Introduction to Mosquito biology, traps, and diseases

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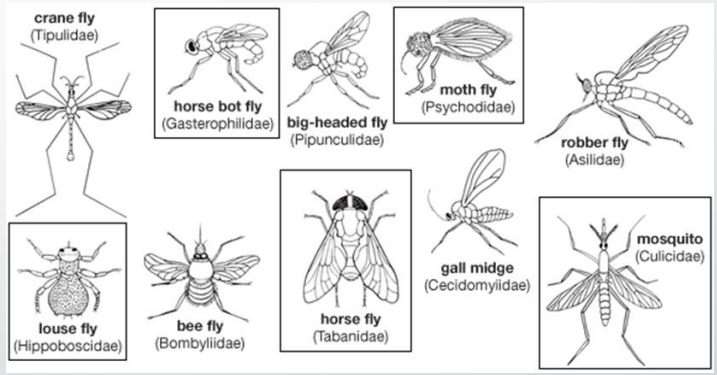
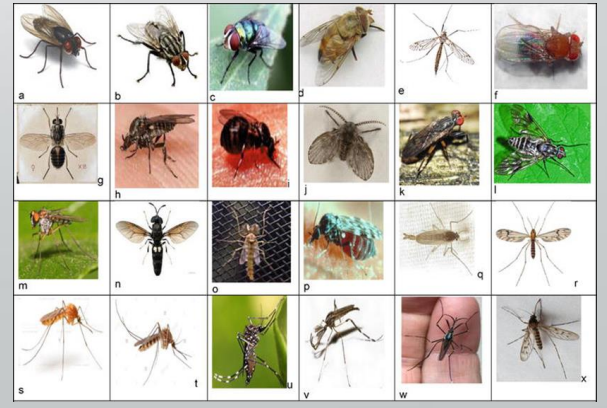
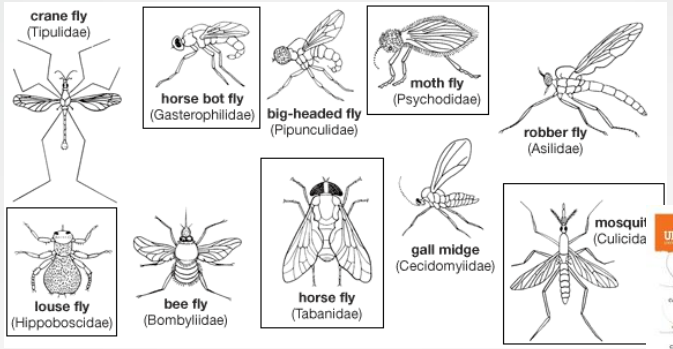
Classification of Mosquitoes

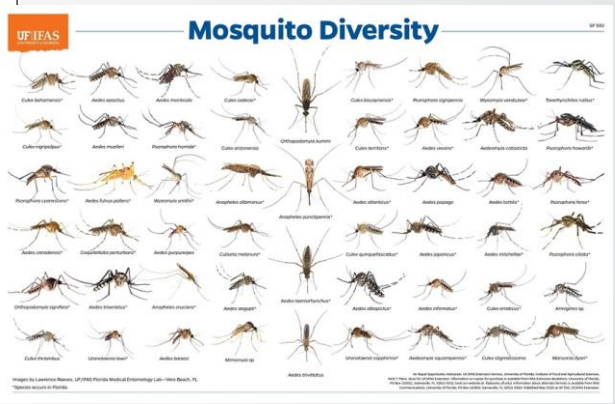
- Domain: Eukaryota
  - Kingdom: Animalia
    - Phylum: Arthropoda
      - Class: Insecta
        - Oder: Diptera (Flies)





Classification of Mosquitoes



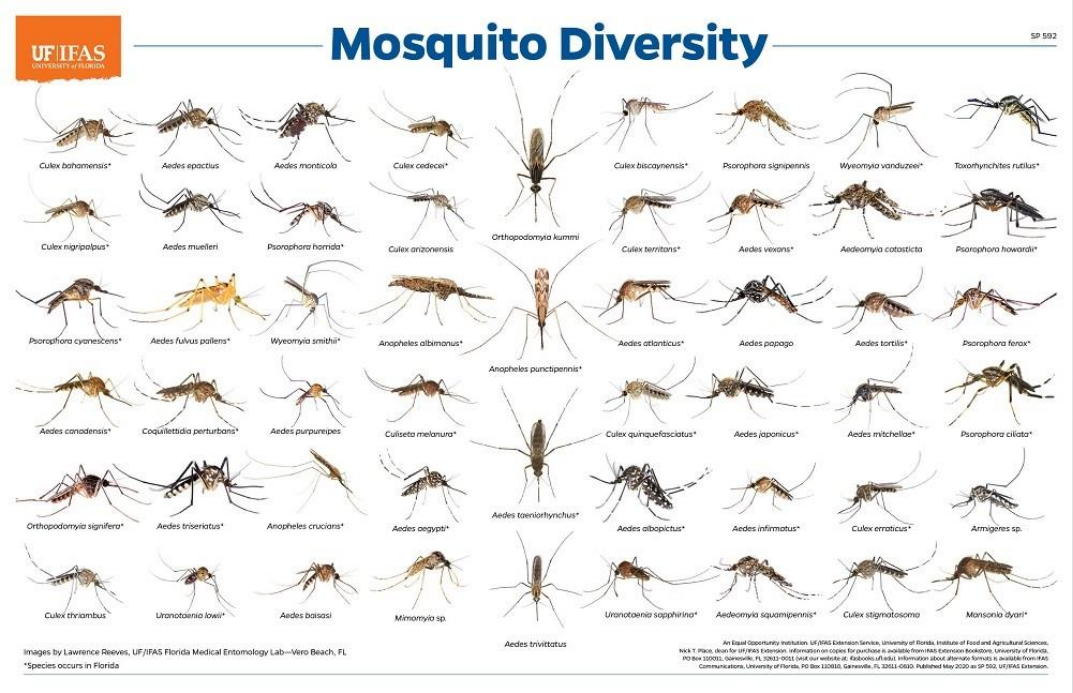


- Domain: Eukaryota
  - Kingdom: Animalia
    - Phylum: Arthropoda
      - Class: Insecta
        - Oder: Diptera (Flies)
          - Family: Culicidae (mosquitoes)

- Order Diptera (flies)
  - One pair of wings
  - Complete metamorphosis-
    - Egg, larvae, pupa, adult

- Family Culicidae
  - Proboscis (piercing mouth parts)
  - Scales on the wings

Classification of Mosquitoes



- Domain: Eukaryota
  - Kingdom: Animalia
    - Phylum: Arthropoda
      - Class: Insecta
        - Oder: Diptera (Flies)
          - Family: Culicidae (mosquitoes)
            - 2 subfamilies and 112 genera

- Virginia Genera:
  - *Aedes*
  - *Anopheles,*
  - *Coquillettidia*
  - *Culex*
  - *Culiseta*
  - *Orthopodomyia*
  - *Psorophora*
  - *Toxorhychites*
  - *Wyeomyia*
  - *Uranotaenia*

Mosquito Species

- How many species of mosquito do you think live in Virginia?

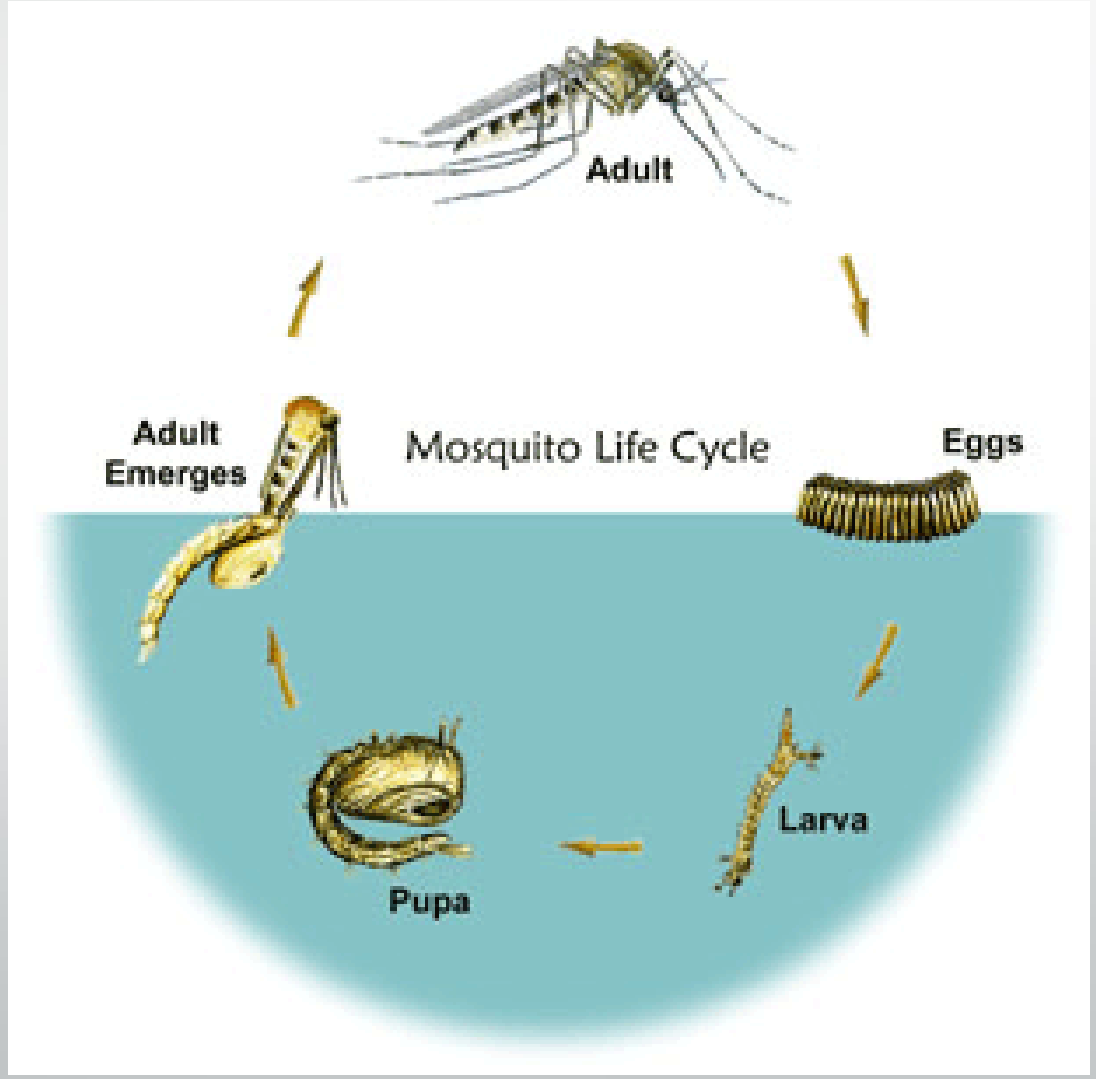
A. 1
B. 13
C. 26
D. 59

- How many species of mosquito do you think live in the World?

A. 1
B. 250
C. 1,250
D. 3,600

Diversity of Bird species

Mosquito Life Cycle



Mosquito Life Cycle

Eggs - Larvae - Pupae - Adults

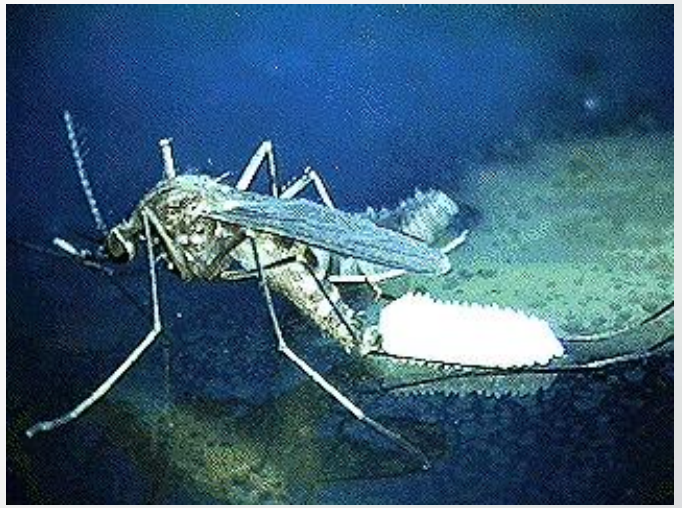
Anopheles

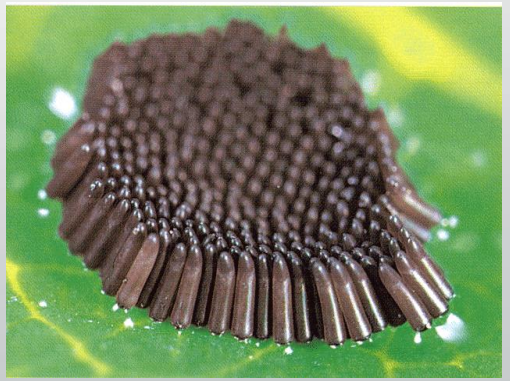
Aedes

Culex

Mosquito Eggs

- Oviposition- process of laying eggs
  - Single eggs or in rafts (hundreds)
  - Site is species specific:
    - Brackish / fresh water
    - Permanent / temporary bodies of water
    - Containers (natural and man-made)
  - Eggs hatch soon after contacted by water
    - Under other ideal environmental conditions: temp, hours of sunlight, no predators
  - Most species over-winter in this stage
    - Eggs resist desiccation
    - Can remain in the environment for extended periods





Where Eggs are laid

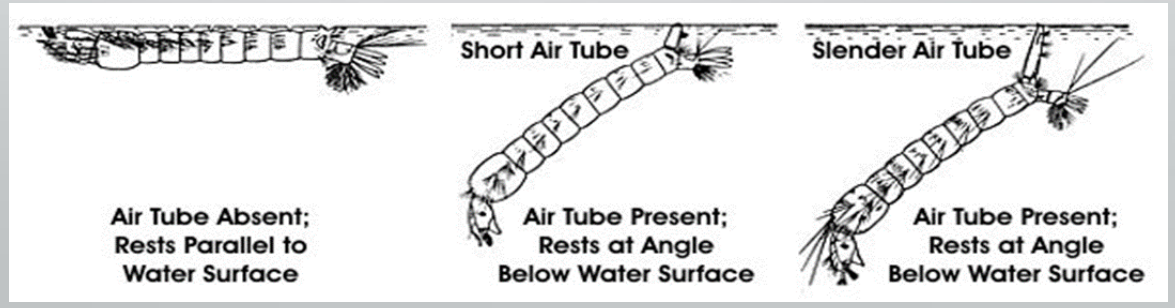
Mosquito Life Cycle

Eggs - Larvae - Pupae - Adults

Anopheles

Aedes

Culex

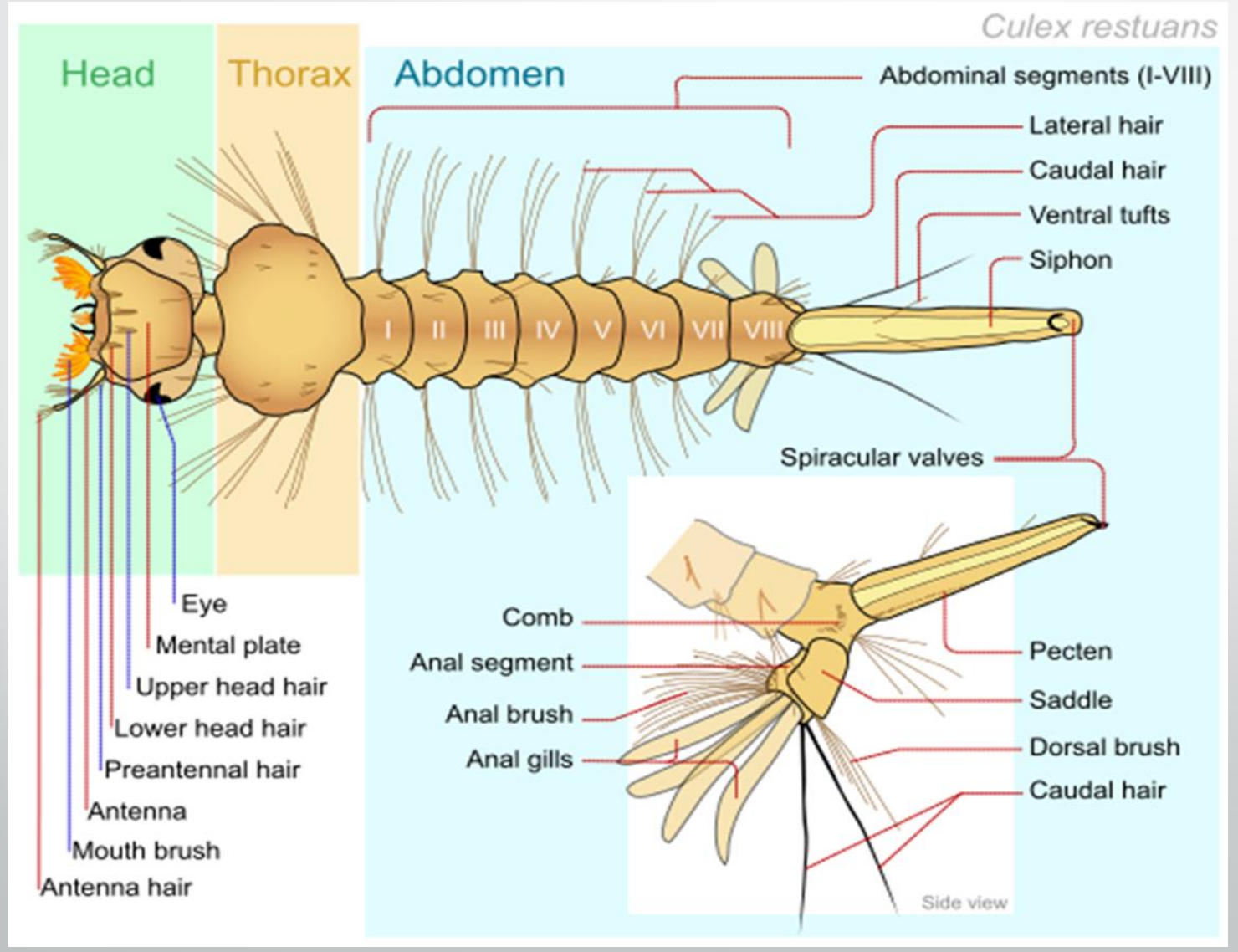


Mosquito Larvae

- Four larval stages or instars
  - Developmental stage between each molt
- Most are Filter feeders
  - Feeds almost continually on particulate material in the water
  - Some are predatory
  - Latter part of the 4th instar they stop eating
- Need access to air at the water surface
  - Siphon/Air tube
- Can exist in this stage from 3 days to overwinter

Larval Surveillance

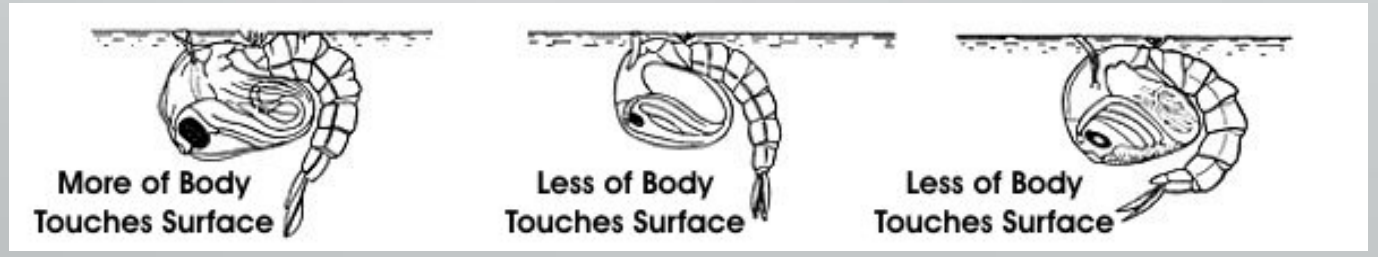
Mosquito Larvae Morphology



Mosquito Life Cycle

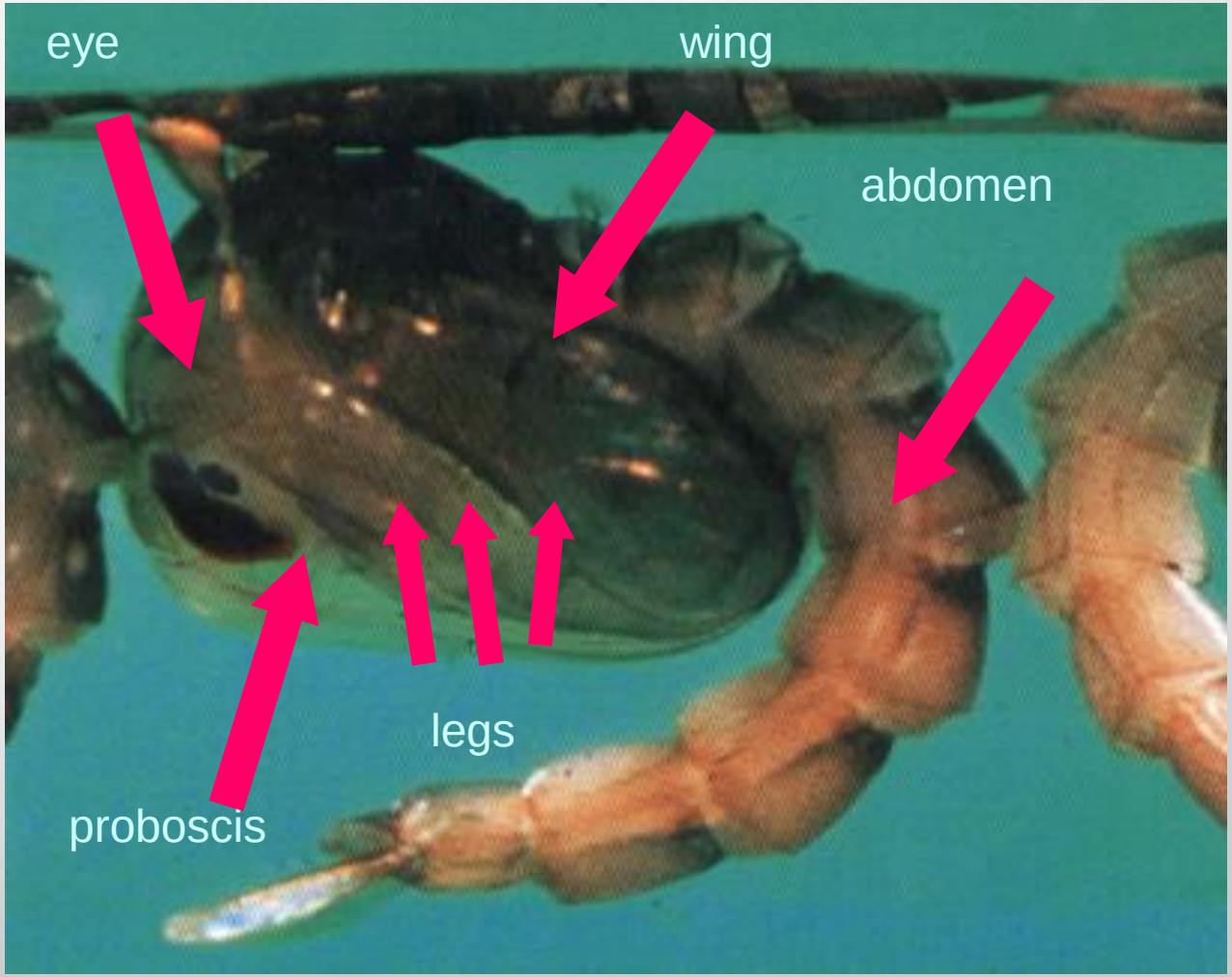
Eggs - Larvae - Pupae - Adults

Anopheles *Aedes* *Culex*



Pupal Stage

- Active stage: tumbles through the water column
- No eating
- Surface breathing via tubes called “trumpets”

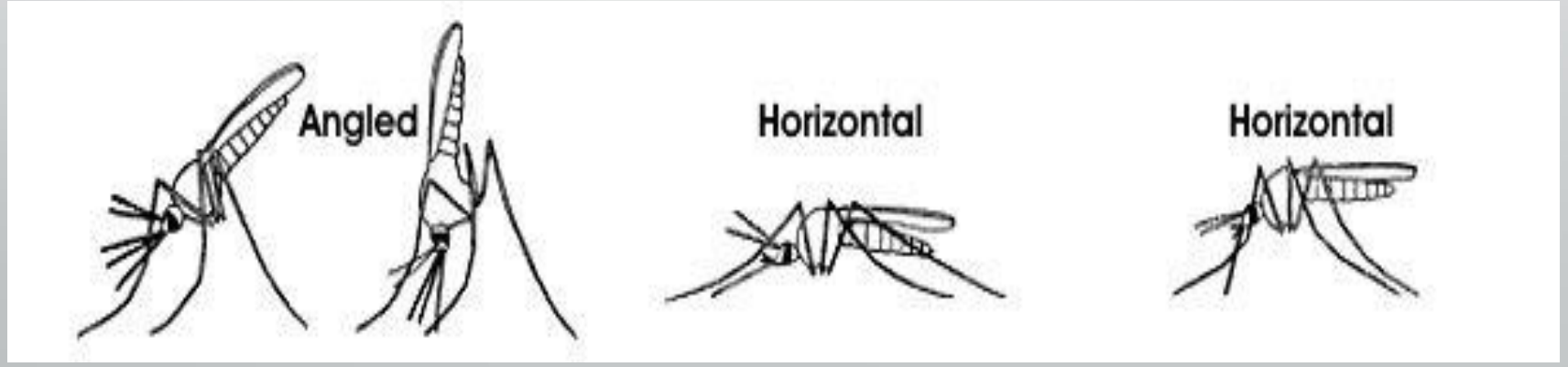


Emerging Adult Mosquito

Mosquito Life Cycle

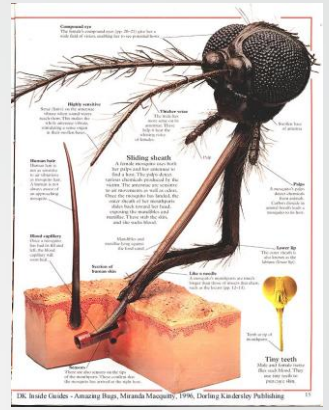
Eggs - Larvae - Pupae - Adults

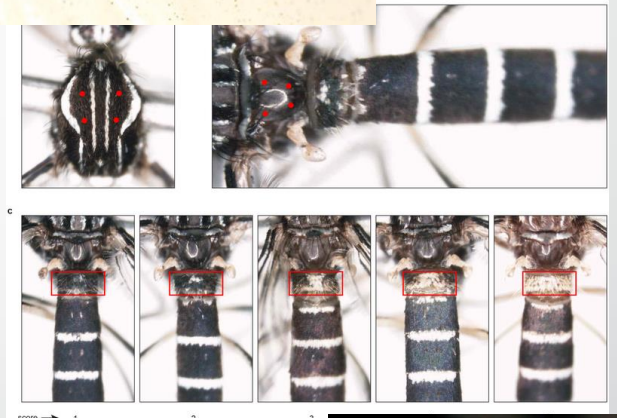
Anopheles *Aedes* *Culex*

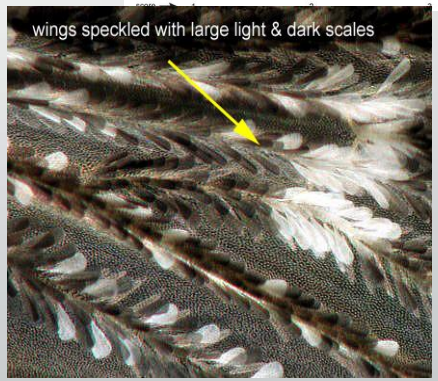


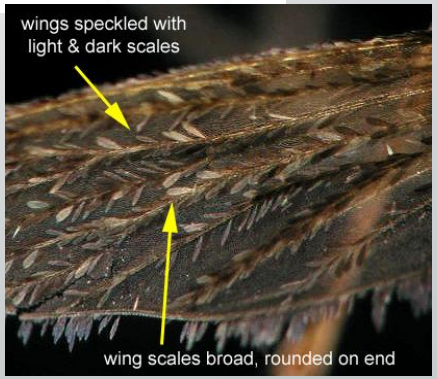
Adult Mosquitoes

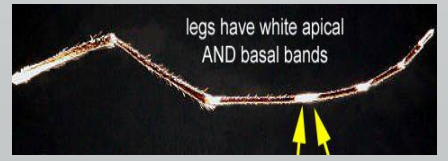
- Differences in scale patterns seen within and between species
  - Helps with identification
- Mouthparts modified into piercing-sucking proboscis
  - Both Males and Females get their calories from nectar and plant juice
  - Only females take blood meals
  - Not all mosquito species take blood meals
- Attracted to CO_2, temperature, moisture, color, movement, and host body chemistry
- Variety of adult lifespans
  - 2 to 3 weeks
  - Some over winter as adults, live 6 to 8 months

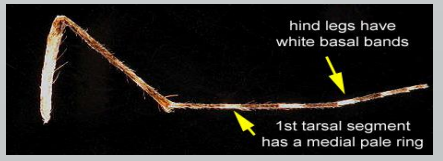












Adult Mosquito Behavior

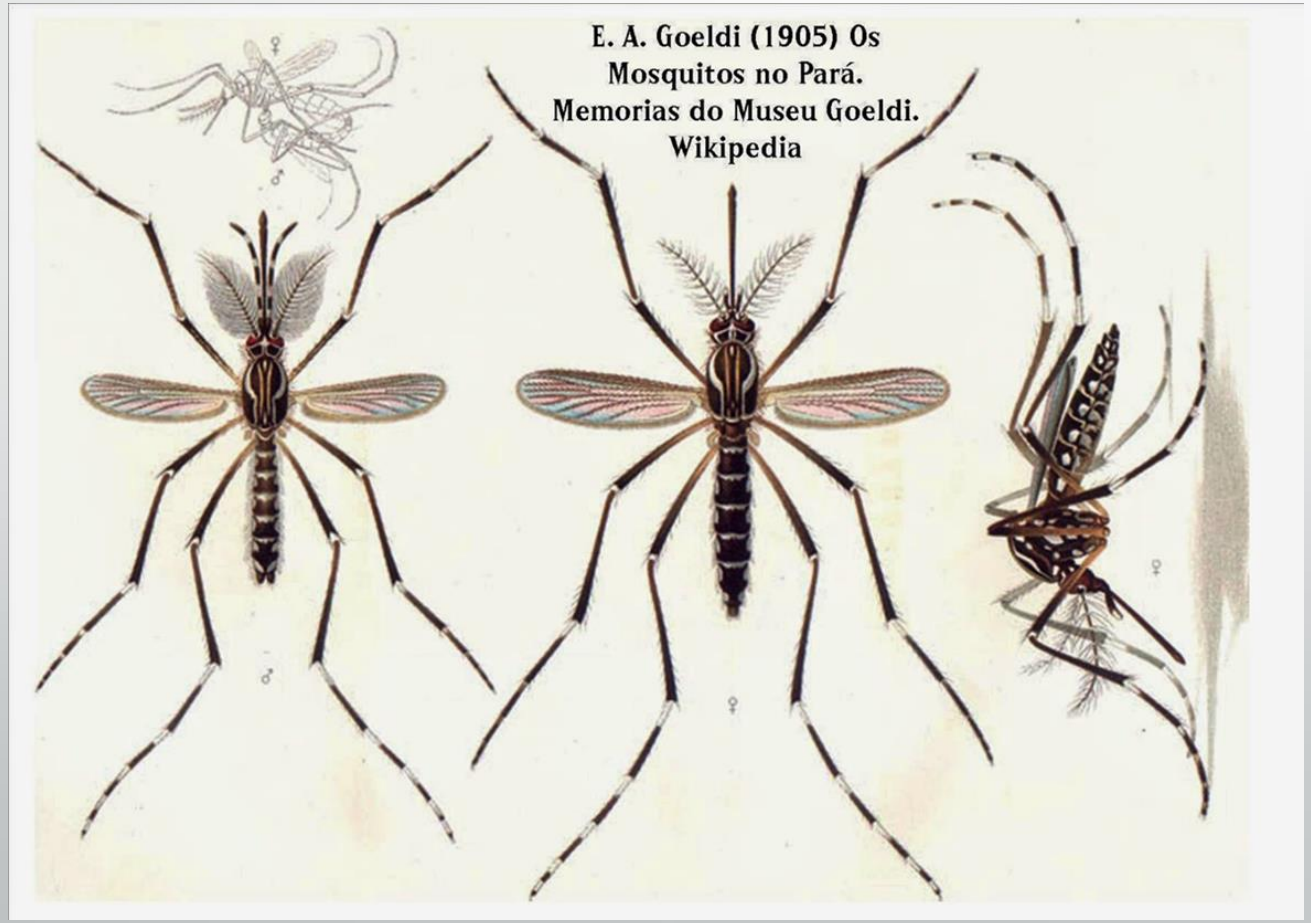
- Flying distances of adult female mosquitoes will vary with species
  - *Aedes albopictus:* Less than 300 feet
  - *Aedes sollicitans:* 20 miles or greater (over 100 miles recorded)

Adult Mosquito Blood Feeding Behavior

- Host preference varies with each species
  - Some prefer a certain group of animals (birds, mammals, reptiles, etc.)
  - Some prefer more specific hosts (cattle, horses, man, etc.)
  - Some are opportunistic or change preference throughout the season
  - Daytime vs nighttime biters

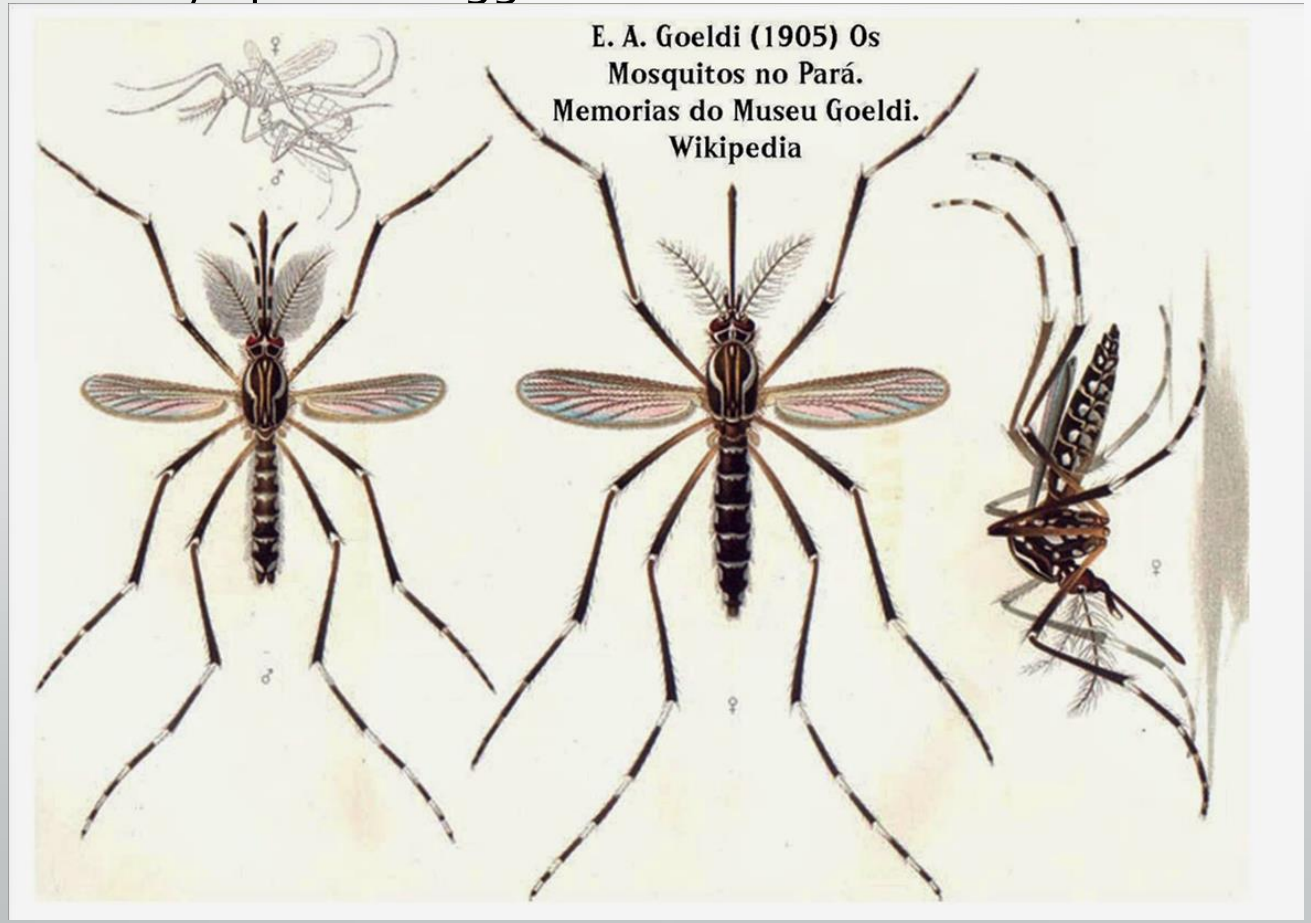
Adult Mosquitoes: Males vs Females

- Males emerge from pupal stage first (approx. 24h)
- Species have specific wing beat frequency
  - Males can identify female of same species with large antennae

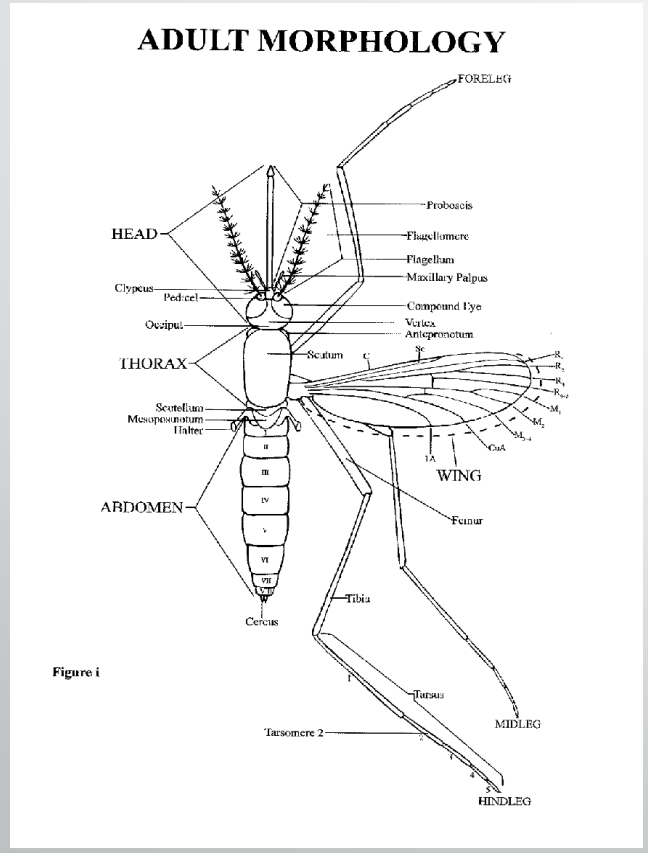


Adult Mosquitoes: Mating

- Males live long enough to breed
- Males recognize unmated females by pheromones
- Males produce mating plug-inhibits further mating and stimulates egg laying
- Females can lay up to 200 eggs with each blood meal



Mosquito Morphology



Head – Sensory

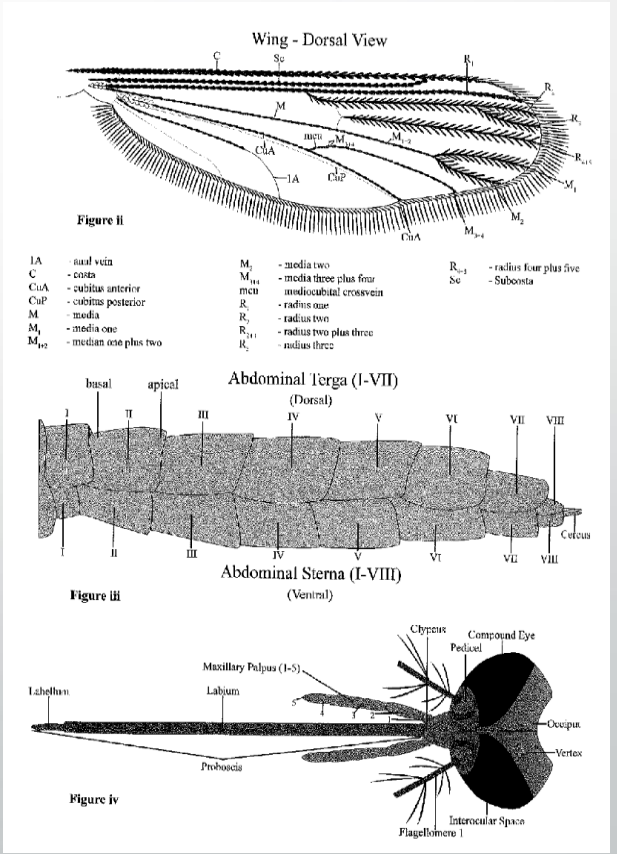
- Compound Eyes
- Antennae
- Palps
- Mouthparts (proboscis)

Thorax – Locomotion

- Legs
- Wings

Abdomen –Body Processes

- Digestion
- Excretion
- Reproduction



ADULT MORPHOLOGY

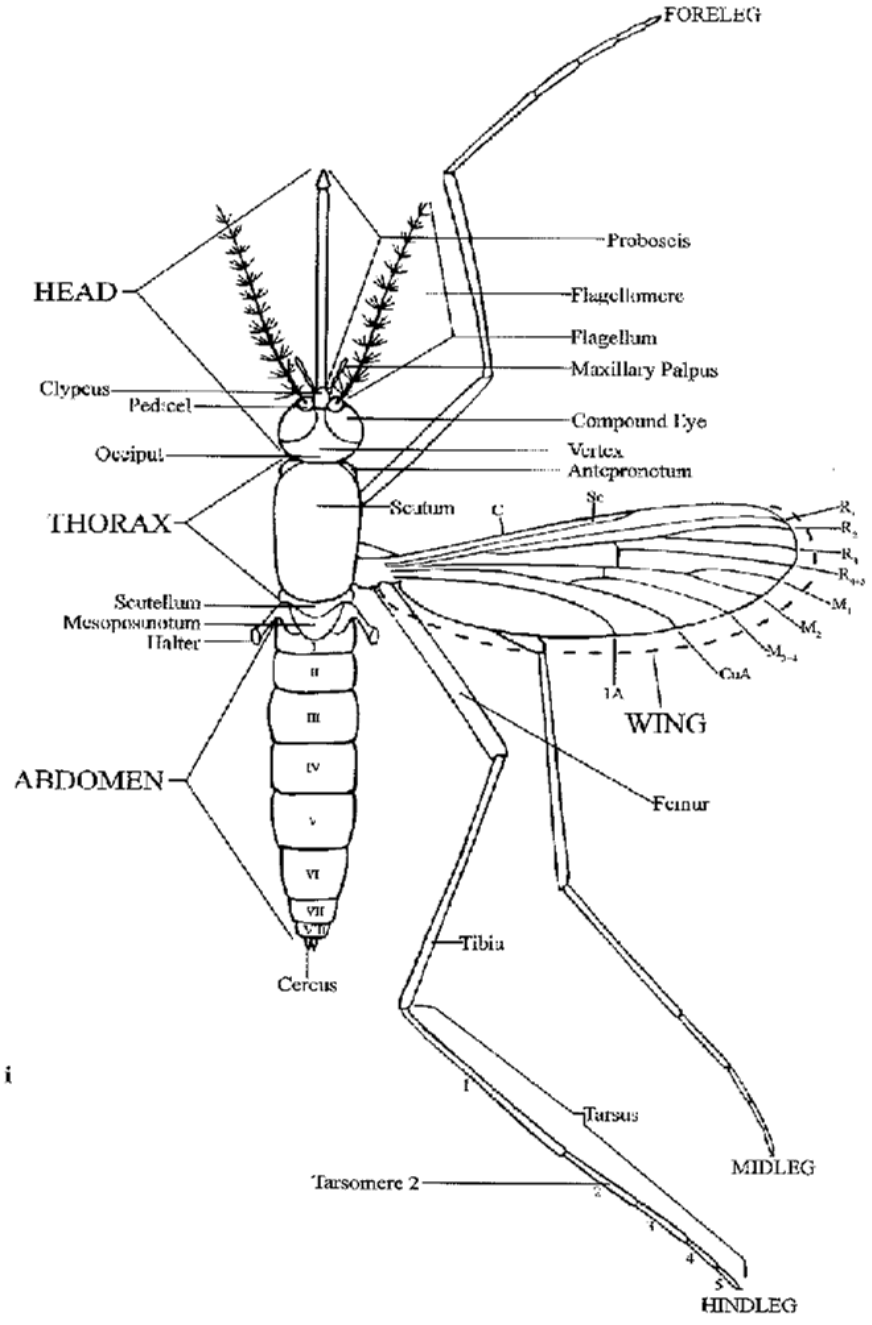
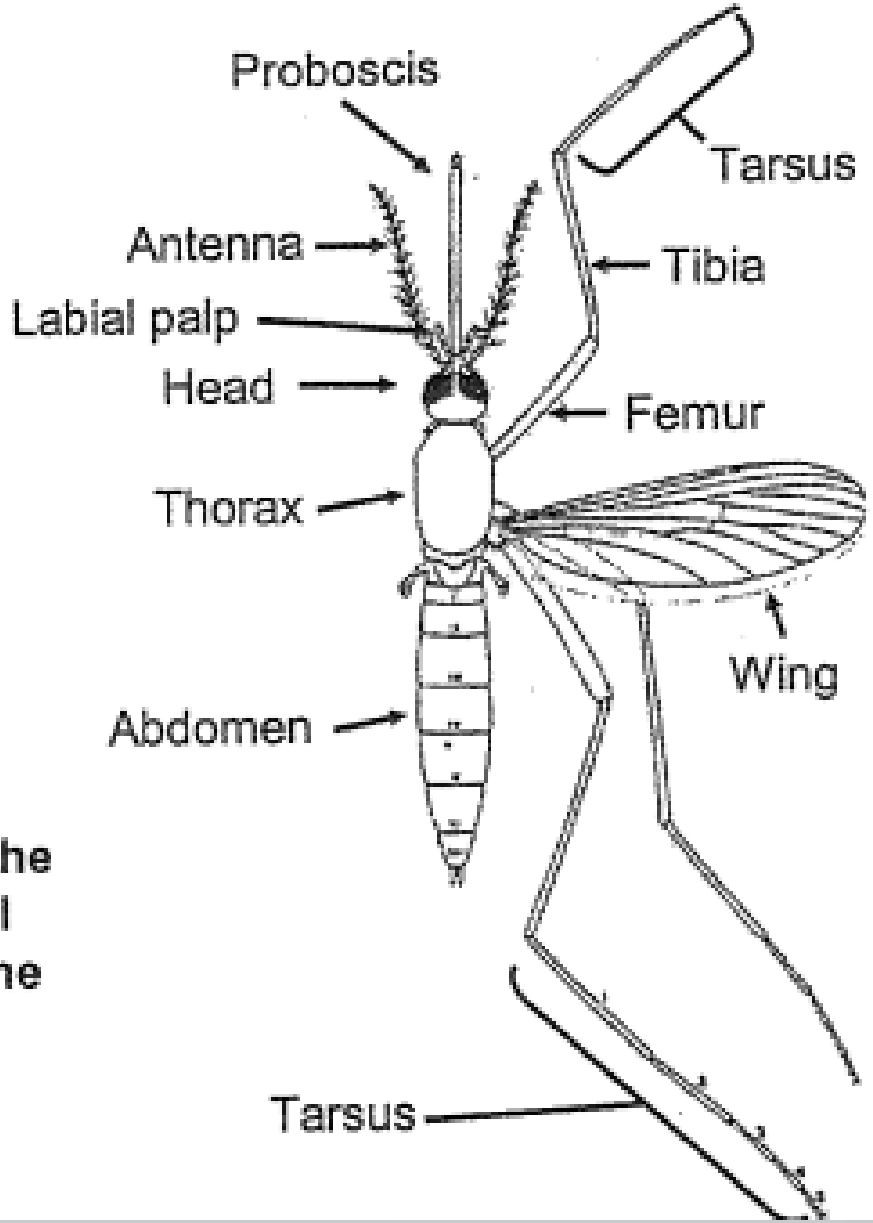


Figure i

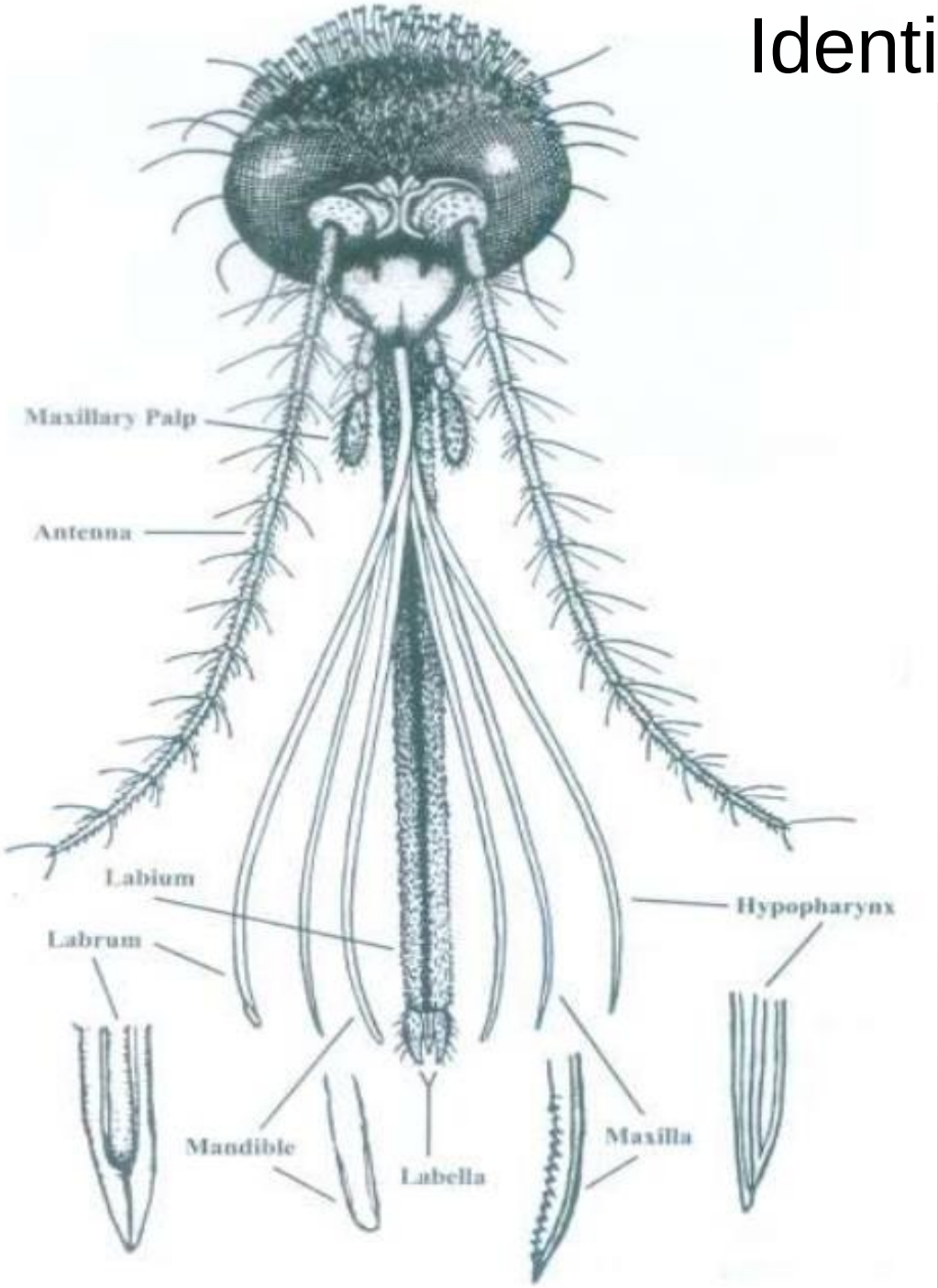
Pg. 25 in your ID books.

Important structures used for separating the mosquito genera and species

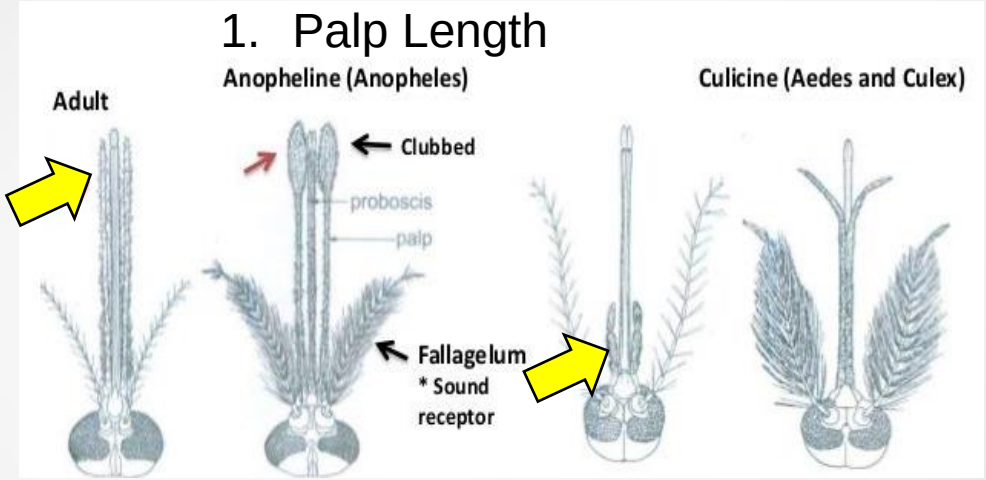


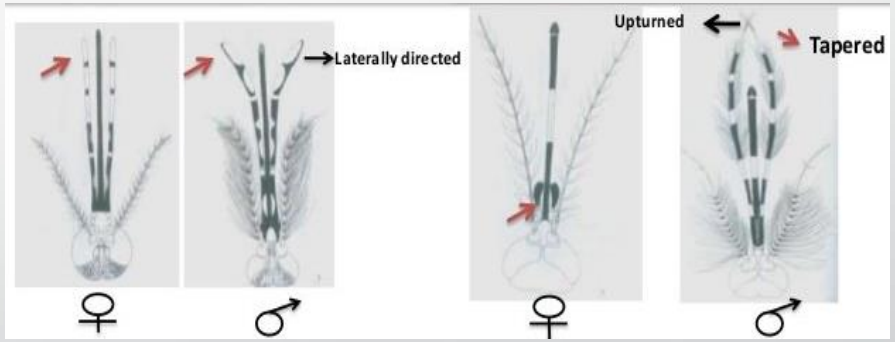
Aspects seen on many of the body parts listed here will be used to distinguish one mosquito genera and/or species from another.

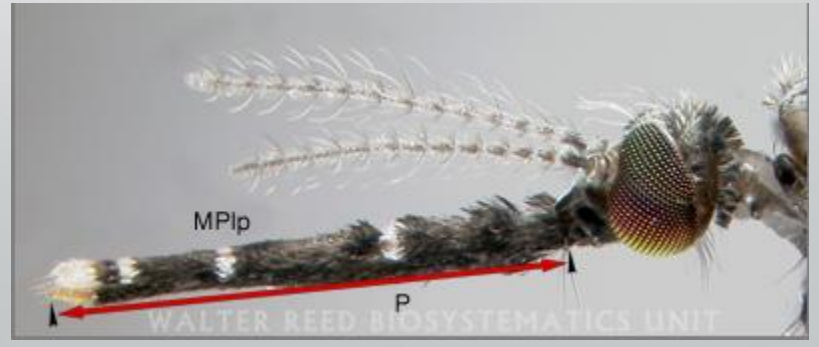
Identification Characters (Head)



1. Palp Length

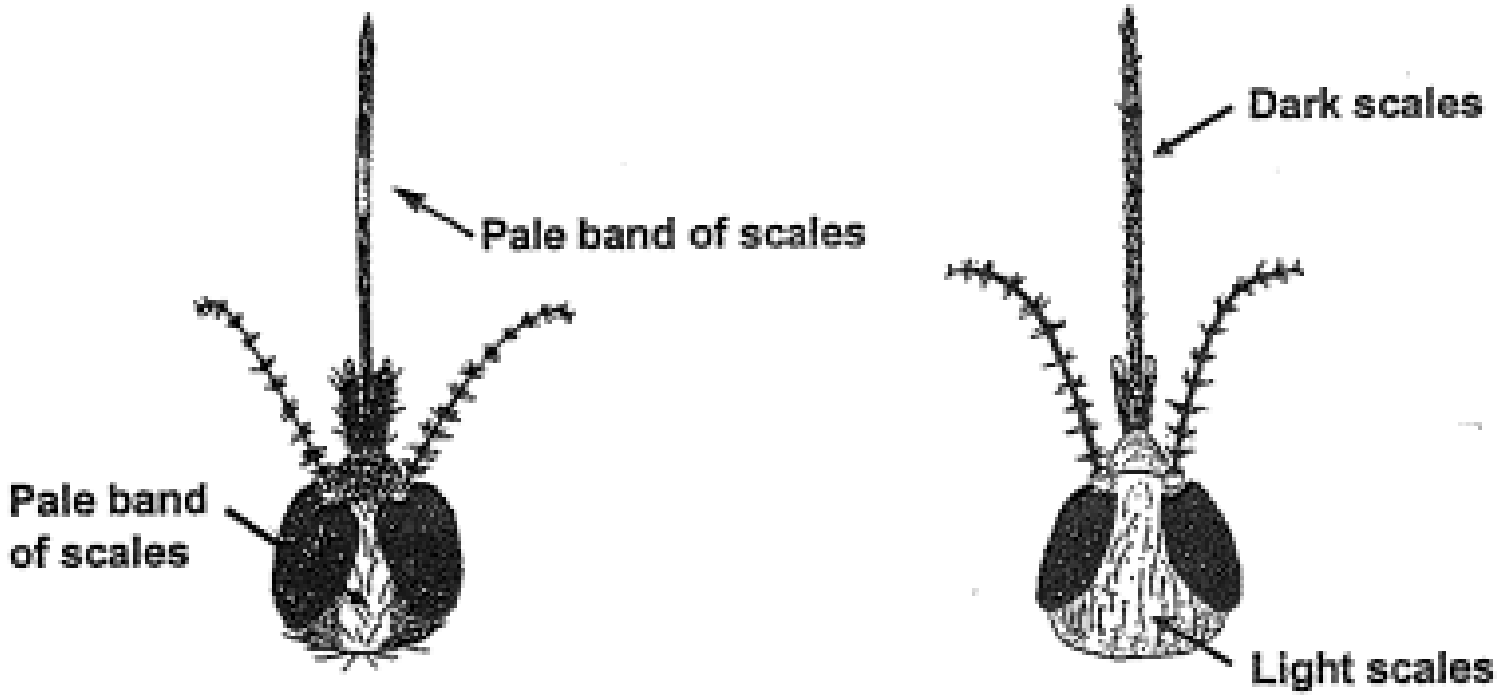






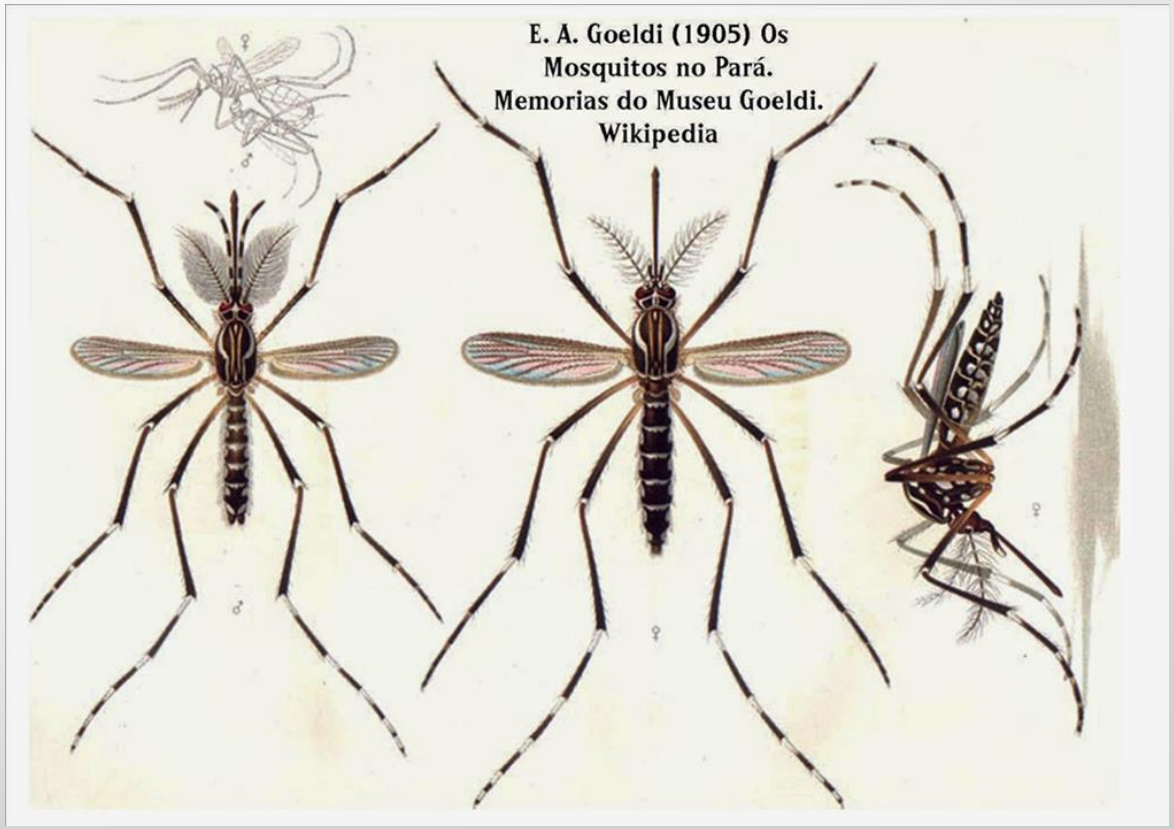
Important characters used for separating mosquito species

Coloration and pattern of scales on the head, proboscis and palps are used to distinguish between different mosquito species.

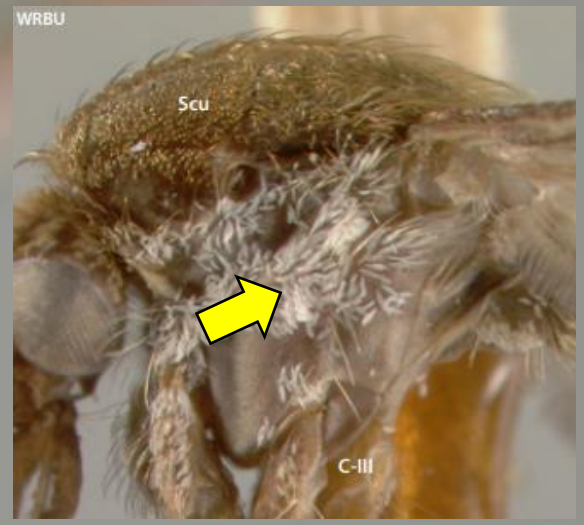


Toxorhynchites rutilus female

Toxorhynchites rutilus male



Identification Characters (Thorax)



Scutum

Scutum – scales & setae

(scale size, aggregation, location)

Pg.27 in your ID books

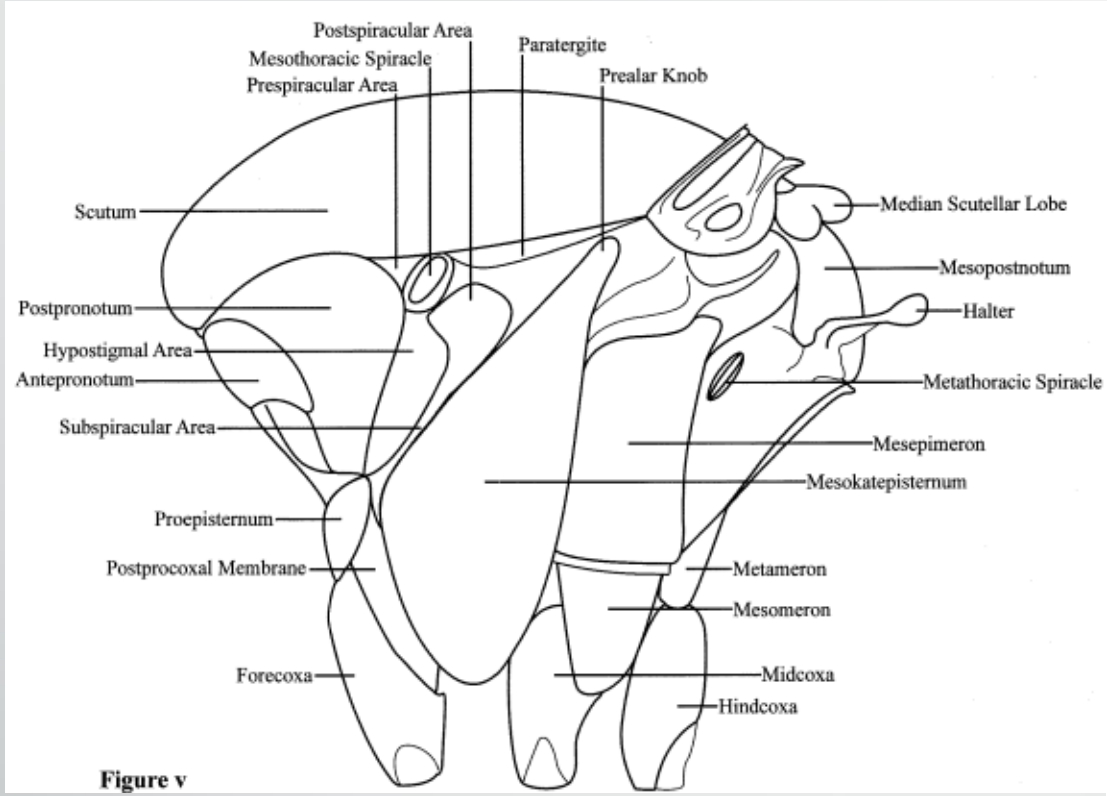


Figure v

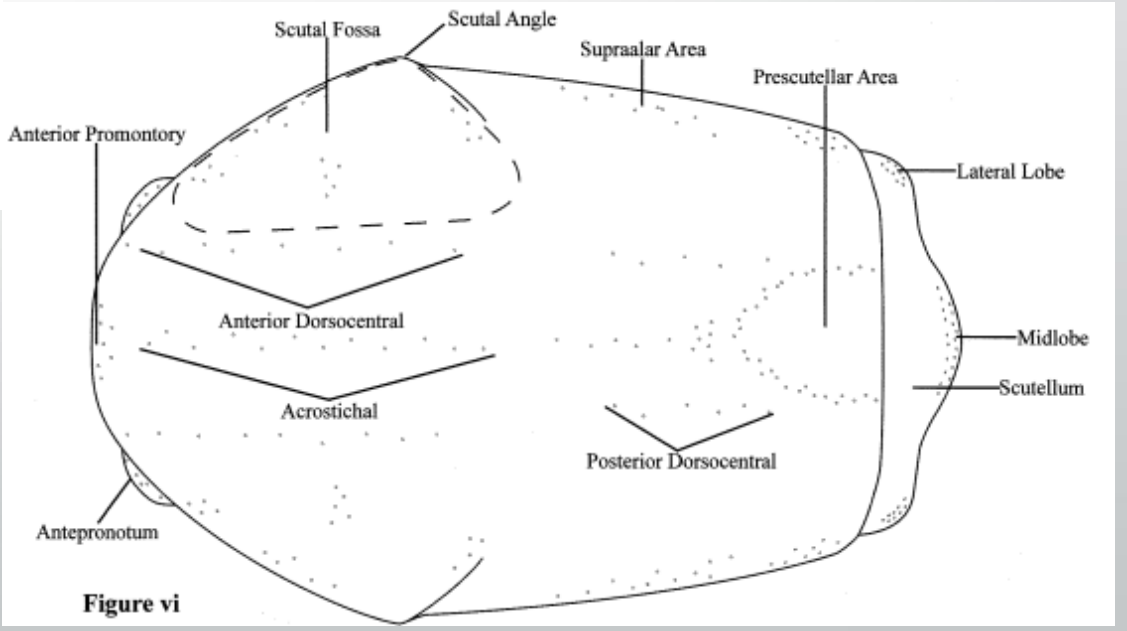
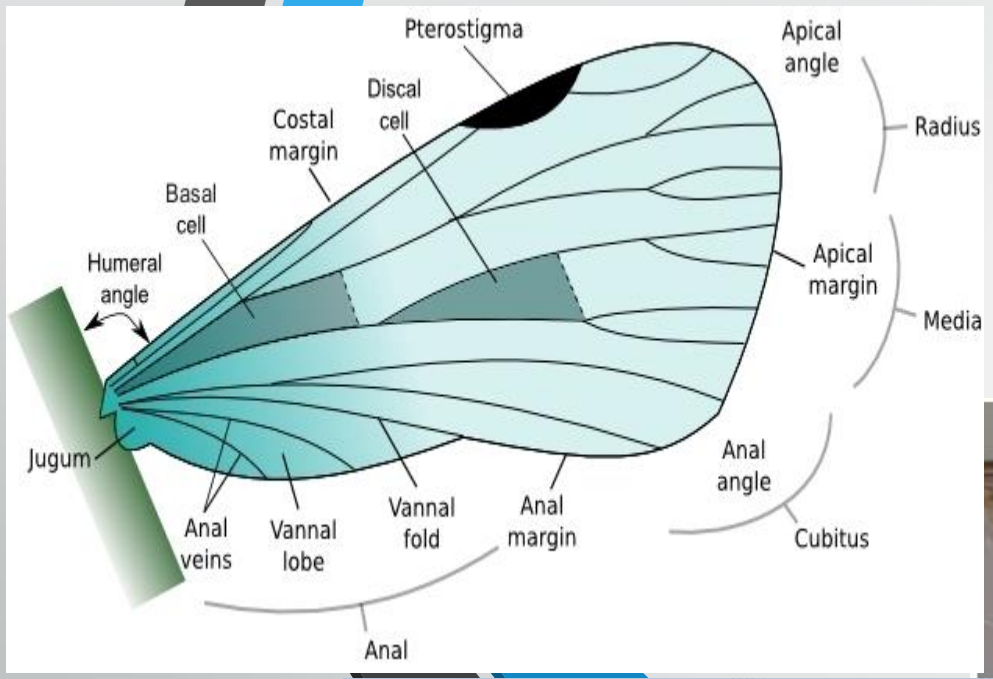
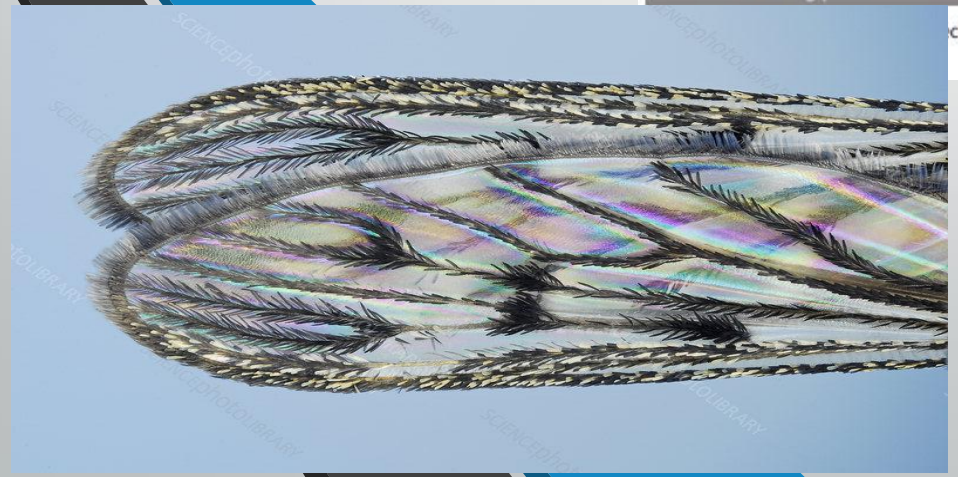


Figure vi

Identification Characters (Thorax)

Wings





Wing Scales?

Fig. 5. Wing with scales

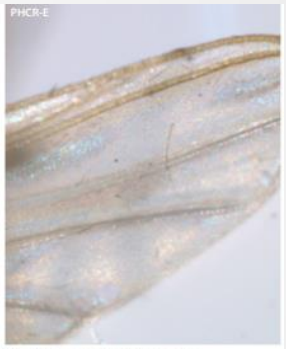
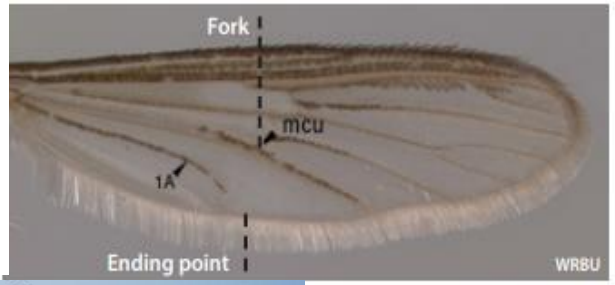


Fig. 6. Wing usually without scales

Wing Veins



ction (fork) of mcu: *Uranotaenia spp.*

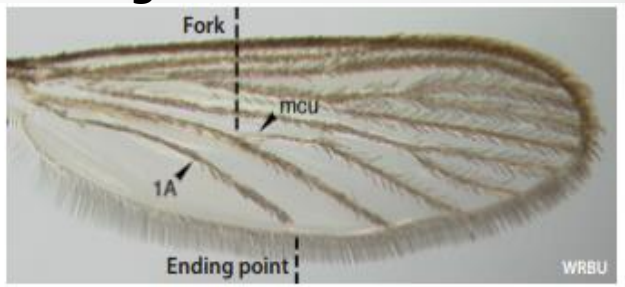


Fig. 26. Vein 1A ending beyond intersection (fork) of mcu: *Culex spp.*

Wing Bristles

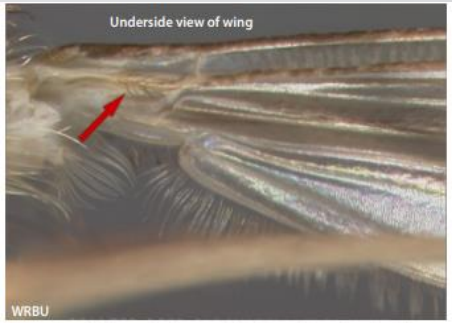


Fig. 31. Base of subcostal with a row of bristles on the underside: *Culiseta morsitans*

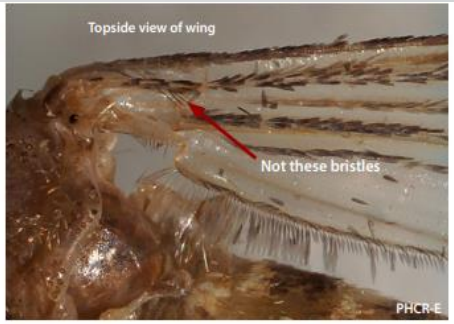


Fig. 32. Base of subcostal without a row of bristles on the underside. Do not mistake bristles found on the top side of the wing for this feature: *Culex quinquefasciatus*

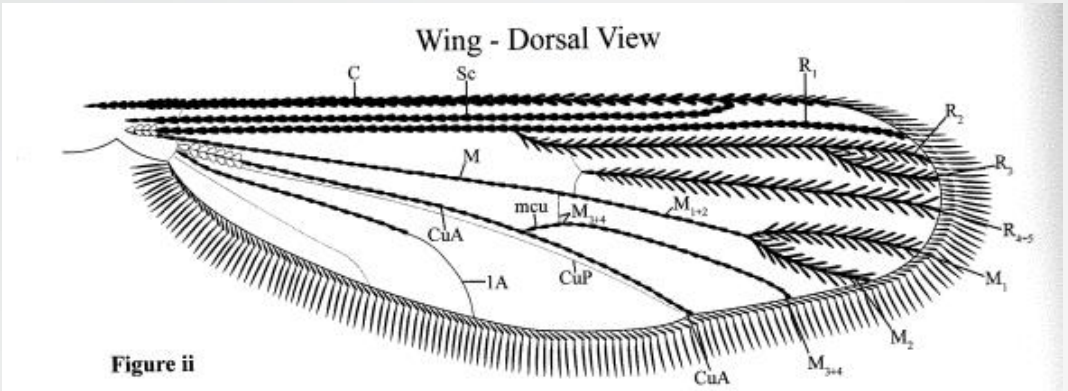


Figure ii

1A	- anal vein	M_2	- media two	R_{4+5}	- radius four plus five
C	- costa	M_{3+4}	- media three plus four	Sc	- Subcosta
CuA	- cubitus anterior	mcu	- mediocubital crossvein		
CuP	- cubitus posterior	R_1	- radius one		
M	- media	R_2	- radius two		
M_1	- media one	R_{2+3}	- radius two plus three		
M_{1+2}	- median one plus two	R_3	- radius three		

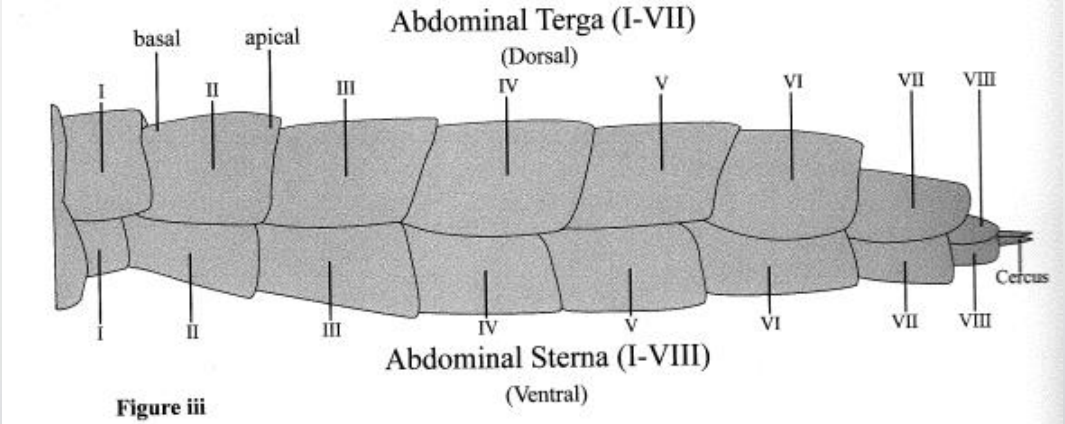


Figure iii

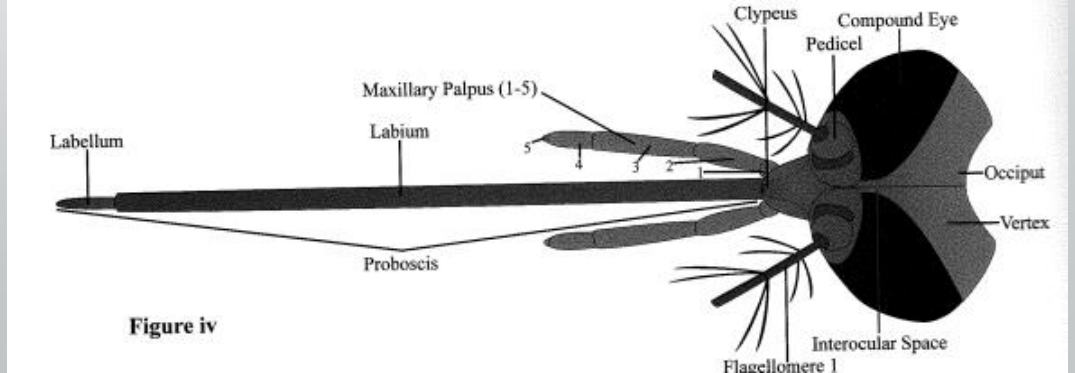
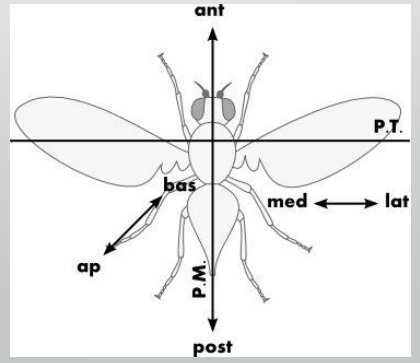


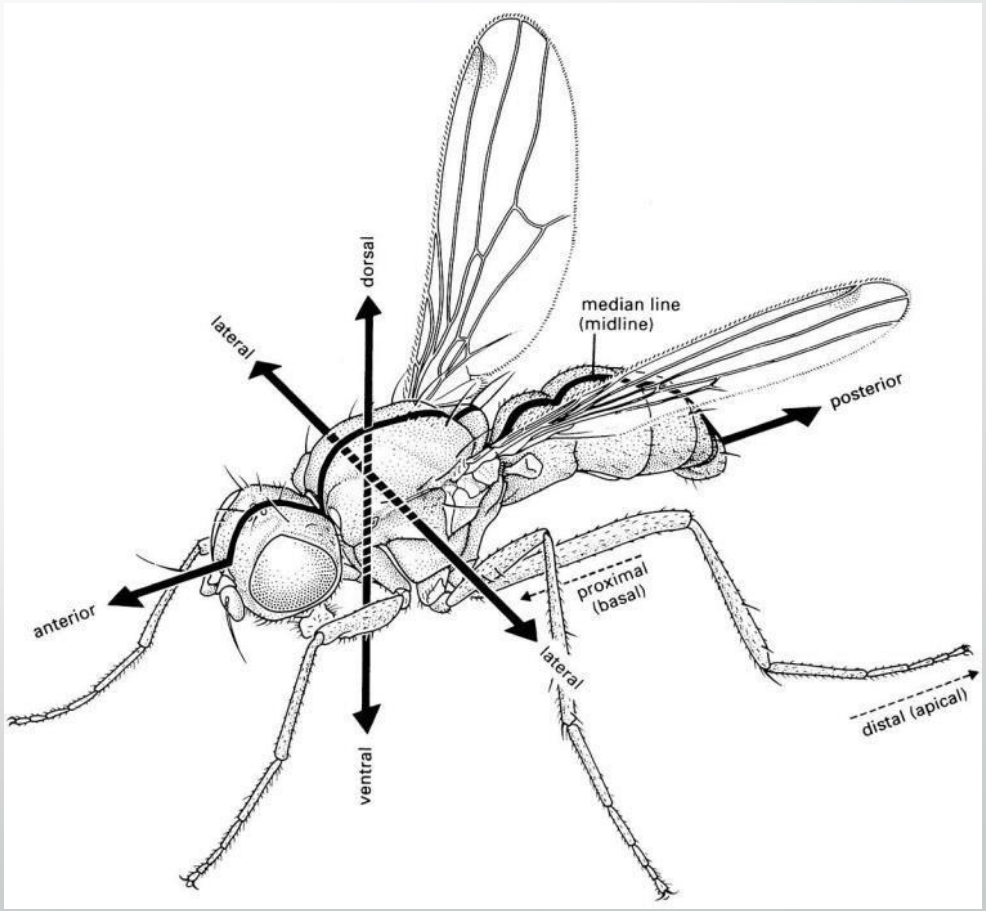
Figure iv

Pg. 26 in your ID book

Terms to know for Morphology

- Dorsal – Top portion
- Ventral – Bottom portion (underside)
- Lateral – Side
- Apical – Away from the body
- Basal – Towards the body
- Anterior – Head end
- Posterior – Tail end





Identification Characters (Thorax)

3. Legs

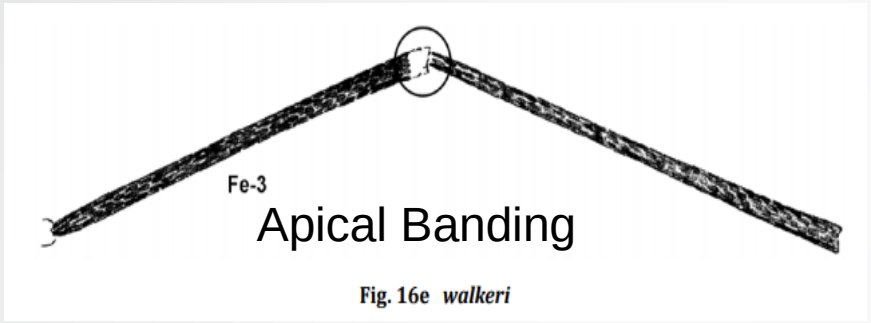
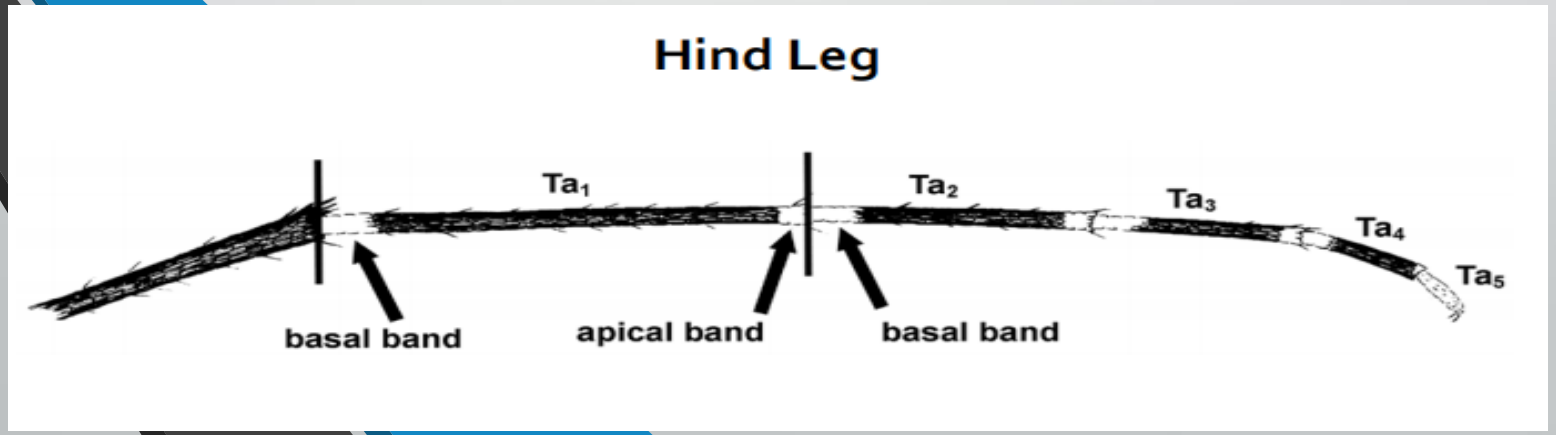


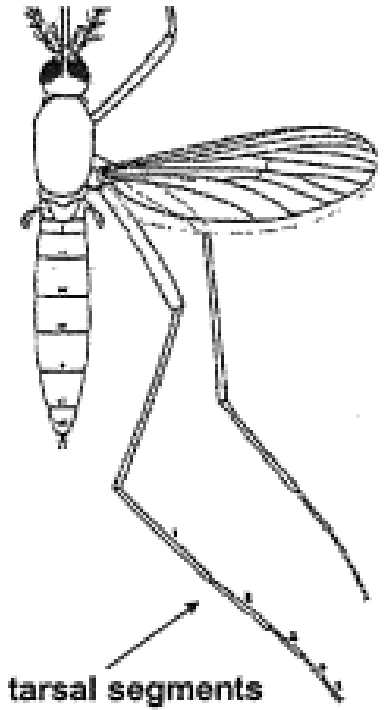
Fig. 16e *walkeri*

Fig. 16f *atropos*



Important characters used for separating mosquito species

The scales on mosquito legs can be all one color or can be light and dark creating a banding pattern.



Banding patterns are most frequently seen on the five tarsal segments at the end of each leg.

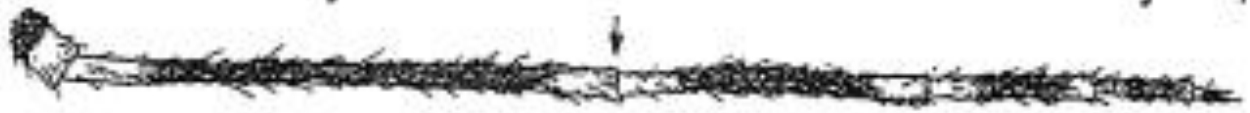
Un-banded tarsal segments

Banded tarsal segments

Important characters used for separating mosquito species

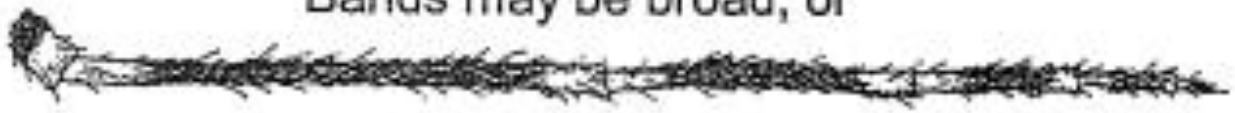
Banding patterns on legs vary considerably between species.

Bands may occur on both sides of each tarsal joint, or



bands may occur on only one side of each tarsal joint.

Bands may be broad, or



bands may be narrow

Identification Characters (Abdomen)

1. Shape

Round & Blunt

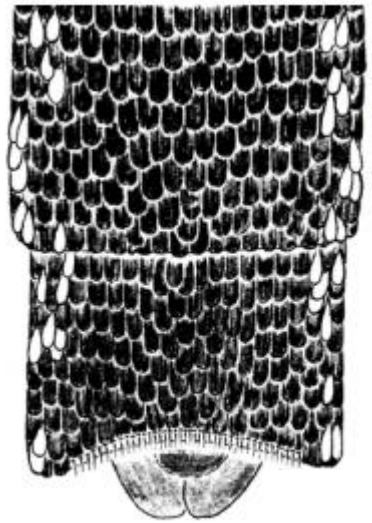


Fig. 33. Abdomen blunt, dorsal view: *Mansonia titillans*

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: *Coquillettidia perturbans*

Fig. 38. Abdomen blunt, lateral view: *Coquillettidia 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*

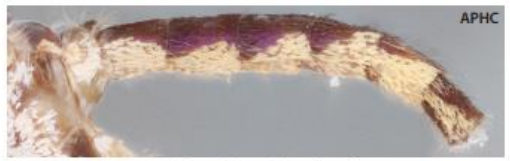


Fig. 42. Abdomen pointed, lateral view: *Psorophora ferox*

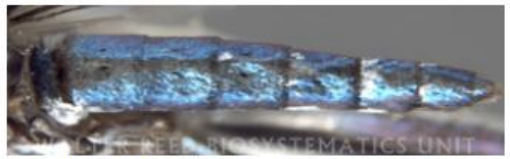


Fig. 43. Abdomen pointed, dorsal view: *Haemagogus mesodentatus**

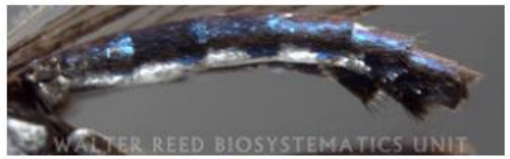
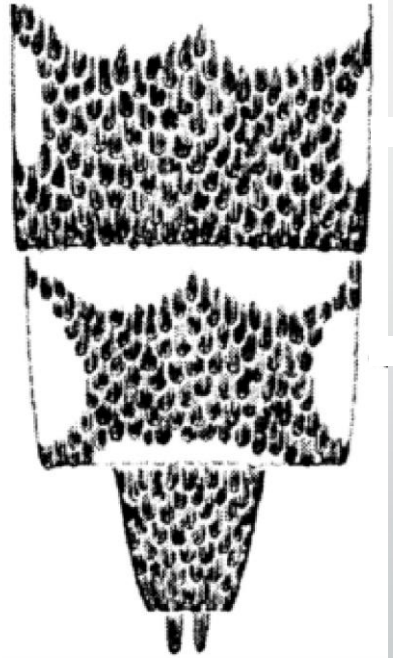


Fig. 44. Abdomen pointed, lateral view: *Haemagogus mesodentatus**

Pointed at Tip



Identification Characters (Abdomen)

2. Banding

Apical
or
Apical-lateral

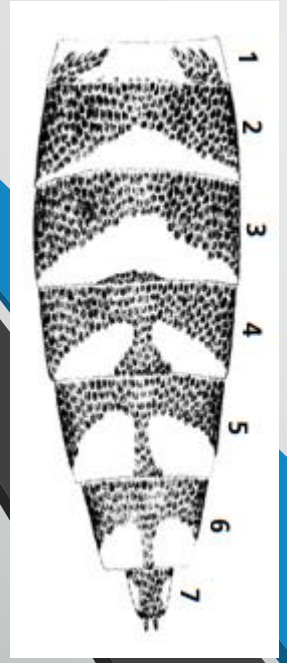


Fig. 33. Abdomen blunt, dorsal view: *Mansonia titillans*

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

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

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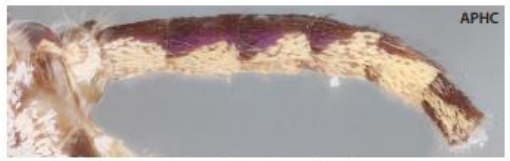


Fig. 42. Abdomen pointed, lateral view: *Psorophora ferox*

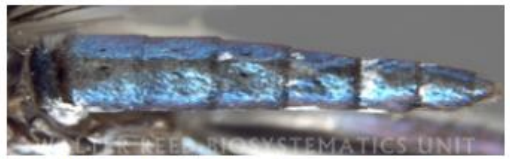


Fig. 43. Abdomen pointed, dorsal view: *Haemagogus mesodentatus**

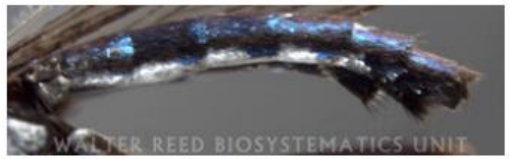
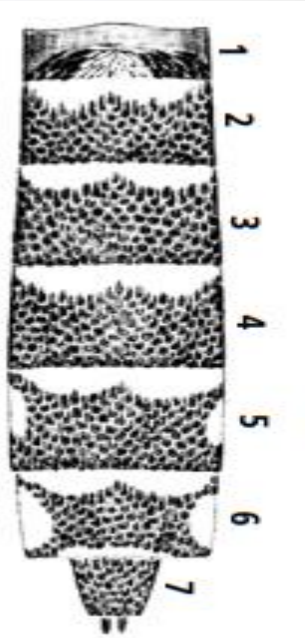


Fig. 44. Abdomen pointed, lateral view: *Haemagogus mesodentatus**

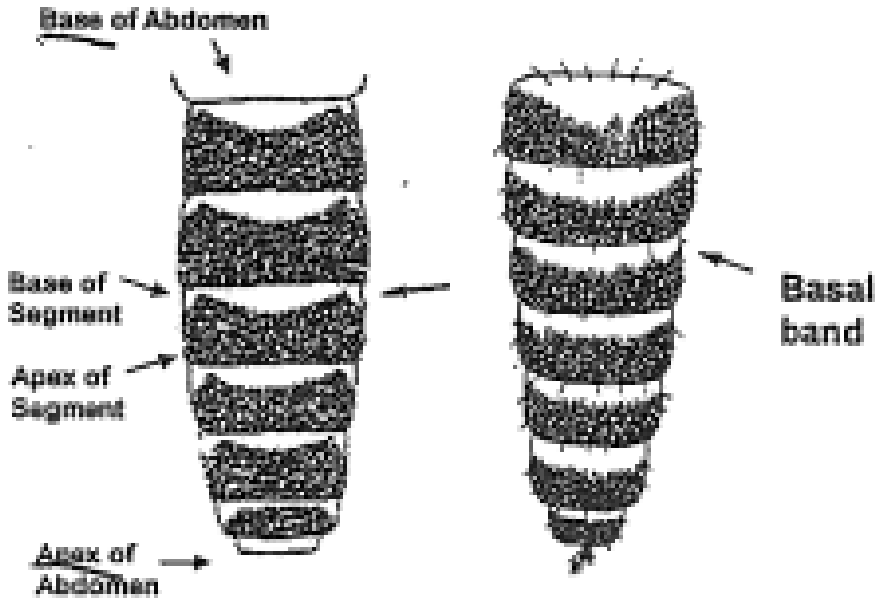
Basal
or
Basal-lateral



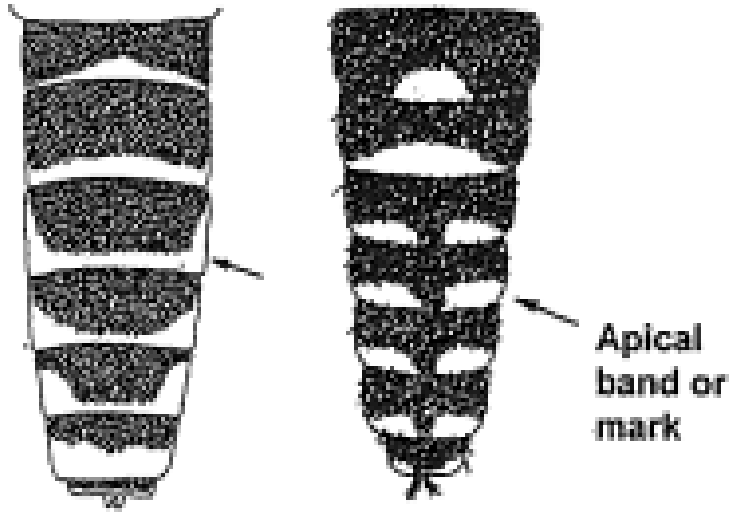
Important characters used for separating the mosquito genera and species

Abdomen (top view):

The position and color of scales on a mosquito's abdomen is commonly used to differentiate mosquito genera and species.



Pale markings or bands at the base of abdominal segments



Pale markings or bands at the apex of abdominal segments

Mosquito Trapping

Why do we trap?

- Monitor fluctuations of mosquito populations
- Test for diseases, primarily West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE)
- In order to reduce the mosquito population to make life more comfortable for citizens
- Have a better understanding of where to look for larval habitats, based off adult catches
- Collect data
- Find new species in the area

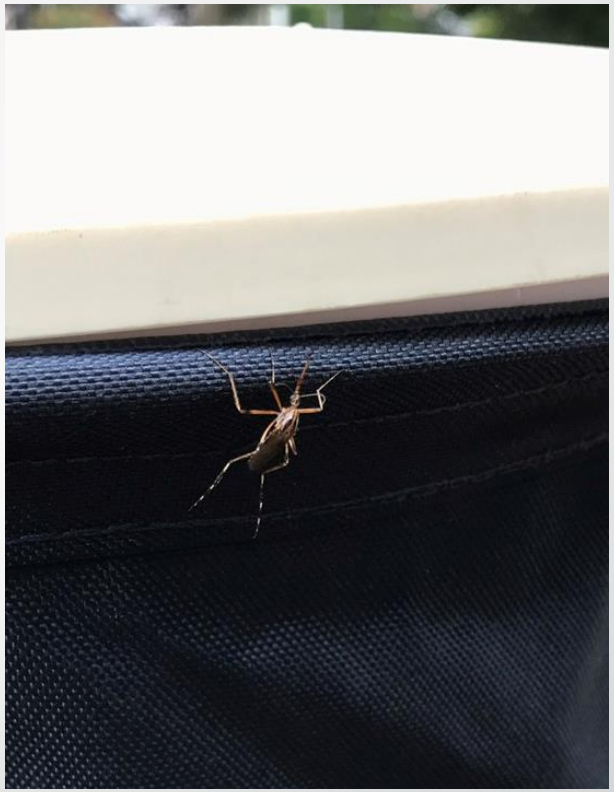
What do traps collect?

- Traps are designed to catch adult female mosquitoes
- You may also catch male mosquitoes, moths, spiders, midges, crane flies, etc.

Mosquito Trapping

Where do we trap?

- Areas close to mosquito larval habitats
  - **Woods with woodland pools**
  - **Salt marshes**
  - **Urban areas**, near containers with standing water
- At **pump stations** which attract *Culex pipiens* and *Culex restuans*
- Somewhere **hidden** to avoid interference from the public
- In **shaded areas** where mosquitoes tend to rest during the day



When do we trap?

- Usually **April through October**
  - This can vary depending on your area and the weather conditions
- Traps are usually out in the field for **16 to 24 hours**
  - Usually set in afternoons and picked up the following morning

Surveillance- Adult Mosquito Traps

CO_2 baited **CDC Trap**

Attracts blood seeking females

- CO_2 and light bulb
- Collects variety of species
- *Cs. melanura*- EEEV vectors

BG Trap

Attracts blood seeking and container Breeders

- CO_2 and BG lure
- Wide variety of species
- *Aedes albopictus*

Gravid Trap

Attracts females Seeking Oviposition sites

- *Culex* pipiens and Culex restuans – WNV vectors

Adult Surveillance

CDC Light Trap

BG Sentinel Trap

Gravid Trap


10/17/2017


Mosquitomist®
and ANVIL®

Mosquito-borne Diseases

- Eastern Equine Encephalitis (EEE)
- West Nile Virus (WNV)
- La Crosse Encephalitis
- St. Louis Encephalitis
- Chikungunya (CHIKV)
- Zika Virus
- Malaria
- Dengue
- Dog Heartworms

West Nile Virus

- 70-80% people non-symptomatic
- 20-30% people have fever, mild flu
- Less than 1% have severe symptoms

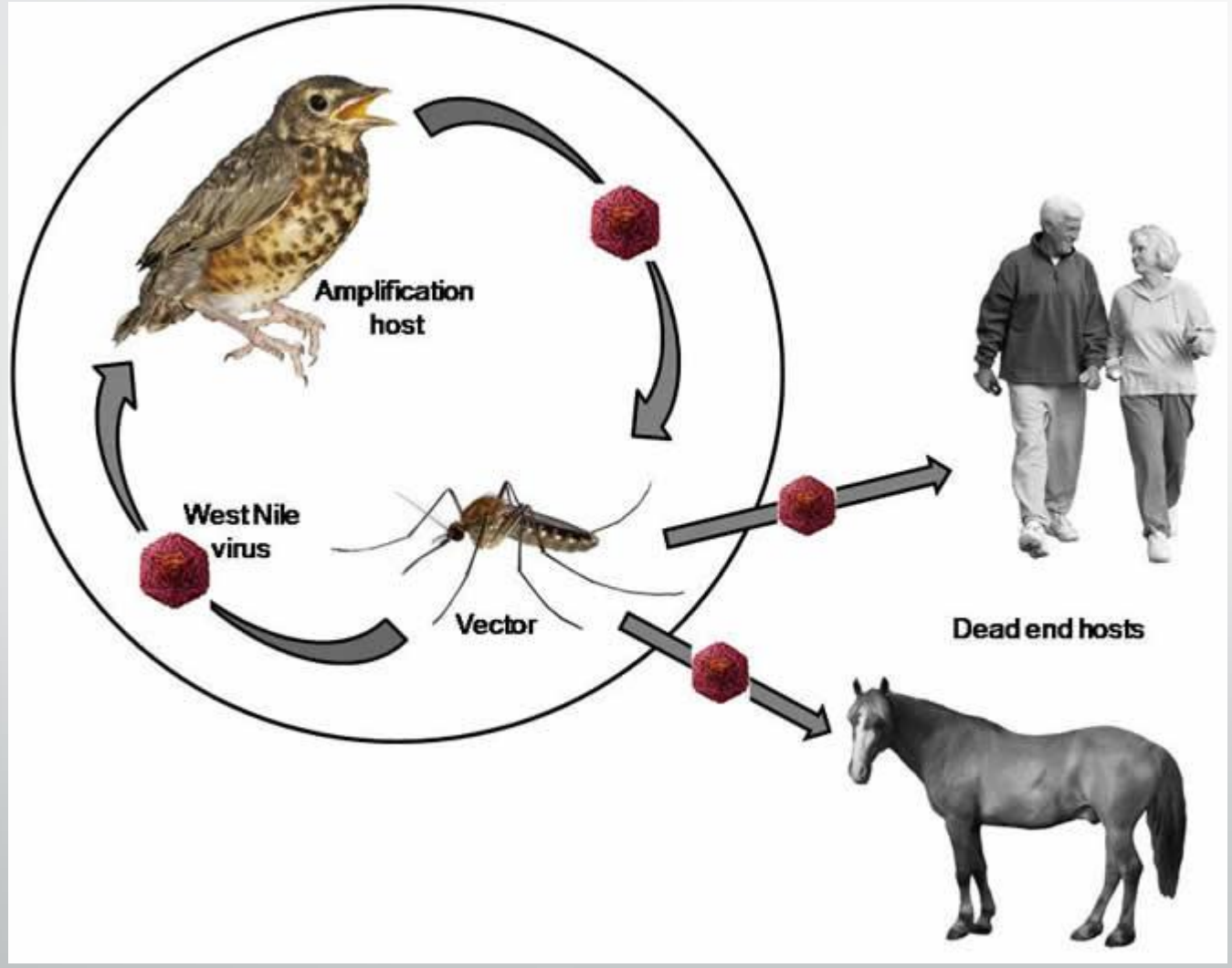
- Affect Horses if not vaccinated
- Symptoms: stumbling, impaired coordination, weak limbs, quick onset
  No fever

Eastern Equine Encephalitis

- Mainly affects Horses
- Horse Vaccines are readily available
- Symptoms: stumbling, impaired coordination, weak limbs, quick onset, High fever.

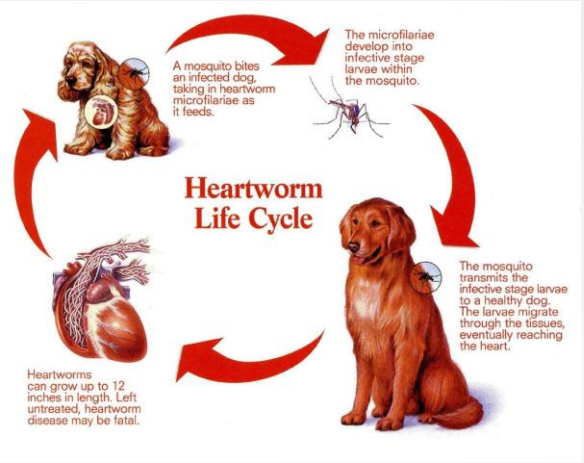
- Humans can be infected,
  33% of those infected exhibit signs of encephalitis

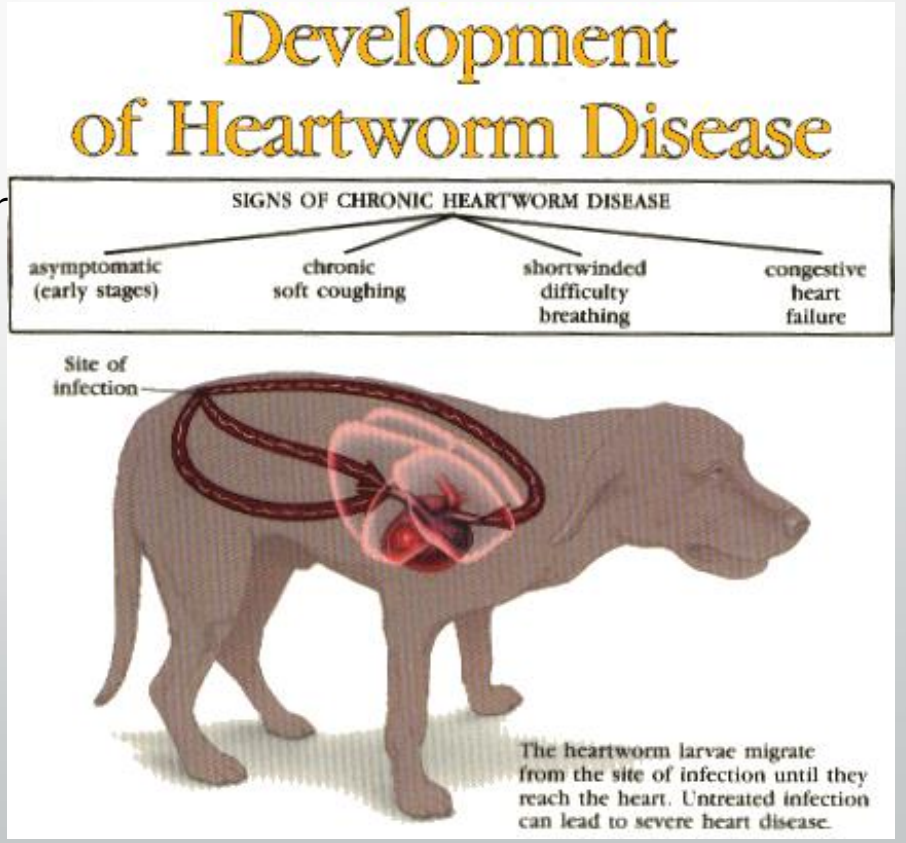
EEE and WNV Transmission Cycle

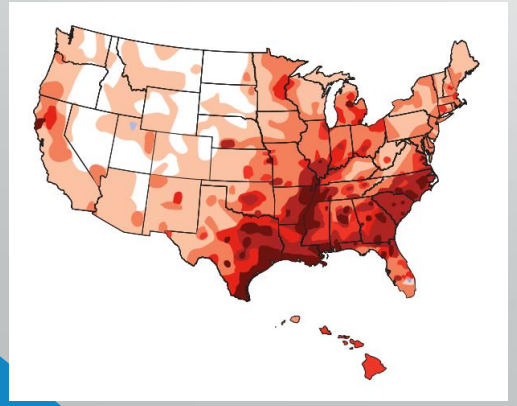


Dog Heartworm

- Heartworm is spread by mosquitoes that bite an infected host and then pass the parasite to another host during a blood meal.
  - Dogs, coyotes, foxes, cats…
- Mosquito vectors include species from *Aedes, Culex, Anopheles, Mansonia*
- Prevention medication readily available for both cats and dogs
- Once a dog is infected, treatment can be costly and long term effects can linger.

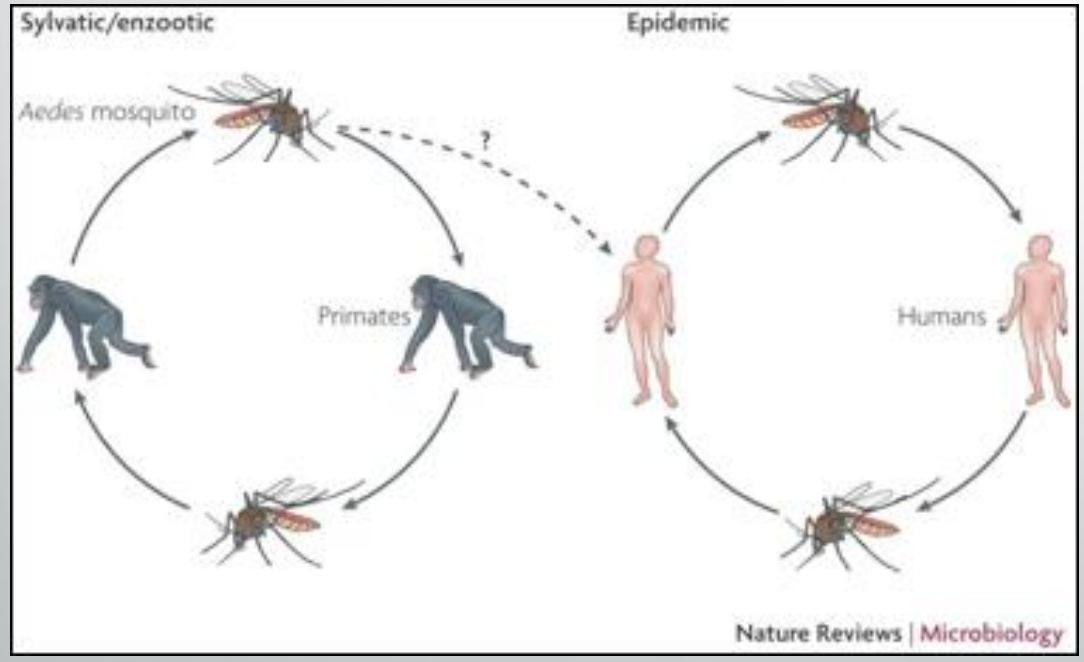






Chikungunya, Zika, and Dengue Viruses

Life Cycle



- New to the US in last decade or so
- Local Transmission cases in Florida, Texas and Caribbean islands
- Symptoms
  - Fever
  - Headaches
  - Muscle, bone, and joint pain
  - Sever cases can cause life long disabilities and sometimes death

Information provided by the CDC website

- La Crosse (LAC) virus is spread to people by an infected mosquito. Mosquitoes become infected when they feed on small mammals such as chipmunks and squirrels. The primary vector for LAC is *Aedes triseriatus* (the eastern tree hole mosquito). People are considered "dead-end" hosts.

- St. Louis encephalitis virus cycles between mosquitoes (primarily *Culex* species) and birds. Some infected birds can develop high levels of the virus in their bloodstream and mosquitoes can become infected by biting these birds. People become infected with the virus when mosquitoes feed on infected birds and then bite people. People are considered dead-end hosts.

- Dengue viruses are spread to people through the bite of an infected *Aedes* species (*Ae. aegypti* or *Ae. albopictus*) mosquito. Almost half of the world's population, about 4 billion people, live in areas with a risk of dengue. Each year, up to 400 million people get infected with dengue. Approximately 100 million people get sick from infection, and 40,000 die from severe dengue. Dengue is caused by one of any of four related viruses: Dengue virus 1, 2, 3, and 4. For this reason, a person can be infected with a dengue virus as many as four times in his or her lifetime.

- Chikungunya virus is primarily transmitted to people through the bite of an infected mosquito, mainly *Aedes aegypti* and *Aedes albopictus*. People are the primary hosts for chikungunya virus. Mosquitoes become infected when they feed on an infected person.

Information provided by the CDC website

- Malaria is a serious and sometimes fatal disease caused by a parasite that commonly infects *Anopheles* mosquitoes, which feeds on humans. People who get malaria are typically very sick with high fevers, shaking chills, and flu-like illness. Although malaria can be a deadly disease, illness and death from malaria can usually be prevented. About 2,000 cases of malaria are diagnosed in the United States each year. The vast majority of cases in the United States are in travelers and immigrants returning from countries where malaria transmission occurs, many from sub-Saharan Africa and South Asia.

- Zika is spread mostly by the bite of an infected *Aedes* species mosquito (*Aedes aegypti* and *Aedes albopictus*). Zika can be passed from a pregnant person to their fetus and can cause birth defects. It can also be sexually transmitted. Its important to know that there has been no local Zika transmissions since 2018 in the continental United States.

Questions?

Big thanks to Wes, Mike, Janice, and Carla for letting me use parts of their presentations!