



# MOSQUITO BEACONS WORKSHOP 2022

Data management and visualization and  
invasive mosquito bionomics

Presented on: Monday January 24th, 2022

# Invasive Species Bionomics, Identification, and Collection



BIONOMICS



IDENTIFICATION



COLLECTION



# MOSQUITO BIONOMICS

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Slide Contributions: Bryan V. Giordano, Benjamin Allen, Michael Riles, Ana Romero-Weaver, Yoosook Lee



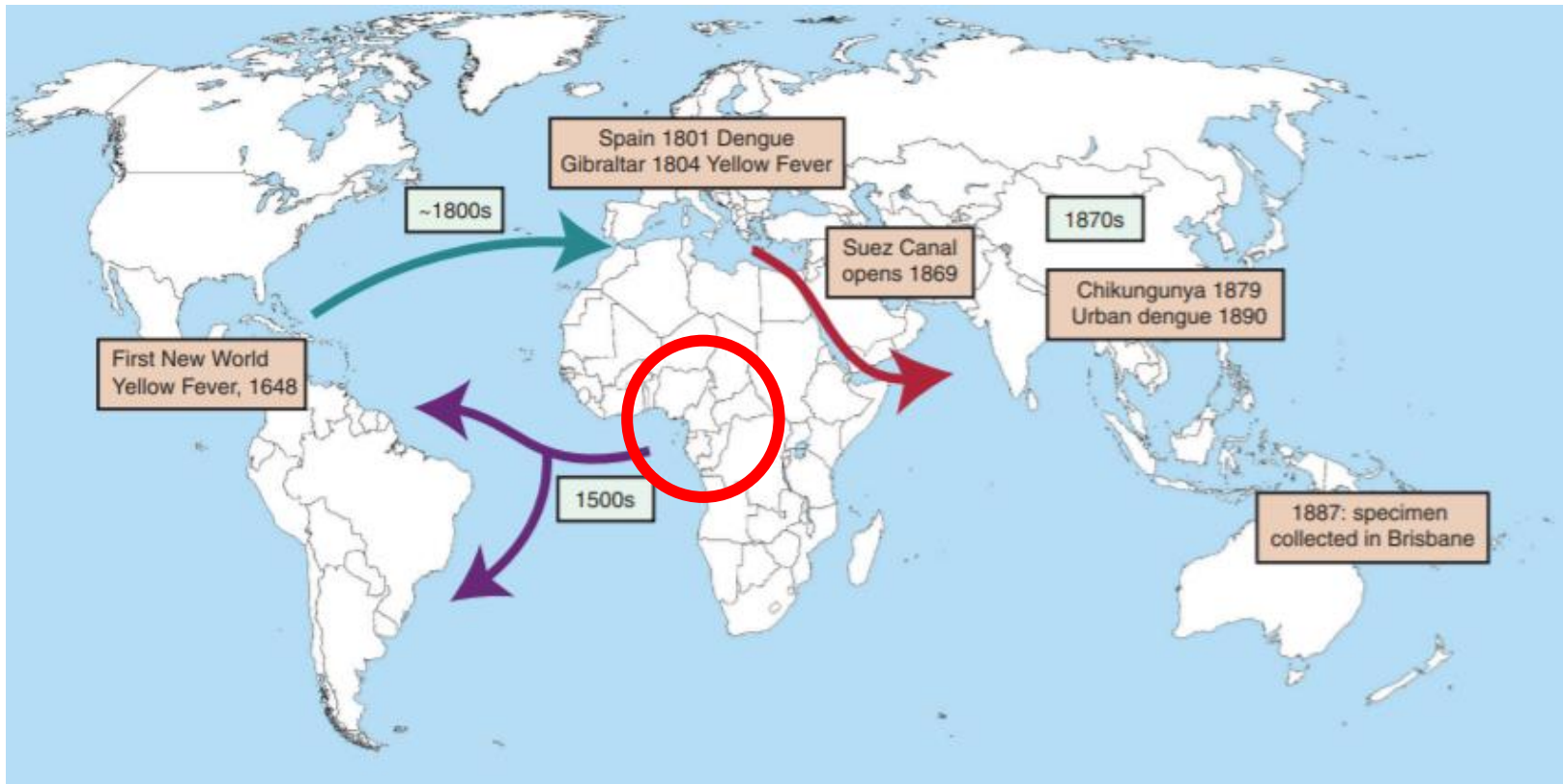
- *Aedes aegypti* - The Yellow Fever Mosquito
- *Aedes* – Greek: unpleasant; *aegypti* – Latin: Egypt.
- First described in Egypt by Fredrik Hasselqvist in 1757 as *Culex* (Latin for “gnat”) *aegypti*

# *Aedes aegypti*

- **Etymology**

- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

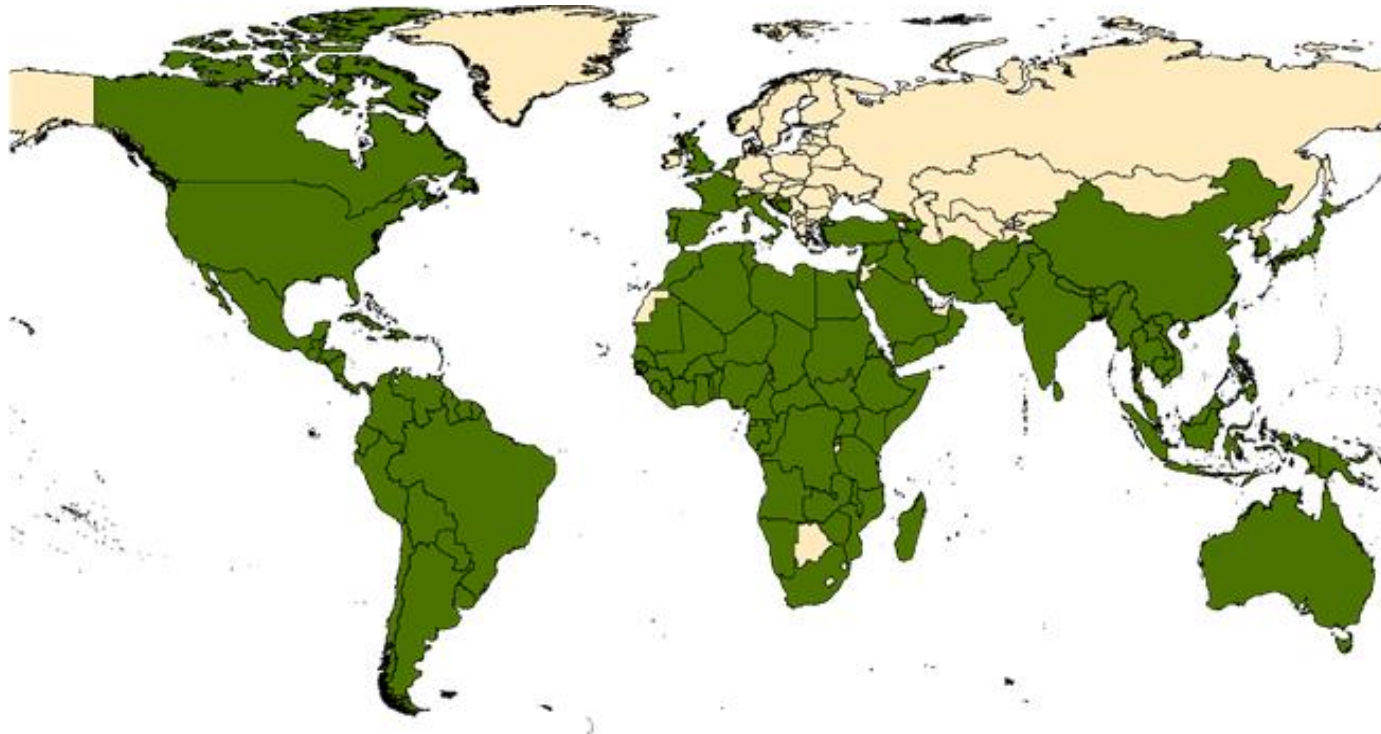




- Likely origin: West Africa
- Populations still exist in forested regions of sub-Saharan Africa . Utilize tree holes and phytotelmata (water holding plants) as production sites and feeding on non-human primates
- Transported around the world by colonizers and slave traders

# *Aedes aegypti*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
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- Collection Methods
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- Pathogen Transmission



- Invasive range (highlighted green) includes all Americas and Caribbean countries, most of Africa, England, Portugal, Spain, France, Italy, the Netherlands, Bosnia & Herzegovina, South districts of Russia, all Arab countries, Asia, Japan, Australia and the Pacific Islands

# *Aedes aegypti*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
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- Larval habitats include natural or artificial containers.
- In rural environments, larvae can also be found in tree holes, and rotten tree stumps.

# *Aedes aegypti*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- *Ae. aegypti* disperse relatively short distances (100–500 meters < 0.3 miles)
- Reduction of oviposition sites facilitate dispersal of females
- Egg desiccation tolerance
  - Eggs/larvae in containers are transported around the globe

# *Aedes aegypti*

- Etymology
- Native Range
- Invasive Range
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- **Dispersal Strategies**
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- Host Biting Preference
- Pathogen Transmission





- For larvae: turkey Baster and dipping cups



- For adults: BG sentinel traps, aspirators, Hand nets

# *Aedes aegypti*

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- Native Range
- Invasive Range
- Larval Habitat
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- **Collection Methods**
  - Host Biting Preference
  - Pathogen Transmission





# *Aedes aegypti*

- Etymology
- Native Range
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- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission

- *Aedes aegypti* bites primarily during the day. This species is most active for approximately two hours after sunrise and several hours before sunset, but it can bite at night in well lit areas.
- *Ae. aegypti* mosquitoes have a strong preference for human hosts but occasionally they can feed on dogs, cats, horses and other domestic animals, mostly mammals.



- *Aedes aegypti* is known to transmit yellow fever virus, dengue virus, chikungunya virus, and Zika virus. It may potentially be a vector of Venezuelan Equine Encephalitis virus and vector competency studies have shown *Ae. aegypti* is capable of transmitting West Nile virus.
- Except for yellow fever, there is no treatment for these diseases.



# *Aedes aegypti*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

# References

- Edman JD, Scott TW, Costero A, Morrison AC, Harrington LC, Clark GG. 1998. *Aedes aegypti* (Diptera: Culicidae) Movement Influenced by Availability of Oviposition Sites, Journal of Medical Entomology 35:578-583. [doi.org/10.1093/jmedent/35.4.578](https://doi.org/10.1093/jmedent/35.4.578)
- Etymologia: *Aedes aegypti*. 2016. Emerging Infectious Diseases 22:1807. [doi.org/10.3201/eid2210.et2210](https://doi.org/10.3201/eid2210.et2210)
- Featured creatures [https://entnemdept.ufl.edu/creatures/aquatic/aedes\\_aegypti.htm](https://entnemdept.ufl.edu/creatures/aquatic/aedes_aegypti.htm)
- Harrington LC, Scott TW, Lerdthusnee K, Coleman RC, Costero A, Clark GG, Jones JJ, Kitthawee S, Kittayapong P, Sithiprasasna R, Edman JD. 2005. Dispersal of the dengue vector *Aedes aegypti* within and between rural communities. American Journal of Tropical Medicine and Hygiene 72:209-20. PMID: 15741559.
- Powell JR, Gloria-Soria A, Kotsakiozi P. 2018. Recent history of *Aedes aegypti*: Vector genomics and epidemiology records. BioScience 68:854-860.
- WRBU <https://wrbu.si.edu/vectorspecies/mosquitoes/aegypti>



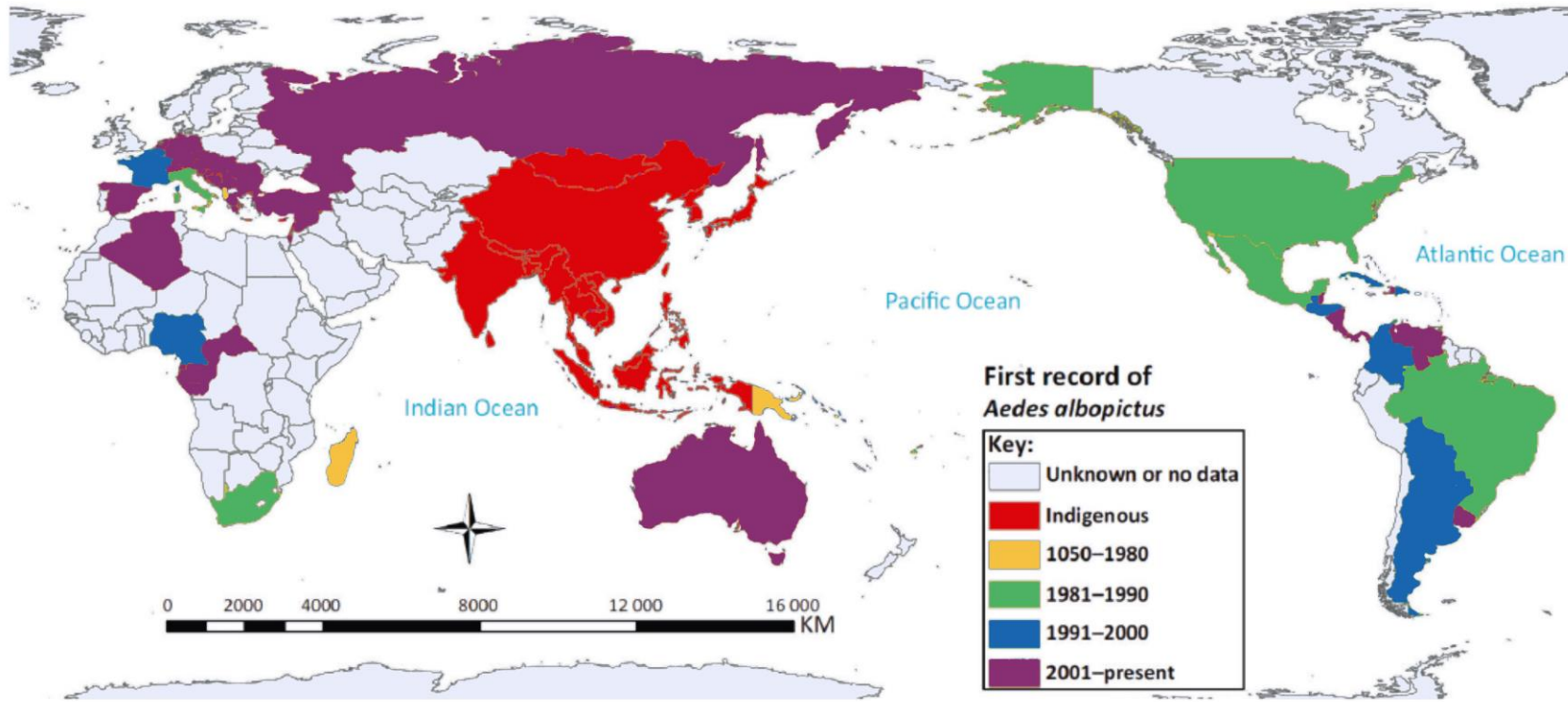
- The Asian Tiger Mosquito - “The white-painted unpleasant one”
- Aedes – Greek: unpleasant; albopictus – Latin: marked with white
- First described by Frederick A. Askew Skuse in 1894 as *Culex albopictus*.

## Aedes *albopictus*

- **Etymology**

- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



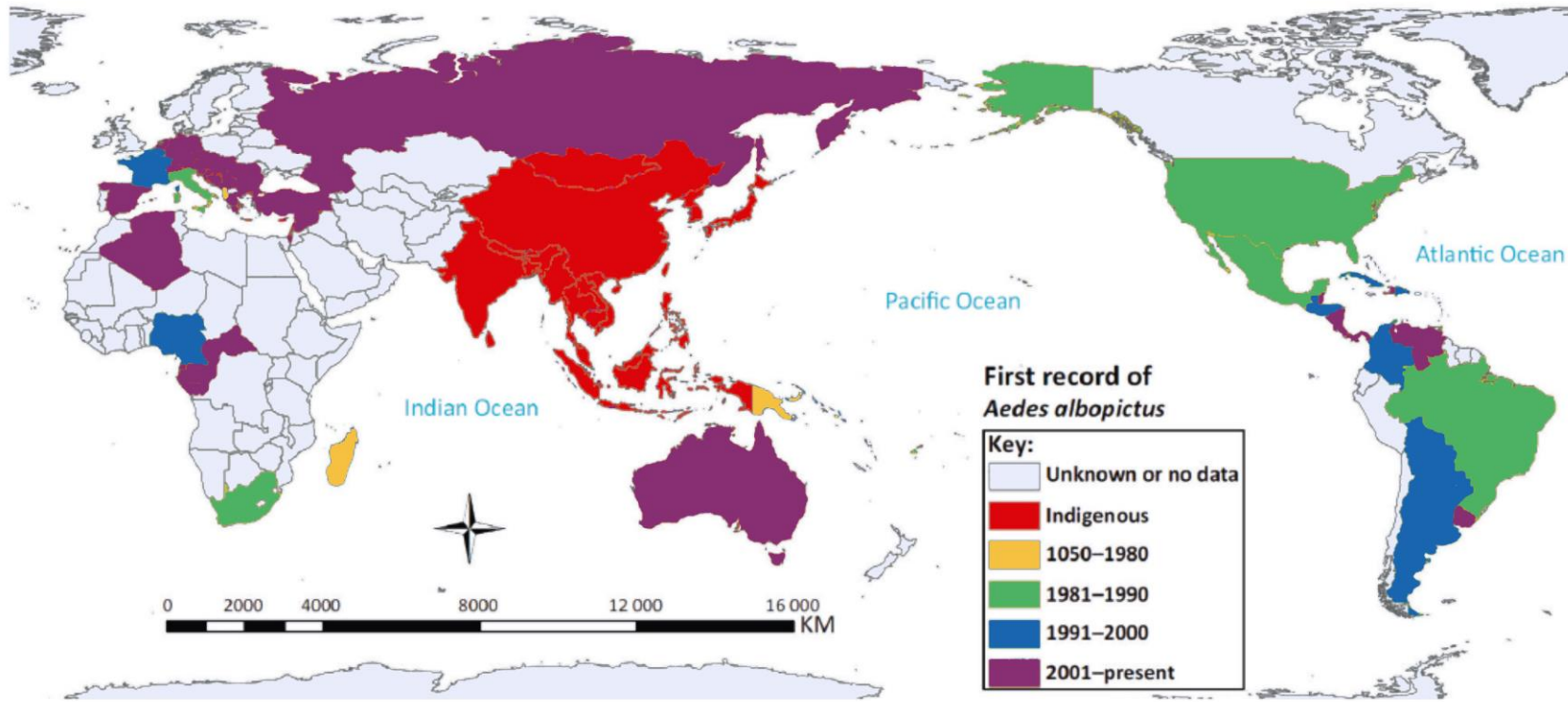


- Native (Indigenous) range **(Highlighted in Red)**:  
Oriental Region from the tropics of Southeast Asia  
Pacific and Indian Ocean Islands,  
China  
Japan

# *Aedes albopictus*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Invasive range:
  - North America (Continental United States 1980s)
  - Canada (southern Ontario 2016)
  - South America
  - Africa
  - Europe

## *Aedes albopictus*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Various artificial (manmade) and natural containers
- Used tires, discarded plastic containers, tree holes,

# *Aedes albopictus*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Egg desiccation tolerance
- Ornamental plant trade
- Used tire trade (internationally and locally)
- Even follow people into cars!

# *Aedes albopictus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- **Dispersal Strategies**
  - Collection Methods
  - Host Biting Preference
  - Pathogen Transmission

- Not commonly collected with CDC light traps
- Larval surveillance and ovitraps often yield more collections than trapping
- Biogents Sentinel traps are the preferred tool for invasive *Aedes* surveillance in North America
  - Biogents Lure can be combined with CO<sub>2</sub> (dry ice or compressed gas) to increase yield of collections



## *Aedes albopictus*

- Etymology
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- **Collection Methods**
  - Host Biting Preference
  - Pathogen Transmission



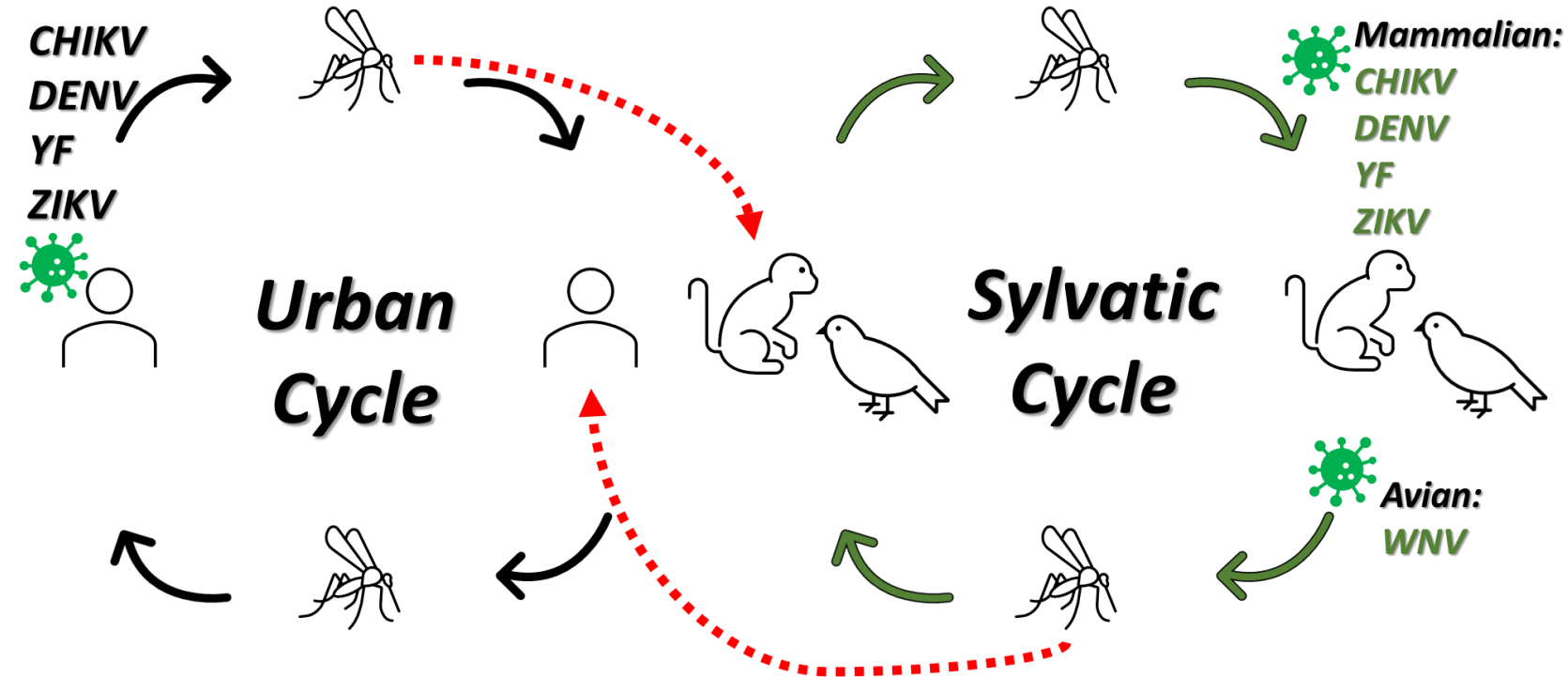
- Crepuscular biters: feeding peaks early morning and late afternoon
- Aggressive and persistent biters
- Bite a variety of mammals (Humans, dogs, cats, ruminants)
- Opportunistic feeders and will occasionally bite birds



## *Aedes albopictus*

- Etymology
- Native Range
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- Dispersal Strategies
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission





- Dengue
- Yellow Fever
- Chikungunya

- Zika
- West Nile (Rare)

## *Aedes albopictus*

- Etymology
- Native Range
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- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

# References

- Bonizzoni M, Gasperi G, Chen X, James AA. 2013. The invasive mosquito species *Aedes albopictus*: current knowledge and future perspectives. *Trends in Parasitology* 2, 460-68.
- Eritja R, Palmer JRB, Roiz D, Sanpera-Calbet I, Bartumeus F. 2017. Direct Evidence of Adult *Aedes albopictus* Dispersal by Car. *Scientific Reports* 7: 14399. <https://www.nature.com/articles/s41598-017-12652-5>
- Giordano BV, Gasparotto A, Liang P, Nelder MP, Russell C, Hunter FF (2020). Discovery of an *Aedes (Stegomyia) albopictus* population and first records of *Aedes (Stegomyia) aegypti* in Canada. *Medical and Veterinary Entomology* 34:10-16.
- Hofhuis A, Reimerink J, Reusken C, Scholte E-J, de Boer A, Takken W, Koopmans M. 2009. The hidden passenger of lucky bamboo: Do imported *Aedes albopictus* mosquitoes cause dengue virus transmission in the netherlands? *Vector-borne and Zoonotic Diseases* 9:217-220. DOI: 10.1089/vbz.2008.0071.
- Lacour G. 2016. Eco-physiological mechanisms and adaptive value of egg diapause in the invasive mosquito *Aedes albopictus* (Diptera: Culicidae). [PhD Dissertation, UCL, Belgium]



- First described by Theobald in 1901
- Latin: *japonica*: of Japan
- Common name: Asian Bush Mosquito or Asian Rock Pool Mosquito
- Informal Name: Tokyo Japanese Pointy Mosquito

## *Aedes japonicus*

- **Etymology**

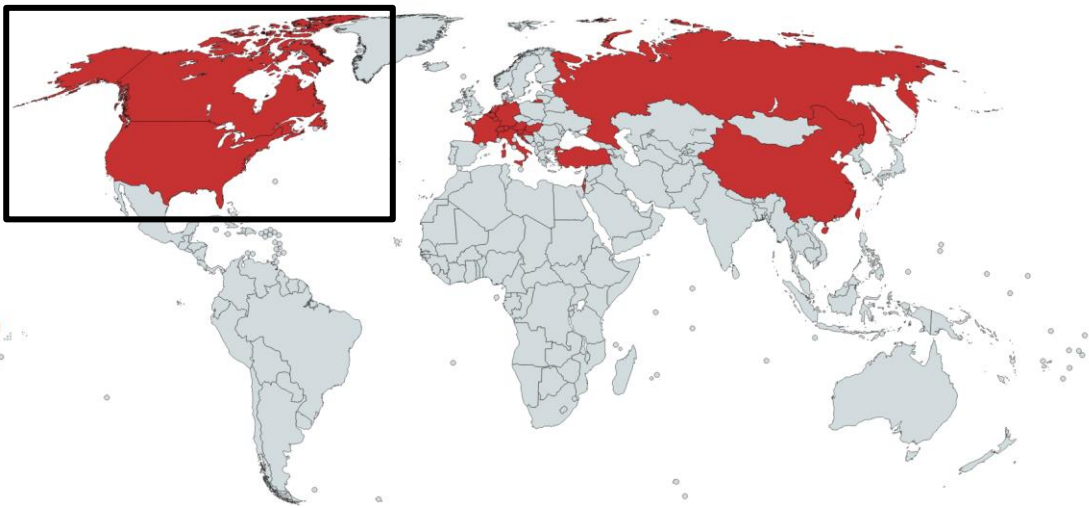
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



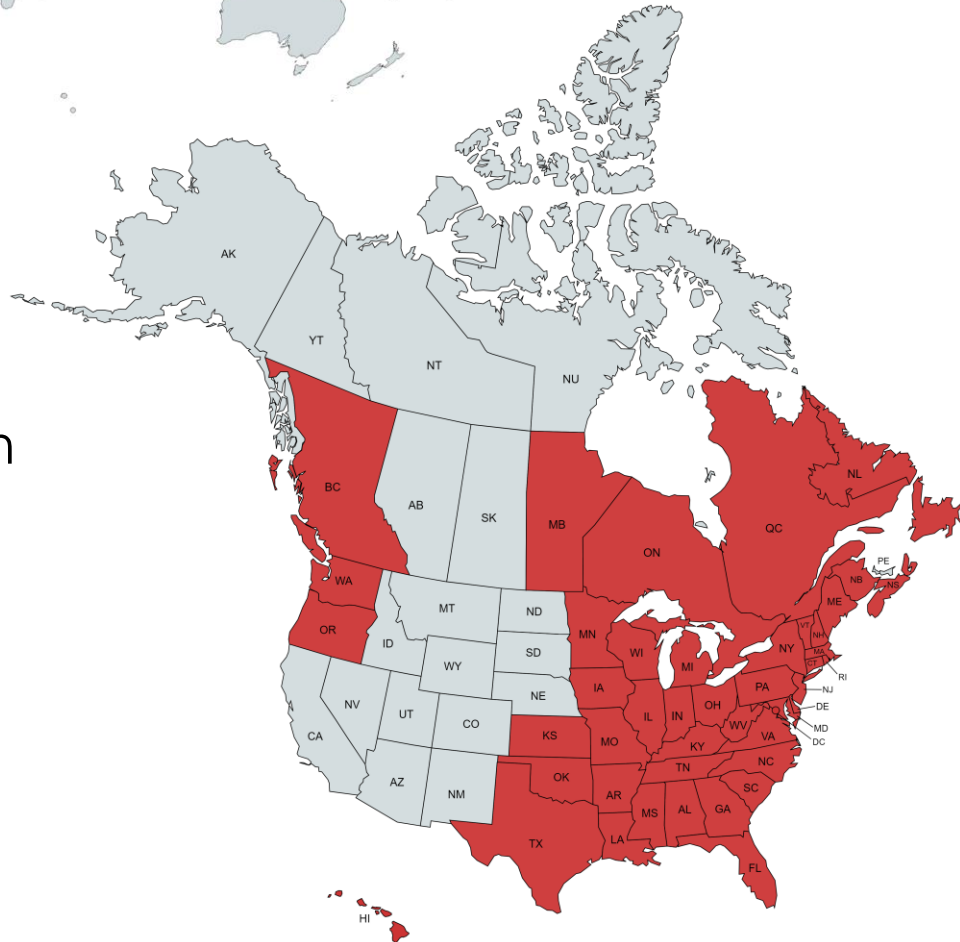
- Species complex native to Japan and the Korean Peninsula

## *Aedes japonicus*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Slower expansion than *Aedes albopictus*
- Introduced into North America & Europe in mid-late 1990's
- Florida, Texas, Louisiana, Oklahoma & Kansas 2014-2021

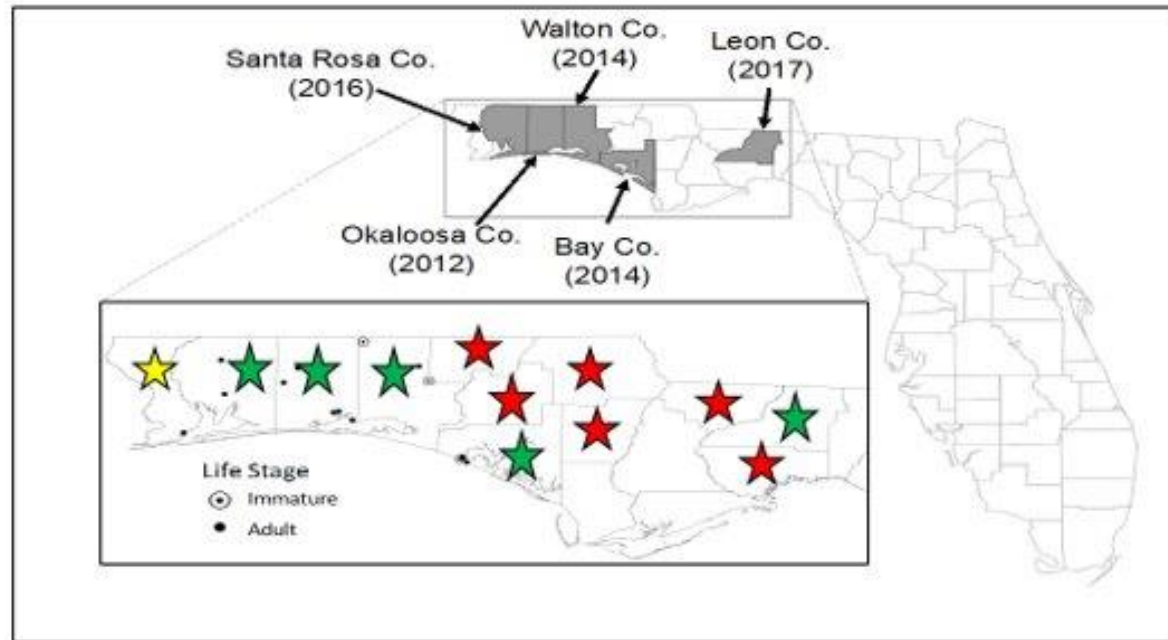


# *Aedes japonicus*

- Etymology
- Native Range
- **Invasive Range**
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- Pathogen Transmission



# Distribution Update Florida



## *Aedes japonicus*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

★ Riles et al. 2017. J Am Mosq Cont Assoc 33:340-344

★ Riles & Connelly 2020. J Am Mosq Cont Assoc 36:107-111

★ Smith et al. 2020. J Fla Mosq Cont Assoc 67:1-9



- Rock pools in native range
- Oviposit on the walls of natural and artificial containers
- Examples: Tree holes, tires, containers made of concrete, stone, plastic, or metal

## *Aedes japonicus*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Egg desiccation tolerance
- Eggs or larvae transported via used tire trade
- Movement of gardening supplies

## *Aedes japonicus*

- Etymology
- Native Range
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- Larval Habitat
- **Dispersal Strategies**
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Larval surveillance of potential production sites
- Not readily trapped with CDC light traps + CO<sub>2</sub>
- octenol-based lures collect 100X more compared to CO<sub>2</sub>
- Gravid and oviposition traps are ideal
- Biogents Sentinel traps
- Aspirations work well

## *Aedes japonicus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- **Collection Methods**
- Host Biting Preference
- Pathogen Transmission

- Crepuscular biters: feeding peaks early morning and late afternoon
- Known to leave shady or wooded areas during the daytime for the chance to feed
- Persistent and painful bites
- Opportunistic, wide-range of host species



## *Aedes japonicus*

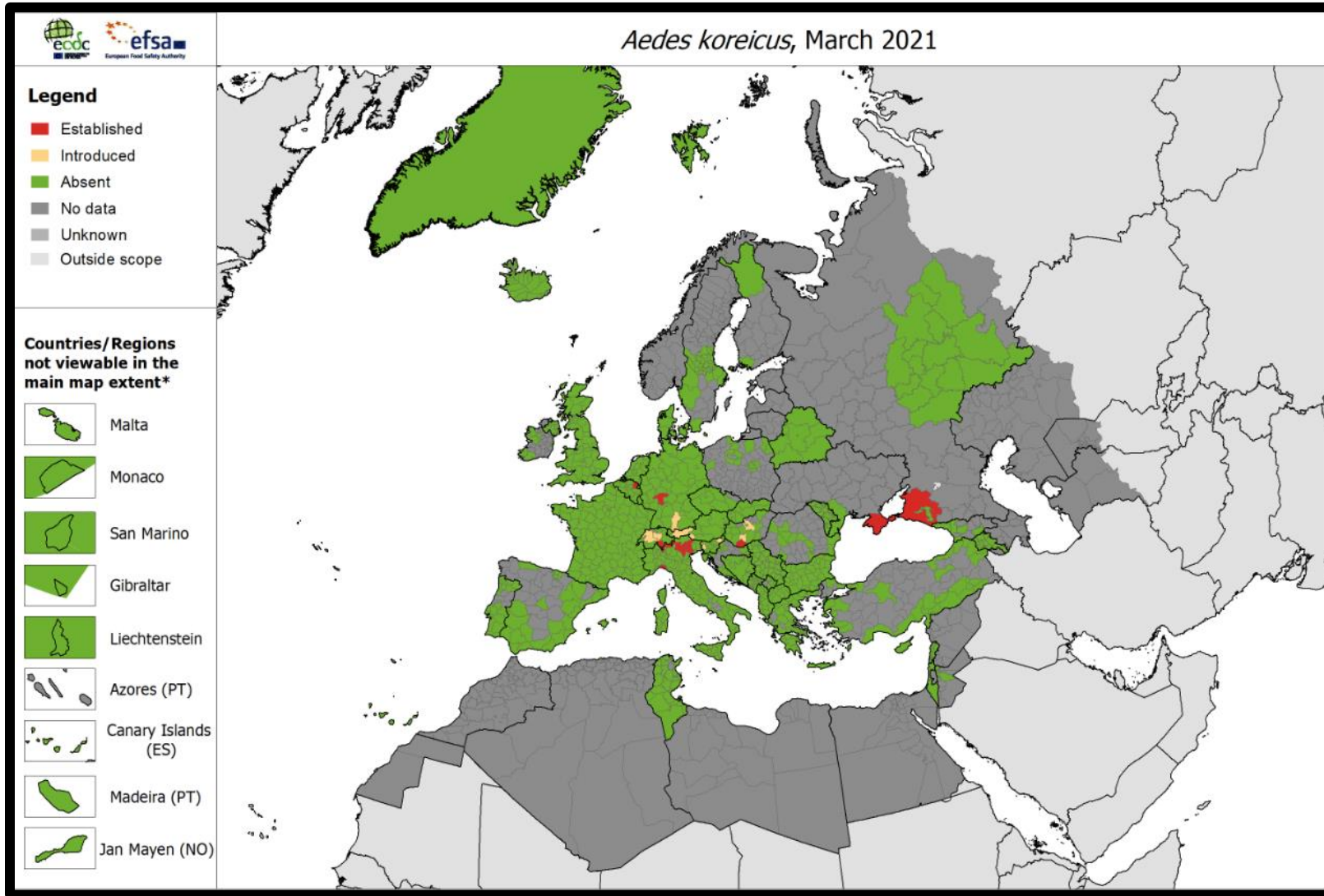
- Etymology
- Native Range
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- Larval Habitat
- Dispersal Strategies
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission

- Chikungunya virus (CHIKV)
- Cache Valley virus (CVV)
- Dengue virus (DENV)
- Eastern Equine Encephalitis virus (EEEV)
- Japanese Encephalitis virus (JBEV)
- Lake Victoria cormorant virus (LVC)
- Usutu virus (USUV)
- LaCrosse Virus (LACV)
- Orungo virus (ORUV)
- Rift Valley fever virus (RVFV)
- St. Louis Encephalitis virus (SLEV)
- Western Equine Encephalitis virus (WEEV)
- West Nile virus (WNV)
- Zika (ZIKV)

## *Aedes japonicus*

- Etymology
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- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**





# *Aedes japonicus koreicus*

*Aedes koreicus* is morphologically and genetically similar to *Aedes japonicus*

- Invasive Range**

Predicted to be the next subspecies within complex to enter North America

# References

- <https://www.wrbu.si.edu/vectorspecies/mosquitoes/japonicus>
- Kaufman MG, Fonseca DM. 2014. Invasion Biology of *Aedes japonicus japonicus* (Diptera: Culicidae). Annual Review of Entomology 59(1):31-49. DOI: 10.1146/annurev-ento-011613-162012
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- Rogers DC, Goldhammer DS, Garrison I, Cook A. First record of *Aedes japonicus japonicus* (Theobald, 1901) (Diptera: Culicidae) in Kansas. Zootaxa. 2021 Sep 23;5040(4):592-600.
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- <https://www.ecdc.europa.eu/en/publications-data/aedes-koreicus-current-known-distribution-march-2021>
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*Aedes scapularis*  
FLORIDA: Miami-Dade Co.  
Florida City; 17 February 2020



Photo Credit: Lawrence E. Reeves

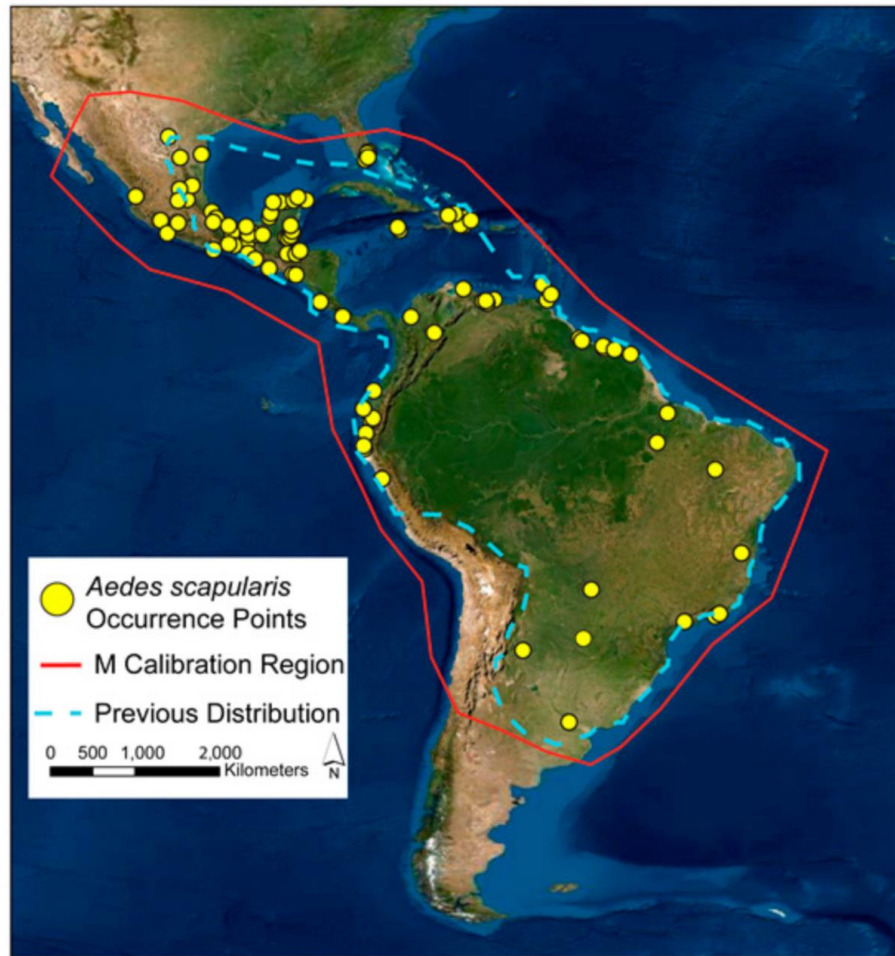
# *Aedes scapularis*

## • **Etymology**

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- Pathogen Transmission

- *Aedes* (Greek): ἀηδής, aēdēs; Unpleasant, odious
- *scapularis* (Latin): Adjective, medieval monastic garment that draped over the shoulders
- *Aedes scapularis*: Odious thing in a monk's scapular

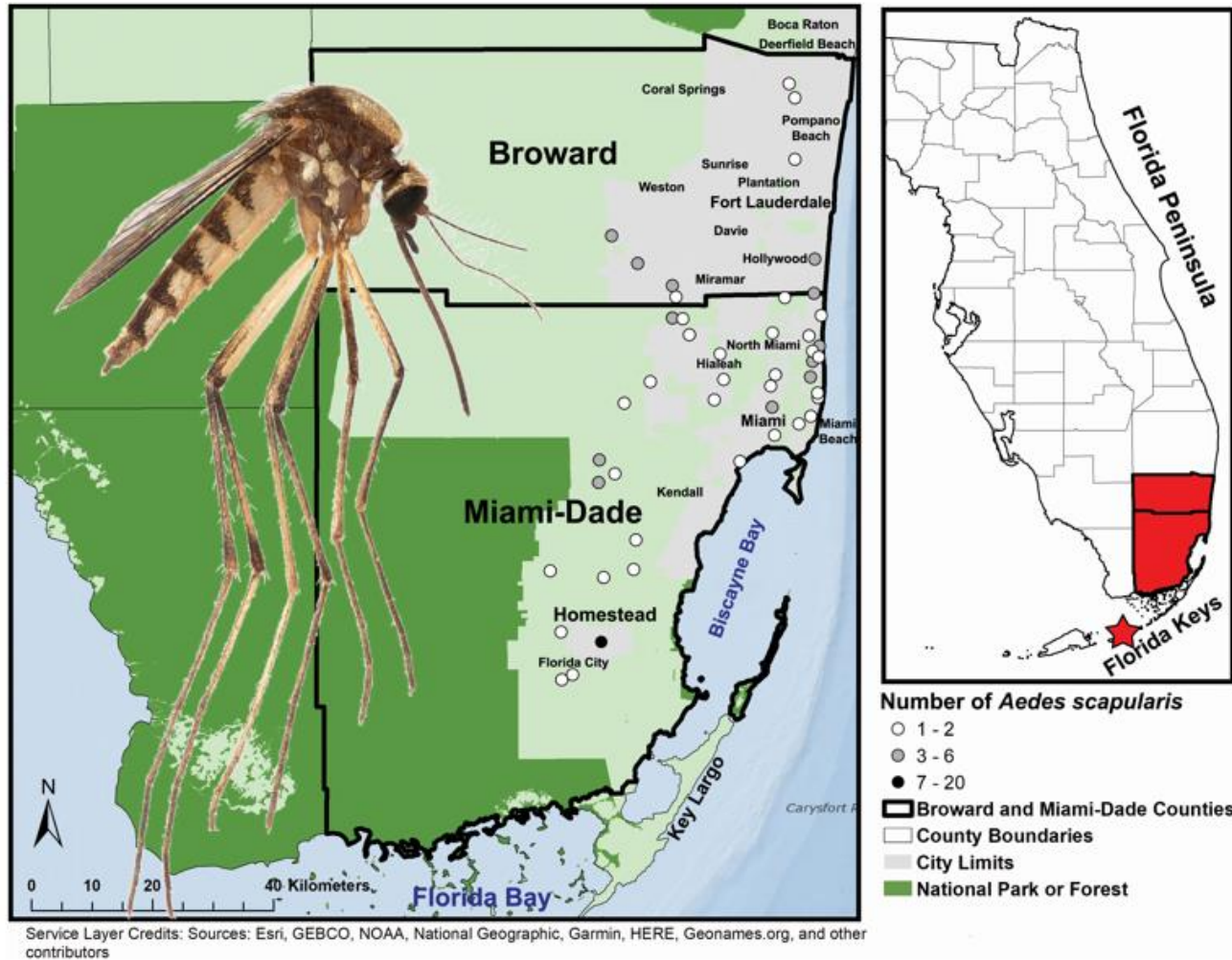




- Native range is from Rio Grande Valley south all the way to Argentina. Geographic barrier to northern expansion seems to be the Chihuahuan Desert

## *Aedes scapularis*

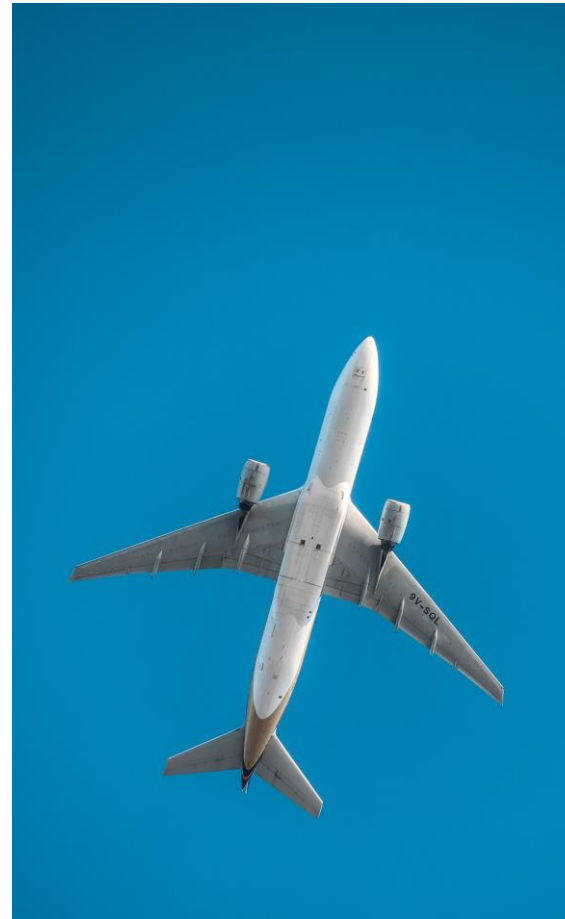
- Etymology
- **Native Range**
- Invasive Range
- Dispersal Strategies
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- Current invasive range is the southern tip of Florida
  - Broward County
  - Miami-Dade County

# *Aedes scapularis*

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# *Aedes scapularis*

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- **Dispersal Strategies**
- Larval Habitat
- Collection Methods
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- Pathogen Transmission

- Dispersal has been hypothesized to occur by aircraft, movement of plants and soil where eggs and larvae may be present





- Temporary and semi-permanent freshwater such as swamp margins, crab holes, overflowing waterways, and rain pools. Lays eggs in soil prone to flooding.
- Sometimes containers.

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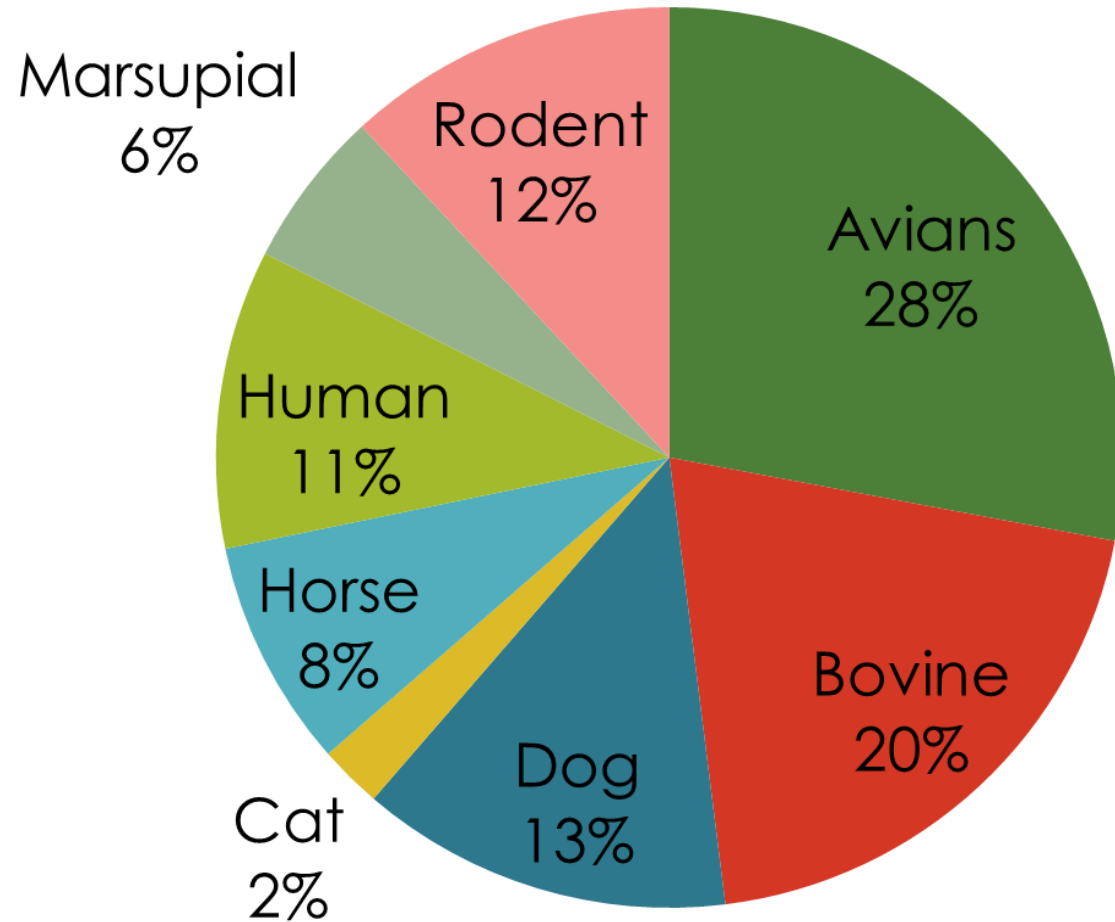


- Rough equivalency in catch between CO<sub>2</sub>-Baited CDC traps, and BGS Traps

# *Aedes scapularis*

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## *Aedes scapularis* Feeding Preference in Brazil

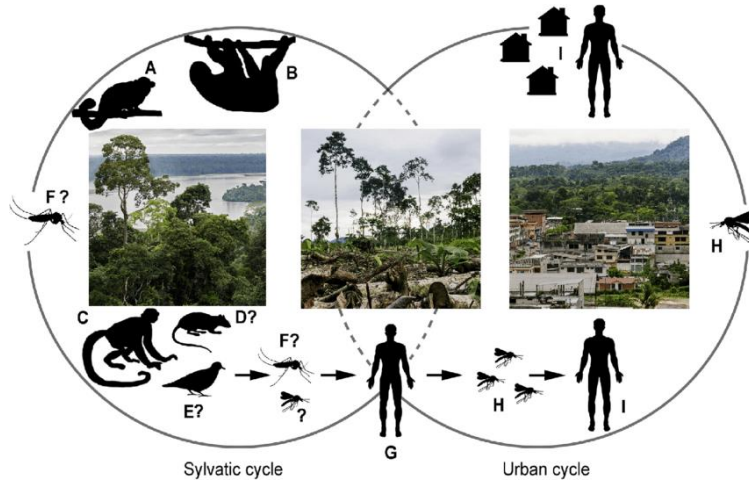


- Feeds in the middle of the night, on a wild variety of mostly-mammal hosts, including humans and possibly preferentially on humans

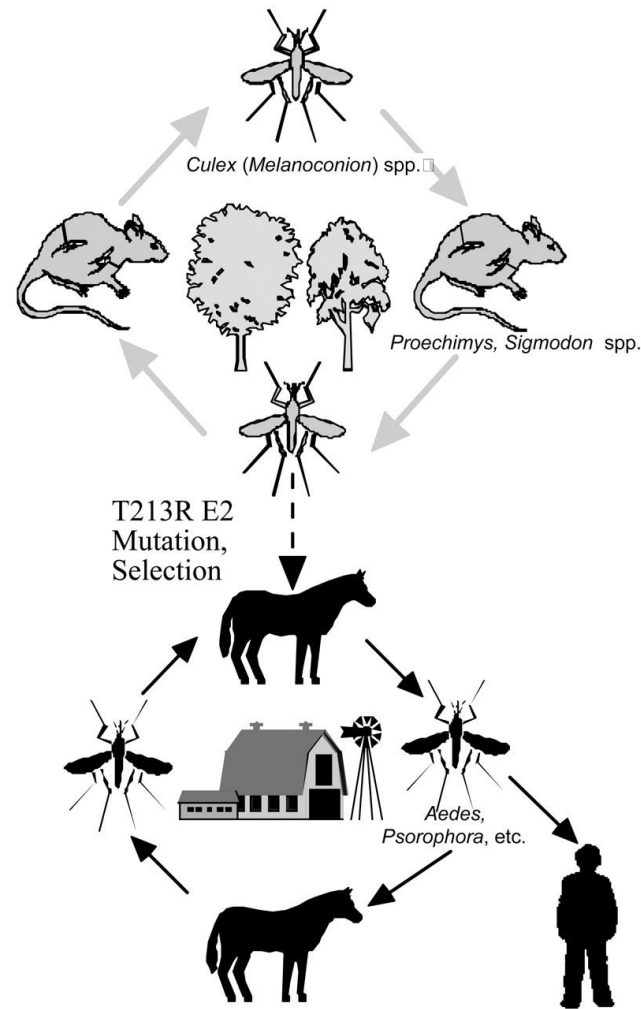
## *Aedes scapularis*

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- **Host Biting Preference**
- Pathogen Transmission





- Melao virus (MELV)
- Oropouche virus (OROV)
- St. Louis Encephalitis virus (SLEV)



- Venezuelan Equine Encephalitis virus (VEEV)
- Yellow Fever virus (YFV)
- *Dirofilaria immitis* (Dog heartworm)

- Etymology
- Native Range
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

# References

- Reeves LE, Medina J, Miqueli E, Sloyer KE, Petrie W, Vasquez C, Burkett-Cadena ND. 2020. Establishment of *Aedes (Ochlerotatus) scapularis* (Diptera: Culicidae) in Mainland Florida, With Notes on the *Ochlerotatus* Group in the United States. *Journal of Medical Entomology* 58:717–729, <https://doi.org/10.1093/jme/tjaa250>
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Photo Credit: Lawrence E. Reeves

- Informal Name: Crowned Trinbagonian Typical Mosquito
- *Culex* from Latin (gnat, mosquito)
- *coronator*, Dyar and Knab 1906: coroner/crown in Latin

## *Culex coronator*

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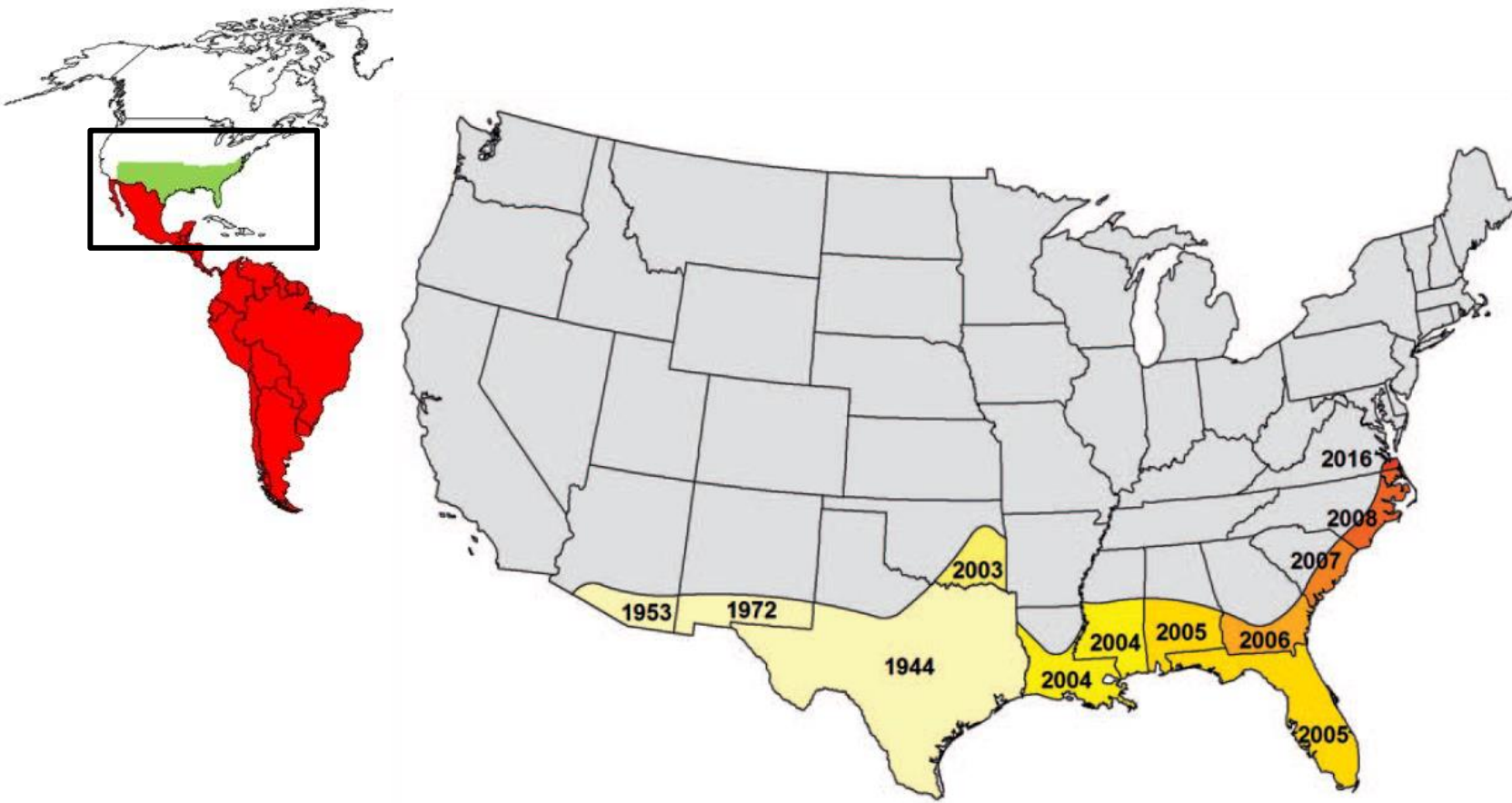




- Native Range: Central and South America
- Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Chile, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, United States (Texas), Uruguay, and Venezuela

## *Culex coronator*

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- Between the 1920s and 1970s spread into western and central United States (Arizona, New Mexico, Louisiana, Mississippi, Oklahoma, and Texas).
- Early 2000s, expanded eastward, and in 2000s and 2010s, it was reported for the first time as far east as Florida and Virginia.

## *Culex coronator*

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- *Culex coronator* females lay rafts of eggs in diverse natural and artificial microhabitats
- Natural habitats: swales, roadside ditches, animal water troughs, forest ponds, and rock pools
- Artificial water-holding containers:
  - trash cans
  - car tires

## *Culex coronator*

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- Highly adaptable to artificial container breeding in urban areas
- Eggs and larvae commonly found in used tires
- Car tire transportation is thought to be an important dispersal mechanism

## *Culex coronator*

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- CDC light traps
- Biogents Sentinel traps
- Gravid traps
- Larval surveys



## *Culex coronator*

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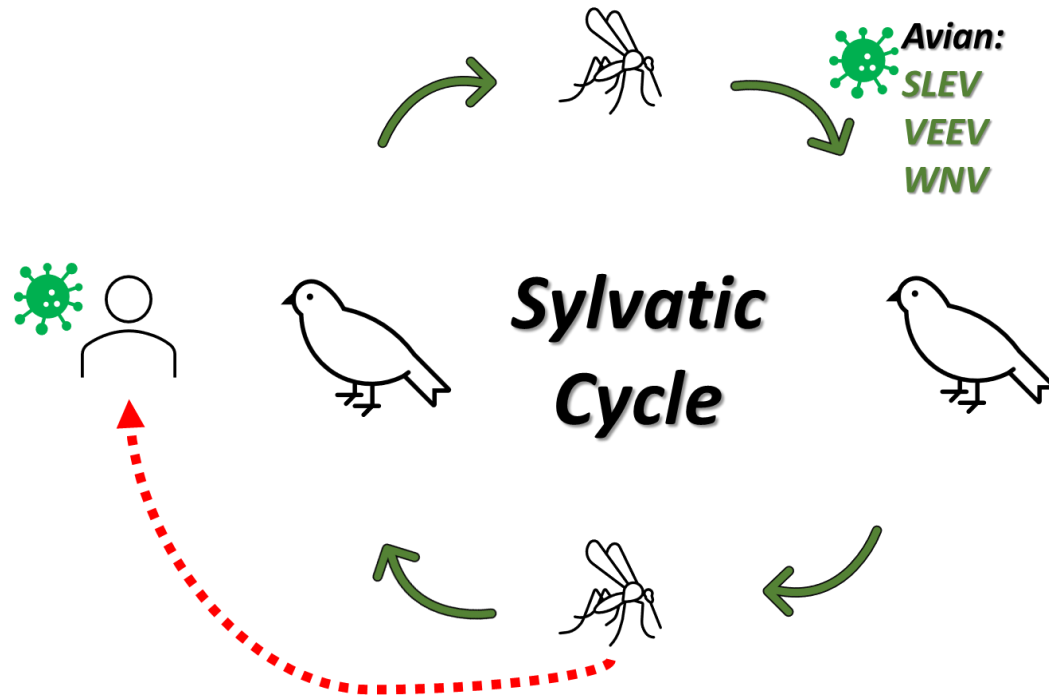
- Predominantly nocturnal
- Blood feed primary upon large mammals such as white-tailed deer and horses
- Opportunistically feed on birds
- Will also bite humans



## *Culex coronator*

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- St Louis encephalitis virus (Aitken et al. 1964, Turell et al. 2005)
- Venezuelan equine encephalitis virus (Burguete et al. 1973)
- West Nile virus (Mackay 2007, Unlu et al. 2010)
- Zika virus (rare, Elizondo-Quiroga et al. 2018)

## *Culex coronator*

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- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

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- First described by Dyar and Knab in 1906
- Culex from Latin (gnat, mosquito)
- Interrogator from Latin: to ask, question
  - Fitting, as this can be difficult to correctly identify using adult characteristics

## *Culex interrogator*

- **Etymology**
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Native Range: Neotropics
  - Central America
  - Mexico
  - Texas

# *Culex interrogator*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



# *Culex interrogator*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Invasive range:
- Likely found throughout the southeastern United States
- Venezuela 2002
- Cuba: 2018
- Dominican Republic 2020

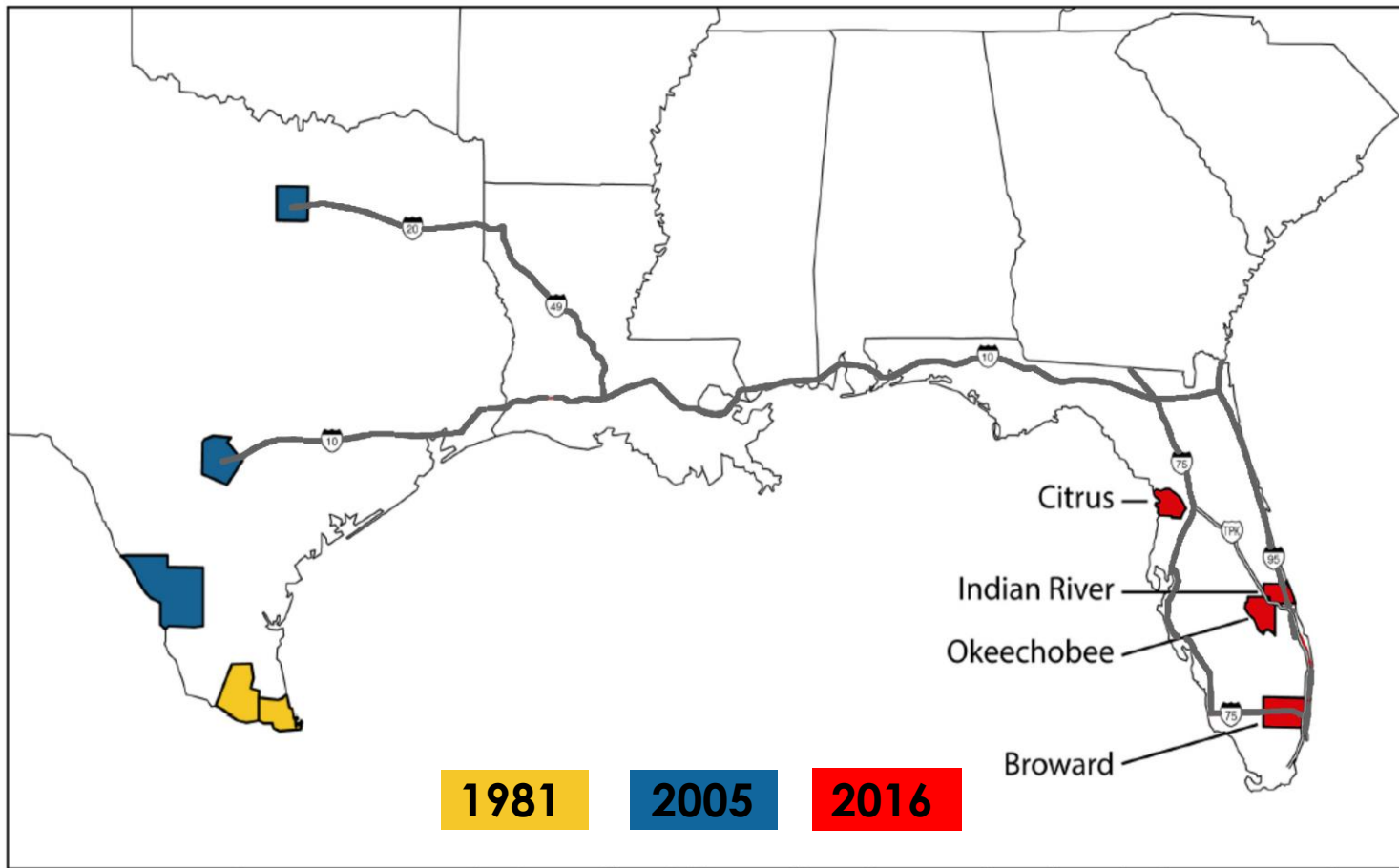


- Permanent and semi-permanent habitats including natural and artificial deposits
- Examples: washtubs, roof gutters, puddles, sewers and manholes

# *Culex* *interrogator*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Likely facilitated by movement of mosquito-infested containers (tires, buckets, pots, etc.) along major highway routes

## *Culex interrogator*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- **Dispersal Strategies**
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Significantly lower abundances compared to *Cx. nigripalpus* and *Culex coronator*
- Adult collections are considered rare
- Ovitrap
- Gravid traps
- Larval collections

# *Culex interrogator*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- **Collection Methods**
- Host Biting Preference
- Pathogen Transmission

- More surveillance and research is needed in this area
- Collected in dog-baited traps in Mexico
- Association with West Nile virus indicates avian host blood meal



# *Culex* *interrogator*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission



- More surveillance and research is needed in this area
- One (1) **West Nile virus** positive mosquito pool identified in Mexico
  - Role in WNV transmission in the United States is unknown
- *Dirofilaria* (dog heartworm parasite) were recovered from one (1) specimen in Mexico
- Insect Specific Virus: Culex flavivirus

## *Culex interrogator*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen  
Transmission**

# References

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Photo Credits: Nathan Burkett-Cadena

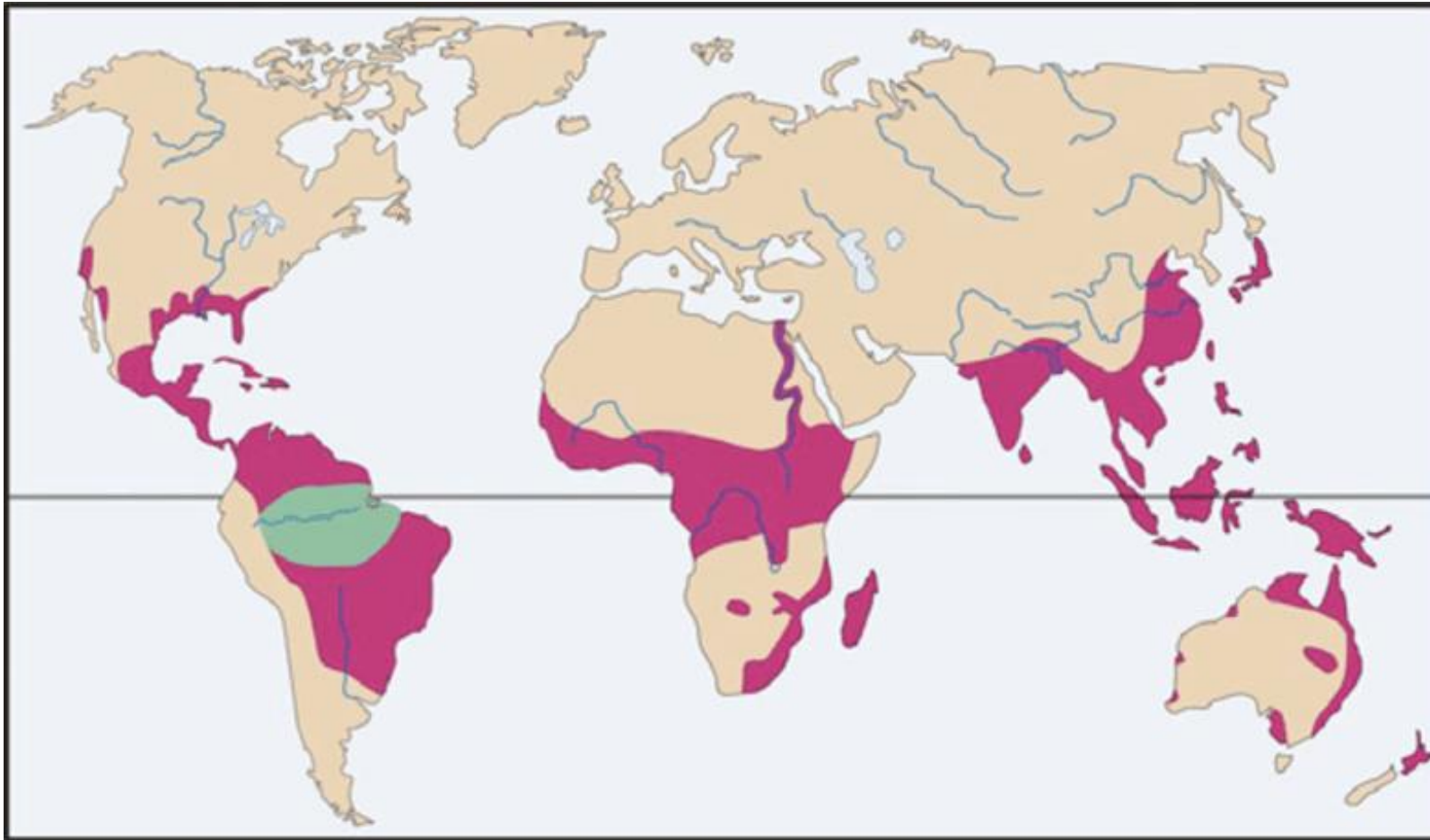
- *Mansonia titillans* (Walker 1848)
- *Mansonia*; Named after Patrick **Manson**
- *Titillans* (Latin); Titillo, to tickle or annoy

## *Mansonia titillans*

- **Etymology**

- Native Range
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

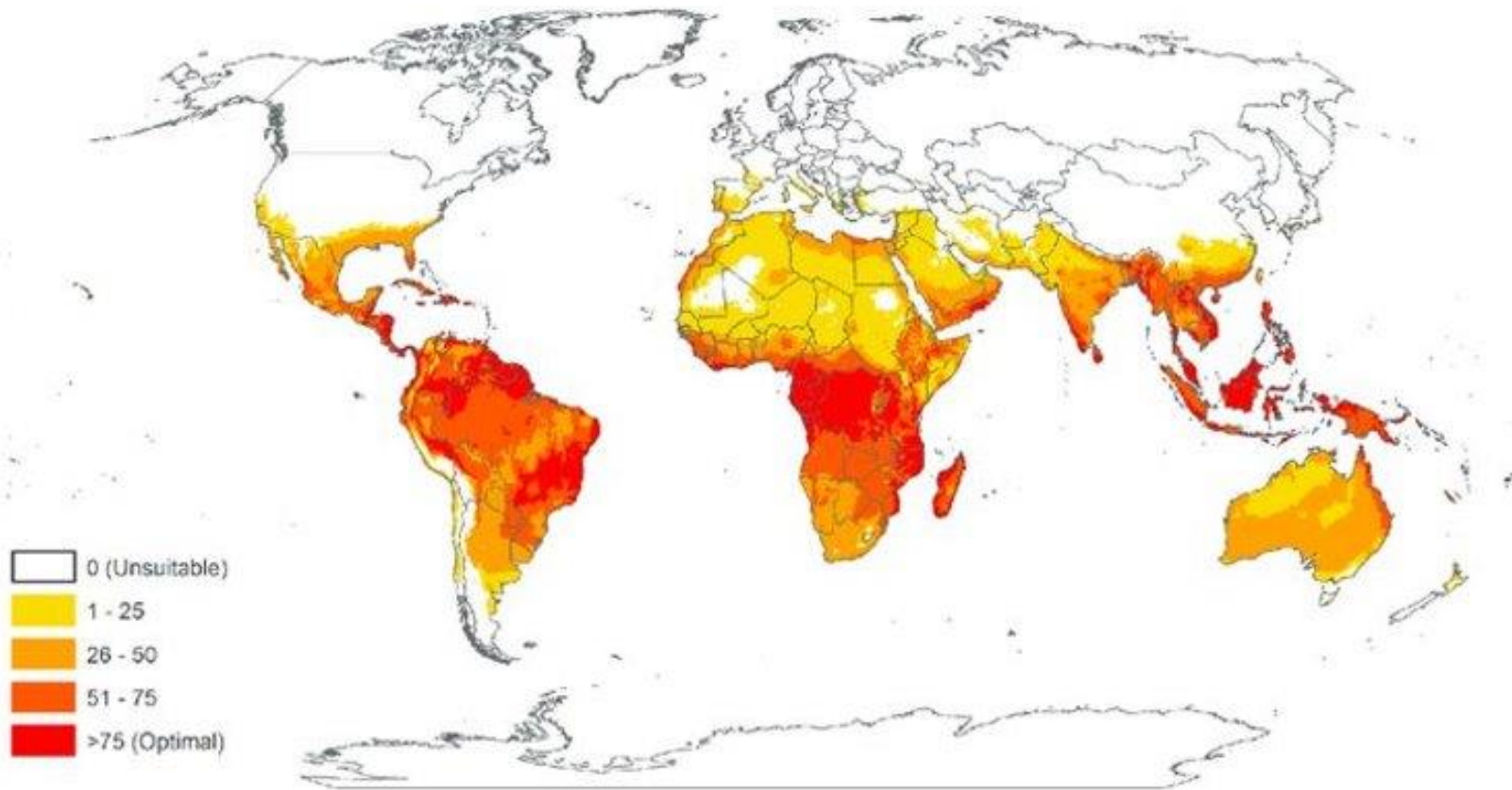




- Subtropical and temperate regions of the globe
- Limited to host-plant

## *Mansonia titillans*

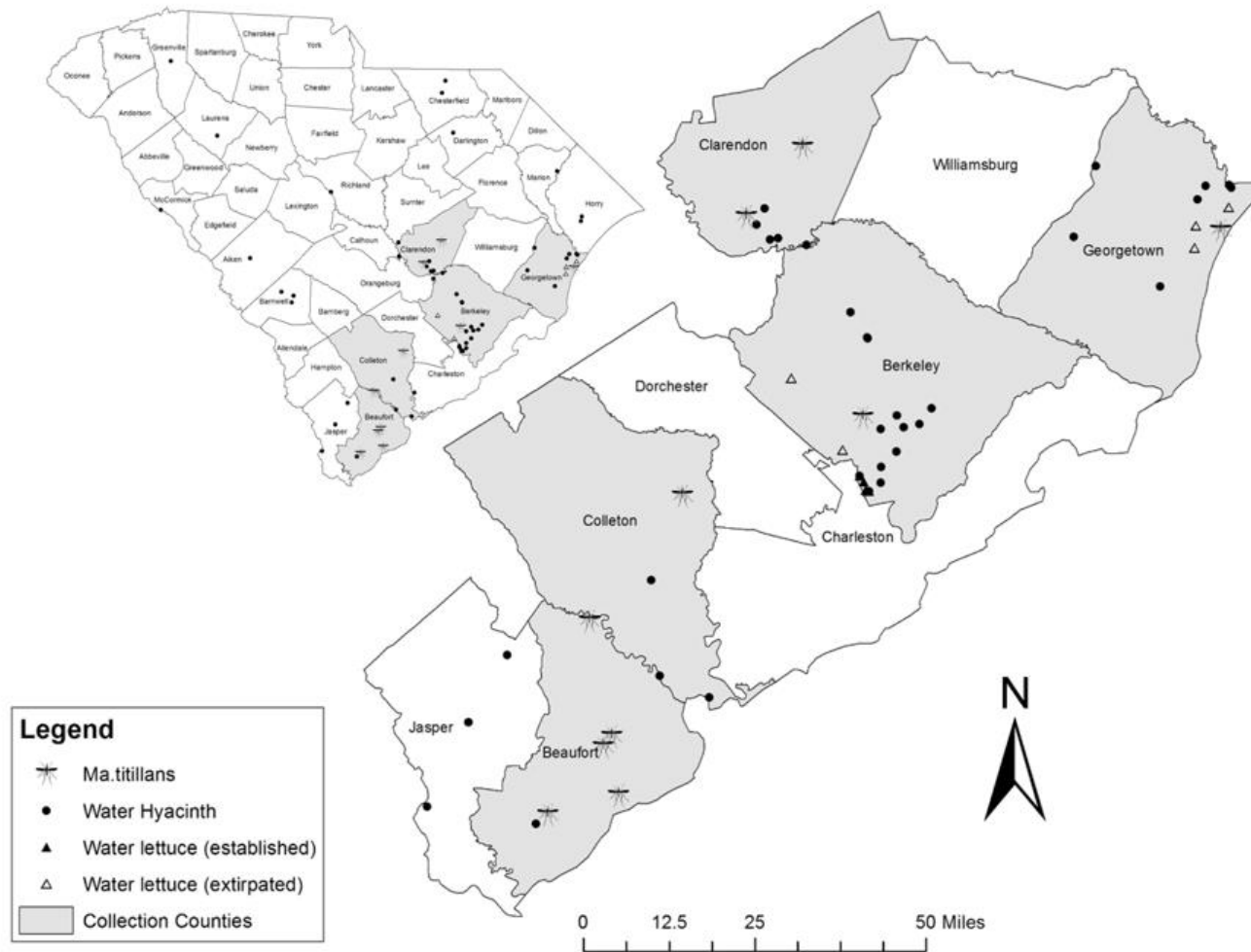
- Etymology
- **Native Range**
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Range is less limited by temperature, because they overwinter as larvae, and more by host-plant availability, which is limited by cold-stress.
- They can survive cold temperature if the host plant survives

## *Mansonia titillans*

- Etymology
- Native Range
- **Invasive Range**
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



# *Mansonia titillans*

- Etymology
- Native Range
- **Invasive Range**
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Recently detected in **South Carolina**
- Last 20 years migration over 15 counties in central and north Florida

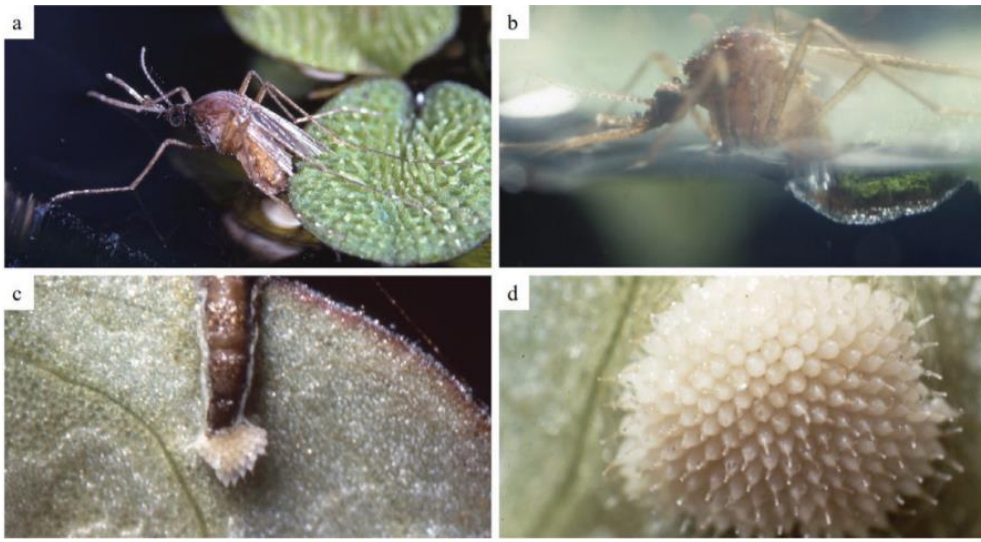




- Max Flight distance: Known to fly several miles in search of host blood meal and oviposition habitat
- Larvae may be transported in ornamental aquatic plants, explaining relative paucity in SC relative to GA.

## *Mansonia titillans*

- Etymology
- Native Range
- Invasive Range
- **Dispersal Strategies**
- Larval Habitat
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Permanent bodies of water (lakes, ponds, swamps, etc.) where host plants are found
- Water hyacinth, *Eichhornia crassipes* (top right)
- Water Lettuce, *Pistia Stratiotes* (bottom right)
- Larvae breath using modified larval siphon to puncture plant root and obtain oxygen

# *Mansonia titillans*

- Etymology
- Native Range
- Invasive Range
- Dispersal Strategies
- **Larval Habitat**
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



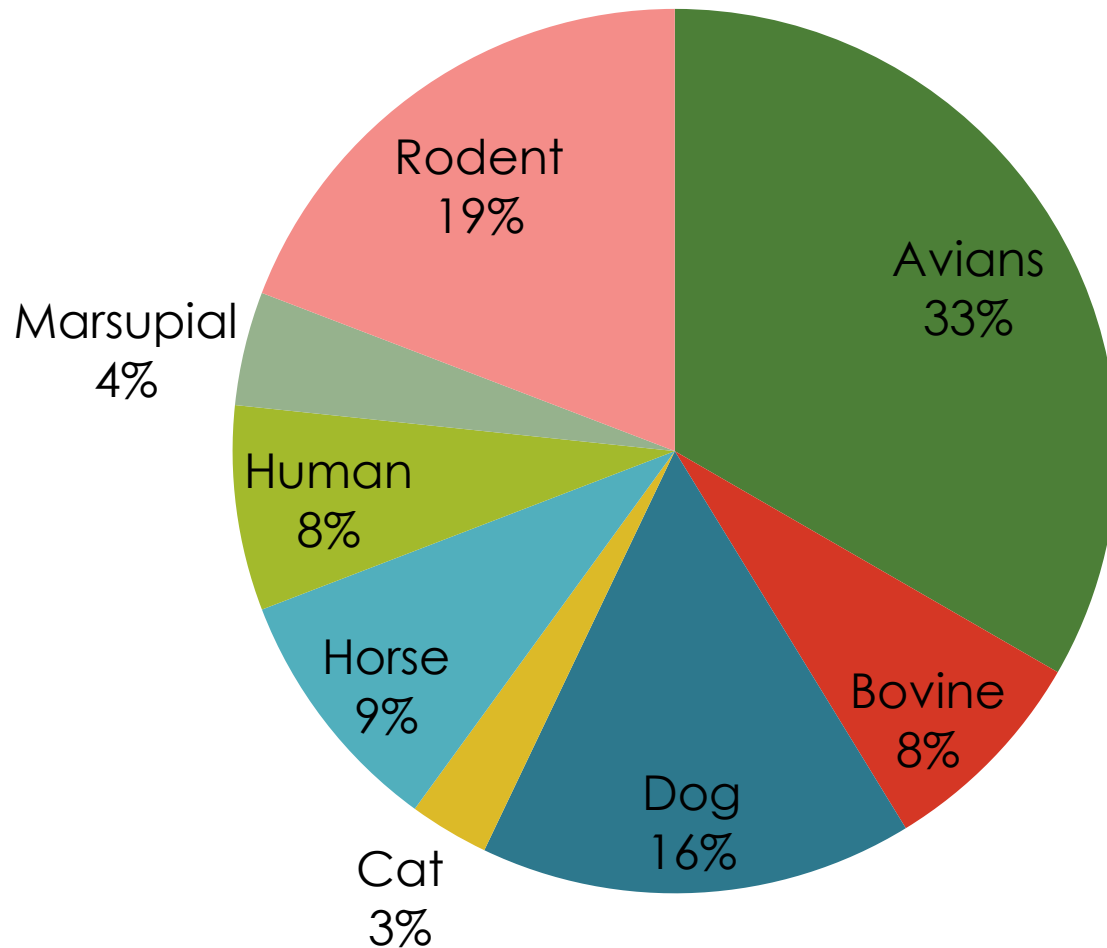


- CDC light traps, bait with CO<sub>2</sub>, Octenol, and BG Lure, ideally in synergy
- Emergence traps placed over larval habitat
- Larval collections best done by removing and washing the host plants

## *Mansonia titillans*

- Etymology
- Native Range
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- **Collection Methods**
  - Host Biting Preference
  - Pathogen Transmission

## *Mansonia titillans* feeding preference in Brazil



- Generalists, feeding on a combination of mammals, birds, and humans.

## *Mansonia titillans*

- Etymology
- Native Range
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission





- Bussuquara virus (BSQV)
- Cabassou virus (CABV)
- St. Louis Encephalitis virus (SLEV)
- Tlacotalpan virus (TLAV)



- Tonate virus (TONV)
- Venezuelan Equine Encephalitis virus (VEEV)
- West Nile virus (WNV)
- *Dirofilaria immitis* (Dog heartworm)

## *Mansonia titillans*

- Etymology
- Native Range
- Invasive Range
- Dispersal Strategies
- Larval Habitat
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

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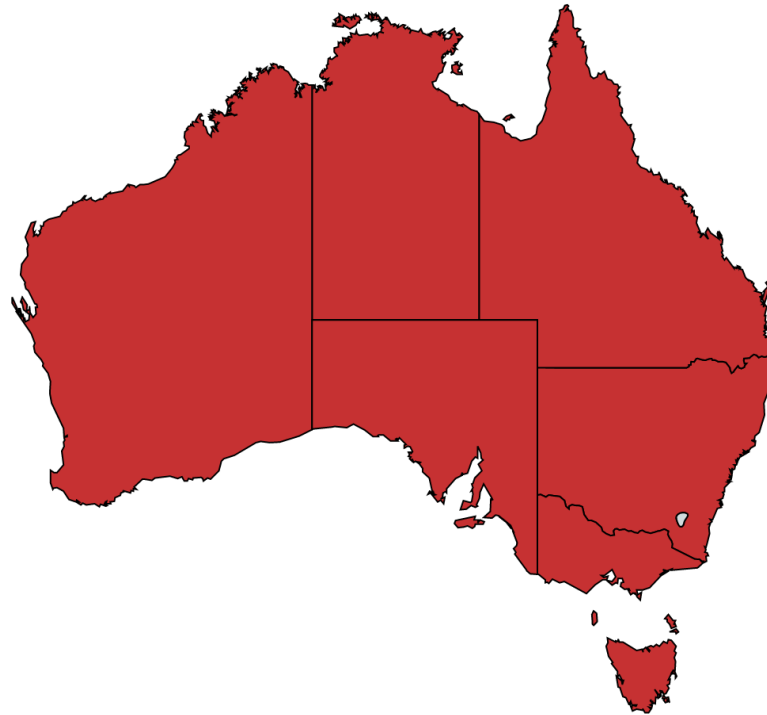
# *Aedes notoscriptus*

- **Etymology**

- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Recognized in 1989 by Skuse; subspecies *montanus* Brug 1939 discovered
- Greek: back, Latin: to write, reference to thorax "several fine longitudinal lines"
- Informal name: Scriptwriting Australian Pointy Mosquito
- Subgenus: *Rampamyia*





- Native to Australia including Tasmania

# *Aedes notoscriptus*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



# *Aedes notoscriptus*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Established in New Zealand around 1920
- Migrated north into South-east Asia & South Pacific Islands
- Established in 3 counties in southern California 2014-present time
- Cryptic in morphology regionally suggesting a diverse phenotypic morphologic complex



# *Aedes notoscriptus*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Wide range of artificial & natural containers
- Bamboo stumps, leaf axils, rock pools, palm fronds
- Containers made of wood, concrete, plastic and metal

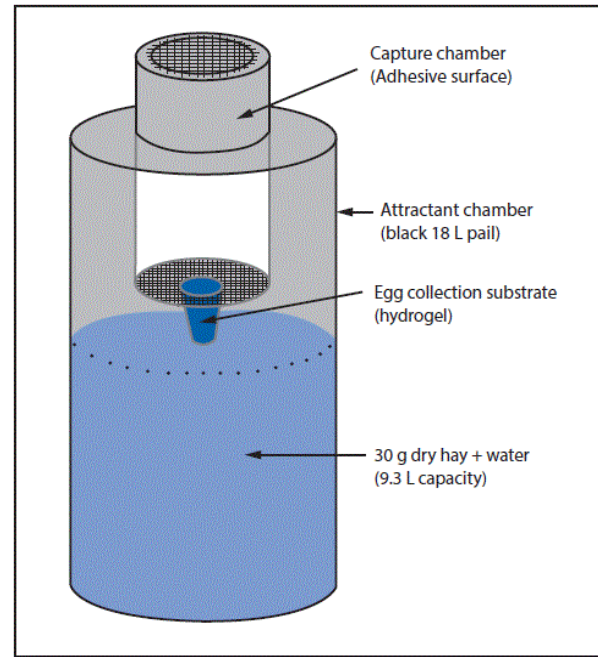




- Container breeders that use diapausing eggs
- Spread by humans along shipping routes

# *Aedes notoscriptus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- **Dispersal Strategies**
  - Collection Methods
  - Host Biting Preference
  - Pathogen Transmission



- CDC trap with CO<sub>2</sub> and Octenol or BG Lure
- BG Sentinel
- Autocidal Gravid Traps
- Gravid Traps



# *Aedes notoscriptus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- **Collection Methods**
- Host Biting Preference
- Pathogen Transmission



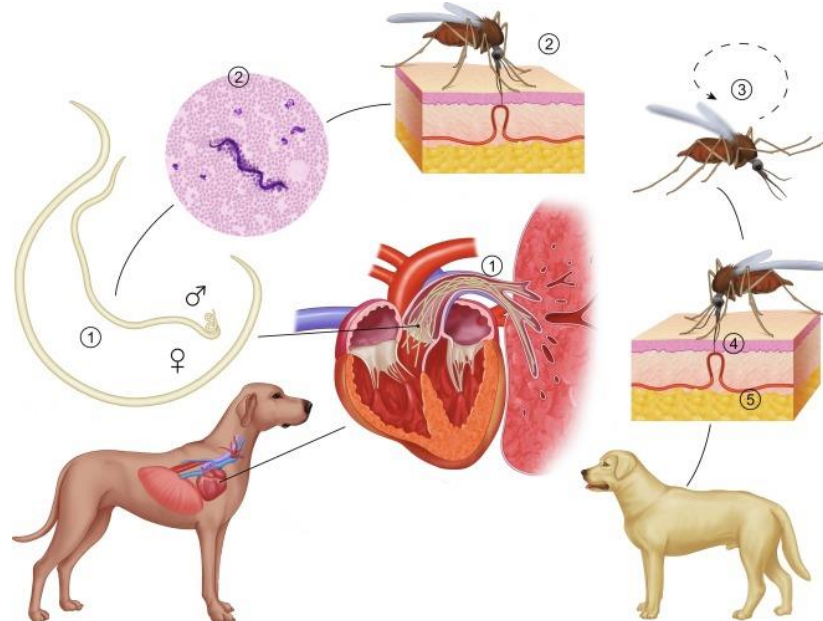
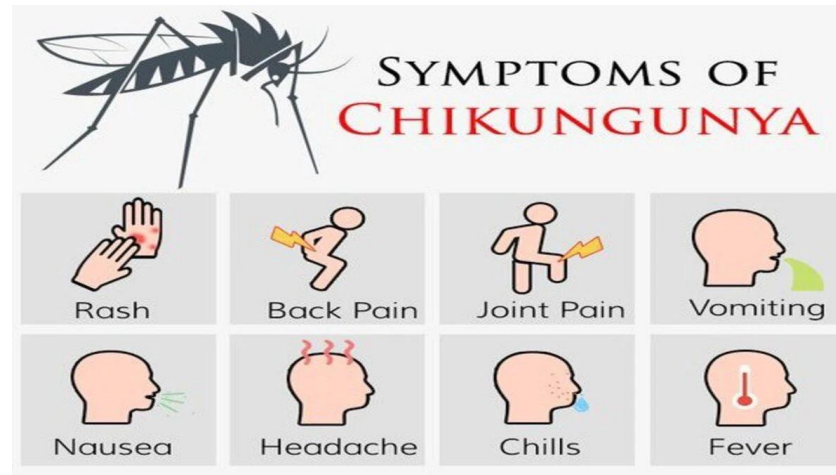
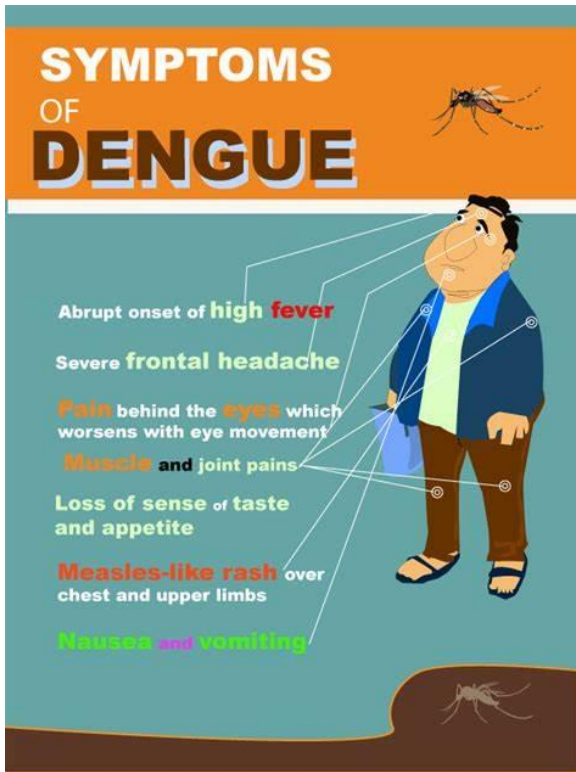


# *Aedes notoscriptus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission

- Humans, domestic pets, birds, marsupials, bats





- Dengue
- Chikungunya
- Zika Virus
- Ross River Virus
- Barmah Forest Virus
- *Dirofilaria immitis*

## Aedes notoscriptus

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

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# *Aedes vittatus*

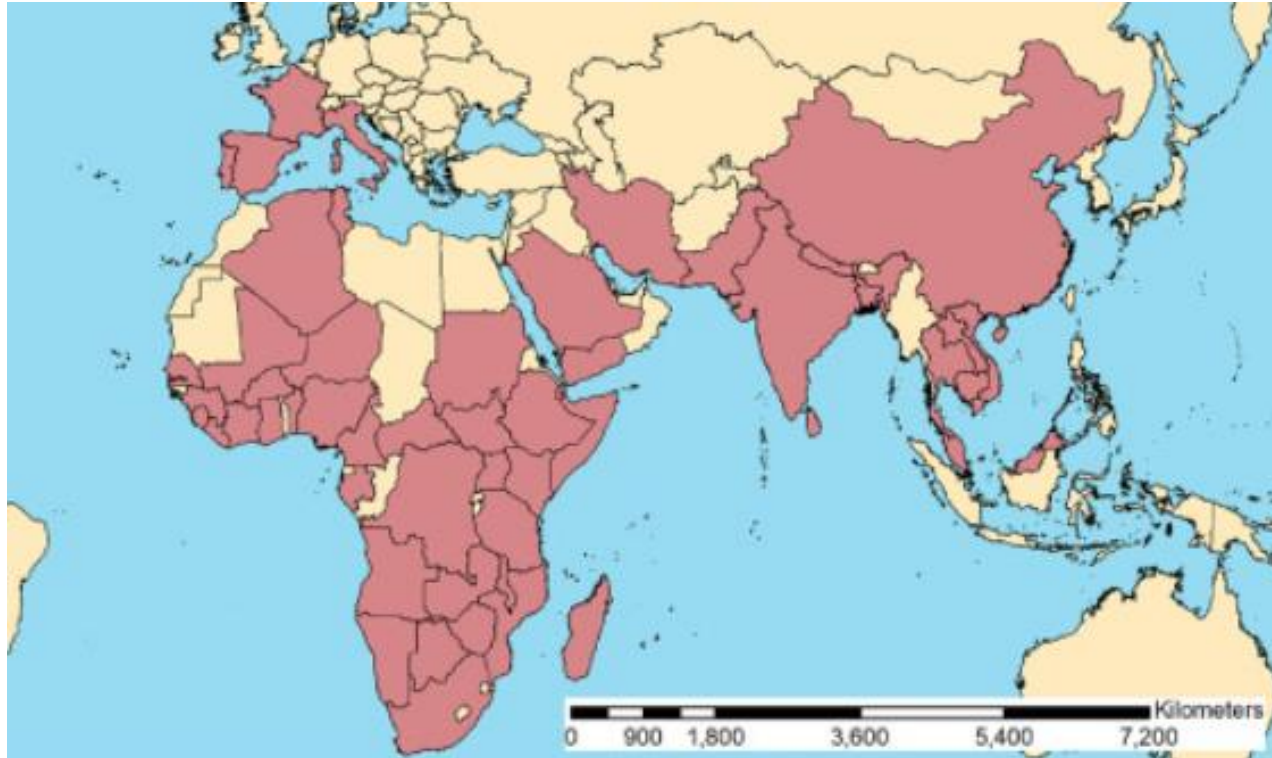
- **Etymology**

- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

**NOT DETECTED IN CONTINENTAL UNITED STATES AS OF JAN 2022**

- Aedes – Greek: unpleasant; vittatus – Latin: wearing or carrying a ritual ribbon (in reference to banded tibia)
- First described by French Entomologist Jacques-Marie-Frangile Bigot in 1861





Country-Level Distribution

- Native Range: Old World
  - Palearctic
  - Oriental
  - Paleotropic

# *Aedes vittatus*

- Etymology
- **Native Range**
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



■ New Country-Level Distribution

- Invasive Range: Neotropical
- Cuba in 2019
- Dominican Republic in 2020

Mitochondrial COI gene sequencing supporting two separate introductions into the Caribbean from the Indian subcontinent

# *Aedes vittatus*

- Etymology
- Native Range
- **Invasive Range**
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission



- Variety of natural and artificial containers:
  - rock pools
  - tree holes
  - hoofprints
  - domestic containers

# *Aedes vittatus*

- Etymology
- Native Range
- Invasive Range
- **Larval Habitat**
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- Pathogen Transmission





- Egg desiccation tolerance
- Caribbean introductions are speculated to have occurred via shipping container transport to and between islands

# *Aedes vittatus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- **Dispersal Strategies**
- Collection Methods
- Host Biting Preference
- Pathogen Transmission

- Like other invasive *Aedes* mosquitoes they are not commonly collected using CDC light traps
- Few or single specimen collections in light traps may not be representative of wild-population abundance
- Surveying potential production sites (artificial and manmade containers) is necessary
- More surveillance data in invasive range (Caribbean) is needed to predict production sites in North America



## *Aedes vittatus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- **Collection Methods**
- Host Biting Preference
- Pathogen Transmission



## Opportunistic Feeders

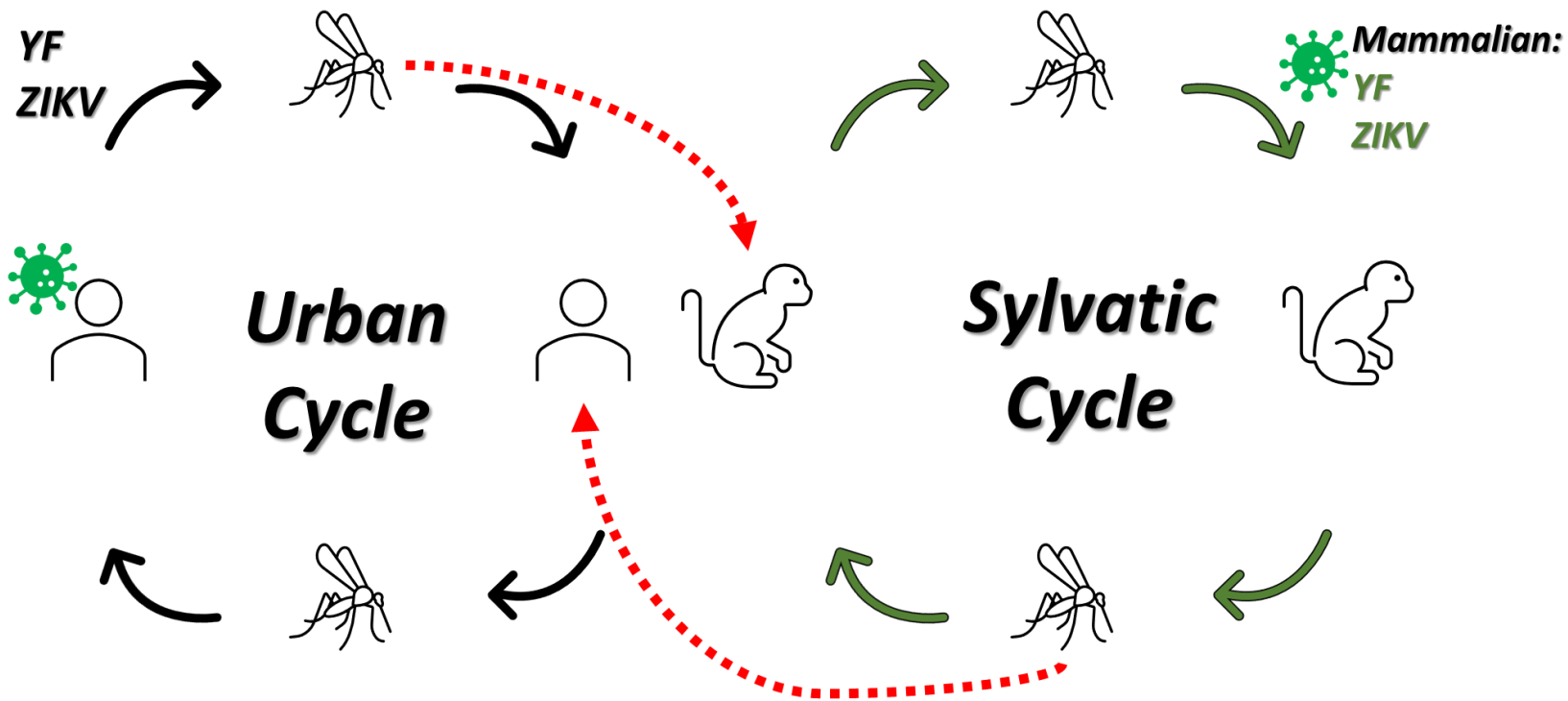
- Non-Human Primates
- Domestic Animals
- Rodents
- Humans
- Bats
- Birds



## *Aedes vittatus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- **Host Biting Preference**
- Pathogen Transmission





- Babanki virus<sup>1,4</sup>
- Chikungunya virus<sup>1,2,4,5</sup>
- Middleburg virus<sup>1</sup>
- Semliki Forest virus<sup>1,4,5</sup>
- Dengue viruses<sup>1,3</sup>
- Saboya virus<sup>1</sup>

- Wesselsbron virus<sup>1</sup>
- Yellow Fever virus<sup>1,3</sup>
- Zika virus<sup>1,2,5</sup>
- Bunyamwera virus<sup>1</sup>

- |                  |           |
|------------------|-----------|
| 1. Africa        | 4. Europe |
| 2. Americas      | 5. Asia   |
| 3. South America |           |

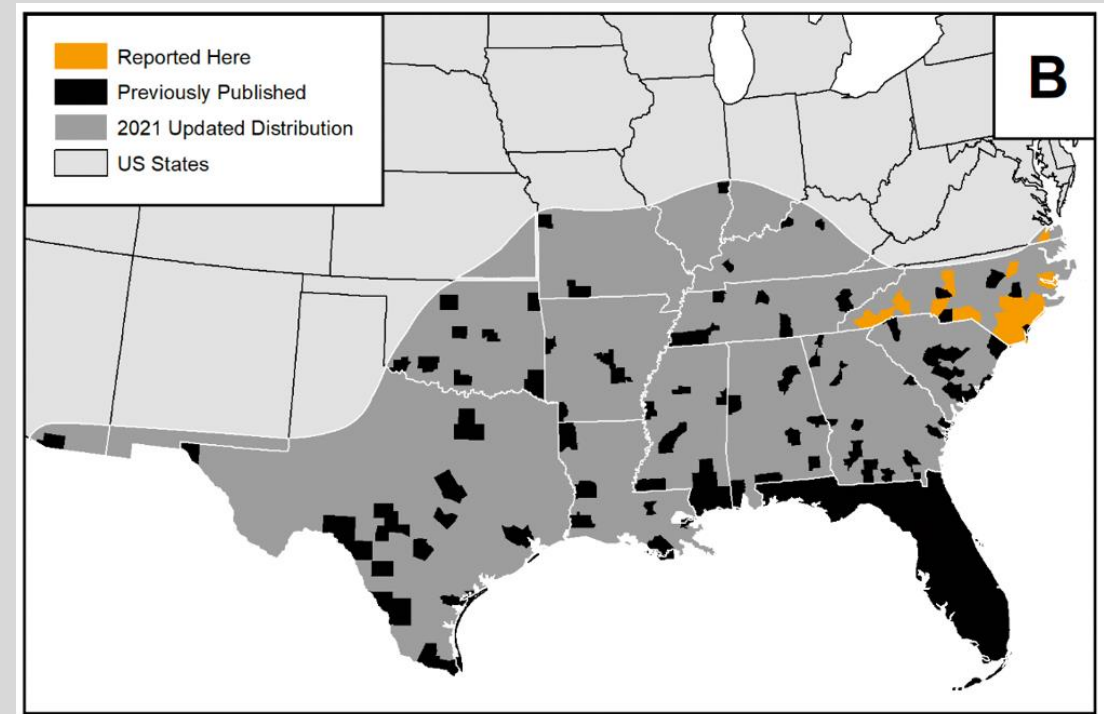
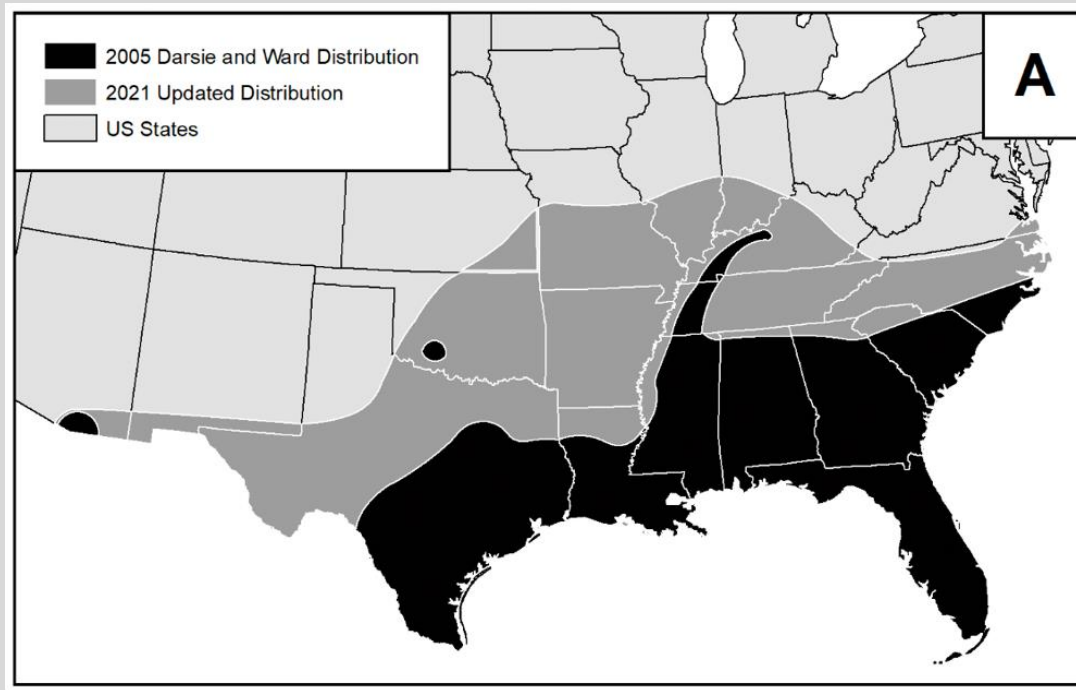
## *Aedes vittatus*

- Etymology
- Native Range
- Invasive Range
- Larval Habitat
- Dispersal Strategies
- Collection Methods
- Host Biting Preference
- **Pathogen Transmission**

# References

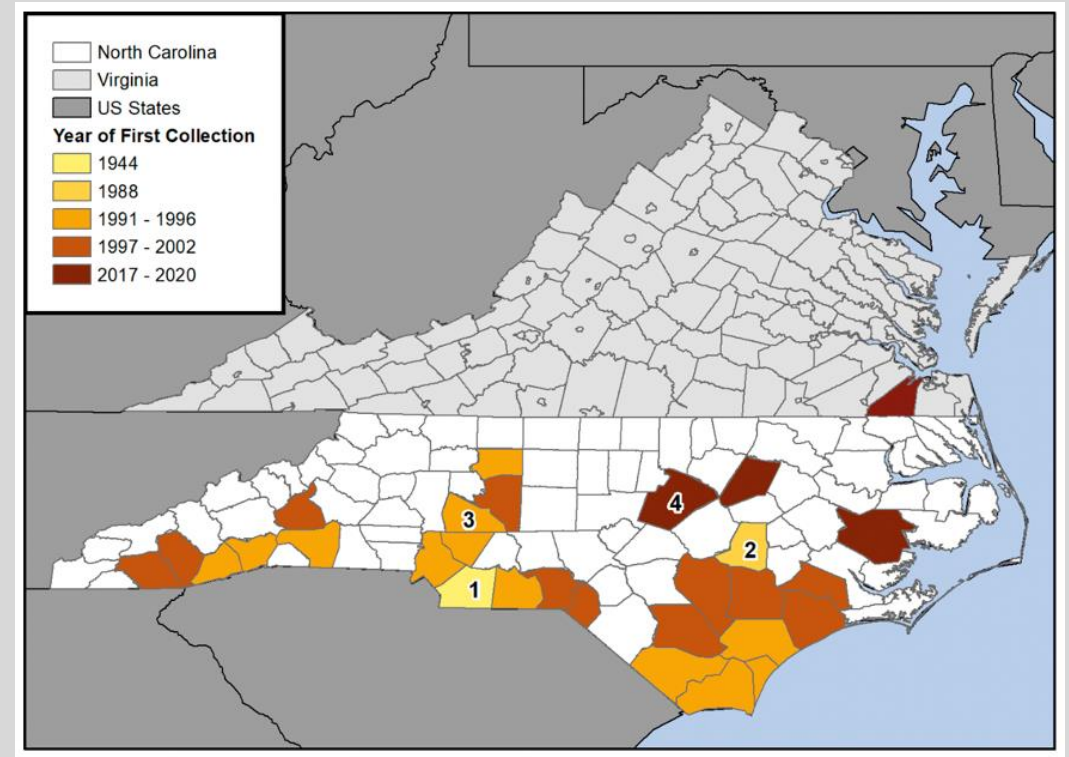
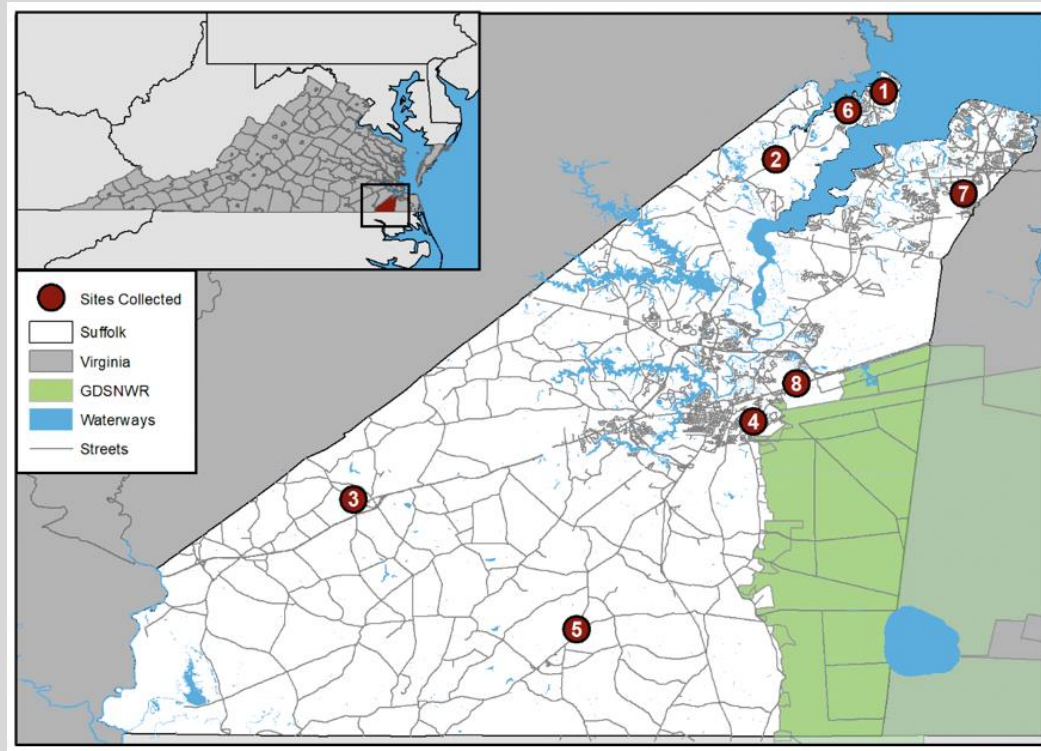
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# *Culex nigripalpus* Range Expansion





# *Culex nigripalpus* Range Expansion



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# MOSQUITO IDENTIFICATION

Mr. Michael Riles

Beach Mosquito Control District

Slide Contributions: Bryan V. Giordano, Benjamin Allen, Michael Riles, Ana Romero-Weaver, Yoosook Lee



# How to Use a Taxonomic Key

- "Keys" are arrangements of taxa. Similar taxa (based on external morphology, or appearance) are grouped together.
- Keys are used to identify unknown specimens using descriptive statements about the organism
- Keys present informational statements that describe unique characteristics
- We must then decide which statement or statements more closely matches the organism we are trying to identify under the microscope
- Mosquito Keys are typically organized as dichotomous keys (di – two), meaning there are two options given at each step of the key
- When you answer a couplet (set of 2 statements), the key will direct you to the next set of statements. Pay attention to the numbering as you make your way through the key.

# How to Use a Taxonomic Key (Continued)

- Eventually you will make your way down the key to the terminal couplet, where you will be directed to select a Genus or species
- Keys will often have figures or illustrations to draw attention to a particular morphological characteristics. Always rely on the written informational statements first and use the pictures to assist with your decision.
- **BEFORE YOU START**
- Read the Introduction or Preamble. Don't skip over this section! These scientists have put a lot of time and effort into these publications, and they have a lot of interesting and relevant information to relay to you.
- Be aware of the format, acronyms and abbreviations, and the limitations of each key. Keys usually only cover genera and species in a specific geographic location.

# How to Use a Taxonomic Key (Example)

Key (Couplet 1)

1. Palpus longer than antennae (Fig. 1); scutellum evenly rounded, with continuous row of posterior setae (Fig. 2)..... 2  
Palpus much shorter than antennae (Fig. 3); scutellum with 3 distinct lobes, long setae confined to the 3 lobes (Fig. 4)..... 3

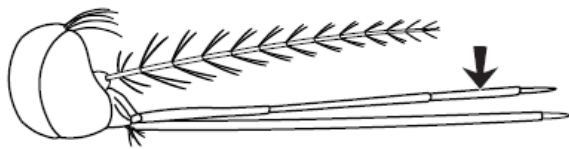


Fig. 1

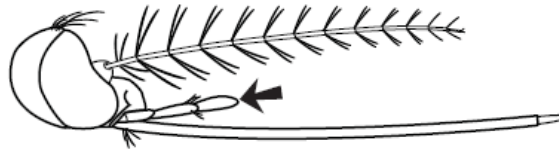


Fig. 3



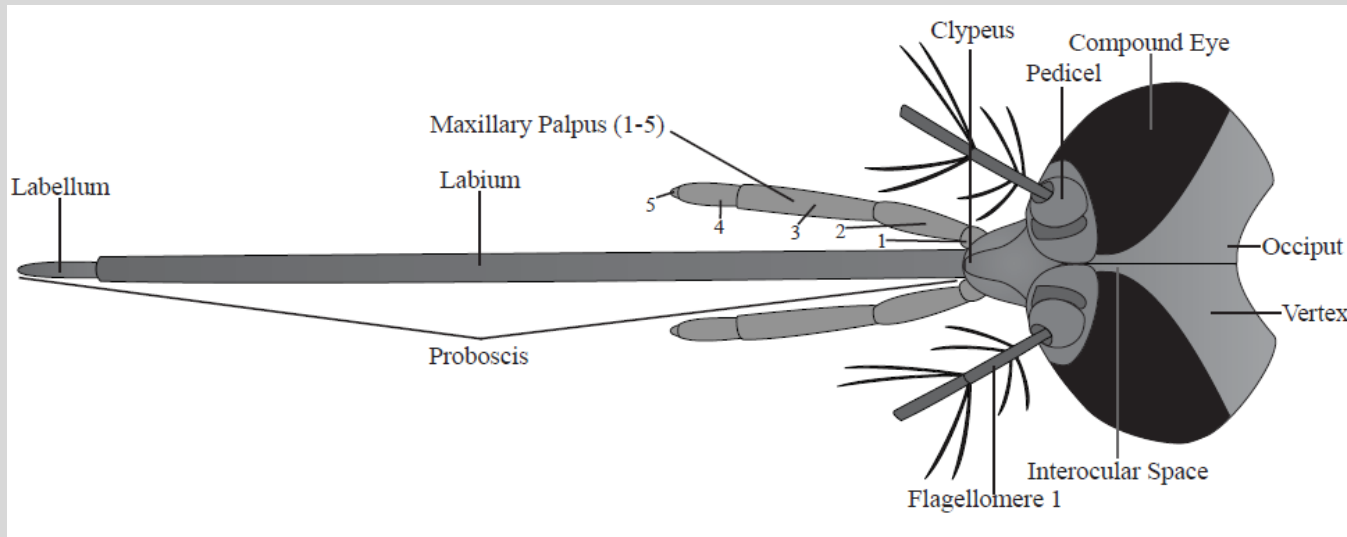
WALTER REED BIOSYSTEMATICS UNIT

Unknown Specimen

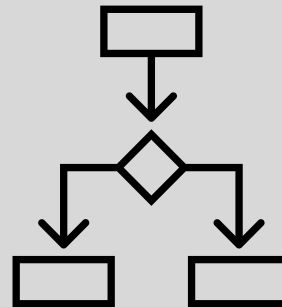
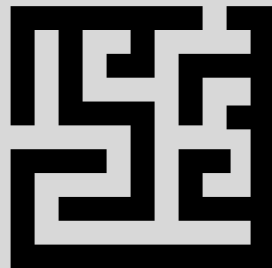
- Always start with couplet 1
- Read each statement from the start to finish. If you do not know a word you will need to consult the Key or Google it.
- Select the statement that best matches your unknown specimen
- We see the specimen's palps are NOT longer than the antennae, so we would continue to couplet # 3



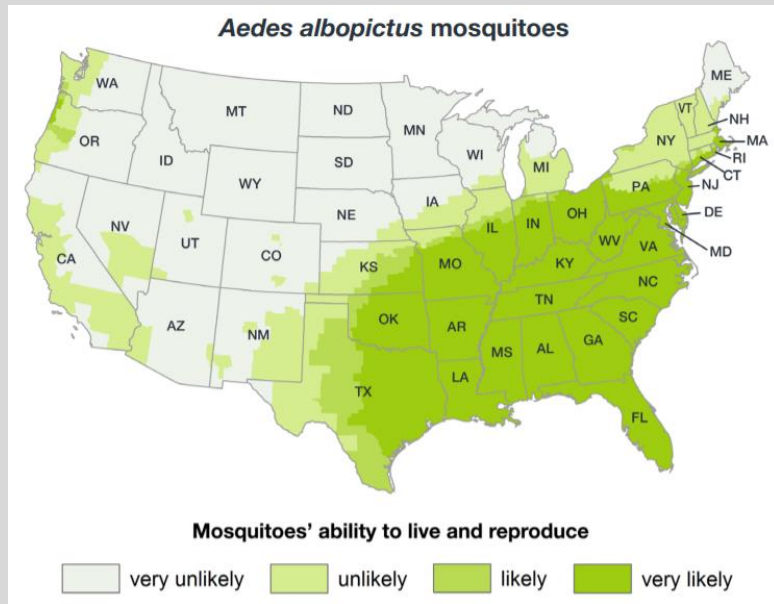
# How to Use a Taxonomic Key (Tips)



- Keys usually have diagrams of mosquito morphology near the beginning.
- Read and fully understand each statement before making your decision.
- Consult other keys and published works
- If you get stuck, try moving forward in one direction and see how the morphology compares. If the morphology doesn't 'key out' then go back and try another route



# How to Use a Taxonomic Key (Tips)



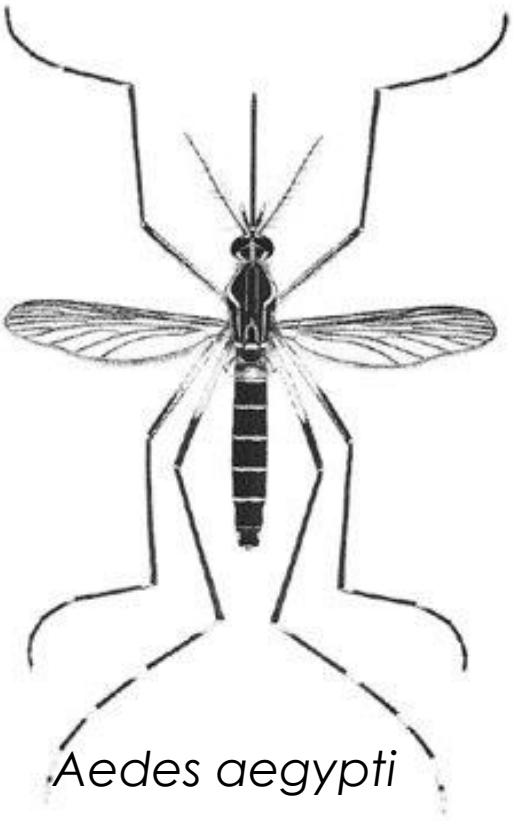
- Be aware of what species are in your area and neighboring regions (Maps or Species Checklists are very useful)
- Compare your samples to photos, illustrations, museum collections
- Build a network of mosquito identifiers. Not sure about something, ask a friend or colleague!
- Start your own collection. Keep a well-organized and labelled collection of your mosquito identifications. Pin freshly caught mosquitoes or store in centrifuge tubes in the freezer.



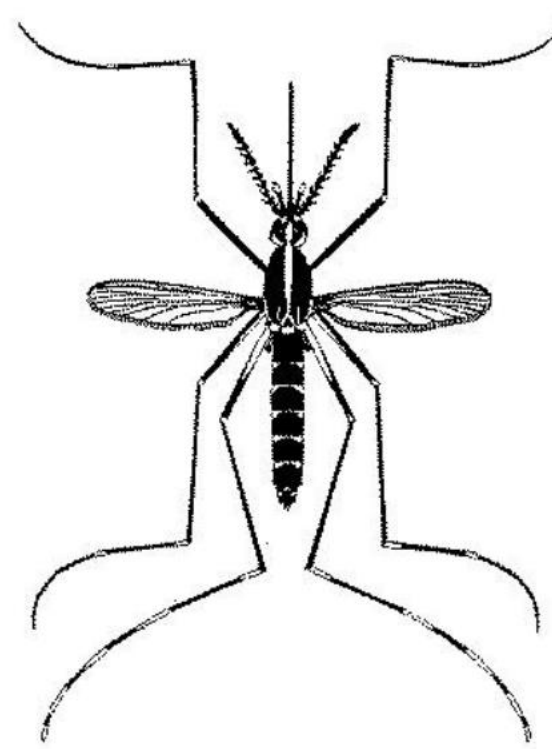
- *Aedes aegypti*, the Yellow-Fever Mosquito, is a small container-inhabiting species (~4 to 7 millimeter).
- Can be confused with *Aedes albopictus* or *Orthopodomyia* spp. – especially if weathered or damaged

## *Aedes aegypti*

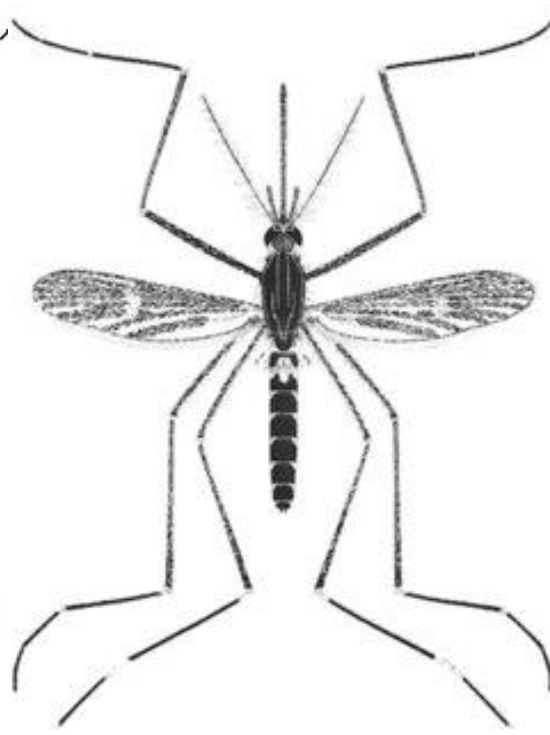
- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Stegomyia*
- Species: *aegypti*



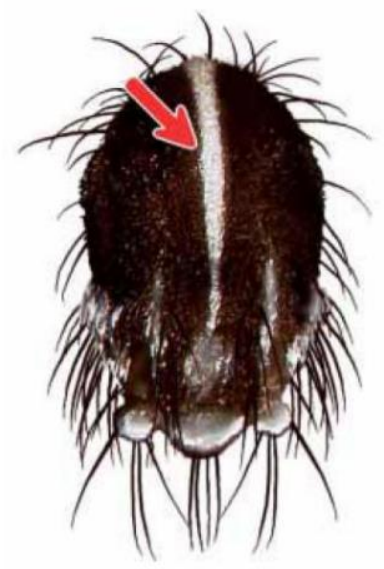
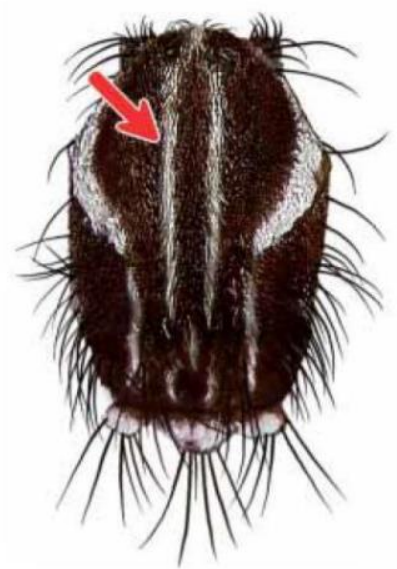
*Aedes aegypti*



*Aedes albopictus*



*Orthopodomyia  
signifera*



# *Aedes aegypti*

- Silvery white scales on the dorsal surface of the thorax form a distinctive lyre (violin)
- Legs are dark with white basal bands forming stripes
- Abdomen is dark with white scales

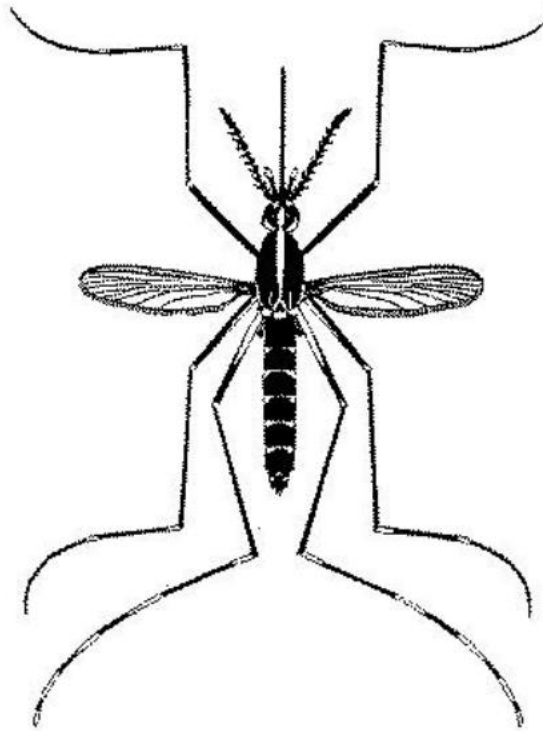




- The Asian tiger mosquito, *Aedes albopictus* (Skuse), is a medium-sized mosquito (approximately 2.0 to 10.0 mm) covered in dark black scales with white/silvery ornamentals
- Easily recognized by white stripe down the center of the head and continuing along the thorax

## *Aedes albopictus*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Stegomyia*
- Species: *albopictus*

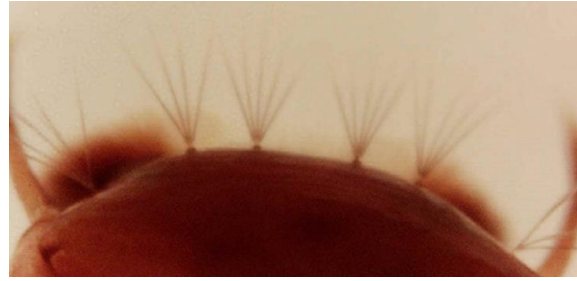


# *Aedes albopictus*

- Scutum with white median longitudinal stripe
- Silvery or white scale patches on legs; Ta-I-III 1-5 with only basal bands
- Palpus with white scales at apex



Photographer: H.J. Harlan, AFPMB



Larvae photo: <http://ruweb.rutgers/copyright.shtml>

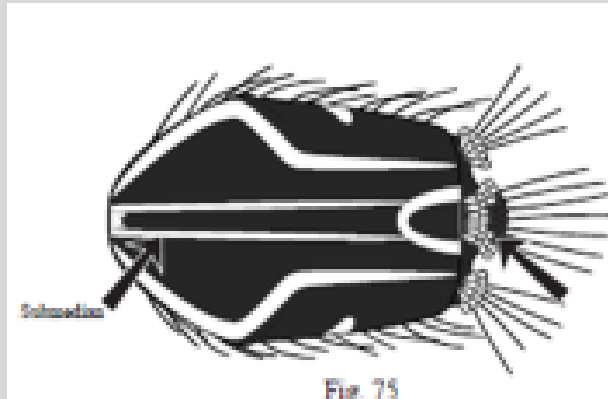
- A medium-sized mosquito with completely dark scaled proboscis
- Has a distinctive golden scaled scutum that is lyre like
- Lateral portions of the thorax and abdomen have patches of whitish-silver scales
- Wide pale basal bands on hind tarsal segments
- Hind femur ventral pale scales mid interior to insertion of thorax
- Larvae have a distinct linear orientation of 5-7-C setae fanlike with 4-6 branches
- Fringe of the anal saddle is conspicuously spiculated

## *Aedes japonicus*

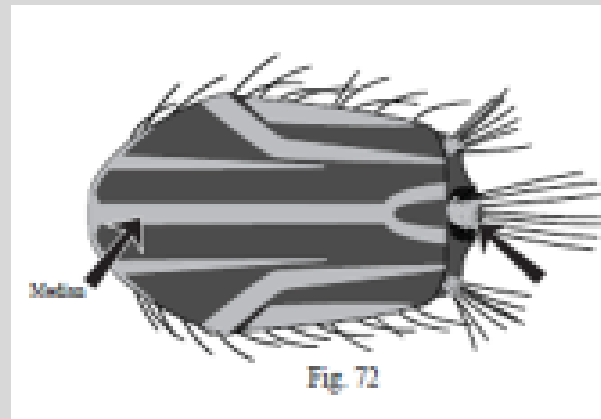
- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Hulecoeteomyia*
- Species: *japonicus*
- Subspecies: *japonicus*



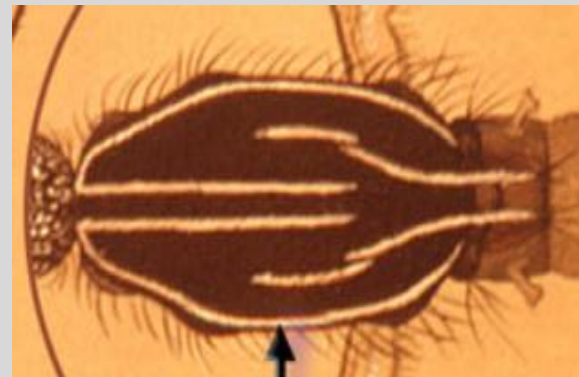
*Aedes aegypti*



*Aedes japonicus*



*Orthopodomyia  
signifera*





11(10). Scutum with golden stripes, including a gold median longitudinal stripe (Fig. 72); scales on lobes of scutellum long and narrow (Fig. 72); palpus with black scales (Fig. 73); hindtarsomeres 1-3 with broad basal white bands, 4 black, rarely with small dorsobasal pale spot, 5 entirely black (Fig. 74). . . . . *Ae. j. japonicus*

Scutum with white or silver stripes, with or without a median longitudinal stripe (Fig. 75); scales on lobes of scutellum short, broad, and silver (Fig. 75); palpus with white scales apically (Fig. 76); hindtarsomeres 1-4 with broad basal white bands, 5 entirely pale or pale dorsally (Fig. 77). . . . . 12

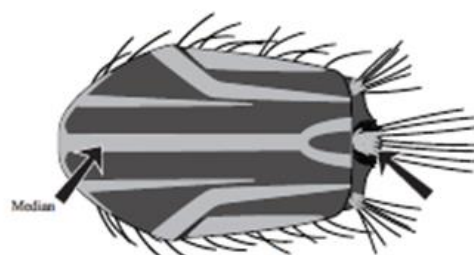


Fig. 72

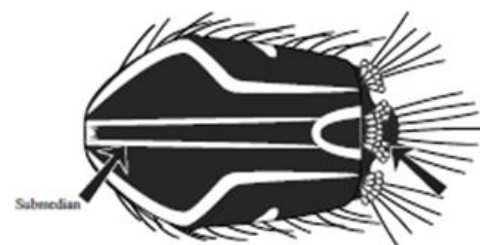


Fig. 75

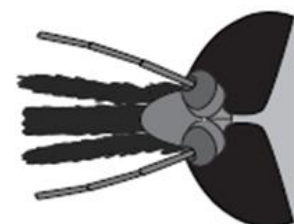


Fig. 73

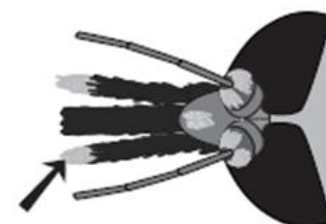


Fig. 76

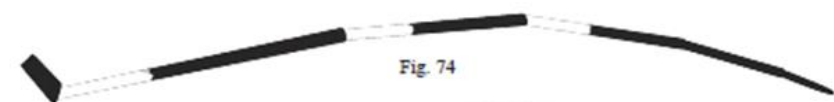


Fig. 74

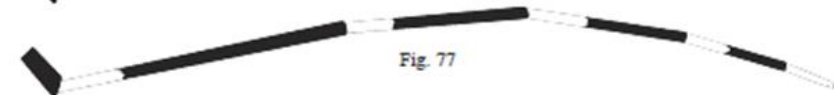
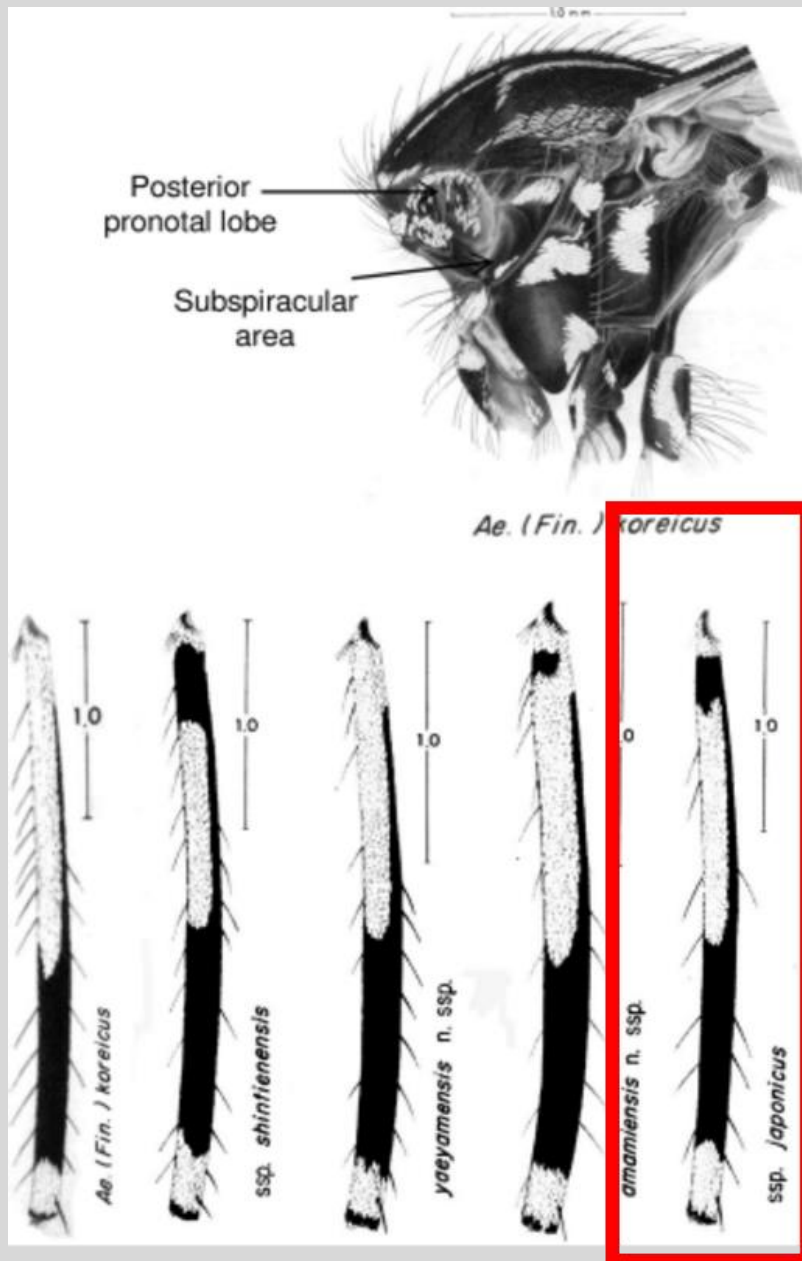


Fig. 77



## *Aedes japonicus* complex

- Femoral characters defined by Tanaka 1979
- Scaling patterns can define subspecies
- *Aedes korecius* identified in Europe

Molecular Phylogenetics of *Aedes japonicus*, a Disease Vector That Recently Invaded Western Europe, North America, and the Hawaiian Islands *Journal of Medical Entomology* 2014;47(4):527-535.  
doi:10.1093/jmedent/47.4.527

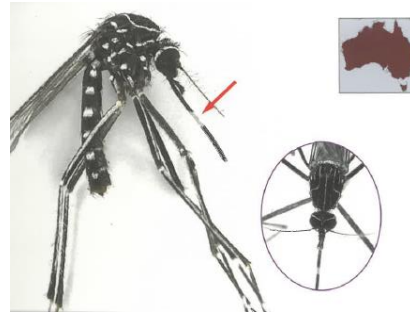
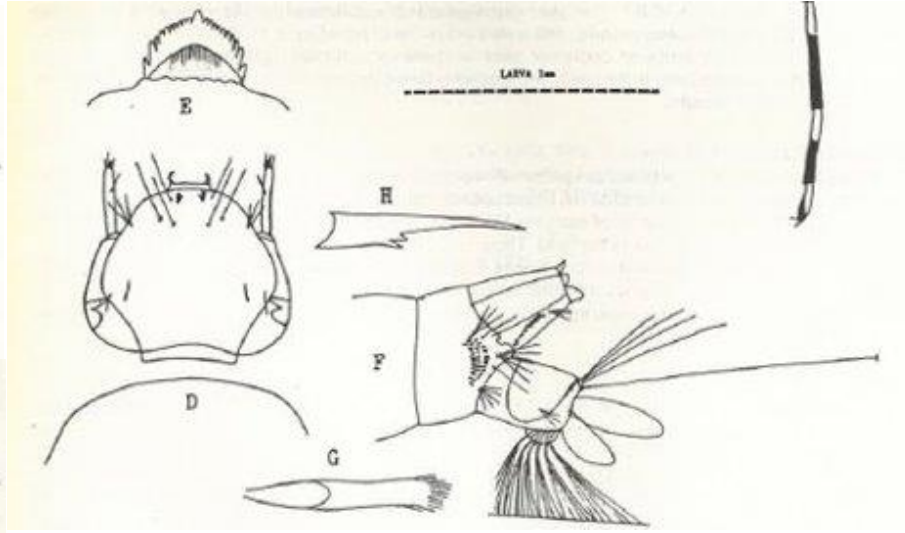
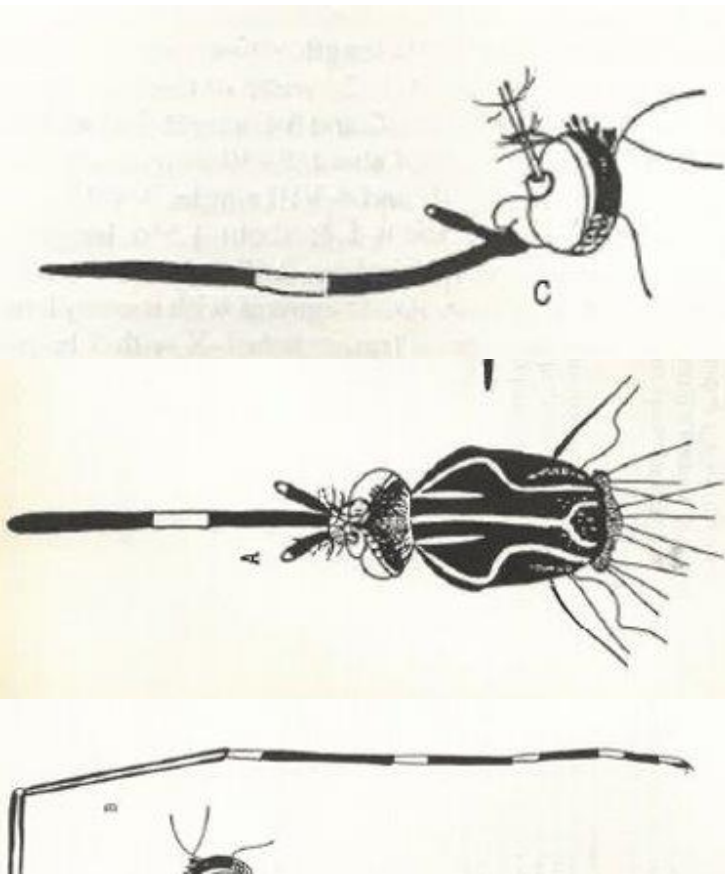
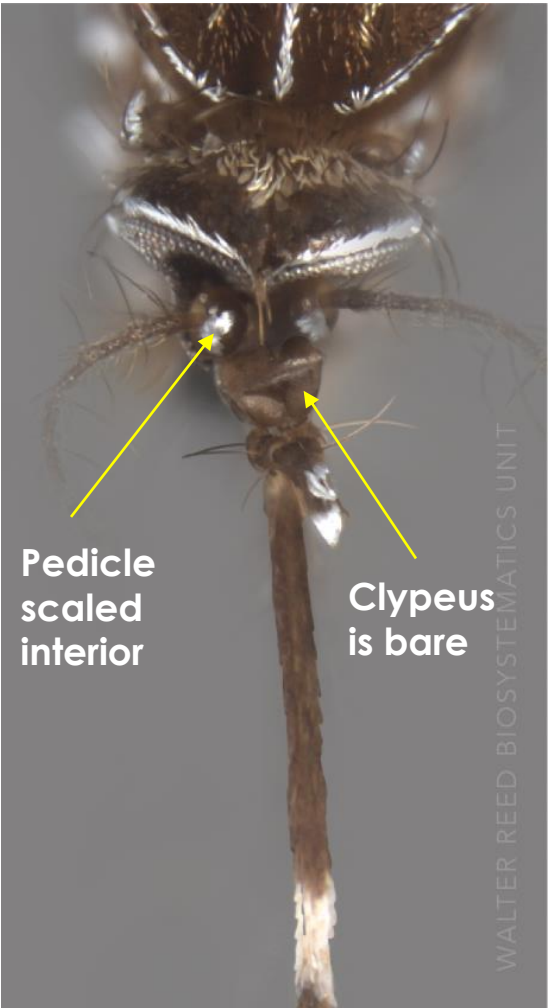


Photo Credit: Paul Zborowski

# Aedes *notoscriptus*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: Aedes
- Subgenus: *Rampamyia*
- Species: *notoscriptus*

- Variable in size~ small-medium-large
- Coloring of scales highly variable: silver/white through golden/yellow
- Scutum with distinct lyre-like pattern w/ 2 sub median stripes
- Palps white tipped 0.125X the length of proboscis
- Clypeus bare
- Pedicle scales important!



Pedicle scaled interior

Clypeus is bare

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*Aedes notoscriptus*

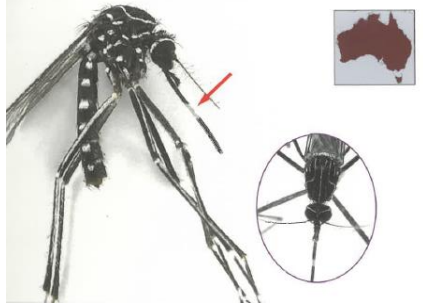
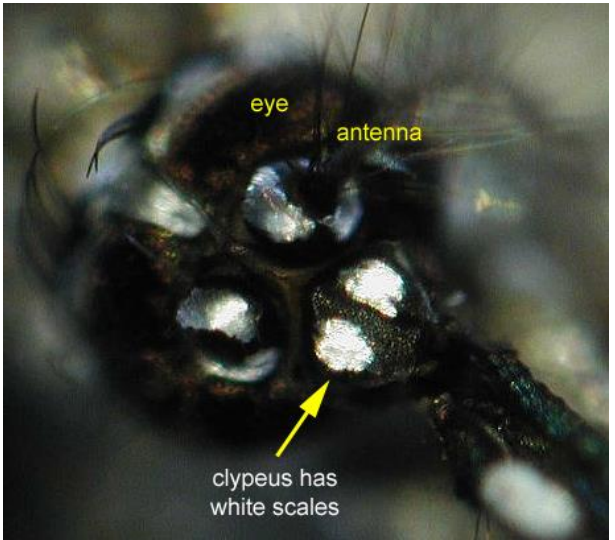
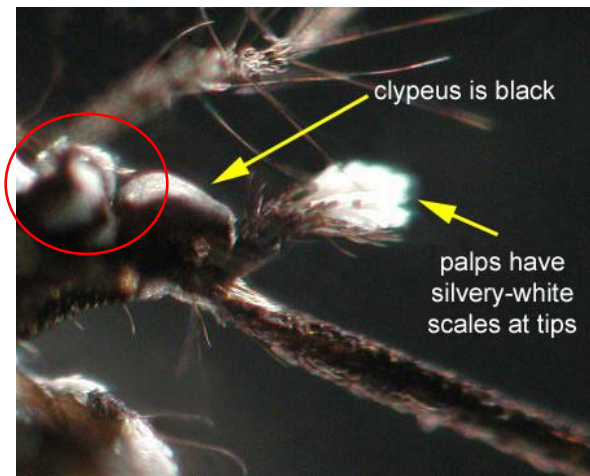


Photo Credit: Paul Zborowski



*Aedes aegypti*

<https://fmel.ifas.ufl.edu/mosquito-guide/mosquito-genera-and-species/genus-aedes/aedes-aegypti/>



*Aedes albopictus*

<https://fmel.ifas.ufl.edu/mosquito-guide/mosquito-genera-and-species/genus-aedes/aedes-albopictus/>

*Aedes notoscriptus*

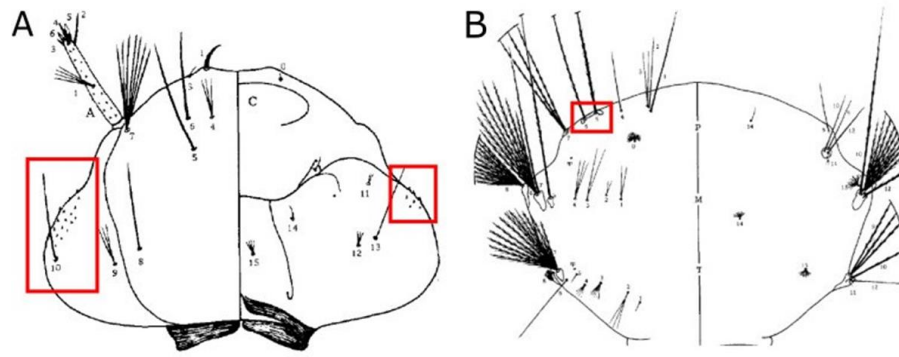
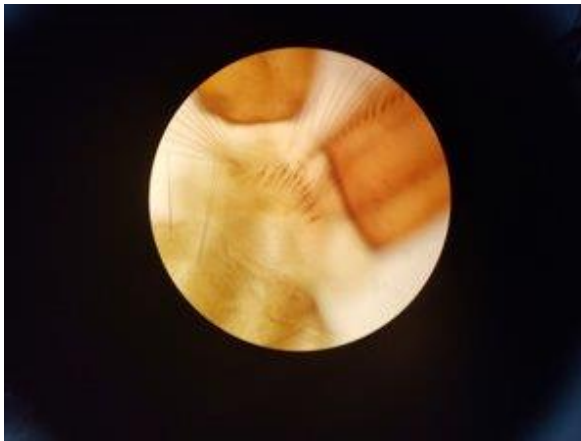
VS.

*Aedes aegypti* &  
*Aedes albopictus*

Pedicle scales

Clypeus scales





Head (A) and thorax (B) of *Aedes pertinax* larvae (image modified from Belkin et al. 1970).



# *Aedes pertinax*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Ochlerotatus*
- Species: *pertinax*
- Group: *Serratus*

- Medium sized w/ brown coloration
- Grey to white scales for a characteristic narrow median longitudinal line~ Can be variable
- Proboscis and palps entirely scaled dark~ palps  $\frac{1}{4}$  length
- Broad "whitish" patch of occipital scales present & extends to and borders the compound eye
- Larvae are separated within *Serratus* by comb scale orientation

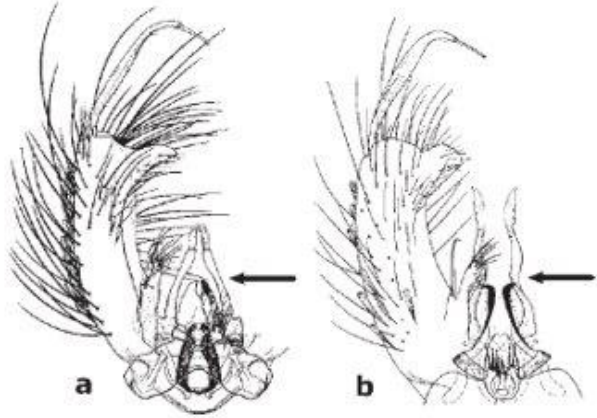


Fig. 2. (a) Illustration of *Aedes pertinax* male genitalia from Belkin et al. (1970). (b) Illustration of *Ae. tormentor* male genitalia from Yamaguti and LaCasse (1951). Arrows identify the claspettes, which differ in shape and orientation in these species.

Shroyer et al. 2015. *Aedes pertinax* A newly recognized mosquito species in the United States

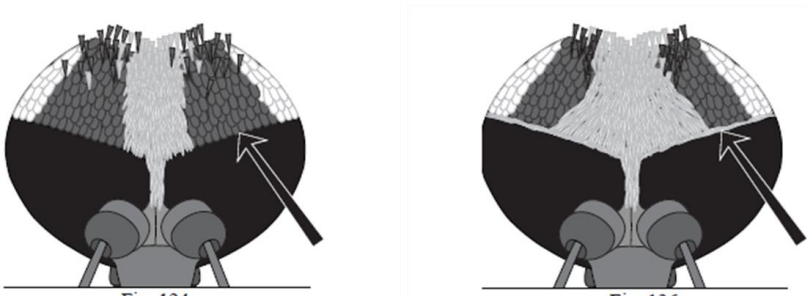
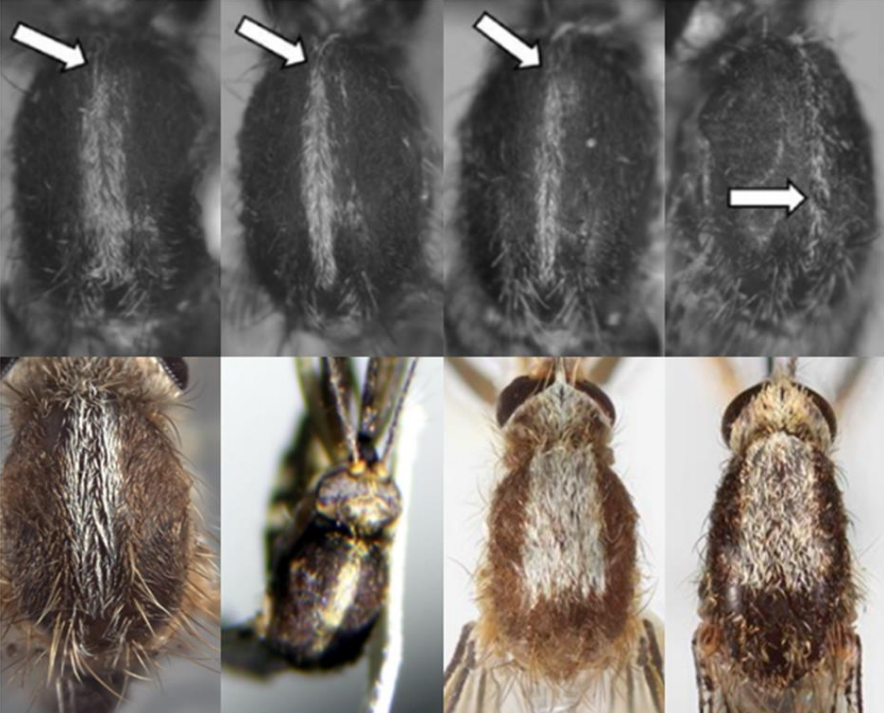


Fig. 124  
Fig. 126  
Harrison BA, Byrd BD, Sither CB, Whitt PB. 2016. *The Mosquitoes of the Mid-Atlantic Region: An Identification Guide*. 1<sup>st</sup> ed. Cullowhee, NC: Western Carolina University

*Aedes pertinax* variation



*Aedes atlanticus*   *Aedes serratus*   *Aedes infirmatus*   *Aedes condolecens*

Dorsal view of *Aedes pertinax* thorax and other similar mosquitoes.

Top row: *Aedes pertinax*, showing variations in scutal pale scales.

Bottom row: other common *Aedes* mosquitoes that could be mistaken for *Aedes pertinax* if damaged or weathered

(Figure modified using images from Shroyer et al. 2015, Reeves et al. 2020, WRBU *Aedes atlanticus* 2021, and Bold Systems *Aedes serratus* 2021).

# *Aedes pertinax*

Can identify through male genitalia~ linear orientation of claspettes

Occiput and vertex w/ white scales bordering the compound eye

Scutum scaling highly variable~ usually narrowing toward the anterior margin

Hind tibia and hind tarsomere I entirely dark scaled

Median and sublateral portions can be covered w/ lateral patches of pale scales



Both specimens are *Ae. vittatus*. Could you tell?

- Medium sized mosquito covered in dark and silvery white scales.
- Distinctive spotted thoracic pattern
- Can be easily confused with other *Aedes* if scutal scales are missing

## *Aedes vittatus*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Fredwardsius*
- Species: *vittatus*





Photo Credits: David Pecor, WRBU



Proboscis dark

Clypeus w/ small patches of narrow white scales

3 pairs of distinct small, white spots on anterior 2/3rds of scutum

All tibia dark scaled with sub-basal white spot and white band

Hind tarsi with basal white bands, 5th tarsi fully scaled white

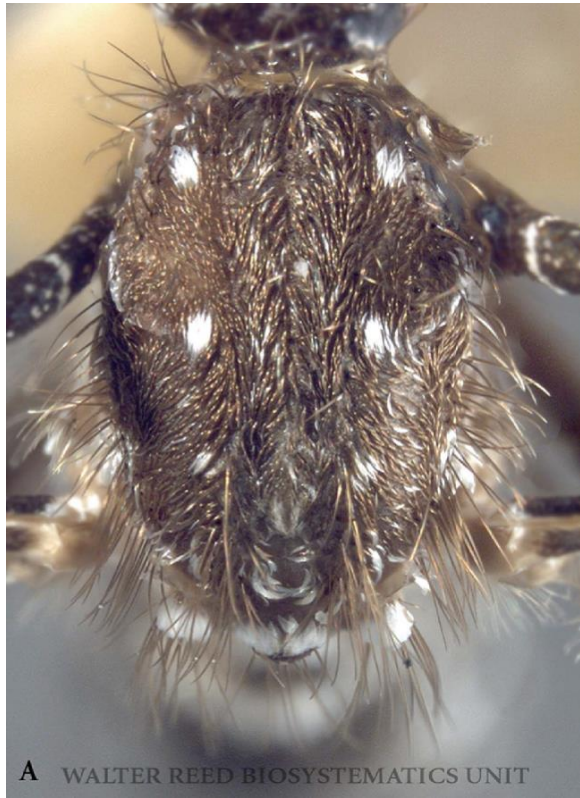
Abdomen: Te-I with large median white spot. Te II- TE VII with basal white bands and lateral curved markings, disparate from bands, segment VIII totally retracted



# *Aedes vittatus*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Aedes*
- Subgenus: *Fredwardsius*
- Species: *vittatus*





# *Aedes vittatus*

A) 3 pairs of distinct, small, white spots of narrow scales on anterior two-thirds of scutum (on scutal fossa, posterior scutal fossa and approximately level with the wing root)

B) Clypeus with bilateral small patches of narrow white scales

C) Basal white bands and lateral white curved markings, disparate from the basal bands

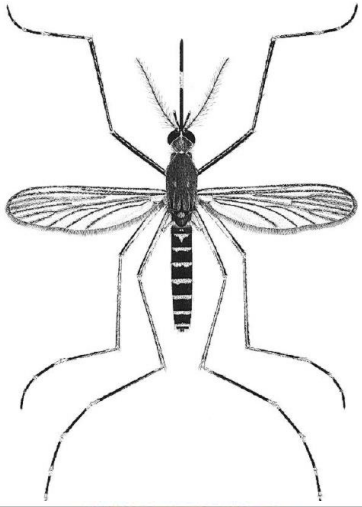


- *Culex coronator* is a medium sized drab, and brownish mosquito
- The mesonotum is brown and lacks ornamentation.
- The presence of obvious pale bands on the hind tarsi of the adult male and female is a notable morphological character. *Culex coronator* adults can be distinguished from other *Culex* subgenus *Culex* species by the presence of these bands, and
- Both *Culex bahamensis* and *Culex tarsalis* have a complete ring of pale scales on the proboscis, and this character distinguishes them from *Culex coronator*.

## *Culex coronator*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Culex*
- Subgenus: *Culex*
- Species: *coronator*

*Culex tarsalis*



- Complete ring of scales on proboscis
- Scutum with pair of pale median spots

vs.

*Culex coronator*



- Absence of complete ring of scales on proboscis
- Scutum without pair of pale median spots

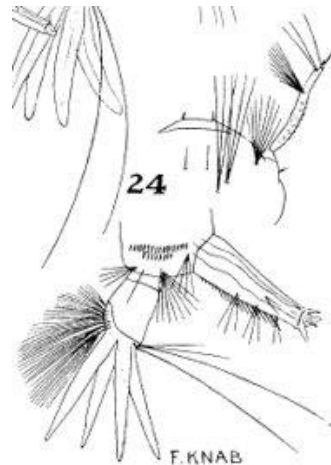
## *Culex coronator*

- Absence of a complete ring of pale scales on the proboscis, although they may have a pale patch on the underside.
- Can be difficult to distinguish from *Cx. tarsalis*
- The hind tarsomeres are ringed with distinct white bands. The white bands are both basal and apical bands, connecting where the tarsomeres meet.





Photo Credit: Lary Reeves UF/FMEL



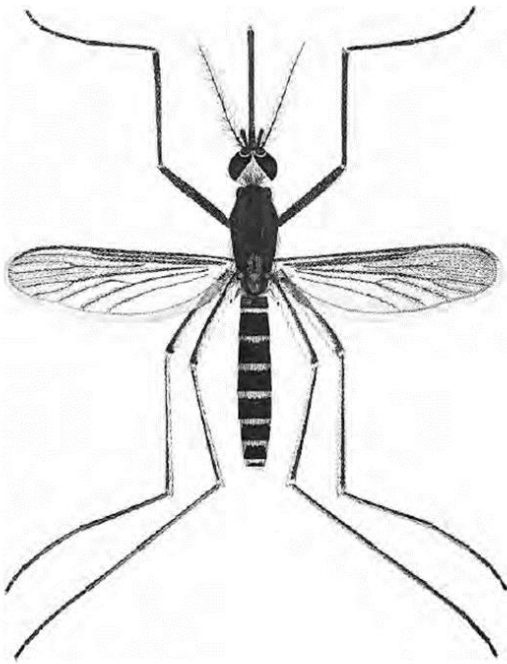
20. *A. insolita* Coq.  
22. *C. pleuristriatus* Theo.  
24. *C. interrogator* D. & K.

# *Culex interrogator*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Culex*
- Subgenus: *Culex*
- Species: *interrogator*

- Commonly mistaken for *Cx. quinquefasciatus* & *Cx. restuans*



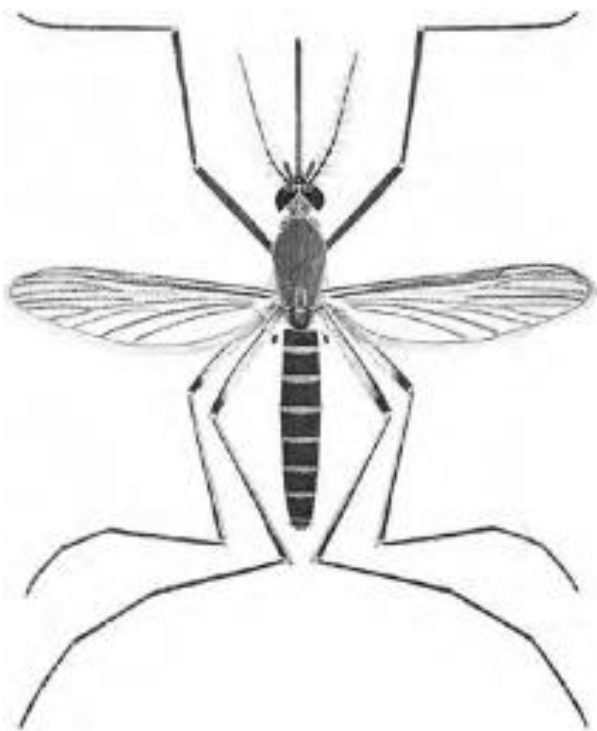


# Culex interrogator

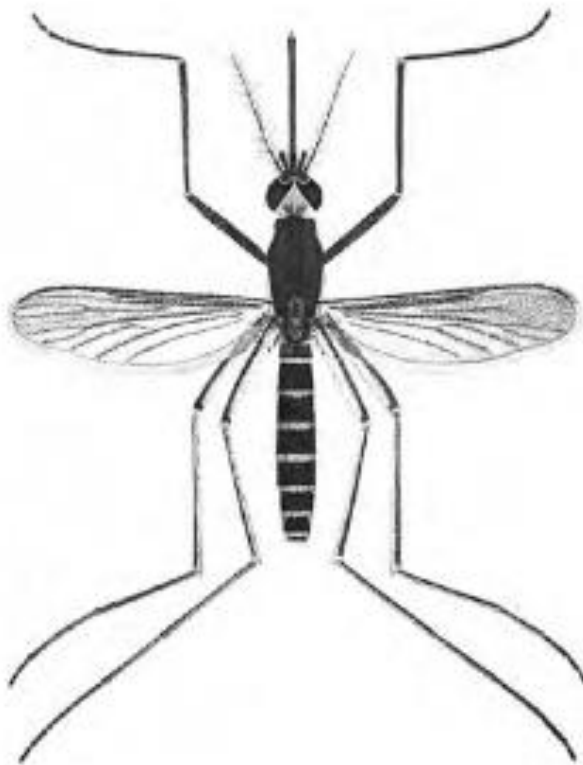
- Similar morphology Cx *restuans* & Cx *quinquefasciatus*
- Size (smaller than Cx. *restuans*)
- Wing Length (smaller than Cx. *restuans*)
- Abdominal Tergum Characters
- Scutum scaling

Carpenter SJ, and LaCasse. 1955. *Mosquitoes of North America (North of Mexico)*. Berkeley: University of California Press.

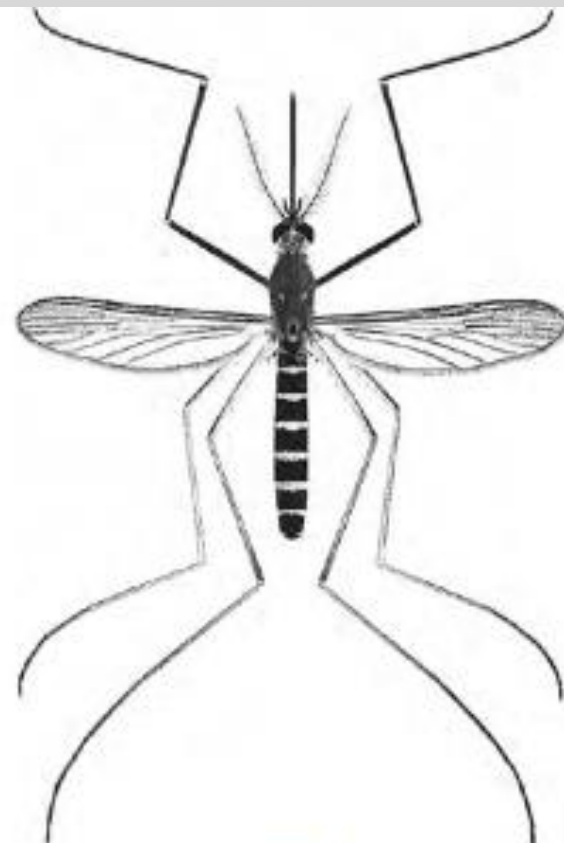
- Smaller species
- Wing length of 2.5-2.8 mm vs. Cx. *restuans* 4.0-4.4 mm in length
- Lack of mid-dorso-central "spots" of pale scaling on the scutum
- Scutum scaling 'fine' and 'golden brown'
- Wing vein R2 + 3 about one third of the length of wing cell R2, erect scales of dorsum of head dark
  - Need calipers to determine lengths
- Abdomen: Tergum I with median patch of dark scales; all other tergites banded basally that widen laterally



*Culex quinquefasciatus*



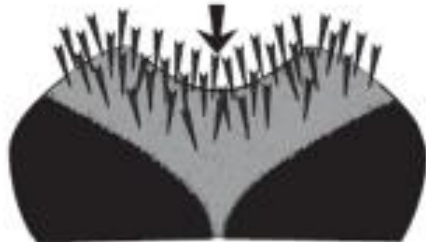
*Culex interrogator*



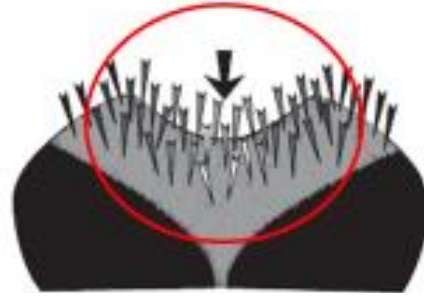
*Culex restuans*

Carpenter SJ, and LaCasse. 1955. *Mosquitoes of North America (North of Mexico)*. Berkeley: University of California Press.

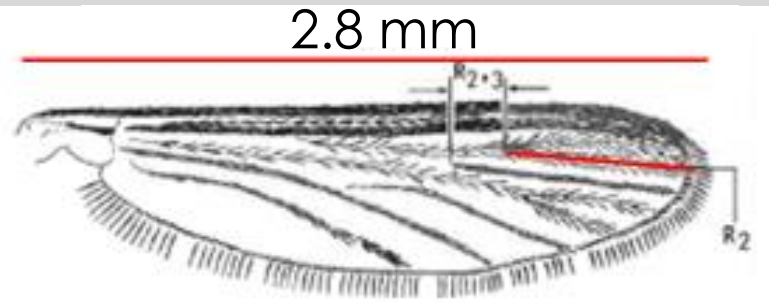
ALL DARK SCALES!!



*Culex restuans* & *interrogator*

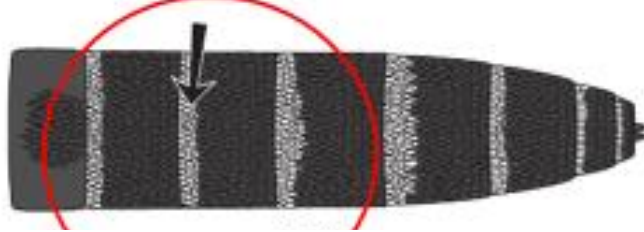


*Culex quinquefasciatus*



Dorsal wing: *Culex interrogator*

REFLECTIVE OF CX INTERROGATOR BANDS

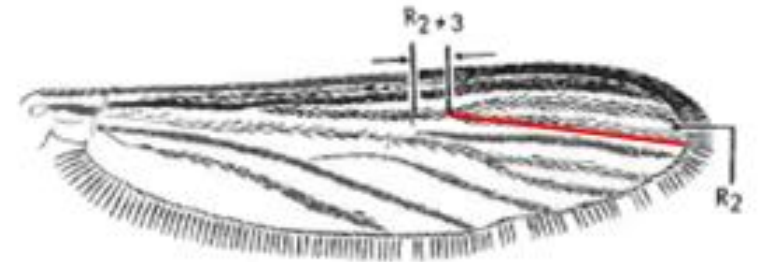


*Culex restuans* abdomen

TRICKY CALL



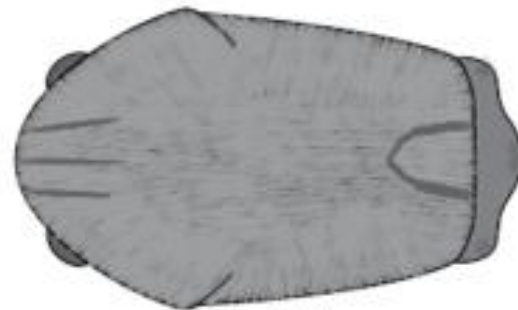
*Culex quinquefasciatus* abdomen



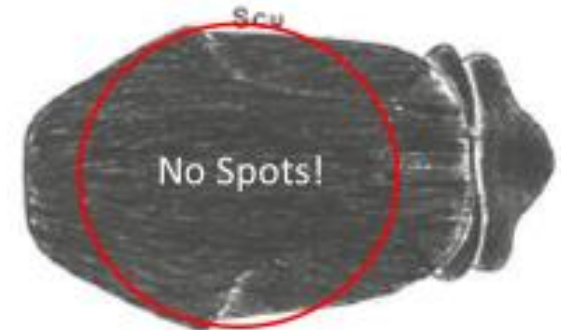
Dorsal wing: *Culex restuans*



*Culex restuans*



*Culex quinquefasciatus*



*Culex interrogator*

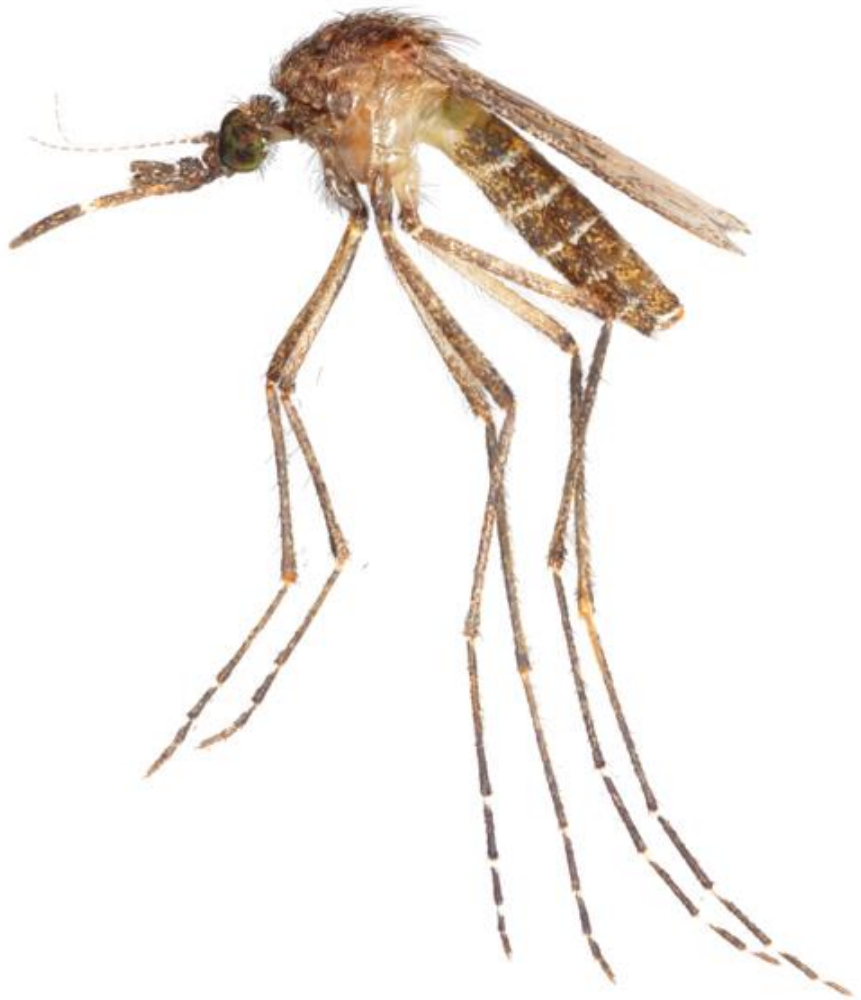


Photo Credits: Nathan Burkett-Cadena, UF/FMEL

- A medium-sized, dark mosquito
- VII tergite with a row of short spiniform setae
- Wings conspicuously speckled with dark and light scales
- Proboscis with a distinct post median white band
- Palps 1/3 the length of the proboscis
- Antennal flagellomere I with a median patch of broad black scales

## *Mansonia titillans*

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Culicidae
- Genus: *Mansonia*
- Subgenus: *Mansonia*
- Species: *titillans*



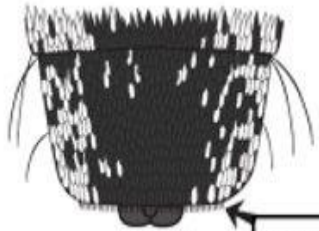
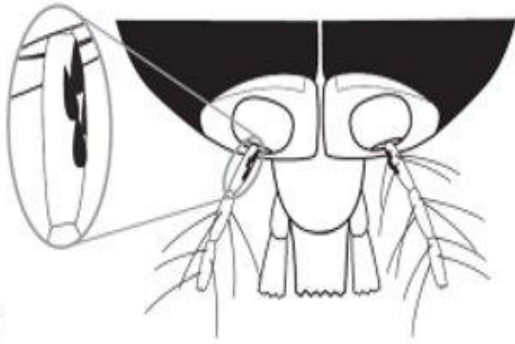
*Mansonia titillans*

vs.

*Mansonia dyari*

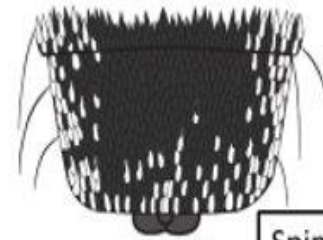
Flagellomere 1

Medial patch  
of dark scales  
(*Ma. titillans*)



Spiniforms present

Length Matters!



Spiniforms absent



## *Mansonia titillans*

- Medial dark patch scales Flagellomere I
- Absence/Presence of spiniforms
- Length Matters!  
Palps 1/3 length of proboscis for *Ma. titillans*



# MOSQUITO COLLECTION

Mr. Michael Riles

Beach Mosquito Control District

Mr. Daniel Killingsworth

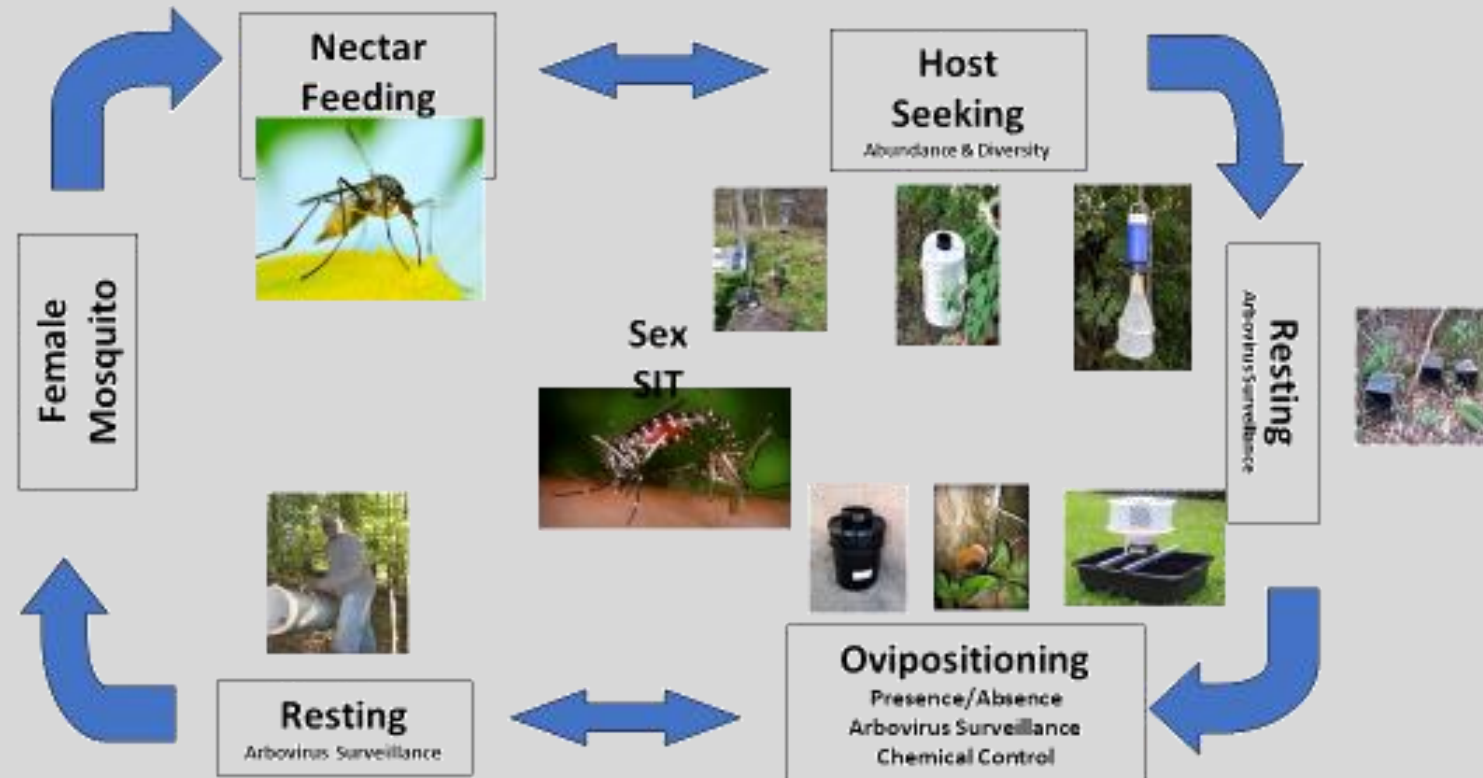
Environmental Security Pest & Lawn

Slide Contributions: Bryan V. Giordano, Daniel Killingsworth, Benjamin Allen,  
Michael Riles, Ana Romero-Weaver, Yoosook Lee

# Life Cycle Road Map

## Surveillance

Targeting the Gonotrophic Cycle



# Integrated Pest Management

## WHAT IS IPM?

Integrated Pest Management (IPM) is a science-based, sustainable decision-making process that uses information on pest biology, environmental data, and technology to manage pest damage in a way that minimizes both economic costs and risks to people, property, and the environment.

<https://www.ipmcenters.org/about/what-is-ipm/>

Management of pest populations through systematic feedback data with **mindfulness toward impacts for each input into a system**, based on a set of values to protect health, economic interests, and the environment.



IP<sub>3</sub>M

INTEGRATED



MANAGEMENT

A fundamental understanding of the human element and ecological systems within an area of concern is essential to recognizing reasons behind pest issues, the solutions for controlling them, and the implications of those actions.

# Surveillance versus Survey

- A survey is a one-time evaluation of collected data and provides a “snap-shot” of the situation.
- Surveillance is a series of surveys over time that are evaluated sequentially to give a more in-depth overview of trends and tendencies.
- Only through diligent surveillance can data be collected to provide sufficient reporting capabilities.
- Surveillance reporting provides real-time actionable information such as heat maps for pinpointing trouble areas as well as for visualizing trends that becomes a powerful predictive tool for pest pressures.

# Understanding the Team and their Tasks

- Ensure team leaders are provided the information and staffing necessary to complete their duties safely and efficiently in accordance with standard operating procedures.
- Post schedules and duties on daily/weekly/monthly calendars so everyone is aware and accountable for their assigned responsibilities.
- Communication between management, team leaders, and team members is essential, especially when pest pressures are increasing, and decisions need to be made quickly to resolve the issue.

# Larval Collections (Dippers)

- Dipper consists of a white plastic cup~ 400mL in volume
- Attached to a handle from 2-5 feet~ can be attached to extension poles
- Used to determine the presence/absence of larvae
- The method involves multiple dipper samples & counting the larvae in each sample
- Methods varies with water depth, presence of aquatic vegetation or other debris and water clarity
- Must be aware of larva behavior such as submerging behavior, life stage differences and larval distribution or aggregation
- Larval density is calculated is equal to the # of larvae collected per dip



Photo Credit: M.T. Riles





# CDC Miniature Light Trap

- Designed to exploit mosquitoes that exhibit phototaxis
- Contains a light source and fan designed to pull mosquitoes into the trap net
- Measures species abundance and diversity
- Carbon dioxide and octenol are attractants that can be used to maximize collections
- Pressurized gas systems are also available in lieu of dry ice
- Typically hung at 1M (shoulder height)/24hrs
- Can be hung at greater height (canopy traps)



Cooler filled with dry ice

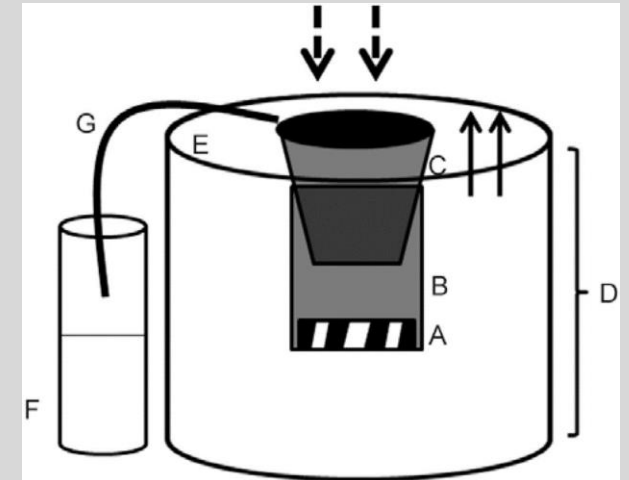
Ultraviolet light

Fan to pull mosquitoes

Collection container

# Biogents Sentinel Trap

- Utilized to collect container inhabiting mosquitoes
- Specialized for *Stegomyia* species *Ae. albopictus* & *Ae. aegypti*
- Variations of attractant can be placed (e.g. CO<sub>2</sub>, lactic acid, BG Lure, BG Sweetscent, Octenol)
- Outward plume holds attractant which brings mosquitoes toward the trap fan



# Gravid or Oviposition Traps

- Used for arbovirus surveillance
- To sense activity~ "presence/absence"
- Can be lethal
- Little Black Jars
- CDC Gravid or Cummings Gravid
- CDC AGO Sticky
- BG GAT

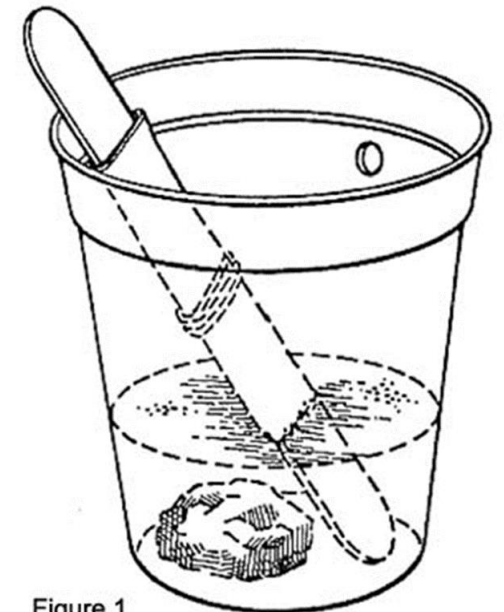
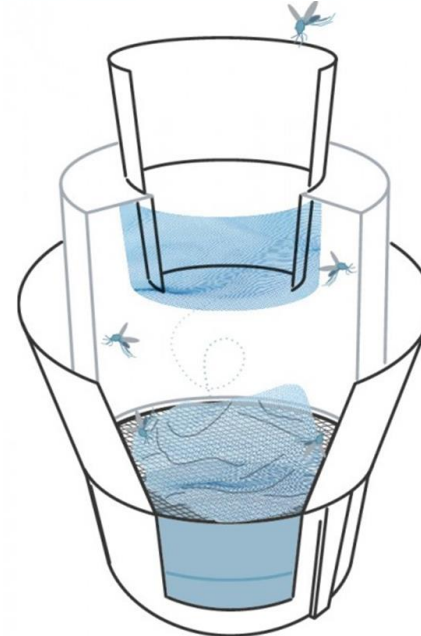
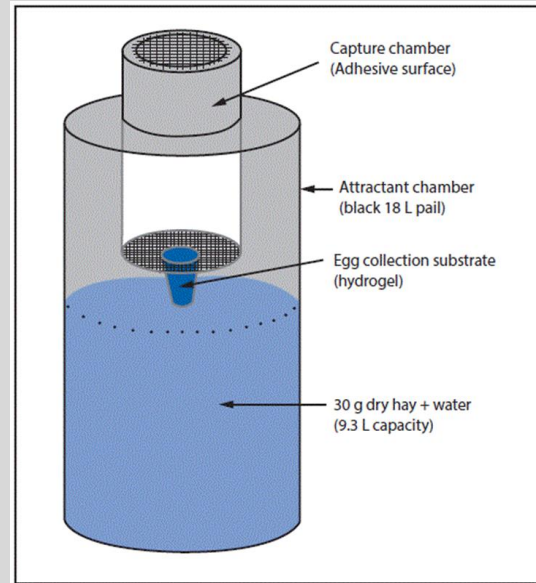
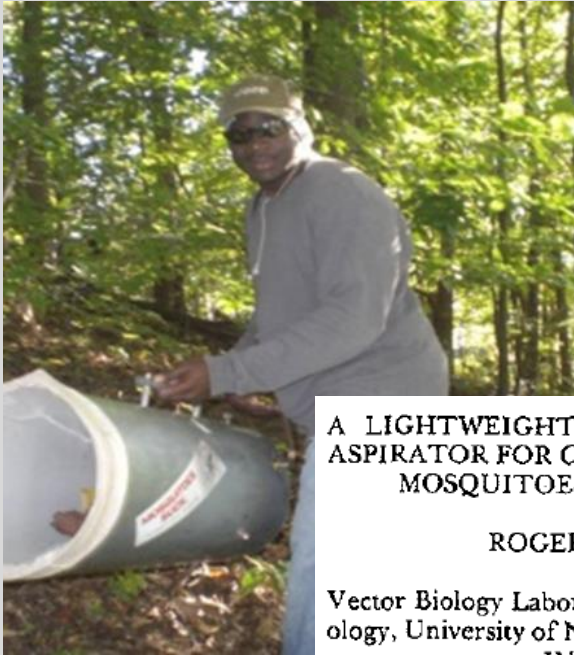


Figure 1



# Aspirators



A LIGHTWEIGHT BATTERY-POWERED  
ASPIRATOR FOR COLLECTING RESTING  
MOSQUITOES IN THE FIELD<sup>1</sup>

ROGER S. NASCI

Vector Biology Laboratory, Department of Bi-  
ology, University of Notre Dame, Notre Dame,  
IN 46556

- Aspiration is a real-time collection tool that gives a true sense of species activity in time and space
- Can be utilized for arbovirus surveillance, blood meal analysis, and landing rate count collections

