

Mosquito Biology

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Malaria Prevention, Control and Treatment
Spring Break 2018 (GH574)

Mosquitoes: world's deadliest animals



Outline

- Basic mosquito classification
- Mosquito morphology (adult)
- Life cycle
- *Anopheles*, the malaria mosquito

Goal: get y'all excited about mosquitoes!!

Basic mosquito classification

Domain: Eukaryota/Eukarya

Kingdom: Animalia

Phylum: Arthropoda (jointed legs)

Class: Insecta

Order: Diptera (one pair of wings)

Family: Culicidae

3 subfamilies within Culicidae:

Anophelinae

3 genera

Anopheles

Culicinae

34 genera

Aedes & Culex

Toxorynchitinae

1 genus

Toxorynchites



Culex: West Nile, filarial worms



Aedes: Zika, Dengue, ChikV



Anopheles: malaria



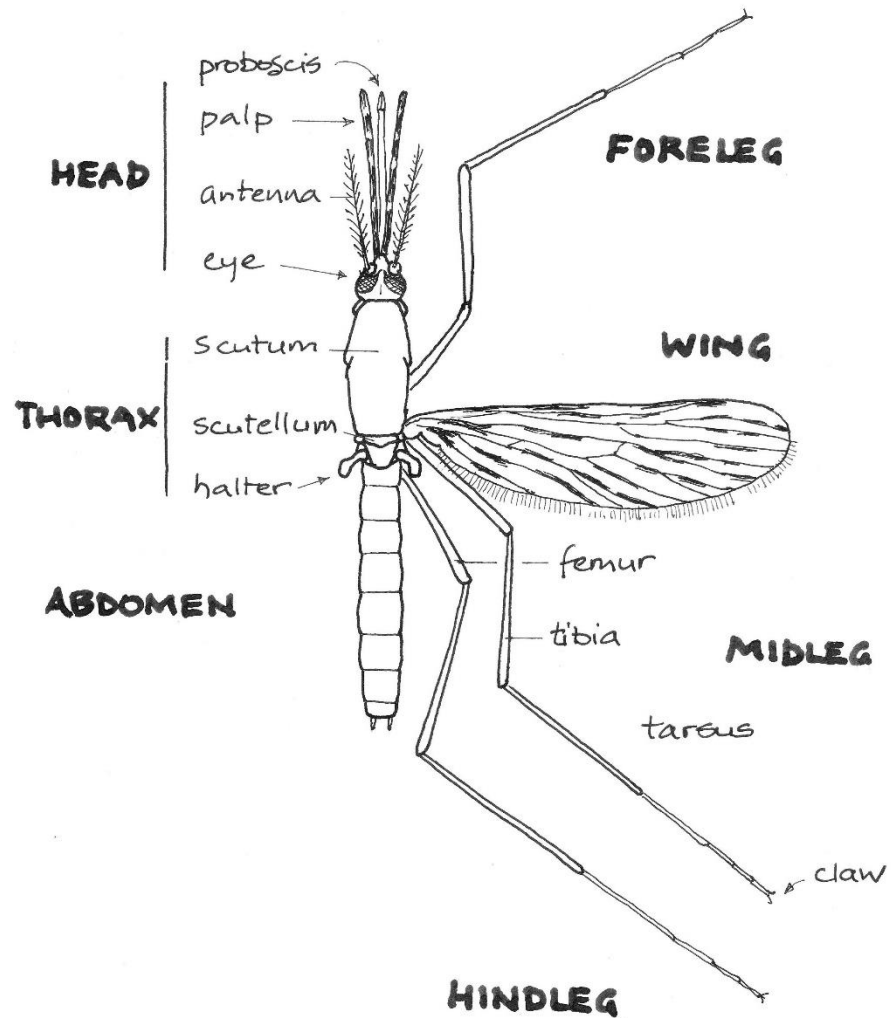
Toxorhynchites: predators

>3,450 species with >75% in the tropics



Found at up to 5500m ASL or 1250m BSL

External mosquito morphology (adult)

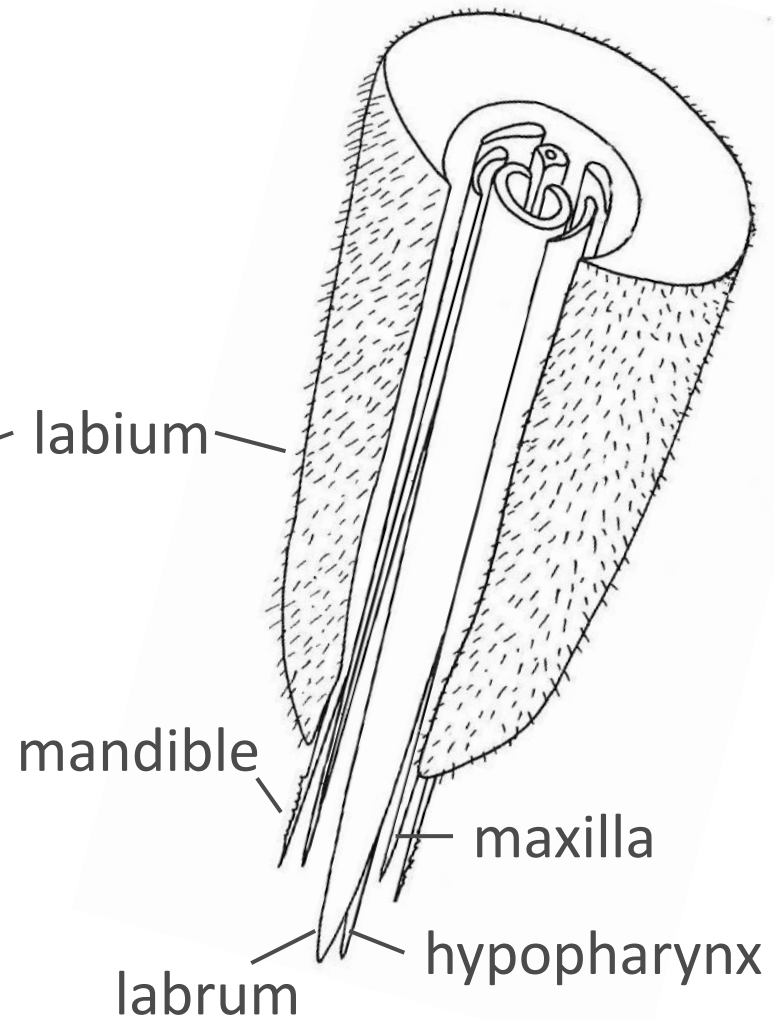


- Slender & small
- 3-6mm in length
- Proboscis
- Scales

External mosquito morphology (adult)



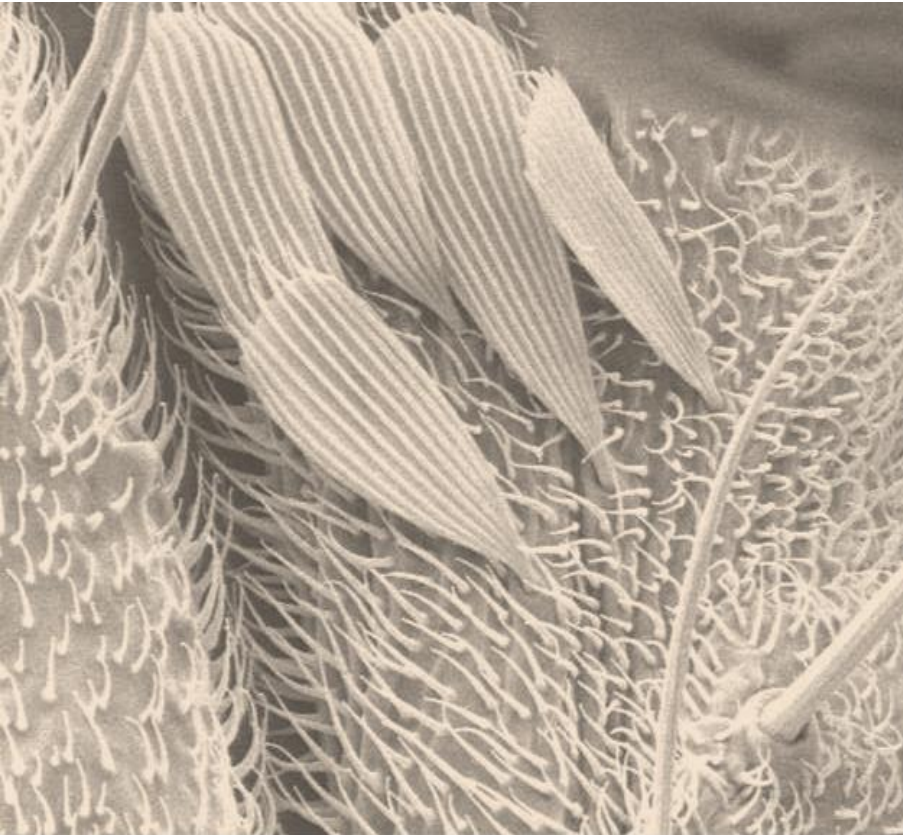
External morphology: proboscis



External morphology: proboscis



External morphology: scales



- Cover thorax, abdomen, wings and legs
- Dull/shiny, white, brown, black, etc.
- Excellent for morphological identification



Culex: West Nile, filarial worms



Aedes: Zika, Dengue, ChikV

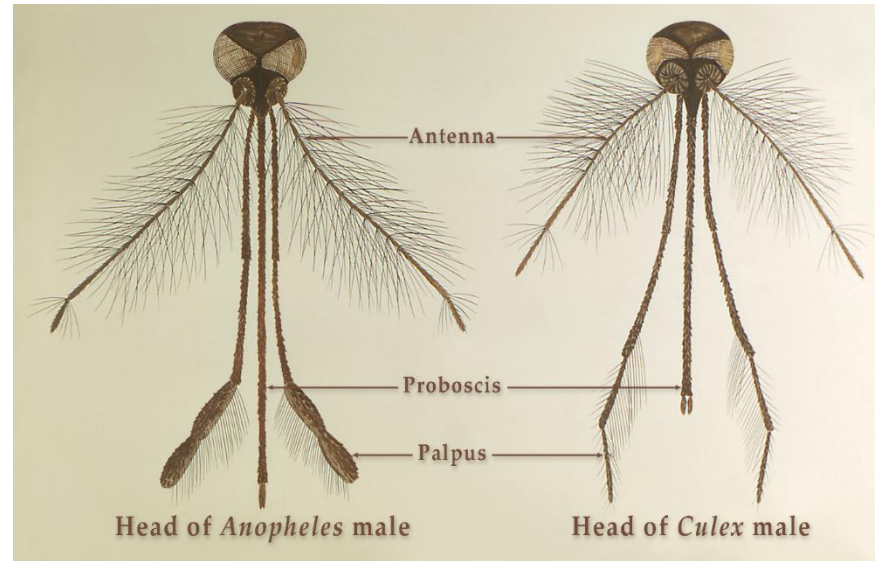
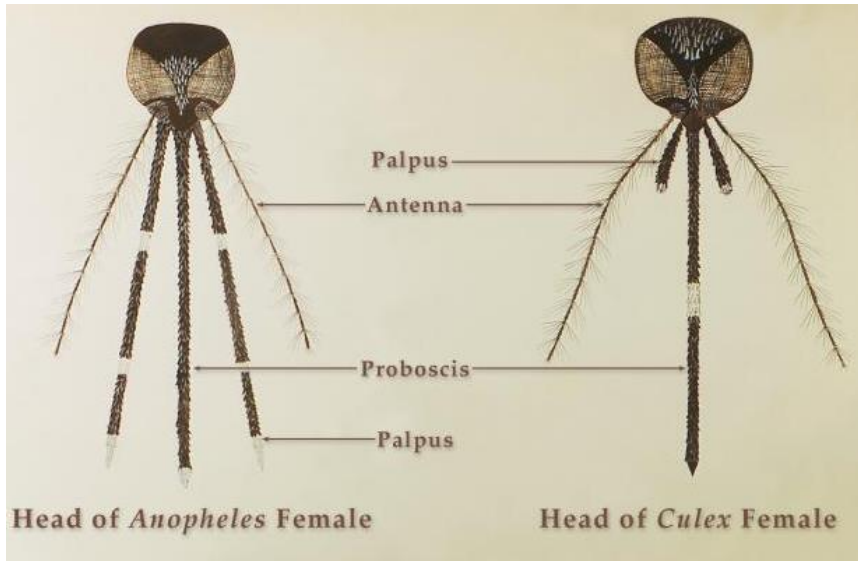


Anopheles: malaria



Toxorhynchites: predators

External morphology: antennae & palps



♀ pilose antennae

♂ plumose antennae



Culex: West Nile, filarial worms



Aedes: Zika, Dengue, ChikV

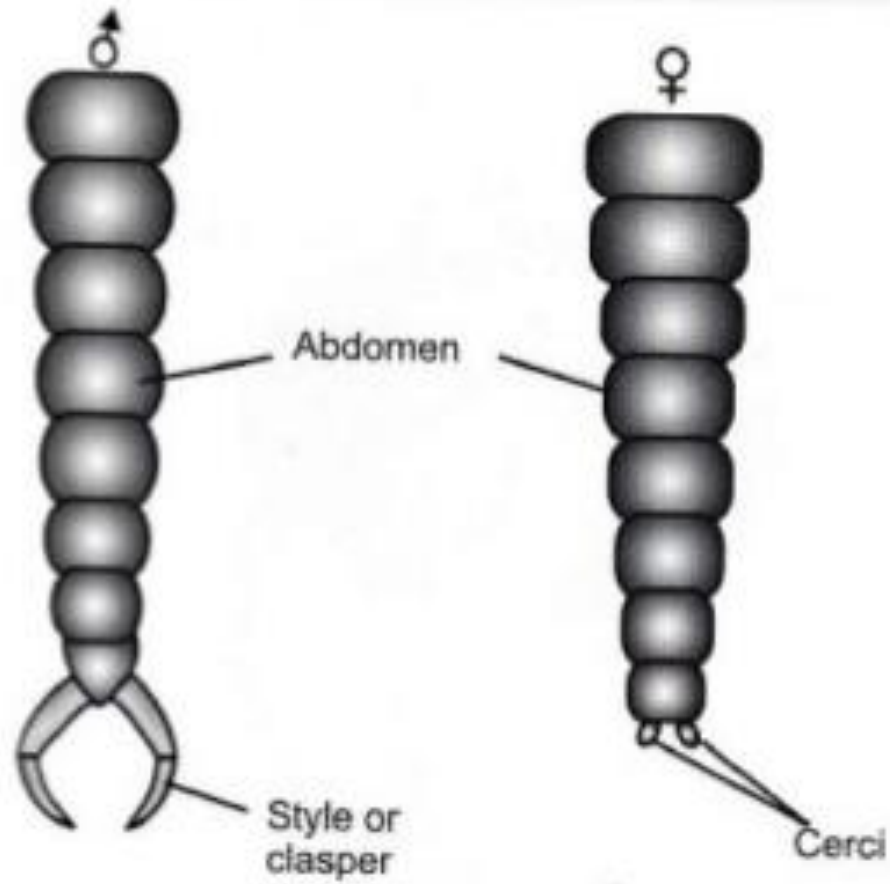


Anopheles: malaria

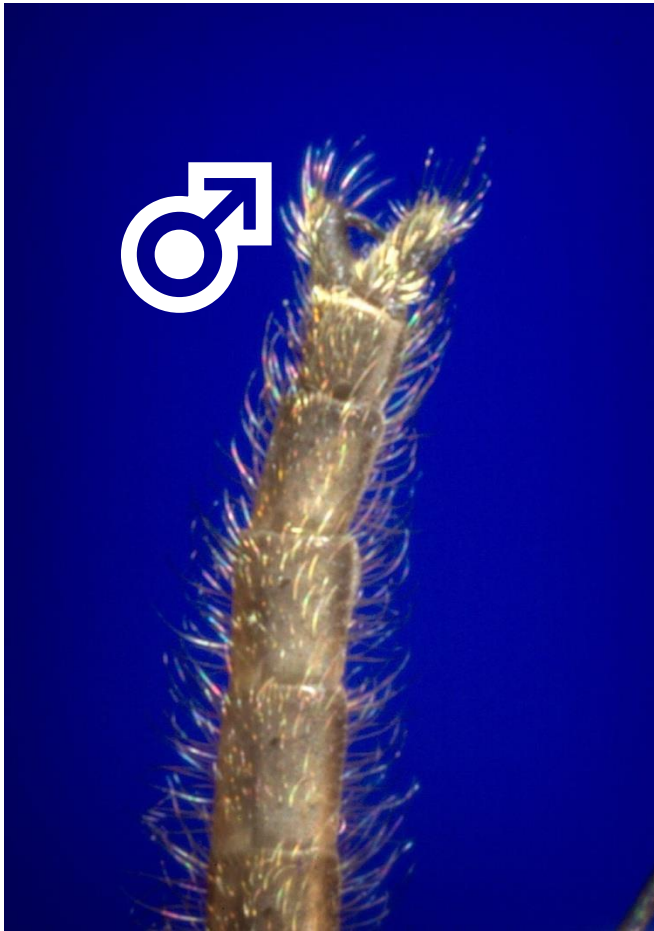


Toxorhynchites: predators

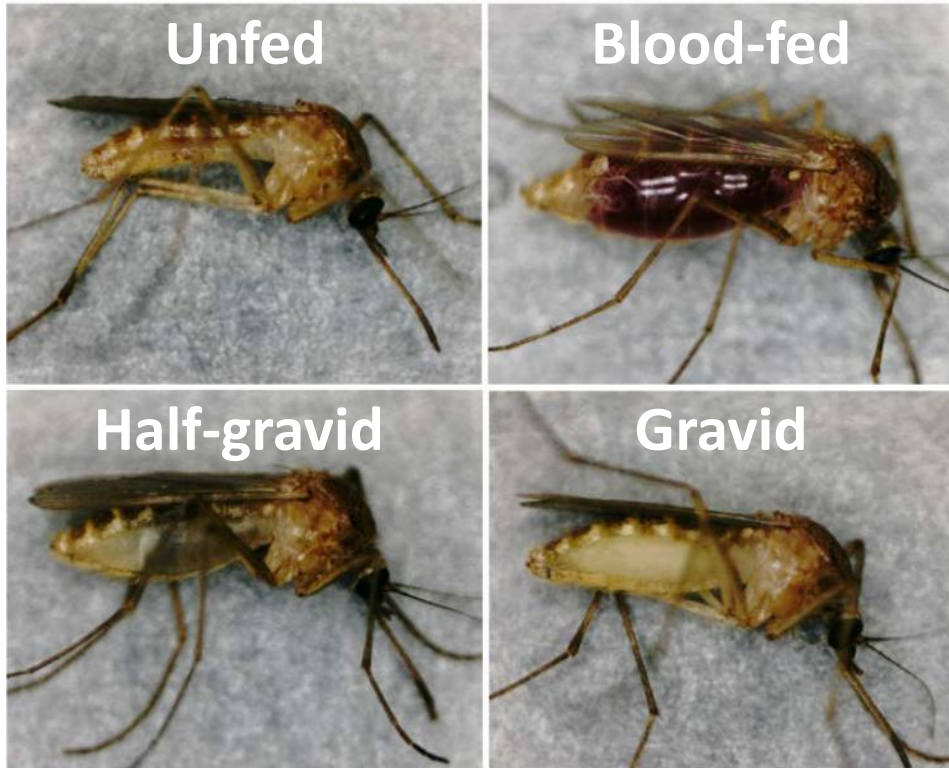
External morphology: abdomen



External morphology: abdomen



Blood-feeding & gonotrophic cycle



Anautogenous:
blood meal necessary
for egg development

2-3d for blood
digestion (tropics)

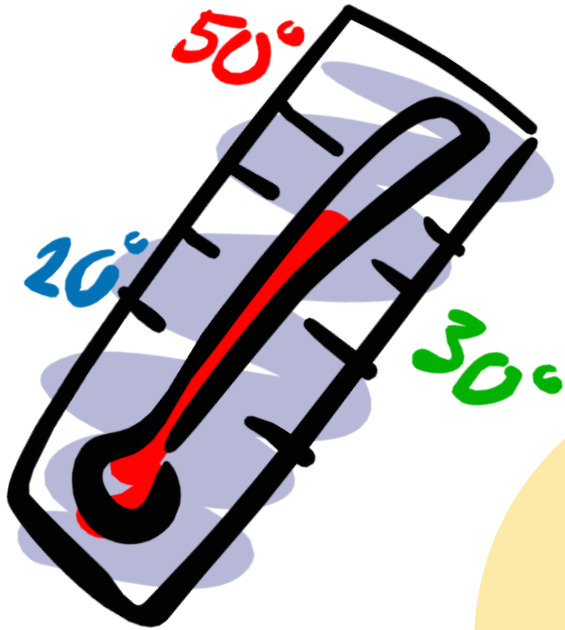
Blood-feed → egg maturation → oviposition → repeat

Holometabolous (complete) life cycle

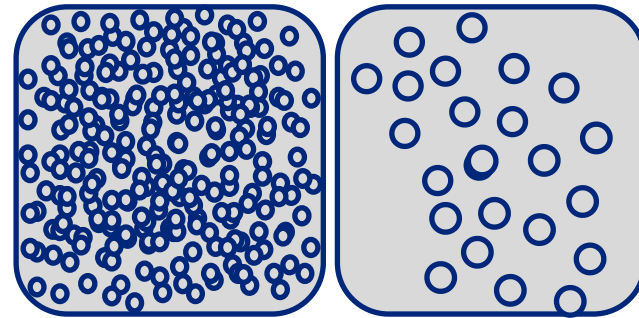


Gina Mikel, www.scientificillustrator.com

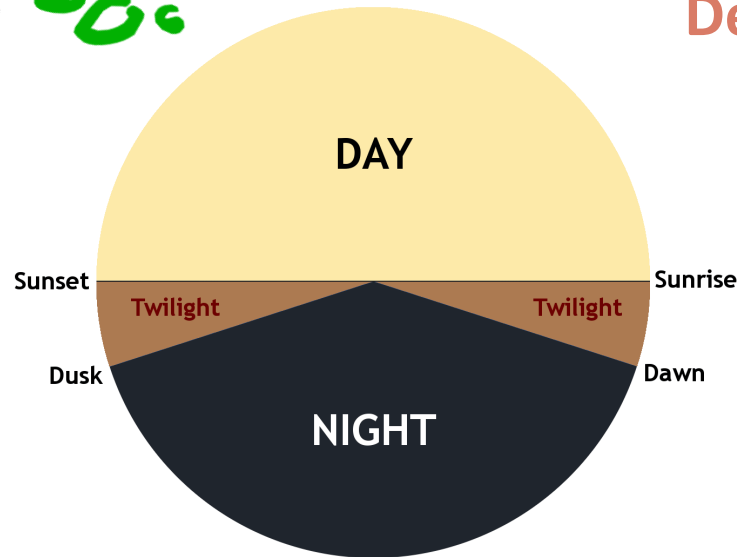
Factors that affect mosquito development



Temperature



Density



Photoperiod



Humidity

Eggs: brown/blackish & $\leq 1\text{mm}$

Anopheles



Aedes

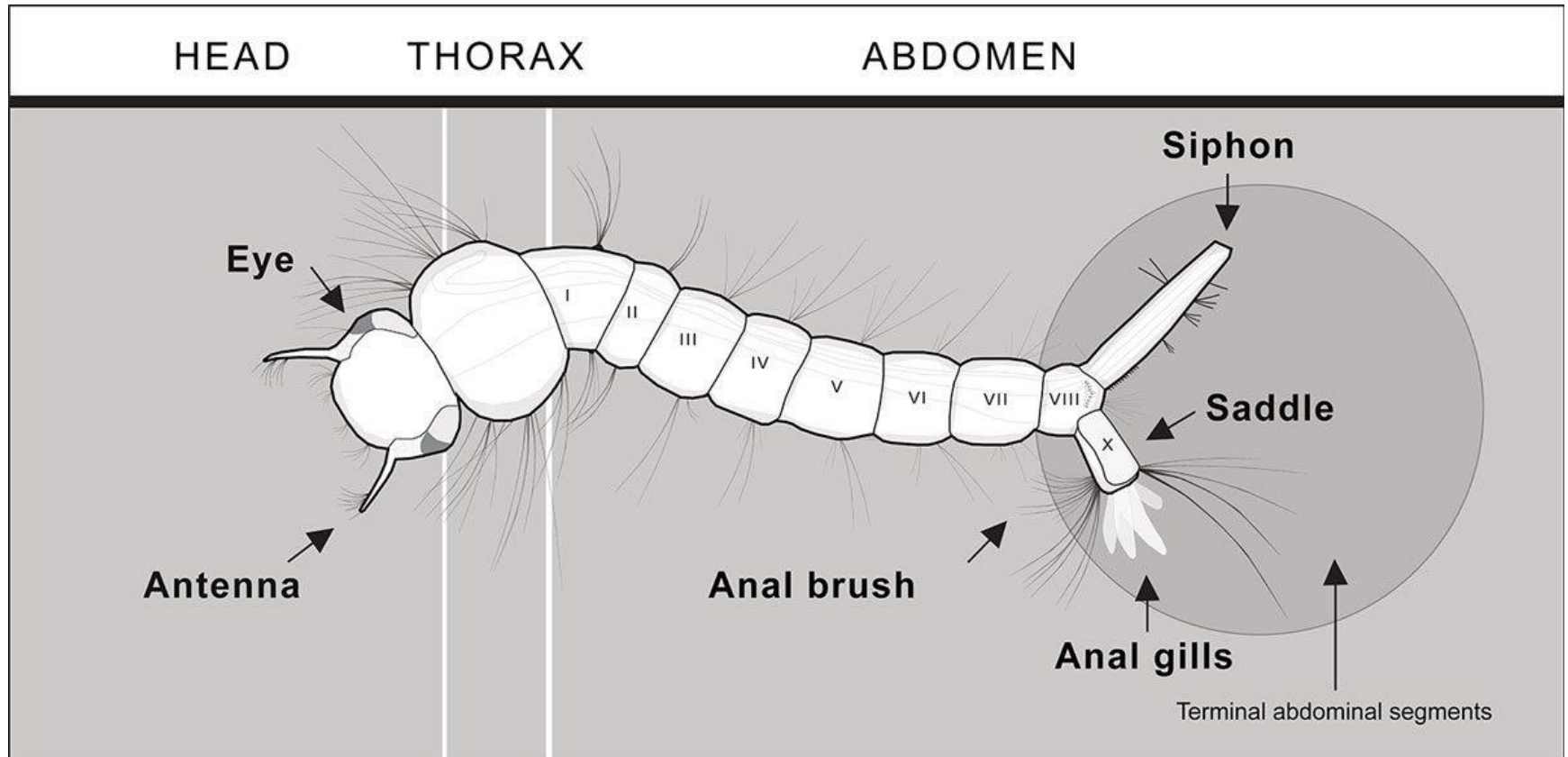


Culex



30-300 eggs/oviposition; hatch within 2-3d (tropics)

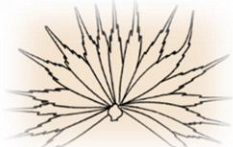
Larva: aquatic, legless, bulbous thorax



Four active instars with development as short as 5-7d (tropics)

Larval morphology: siphon & position

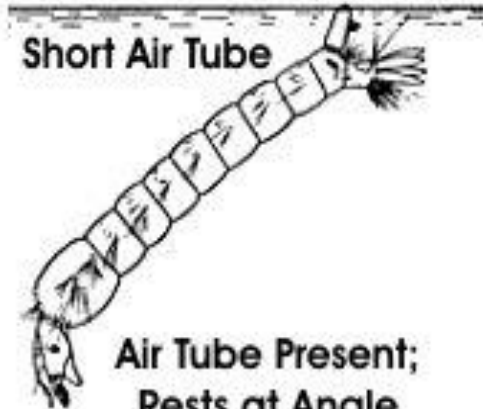
Anopheles



Palmate hairs

**Air Tube Absent;
Rests Parallel to
Water Surface**

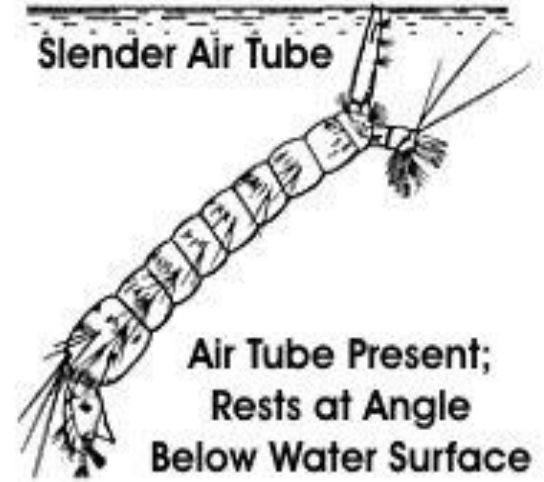
Aedes



Short Air Tube

**Air Tube Present;
Rests at Angle
Below Water Surface**

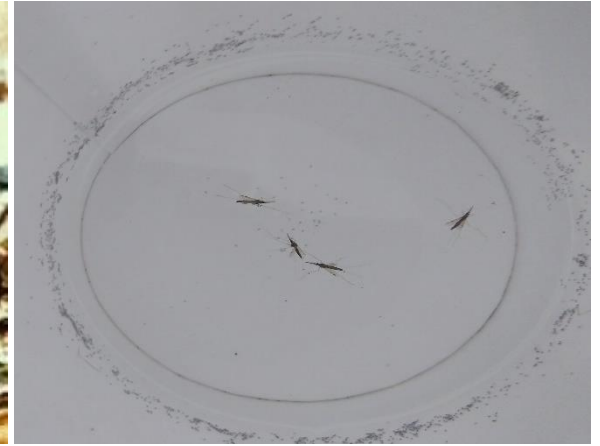
Culex



Slender Air Tube

**Air Tube Present;
Rests at Angle
Below Water Surface**

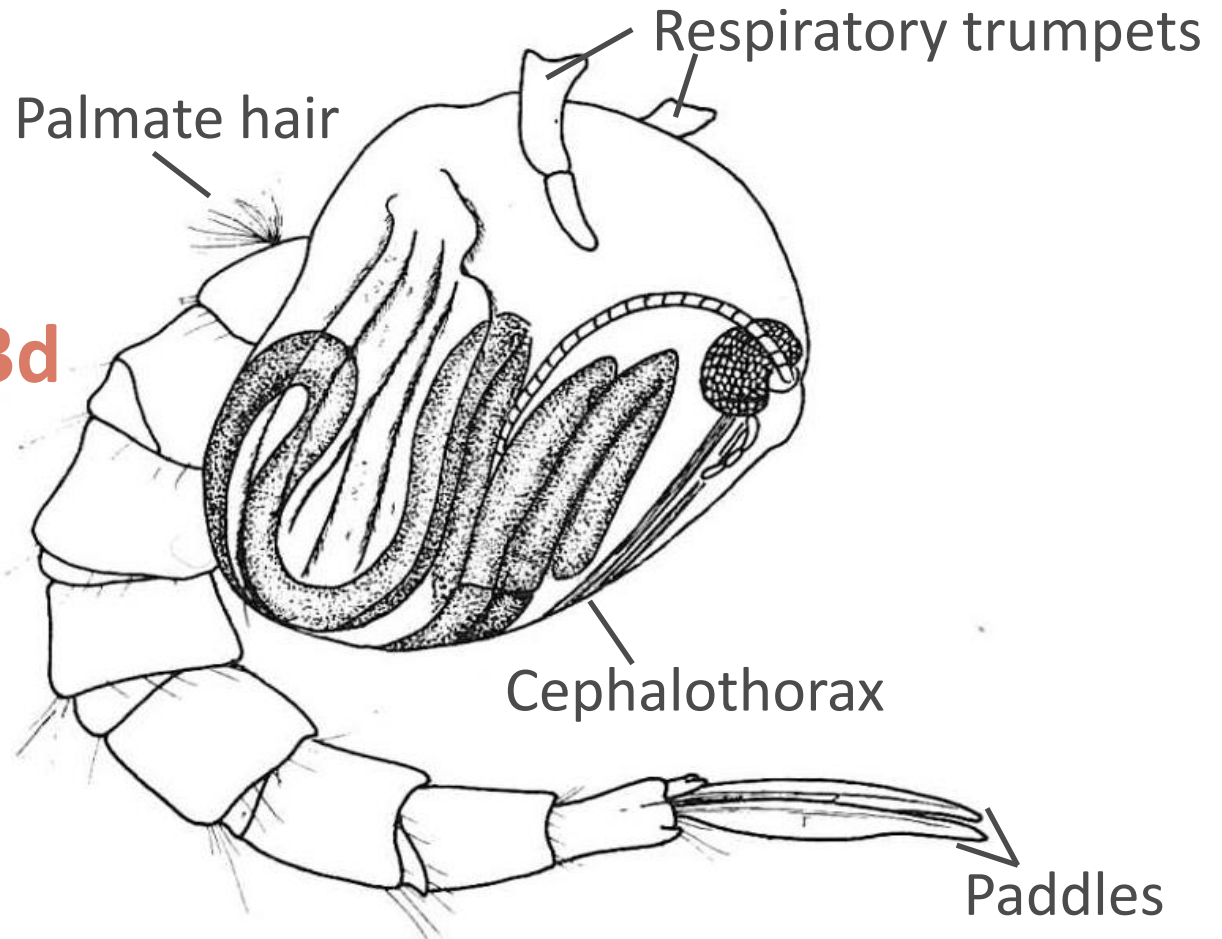
Larval habitats: most collections of H₂O



Usually absent from large expanses of uninterrupted water

Pupa: aquatic, comma-shaped, do not feed

Stage lasts 2-3d
(tropics)



Pupal morphology: Genital lobe

Ventral view

Lateral view

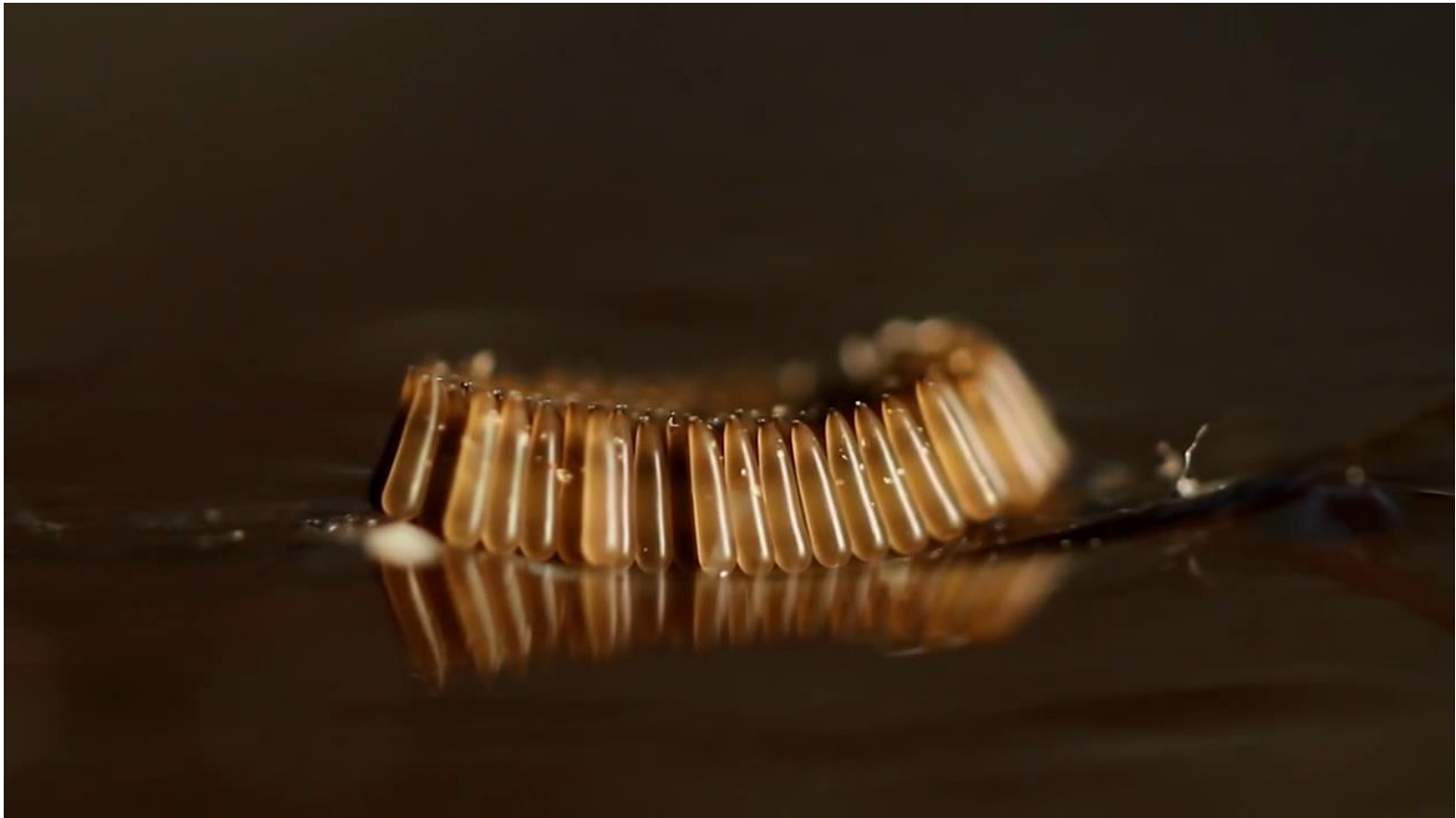


Review

Pay close attention to:

- Eggs
- Larvae (siphons)
- Adult emergence (scales, antennae & palps)

Holometabolus (complete) life cycle



As part of a mosquito surveillance effort, you encounter the breeding site seen in the video during your routine work...

1. Which mosquito eggs (genus) did you identify?
Hint floating egg raft
2. How many larval genera did you identify? Which and why? **Hint: siphons**
3. How many eclosion events did you witness? What genus(era) and sex(s) did you identify?
4. The narrator mentions the egg, larva and *third phase of development*. What is this phase? Does he leave out any pertinent information regarding the larval stage?

Adults: terrestrial, no moulting, scales



Adult mosquito behavior

Biting; resting

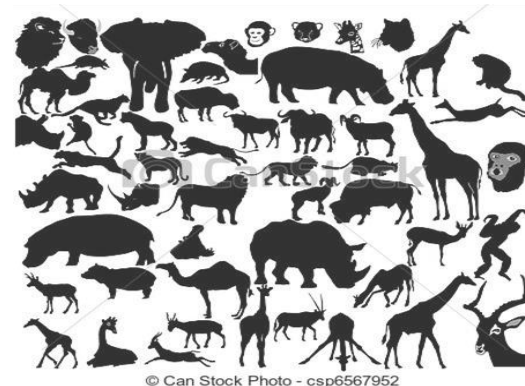
Outdoors



Exophagic; Exophilic

Host preference

Animals



Zoophagic

Indoors



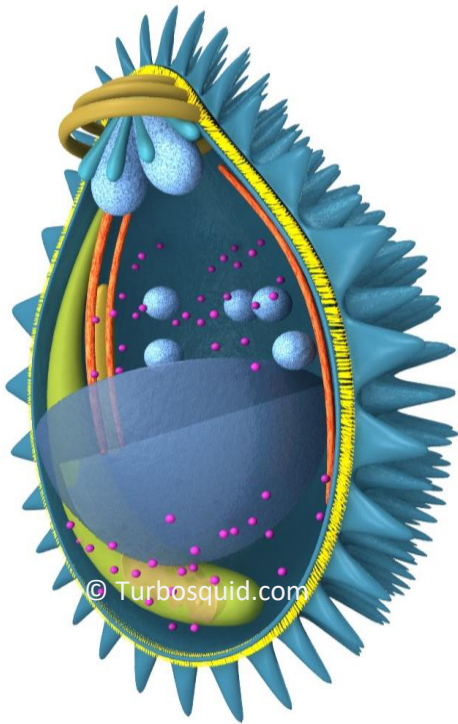
Endophagic; Endophilic

Humans



Anthropophagic

Anopheles, the malaria mosquito



Parasite: *Plasmodium*

4 species cause disease in humans



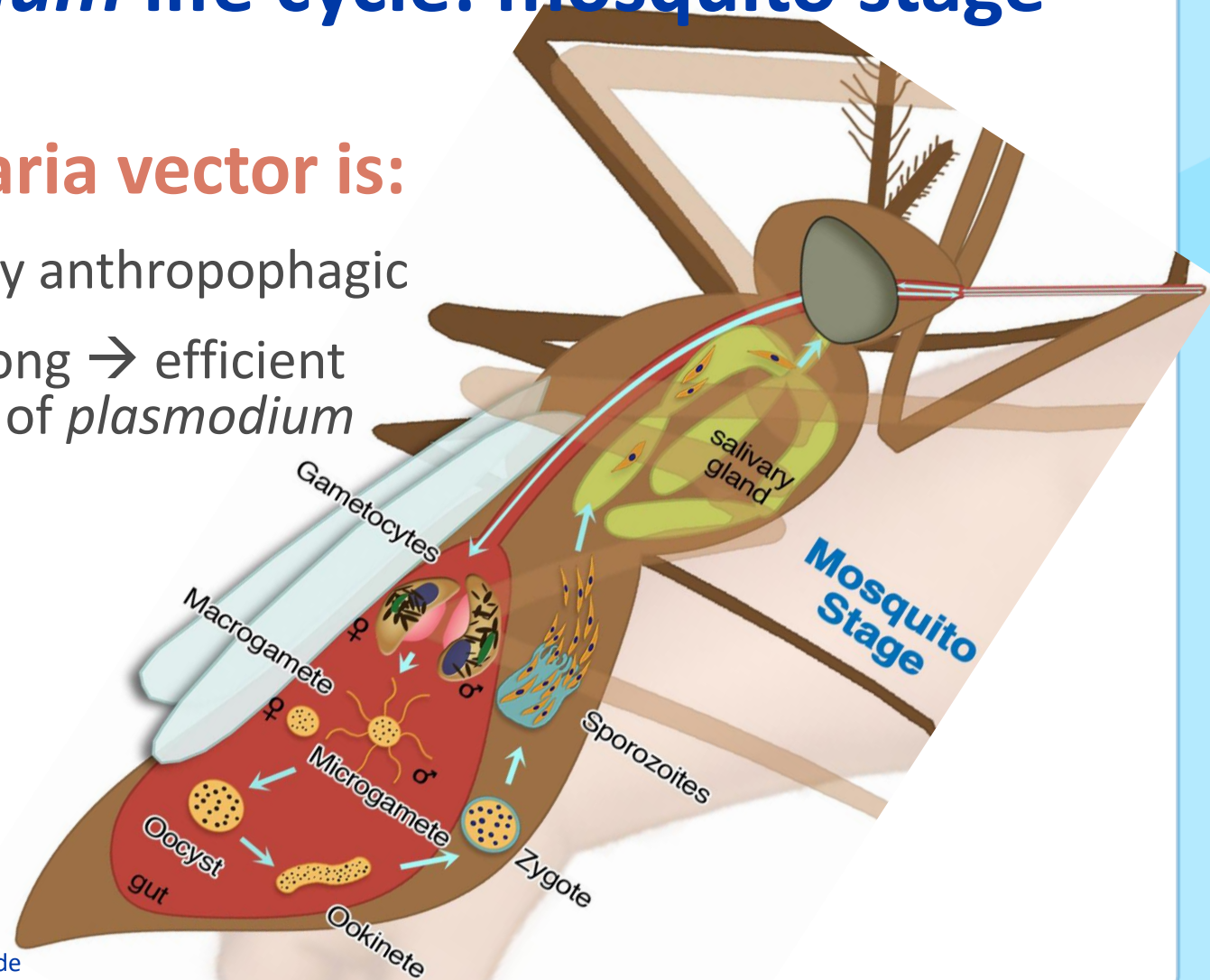
Vector (noun): *Anopheles*

~430 species worldwide (~70 are malaria vectors)

Plasmodium life cycle: mosquito stage

A good malaria vector is:

- Predominantly anthropophilic
- Fit and lives long → efficient development of *plasmodium*



Plasmodium life cycle: mosquito stage



Source: https://www.youtube.com/watch?v=RqRuSwZey_U



Anopheles

- | | | | |
|-------------------------|-------------------------|---------------------------------------|-----------------|
| No vector | funestus and arabiensis | melas | pulcherrimus |
| albimanus | barbivirostris | funestus, arabiensis and gambiae s.s. | quadrifasciatus |
| annularis | culicifacies | funestus and gambiae s.s. | sacharovi |
| anthropophagus | dirus | gambiae s.s. | sergentii |
| arabiensis | farauti | gambiae s.s. and funestus | sinensis |
| arabiensis and funestus | flavivirostris | labranchiae | stephensi |
| aquasalis | fluvialis | maculatus | sundaicus |
| atroparvus | freeborni | darlingi and marajoara | superpictus |
| | | messeae | |
| | | minimus | |
| | | multicolor | |
| | | punctulatus group | |
| | | pharoensis | |
| | | pseudopunctipennis | |

Anopheles morphology: Egg



- Laid singly (50-200/♀)
- Boat-shaped
- Air-filled floats

Floats



Anopheles

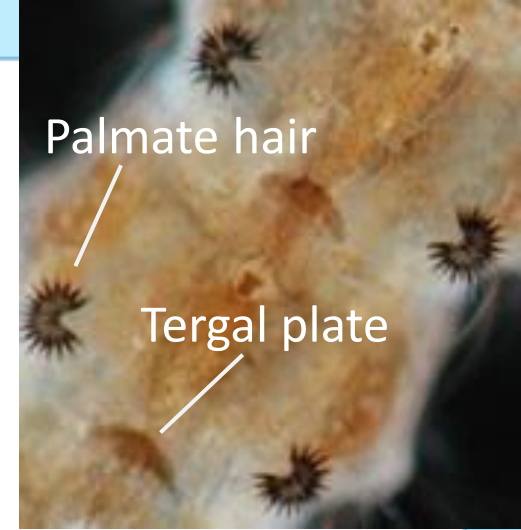
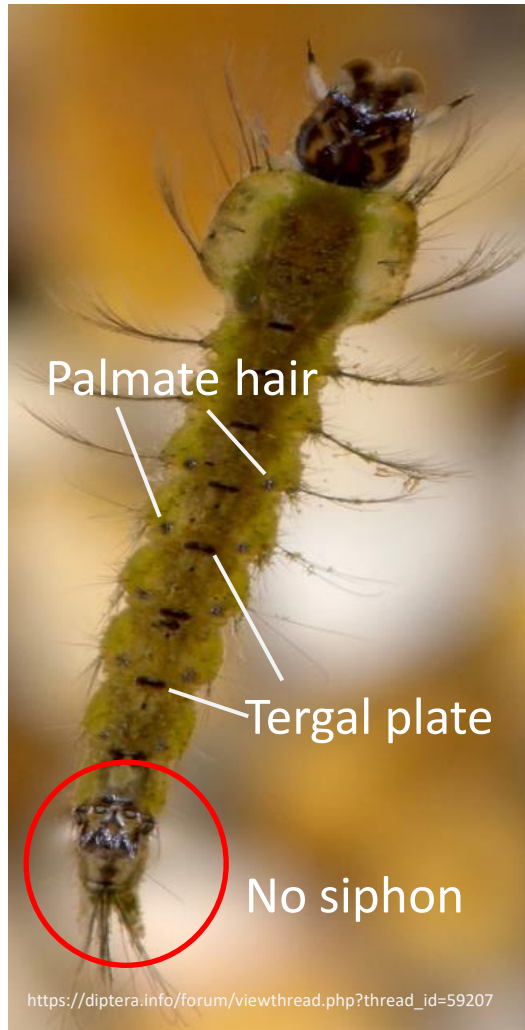


Aedes



Culex

Anopheles morphology: Larva



- No siphon
- Palmate hairs
- Tergal plates
- Parallel to water surface



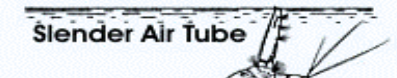
Air Tube Absent;
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Anopheles



Air Tube Present;
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Below Water Surface

Aedes



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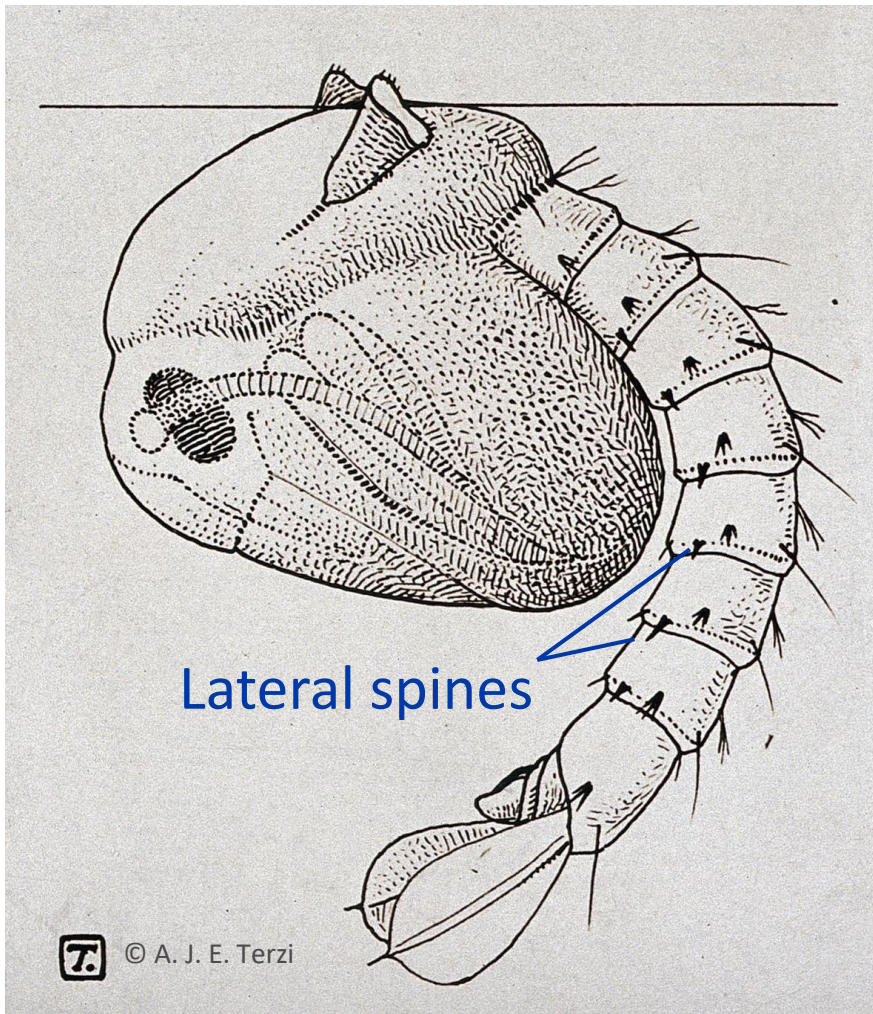
Culex

Anopheles larval habitat



Varies by species/location: usually </> permanent habitats

Anopheles morphology: Pupa



- Short & broad trumpet
- Lateral spines

Anopheles morphology: Adults



‘Blocks’ of dark and pale scales on wings



Palps in ♀ as long as proboscis

Anopheles vs culicines: wing scales & palps



Culex: West Nile, filarial worms



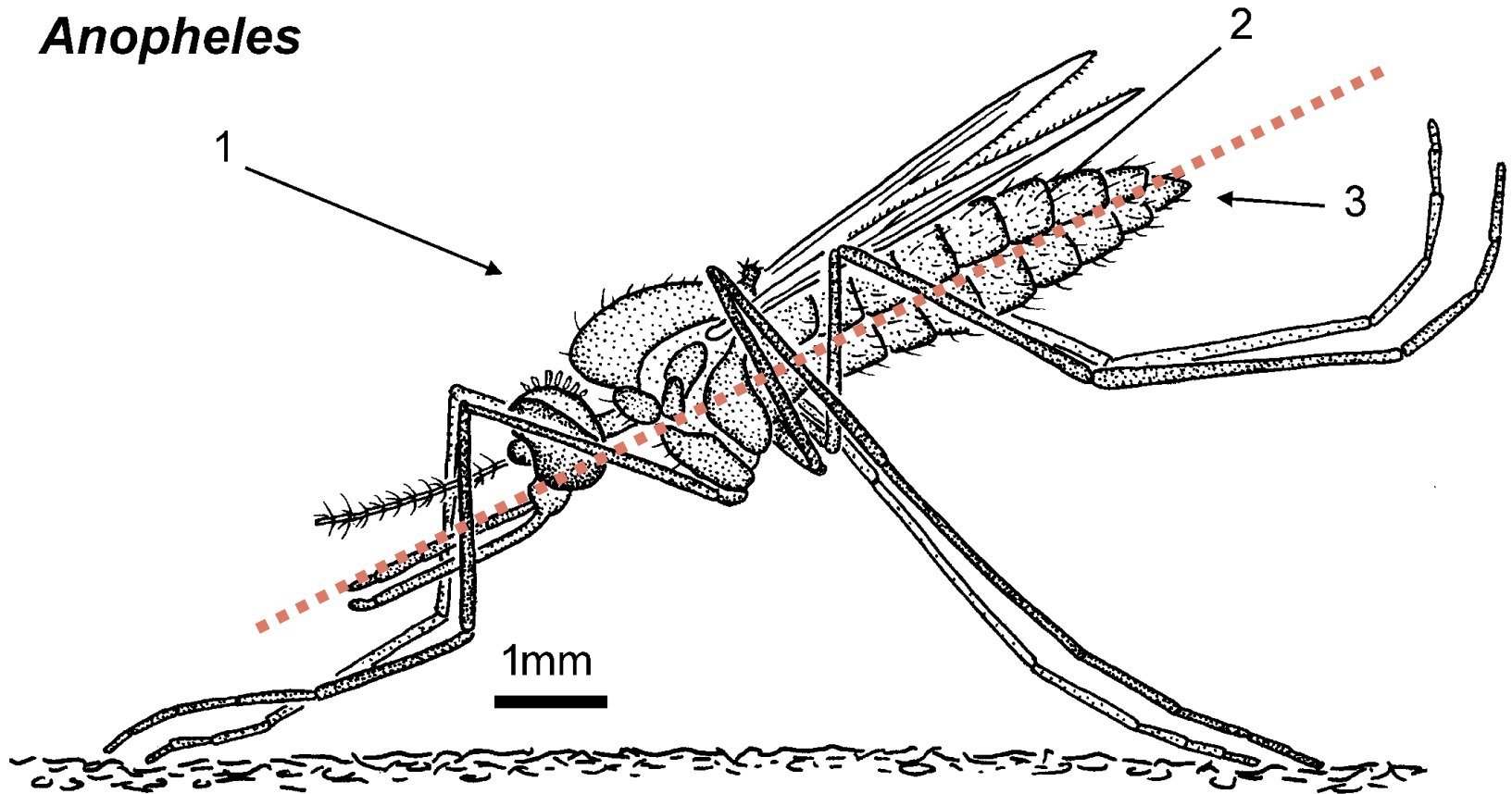
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Anopheles: malaria

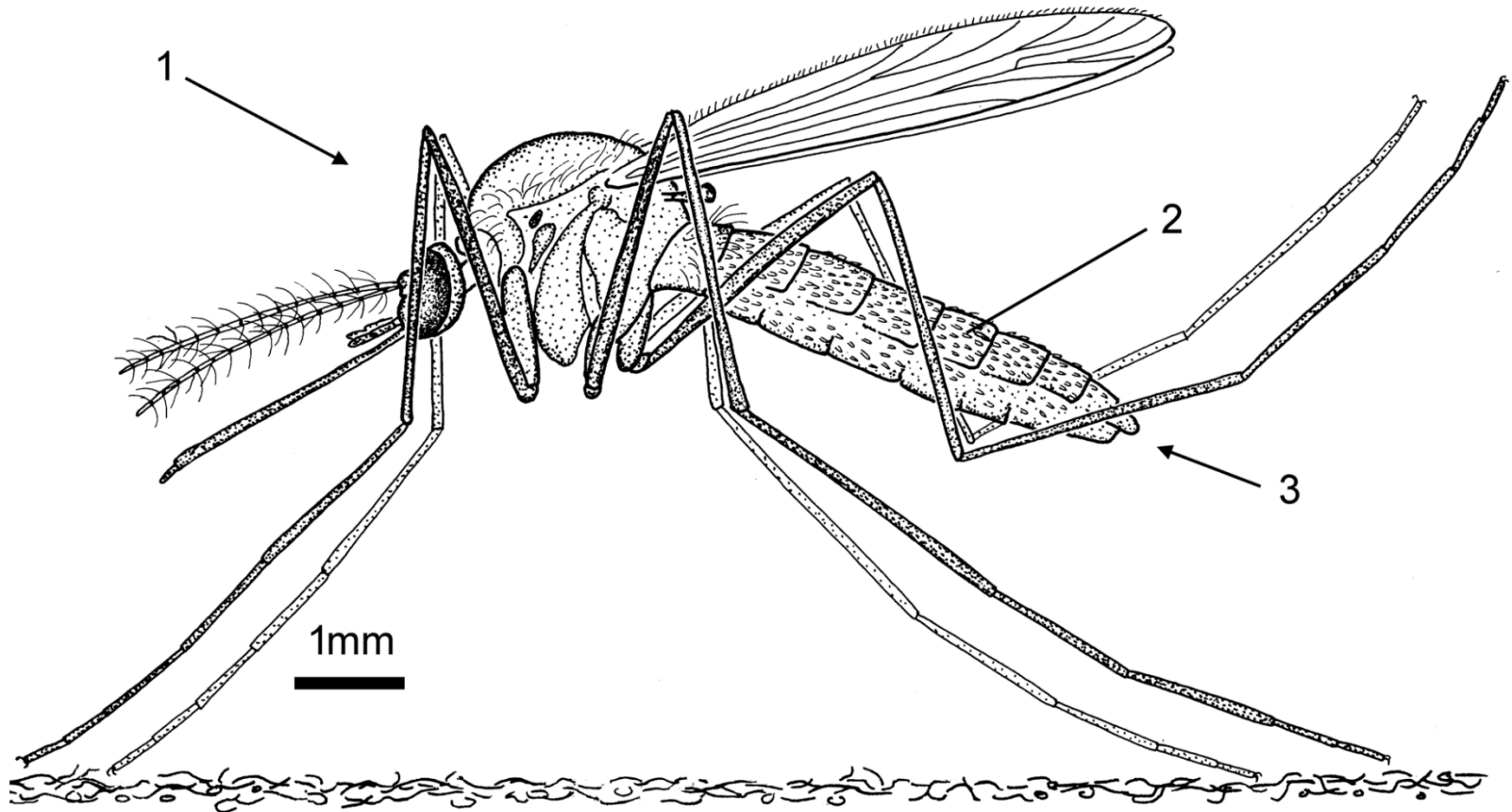
Characteristic *Anopheles* resting position

Anopheles



Rests with body at an angle to surface

Compare to resting position of a culicine



Body is not at an angle to surface

Anopheles vs culicines: resting position



Culex: West Nile, filarial worms

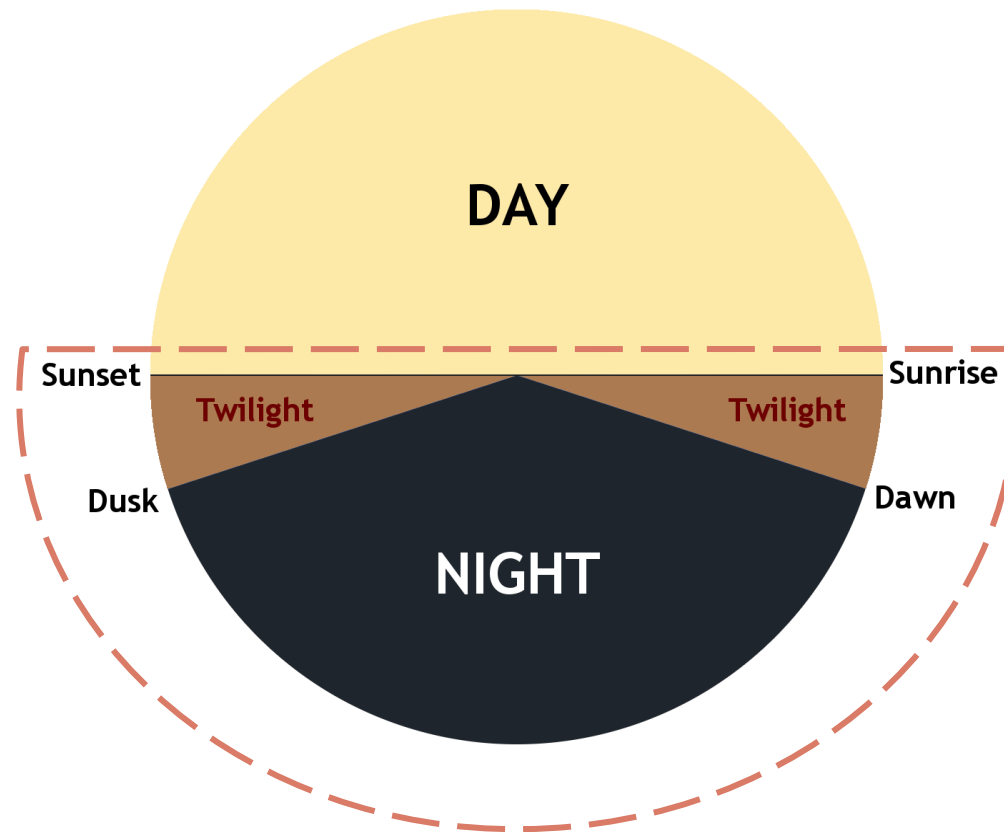


Aedes: Zika, Dengue, ChikV



Anopheles: malaria

Adult *Anopheles* behavior: active times



Mostly crepuscular or nocturnal

Adult *Anopheles* behavior

Biting; resting

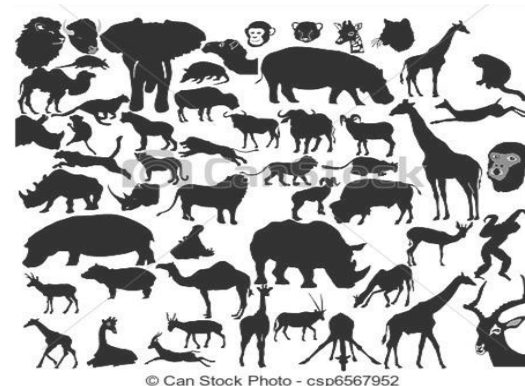
Outdoors



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Humans



Anthropophagic

Mosquito sampling: adults



Aspirators (buccal): Resting on humans/surfaces

Mosquito sampling: larvae



Dippers (dipping)



Pipettes (pipetting)

You are now mosquito biology experts (hopefully)!

Go forth and make more experts ;-)

Reach out at anytime if you have any questions: NDada@cdc.gov