

EEK: Vectors and Public Health Pests Virtual Conference

Mosquitoes and Mosquito-borne Pathogens

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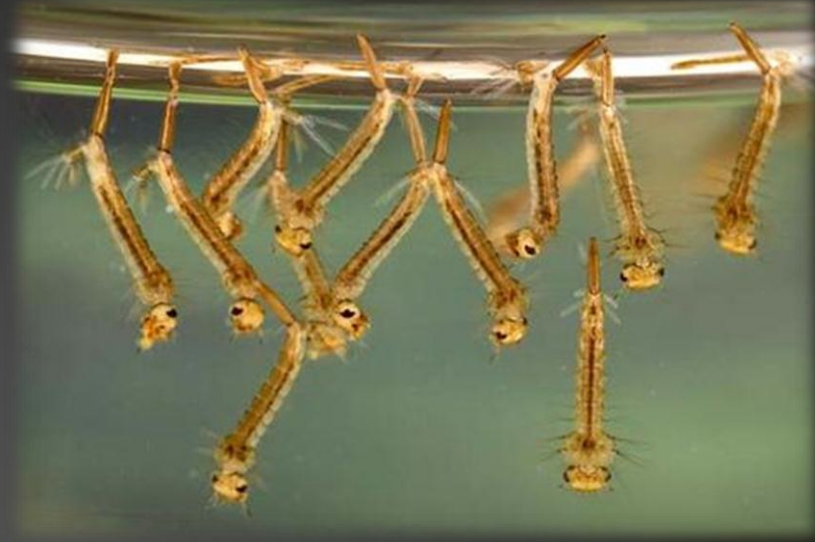




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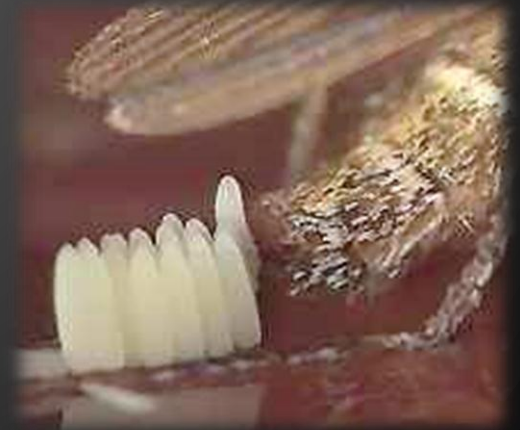
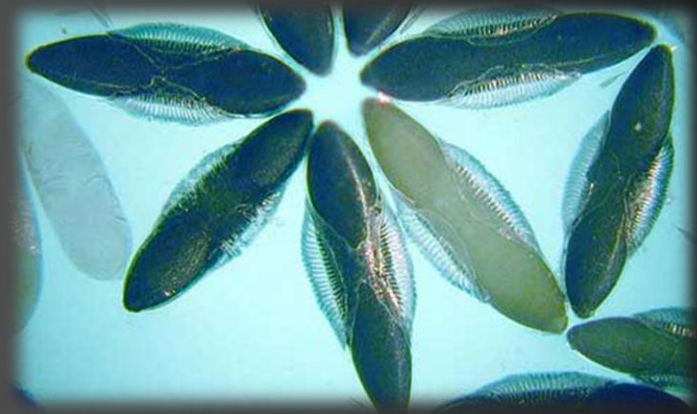
Mosquitoes

- Mosquitoes need water
- Four life stages
egg, larva, pupa, and adult
- Larval and pupal stages are aquatic
- Two-winged Diptera (flies)
Family Culicidae: most
species females have a long
proboscis for sucking blood



Eggs

- Singly on surface or edge of water
- Eggs in rafts on surface of water
- Some sp. hatch 24-36 h
- Some hatch after 1-3 y
- Overwintering stage for some species



Eggs



Larvae

- “Wrigglers”, very active, most come to surface for air
- 1st, 2nd, 3rd, 4th instars
- 4-12 d, some species weeks



Pupae

- Stage that changes from larva to adult
- “Tumblers”
very active,
come to
surface for air
- 3-6 d
- Non-feeding stage



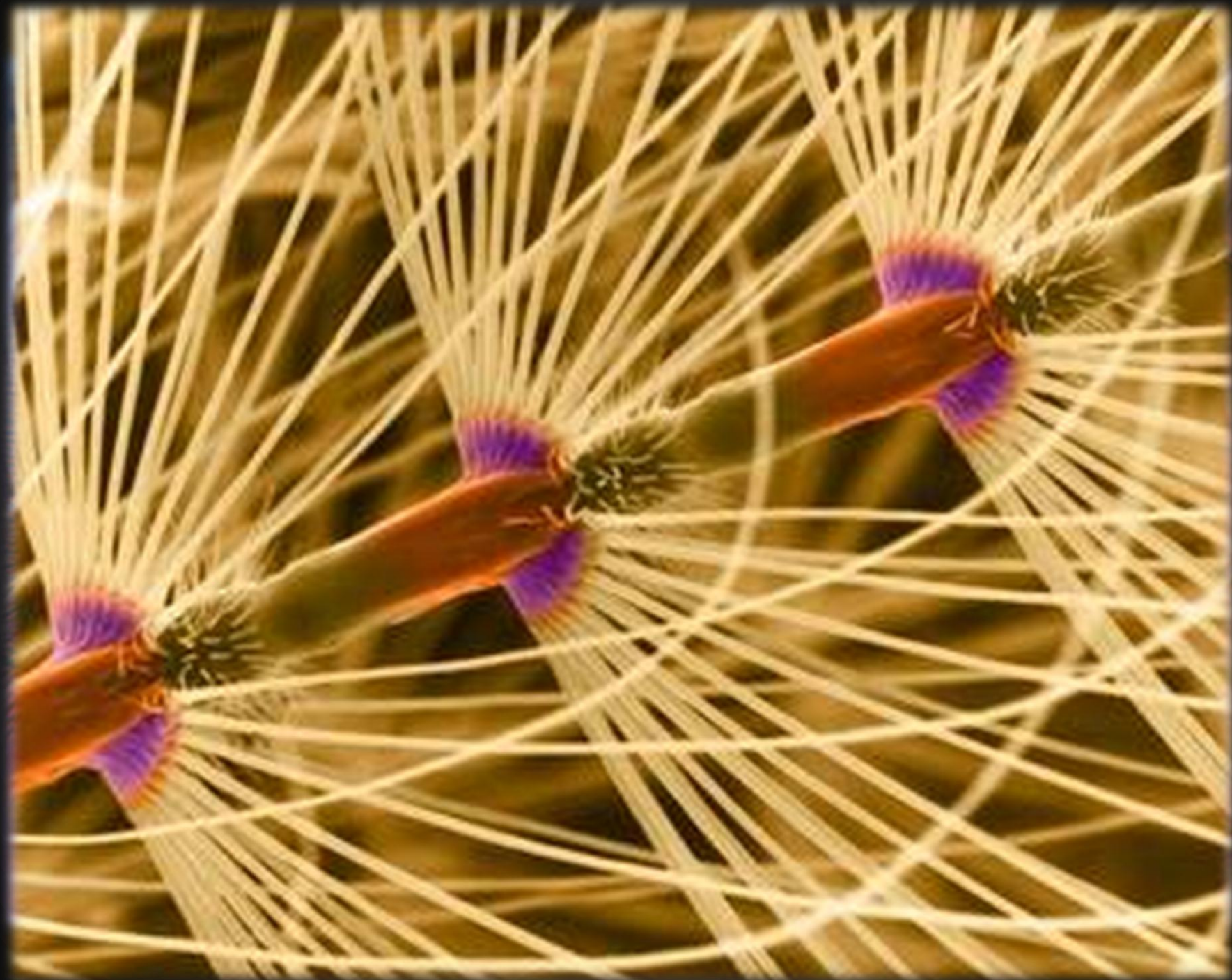
Adult mosquitoes emerge
from aquatic stages



Adult (Male)

- Emerges first
- Feeds on nectar sources for energy
- Mates within 2 -7 d and dies





Adult (Females)

- Emerge and feed on nectar
- Mate usually once
- Need blood meal to develop eggs
- 1-5 blood meals over life of 7 - 28 d



Winter Survival Is Important:

Most overwinter in the **egg stage** (*Aedes*, *Ochlerotatus*, and *Psorophora*)

Some as **larvae** (*Anopheles* and *Ochlerotatus*)

Some as **adults** (*Culex* and *Anopheles*)

Mated females rest in protected, cool locations, such as cellars, sewers, crawl spaces, and well pits

Warm spring days allow females to seek a blood meal





Mosquitoes are classified based on larval habitat

- Floodwater mosquitoes - Eggs laid in damp areas
- Permanent water mosquitoes
- Container mosquitoes



Flood Water Mosquitoes

- *Aedes* and *Psorophora*
- Some genera are important pest species
- Bite humans, livestock, pets
- Can have **very** large populations in spring and early summer



Floodwater (cont.)

- Can survive in egg stage for several years until flooded
- Can have different hatches within several days if increased water levels hatch new eggs



- Adult populations peak in late April, May, and June, some species hatch with late summer fall rains
- **Adults die quickly during hot weather**
- **Flood water usually dries up too fast to support larvae in hot weather**
- Females most active around sunset or in shady areas when disturbed
- Some are active during the day

Aedes vexans & Psorophora



Green space
(parks, soccer
fields, lawns,
etc.)

Vector Roles

- *Aedes vexans* (Inland floodwater mosquito)
 - Known vectors of dog heartworm
- *Psorophora columbiae* (Dark ricefield mosquito)
 - Vector of West Nile Virus in humans (CDC)

Permanent Water Mosquitoes

- *Anopheles*, some *Culex* spp.
- Found in quiet bodies of freshwater with sunlight, surface vegetation and little wave action
- Shallow edges of ponds, some lakes backwaters of rivers slow moving streams
- Never in lakes with wave action



Permanent Water Group (cont.)

- *Anopheles* vectors malaria
- 1,500-2,000 cases of malaria
- Most travel related



Mismanaged ponds:

- Excessive vegetation
- Stagnant water
- Lack of predators

Permanent Water Group (cont.)

- Populations low in spring
- Build through the summer
- Peak July-October (varies by location)
- Many prefer birds as hosts, feed on mammals
- **Vectors of viruses**
- Bite more readily at night

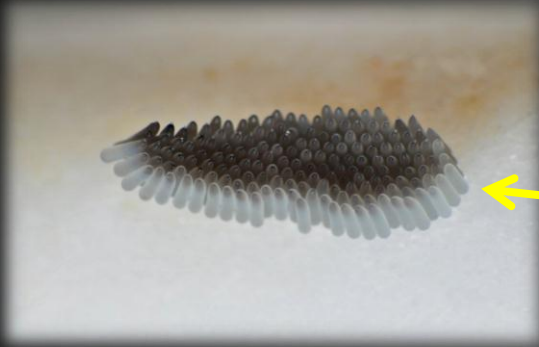


Mosquitoes of Great Concern

- *Culex tarsalis*,
(western encephalitis mosquito)
C. quinquefasciatus
(southern house mosquito)
- Note: all are permanent water mosquitoes,
populations peak in summer through fall at
same time virus activity peaks
- Feed on birds and mammals



Culex quinquefasciatus



Culex tarsalis





Roadside ditches



Wastewater treatment



Culex spp. prefer nasty,
smelly water

Vector role of *Culex* Mosquitoes

- West Nile virus
- St. Louis encephalitis
- Western and Eastern Equine Encephalitis
- Brazilian scientists are investigating if *Culex* is transmitting Zika virus

Container Mosquitoes

(you breed 'em, you feed 'em)

- 99% = *Culex* or *Aedes*
- In nature larvae live in tree holes, rock pools even leaf axils
- Many species associated with **man made containers** or materials that hold water
 - Tires, cans, buckets, birdbaths, gutters, pet water dishes, plant container bottoms that catch water, even cans, paper cups etc.



Typical Container Mosquito Habitat

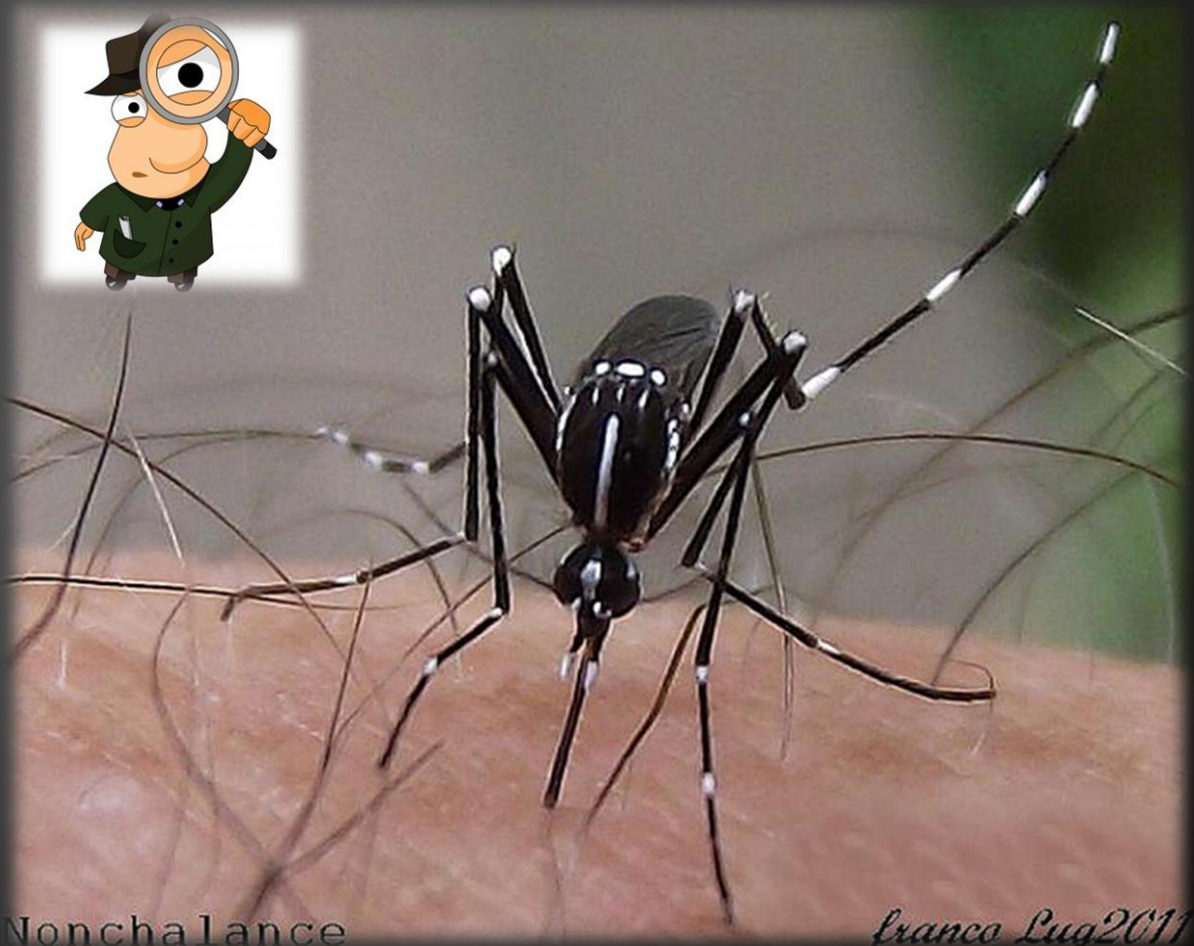




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Asian Tiger Mosquito

- *Aedes albopictus* *vector dengue, ChikV*
- Larvae in containers of any size
- Adults active during the day



Aedes albopictus

Eggs in Container



- Container breeder
- Eggs laid on surface of water, on sides of container, and on stick
- Immediate egg hatch of some eggs, delayed hatch for others

Yellow Fever Mosquito

Aedes aegypti



- Container breeder
- Prefer more sunlight
- Dengue and ChikV

Ae. aegypti and *Ae. albopictus*: Species Competition Factors

- *Ae. aegypti* - correlated with urbanization
- *Ae. albopictus* - rural, suburban & vegetated urban habitats (parks)
- *Ae. aegypti* eggs are more desiccation-resistant.
 - Favored in hot, dry environments
- *Ae. albopictus* better larval competitor
 - Low-nutrient, natural resource environments.
- Larval breeding and adult resting sites typically outdoors in U.S. (screens and use of air conditioning prohibit indoor breeding)

Vector role of *Aedes* Mosquitoes

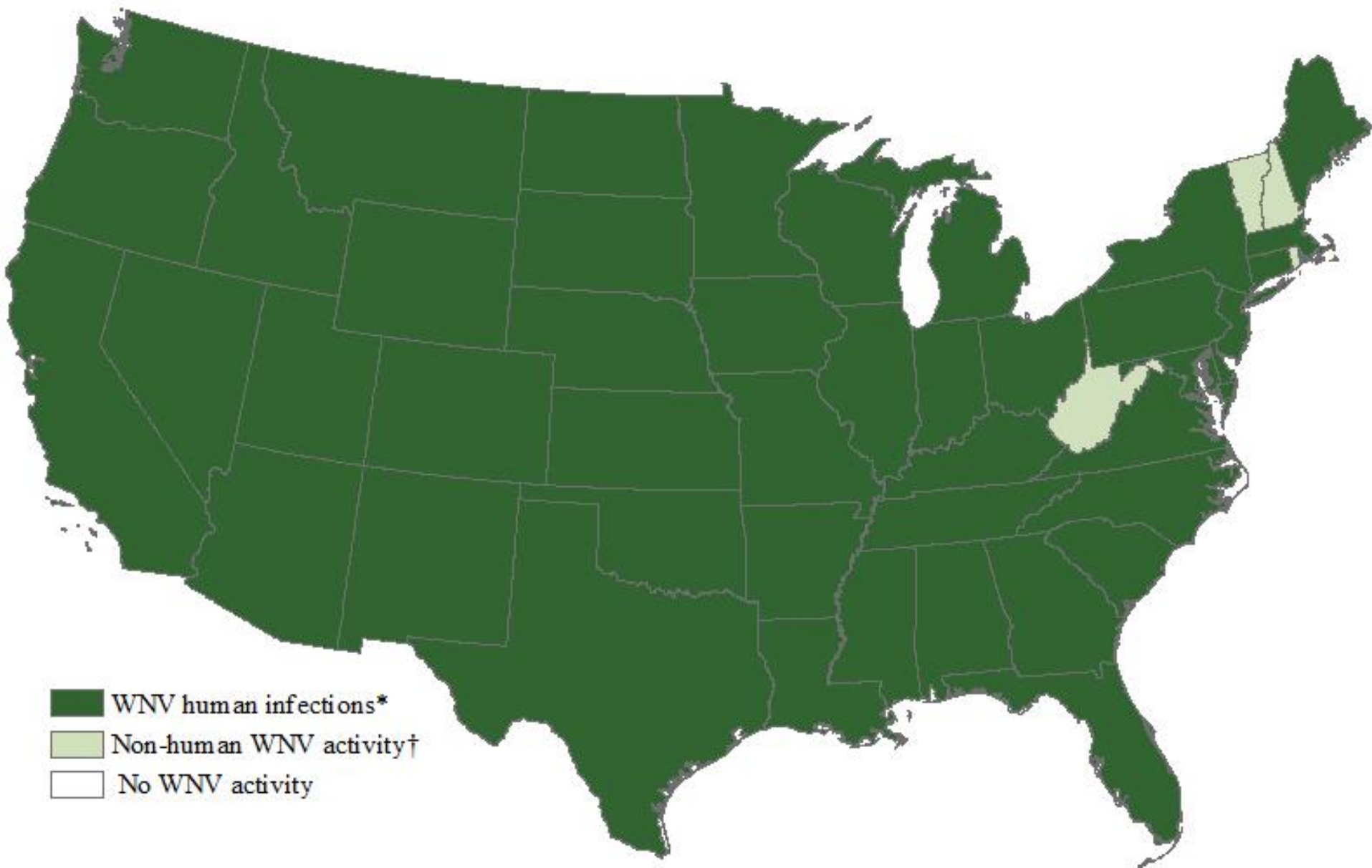
- Chikungunya
- Dengue
- Zika

Prevent – Detect – Respond

West Nile Virus

- West Nile virus (WNV) is most commonly transmitted to humans by *Culex* mosquitoes
- There are no medications to treat or vaccines to prevent WNV infection
- About 1 in 5 people who are infected will develop a fever with other symptoms
- Less than 1% of infected people develop a serious, sometimes fatal, neurologic illness

West Nile Virus



Chikungunya

- Chikungunya (CHIKV) is an arthropod-borne virus (arbovirus) transmitted by *Aedes aegypti* and *Ae. albopictus*
- The CDC and PAHO have developed a preparedness and response plan available at: <http://www.cdc.gov/chikungunya>

Chikungunya Signs & Clinical Symptoms

Incubation period 2-6 d, symptoms appearing 4–7 d post-infection

Symptoms include:

Rash

Pain in the Lower Back

Joint Pain

(with or without swelling)

Headaches

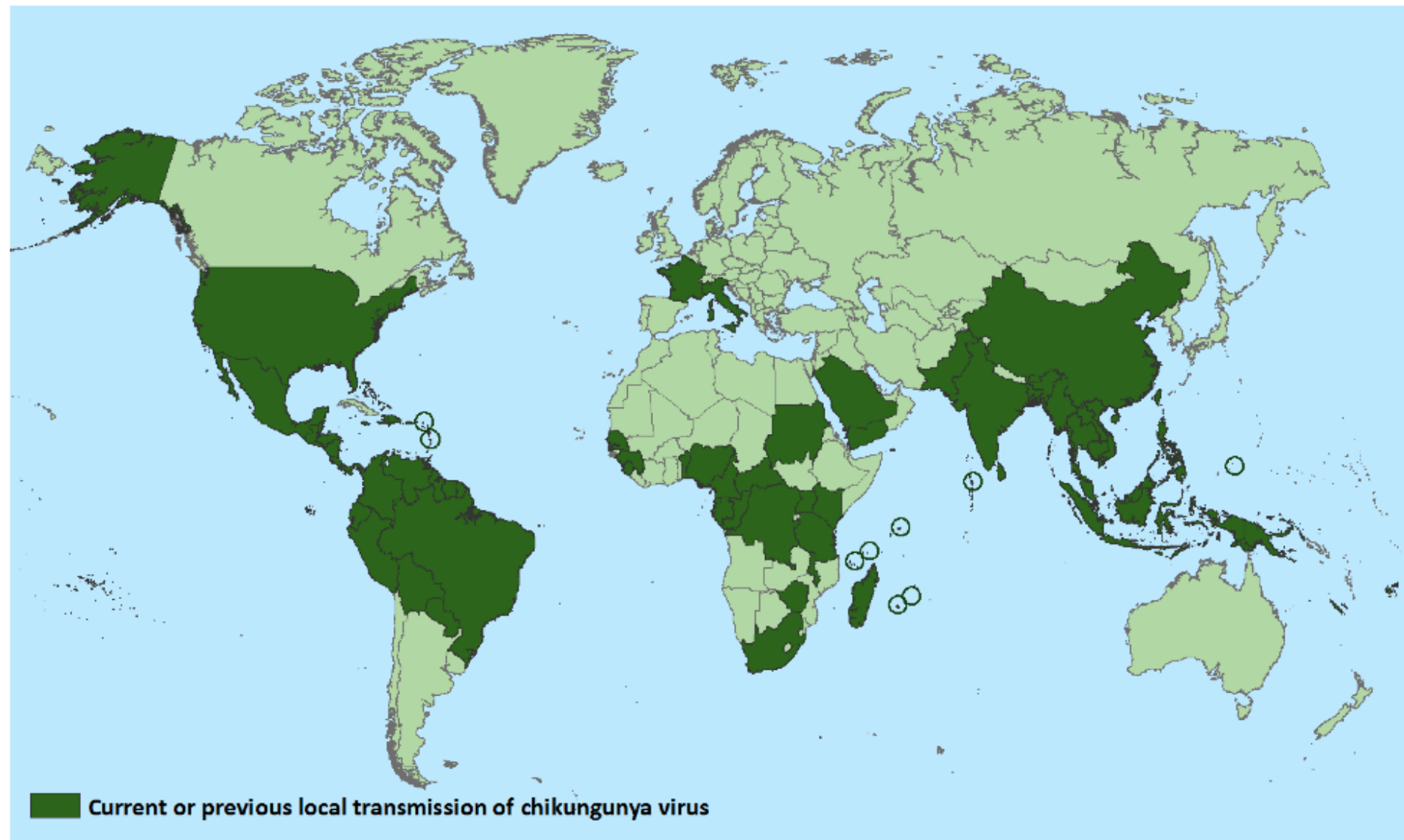
Chills

Nausea

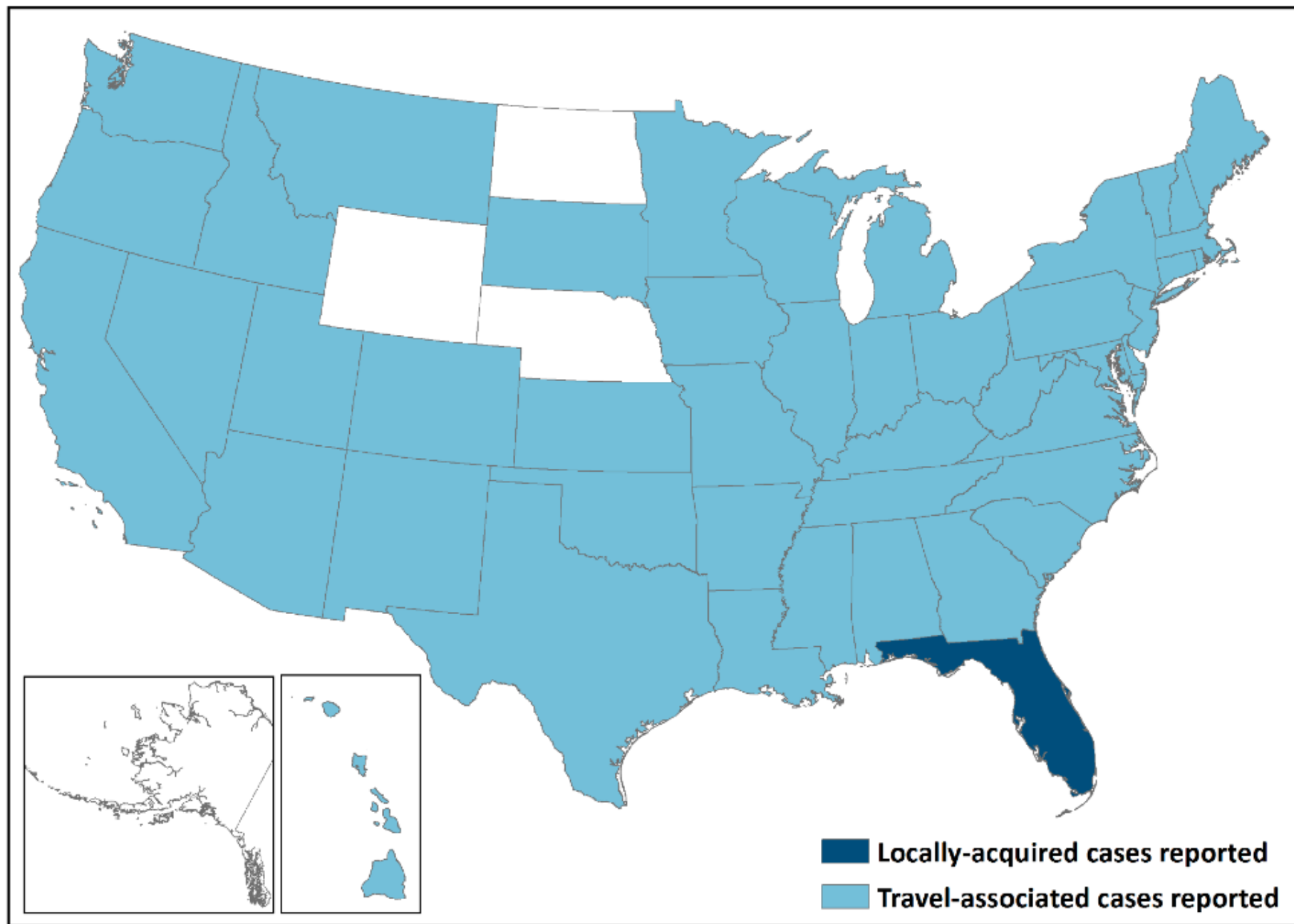
Vomiting

Fevers

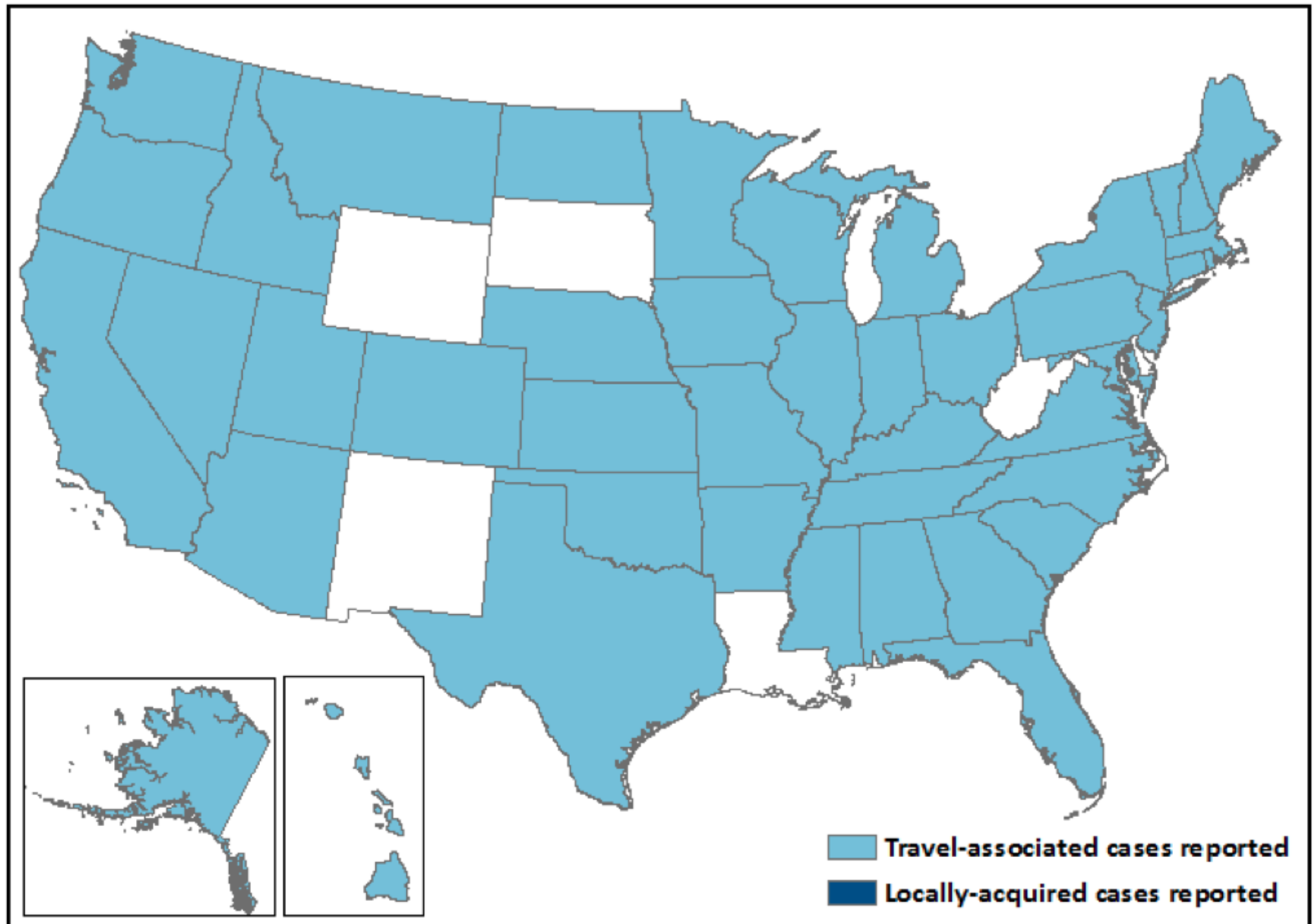
Countries and territories where chikungunya cases have been reported*
(as of October 20, 2015)



States reporting chikungunya virus disease cases – United States, 2014



Map. States reporting chikungunya virus disease cases – United States, 2015 (as of January 12, 2016)

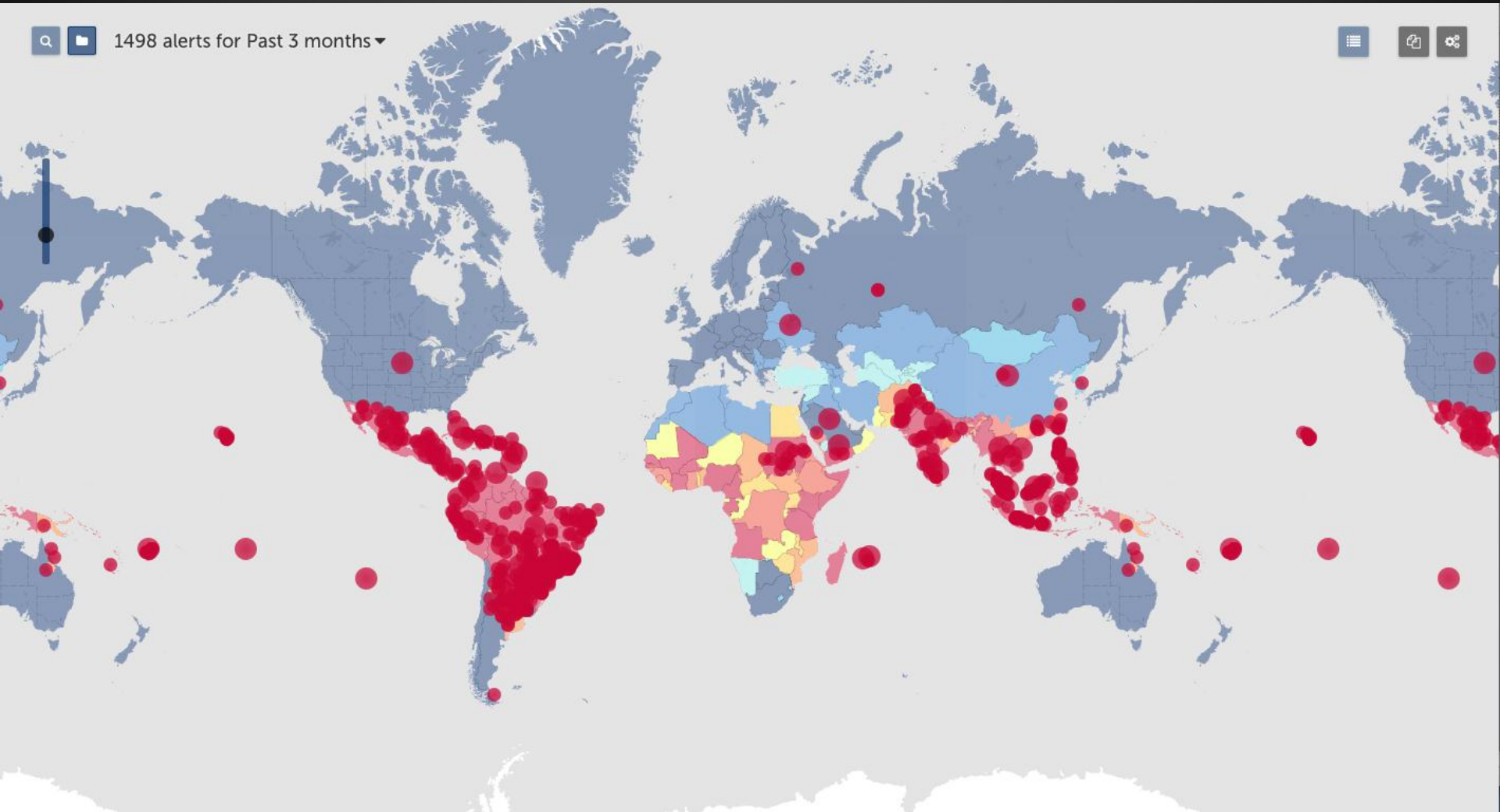


Dengue

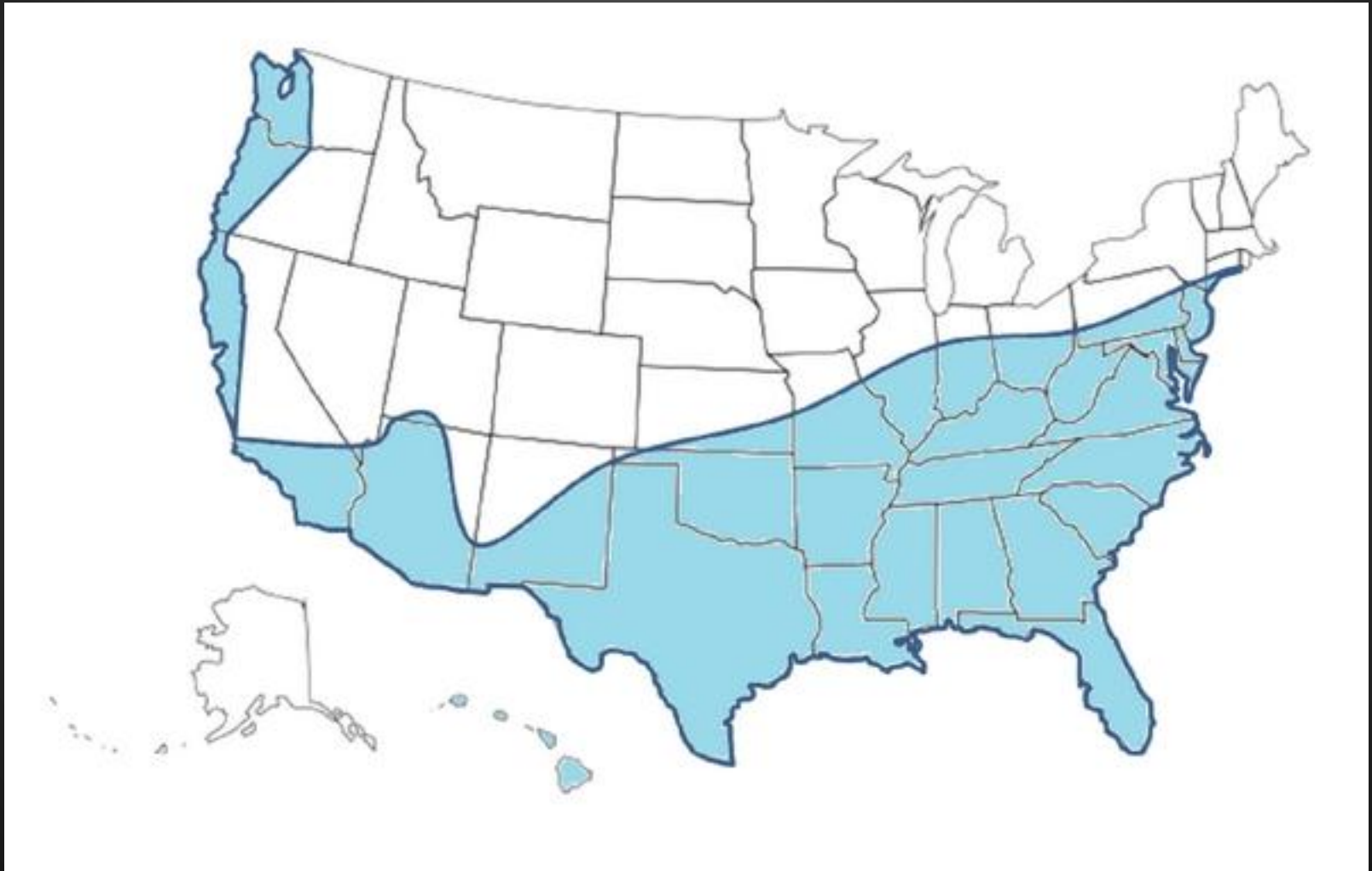
- Dengue is caused by any one of four related viruses (DEN 1-4) transmitted by mosquitoes
- ~ 400 million people are infected yearly
- Latin America, Southeast Asia and the Pacific islands
- *Aedes aegypti* mosquito is the most important transmitter or vector of dengue viruses



Global Dengue



Areas at Risk of Dengue Outbreaks



Dengue Signs & Clinical Symptoms

Dengue fever (DF) symptoms include:

High fever, severe headache, severe pain behind the eyes, joint pain, muscle and bone pain, rash and mild bleeding

Dengue hemorrhagic fever (DHF) symptoms include: can be fatal

a fever that lasts from 2 – 7 days. When the fever declines, persistent vomiting, severe abdominal pain, difficulty breathing

Zika

- Alert healthcare providers and the public about Zika
- Zika virus is transmitted to people primarily through the bite of an infected *Aedes* mosquito
- *Aedes aegypti* and *Ae. Albopictus*
- Same mosquitoes that spread dengue and chikungunya viruses
- Zika virus can also be transmitted from mother to her fetus during pregnancy, through blood transfusions, and through sexual contact

Zika Signs & Clinical Symptoms

- 20% people infected with zika virus become ill
- The most common symptoms are fever, rash, joint pain, and/or conjunctivitis (red eyes)
- Other symptoms include muscle pain and headache
- Incubation period 2-7 d
- Usually mild with symptoms lasting for a few days to a week
- Death is rare

Zika and Microcephaly

- Brazilian communities have experienced a significant number of Zika cases since May 2015
- Officials have also noticed an increase in the number of babies with congenital microcephaly
- Additional studies are needed to determine the degree to which Zika might be linked with microcephaly
- Pregnant women should take steps to prevent mosquito bites
- <http://www.cdc.gov/zika/hc-providers/qa-pregnant-women.html>

Areas with Zika

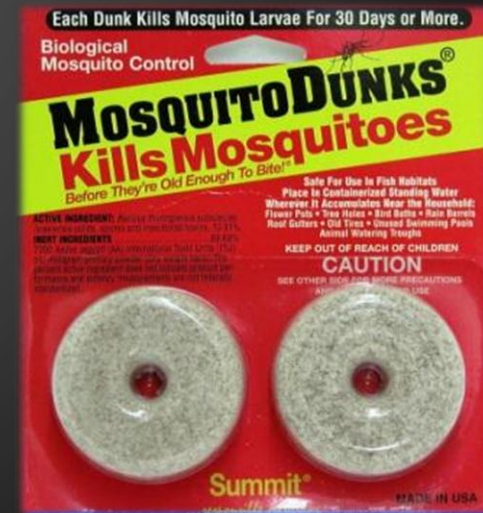


	West Nile	Chikungunya
• Virus	• <i>Flavivirus</i>	• <i>Alphavirus</i>
• 1^o vectors	• <i>Culex</i>	• <i>Aedes</i>
• Human hosts	• Incidental	• 1^o host
• % symptomatic	• <20%	• 72-97%
• % chronic	• <1%	• 30-40%
• % fatality	• <1%	• 0.03%
• Symptoms	• Fever, headache, body aches, skin rash, and swollen lymph nodes	• Headache, muscle pain, joint swelling, rash

	Dengue	Zika
• Virus	• <i>Flavivirus 1-4</i>	• <i>Flaviviru</i>
• 1^o vectors	• <i>Aedes</i>	• <i>Aedes</i>
• Human hosts	• 1^o host	• 1^o host
• % symptomatic	• Can be 50%	• <20%
• % chronic	• Variable	• ?
• % fatality	• <1-50%(DF, DHF)	• Very low GB
• Symptoms	• Headache, eye pain, joint pain, muscle and/or bone pain, rash, nausea	• Fever, rash, joint pain, and conjunctivities (? Microcephaly?)

Integrated Pest Management (IPM)

- Surveillance
- Source Reduction
- Larvicides
- Adulticides – “when not to spray”
- Biological Control Agents
- Public Education
 - Reduce conducive conditions
 - Eliminate containers holding water
 - Repellents



Mosquito Management

- Stop them at their source – larvicide
- Kill vectoring adults – adulticide
- Erect barriers against the ones you miss
- Advocate personal protection as the final layer of protection – repellents



CDC

<http://www.cdc.gov/features/stopmosquitoes/>

USGS

http://diseasemaps.usgs.gov/dep_ga_human.html

University of Arizona

<http://cals.arizona.edu/apmc/public-health-IPM>

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Prevent Mosquito Bites

Recommend Tweet Share

Stay healthy this summer. Protect yourself and your loved ones from mosquito bites that cause West Nile virus infection.

Mosquito bites can be more than just itchy and annoying. They can cause you to get sick. The most effective way to avoid West Nile virus disease is to prevent mosquito bites. Be aware of the West Nile virus activity in your area and take action to protect yourself and your family.

Know the facts

Almost 40,000 people in the U.S. have been reported with West Nile virus disease since 1999, and of those over 17,000 have been seriously ill and more than 1600 have died. Many more cases of illness are not reported to CDC.

Know your risk

Anyone living in an area where West Nile virus is present in mosquitoes can get infected. West Nile virus has been detected in all lower 48 states (not in Hawaii or Alaska). Outbreaks have occurred every summer since 1999. Though anyone can get infected with West Nile virus, there are people at higher risk for severe disease. People over the age of 50 are at higher risk for encephalitis. The reasons one person becomes severely ill and another doesn't aren't entirely known.



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MOSQUITOES

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Introduction

Mosquitoes are one of the most important insect pests that affect the health and wellbeing of humans and domestic animals worldwide. They can cause a variety of health problems due to their ability to transfer (vector) viruses and other disease-causing pathogens even in the arid Southwest. Female mosquitoes require a blood meal for egg production, and they can produce a painful bite as they feed. While feeding they can transmit to humans and other animals—brain inflammation (encephalitis), dengue fever, yellow fever, malaria and filariasis. The most susceptible to the effects of these mosquito-borne pathogens are children and the elderly. However, in some instances life-threatening illness and/or permanent debilitation can occur in infected human hosts of any age.



The Mosquito Life Cycle

Understanding the basics of mosquito biology will help to reduce mosquito problems. All mosquitoes must have water to complete their life cycle, although some species require very little water and can develop in a thin moisture film. The mosquito life cycle is an example of complete metamorphosis. There are four distinct stages in the life of a mosquito: egg, larva (aquatic feeders), pupa (aquatic non-feeders) and adult (Fig. 1). Like most insects with complete metamorphosis, mosquitoes have developmental stages that look very different from one another.

They begin life as tiny eggs. Female mosquitoes usually lay eggs a few days after acquiring a blood meal. Depending on the species the eggs can be laid either singly (e.g., *Anopheles gambiae*, Fig. 2A) or in rafts (e.g., *Culex* mosquitoes) (Fig. 2B). The eggs are laid on the surface of water, on the sides of containers, or on damp soil.

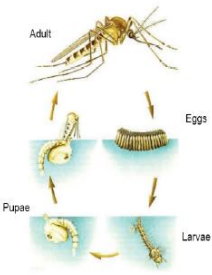


Fig. 1 Generalized mosquito life cycle: Mosquitoes need water to complete their life cycle.

Fig. 2 Mosquito eggs: A, single egg of *Anopheles gambiae*. B, eggs of *Culex quinquefasciatus* in raft. Photograph by the Centers for Disease Control and Prevention (CDC) Public Health Image Library, CDC/Cheryl Weinburg.

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