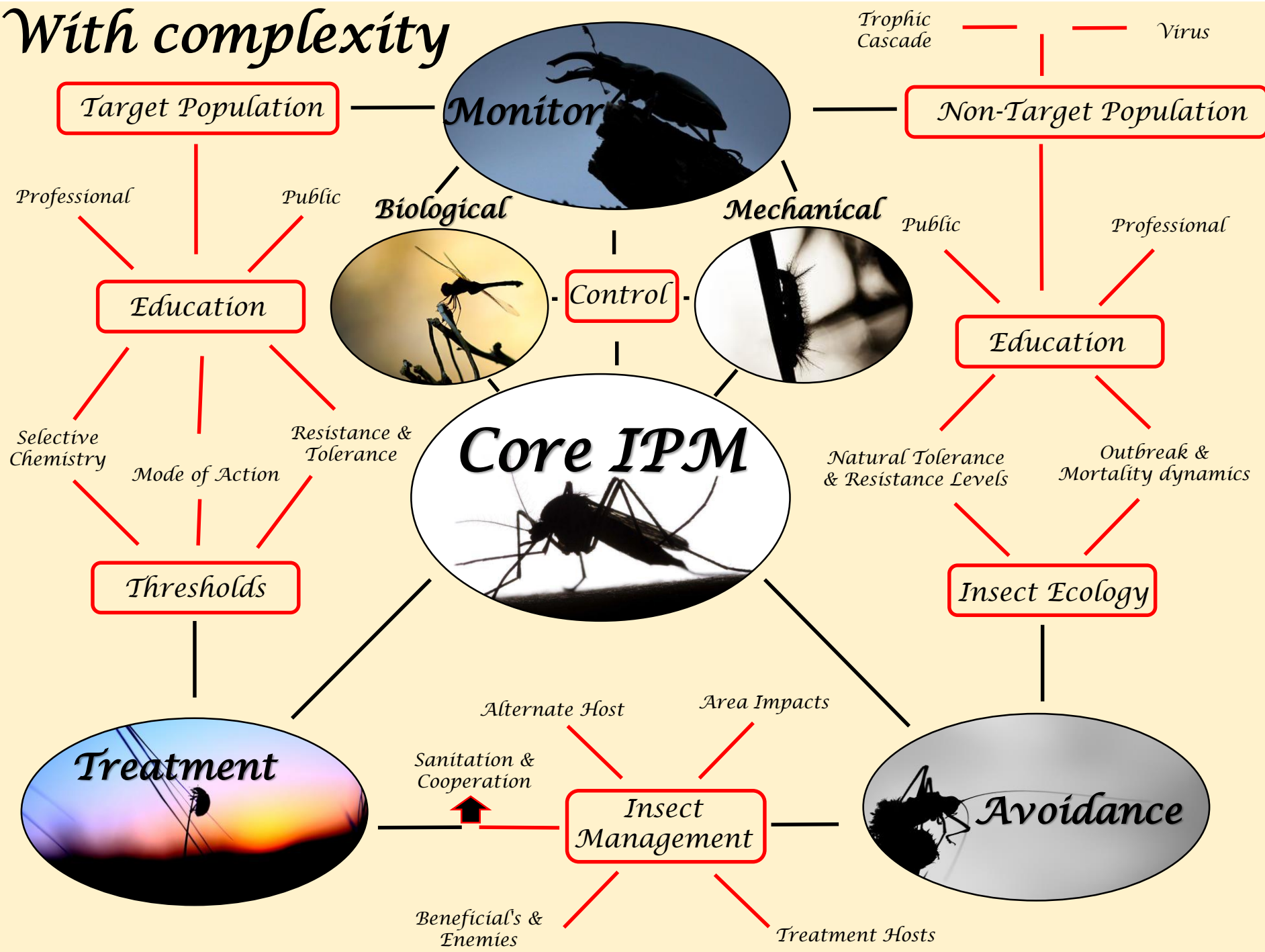
*Mosquitoes  
&  
Associated Pathogens*





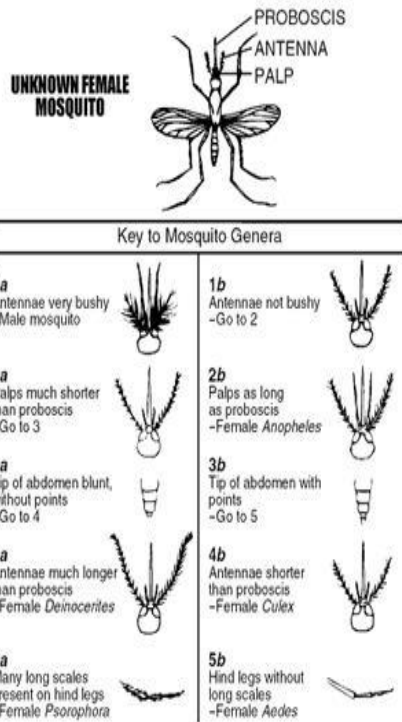
*Or a slightly more complex approach?*

# With complexity



# Applied IPM: Integrated Mosquito Management

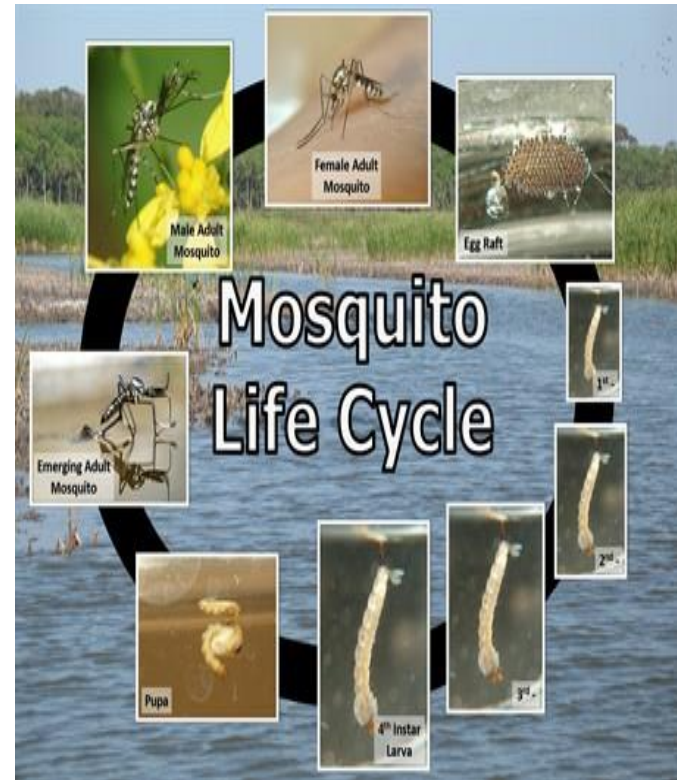
- Learn how to properly identify mosquito species
- Learn which habitats those species like to occupy
- Learn the life cycles of key mosquito species to ensure proper treatment techniques are used



*Proper Identification*



*Habitat Identification*



*Understanding the Life Cycles*

	BASE	HEART HEALTH
10	100-120	100-120
11	100-120	100-120
12	100-120	100-120
13	100-120	100-120
14	100-120	100-120
15	100-120	100-120

Science  
Technology  
Engineering  
Mathematics

County  
of  
Henrico  
Environmental  
Program  
Specialist



**Virginia's #1 Pest Mosquito**

**Asian Tiger Mosquito**

*Aedes albopictus* Sample Population in Henrico County

The graph shows the population of *Aedes albopictus* in Henrico County from 2000 to 2010. The y-axis represents the number of mosquitoes, and the x-axis represents the year. The population shows a significant increase starting around 2005, peaking in 2008, and then declining.

**Asian Tiger Mosquito**

Asian Tiger Mosquitoes are the most common and most aggressive mosquito in Virginia. They are known for their ability to bite humans and animals, and for their role in spreading several diseases, including West Nile virus, St Louis encephalitis virus, and Eastern equine encephalitis virus.

Prevention tips include:
 

- Eliminate standing water around your home.
- Use mosquito netting on your porch.
- Use mosquito coils or candles.
- Wear long sleeves and pants.
- Use mosquito repellent.



*Applied IPM:  
Integrated Mosquito Management  
Outreach and Education*



## *CDC-Light Trap*

- *Variable spp.*
- *Uses CO<sub>2</sub> as Lure*
- *Simulates respiration*
- *Attract host seeking*

# *Applied IPM: Source Reduction*



# Applied IPM: Control Decisions

(What type of control to use?)

## Natural Control

doesn't require human intervention for continued success

## Cultural Control

alter the environment, a host, or the behavior of the mosquito (e.g. sanitation)

## Biological Control

natural enemies (including pathogens) to manage pests

## Genetic Control

breeding specific species for resistance or sterilization

## Mechanical Control

use devices, machines, and other physical controls (e.g. traps & exclusion nets)

## Chemical Control

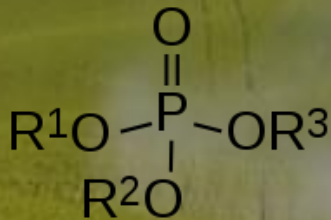
use of pesticides



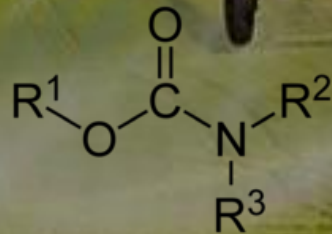
# Applied IPM: Control Decisions

## Chemical Control

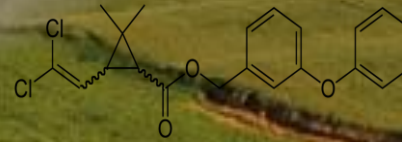
*Pesticides that are either naturally derived or synthesized. Their effectiveness is enhanced when used in combination with other control methods. Pesticides reduce or eliminate pest activities but if not used as part of an integrated approach can risk the development of resistance within populations*



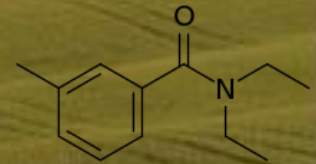
*Organophosphate*



*Carbamate*



*Permethrin*

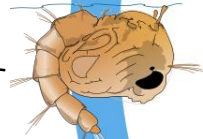


*Deet*

# *Mosquito Biology*

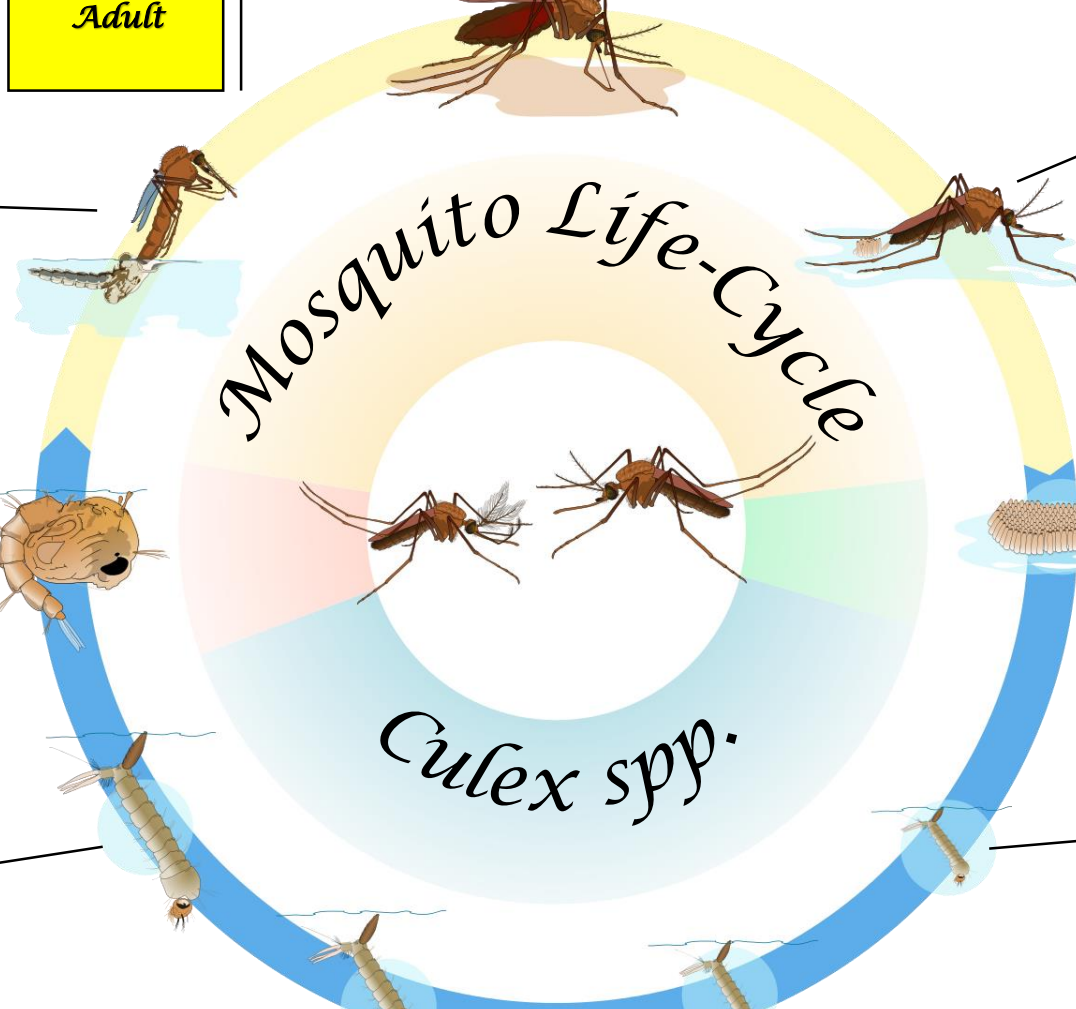


# Mosquito Biology



Mosquito Life-Cycle

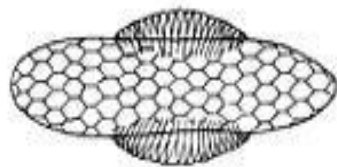
*Culex spp.*



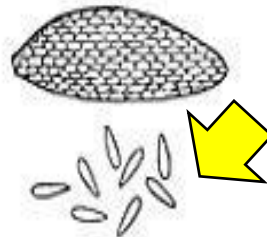
# Mosquito Biology

## Genus: *Aedes*

- Lay eggs in installments over time
- Usually singularly or in small groups  
(clusters are generally a result of superoviposition)
- Laid in areas of expected saturation



Single Eggs with Floats



Single Eggs on Dry Surface

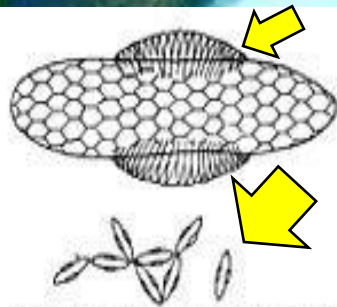


Floating Egg Raft

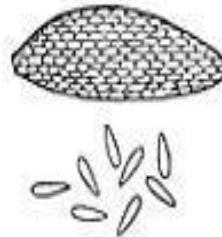
# Mosquito Biology

## Genus: *Anopheles*

- Usually lay individual eggs
- Can be deposited in large clusters
- Can be oviposited while in flight
- Laid on water surface or on moist soil
  - Recognizable by floats



Single Eggs with Floats



Single Eggs on Dry Surface

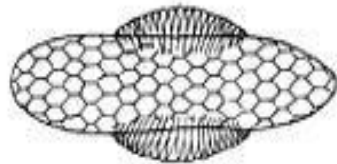


Floating Egg Raft

# Mosquito Biology

## Genus: *Culex*

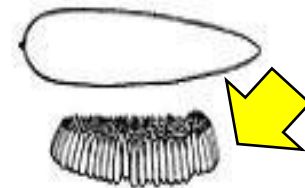
- Corolla present
- Deposited as “rafts”
- Laid on water surface



Single Eggs with Floats



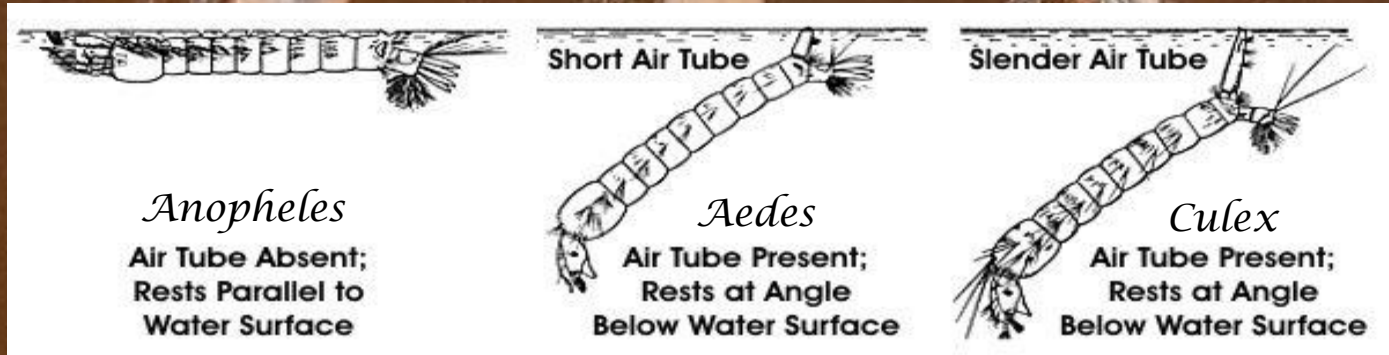
Single Eggs on Dry Surface



Floating Egg Raft

# Mosquito Biology

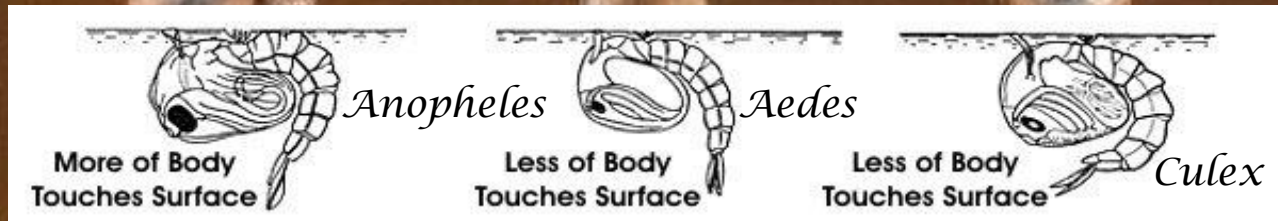
## Larva



- *Wrigglers live in water from 4-14 days*
  - *Surface breathing via siphon*
  - *Filter feeders (some predators e.g. Toxorhynchites)*
- *Shed cuticle 4 times each time is called an instar*

# Mosquito Biology

## Pupa

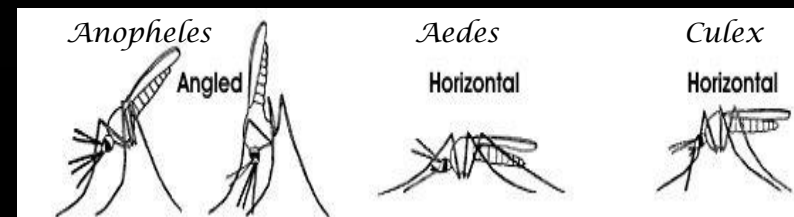
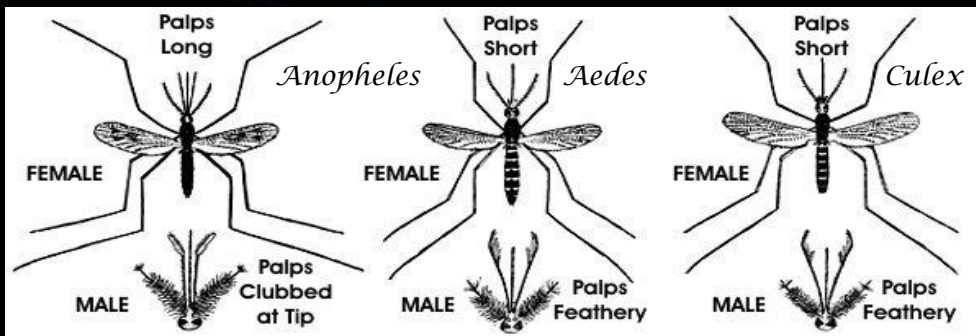


- *Tumblers live in water from 1-4 days*
- *Surface breathing via tubes called “trumpets”*
  - *Does not eat but not totally inactive*
- *Shed cuticle 4 times each time is called an instar*



# Mosquito Biology Adults

- Only females require blood
- Stimulated by CO<sub>2</sub>, temperature, moisture, color, movement



# Mosquito Biology Form & Function

## ADULT MORPHOLOGY

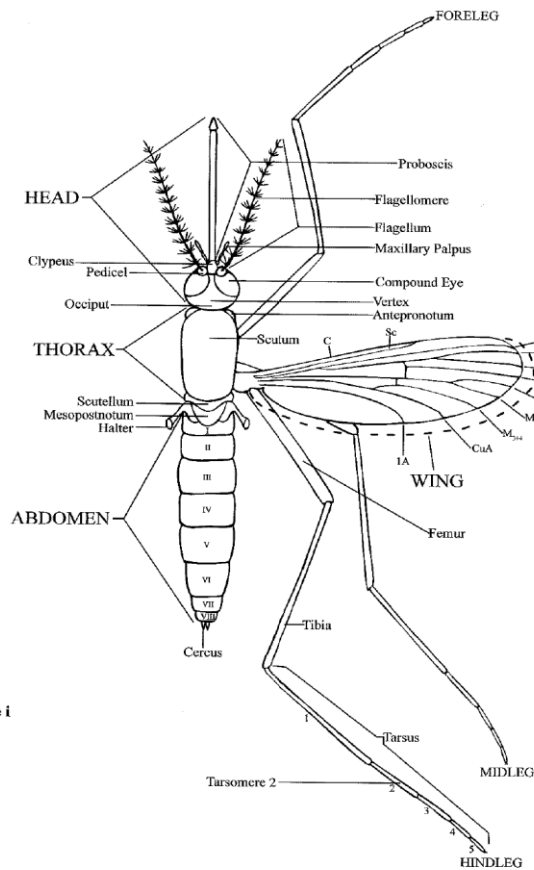


Figure i

### Head - Sensory

- Compound Eyes
- Antennae
- Palps
- Mouthparts (proboscis)

### Thorax - Locomotion

- Legs (5 segments)
- Wings (4 wings)

### Abdomen - Body Processes

- Digestion
- Excretion
- Reproduction

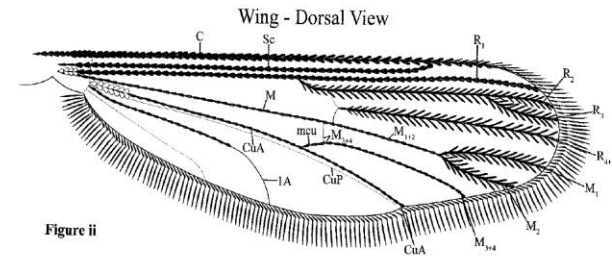


Figure ii

- |                  |                       |                  |                          |                  |                         |
|------------------|-----------------------|------------------|--------------------------|------------------|-------------------------|
| IA               | - anal vein           | M <sub>2</sub>   | - media two              | R <sub>3+5</sub> | - radius four plus five |
| C                | - costa               | M <sub>3+4</sub> | - media three plus four  | Sc               | - Subcosta              |
| CuA              | - cubitus anterior    | mcu              | - mediocubital crossvein |                  |                         |
| CuP              | - cubitus posterior   | R <sub>1</sub>   | - radius one             |                  |                         |
| M                | - media               | R <sub>2</sub>   | - radius two             |                  |                         |
| M <sub>1</sub>   | - media one           | R <sub>2+3</sub> | - radius two plus three  |                  |                         |
| M <sub>1+2</sub> | - median one plus two | R <sub>3</sub>   | - radius three           |                  |                         |

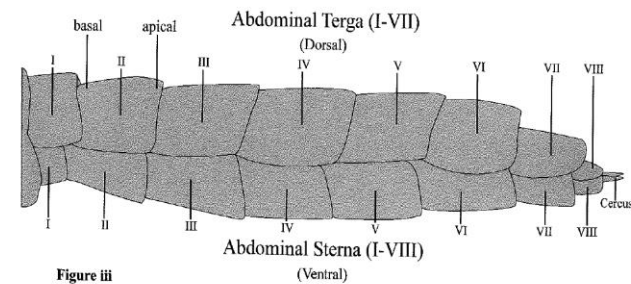


Figure iii

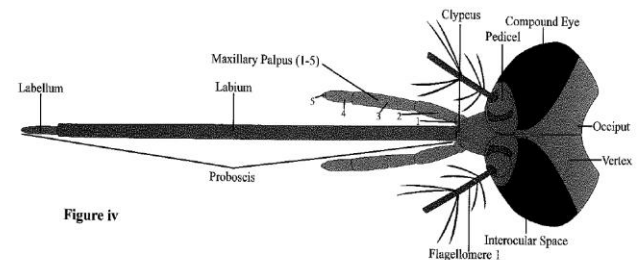
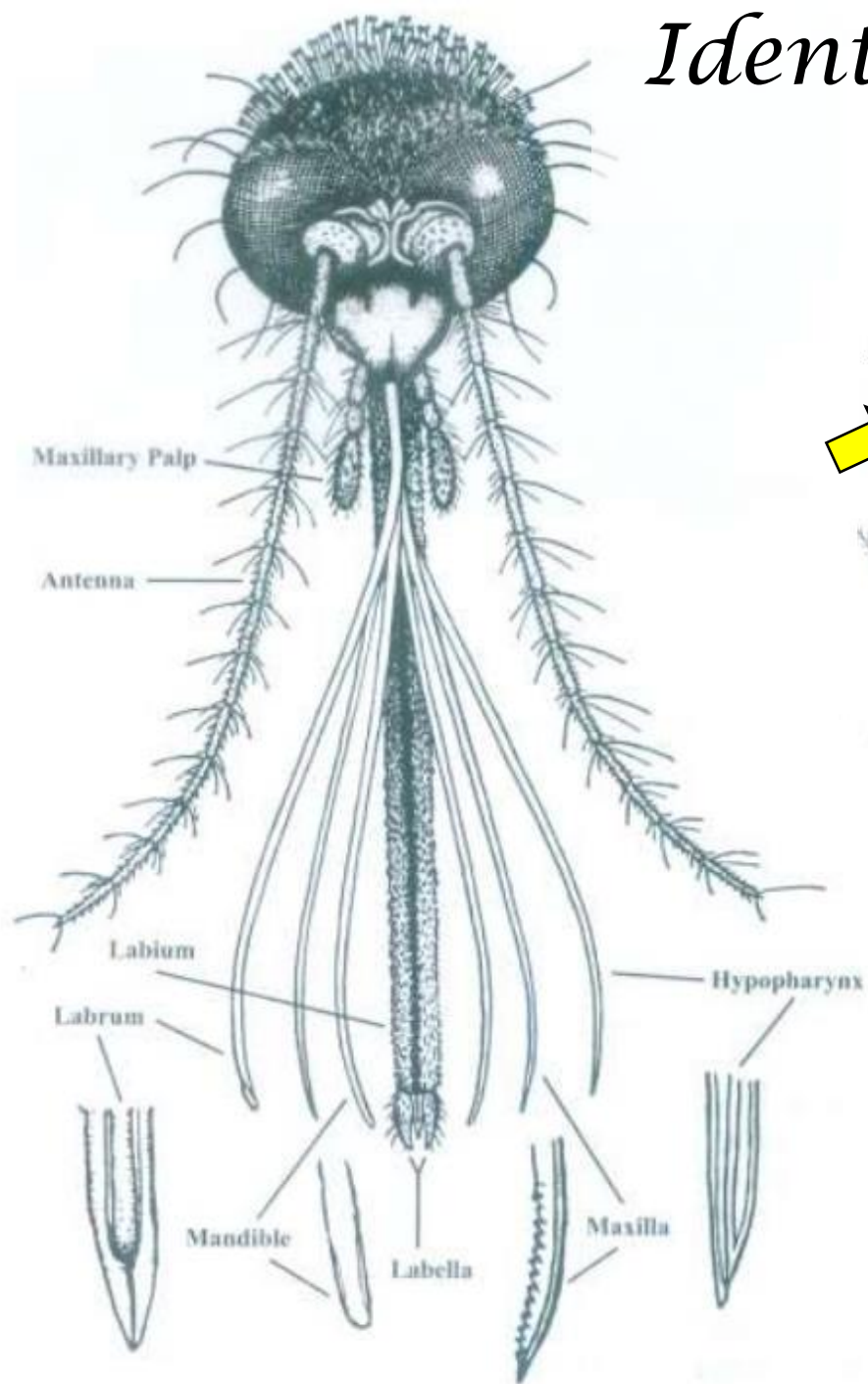
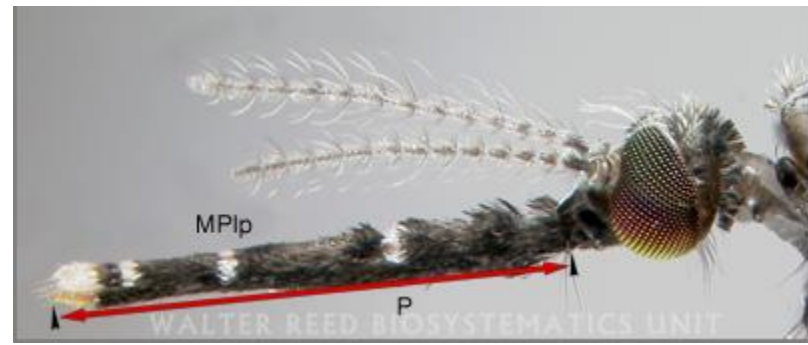
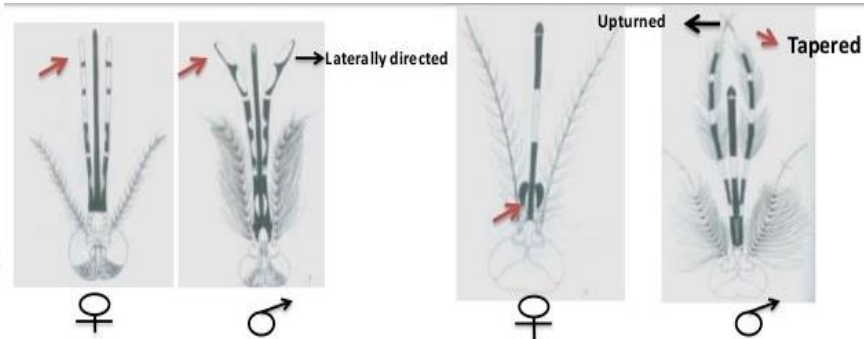
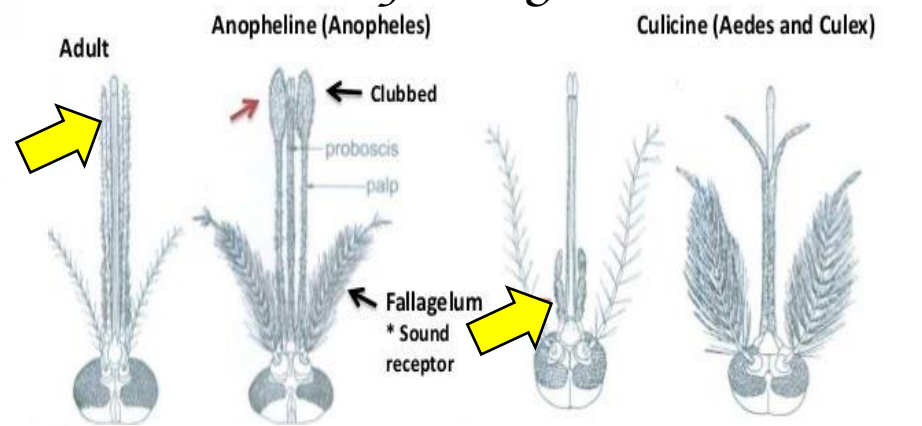


Figure iv

# Identification Characters (Head)



## 1. Palp Length

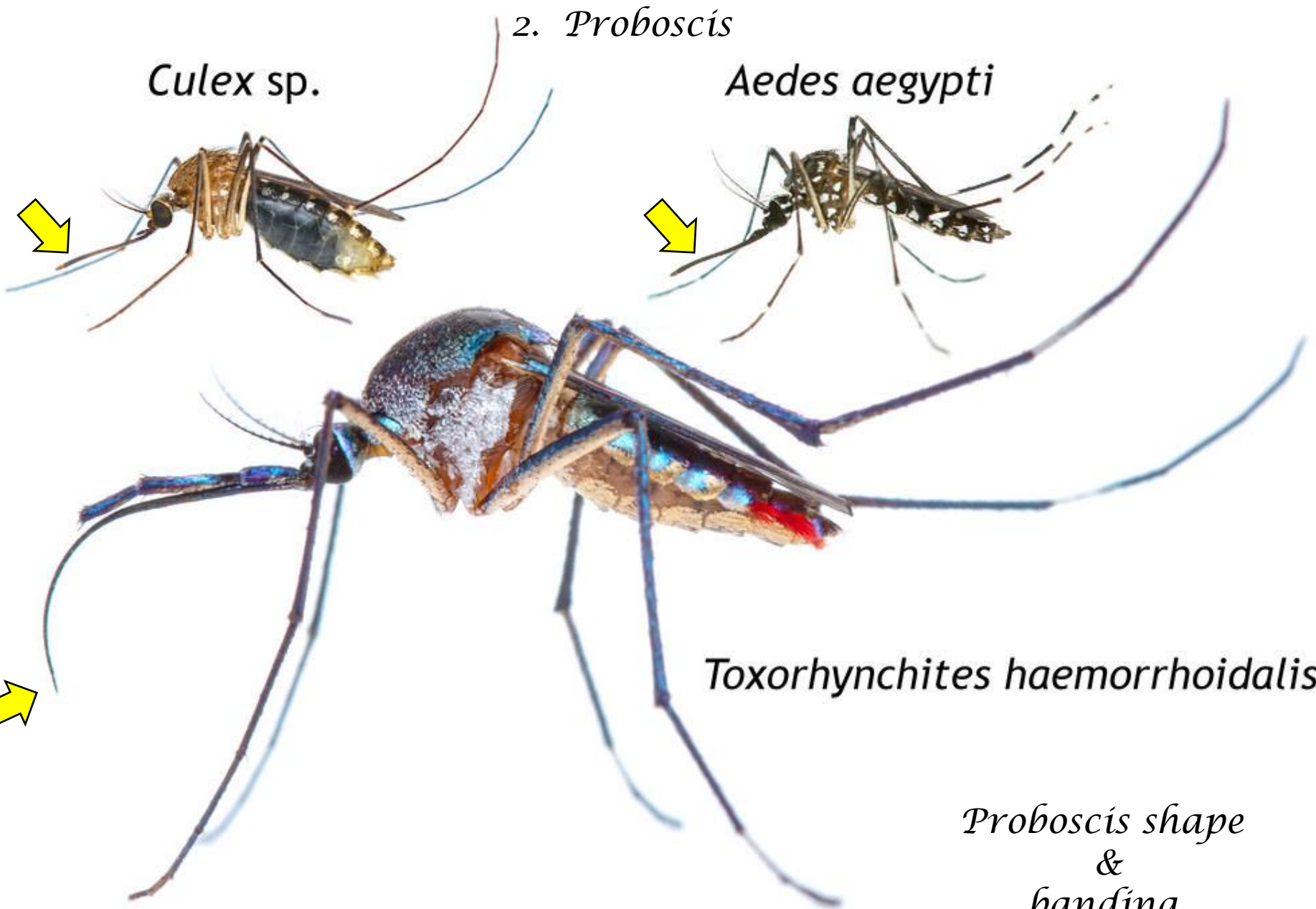


# Identification Characters (Head)

2. Proboscis

*Culex* sp.

*Aedes aegypti*

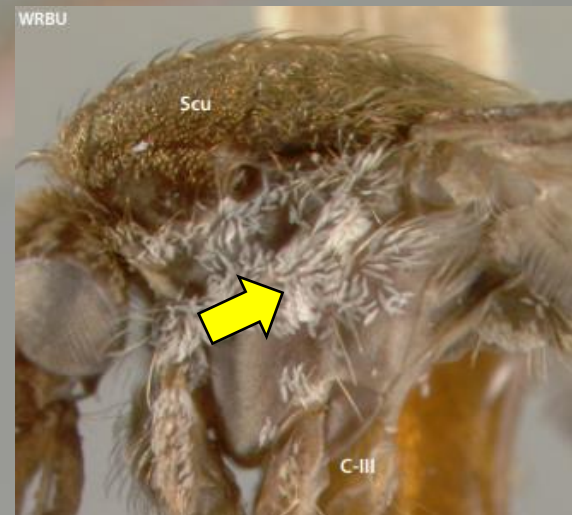


*Toxorhynchites haemorrhoidalis*

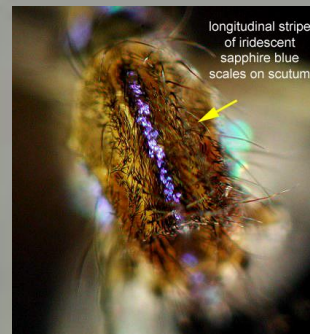
Proboscis shape  
&  
banding

# Identification Characters (Thorax)

## 1. Scutum - scales & setae (scale size, aggregation, location)

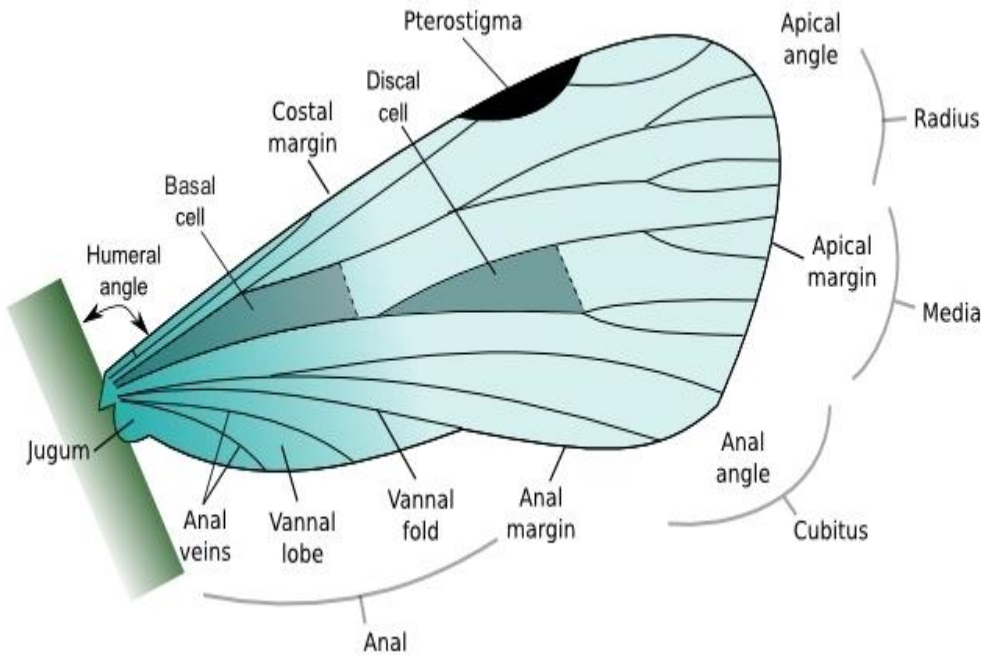


Scutum



# Identification Characters (Thorax)

## 2. Wings



## Wing Scales?

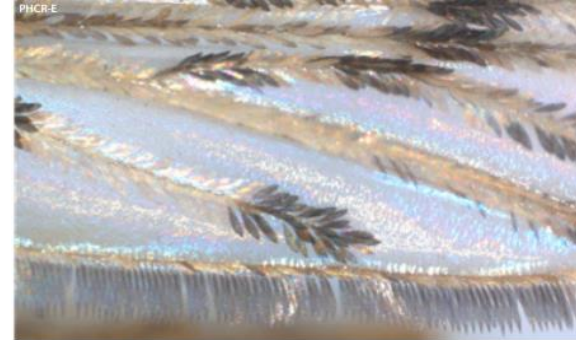


Fig. 5. Wing with scales



Fig. 6. Wing usually without scales

## Wing Veins

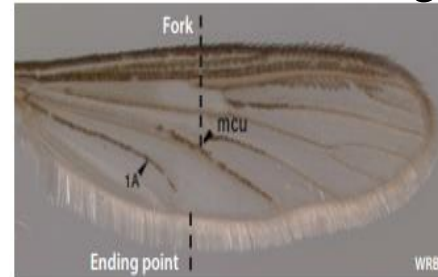


Fig. 25. Vein 1A ending before intersection (fork) of mCu: *Uranotaenia* spp.

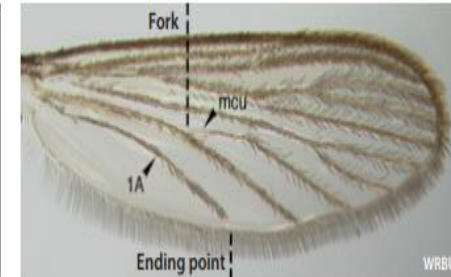


Fig. 26. Vein 1A ending beyond intersection (fork) of mCu: *Culex* spp.

## Wing Bristles

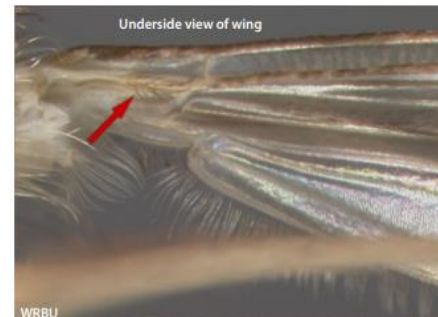


Fig. 31. Base of subcostal with a row of bristles on the underside: *Culiseta morsitans*

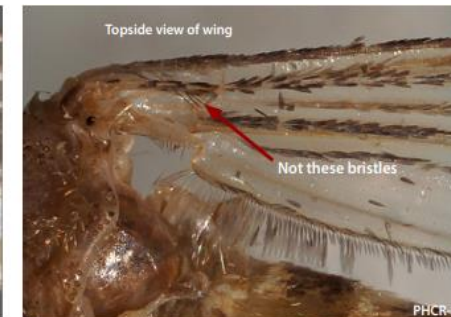
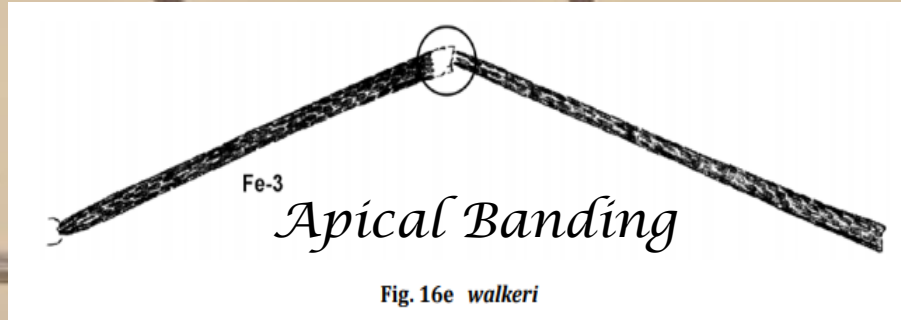


Fig. 32. Base of subcostal without a row of bristles on the underside. Do not mistake bristles found on the top side of the wing for this feature: *Culex quinquefasciatus*

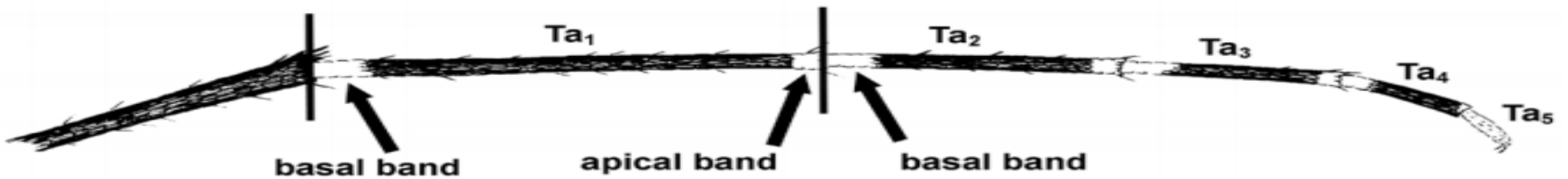


# Identification Characters (Thorax)

## 3. Legs



## Hind Leg



# Identification Characters (Abdomen)

## 1. Shape

Round & Blunt

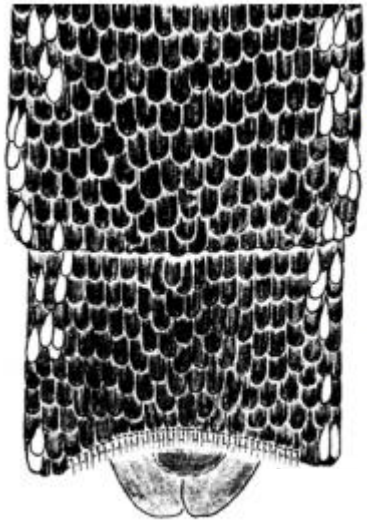


Fig. 33. Abdomen blunt, dorsal view: *Mansonia titillans*



Fig. 34. Abdomen blunt, lateral view: *Mansonia titillans*



Fig. 35. Abdomen blunt, dorsal view: *Culex quinquefasciatus*

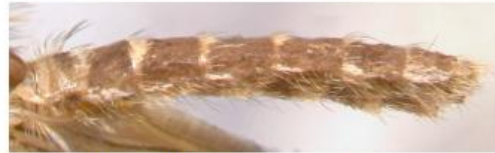


Fig. 36. Abdomen blunt, lateral view: *Culex quinquefasciatus*



Fig. 37. Abdomen blunt, dorsal view: *Coquillettia perturbans*



Fig. 38. Abdomen blunt, lateral view: *Coquillettia perturbans*



Fig. 39. Abdomen pointed, dorsal view: *Aedes japonicus*



Fig. 40. Abdomen pointed, lateral view: *Aedes japonicus*



Fig. 41. Abdomen pointed, dorsal view: *Psorophora ferox*

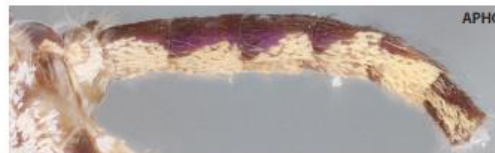


Fig. 42. Abdomen pointed, lateral view: *Psorophora ferox*

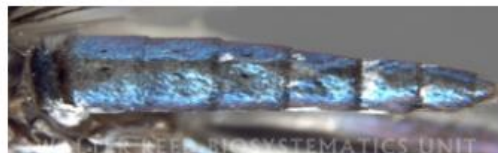
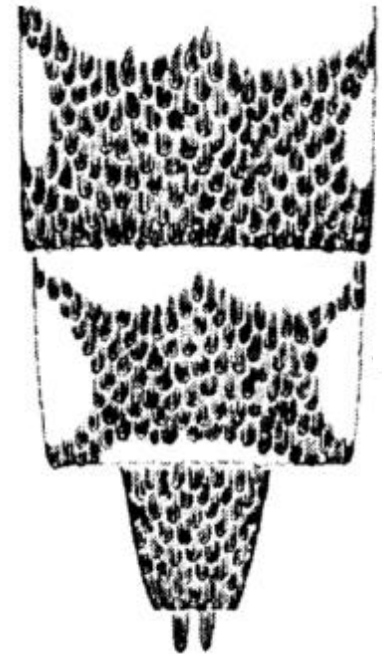


Fig. 43. Abdomen pointed, dorsal view: *Haemagogus mesodentatus*\*



Fig. 44. Abdomen pointed, lateral view: *Haemagogus mesodentatus*\*

Pointed at Tip





# Identification Characters (Abdomen)

## 2. Banding

Apical  
or  
Lateral

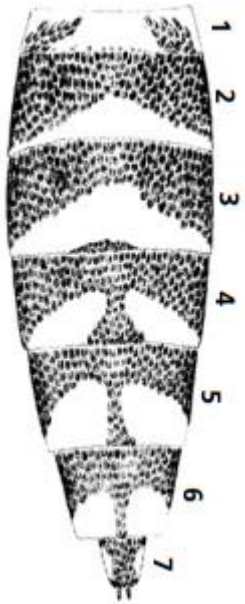


Fig. 33. Abdomen blunt, dorsal view: *Mansonia titillans*



Fig. 34. Abdomen blunt, lateral view: *Mansonia titillans*



Fig. 35. Abdomen blunt, dorsal view: *Culex quinquefasciatus*



Fig. 36. Abdomen blunt, lateral view: *Culex quinquefasciatus*



Fig. 37. Abdomen blunt, dorsal view: *Coquillettia perturbans*



Fig. 38. Abdomen blunt, lateral view: *Coquillettia perturbans*



Fig. 39. Abdomen pointed, dorsal view: *Aedes japonicus*



Fig. 40. Abdomen pointed, lateral view: *Aedes japonicus*



Fig. 41. Abdomen pointed, dorsal view: *Psorophora ferox*

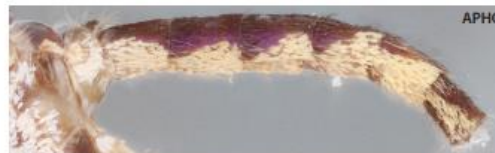


Fig. 42. Abdomen pointed, lateral view: *Psorophora ferox*

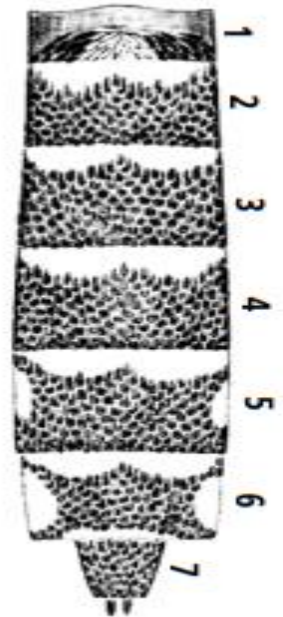


Fig. 43. Abdomen pointed, dorsal view: *Haemagogus mesodentatus*\*



Fig. 44. Abdomen pointed, lateral view: *Haemagogus mesodentatus*\*

Basal  
or  
Lateral



# Mosquito-Borne Disease

*Diseases spread by the bite of an infected mosquito.*

- *Malaria*
- *Chikungunya*
- *Dengue*
- *Yellow Fever*
- *West Nile Virus*
- *Eastern Equine Encephalitis*
- *St. Louis Encephalitis*
- *LaCrosse Encephalitis*
- *Western Equine Encephalitis*
- *Zika*

&

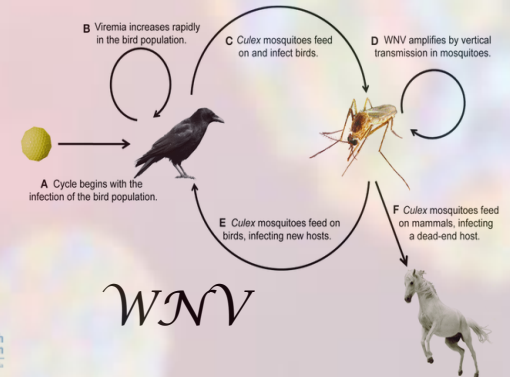
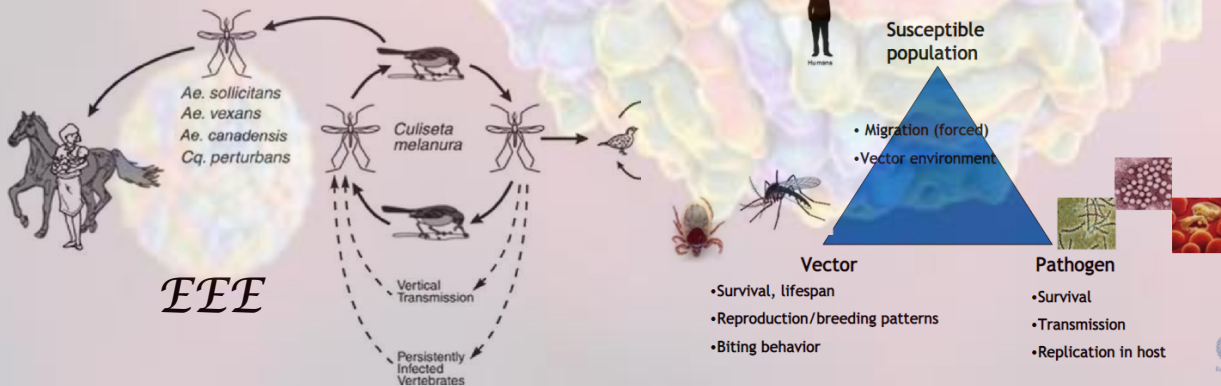
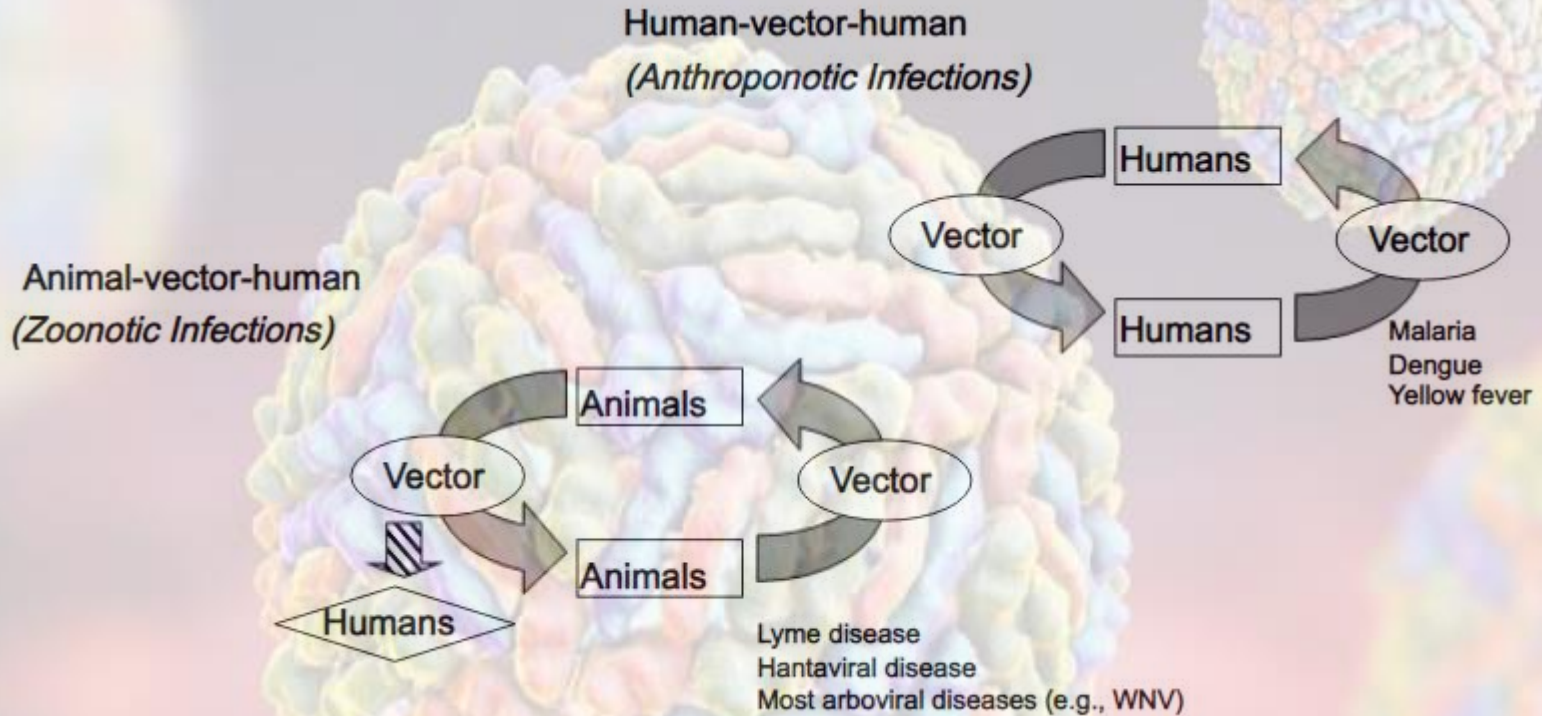
*Dirofilaria imitis* aka heartworm

*Virginia Mosquito-Borne Diseases*

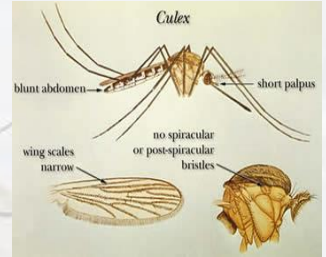
- *West Nile virus (WNV)*
- *Eastern Equine Encephalitis (EEE)*
- *LaCrosse Encephalitis (LAC)*
- *St. Louis Encephalitis (SLE)*



# Vector-Borne Disease Transmission Cycles



# Vector-Borne Disease Transmission Cycles



## West Nile virus

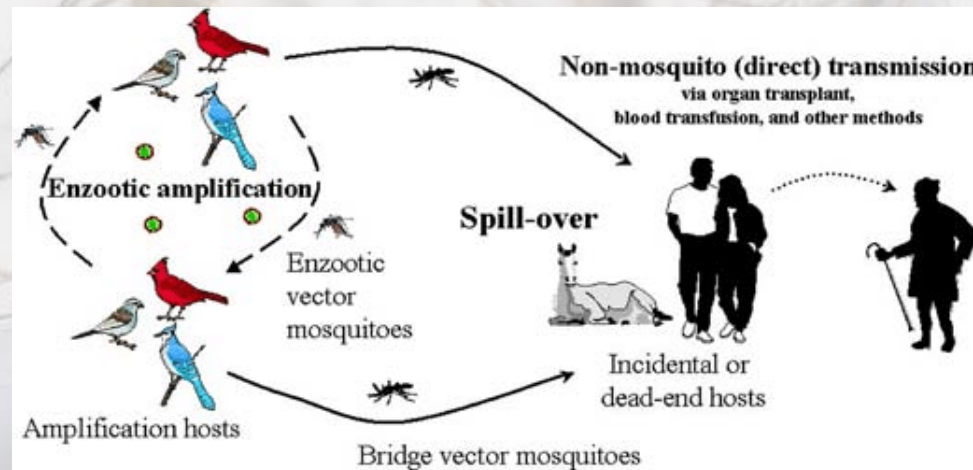
- Appeared in 1999 in US
- Cycled between birds and mosquitoes (Primarily)
  - Humans/Horses Dead End Host
    - “Flu-like”

### General Symptomology

Fever  
Headache  
Tiredness  
Arches and Pains  
Rash

### Severe Impacts

Neuroinvasive disease  
West Nile encephalitis  
West Nile meningitis

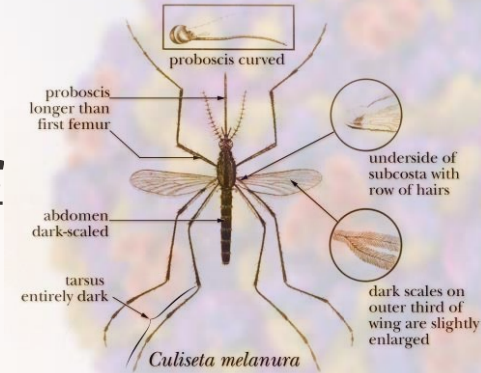


# Vector-Borne Disease Transmission Cycles



## Eastern Equine Encephalitis

- Mainly impacts horses
- “Flue-like” symptoms

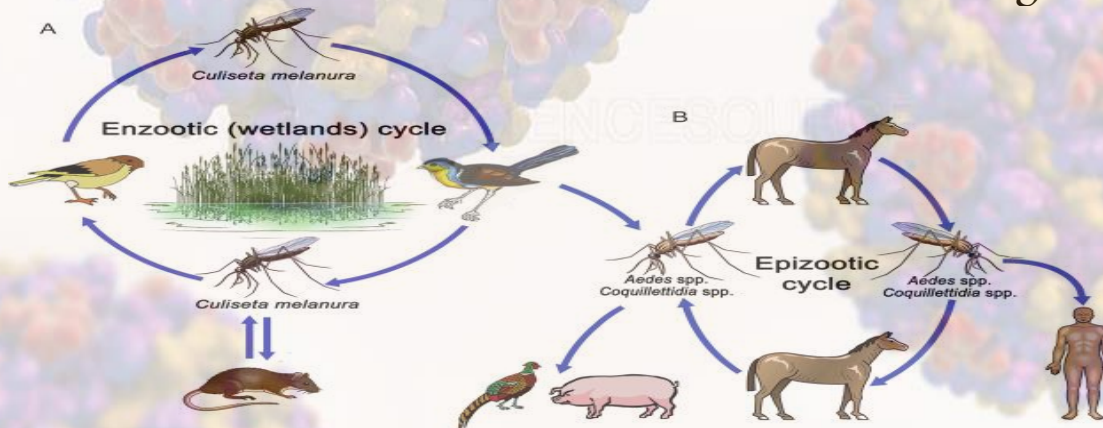


## General Symptomology

Fever  
Headache  
Sore Throat  
Arches and Pains  
Rash

## Severe Impacts

Systemic - fever, chills, malaise, arthralgia, myalgia  
Or  
Encephalitic - fever, headache, irritability, tiredness, anorexia, vomiting, seizures, coma



# Vector-Borne Disease Transmission

## La Crosse encephalitis

- *Ochlerotatus triseriatus* and small vertebrate hosts
  - Humans are “dead ends”

### General Symptomology

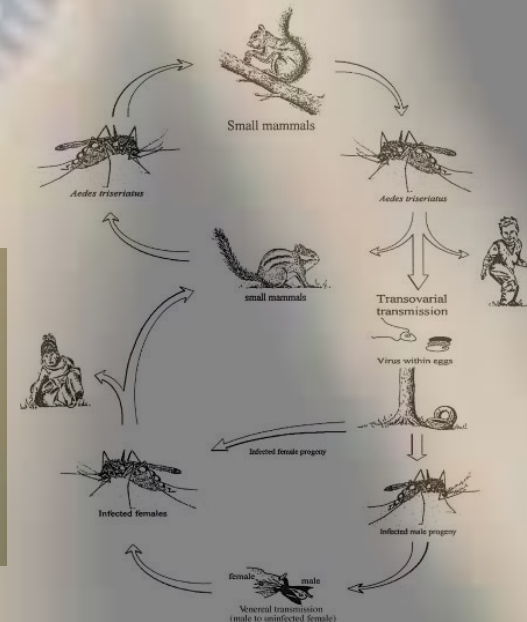
Fever  
Headache  
Nausea  
Vomiting  
Lethargy

### Severe Impacts

Neuroinvasive disease



Natural cycle of La Crosse virus



# Vector-Borne Disease Transmission

## St. Louis Encephalitis

- *Culex pipiens* and *quinquefasciatus* (In Eastern U.S.)
  - <1% are clinically apparent”

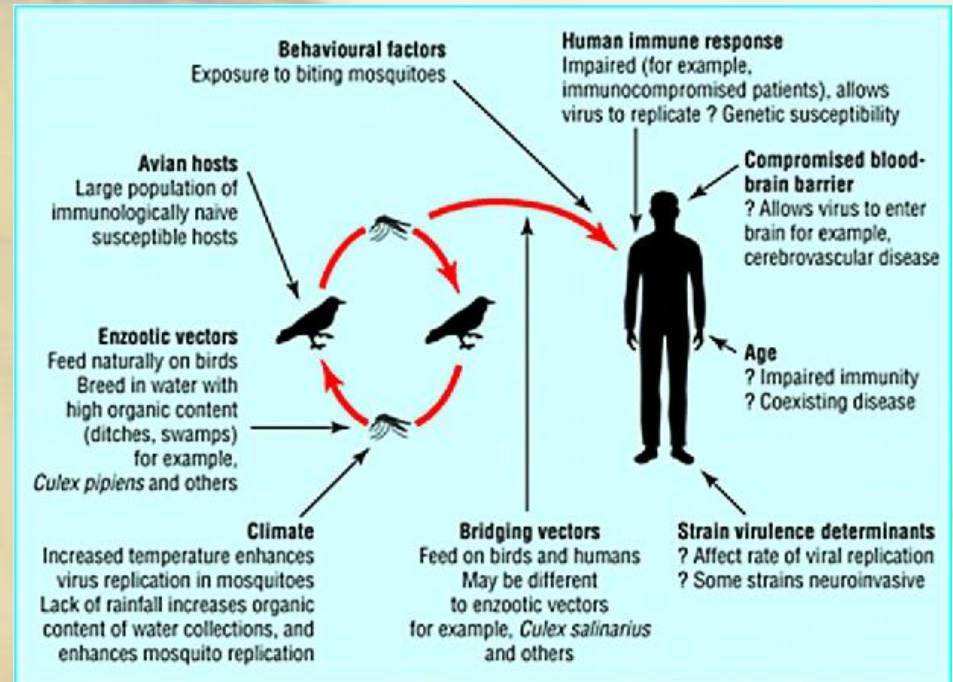
### General Symptomology

Fever  
Headache  
Dizziness  
Nausea  
Malaise

### Severe Impacts

Central Nervous impacts:

- Stiff neck
- Confusion
- Disorientation
- Dizziness
- Tremors
- Coma for more severe cases



*Cx. quinquefasciatus*



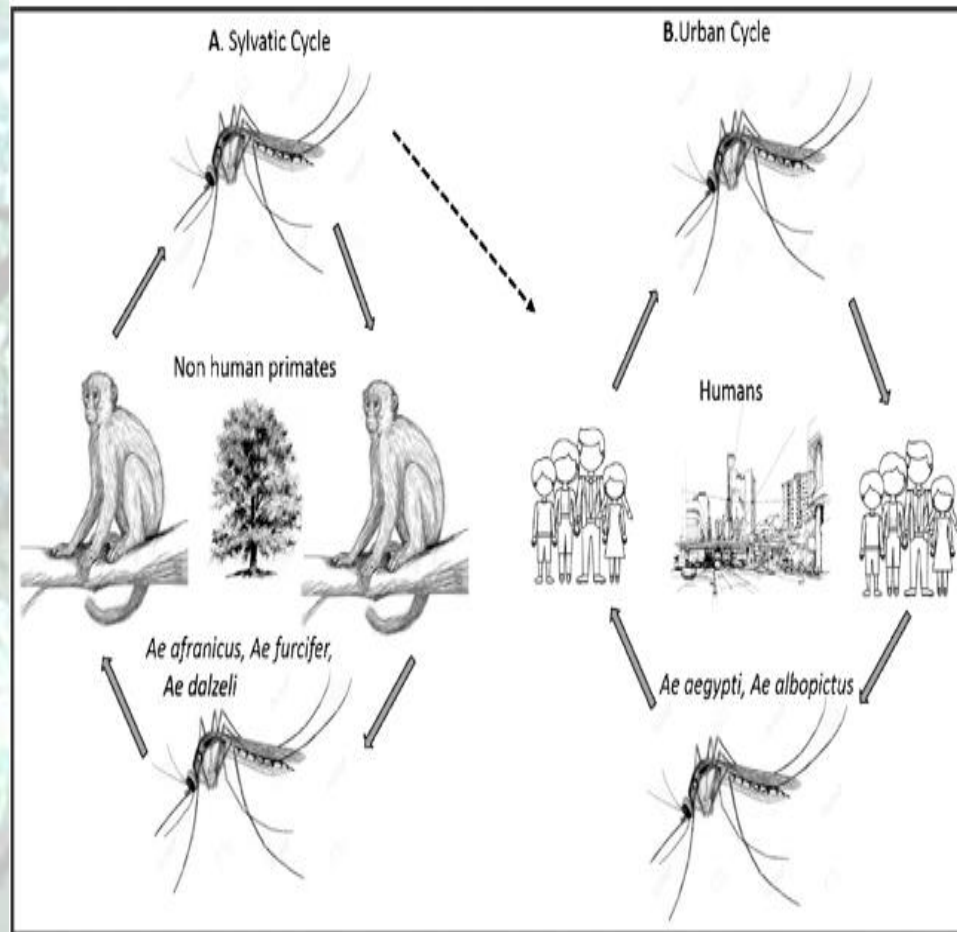
*Cx. pipiens*



# Vector-Borne Disease Transmission

## Chikungunya virus

- Mainly impacts horses
- “Flue-like” symptoms



**Figure-2:** Lifecycle of the Chikungunya virus. Part A represents sylvatic cycle, where transmission is between mosquitoes-monkeys-mosquitoes. Part B represents urban cycle where transmission is between mosquitoes-human-mosquitoes. Dashed arrow represents occasional interconnection between sylvatic and urban cycle.



# Vector-Borne Disease Transmission Cycles

## Zika virus

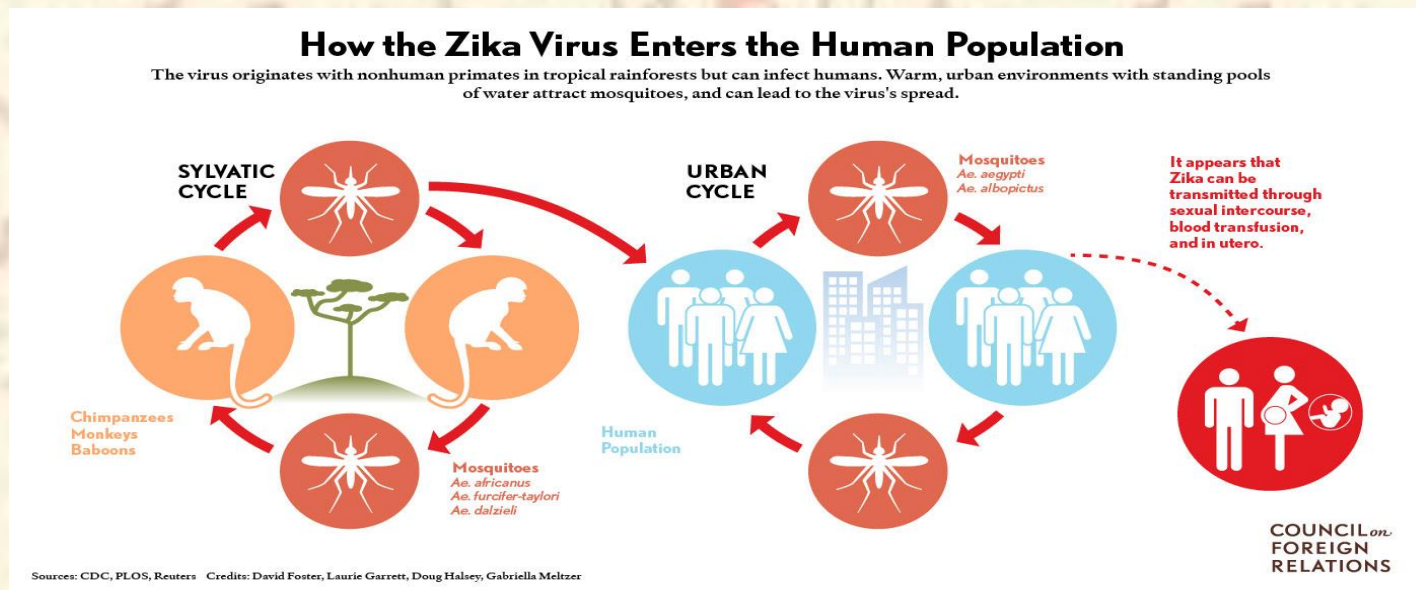
- Peridomestic mosquitoes (*Aedes aegypti* & *albopictus*)
  - No vaccine

### General Symptomology

Fever  
Rash  
Conjunctivitis  
Joint Pain  
Rash

### Severe Associations

Microcephaly or Guillain-Barre syndrome



# Vector-Borne Disease Transmission

## Heartworm

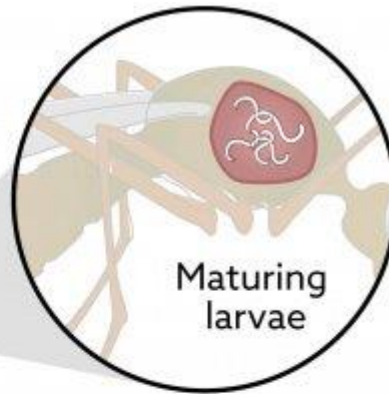


- Worms that live in heart, lungs, associated blood vessels
  - Parasite transferred by mosquito (~70 species)
    - *Aedes*, *Anopheles*, & *Mansonia*



### General Symptomology

Cough  
Fatigue  
Decreased appetite  
Weight loss



Severe Impacts  
Caval syndrome - blood flow stops

Infected dog serves as a host to other mosquitoes.

Larvae of mosquito infects

