Invasive and Non-Native Adult Female Mosquitoes Found in Southeastern United States
&
Emerging Invasive Species Not Yet Established in Continental US

Mosquito BEACONS Working Group
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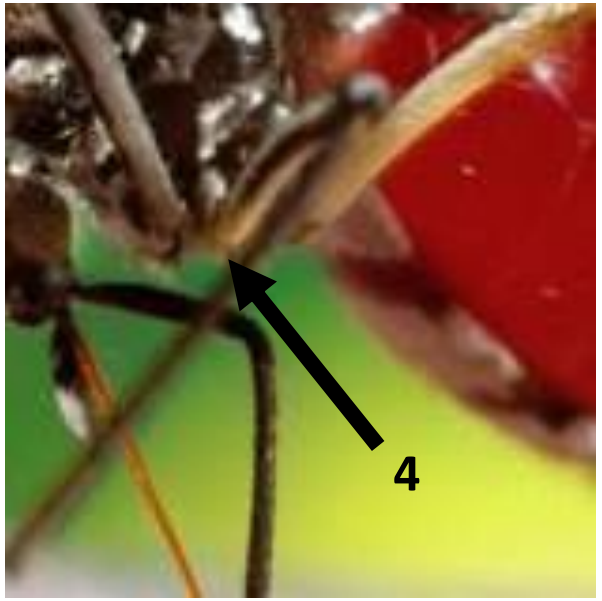
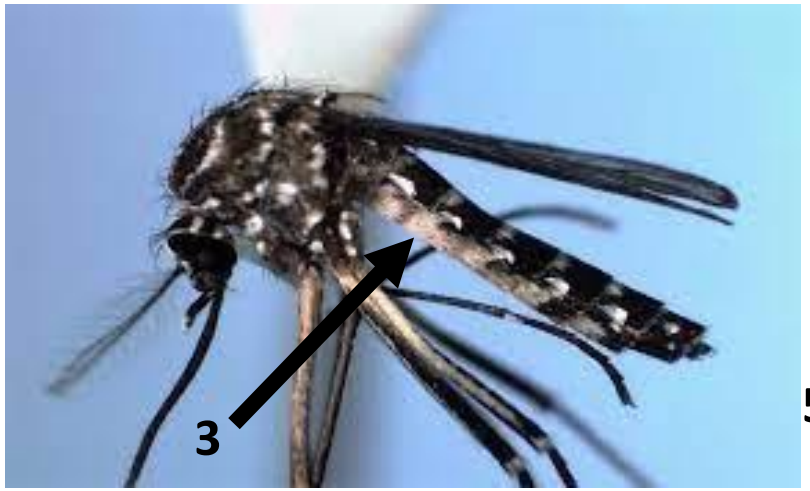
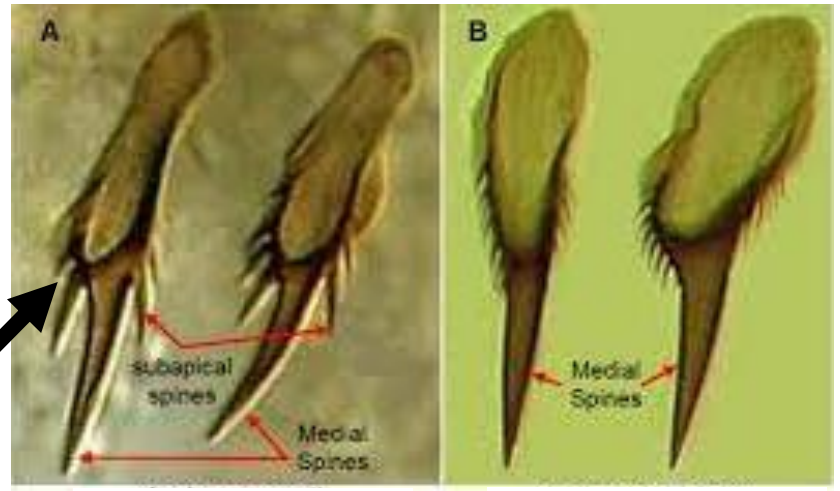
Aedes aegypti



1. Lyre shaped patch of white scales on Dorsal Thorax
2. White scales on Clypeus
3. Solid white abdominal sternites
4. White Band on dorsal middle femur
5. Larval comb scales with prominent sub-apical spines





Aedes aegypti *Aedes albopictus*

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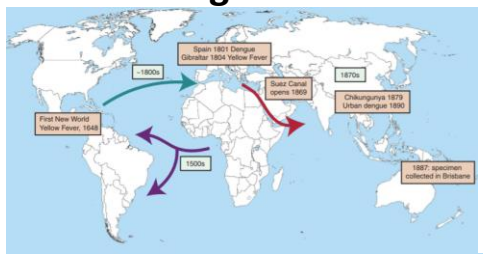
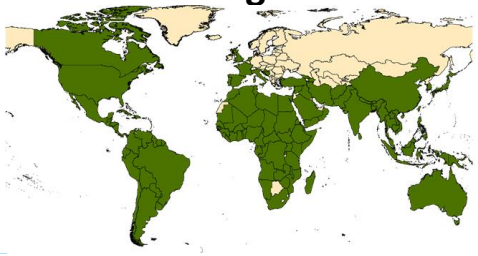
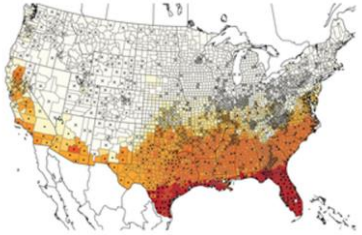
Aedes aegypti

Native Range

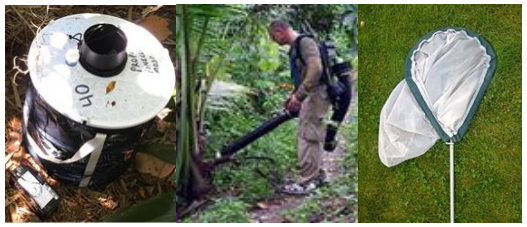


Invasive Range





Collection Methods



- For larvae: turkey baster and dipping cups
- For adults: BG sentinel traps, BG Lyre baited CDC traps, aspirators, sweep nets

Larval Habitat

- Rotten tree stumps, tree holes, water-holding plants
- Vases, bird baths, gutters, tires

Host Biting Preference

- Most active for roughly two hours after sunrise and several hours before sunset
- It can bite at night in well-lit areas.
- have a strong preference for human hosts
- occasionally feed on dogs, cats, horses and other domestic animals.

Dispersal Strategies

- Short flight range (100–500 meters < 0.3 miles)
- Desiccation tolerant eggs
- Spread by human transport of containers

Pathogen Transmission

- Transmit yellow fever virus, dengue virus, chikungunya virus, and Zika virus.
- potential vector of Venezuelan Equine Encephalitis virus and West Nile virus.

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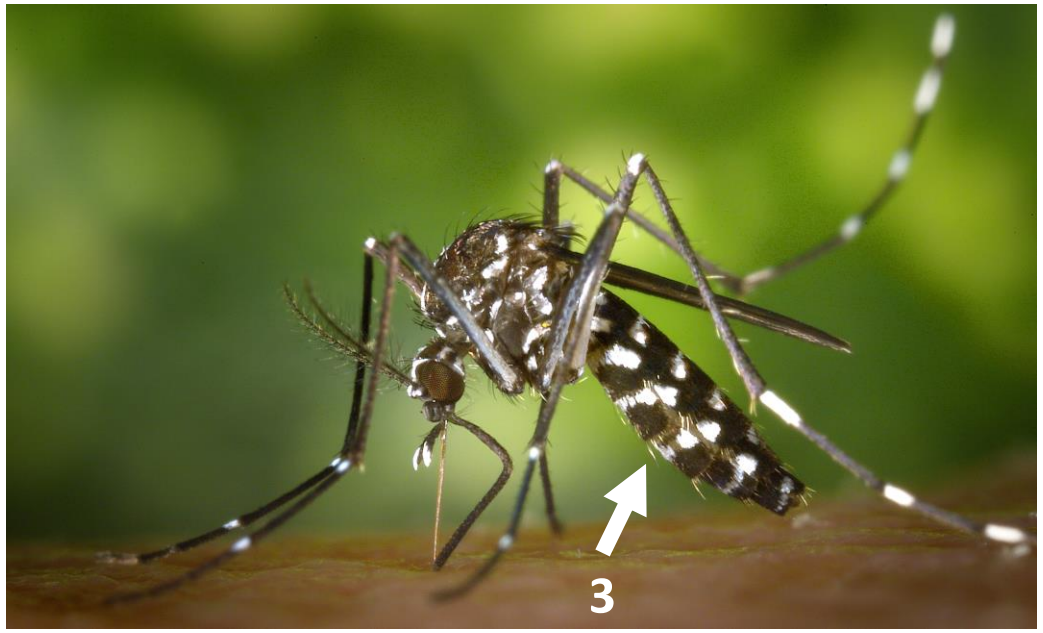
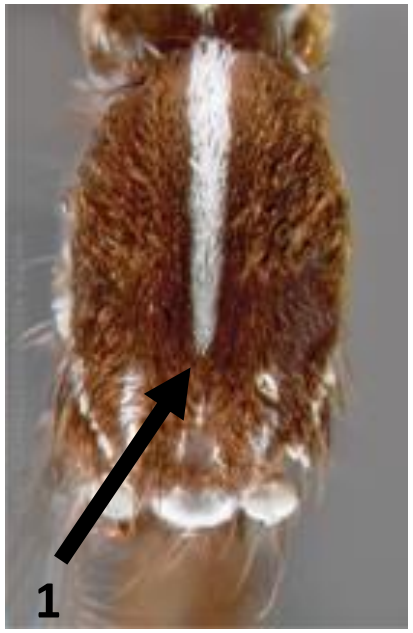
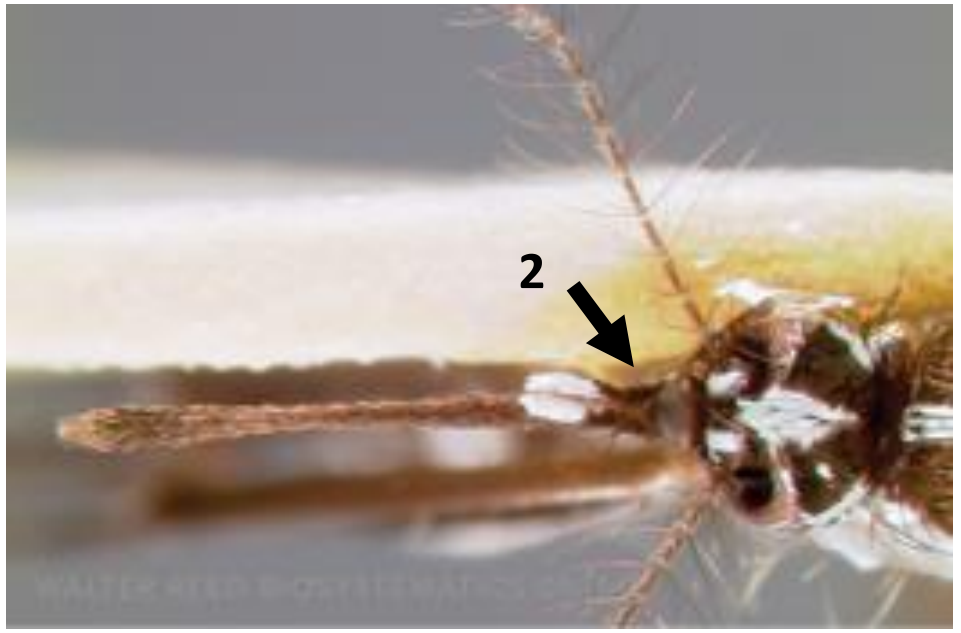
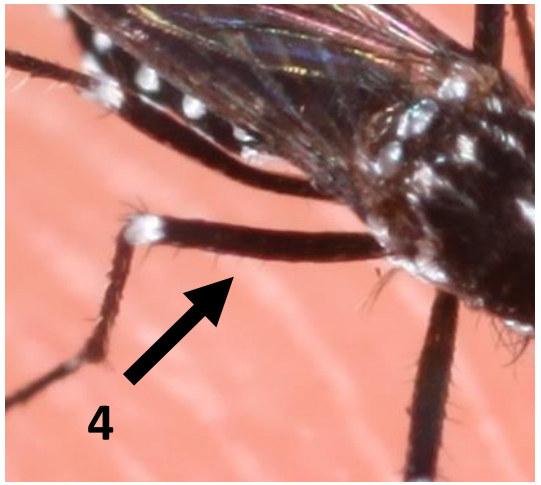
Aedes albopictus

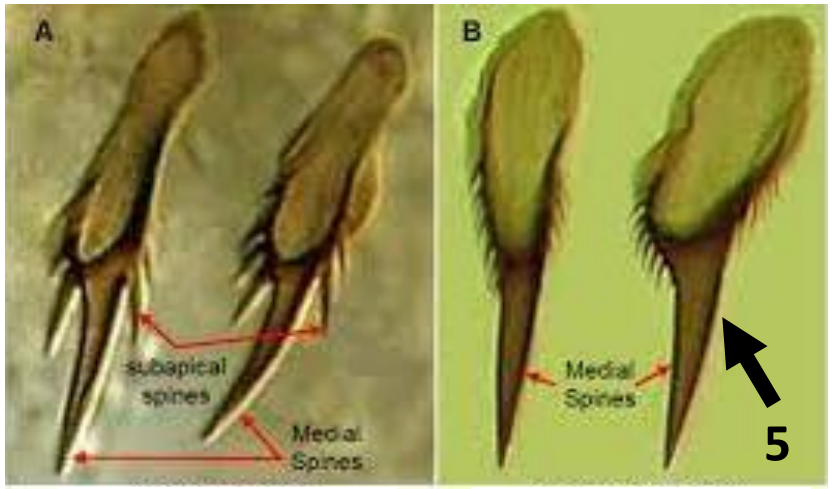






1. White stripe down dorsal thorax
2. Clypeus entirely dark, secondary differentiation *from Ae aegypti*
3. Abdominal sternites are white-banded
4. No white band on middle dorsal femur
5. Comb scales have only the apical spine





Aedes aegypti *Aedes albopictus*

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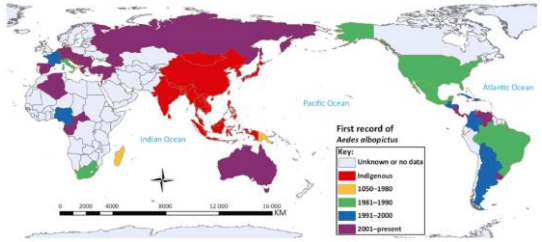
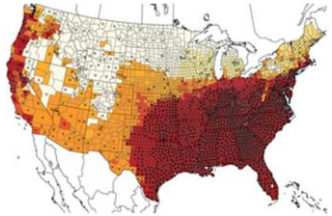
Aedes albopictus

Native (Red) and Invasive (other colors) Range





Larval Habitat

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

Dispersal Strategies

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

Collection Methods

- Larval surveillance highly productive
- BG-Sentinel traps BG-Lure can be combined with CO_2 (dry ice or compressed gas) to increase yield of collections
- Not commonly collected with CDC light traps unless baited with BG Lure

Host Biting Preference

- Early morning and late afternoon
- Bite a variety of mammals (Humans, dogs, cats, ruminants)
- Opportunistic feeders and will occasionally bite birds

Pathogen Transmission

- Transmit yellow fever virus, dengue virus, chikungunya virus, and Zika virus.
- potential vector of West Nile virus.

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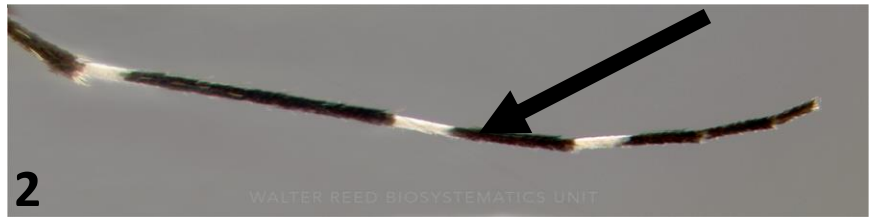
Aedes japonicus

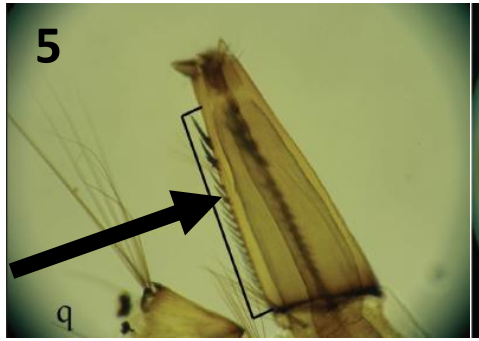


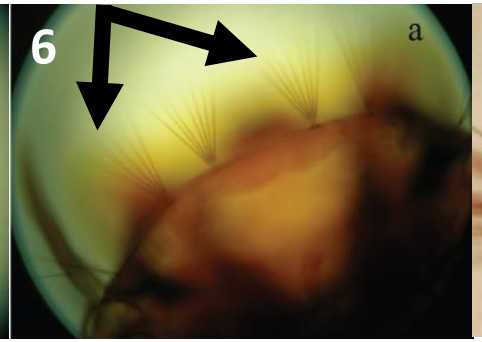
5. Siphon pecten spines >15 with two pronounced larger spines outside row
6. Seta 5,6-C >5 branches set in linear orientation
7. Anal Saddle conspicuously spiculated

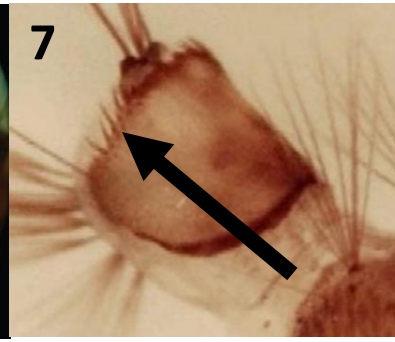
1. Medium to large mosquito. Banded legs, golden , dark-brown and pale scales throughout. Proboscis dark scaled not banded
2. Tarsi Ta-III 1–3 with broad pale basal bands; Ta-III5 all dark
3. Femoral character; pale scaled not touching insertion of thorax; origin at middle of femur

4. Scutum with golden stripes; distinctive lyre-shaped stripes, and two sub-median and a median stripe.

Scutellar lobes with long, narrow scales







Larvae Photo Credit: George O'Meara UF/FMEL
Adult Photo Credit: WRBU; Lyle J. Buss UF/FMEL

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Aedes japonicus

Native Range **Invasive Range** **Current Expansion 2022**

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

Larval Habitat

- 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

Dispersal Strategies

- Egg desiccation tolerance
- Commercial transport (tires, botanicals, construction)
- Ports of entry (seaports, airports, bio-securities)

Collection Methods

- Larval surveillance
- Not readily trapped with CDC light traps + CO_2
- octenol-based lures more effective
- Gravid and oviposition traps are ideal
- BG-Sentinel traps
- Aspirations work well

Host Biting Preference

- Feeding peaks early morning and late afternoon
- Leave shady or wooded areas to feed
- Opportunistic, wide-range of host species

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)
- Usuntu virus (USUV)
- LaCrosse Virus (LACV)
- Jamestown Canyon virus
- Orungo virus (ORUV)
- Rift Valley fever virus (RVFV)
- St. Louis Encephalitis virus (SLEV)
- Western Equine Encephalitis virus (WEEV)
- West Nile virus (WNV)
- Zika (ZIKV)

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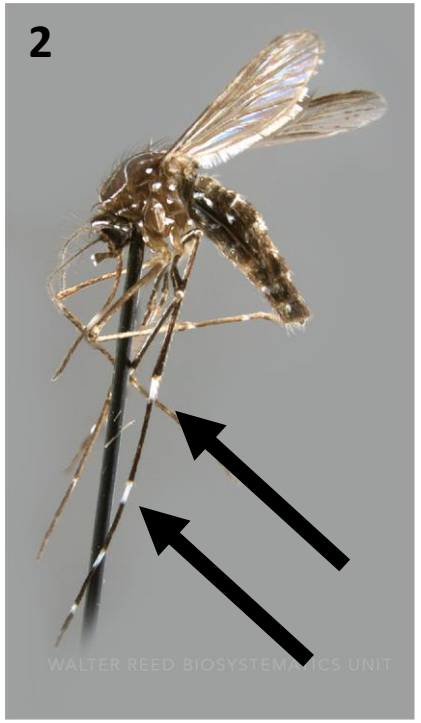
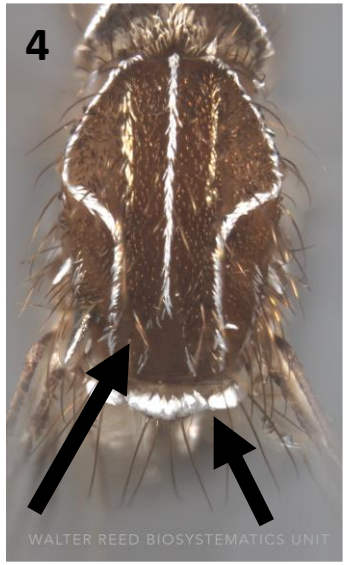
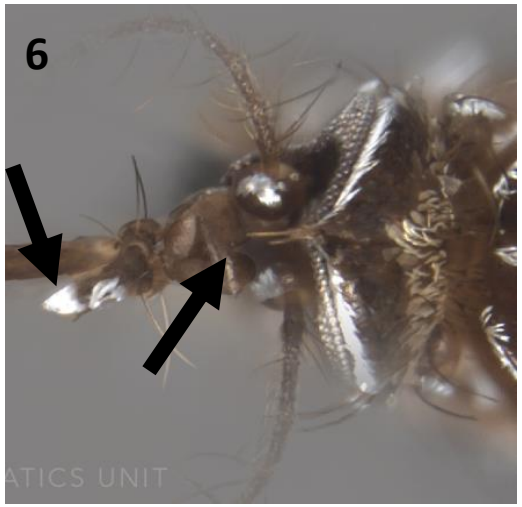
Aedes notoscriptus







1. Female & Male Small to mid-sized species; Integument can vary in color form reddish brown to dark brown to black

2. Fe-II and Ti-III with anterior lines of pale scales along nearly whole length

   Hind tarsi with wide bands bright silvery whitish scales

3. Proboscis dark-scaled with median pale ring

   Wings scales all dark dorsally

4. Scutum with lyre-shaped lateral silvery lines
   - Narrow median silvery lines and anterior sublateral golden lines of scales
   - Postpronotum with small distinct lower patch of silvery scales

5. Small patches of silvery scales throughout thoracic area

6. Pedicle not scaled exteriorly only interiorly. Palps tipped with silvery scales

7. Terminal segments Larvae: Comb scales in irregular triangular patch; siphon not pilose; siphonal acus large and broadly joined to siphon; seta 1-S short, <0.5 x length of siphon

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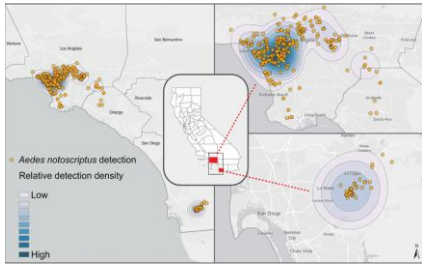
Aedes notoscriptus

Native Range

Invasive Range



- 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

Larval Habitat

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

Dispersal Strategies

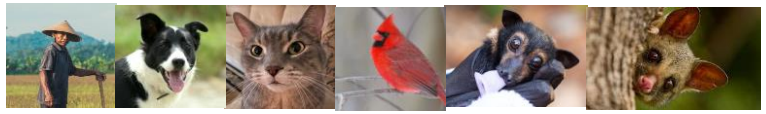
- Container breeders that use diapausing eggs
- Spread by humans along shipping routes

Collection Methods

- CDC trap with CO_2 and Octenol or BG Lure
- BG Sentinel
- Autocidal Gravid Traps
- Gravid Traps

Host Biting Preference

- Humans, domestic pets, birds, marsupials, bats



Pathogen Transmission

- Barmah Forest Virus
- Chikungunya virus (CHIKV)
- Dengue virus (DENV)
- Ross River Virus
- Zika (ZIKV)
- *Dirofilaria* (dog heartworm parasite)

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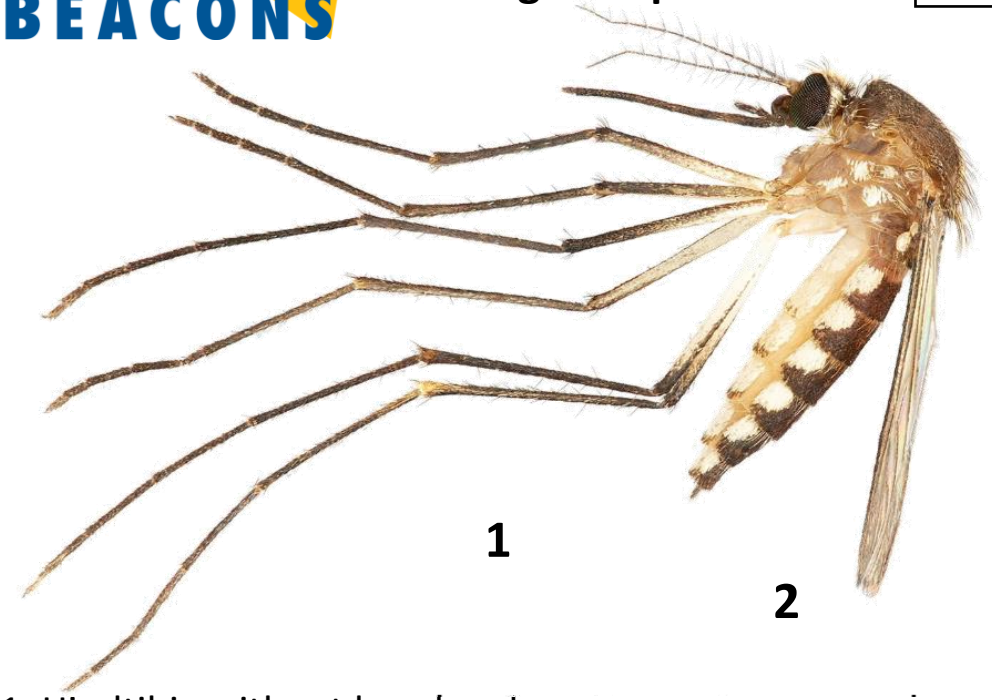
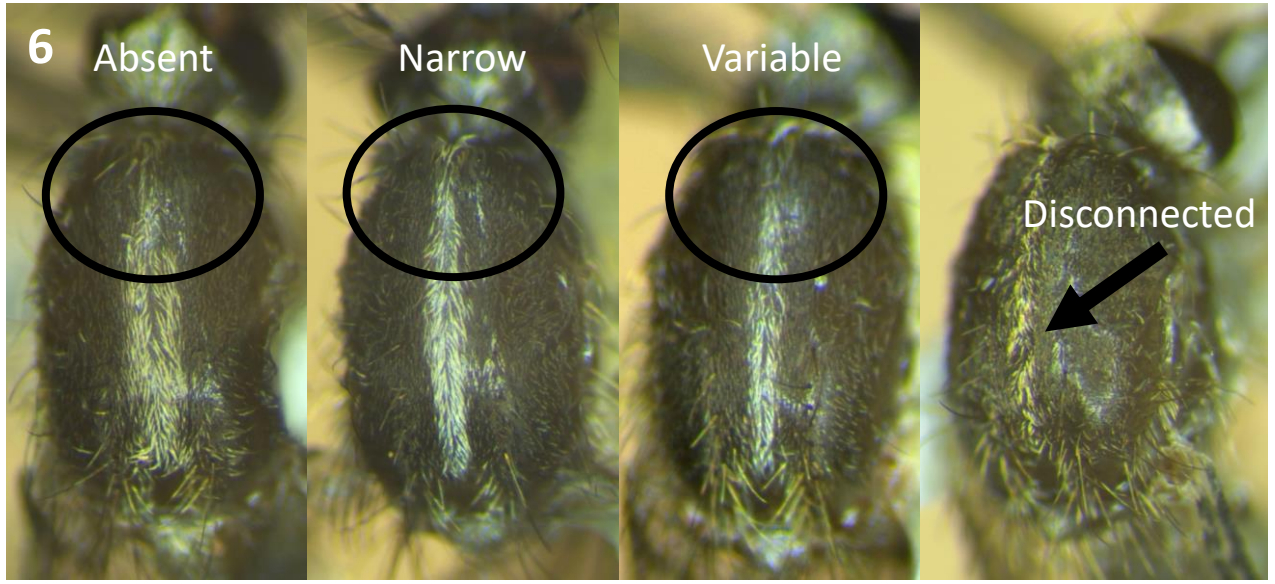
Aedes pertinax



1. Hindtibia without basal and apical dark-scaled bands
2. Unbanded abdomen
3. Occiput clothed medially with white or yellow scales,
4. White to yellow scales extended on interocular space and along orbital line
5. Longitudinal stripe extending from anterior margin to full length of scutum
6. Scutum with narrow acrostichal line of whitish scales, absence of pale scales on anterior end, extremely thin anterior stripe, or disconnected exceptionally narrow stripe



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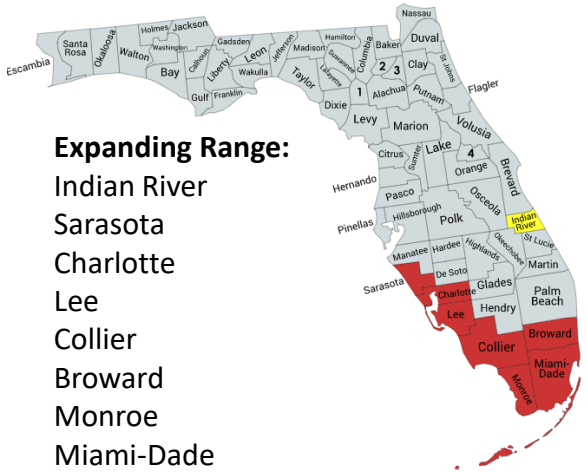
Aedes pertinax

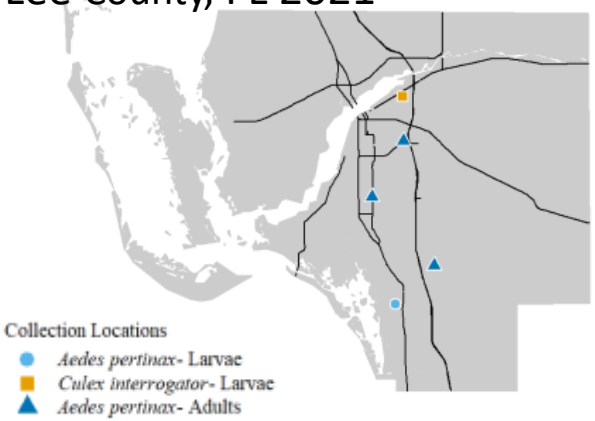
Native and Invasive Range

- Native to South America and Caribbean
  - Actual distribution widely unknown
- Invasive in Florida



Expanding Range:
Indian River
Sarasota
Charlotte
Lee
Collier
Broward
Monroe
Miami-Dade

Lee County, FL 2021



Charlotte County, FL 2022

Larval Habitat

- More research is needed in this area
- Coastal flooded woodlands
- Temporary and permanent grasslands / woodlots prone to flooding
- In Florida, *Ae. pertinax* was found in in freshwater sites
  - E.g., nontidal, rain-filled depression

Dispersal Strategies

- More research is needed in this area
- No flight distance is recorded for this species
- Hypothesis: Major storm winds driving dispersal

Collection Methods

- Can be very abundant in CDC and BGS collections
- Larval collections from floodwater (freshwater)

Host Biting Preference

- More research is needed in this area

Pathogen Transmission

- Nothing none to date

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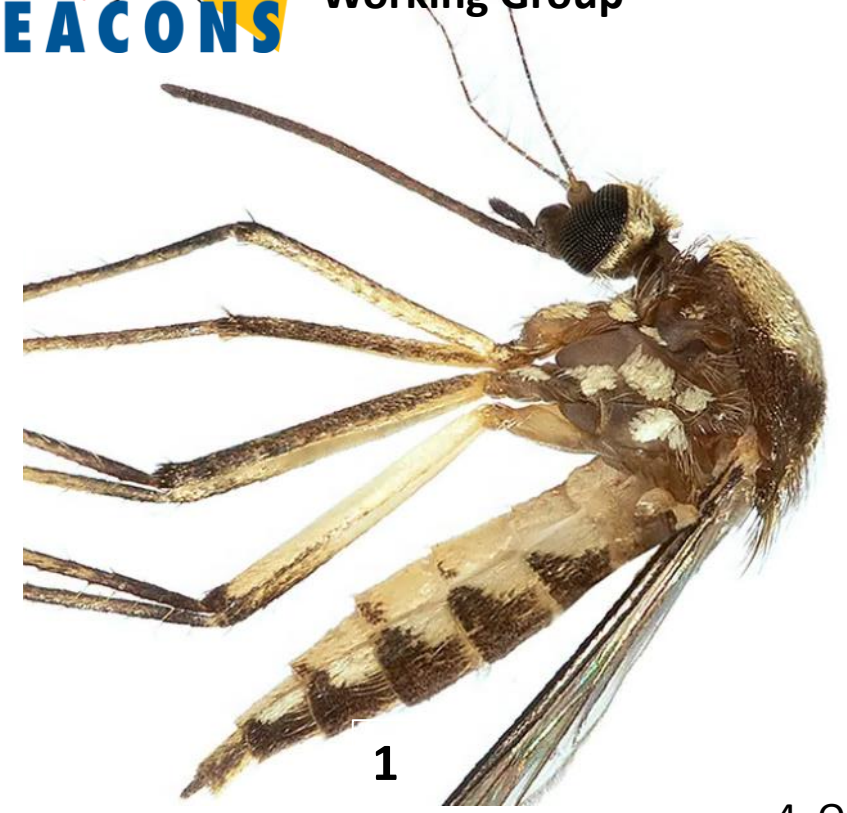
Aedes scapularis



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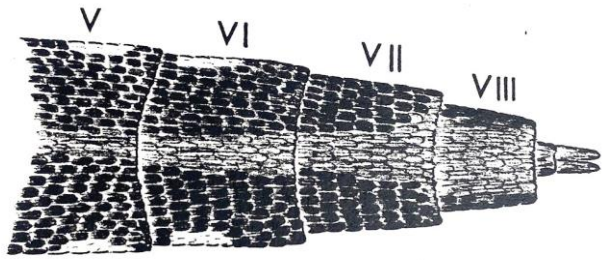


2

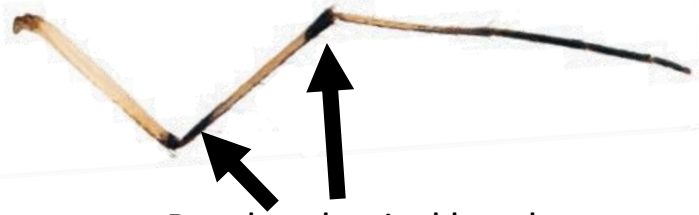
3

4

5

1. Unbanded abdomen
2. Abdominal terga VI-VIII with light colored scales medially
3. White to yellow scales extended on interocular space and along orbital line

4. Occiput clothed medially with white or yellow scales
5. Scutum with median longitudinal stripe extending from anterior margin to ~2/3 length of scutum
6. Hindtibia with basal and apical dark-scaled bands



6

Basal and apical bands

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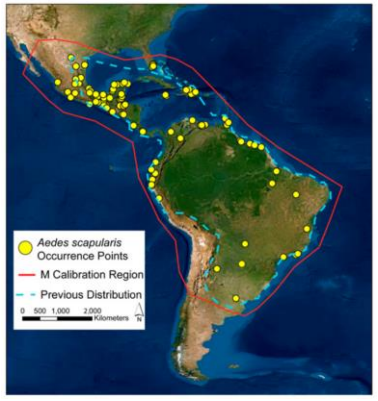
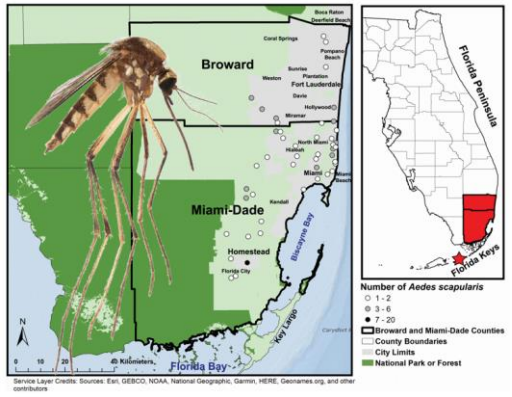
Aedes scapularis

Native Range



Invasive Range (as of 2021)



Expanding range in south Florida

- Monroe County (Florida Keys)
- Miami-Dade
- Broward County
- Collier County

Larval Habitat

- 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.

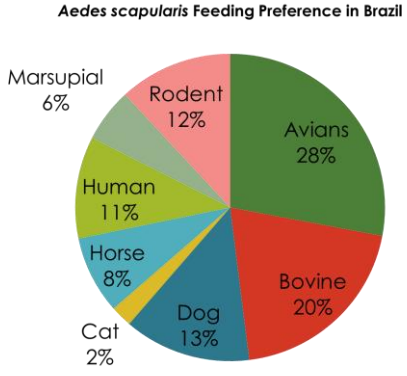
Dispersal Strategies

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

Collection Methods

- Rough equivalency in catch between CO_2-Baited CDC traps, and BGS Traps

Host Biting Preference



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

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)

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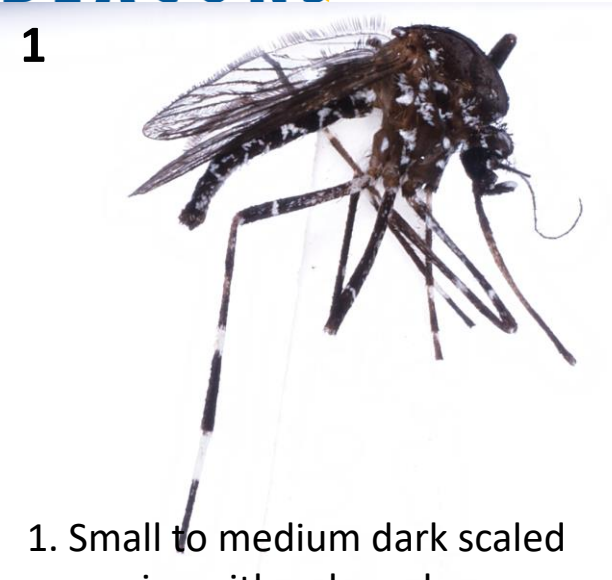
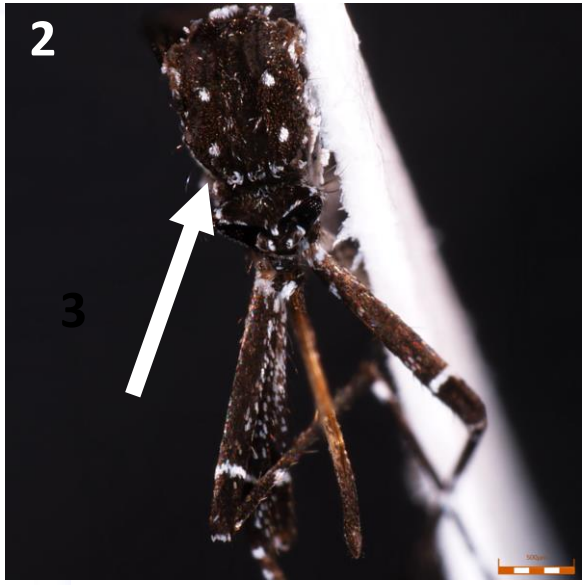
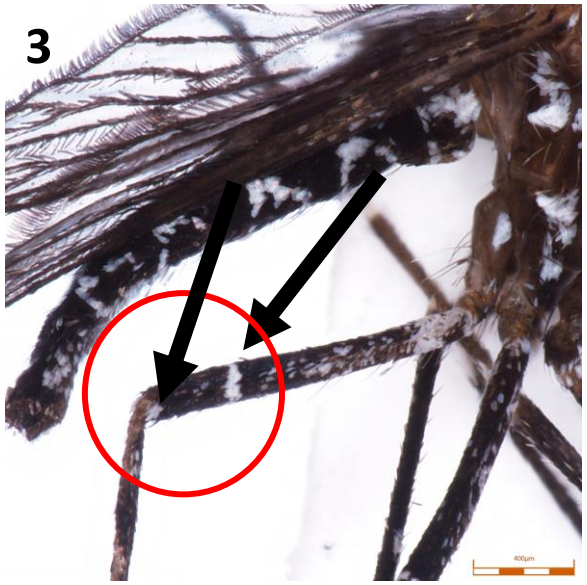
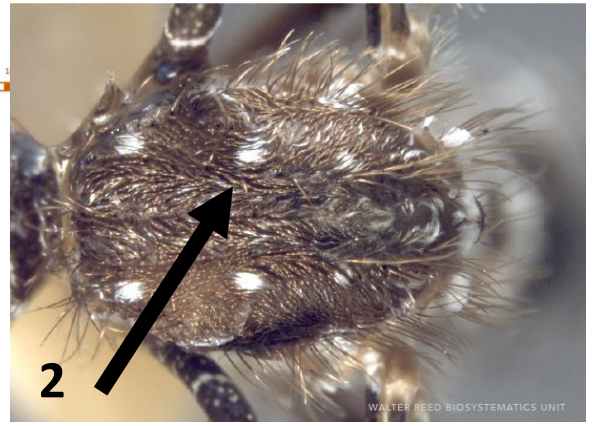
Aedes vittatus



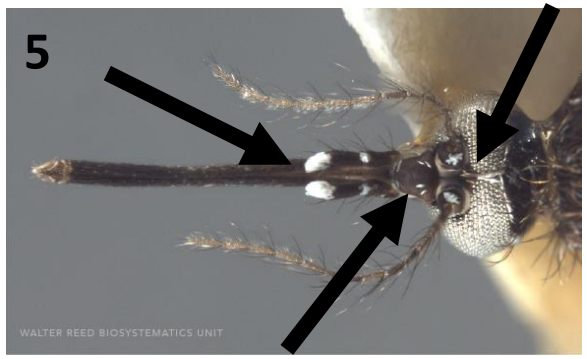




1. Small to medium dark scaled species with pale scales throughout
2. Scutum: 3 pairs of distinct, small, white spots of narrow scales on anterior two-thirds of scutum
3. Tibia dark, with sub-basal white spot and white band approximately level with basal third of Ti-I, Ti-II, and at mid-point of Ti-III



4. Mesopostnotum and prespiracular area bare
5. Proboscis dark with sporadic pale scales; clypeus w/ bilateral small patches of narrow pale scales; palps pale scales at tip and band half-way; pedicle w/ ext/int pale scales
6. Abdomen Te-I large median white spot; basal white bands w/ lateral curved white markings: disparate from bands



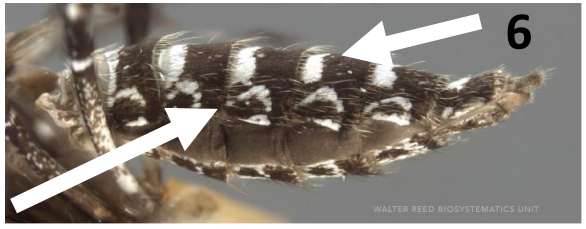


Photo Credit: David Pecor WRBU; 1-4 original 2 specimens in the Americas

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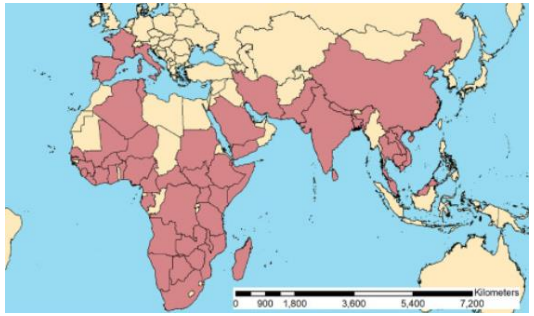
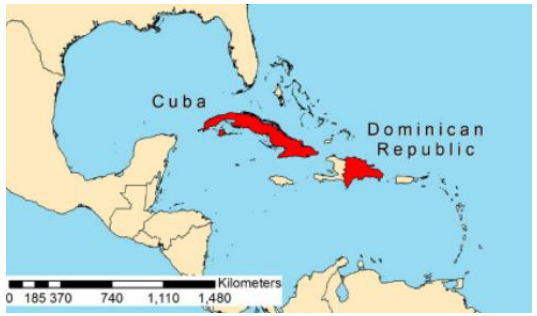
Aedes vittatus

Native Range



Invasive Range (as of 2021)



Larval Habitat

Variety of natural and artificial containers:

- rock pools
- tree holes
- hoofprints
- domestic containers

Dispersal Strategies

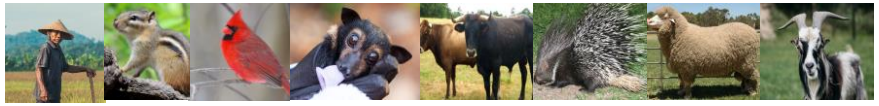
- Egg desiccation tolerance
- Caribbean introductions are speculated to have occurred via shipping container transport to and between islands

Collection Methods

- Like other invasive *Aedes* they are not commonly collected using CDC light traps
- 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

Host Biting Preference

- Opportunistic feeders:
  - Non-Human Primates
  - Domestic Animals
  - Rodents
  - Humans
  - Bats
  - Birds



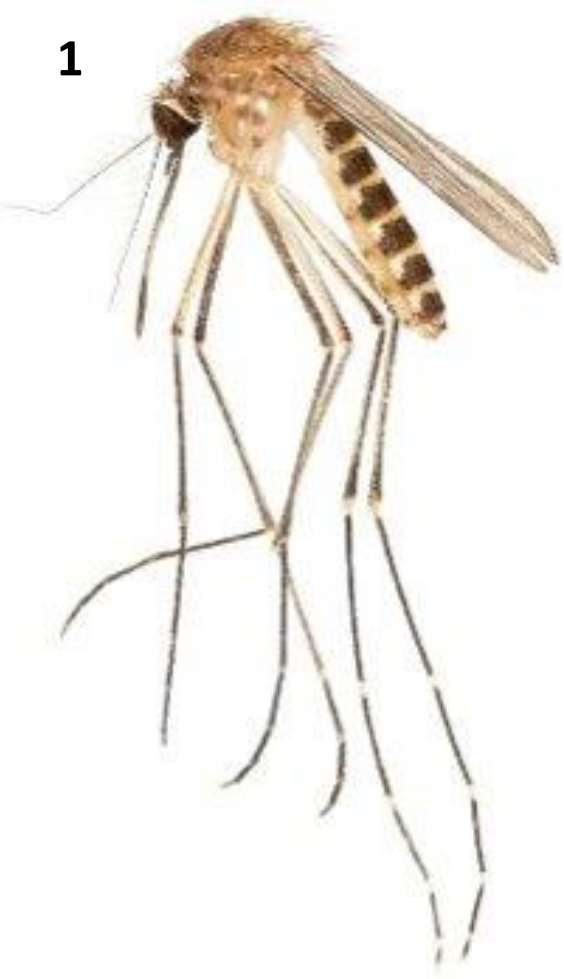
Pathogen Transmission

- Babanki virus
- Bunyamwera virus
- Chikungunya virus
- Dengue viruses
- Middleburg virus
- Semliki Forest virus
- Saboya virus
- Wesselsbron virus
- Yellow Fever virus
- Zika virus

Mosquito BEACONS Working Group

Culex coronator

1

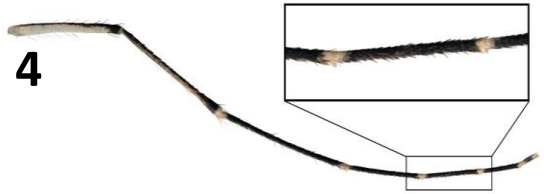


1. The adult mosquito is medium sized, drab and brownish

2

3

4



2. The head has dark erected forked scales dorsally. The occiput has narrow golden scales and broad white scales laterally. The proboscis is mostly covered in dark scales, with a ventral median area of pale scales that does not form a complete ring (arrow)

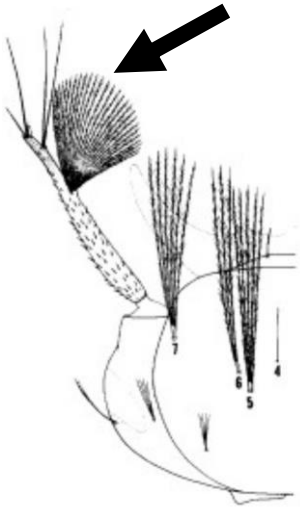
3. The veins of the wings are covered in narrow dark scales

5

4. The hind tarsomeres on the legs are ringed with distinct basal and apical bands

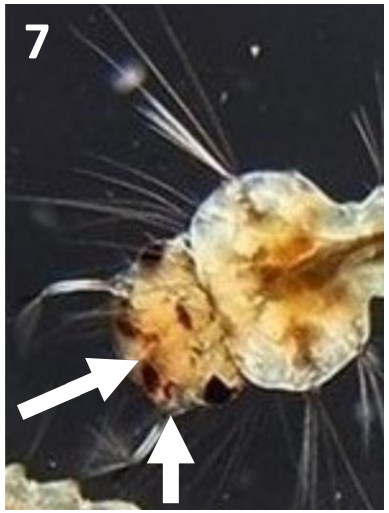
5. Immature four instar larva

6



6. The antennal turf of the head is located on a constriction near the outer third (arrow), with the shaft spiculated basally

7

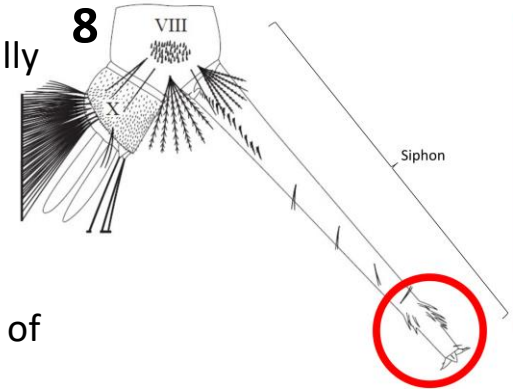


Upper hair

Lower hair

7. The larva head has 4 or 5 upper hairs and 3 or 4 lower hairs

8

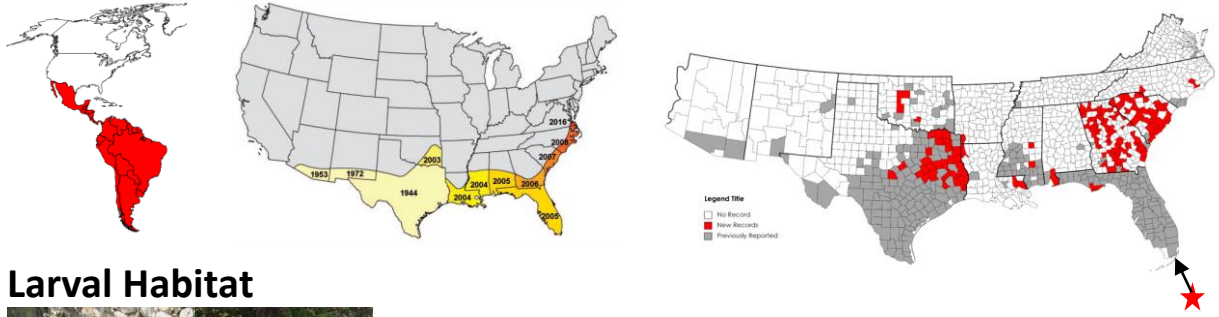


8. The siphon is long and thin with four double siphonal turfs beyond the pecten. Most specimens have a crown of prominent spines.

Mosquito BEACONS Working Group

Culex coronator

Native (Red) and Invasive (other colors) Range



Larval Habitat

- 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

Dispersal Strategies

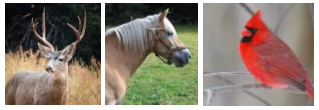
- Highly adaptable to artificial container breeding in urban areas
- Eggs and larvae commonly found in used tires
- Car tire transportation is thought to be an important dispersal mechanism

Collection Methods

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

Host Biting Preference

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



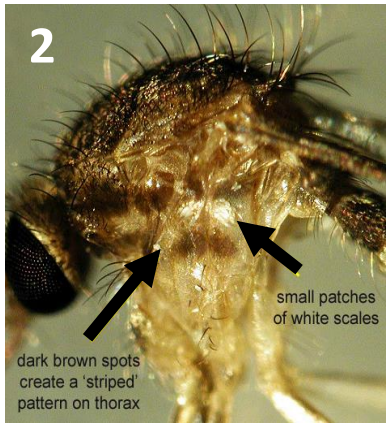
Pathogen Transmission

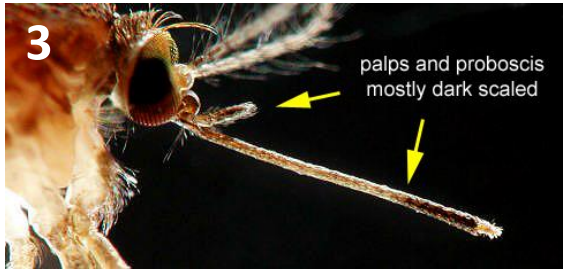
- St Louis encephalitis virus (Aitken et al. 1964, Turell et al. 2005)
- Venezuelan equine encephalitis virus (Burguete et al. 1973)
- West Nile virus (Mackay 2007, Kelly et al. 2008, Unlu et al. 2010)
- Zika virus (rare, Elizondo-Quiroga et al. 2018)

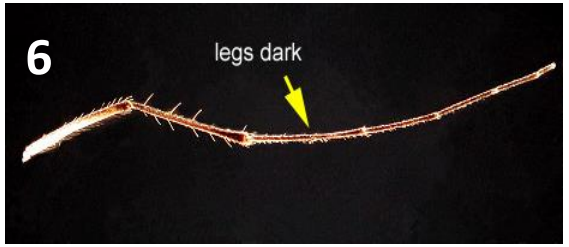
Mosquito BEACONS Working Group

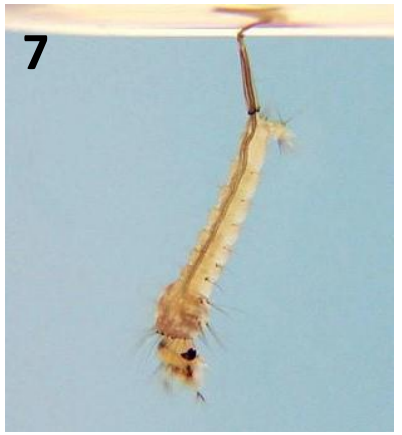
Culex declarator

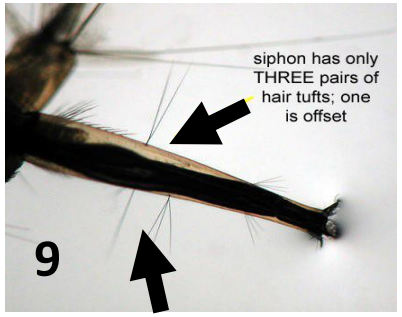
1

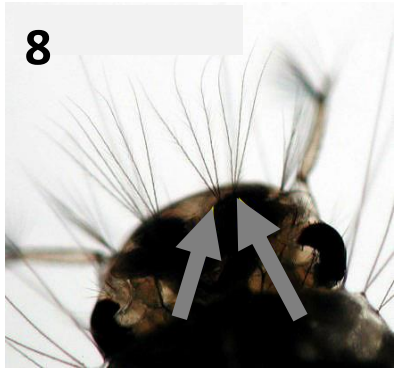


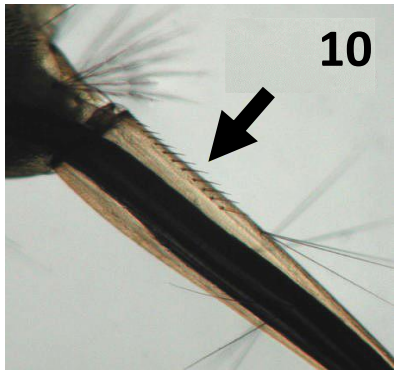












2. The thorax has dark brown, narrow scales with lateral brown spots thar crate a striped pattern and lateral small patches of white scales

3. The proboscis has a long pale area on lower surface

4. The abdomen is dark-scaled dorsally with white lateral patches

5. The wing has dark narrow scales

6. Posterior surface of femora and tibiae pale, tarsal segments either dark-scaled or with very narrow white bands

7. Immature larvae

8. The larvae upper and lower head hairs have 3 branches

9. The siphon has 3 pairs of hair turfs; one is offset

10. The pecten teeth is in 1 singly spirally-twisted row

Mosquito BEACONS Working Group

Culex declarator

Native and Invasive Range

Larval Habitat

- Rural and Suburban habitats
- Tropical and subtropical
- Moist broad leaf forest
- Tree holes
- Close to temporal ponds, swamp and small dams.
- Artificial containers

Collection Methods

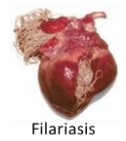
- CDC light traps
- Resting boxes

Host Biting Preference

- Non-human mammals
- Birds
- Less frequently humans

Pathogen Transmission

- Saint Louis Encephalitis virus
- West Nile Virus
- Dirofilariasis (dog heartworm)

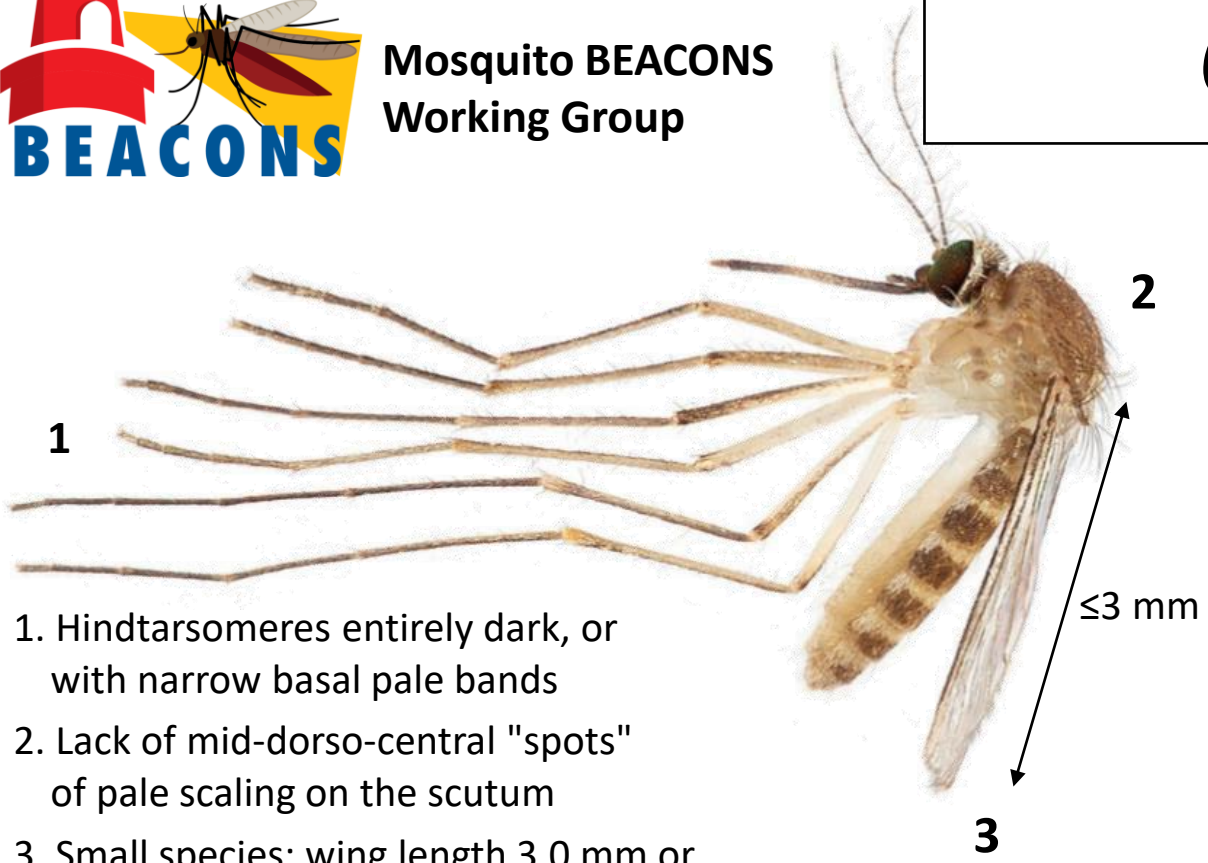


Dispersal Strategies

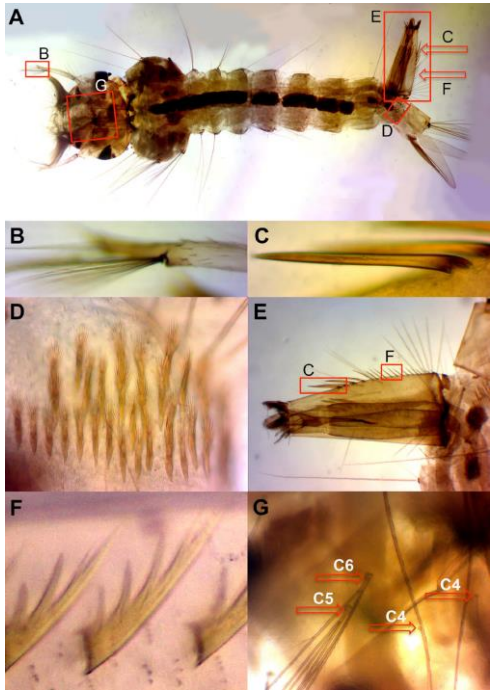
- More research needs to be done in this area

Mosquito BEACONS Working Group

Culex interrogator



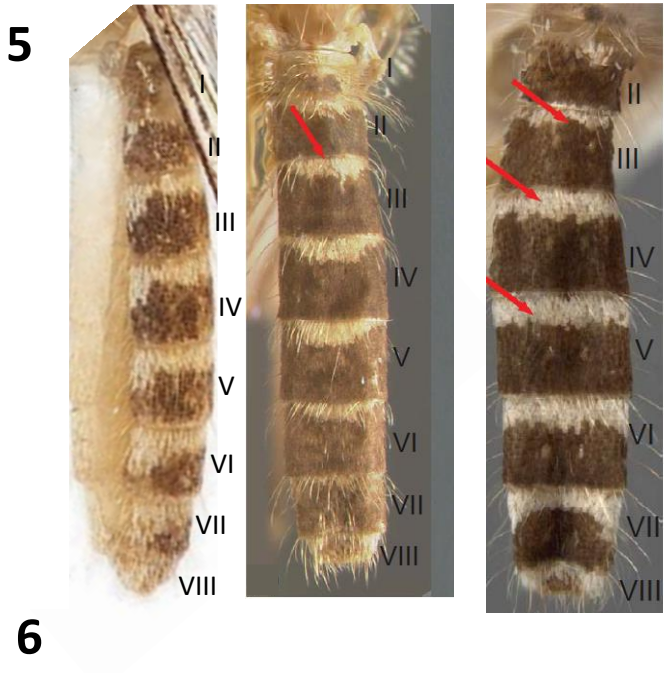
1. Hindtarsomeres entirely dark, or with narrow basal pale bands
2. Lack of mid-dorso-central "spots" of pale scaling on the scutum
3. Small species; wing length 3.0 mm or less.
4. Dark integumental spots on the meskatepisternum and mesepimeron
5. Terga with distinct basal pale bands on segments II–VII. Terga with basal pale bands almost straight posteriorly
6. Cell R_2 usually about 1.2 or less length of vein R_{2+3}



7. *Culex interrogator* larva
   - A. Dorsal view
   - B. Antenna, seta 1–A
   - C. Distal siphonic spine
   - D. Lateral view of the segment VIII, spicules of the pecten
   - E. Lateral view of the siphon
   - F. Basal siphonic spines
   - G. Cephalic setae (C-4, C-5 and C-6)

Cx. quinquefasciatus

Cx. interrogator *Cx. restuans*



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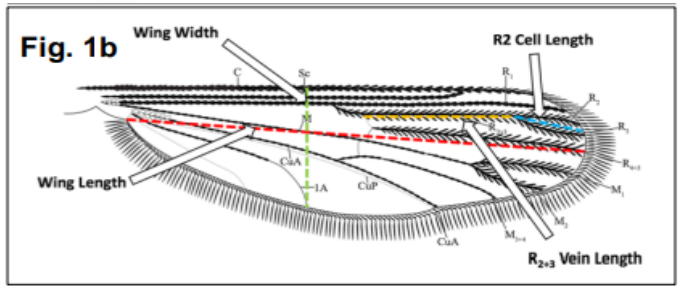


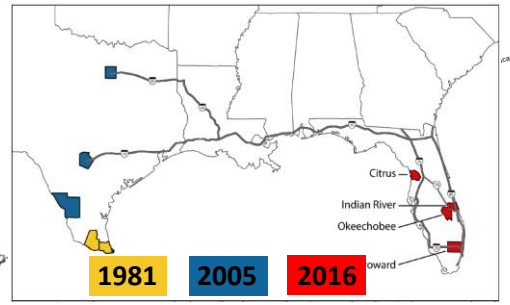
Fig. 1. Many members of the genus *Culex* remain difficult to morphologically identify, especially when damaged by collection devices such as fan-based traps. The three species we studied in this project include two known West Nile virus (WNV) vectors (*Cx. quinquefasciatus* (**Fig.1a**) and *Cx. restuans*). The vector status of *Cx. interrogator* remains unknown. We used a combination of wing measurements (**Fig.1b**) to evaluate potential indices that may be useful for accurately identifying the three species.

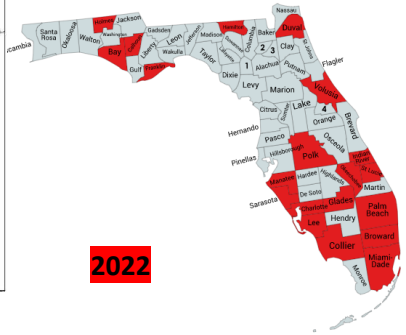
Mosquito BEACONS Working Group

Culex interrogator

Native (Red) and Invasive (green)

Current Expansion





Collection Methods

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

Larval Habitat

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

Host Biting Preference

- 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

Dispersal Strategies

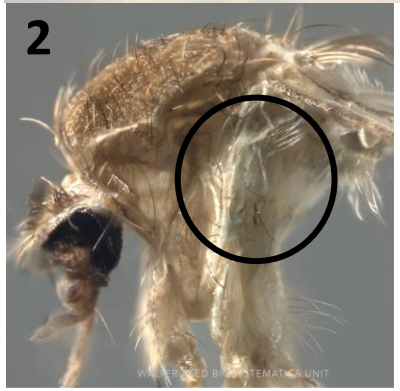
- Likely facilitated by movement of mosquito-infested containers (tires, buckets, pots, etc.) along major highway routes

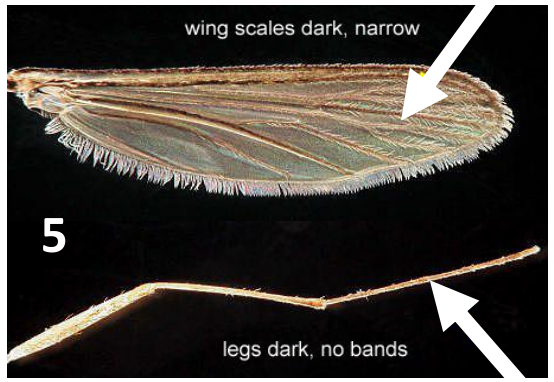
Pathogen Transmission

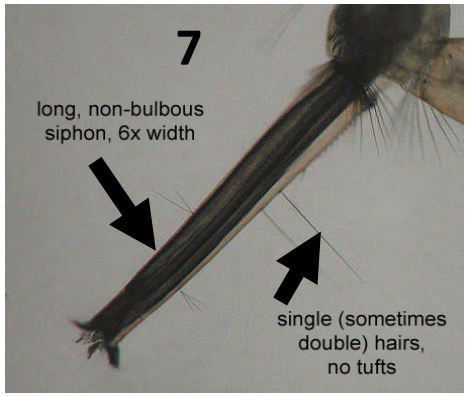
- More surveillance and research is needed in this area
- One (1) **West Nile virus** positive mosquito pool identified in Mexico
  - Role in WNV transmission in the United States is unknown
- *Dirofilaria* (dog heartworm parasite) were recovered from one (1) specimen in Mexico
- Insect Specific Virus: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

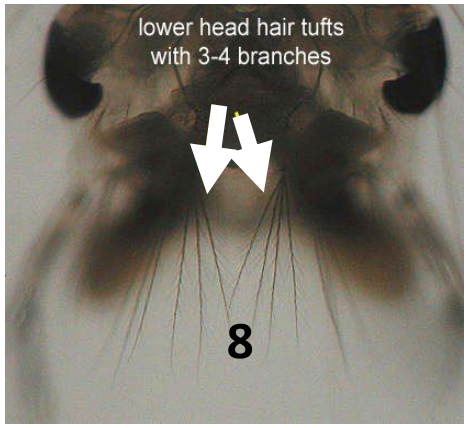
Mosquito BEACONS Working Group

Culex nigripalpus







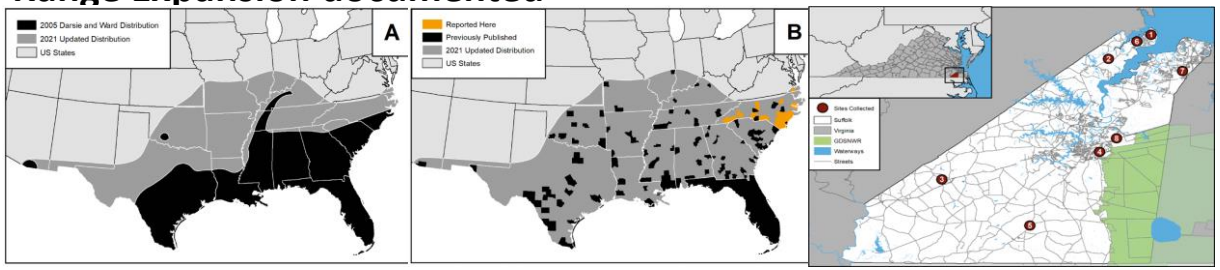


1. Medium sized dark-brown, dark scaled mosquito species with a rounded abdomen
2. No scales present; if present less than 5
3. Acrosticial seta present; brown scaled scutum
5. Winds scaled dark; legs not banded
4. Triangled shaped pale scaled patches; no bands across tergites
6. Larval Body
7. Long non-bulbous siphon 6X width of base; S-2,3 single sometime double
8. 3-C seta with 3 branches

Mosquito BEACONS Working Group

Culex nigripalpus

Range Expansion documented



Larval Habitat

- Permanent & transient pools
- Freshwater swamps
- Natural & artificial containers
- Effluent ponds
- Brackish water and salt-marsh habitat

Dispersal Strategies

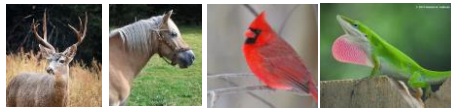
- 5 km flight range
- Not considered a migratory species
- Increasing temperatures and severe storm systems may be a contributing factor
- Anthropogenic introductions cannot be ignored

Collection Methods

- New Jersey Light Traps
- CDC Light Traps
- Canopy Suction Traps
- BG Sentinel Traps
- Aspiration

Host Biting Preference

- Birds
- Mammals
- Reptiles
- Hypothesized as a major zoonotic transmission contributor



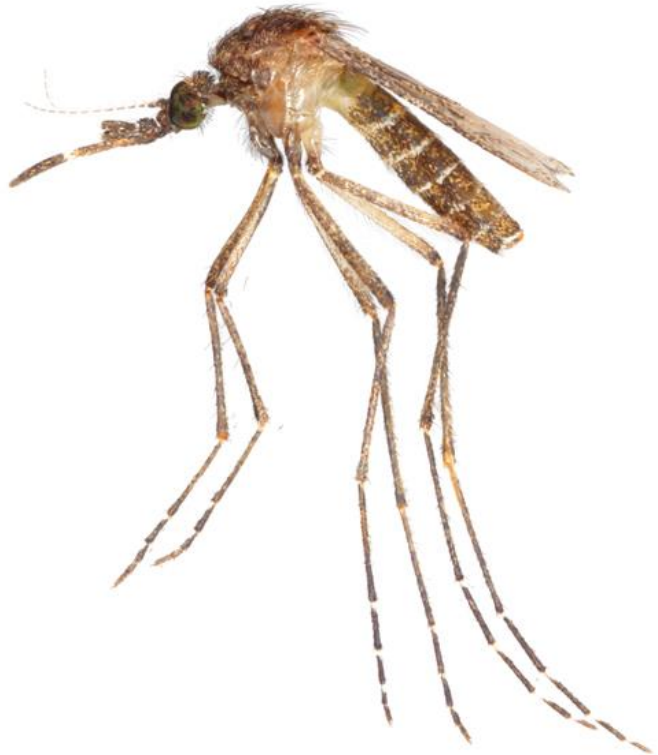
Pathogen Transmission

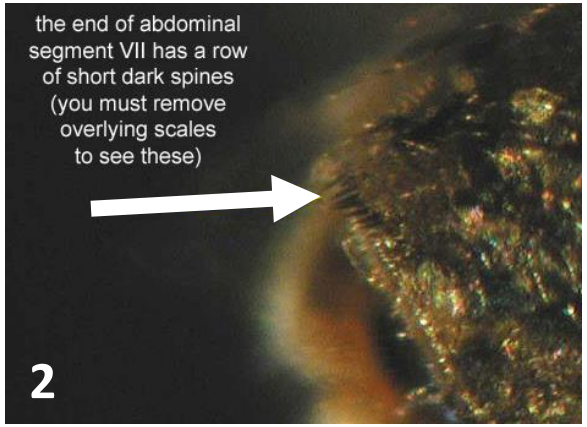
- St. Louis encephalitis virus
- West Nile virus

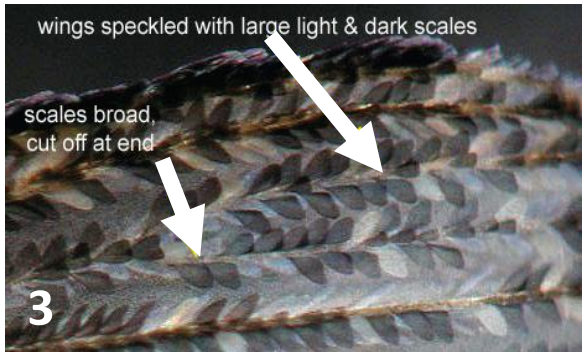
Mosquito BEACONS Working Group

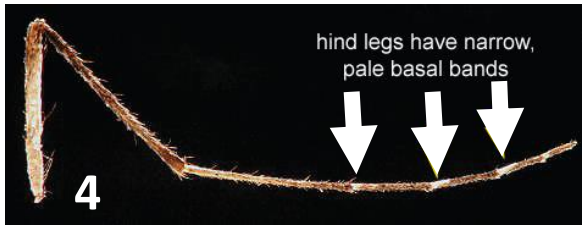
Mansonia titillans

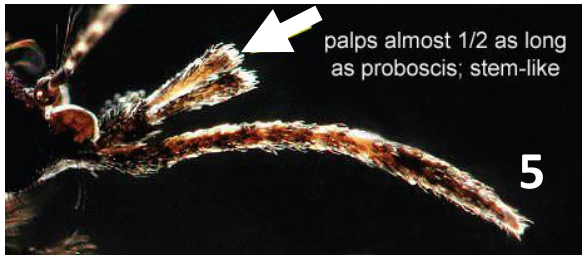
1

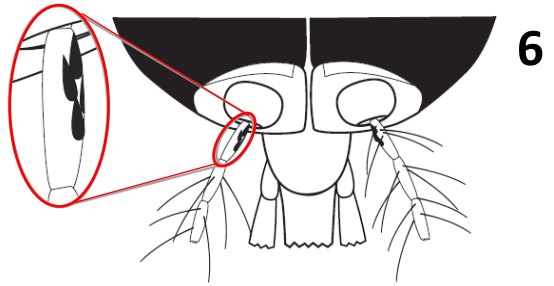


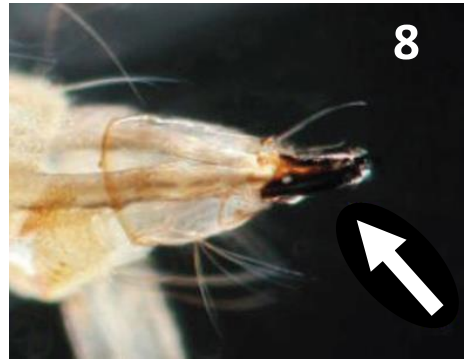


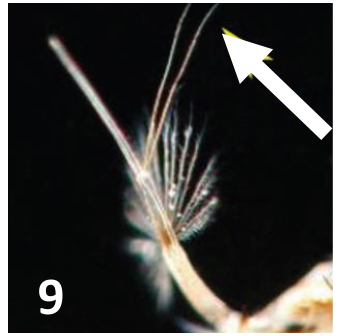












1. Medium to large species. Speckled scales throughout.

   Blunted abdomen; banded proboscis, tarsi and tergites

2. Spiniforms present

3. Pale and dark flat scales present on wing veins

4. Tarsi pale scaled bands below joint

5. Palps almost ½ length of proboscis

6. Flagellomere I >5 dark scales present

7. Larvae attached to roots of aquatic plant (Photo Credit Michele Cutwa, UF)

8. Modified siphon for piercing roots

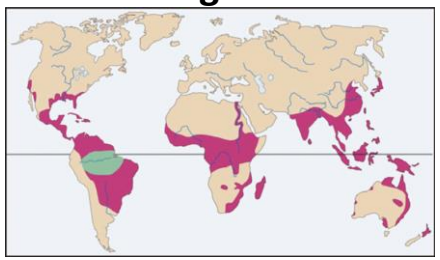
9. Antennae seta 1 long and branched

(Photo Credit Nathan Burkett-Cadena, UF)

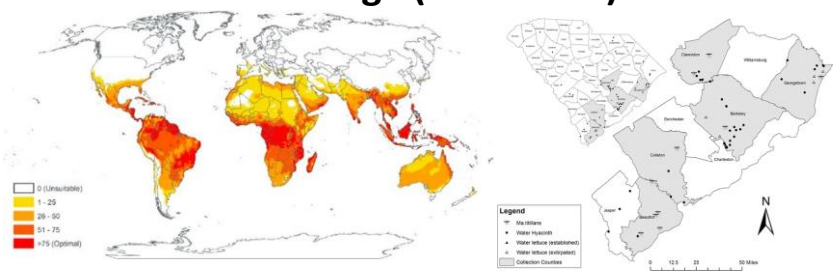
Mosquito BEACONS Working Group

Mansonia titillans

Native Range



Invasive Range (as of 2021)



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

Larval Habitat

- 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

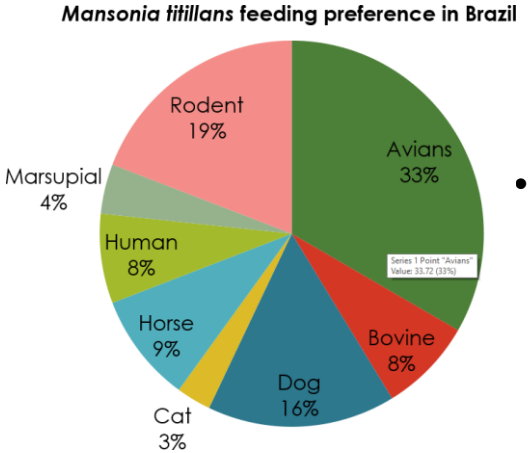
Dispersal Strategies

- 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.

Collection Methods

- CDC light traps, bait with CO2, Octenol, and BG Lure, ideally in synergy
- Emergence traps placed over larval habitat
- Larval collections best done by removing and washing the host plants

Host Biting Preference



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

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)

References

Aedes aegypti

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