# The Natural History of Mosquitoes



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*Aedes intrudens*, Superior National Forest, Minnesota


*Johnbelkinia ulopus*
COSTA RICA: Heredia
La Selva Biological Station



*Toxorhynchites* (*Ankylorhynchus*) *purpureus*
BRAZIL: Espíritu Santo
Pedra Azul


*Culex nigripalpus*, at hummingbird nest
La Selva Biological Station, Costa Rica



*Leptus* mites attached to legs of *Culex restuans*
Booneville, Arkansas




*Hesperus arizonicus* eating mosquito larvae; Huachuca Mountains, Arizona


*Toxorhynchites septentrionalis* nectaring from milkweed
Ouachita Mountains, Arkansas

*Nepenthes villosa*, Mt. Kinabalu, Borneo

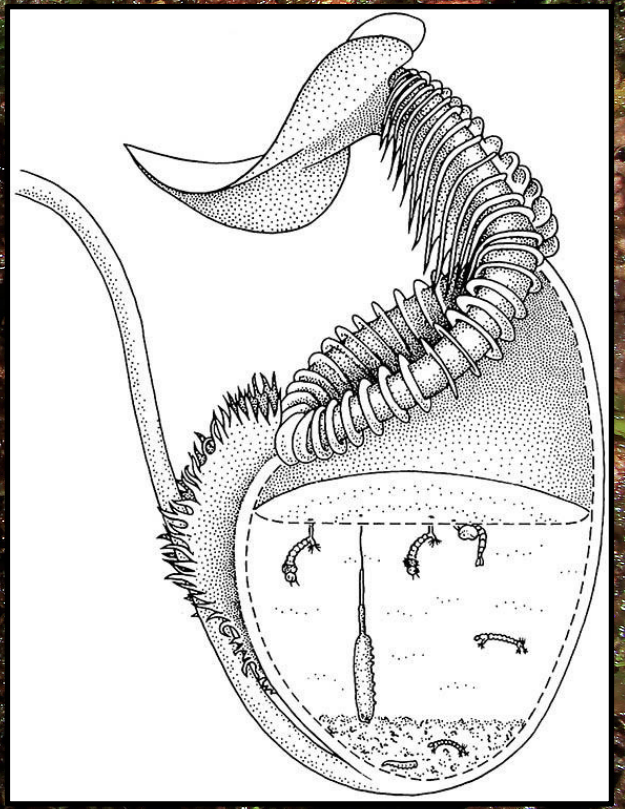


Figure: Gullan and Cranston 2021



*Culex quinquefasciatus* feeding from chicken
Kabankalan City, Philippines

Oldest mosquito fossil:

## ***Priscoculex burmanicus***

Mid Cretaceous, ~110 MYA

Subfamily Anophelinae

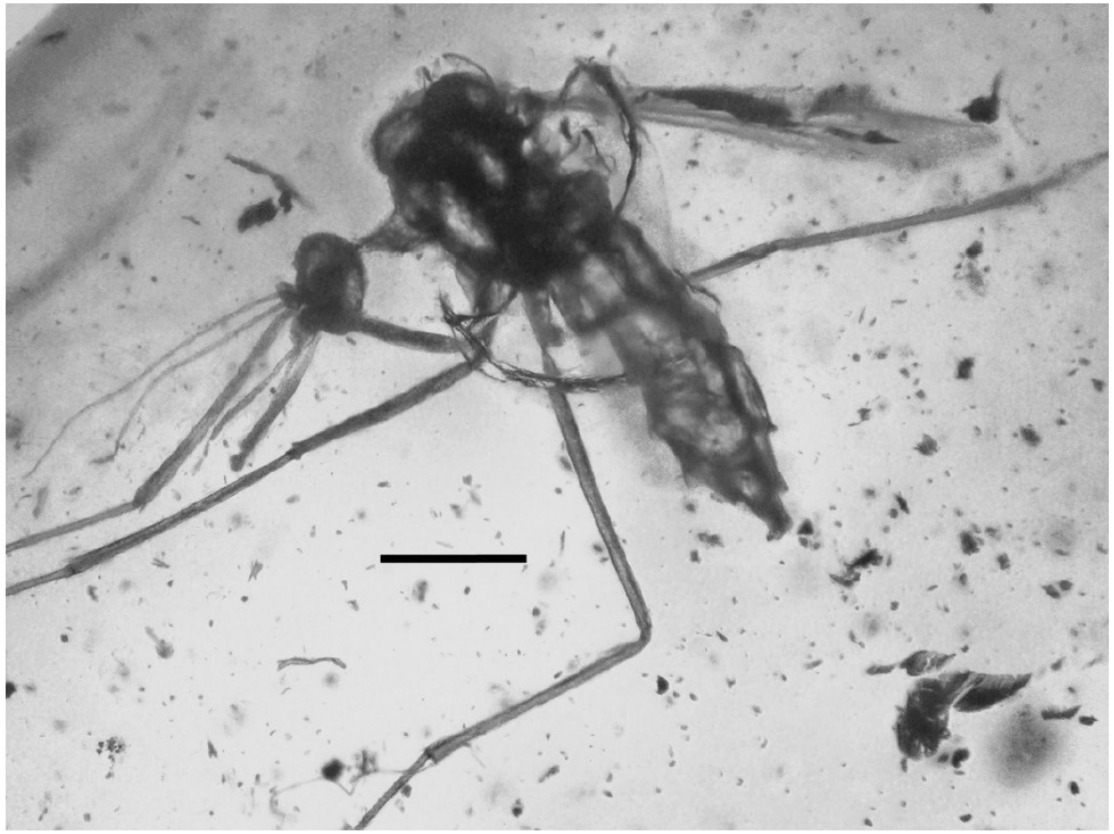


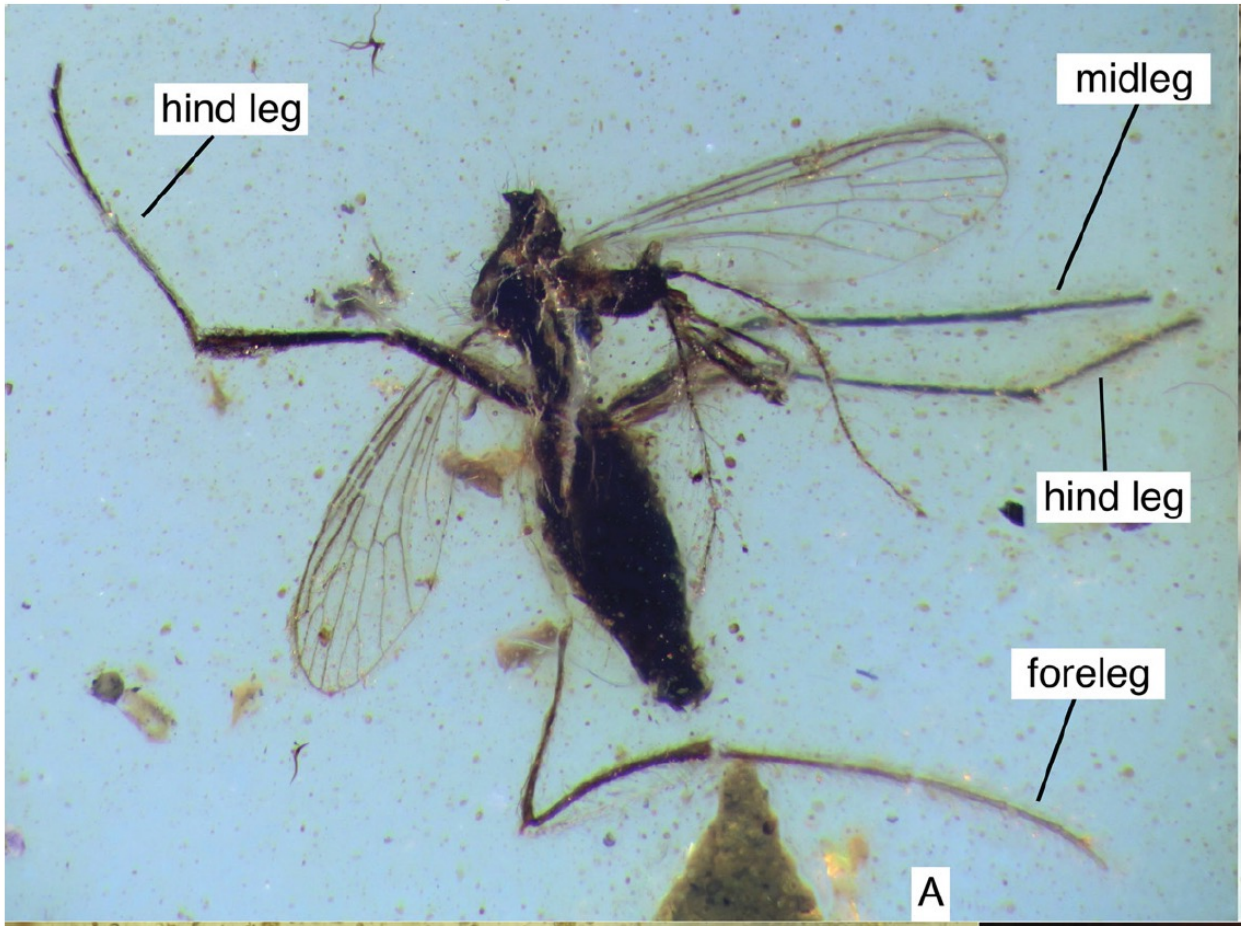
**Figure 1.** Holotype of *Priscoculex burmanicus* in Myanmar amber. Scale bar = 674 µm.

More information:
Poinar et al. 2019. *Priscoculex burmanicus* n. gen. et sp. (Diptera: Culicidae: Anophelinae) from mid-Cretaceous Myanmar amber. Historical Biology 32: 1157-1162.

## ***Burmaculex antiquus***

Mid Cretaceous, ~99 MYA

Subfamily Burmaculicinae

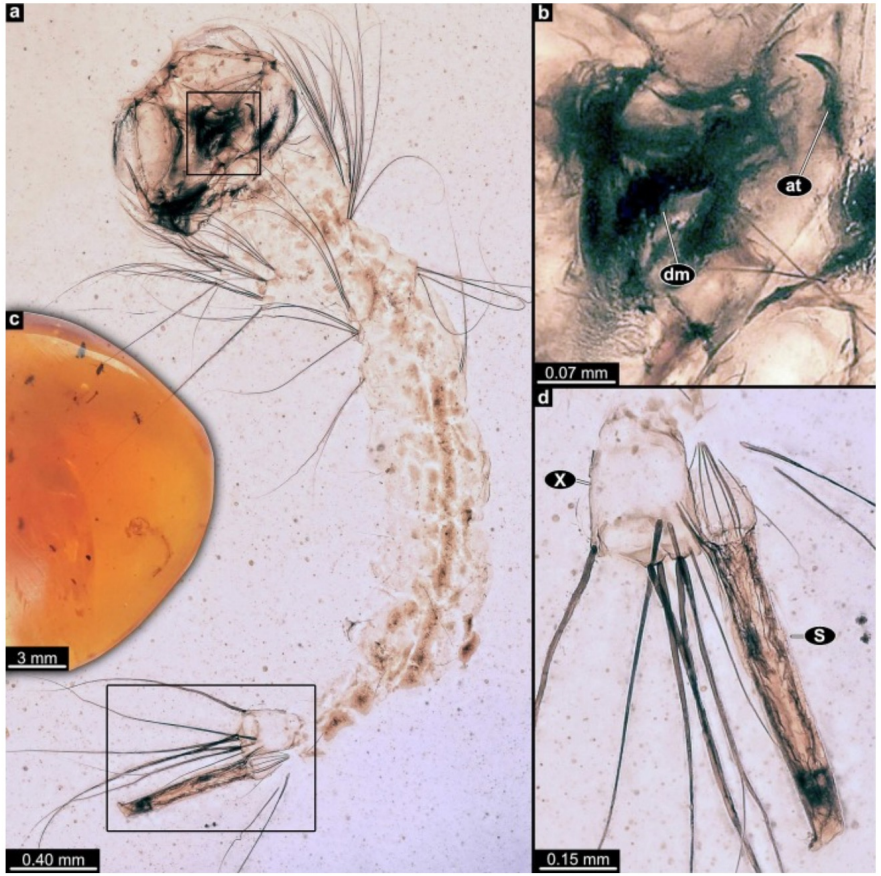


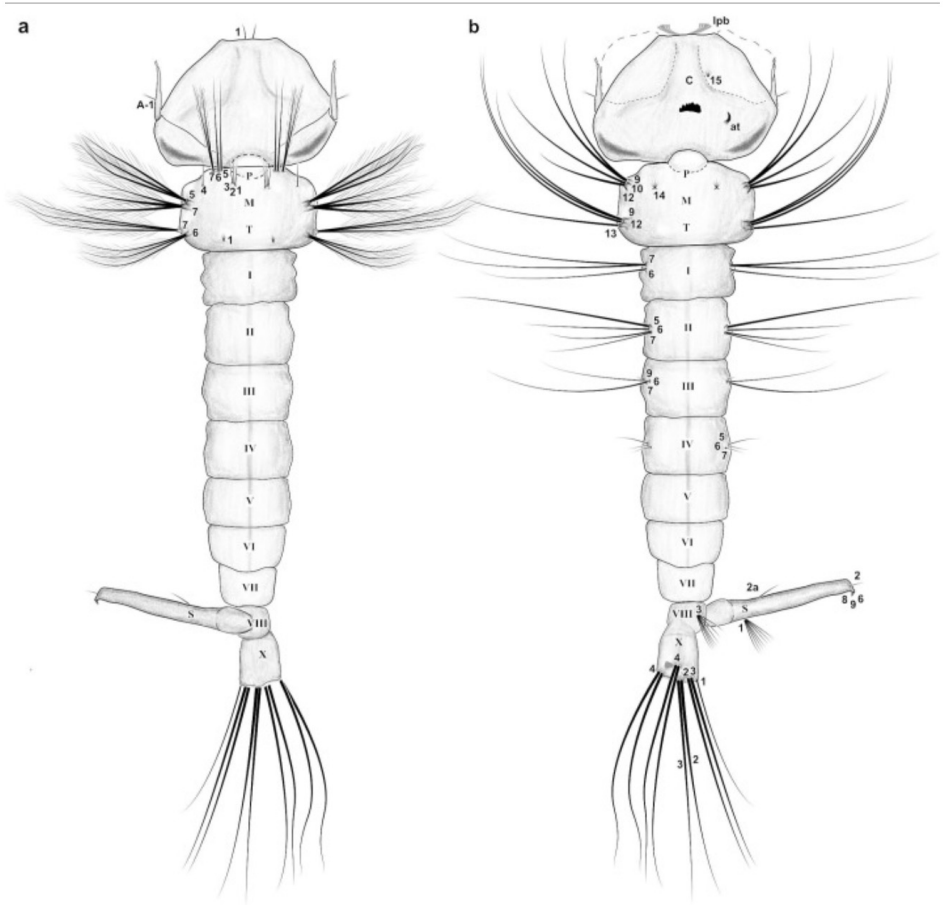

More information:
Borkent and Grimaldi 2016. The Cretaceous fossil *Burmaculex antiquus* confirmed as the earliest known lineage of mosquitoes (Diptera: Culicidae). Zootaxa 4079: 457-466.

# *Cretosabethes primaevus*

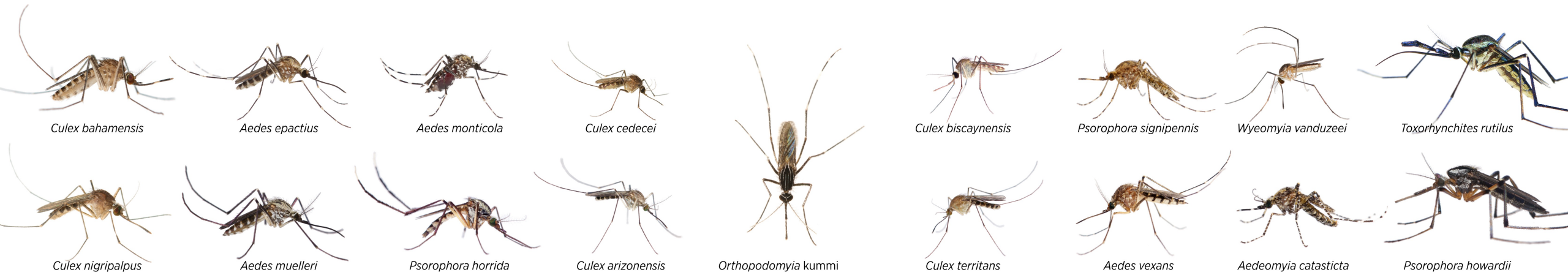
## Mid Cretaceous, ~99 MYA

### Subfamily Culicinae, Tribe Sabethini



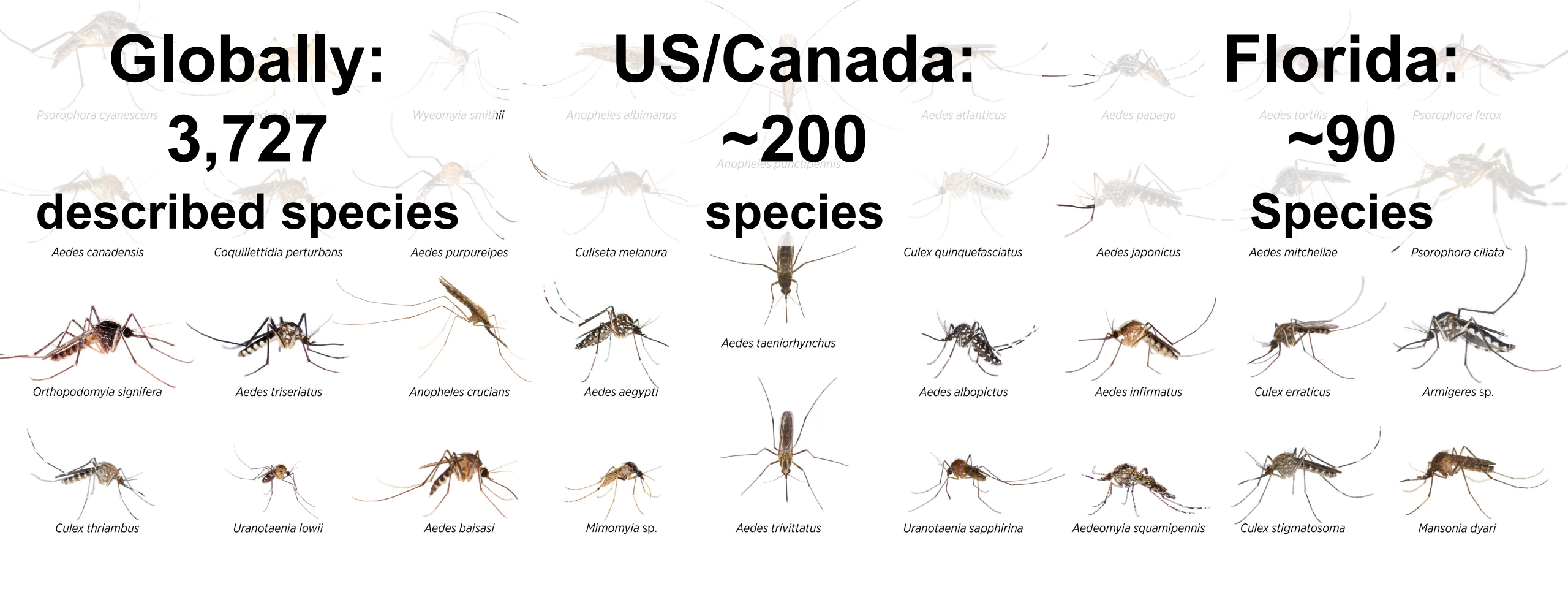

More information:
Amaral et al. 2026. First fossil mosquito larva in 99-million-year-old amber with a modern type of morphology sheds light on the evolutionary history of mosquitoes (Diptera: Culicidae). Gondwana Research 150: 154-162.




# Globally:
# 3,727
# described species

# US/Canada:
# ~200
# species

# Florida:
# ~90
# Species



*Chagasia bathana*
COSTA RICA: Heredia
La Selva Biological Station





*Aedes albopictus*


Toxorhynchites rutilus
Aedes albopictus



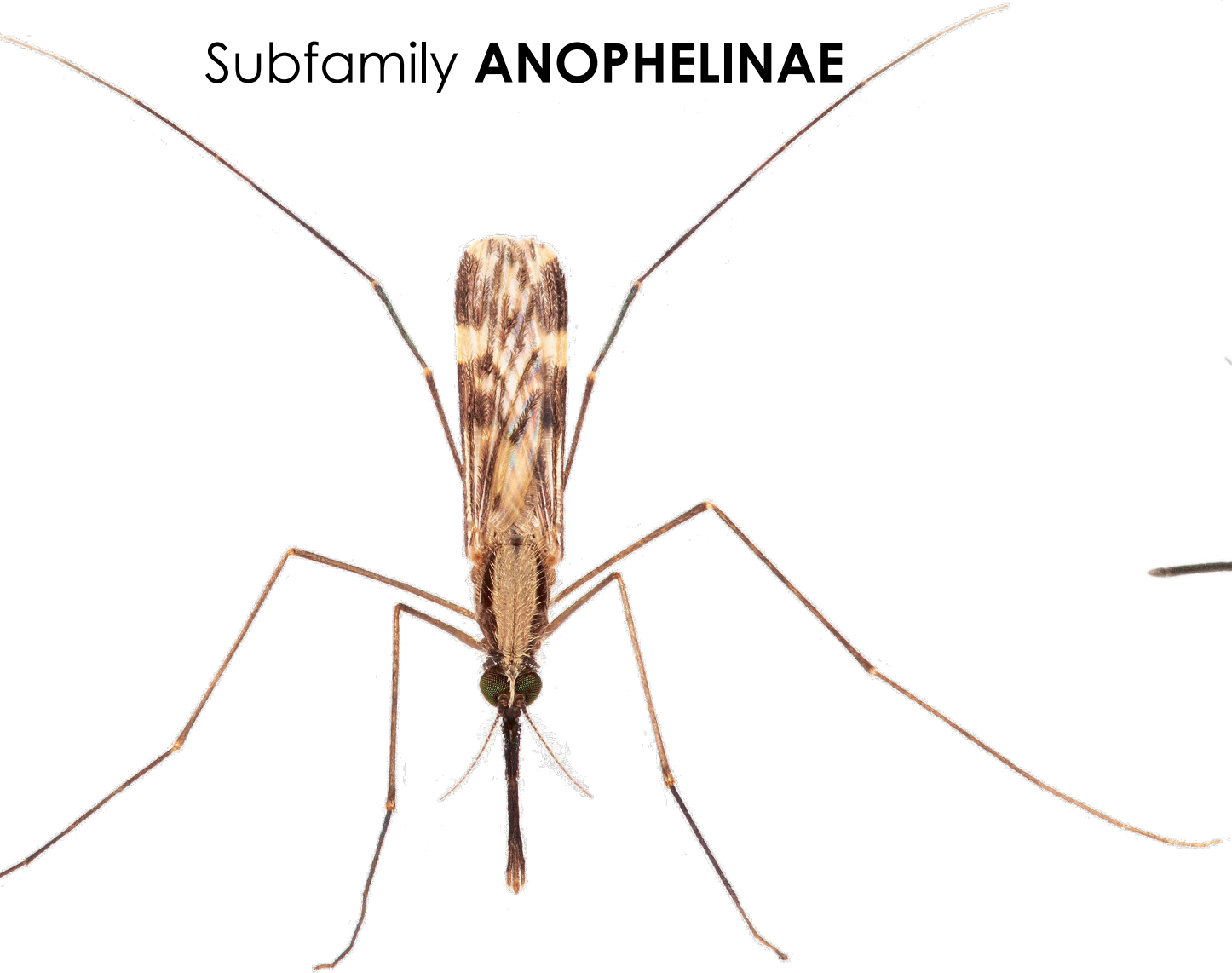
*Toxorhynchites rutilus* larva consuming larvae of *Aedes albopictus*

*Toxorhynchites rutilus* nectaring from *Bidens alba*



# Family **CULICIDAE**

## Subfamily **ANOPHELINAE**



*Anopheles punctipennis*

## Subfamily **CULICINAE**



*Aedes purpureipes*

Subfamily

# Anophelinae



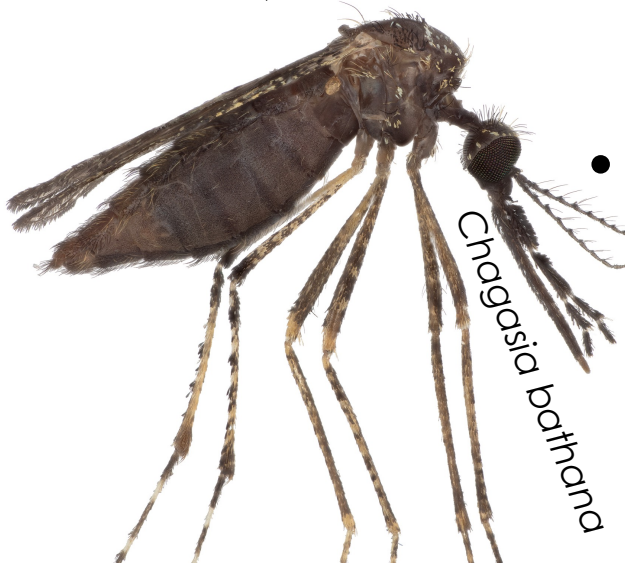
*Anopheles (Nyssorynchus) albimanus*



*Anopheles (Kerteszia) neivei*



*Anopheles (Stethomyia) sp.*



*Chagasia bathana*

- **Basal to all other Culicidae**
  - **Diverged during Jurassic**
- **Three genera**
  - ***Anopheles* (487 species)**
  - ***Chagasia* (5 species)**
  - ***Bironella* (8 species)**
- **Primary vectors of human malaria parasites**



*Anopheles (Anopheles) crucians A*

# Family Culicidae

## Subfamily **Anophelinae**

*Except genus *Bironella*

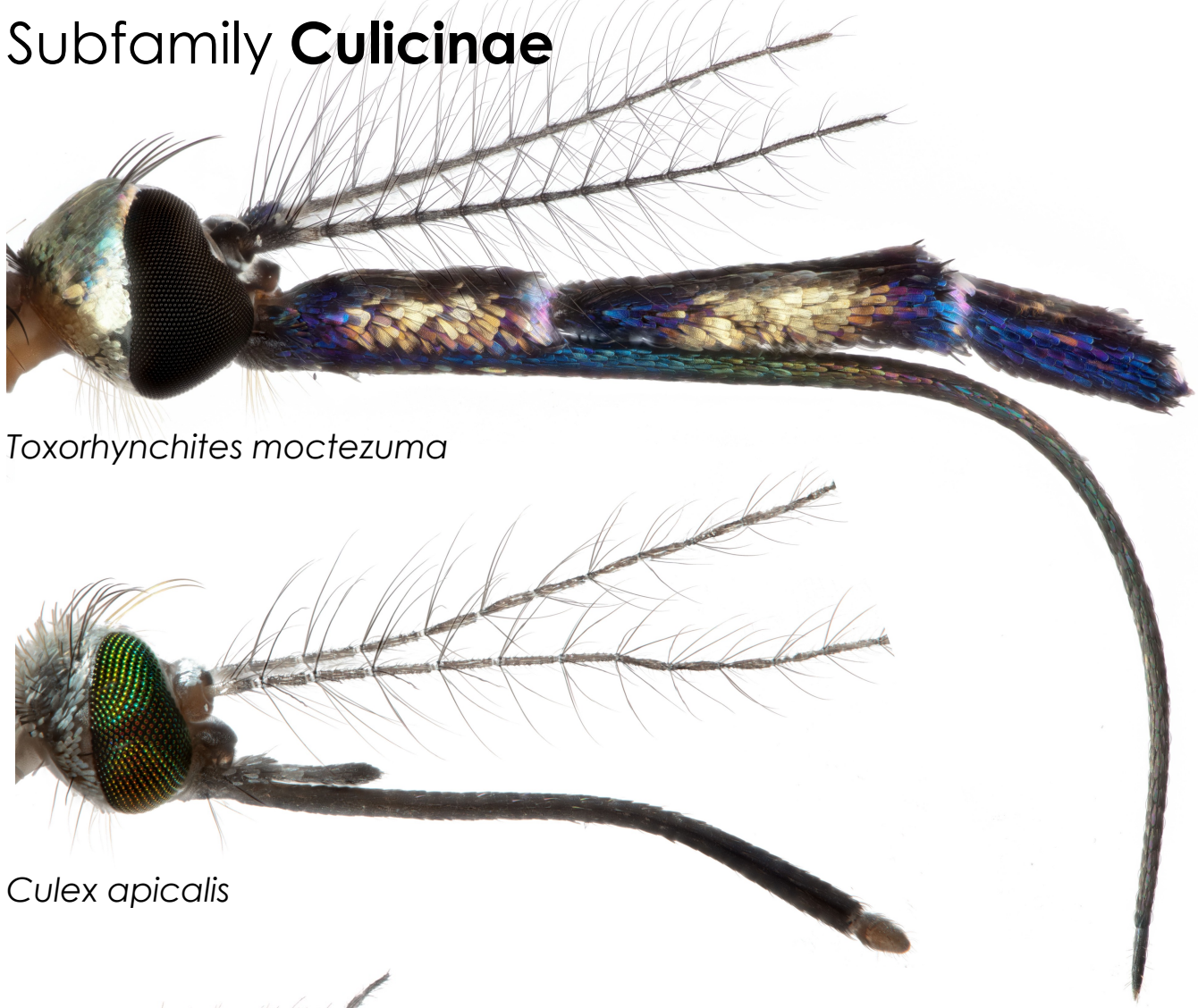


*Anopheles atropos*



*Chagasia bathana*

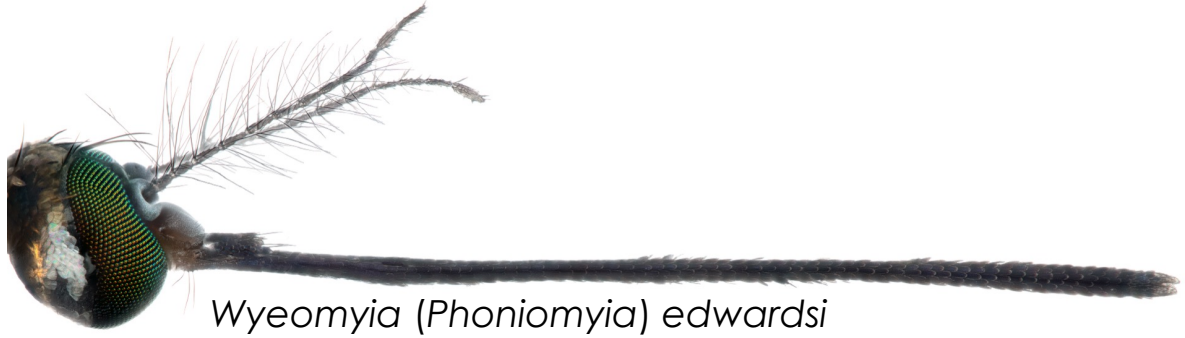
## Subfamily **Culicinae**



*Toxorhynchites moctezuma*

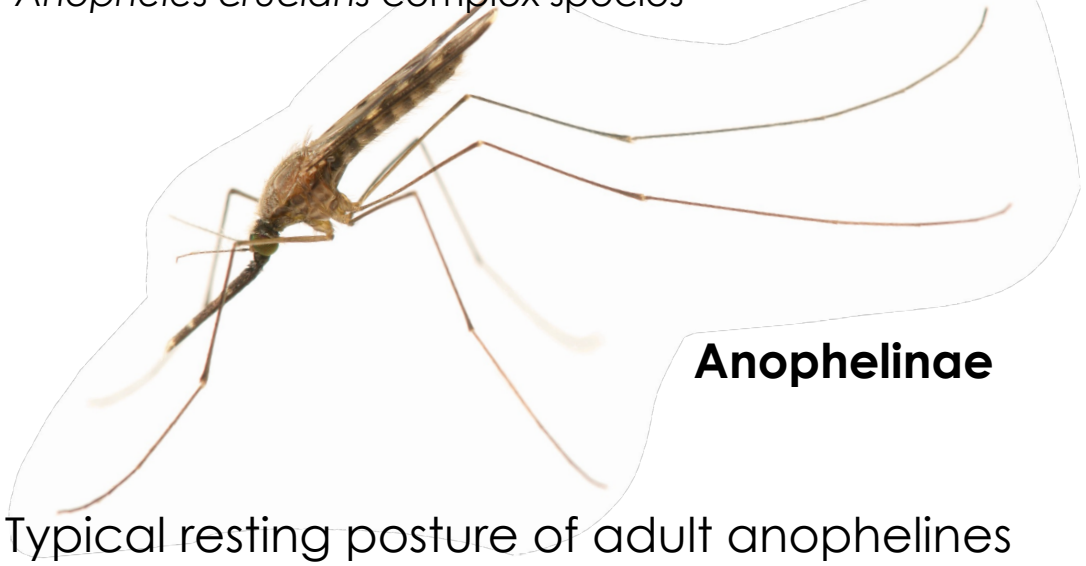


*Culex apicalis*



*Wyeomyia (Phoniomyia) edwardsi*

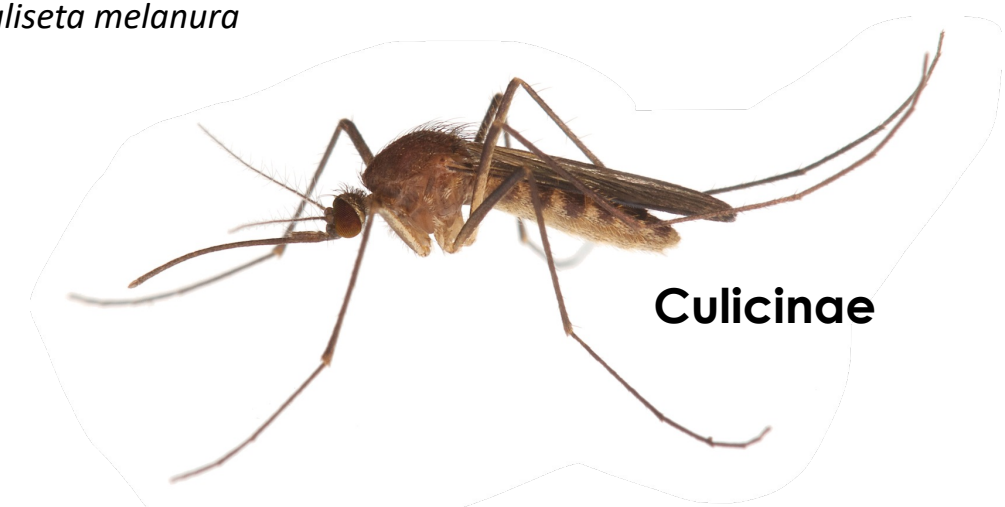
*Anopheles crucians* complex species



**Anophelinae**

Typical resting posture of adult anophelines

*Culiseta melanura*



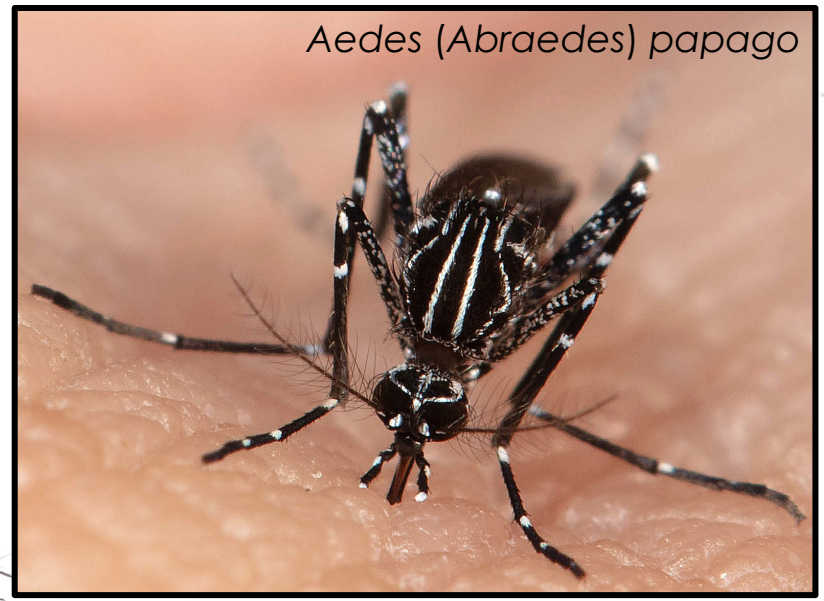
**Culicinae**

Typical resting posture of adult culicines

*Anopheles apicimacula*

Subfamily

# Culicinae

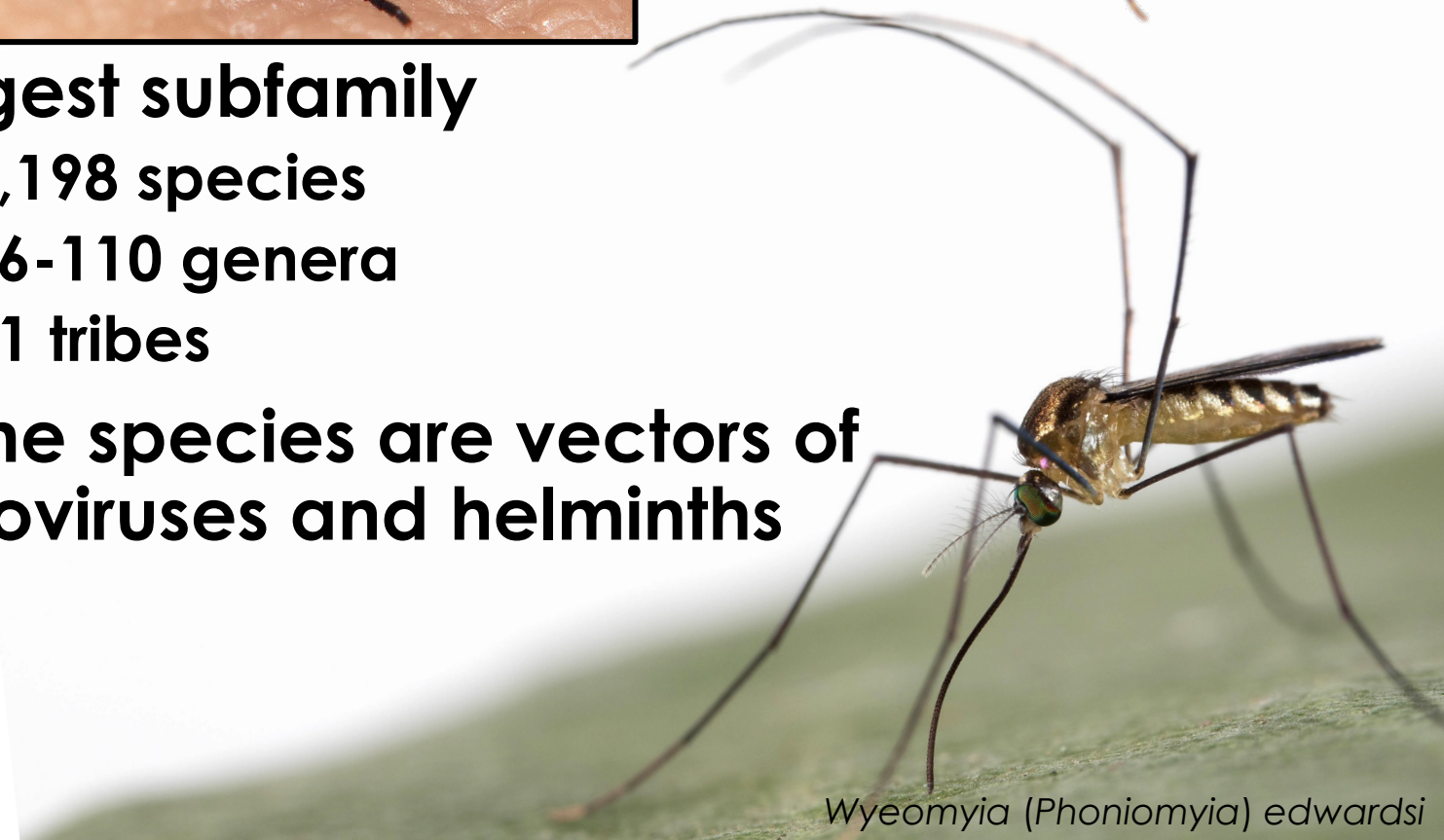




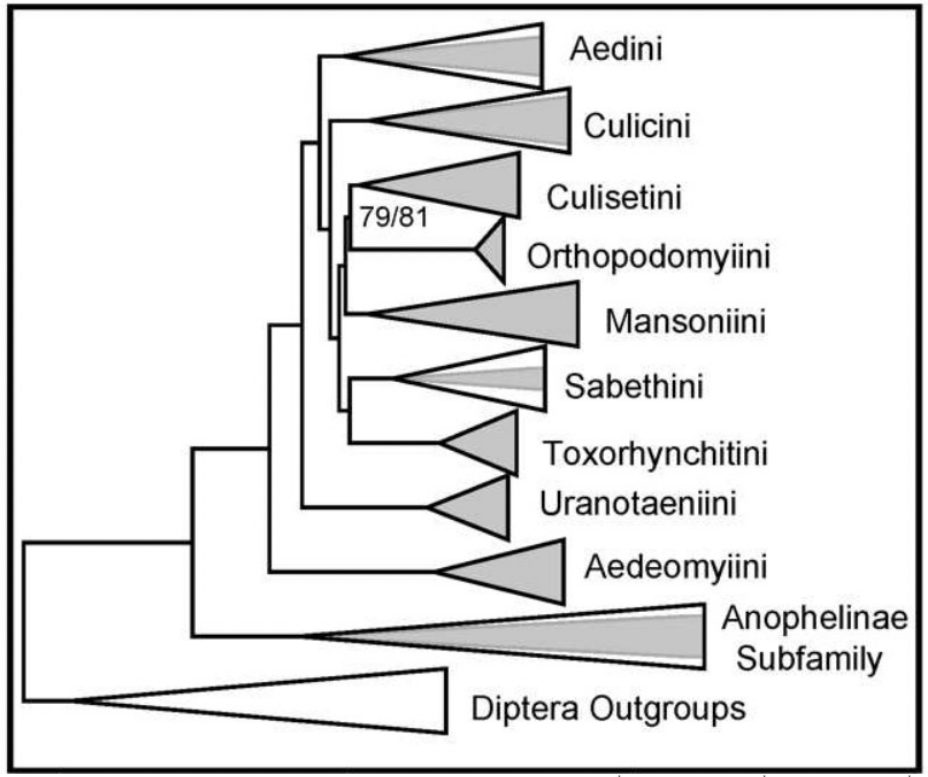


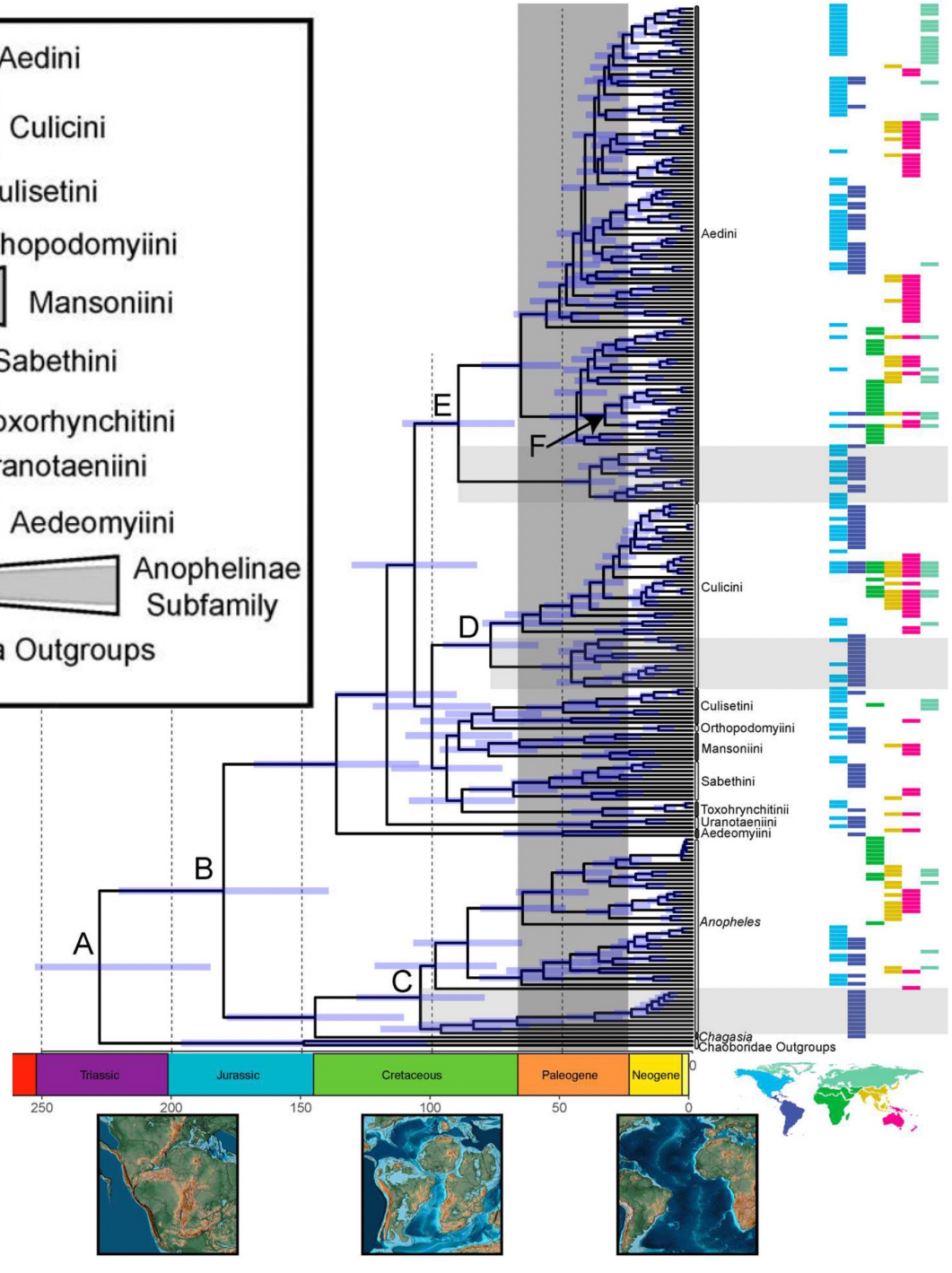



- **Largest subfamily**
  - **3,198 species**
  - **36-110 genera**
  - **11 tribes**
- **Some species are vectors of arboviruses and helminths**



**More information:**
Soghigian et al. 2023. Phylogenomics reveals the history of host use in mosquitoes. Nature Communications 14: 6252.




*Chagasia bathana*



*Aedeomyia squamipennis*



Subfamily Culicinae

# Tribe Aedeomyiini

- Seven species, one in Americas
- Low medical importance
- Associated with avian hosts



*Aedeomyia squamipennis* pupa and larva





*Aedeomyia catasticta*

*Aedeomyia squamipennis*, wing





Subfamily Culicinae

# Tribe Uranotaeniini



*Uranotaenia pulcherrima*



*Uranotania (Uranotaenia) sp.*



*Uranotaenia sapphirina*

- Small, often with metallic scales
- Diverse (276 sp.), poorly known
- Associated with ectothermic hosts



*Uranotaenia lowii*



*Uranotaenia calosomata*

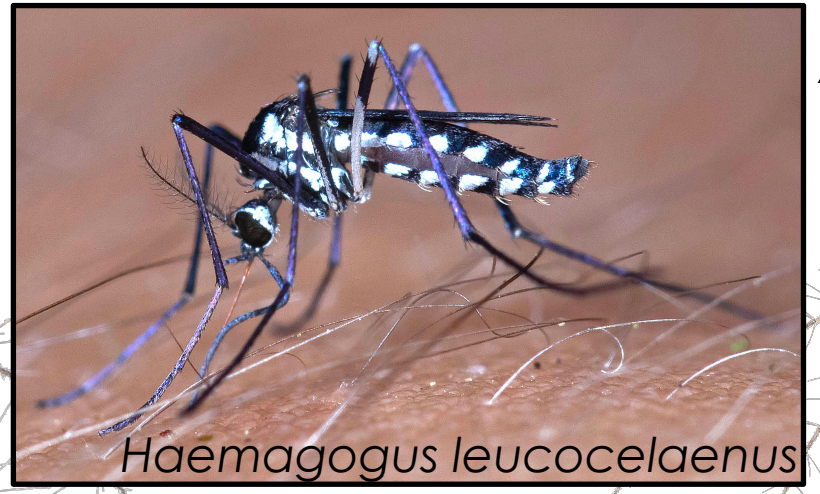
Subfamily Culicinae

# Tribe Aedini

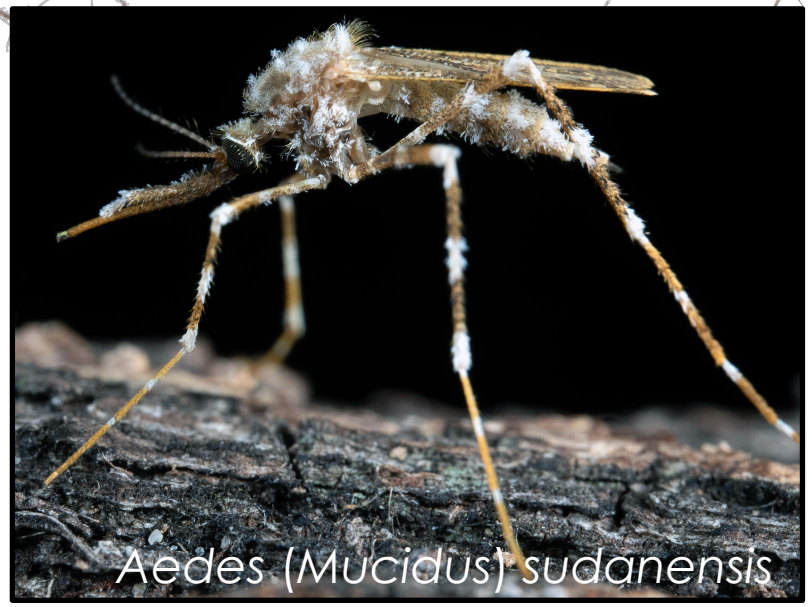
- Largest mosquito tribe: 1,296 species
- Global distribution (except southernmost latitudes)
- Some species transmit important arboviruses



*Psorophora (Grabhamia) cingulata*

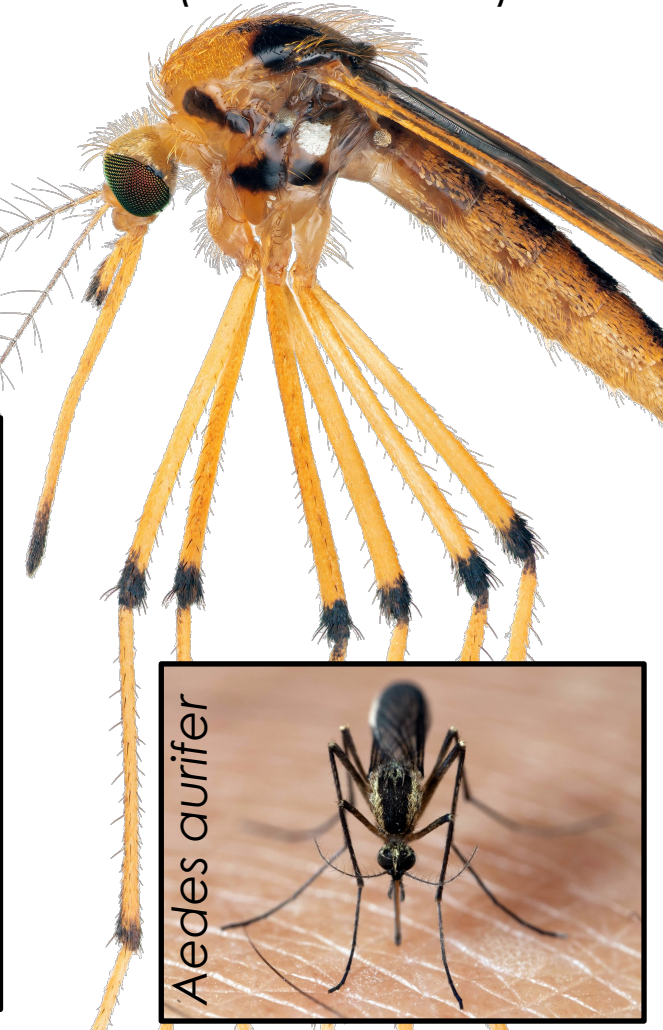


*Haemagogus leucocelaenus*



*Aedes (Mucidus) sudanensis*

*Aedes (Ochlerotatus) fulvus*





*Aedes aurifer*

Subfamily Culicinae

# Tribe Culicini

- 817 species, global distribution
- Genera:
  - *Culex*
  - *Deinocerites*
  - *Lutzia*
  - *Galindomyia*

*Culex (Carrollia) secundus*



*Deinocerites cancer*





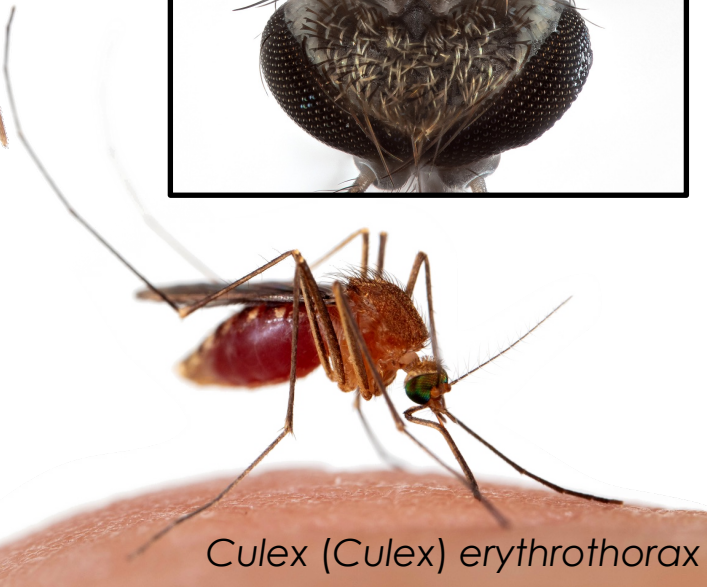
*Culex (Neoculex) apicalis*



*Culex (Culex) thriambus*

*Culex (Melanconion) spissipes*



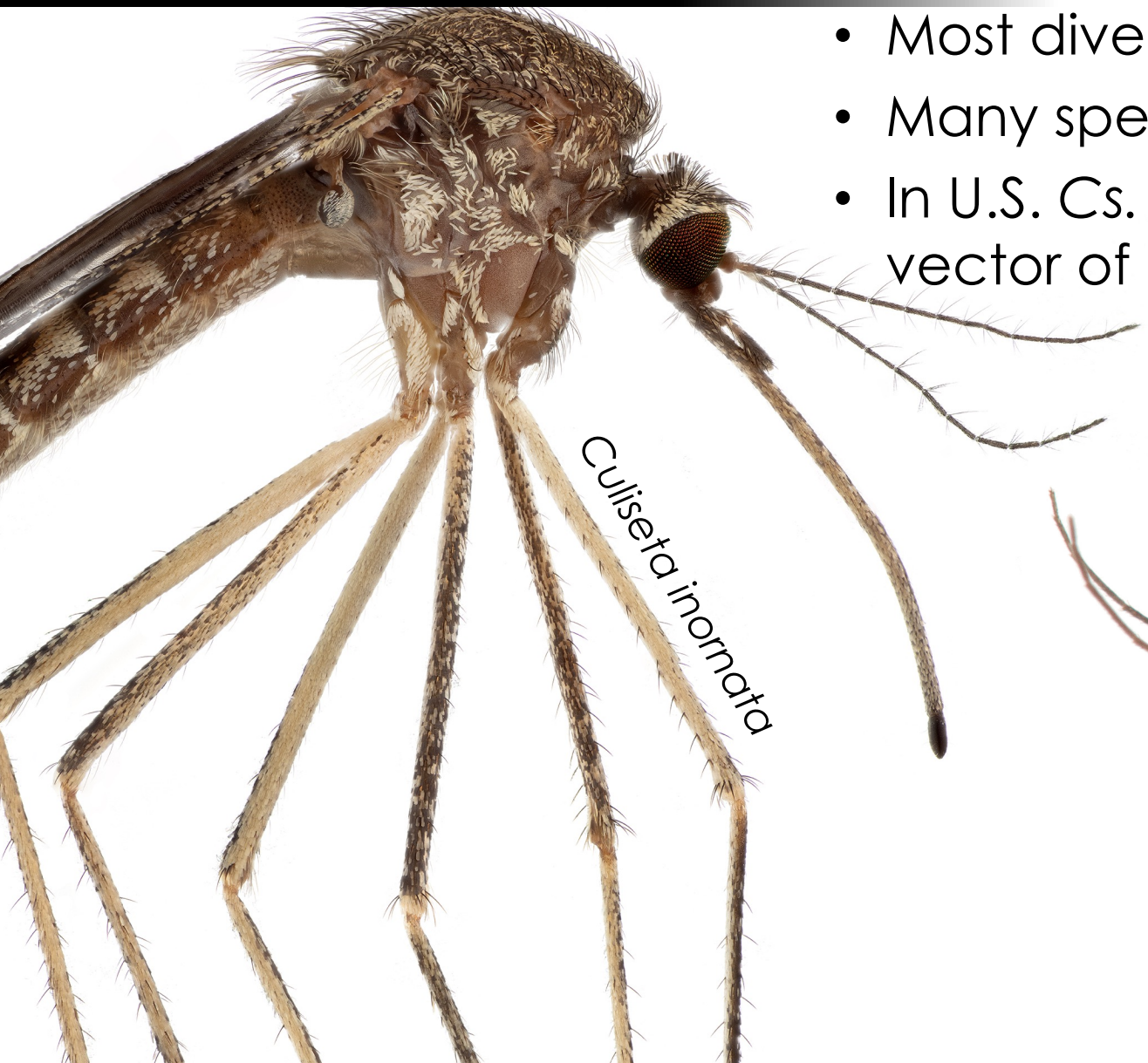


*Culex (Culex) erythrothorax*

Subfamily Culicinae

# Tribe Culisetini

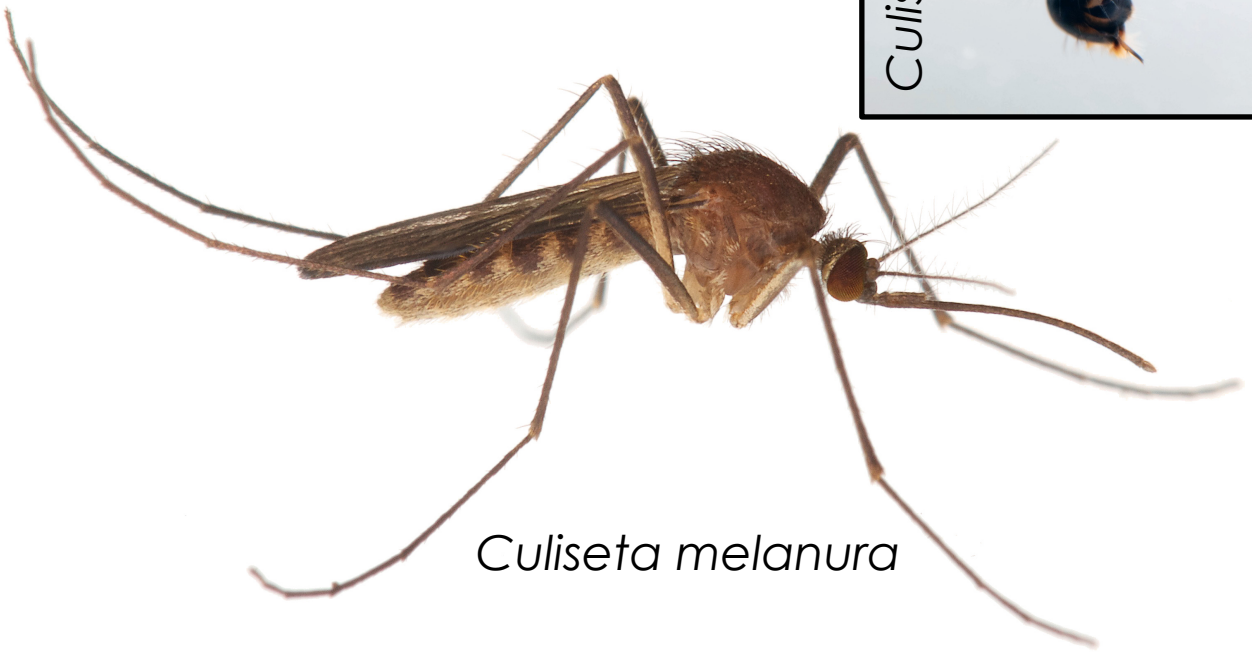
- 41 species, 8 in North America
- Most diverse at middle latitudes
- Many species are cold-adapted
- In U.S. *Cs. melanura* is the primary vector of EEE



*Culiseta inornata*



*Culiseta incidens*



*Culiseta melanura*

Subfamily Culicinae

# Tribe Orthopodomyiini

- 36 species, poorly known
- Hosts unknown, possibly birds?
- Associated with tree holes

*Orthopodomyia signifera*





*Orthopodomyia kummi*





*Orthopodomyia kummi*

Subfamily Culicinae

# Tribe Mansoniini

- Two genera, 82 species
- Larvae with saw-like siphon, used to pierce plant tissue from which they breathe



*Mansonia titillans*, wing

- Broad wing scales present in all *Mansonia*, some *Coquillettidia*



*Coquillettidia perturbans*




*Mansonia dyari*





*Coquillettidia chrysosoma*



Subfamily Culicinae

# Tribe Toxorhynchitini

- Predatory larvae
- Adults do not blood feed
- 101 species
- Pantropical

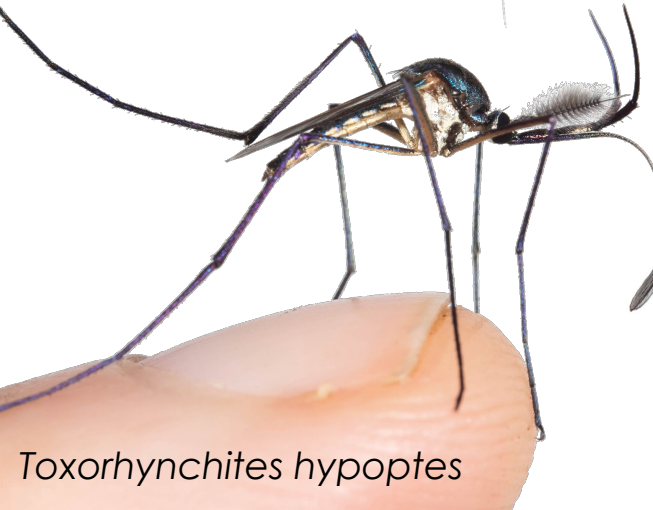


*Toxorhynchites purpureus*

*Toxorhynchites moctezuma*



*Toxorhynchites haemorrhoidalis*



*Toxorhynchites hypoptes*



*Toxorhynchites rutilus*

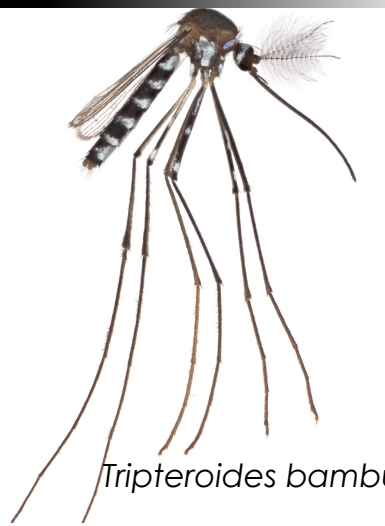
Subfamily Culicinae

# Tribe Sabethini

- Associated with phytotelm larval habitats
- Few species involved in arbovirus transmission
- Diverse in the tropics: 14 genera, 447 species
- Diurnal, some species most active in canopy



*Sabethes (Peytonulus) undosus*



*Tripteroides bambusa*



*Johnbelkinia leucopus*



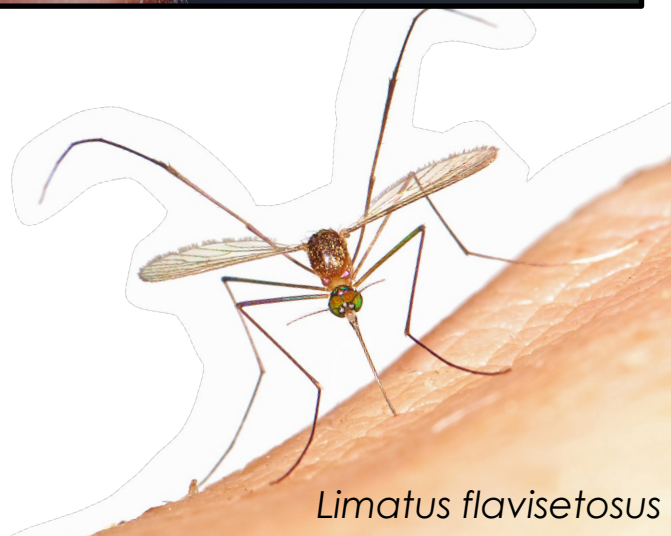
*Wyeomyia (Phoniomyia)* sp., biting a nose



*Sabethes (Sabethes) albiprivus*



*Wyeomyia (Wyeomyia) mitchellii*



*Limatus flavisetosus*

# Mosquitoes are holometabolous.

**Egg**



**Larva**



**Pupa**



**Adult**



*Aedes purpureipes*

***Photos: Nathan Burkett-Cadena**



*Culex secutor*



*Culex secutor*



*Psorophora cingulata*



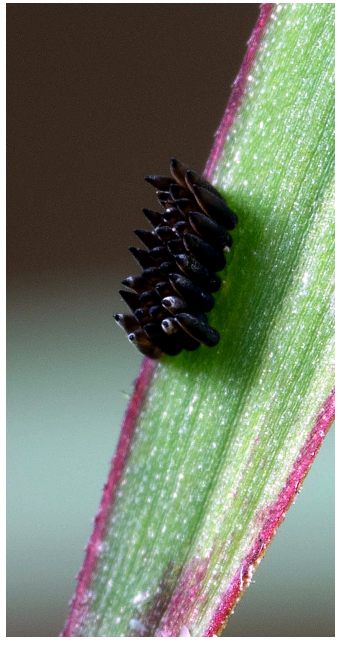
*Aedes purpureipes*



*Aedes fulvus*



*Anopheles albimanus**



*Culex erraticus*



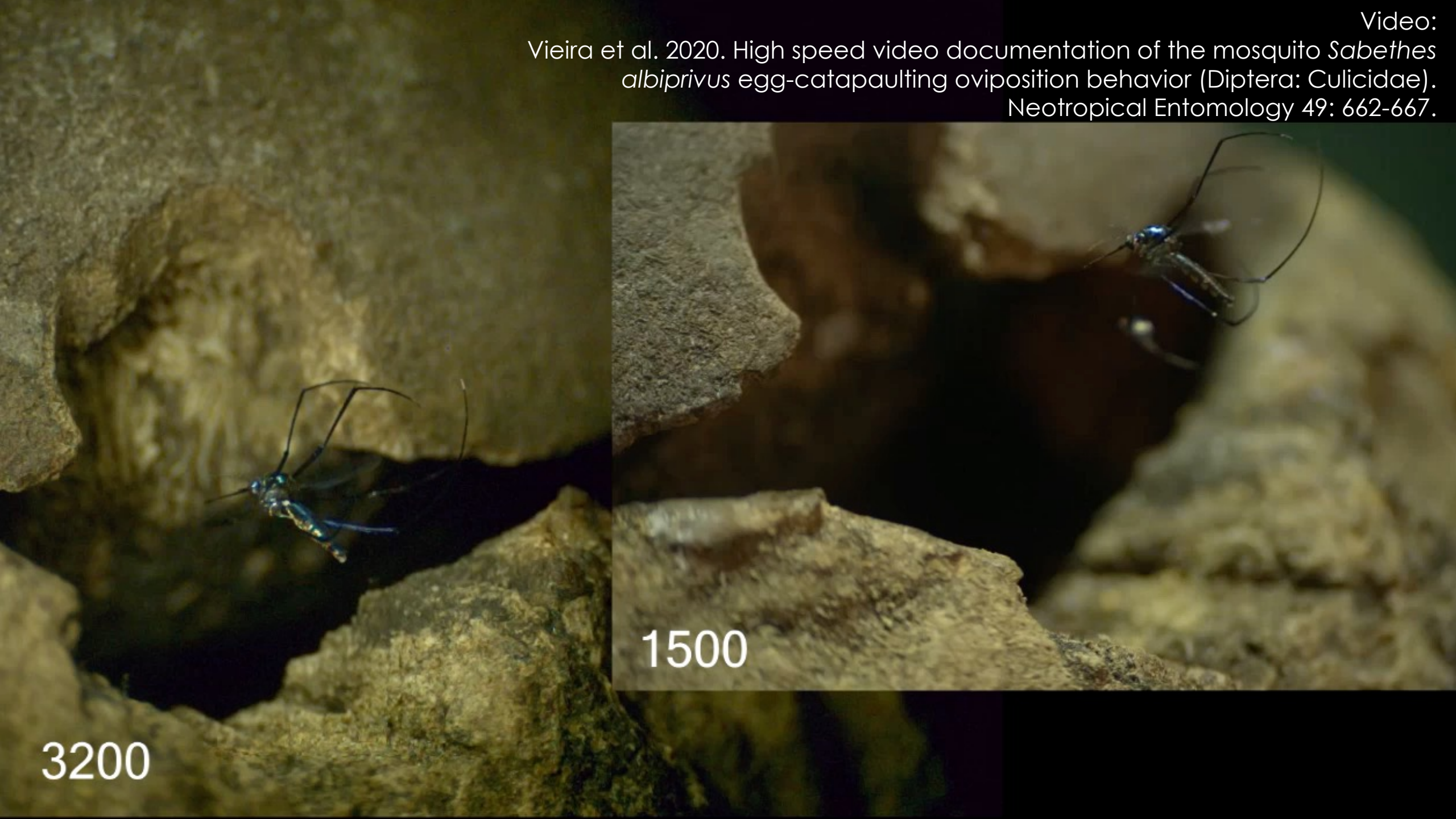
*Culex pilosus**



*Toxorhynchites purpureus*

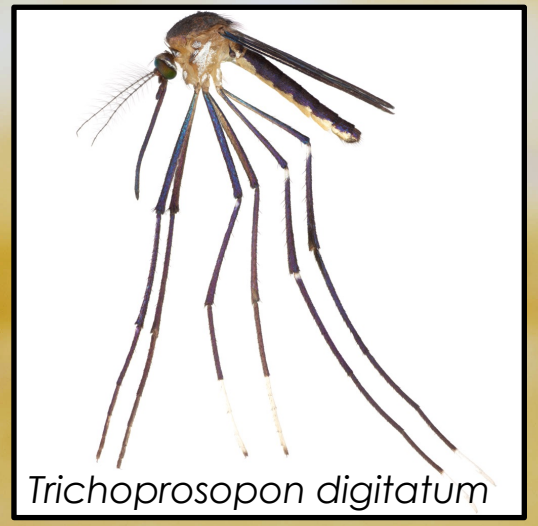


*Uranotaenia sapphirina*




Video:
Vieira et al. 2020. High speed video documentation of the mosquito *Sabethes albiprivus* egg-catapaulting oviposition behavior (Diptera: Culicidae). Neotropical Entomology 49: 662-667.





*Trichoprosopon digitatum*

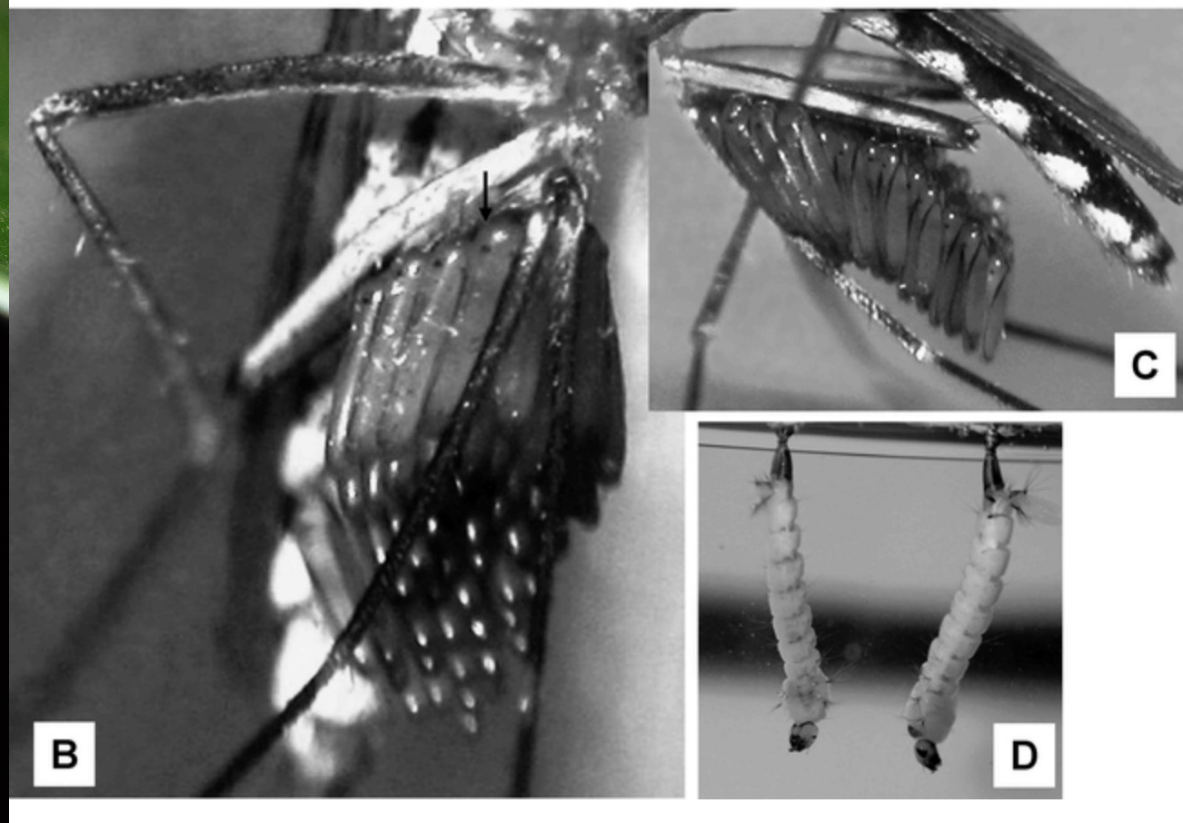

Egg-guarding *Tr. Digitatum* lifted out of cacao husk; Photo: Phil Lounibos

Female *Trichoprosopon digitatum* guarding eggs, Ilha Grande, Brazil

Miyagi et al. 2005. Female *Armigeres* (*Leicesteria*) *flavus* holding an egg raft with her hind legs. Journal of the American Mosquito Control Association 21: 466-468.

*Armigeres cf. joloensis*, Negros Oriental, Philippines






*Psorophora horrida*



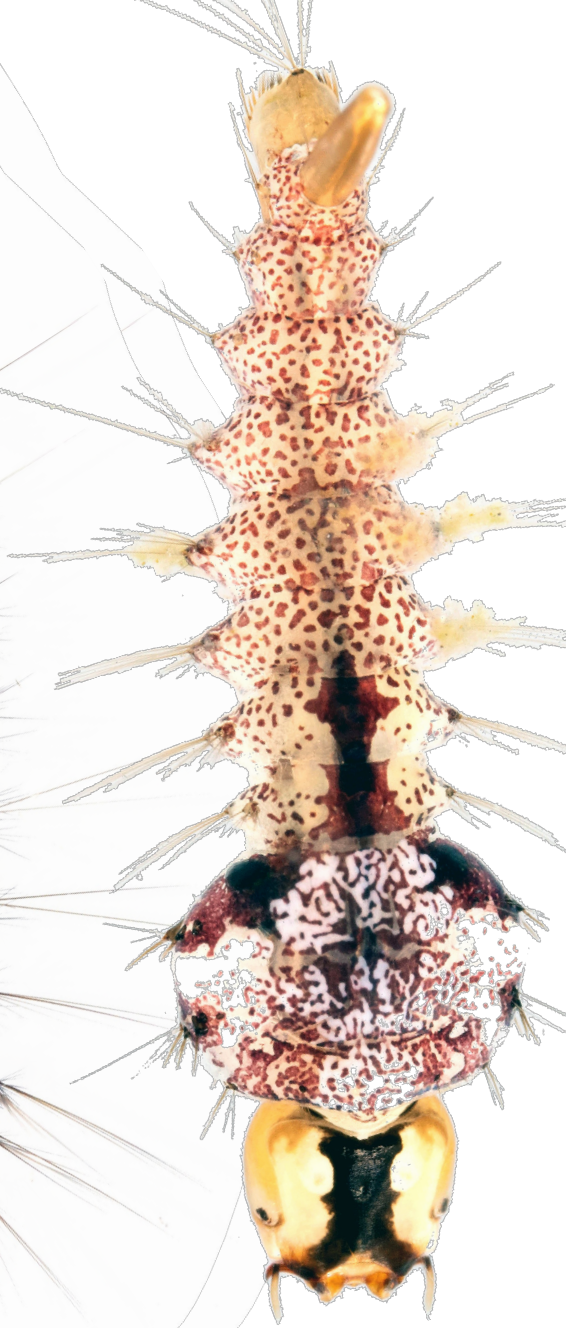
*Anopheles judithae*



*Microculex* sp.



*Wyeomyia oblita*



*Toxorhynchites purpureus*

Subfamily **Culicinae**



*Aedes atropalpus*

Subfamily **Culicinae**



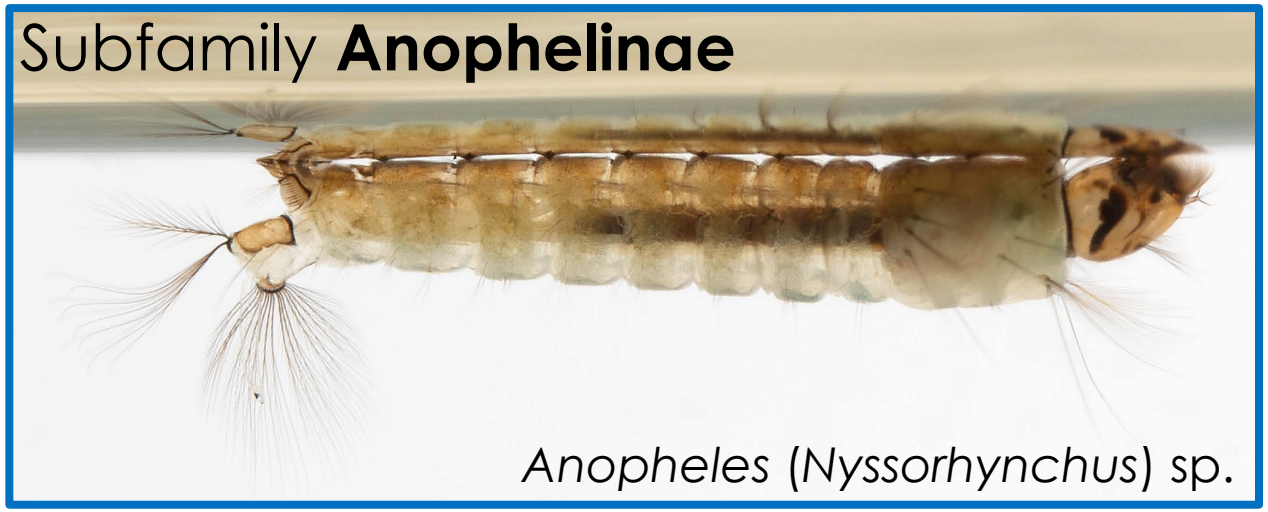
*Aedes burgeri*

Subfamily **Culicinae**



*Culiseta incidens*

Subfamily **Anophelinae**



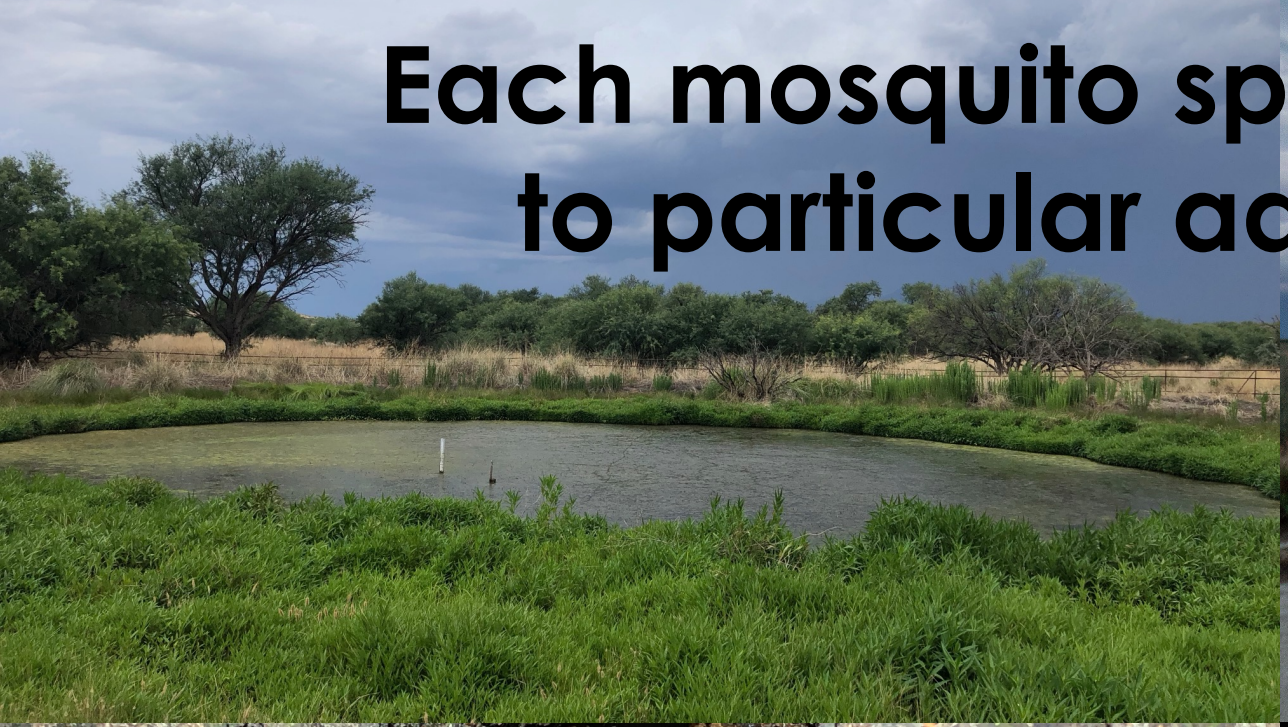
*Anopheles (Nyssorhynchus) sp.*

Subfamily **Anophelinae**



*Anopheles judithae*

# Each mosquito species is adapted to particular aquatic habitats.









# Permanent Wetlands









# Permanent Wetlands



*Gambusia* sp. consuming *Aedes albopictus* larvae



*Mansonia titillans* / Photo: Nathan Burkett-Cadena

# Permanent Wetlands

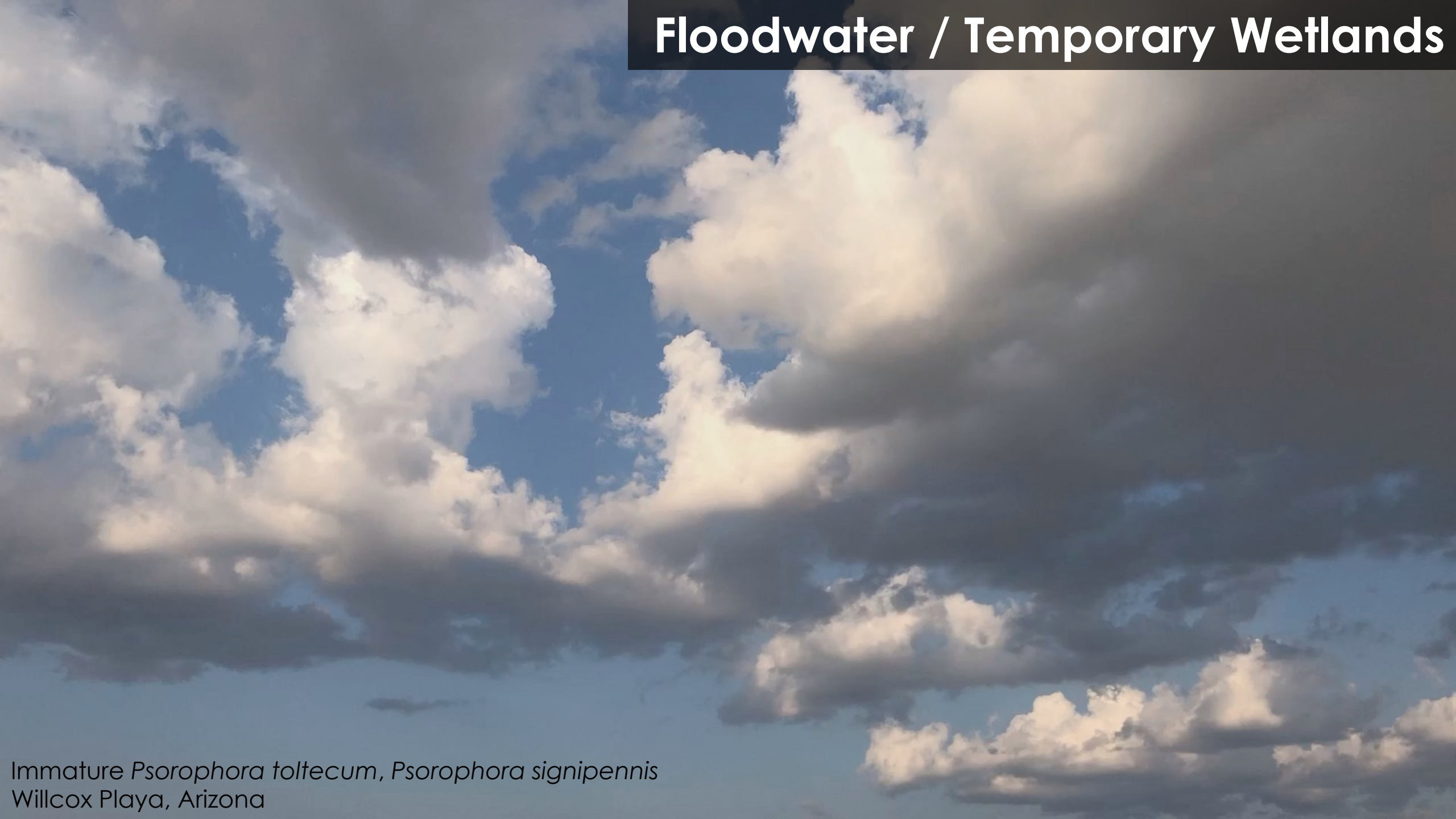


Water lettuce, *Pistia stratiotes*

# Floodwater / Temporary Wetlands



# Floodwater / Temporary Wetlands



Immature *Psorophora toltecum*, *Psorophora signipennis*
Willcox Playa, Arizona

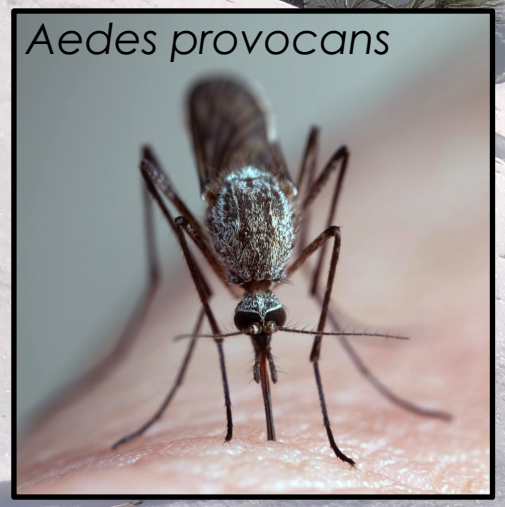
# Floodwater / Temporary Wetlands



*Psorophora horrida*

Ephemeral wetlands

# Floodwater / Temporary Wetlands



*Aedes provocans*

Snowmelt



*Aedes communis*

# Rock Pools

Rock pool, Cochise Stronghold, Dragoon Mtns., Arizona



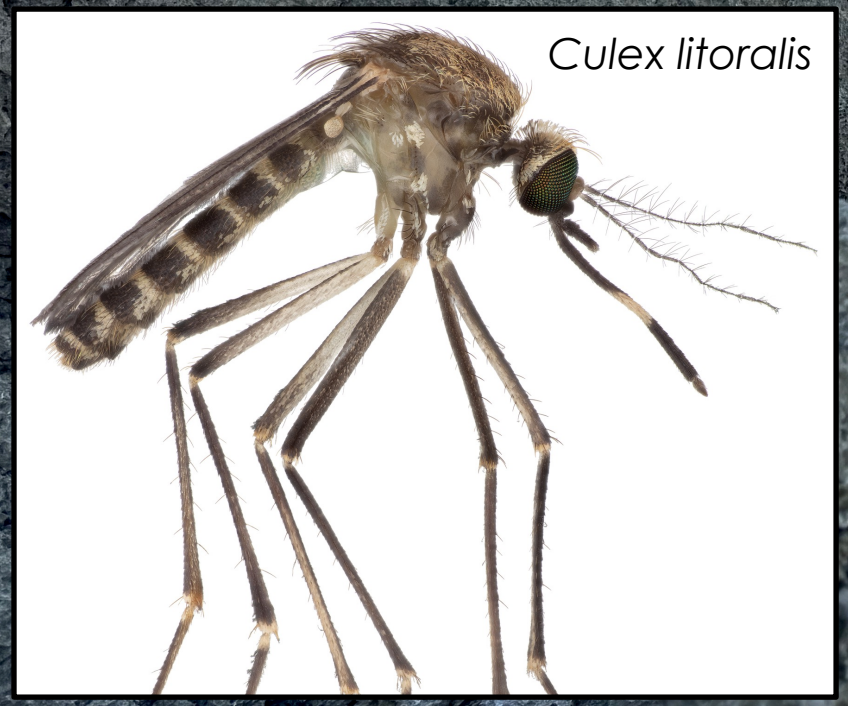
*Aedes epactius*



# Rock Pools

Rock pools in coral limestone, Oka Point, Guam





# Crustacean Burrows



*Deinocerites* sp., resting in land crab burrow, Isla Coiba, Panama



*Cardisoma guanhumi*



*Cardisoma guanhumi* burrow



Gravid female *Culex corniger* resting in crab burrow



*Aedes baisasi*

# Crustacean Burrows



*Cardisoma guanhumi* burrow, Indian River Co., Florida

# Phytotelmata: Bromeliads






*Culex* (*Micraedes*) *biscaynensis*

*Culex* (*Microculex*) sp., Rio de Janeiro, Brazil



# Phytotelmata: Pitcher Plants

*Wyeomyia smithii*, in *Sarracenia rosea* pitcher, Sumatra, Florida

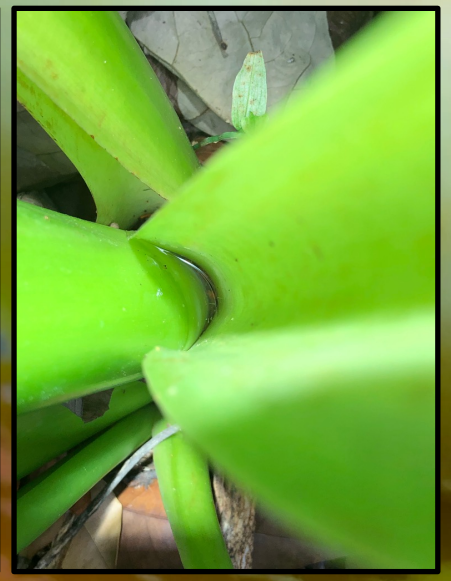
# Phytotelmata:
# Pitcher Plants



*Wyeomyia smithii*, in *Sarracenia rosea* pitcher, Sumatra, Florida

# Phytotelmata:
# Flower Bracts, Leaf Axils





*Culex antillummagnorum* larvae in aroid leaf axils





*Topomyia* sp. larvae in ginger flower bracts, Philippines

Mosquito larvae in bracts of *Heliconia wagneriana*, Costa Rica

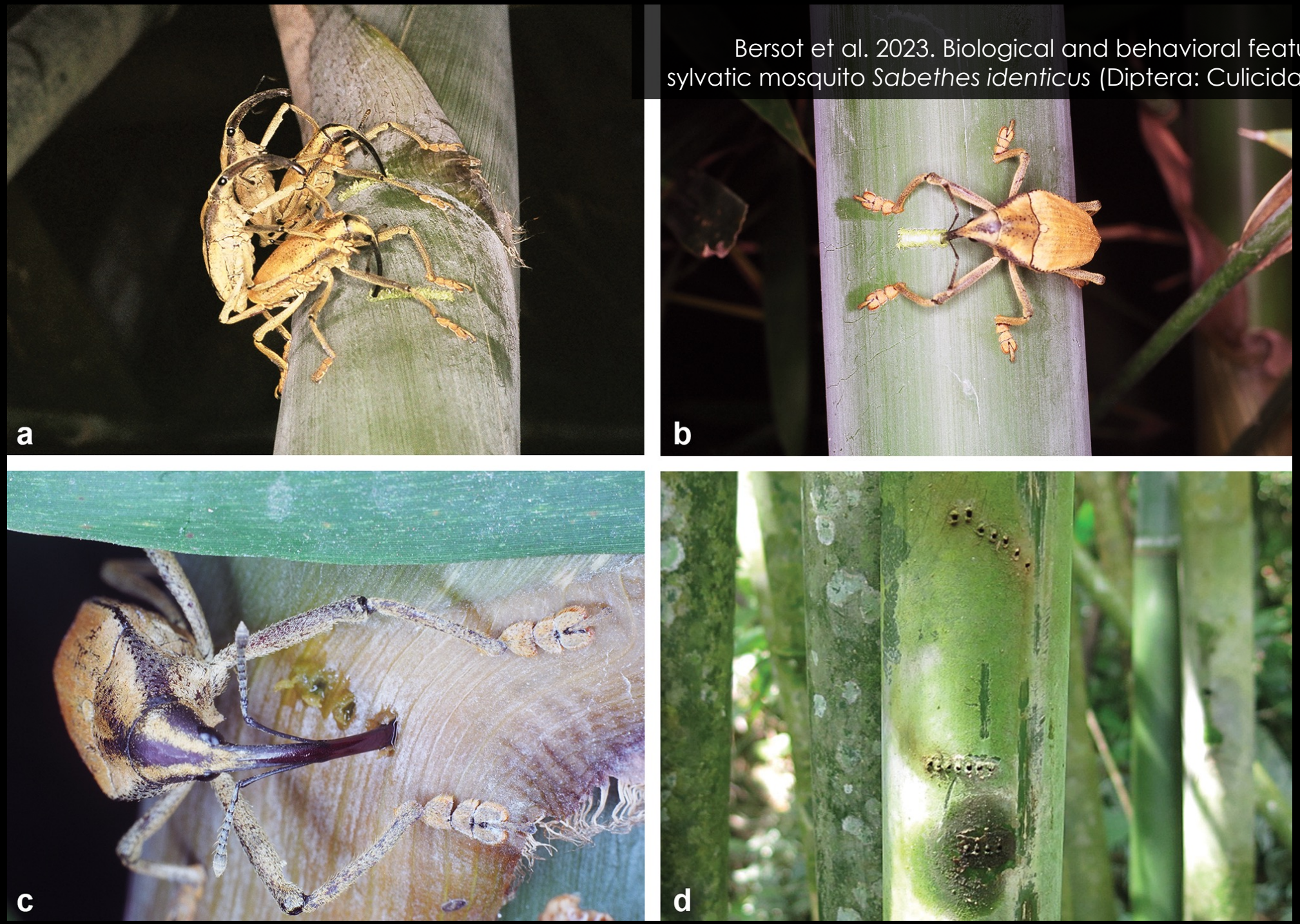
# Phytotelmata:
# Fruit Husks and Flower Spathes



*Armigeres* sp. in coconut husk, Casaroro Falls, Negros Oriental, Philippines


Phytotelmata:
Bamboo

Images and video:
Bersot et al. 2023. Biological and behavioral features and colonization of the sylvatic mosquito *Sabethes identicus* (Diptera: Culicidae). PLOS One 18: e0296289.





Images and video:
Bersot et al. 2023. Biological and behavioral features and colonization of the sylvatic mosquito *Sabethes identicus* (Diptera: Culicidae). PLOS One 18: e0296289.

Images and video:
Bersot et al. 2023. Biological and behavioral features and colonization of the sylvatic mosquito *Sabethes identicus* (Diptera: Culicidae). PLOS One 18: e0296289.

# Phytotelmata: Tree Holes




Blue palo verde, *Parkinsonia florida*, tree hole, foothills of Santa Rita Mountains, Arizona



*Hesperus arizonicus* hunting mosquito larvae

More information:
Reeves and Chambers. In review. Underwater predation of mosquito larvae by the rove beetle *Hesperus arizonicus* (Coleoptera: Staphylinidae) in the Sky Islands Region, Arizona, USA. Southwestern Naturalist.

# Containers








*Culex biscaynensis*, Fairchild Tropical Garden, Miami-Dade Co., Florida



*Psorophora ciliata*

Photo: Nathan Burkett-Cadena

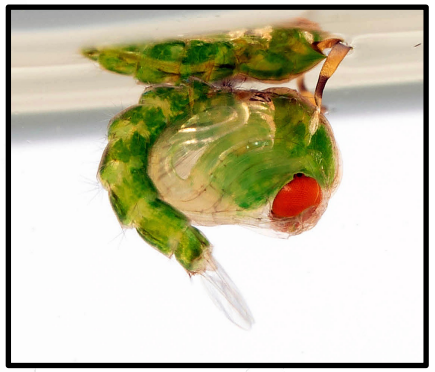
*Aedes* (*Mucidus*) *sudanensis*

*Toxorhynchites hypoptes*

*Toxorhynchites purpureus* / *Wyeomyia* (*Phoniomyia*) sp.

*Toxorhynchites rutilus* pupa

**Respiratory trumpets**



*Culex* (*Melanoconion*) sp.

**Paddles**

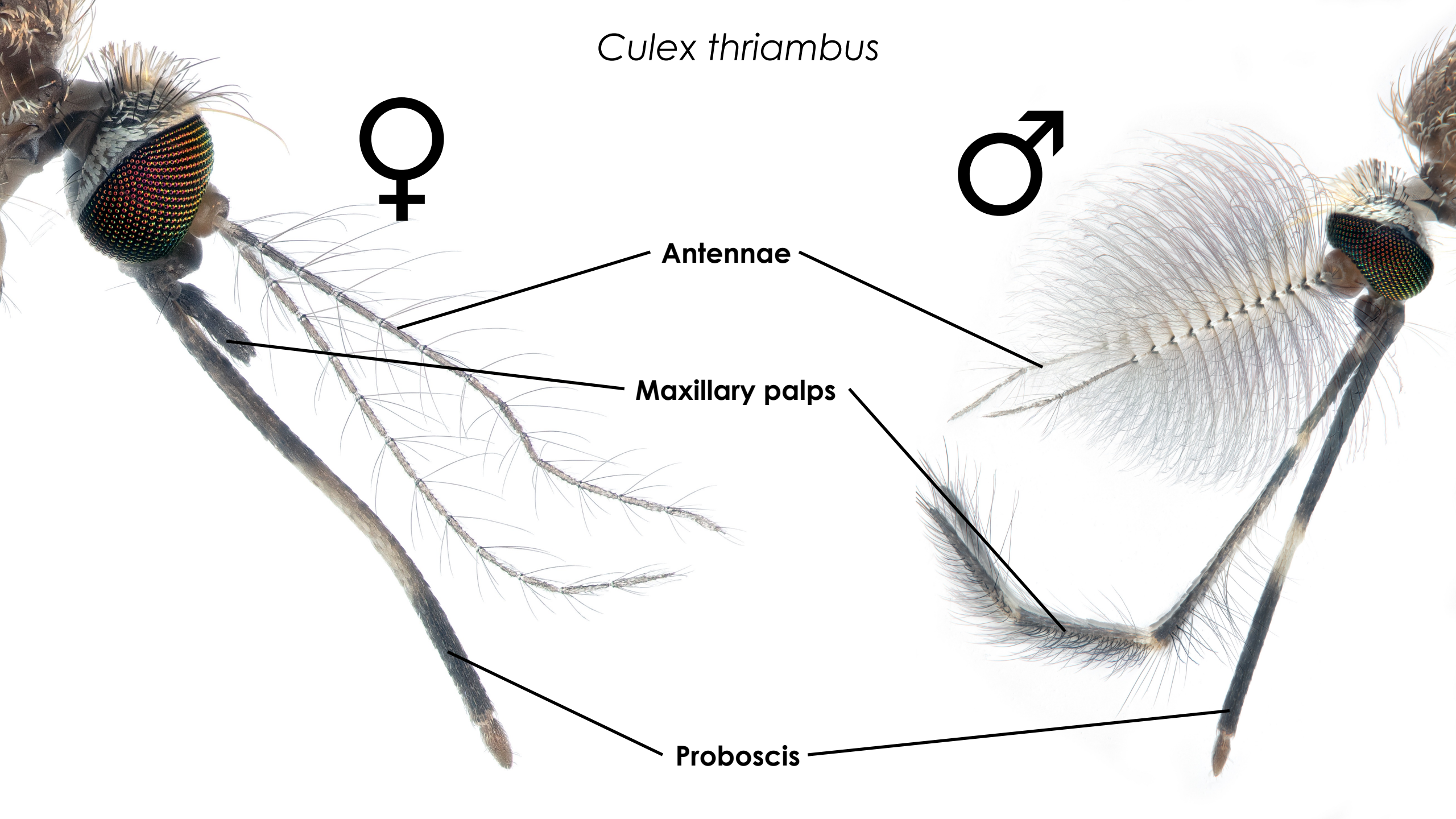


*Wyeomyia* (*Phoniomyia*) *edwardsi*



*Culex nigripalpus*, Vero Beach, Florida

*Culex thriambus*





*Psorophora horrida*, male



*Sabethes (Sabethes) albiprivus* mid-tibia



*Limatus asulleptus,*
male, underside of head



*Sabethes (Sabethes) albiprivus*



*Sabethes (Sabethes) gymnothorax* mid-tibia


Male *Deinocerites cancer* guarding pupae



*Culex erraticus* feeding from damaged leaf


*Aedes aegypti* feeding from *Passiflora edulis* extrafloral nectary
Vero Beach, Florida

*Malaya genurostris*
Pulangbato Hot Springs
Negros Oriental, Philippines



Photo: Taku Shimada, antroom.jp


*Culex nigripalpus* nectaring from mango flowers, Vero Beach, Florida

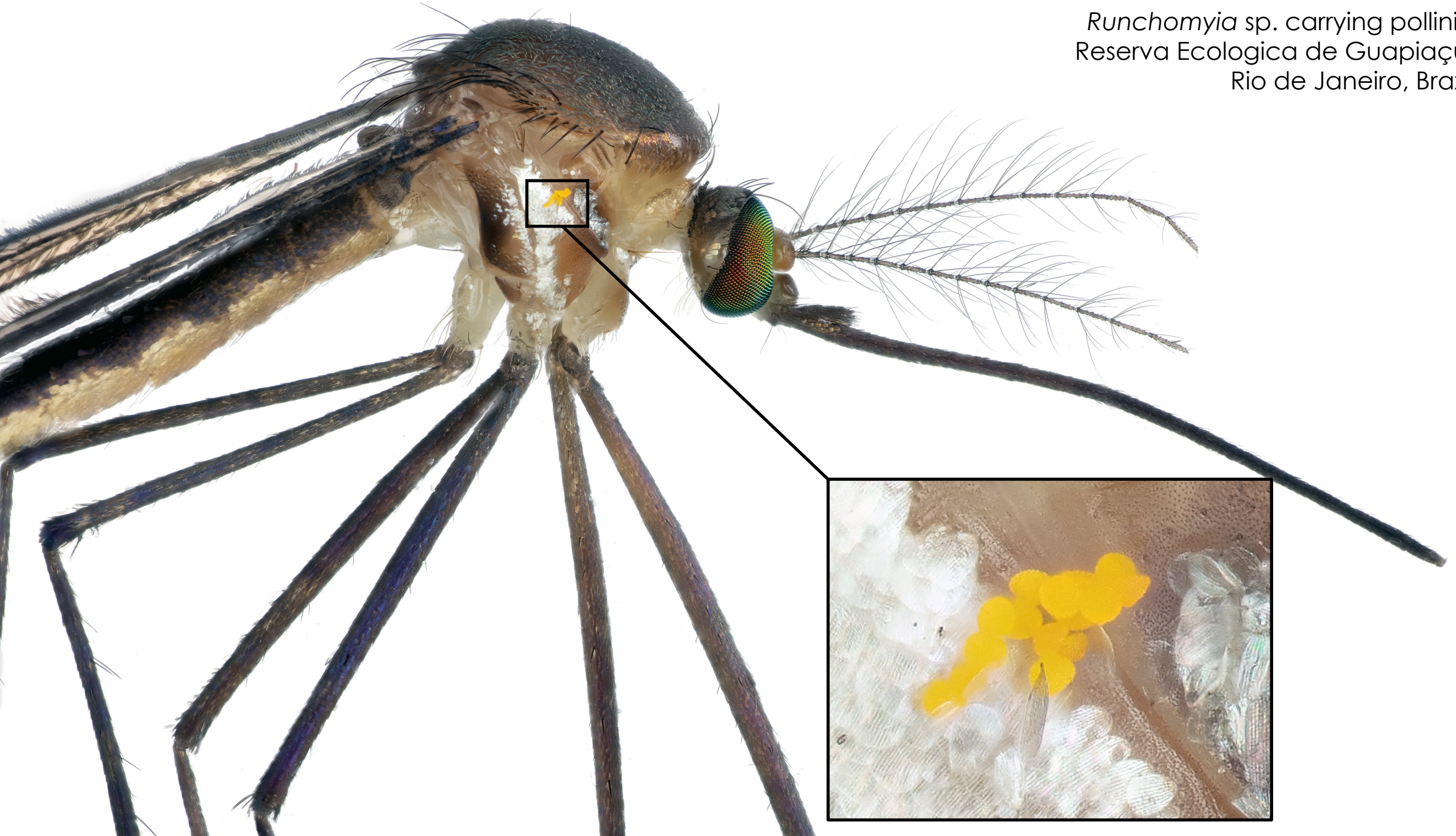
*Cq. perturbans* and *Ae. vexans* nectaring from common milkweed
Waseca Co., Minnesota





*Psorophora horrida* carrying pollen
Gainesville, Florida

*Runchomyia* sp. carrying pollinia
Reserva Ecologica de Guapiaçu,
Rio de Janeiro, Brazil





*Aedes pertinax*
Vero Beach, Florida




*Psorophora* sp. as a vector for human botfly eggs and larvae, St. Laurent du Maroni, French Guiana

*Wyeomyia* sp. with human botfly eggs
La Selva Biological Station, Costa Rica

**Woodrat botfly**
*Cuterebra americana*





# Globally:

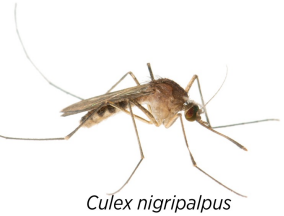
# 3,727

## described species


*Culex bahamensis*


*Aedes epactius*


*Aedes monticola*


*Culex nigripalpus*


*Aedes muelleri*


*Psorophora horrida*


*Psorophora cyanescens*


*Aedes fulvus*


*Wyeomyia smithii*


*Aedes canadensis*


*Coquillettidia perturbans*


*Aedes purpureipes*


*Orthopodomyia signifera*


*Aedes triseriatus*


*Anopheles crucians*


*Culex thriambus*


*Uranotaenia lowii*


*Aedes baisasi*

*Culex cedecei*

*Culex biscaynensis*

*Culex arizonensis*

*Orthopodomyia* kummi

*Culex territans*

*Anopheles albimanus*

*Aedes atlanticus*

*Anopheles punctipennis*

*Culiseta melanura*

*Culex quinquefasciatus*

*Aedes taeniorhynchus*

*Aedes aegypti*

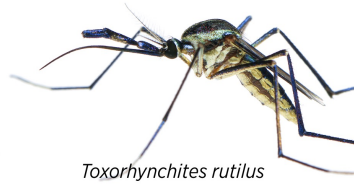
*Aedes albopictus*

*Mimomyia* sp.

*Uranotaenia sapphirina*


*Psorophora signipennis*


*Wyeomyia vanduzeei*


*Toxorhynchites rutilus*


*Aedes vexans*


*Aedeomyia catasticta*

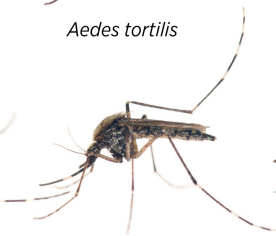

*Psorophora howardii*


*Aedes papago*


*Aedes tortilis*


*Psorophora ferox*


*Aedes japonicus*


*Aedes mitchellae*


*Psorophora ciliata*


*Aedes infirmatus*


*Culex erraticus*


*Armigeres* sp.


*Aedeomyia squamipennis*


*Culex stigmatosoma*


*Mansonia dyari*

# <2.5%

## known vectors of human pathogens

# <6.8%

## likely or potential vectors

More information:
Yee et al. 2022. Robust network stability of mosquitoes and human pathogens of medical importance. Parasites and Vectors 15: 216.

*Anopheles gambiae s.s.*
ZAMBIA: Southern Province
Macha Research Trust



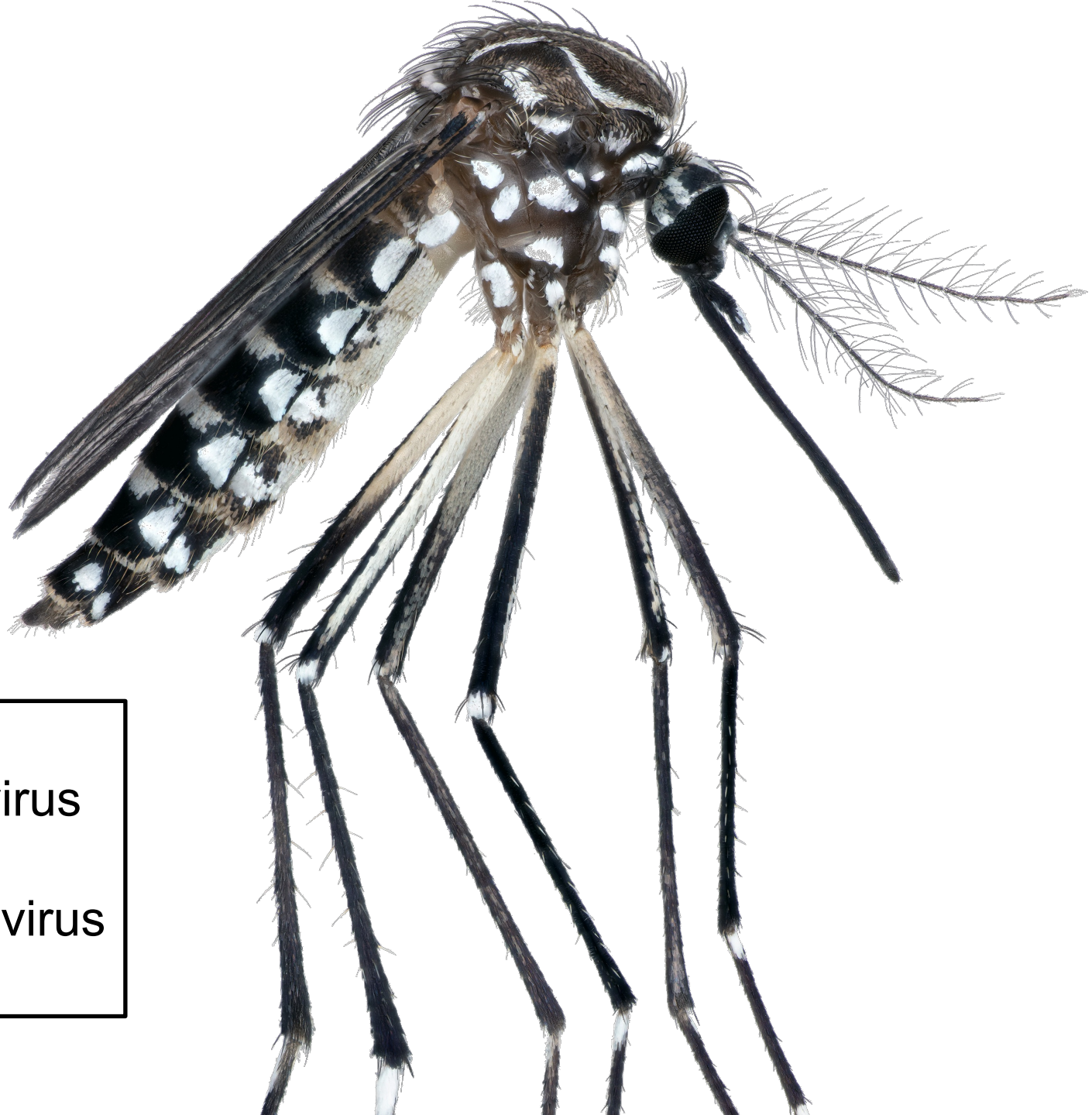
**Vector for:**

- *Plasmodium* species that cause malaria in humans

Distribution:



*Aedes aegypti*
FLORIDA: Indian River Co.
Vero Beach



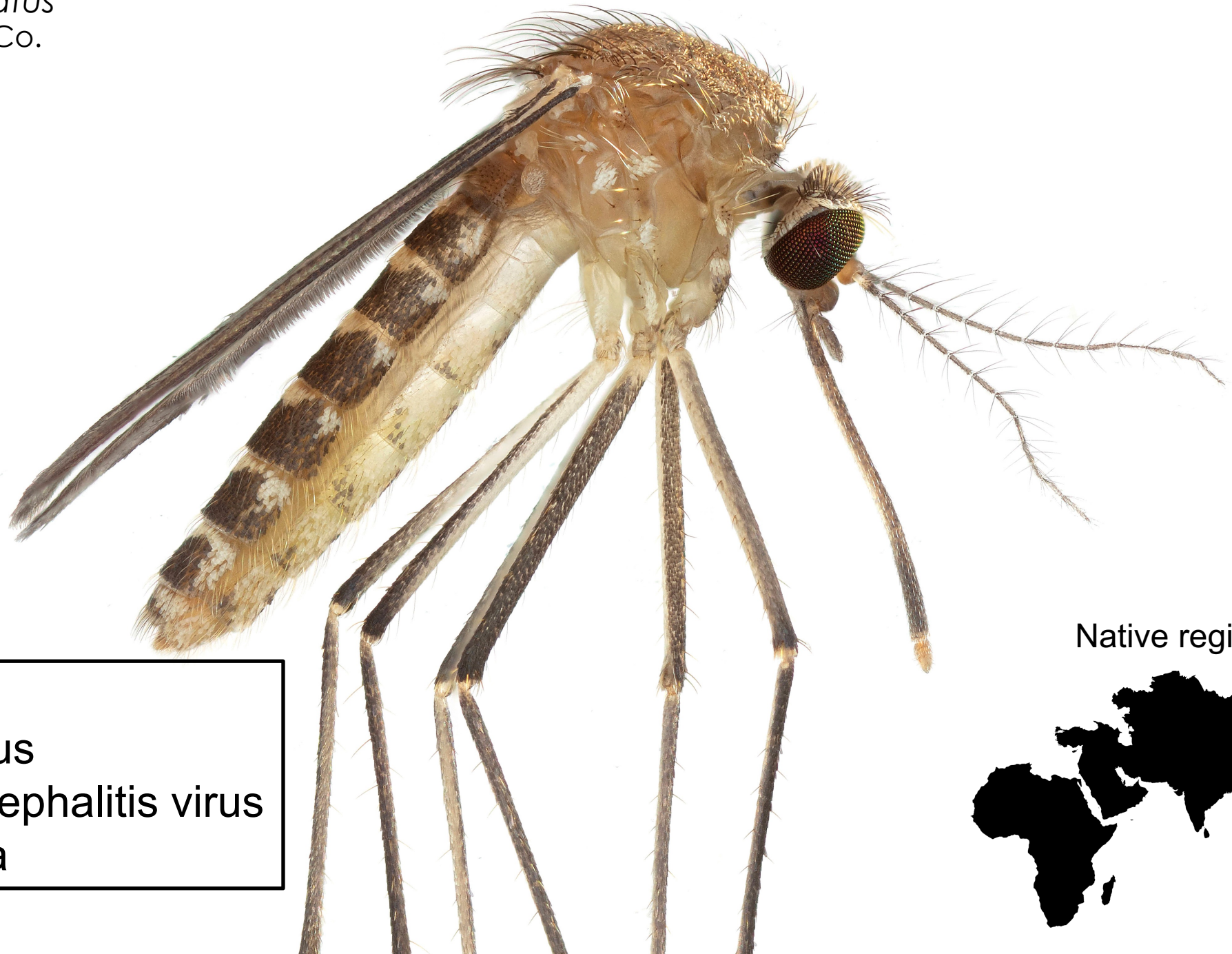
**Vector for:**

- Yellow fever virus
- Dengue virus
- Chikungunya virus
- Zika virus

Native region:



*Culex quinquefasciatus*
FLORIDA: Indian River Co.

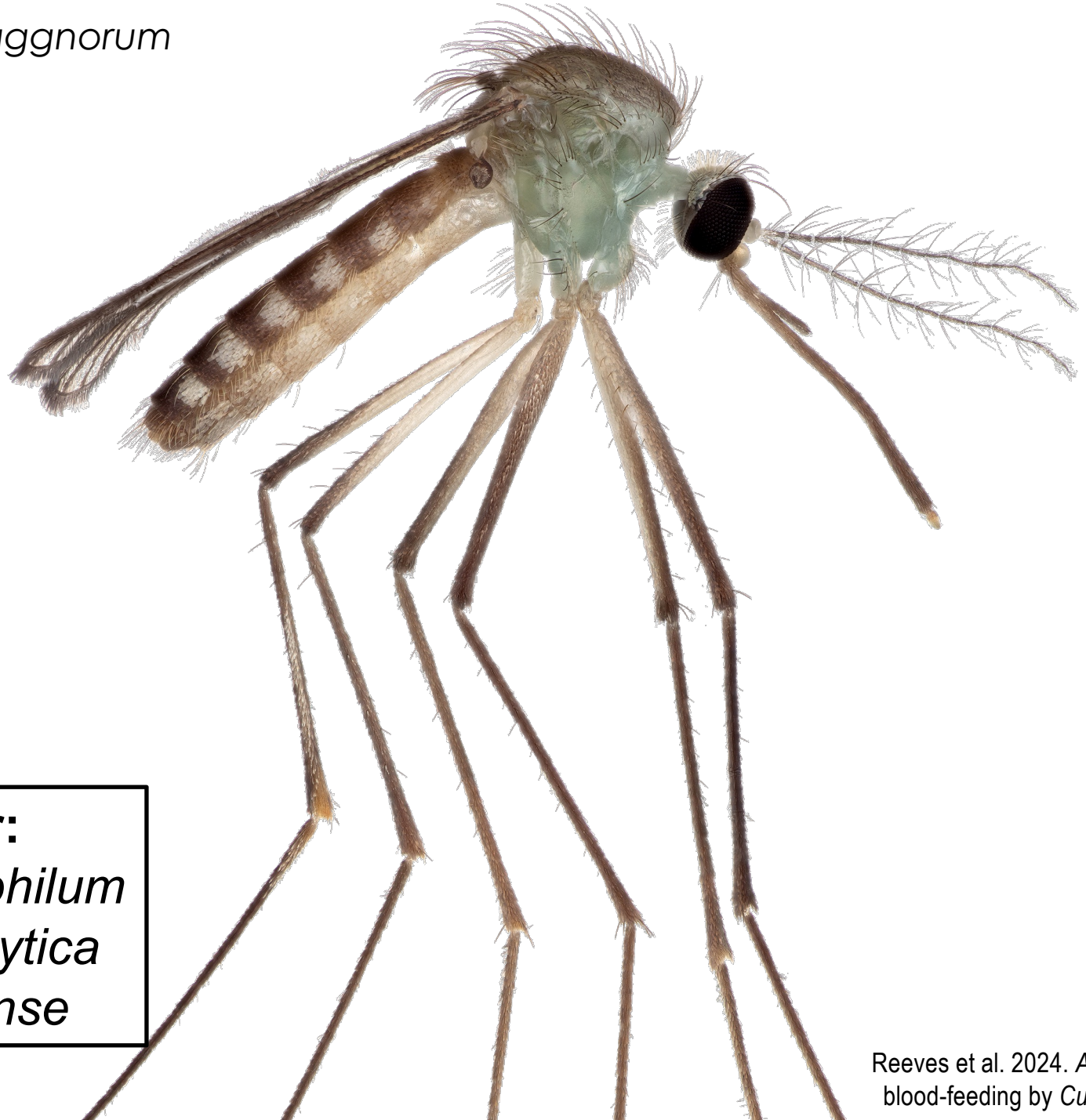


**Vector for:**

- West Nile virus
- St. Louis encephalitis virus
- Avian malaria

Native region:

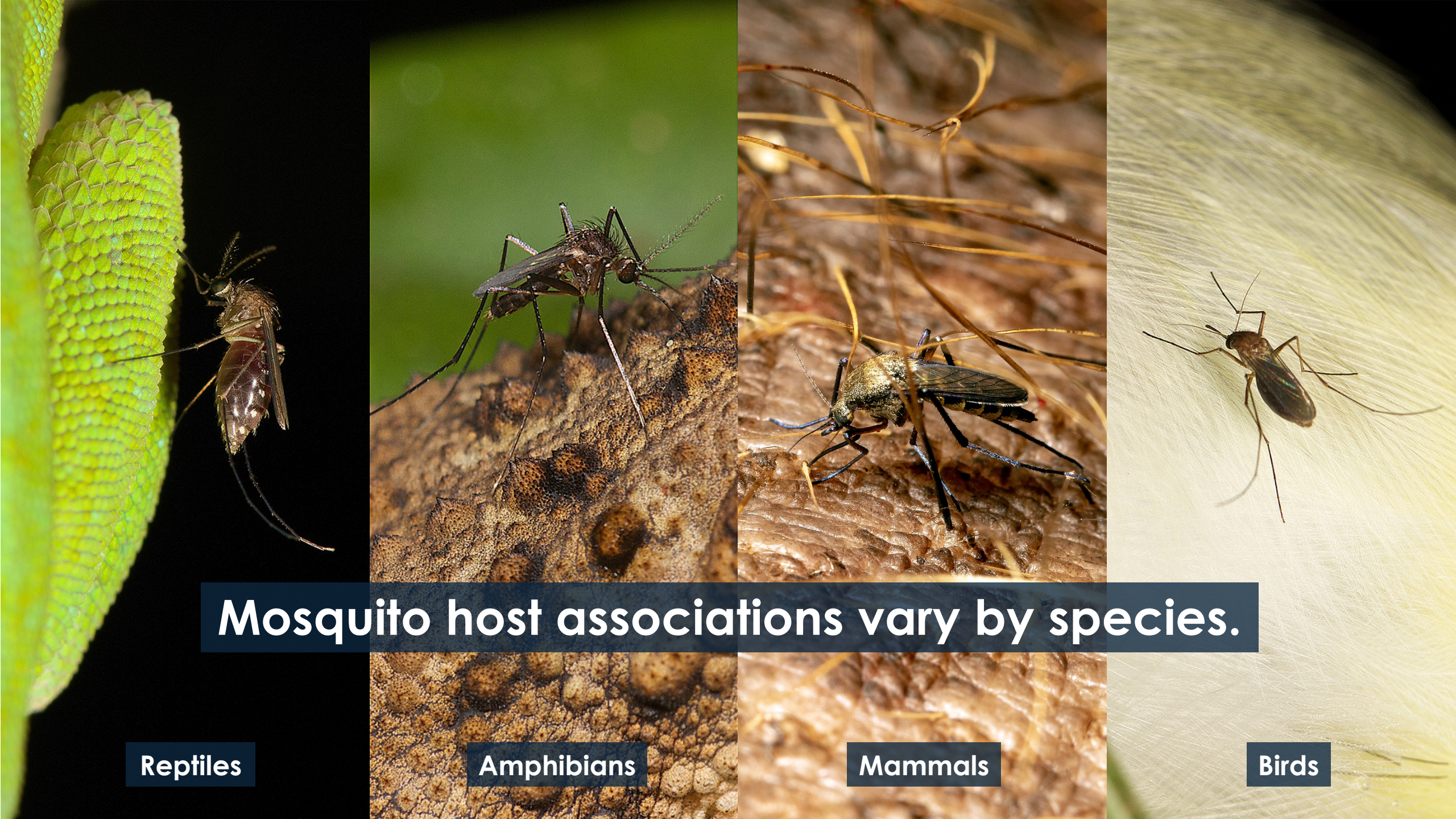
*Culex* (*Micraedes*) *antillumaggnorum*
PUERTO RICO: Luquillo
El Yunque National Forest



**Suspected vector for:**

- *Plasmodium azurophilum*
- *Plasmodium leucocytica*
- *Plasmodium floridense*

More Information:
Reeves et al. 2024. *Anolis gundlachi* and *Anolis cristatellus* blood-feeding by *Culex antillummagnorum*. Herpetol. Rev.


Mosquito host associations vary by species.
Reptiles
Amphibians
Mammals
Birds


*Culex nigripalpus*
Violaceous trogon
La Selva Biological Station, Costa Rica


Everglades National Park, Florida
*Culex cedecei*
Hispid cotton rat
More information:
Hoyer et al. 2017. Mammal decline, linked to invasive Burmese python, shifts host use of vector mosquito towards reservoir hosts of a zoonotic disease. Biology Letters 15: 20170353.

Blue Cypress Lake, Florida

# *Culex pilosus*

## Brown anole



*Culex pilosus* / pygmy rattlesnake



*Culex pilosus* / black racer

More information:
Reeves et al. 2019. Host Associations of *Culex* (*Melanoconion*) *atratus* (Diptera: Culicidae) and *Culex* (*Melanoconion*) *pilosus* from Florida, USA. Insects 10: 239.

More information:
Reeves & Burkett-Cadena 2022. Lizards are important host for zoonotic Flavivirus vectors, subgenus *Culex*, in the southern USA. Frontiers in Tropical Diseases 3: 842523.

Southern Province, Zambia

# *Mimomyia mediolineata*

## Southern foam-nesting frog



*Mimomyia luzonensis* / Cane toad

Received: 2 October 2023 | Revised: 7 November 2023 | Accepted: 9 November 2023

DOI: 10.1111/eth.13424

ethology WILEY

BEHAVIOURAL NOTE

# A little on the nose: A mosquito targets the nostrils of tree frogs for a blood meal

John Gould[1] | Jose W. Valdez[2]

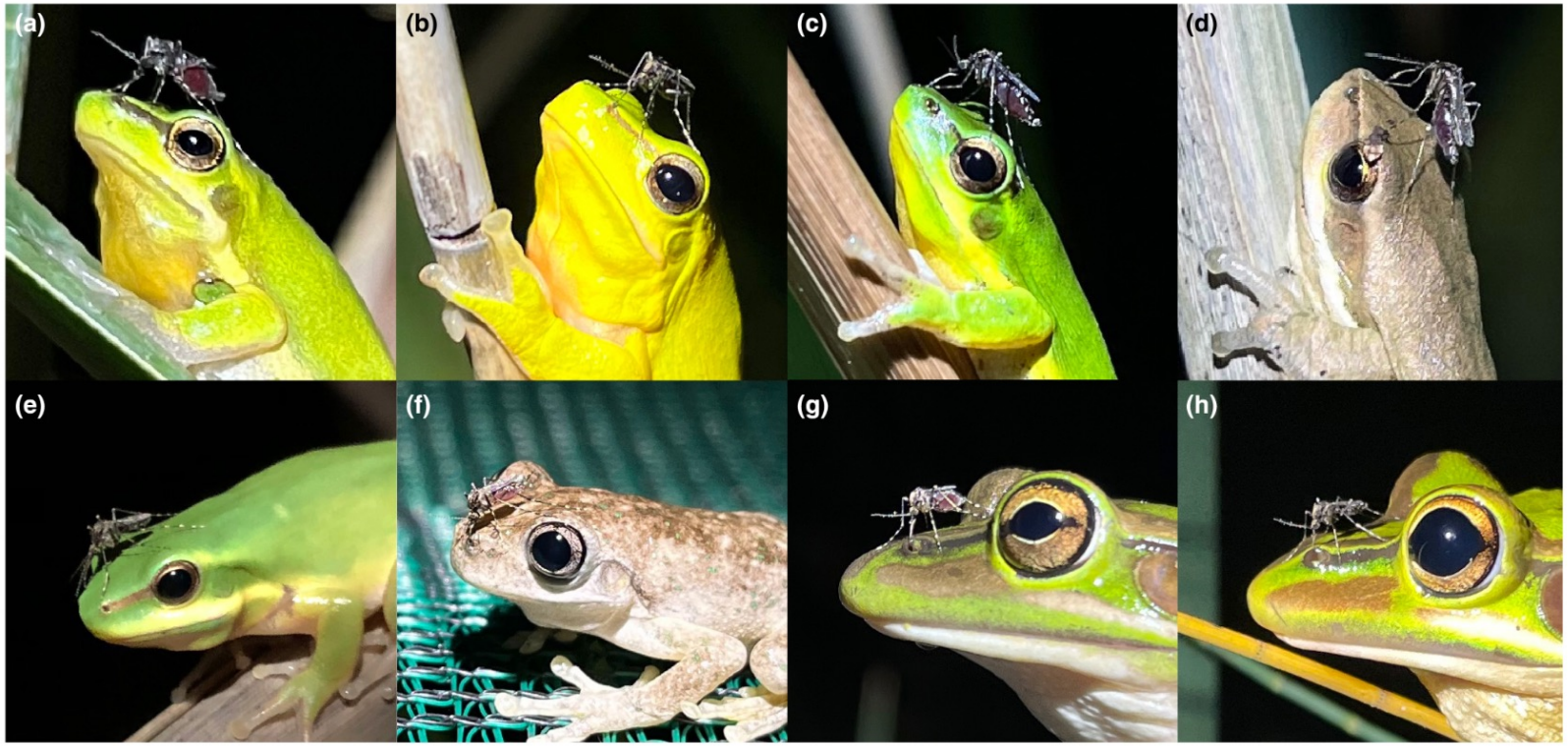



FIGURE 1 Female mosquitoes (*Mimomyia elegans*) feeding on the nostrils of three Australian tree frog species, including *Litoria fallax* (a–e), *Litoria peronii* (f) and *Litoria aurea* (g, h).

*Mimomyia mediolineata*
ZAMBIA: Southern Province
Mpinda




Superior National Forest, Minnesota
*Aedes canadensis*
Common snapping turtle

# *Anopheles crucians* complex

## American alligator



Everglades National Park, Florida

# *Culex* (*Melanoconion*) sp.

## West Indian manatee



Flamingo, Everglades National Park, Florida

More information:
Reeves & Gillett-Kaufman 2020. Interactions between the imperiled West Indian manatee, *Trichechus manatus*, and mosquitoes (Diptera: Culicidae) in Everglades National Park, Florida, USA. Sci. Rep. 10: 12971.

Article | OPEN | Published: 08 March 2019

# Bloodmeal host identification with inferences to feeding habits of a fish-fed mosquito, *Aedes baisasi*

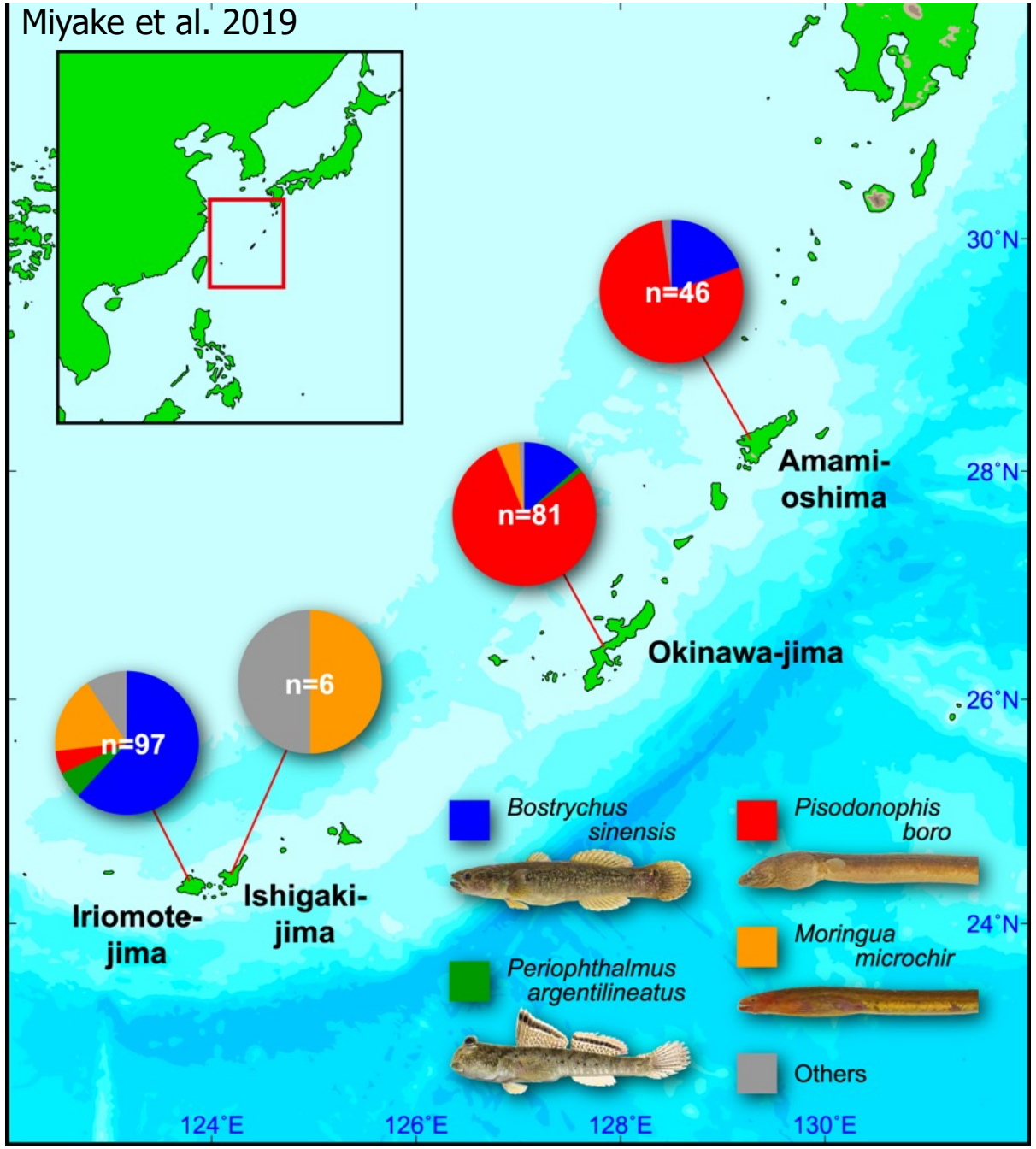
Takashi Miyake ✉, Natsuki Aihara, Ken Maeda, Chuya Shinzato, Ryo Koyanagi, Hirozumi Kobayashi & Kazunori Yamahira

*Scientific Reports* **9**, Article number: 4002 (2019) | Download Citation ⬇



*Aedes baisasi*, Negros Occidental, Philippines






*Uranotaenia lowii*
American bullfrog
Osceola National Forest, Florida




More information:
Reeves et al. 2018. Identification of *Uranotaenia sapphirina* as a specialist of annelids broadens known mosquito host use patterns. Communications Biology 1: 92.



More information:
Reeves et al. 2018. Identification of *Uranotaenia sapphirina* as a specialist of annelids broadens known mosquito host use patterns. Communications Biology 1: 92.

*Aedes taeniorhynchus* / Burmese python
Everglades National Park




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