

A Primer on Vector-Borne Disease

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Outline

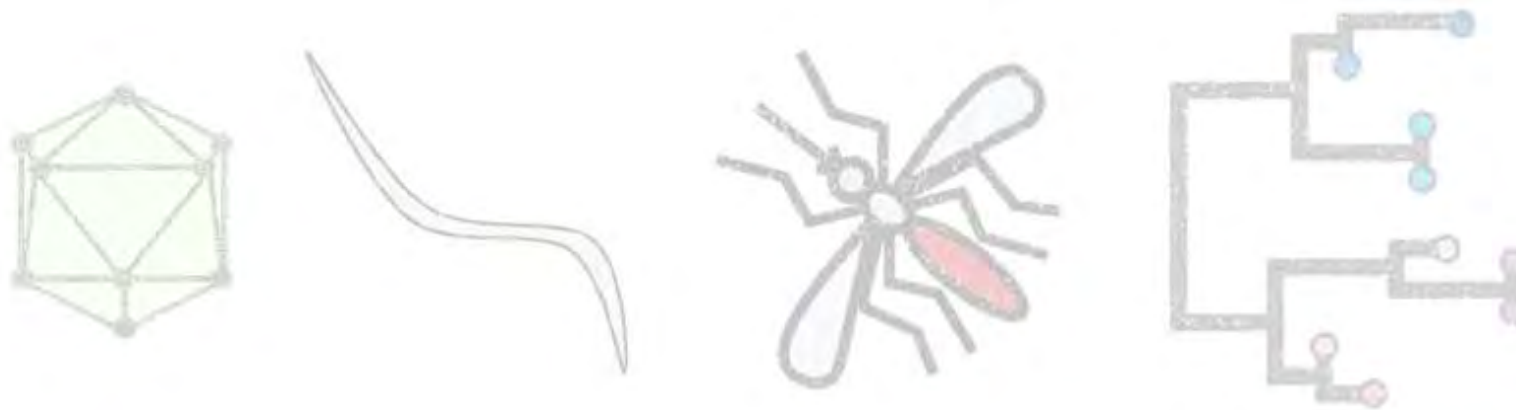
- Introduction
- What are Vector-Borne Diseases (VBD)?
- History of VBDs and VBDs in the US
- Current Statistics and Risk Estimates
- VBD Control and Prevention
- Questions



Pathogens, genomics, and global health

The Fauver Lab

UNMC College of Public Health

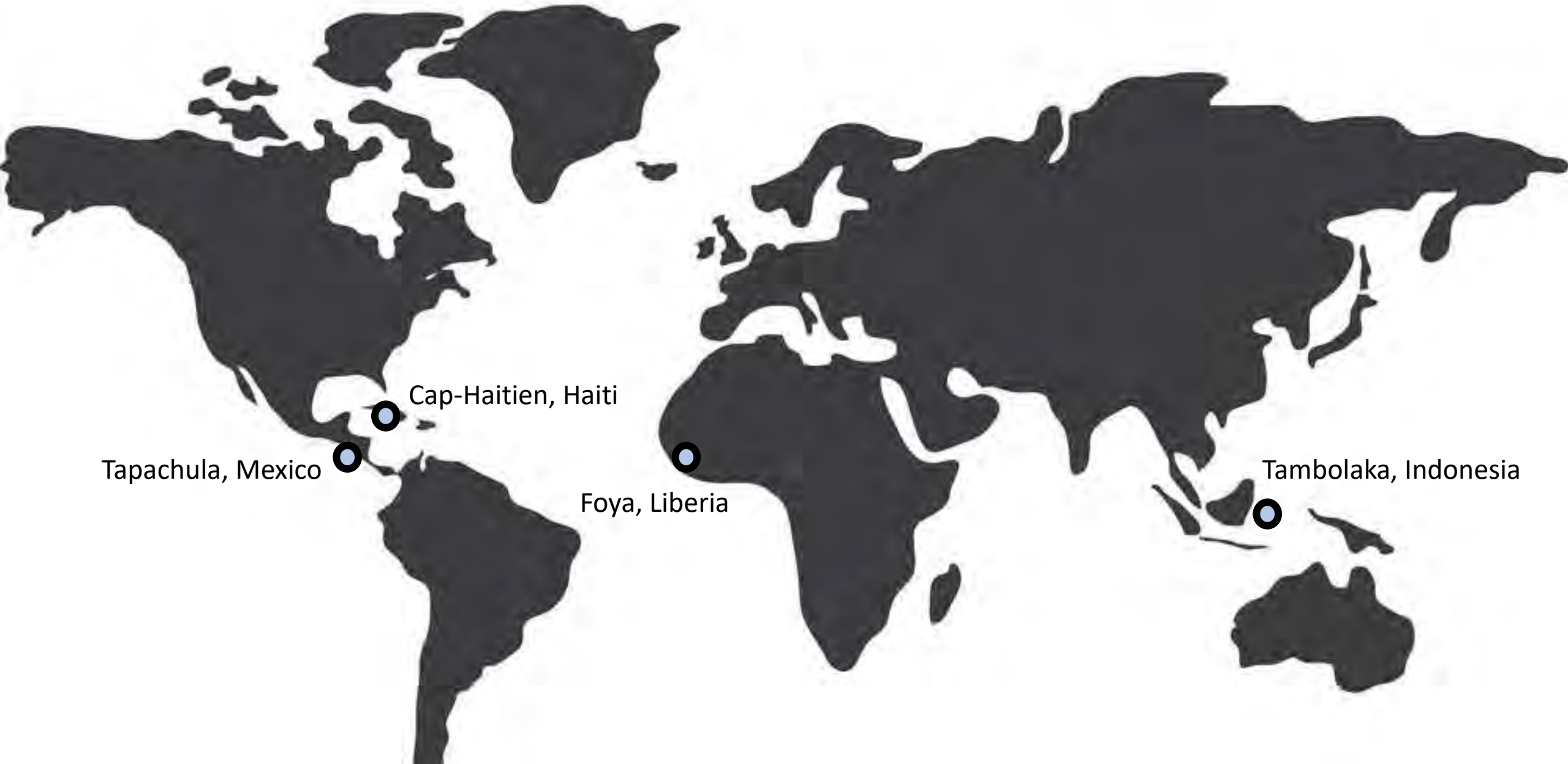


thefauverlab.com

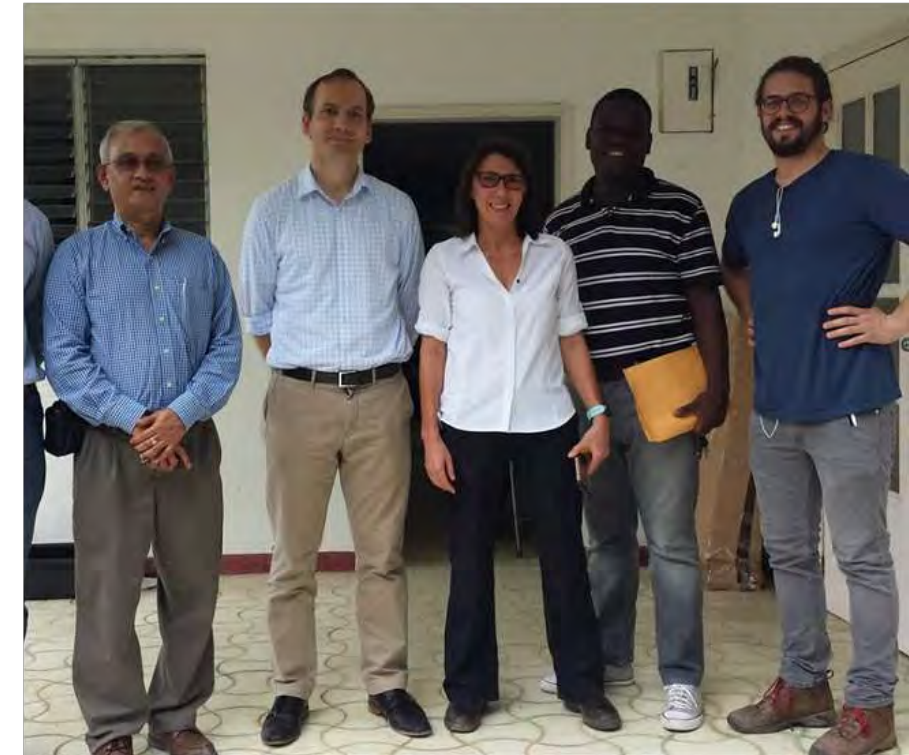


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People, Places, and Parasites



People, Places, and Parasites



What are Vector-Borne Diseases?

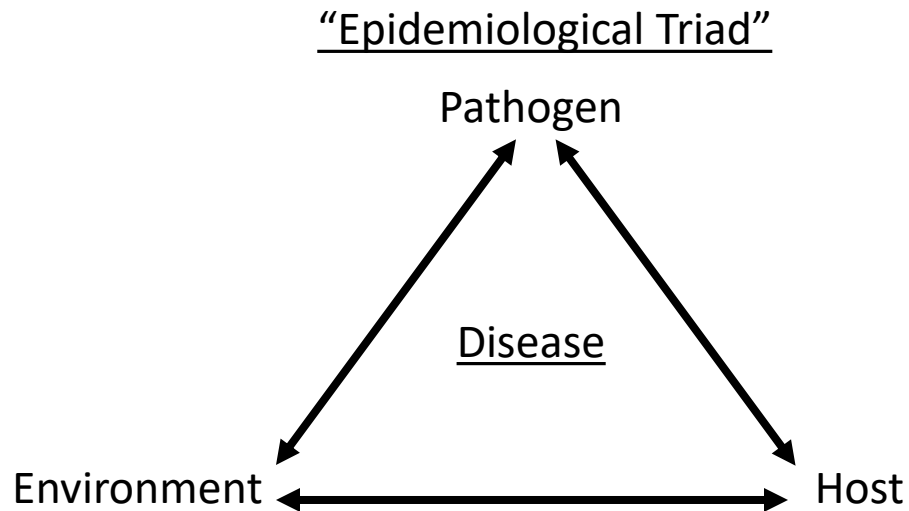
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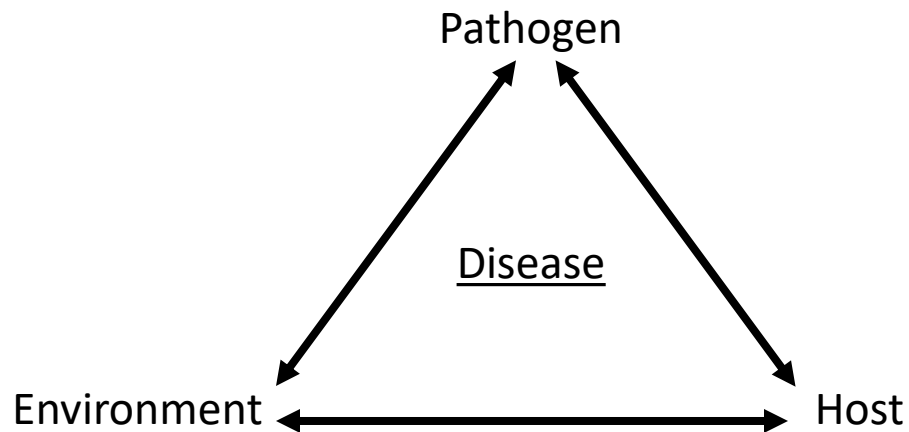
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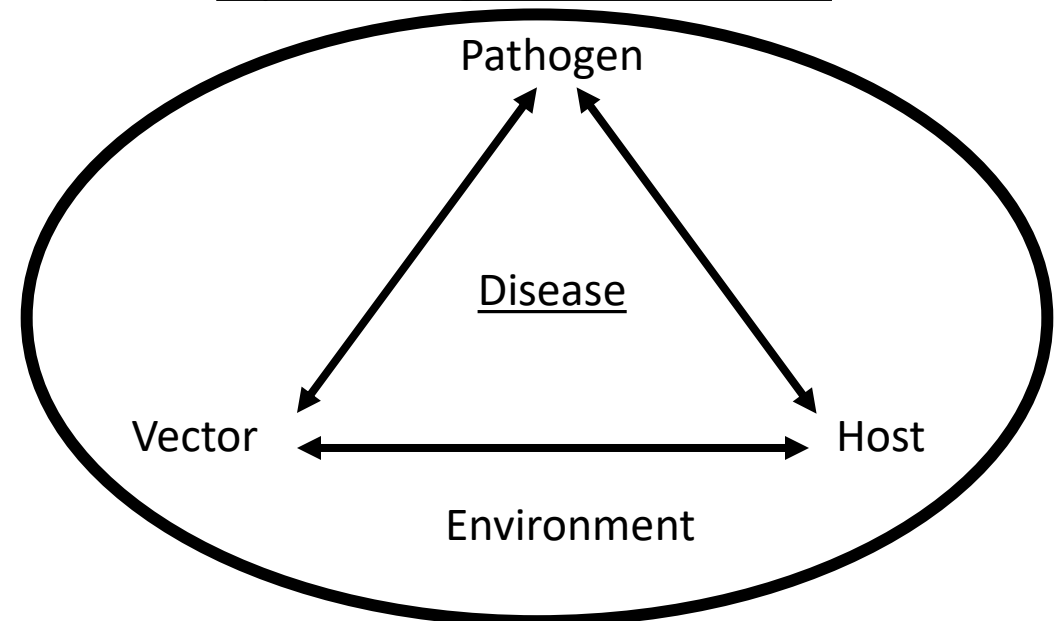
What are Vector-Borne Diseases?

- Vector-borne diseases are human, animal, or plant illnesses caused by parasites, viruses and bacteria (pathogens) that are transmitted by vectors.

"Epidemiological Triad"

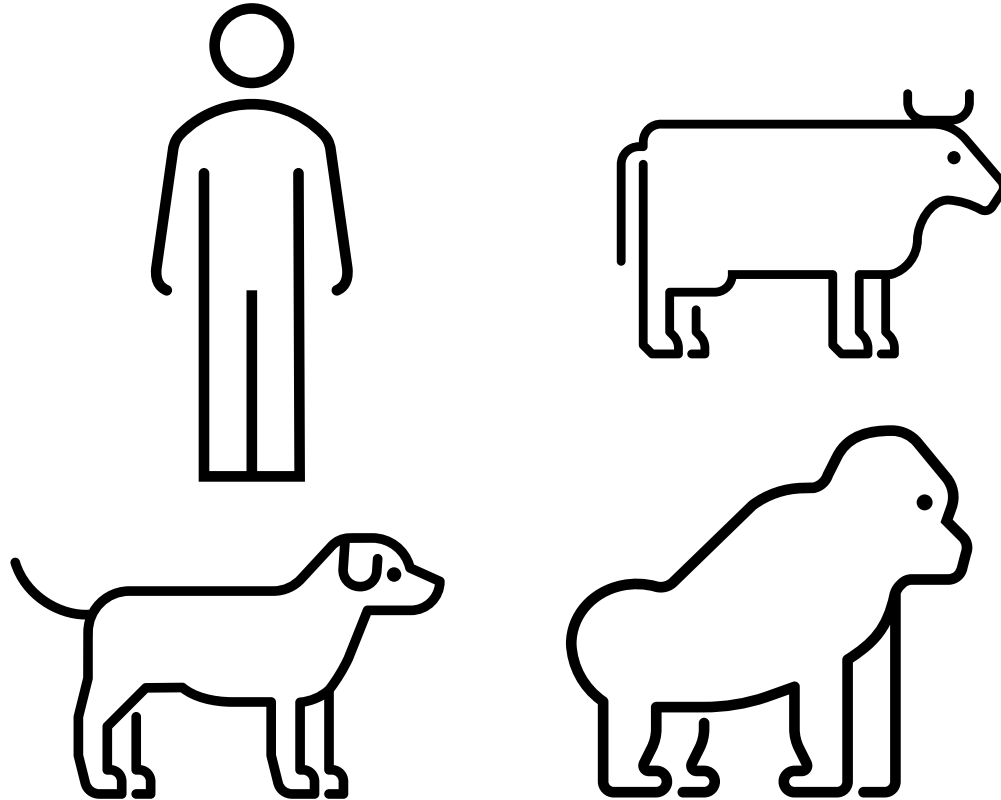


"Epidemiological Triad for VBD"



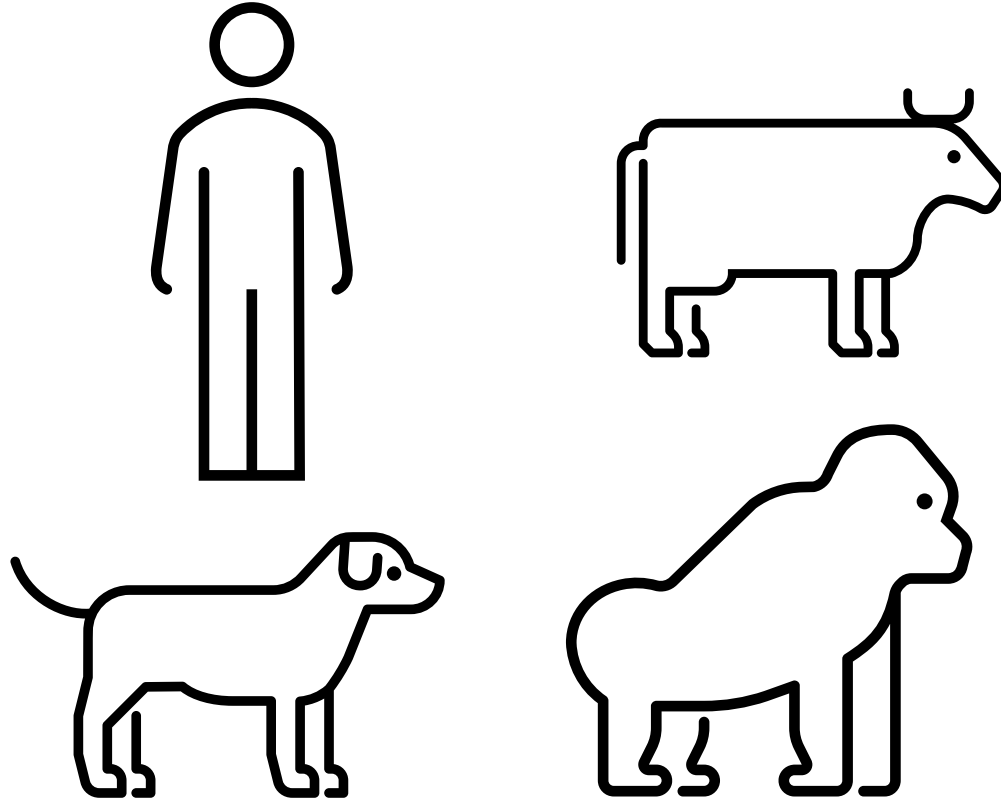
What hosts are we concerned about?

- Humans!
- Companion Animals
- Livestock
- Wildlife



What hosts are we concerned about?

- Humans!
 - Companion Animals
 - Livestock
 - Wildlife
-
- We are healthcare workers, why should we care about wildlife diseases?



What is a vector?

- Vectors are hematophagous arthropods capable of transmitting infectious agents (pathogens) to hosts



What pathogens are transmitted by vectors?

- Three main categories: viruses (arboviruses), bacteria, and parasites



Wucheria bancrofti



Borrelia burgdorferi

Vector	Disease caused	Type of pathogen
Mosquito	<i>Aedes</i>	Chikungunya
		Dengue
		Lymphatic filariasis
		Rift Valley fever
		Yellow Fever
		Zika
	<i>Anopheles</i>	Lymphatic filariasis
		Malaria
	<i>Culex</i>	Japanese encephalitis
		Lymphatic filariasis
		West Nile fever
Aquatic snails	Schistosomiasis (bilharziasis)	Parasite
Blackflies	Onchocerciasis (river blindness)	Parasite
Fleas	Plague (transmitted from rats to humans)	Bacteria
	Tungiasis	Ectoparasite
Lice	Typhus	Bacteria
	Louse-borne relapsing fever	Bacteria
Sandflies	Leishmaniasis	Parasite
	Sandfly fever (phlebotomus fever)	Virus
Ticks	Crimean-Congo haemorrhagic fever	Virus
	Lyme disease	Bacteria
	Relapsing fever (borreliosis)	Bacteria
	Rickettsial diseases (eg: spotted fever and Q fever)	Bacteria
	Tick-borne encephalitis	Virus
	Tularaemia	Bacteria
Triatome bugs	Chagas disease (American trypanosomiasis)	Parasite
Tsetse flies	Sleeping sickness (African trypanosomiasis)	Parasite

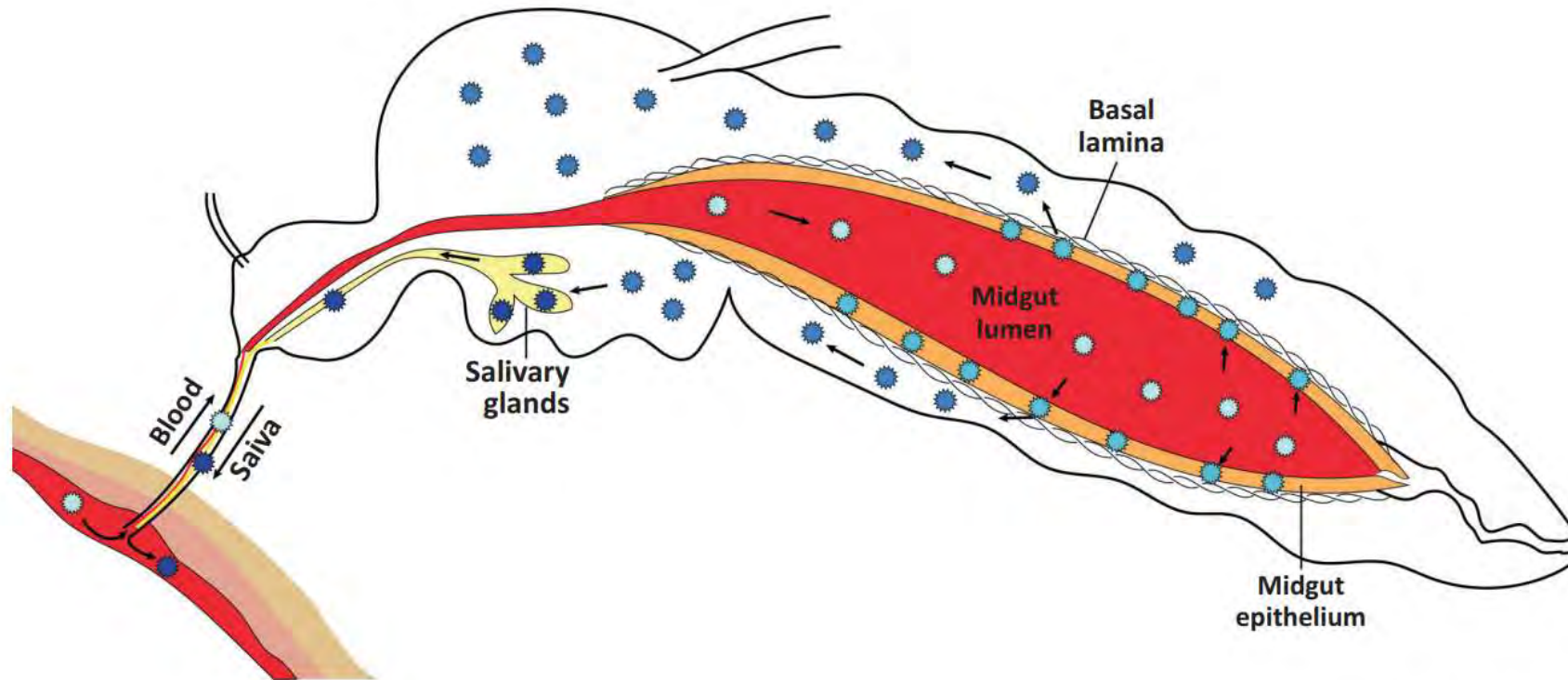


West Nile virus



Plasmodium falciparum

How does it work?



Trends in Parasitology



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How does it work?



Mosquito Proboscis



Tick Hypostome



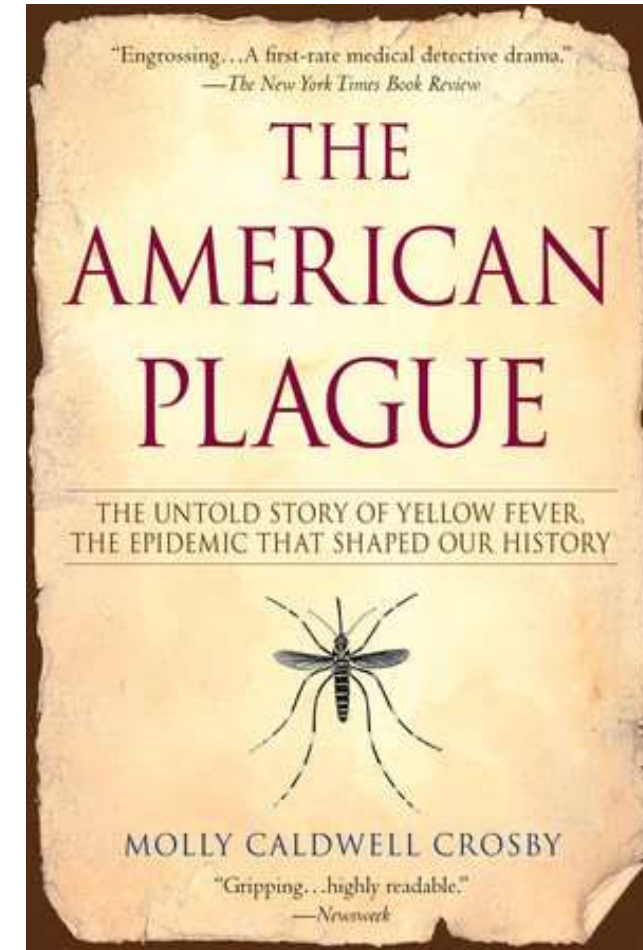
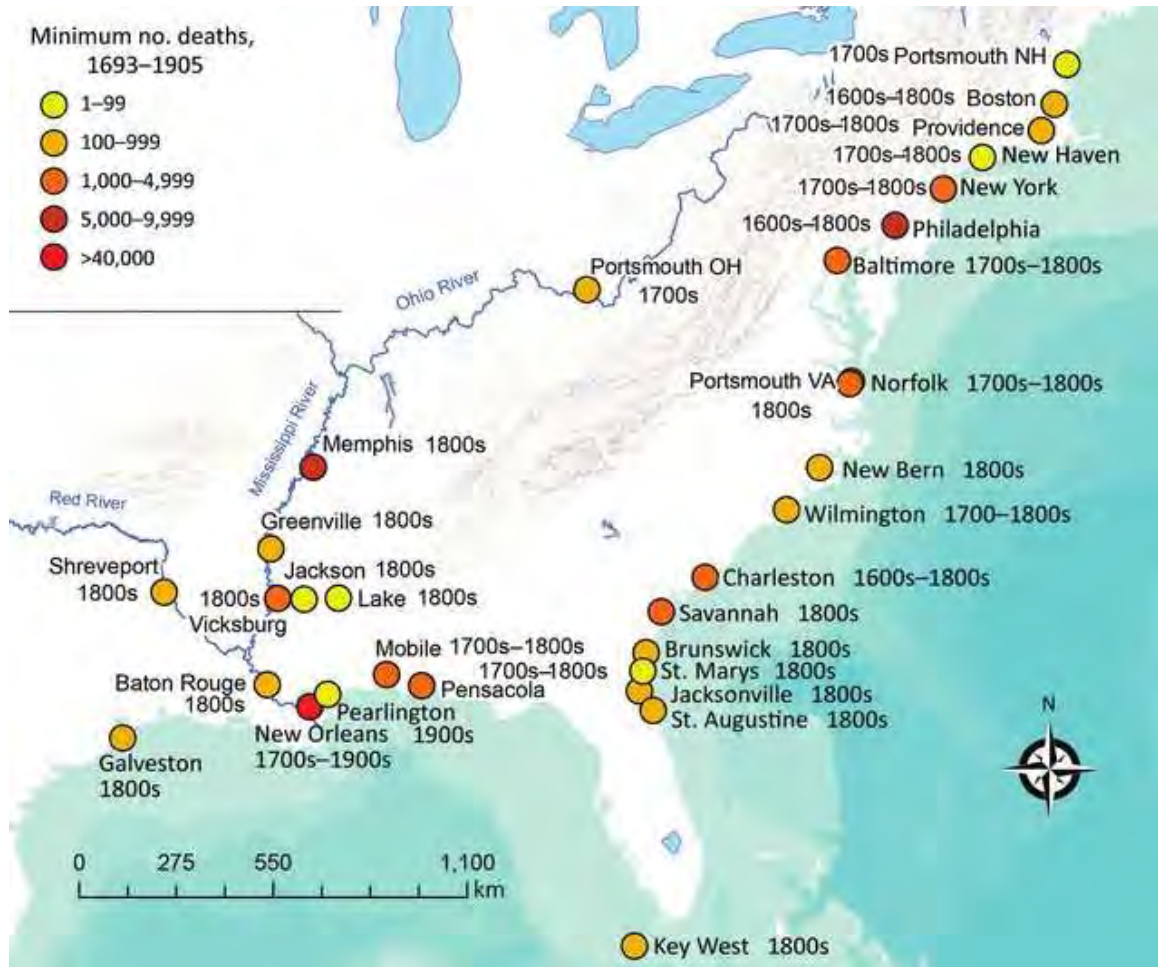
History of Vector-Borne Diseases

- Lymphatic filariasis was the first “identified” vector-borne disease by Patrick Manson in 1870s
- Malaria soon followed suit, with a number of folks involved, but most credit goes to Ronald Ross in 1897
- Yellow fever was the first virus to be discovered as transmitted by mosquitoes in the early 1900s (before viruses were identified!). Most of the credit, correct or not, goes to Walter Reed.

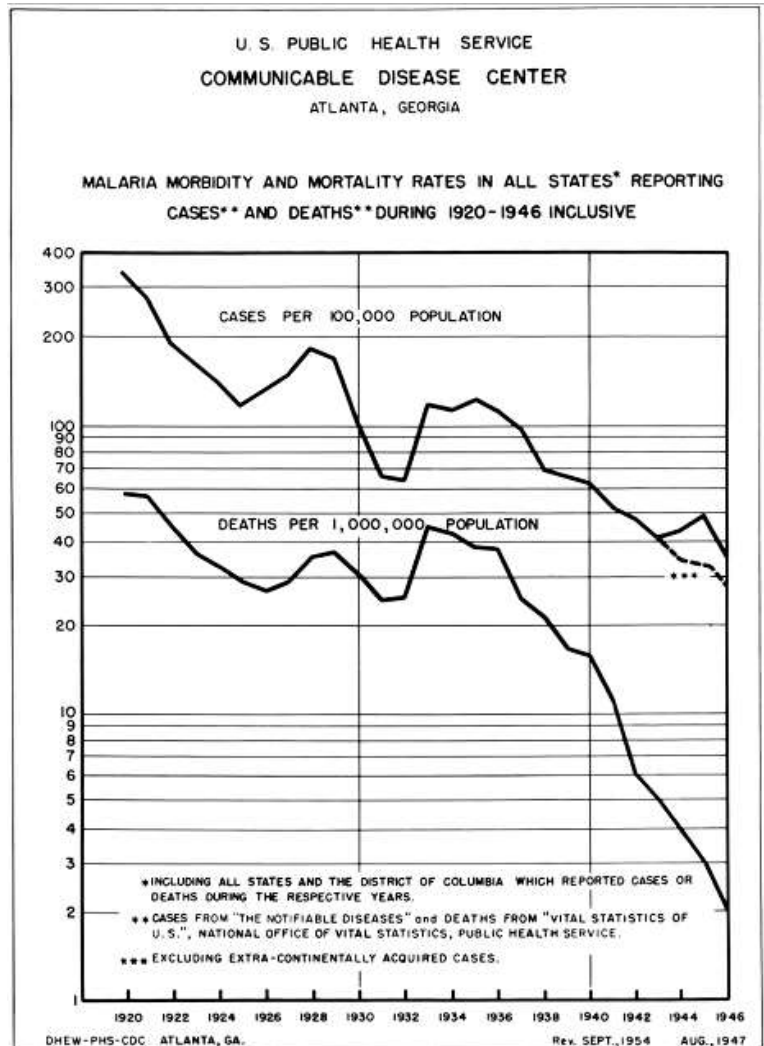
Dr. Carlos Finlay



VBDs have played an outsized roll in shaping US



VBDs have played an outsized roll in shaping US



MALARIOUS AREA OF THE UNITED STATES
1862



MALARIOUS AREA OF THE UNITED STATES
1932



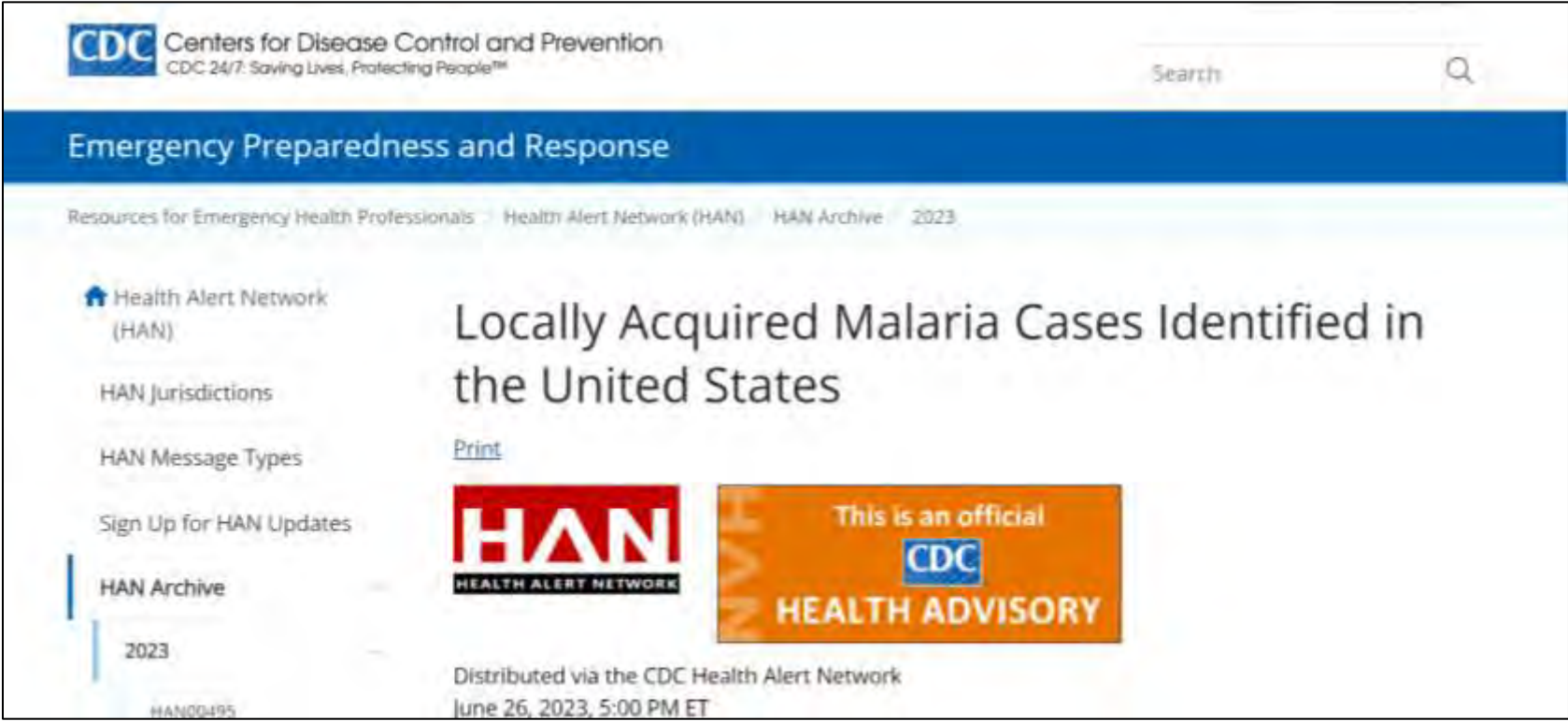
MALARIOUS AREA OF THE UNITED STATES
1942



MALARIOUS AREA OF THE UNITED STATES
1944-5



What's old is new again..



The screenshot shows the CDC Health Alert Network (HAN) interface. At the top, the CDC logo and name are visible, along with a search bar. Below this is a blue header for 'Emergency Preparedness and Response'. The main content area features the title 'Locally Acquired Malaria Cases Identified in the United States' and a 'Print' link. To the left is a sidebar with navigation links: 'Health Alert Network (HAN)', 'HAN Jurisdictions', 'HAN Message Types', 'Sign Up for HAN Updates', 'HAN Archive', and '2023'. Below the title, there is a red 'HAN' logo and an orange box stating 'This is an official CDC HEALTH ADVISORY'. At the bottom, it says 'Distributed via the CDC Health Alert Network' and 'June 26, 2023, 5:00 PM ET'.

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

Search

Emergency Preparedness and Response

Resources for Emergency Health Professionals > Health Alert Network (HAN) > HAN Archive > 2023

Health Alert Network (HAN)

HAN Jurisdictions

HAN Message Types

Sign Up for HAN Updates

HAN Archive

2023

HAN00495

Locally Acquired Malaria Cases Identified in the United States

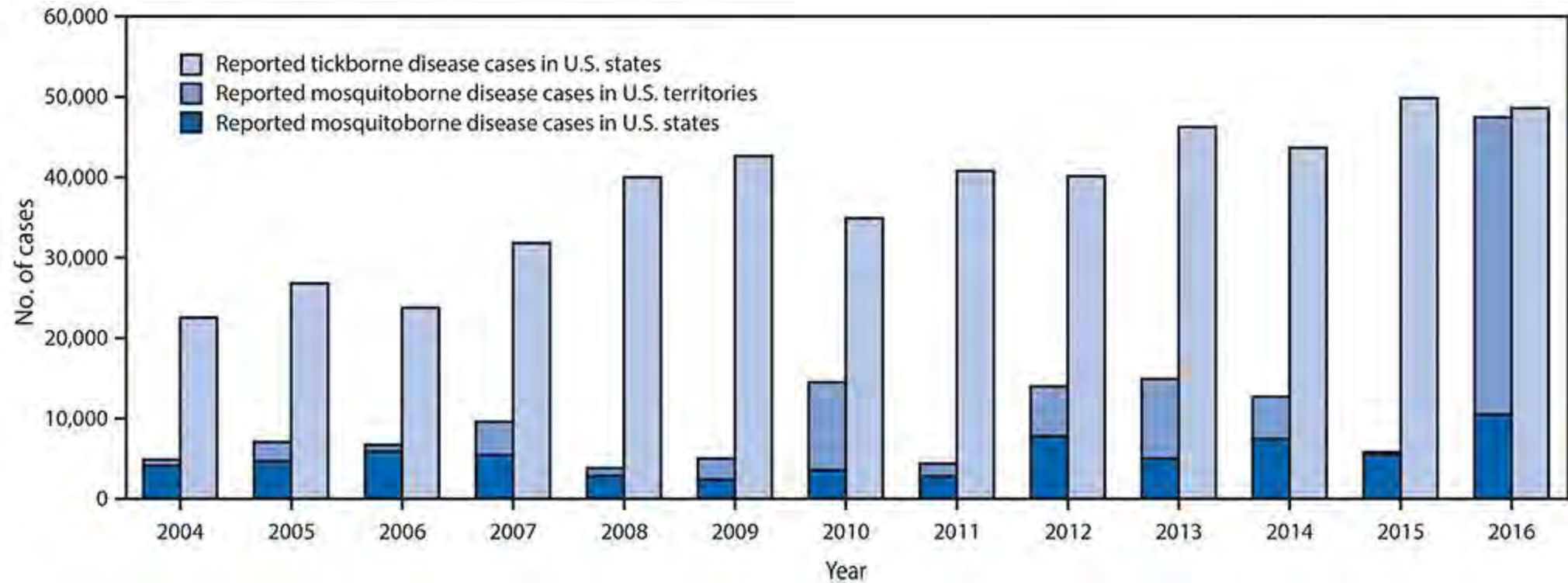
[Print](#)

HAN
HEALTH ALERT NETWORK

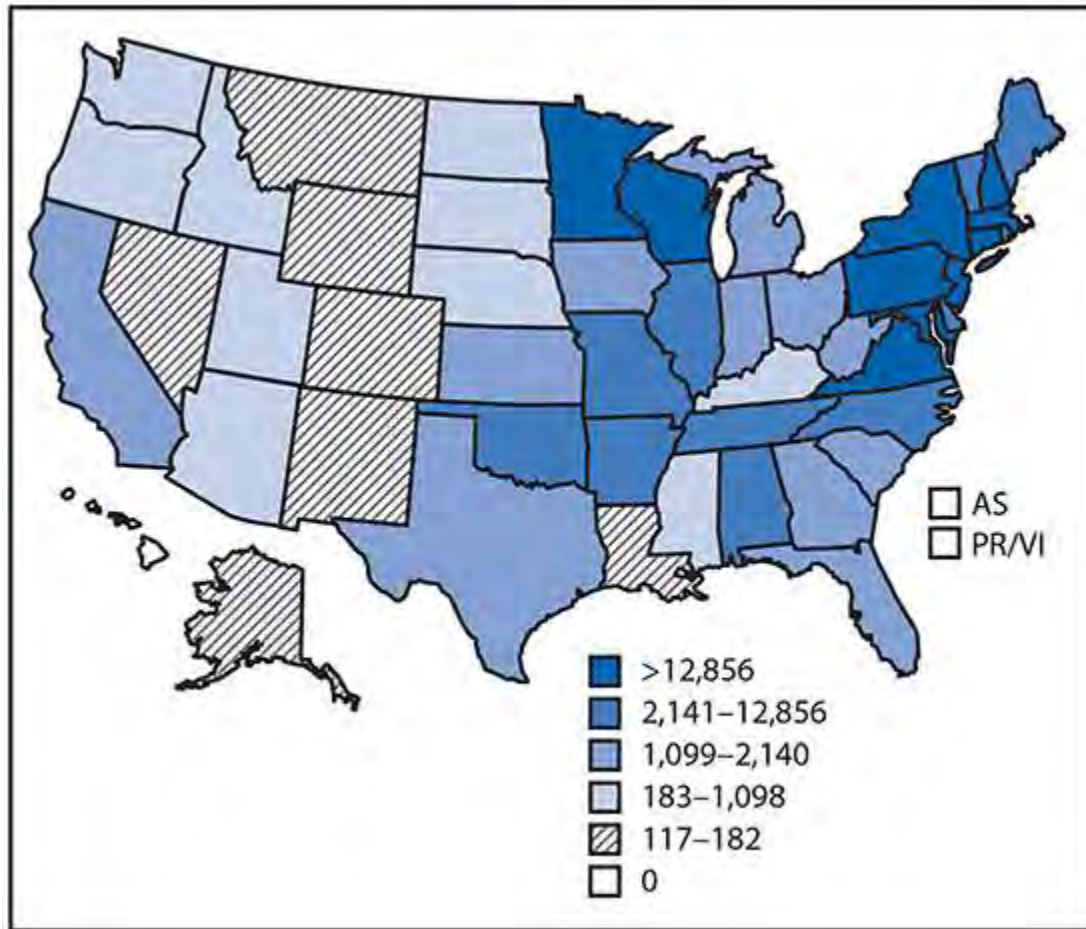
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HEALTH ADVISORY

Distributed via the CDC Health Alert Network
June 26, 2023, 5:00 PM ET

Different pathogens, same problems- VBD in US



Different pathogens, same problems- VBD in US



Tick-borne diseases US 2016

- Lyme disease (34,945)
- Anaplasmosis (5,655)
- Rickettsiosis (5,207)
- Babesiosis (2,420)
- Ehrlichiosis (2,093)

Risk Depends on the Vector- Tick-Borne Diseases US



Ixodes scapularis (Blacklegged tick, deer tick)



Risk Depends on the Vector- Tick-Borne Diseases US



Ixodes scapularis (Blacklegged tick, deer tick)



Risk Depends on the Vector- Tick-Borne Diseases US



Dermacentor variabilis (American dog tick)



Risk Depends on the Vector- Tick-Borne Diseases US



Dermacentor variabilis (American dog tick)



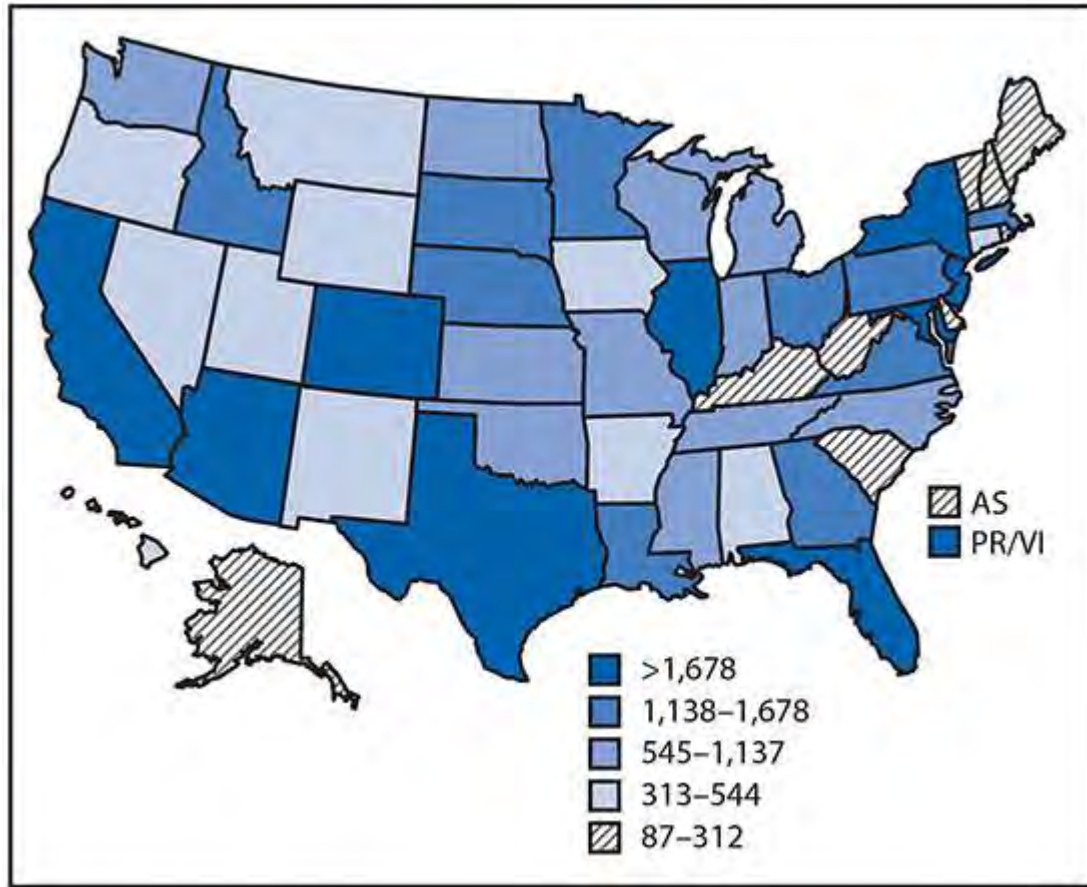
Spotted fever rickettsiosis
reported cases



Tularemia reported cases



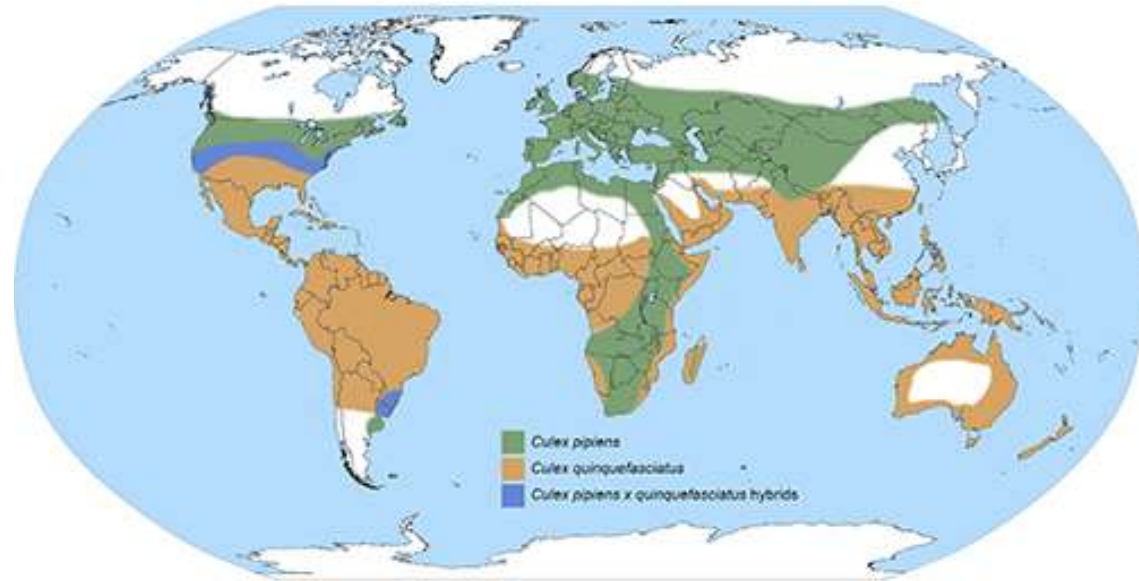
Different pathogens, same problems- VBD in US



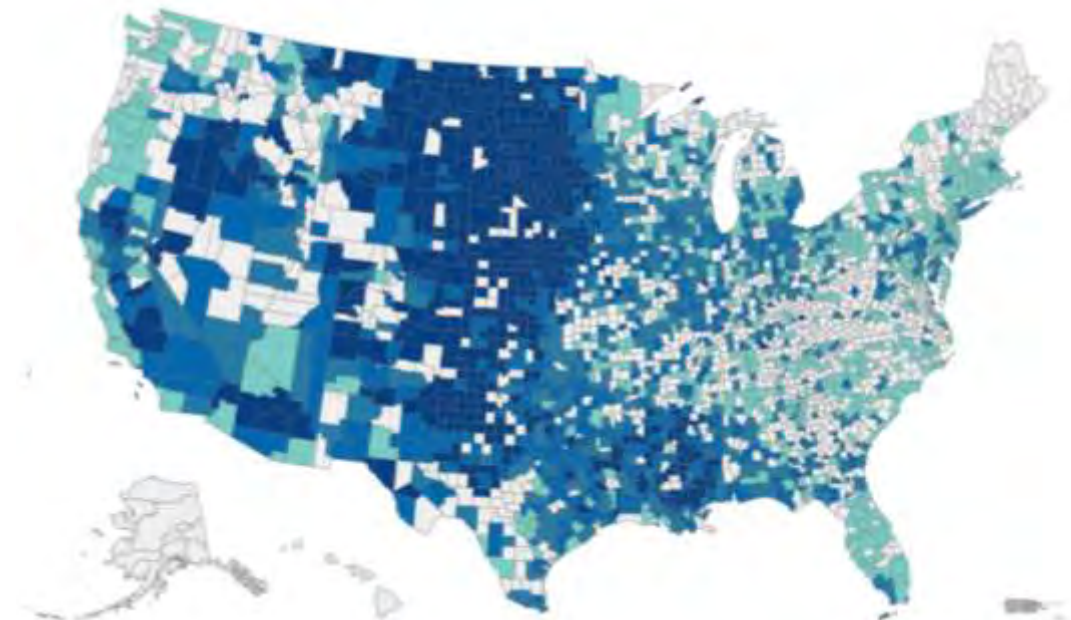
Mosquito-borne diseases US 2021

- West Nile virus (2,911)
- St. Louis encephalitis (17)
- Dengue virus (<100 locally acquired)
- Chikungunya virus (<100 locally acquired)
- Eastern equine encephalitis virus (5)

Risk Depends on the Vector- Mosquito -Borne Diseases US



Culex pipiens (House mosquito)



Incidence per 100,000 Population

0.01 to 0.16 0.17 to 0.37 0.38 to 1.09 >1.10

West Nile virus, 2021

Risk Depends on the Vector- Mosquito -Borne Diseases US

Estimated Potential Range of *Aedes aegypti* in the United States, 2017



Aedes aegypti (Yellow fever mosquito)

Estimated Potential Range of *Aedes albopictus* in the United States, 2017



Aedes albopictus (Asian tiger mosquito)



Risk Depends on the Vector- Mosquito -Borne Diseases US

Estimated Potential Range of *Aedes aegypti* in the United States, 2017

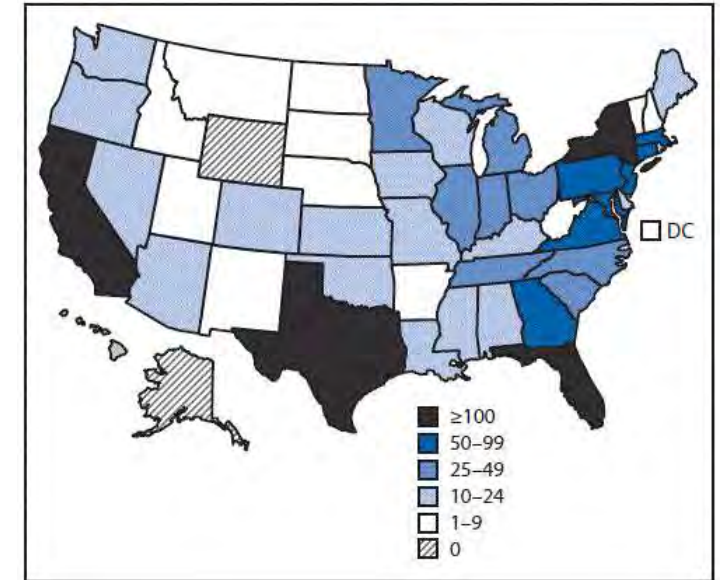


Aedes aegypti (Yellow fever mosquito)

Estimated Potential Range of *Aedes albopictus* in the United States, 2017



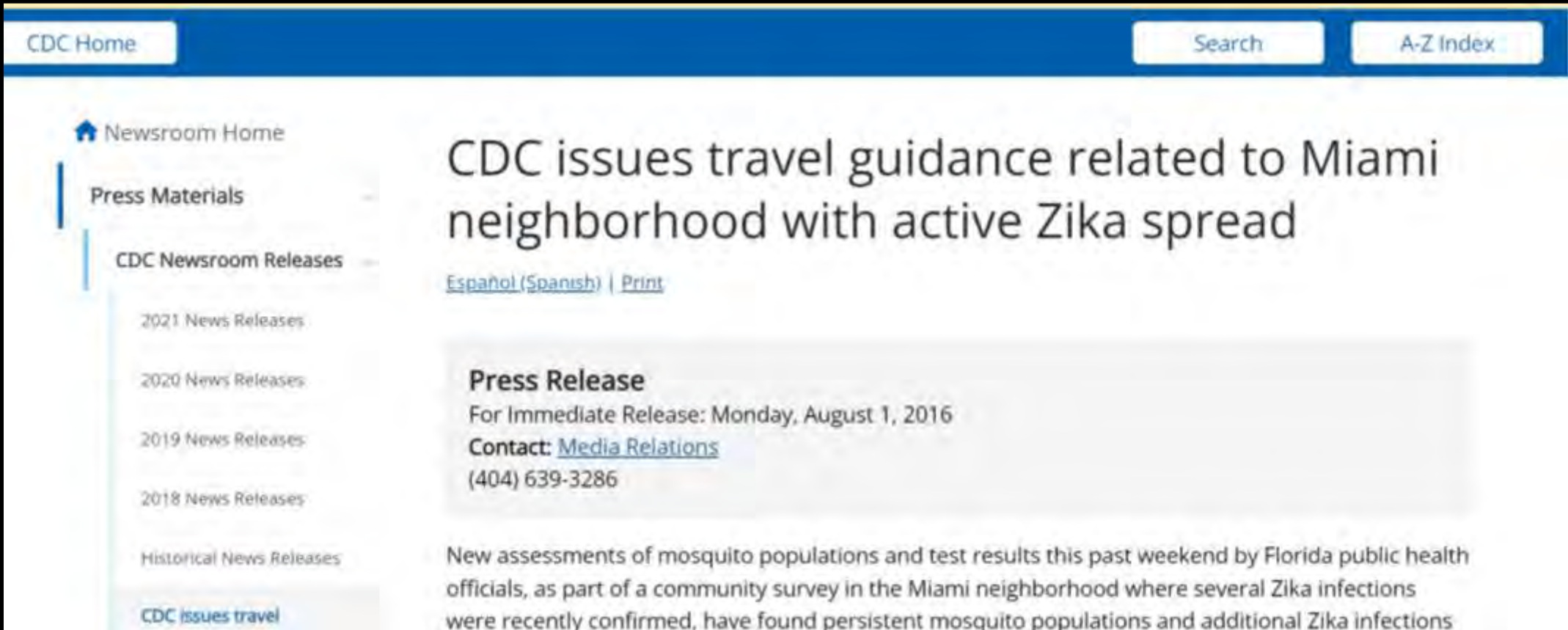
Aedes albopictus (Asian tiger mosquito)



Zika Cases, US 2016-2017

Florida reported >200 locally acquired cases

Risk Depends on the Vector- Mosquito -Borne Diseases US



The screenshot shows the CDC Newsroom Home page. The main headline is "CDC issues travel guidance related to Miami neighborhood with active Zika spread". Below the headline are links for "Español (Spanish)" and "Print". The press release is dated "Monday, August 1, 2016" and the contact is "Media Relations" at "(404) 639-3286". The text of the press release begins with "New assessments of mosquito populations and test results this past weekend by Florida public health officials, as part of a community survey in the Miami neighborhood where several Zika infections were recently confirmed, have found persistent mosquito populations and additional Zika infections". On the left sidebar, there is a "Press Materials" section with a link to "CDC issues travel". On the far left, there is a small legend titled "Mosquito live and n" with four colored squares: light green, light blue, medium blue, and dark blue. On the far right, there is a small map of the United States with a box labeled "DC".

Estim CDC Home Search A-Z Index

Newsroom Home

Press Materials

CDC Newsroom Releases

2021 News Releases

2020 News Releases

2019 News Releases

2018 News Releases

Historical News Releases

CDC issues travel

CDC issues travel guidance related to Miami neighborhood with active Zika spread

[Español \(Spanish\)](#) | [Print](#)

Press Release

For Immediate Release: Monday, August 1, 2016

Contact: [Media Relations](#)
(404) 639-3286

New assessments of mosquito populations and test results this past weekend by Florida public health officials, as part of a community survey in the Miami neighborhood where several Zika infections were recently confirmed, have found persistent mosquito populations and additional Zika infections

Mosquito live and n

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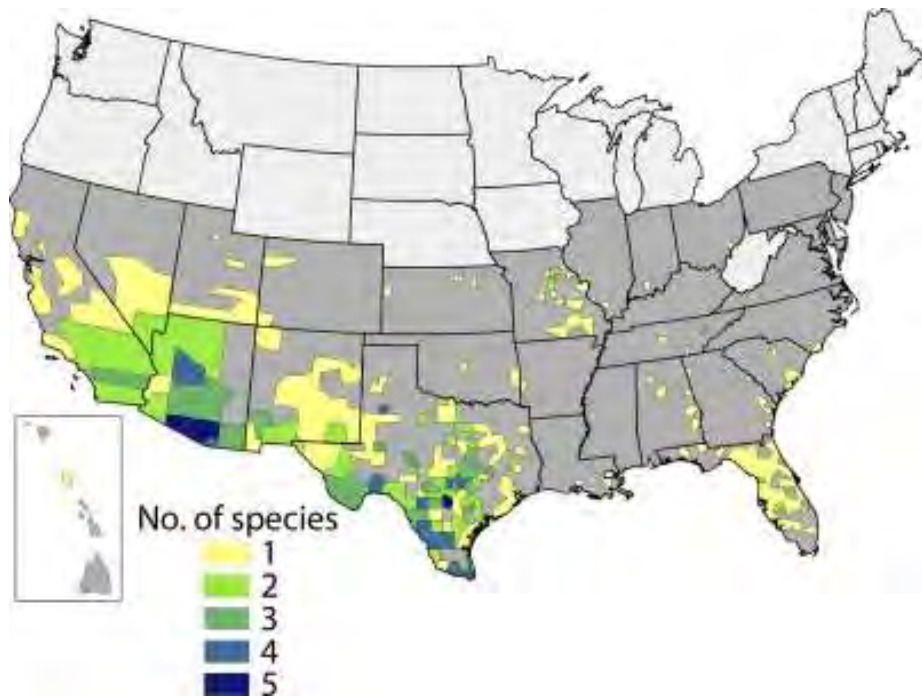
DC

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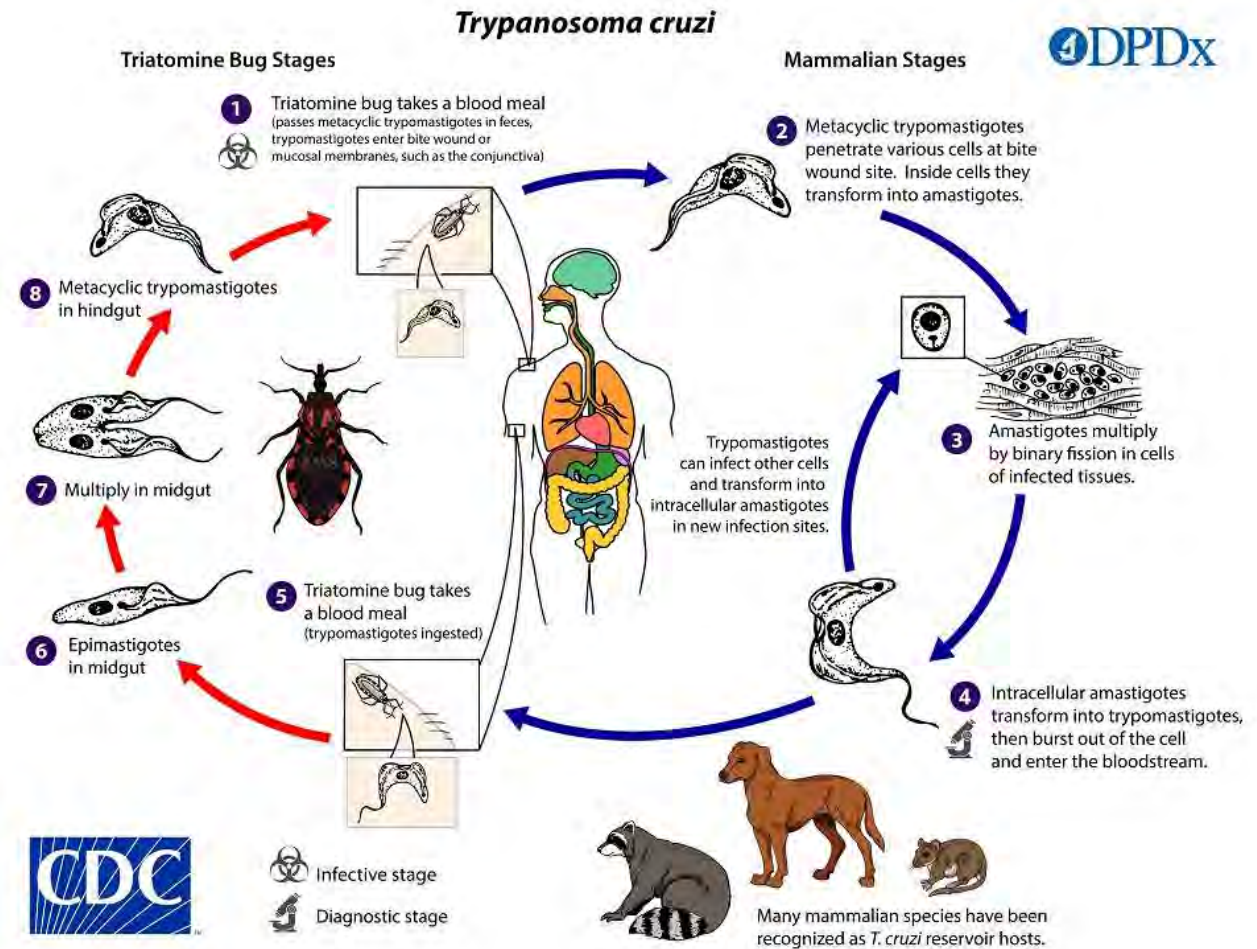
Aedes aegypti (Yellow fever mosquito)

Aedes albopictus (Asian tiger mosquito)

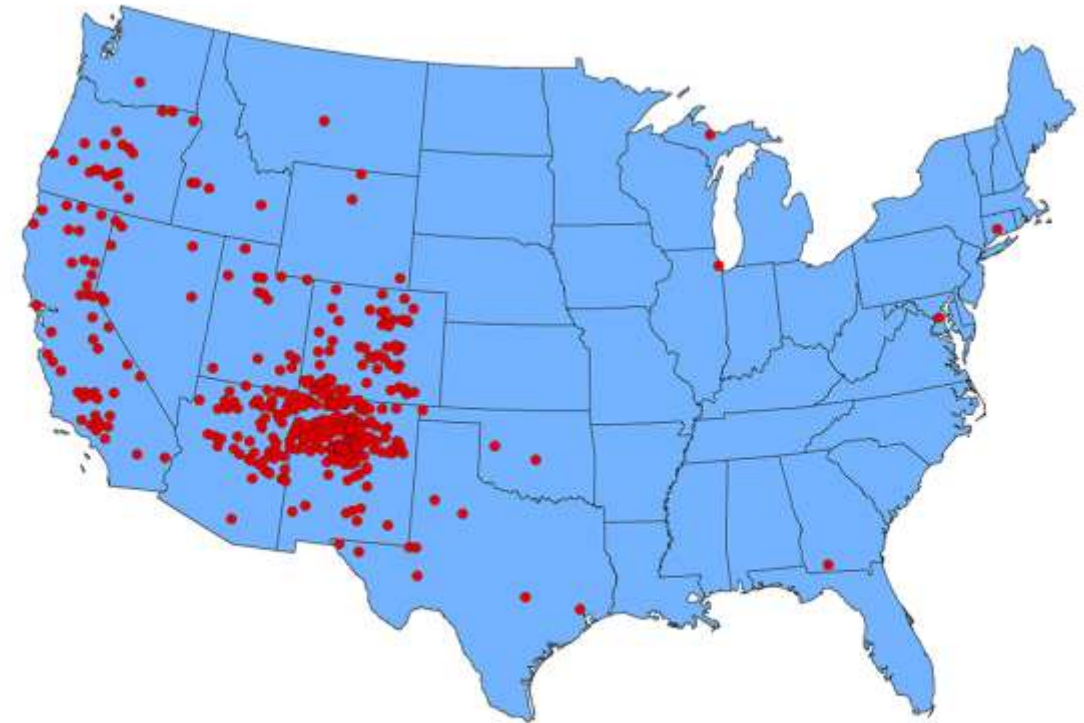
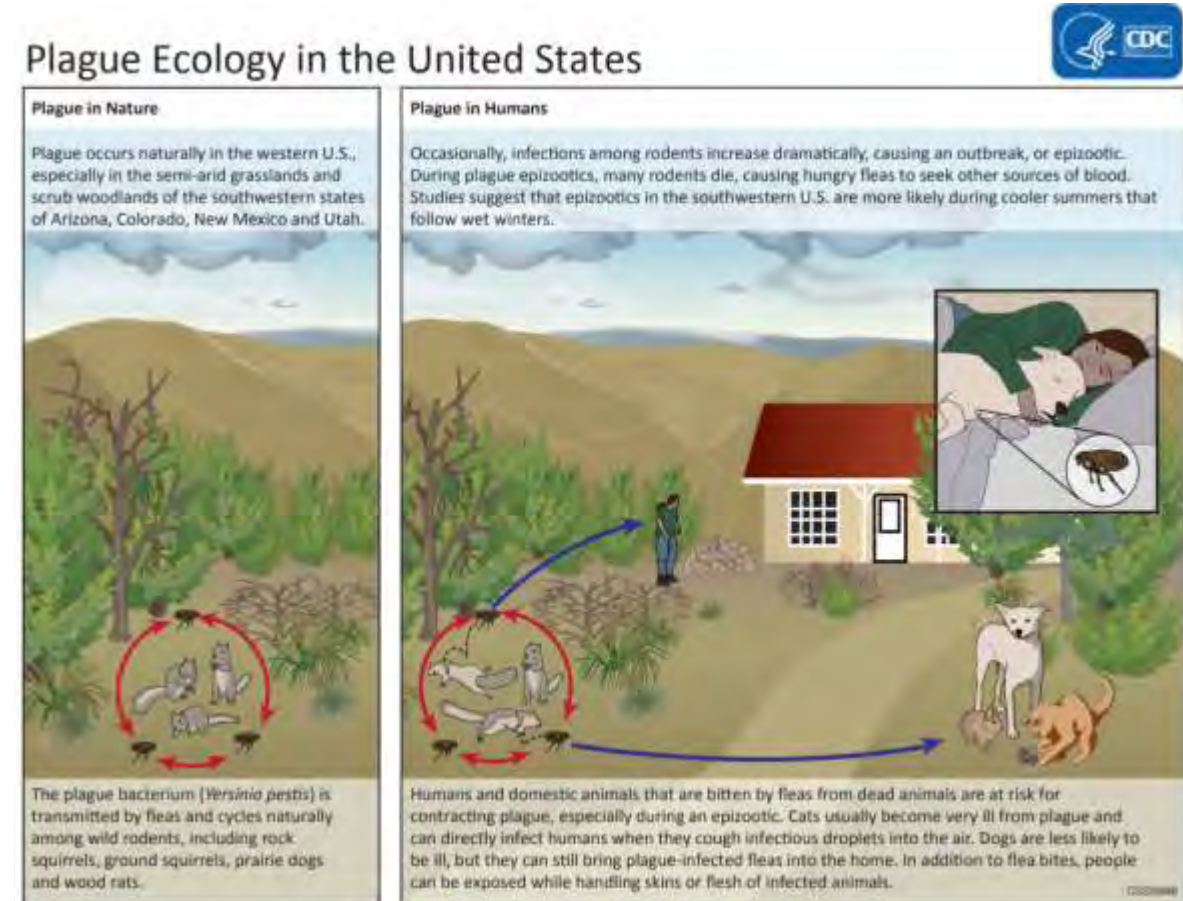
A few other VBDs



Triatominae (Kissing Bug)



A few other VBDs



1 dot placed in state of residence for each reported plague case



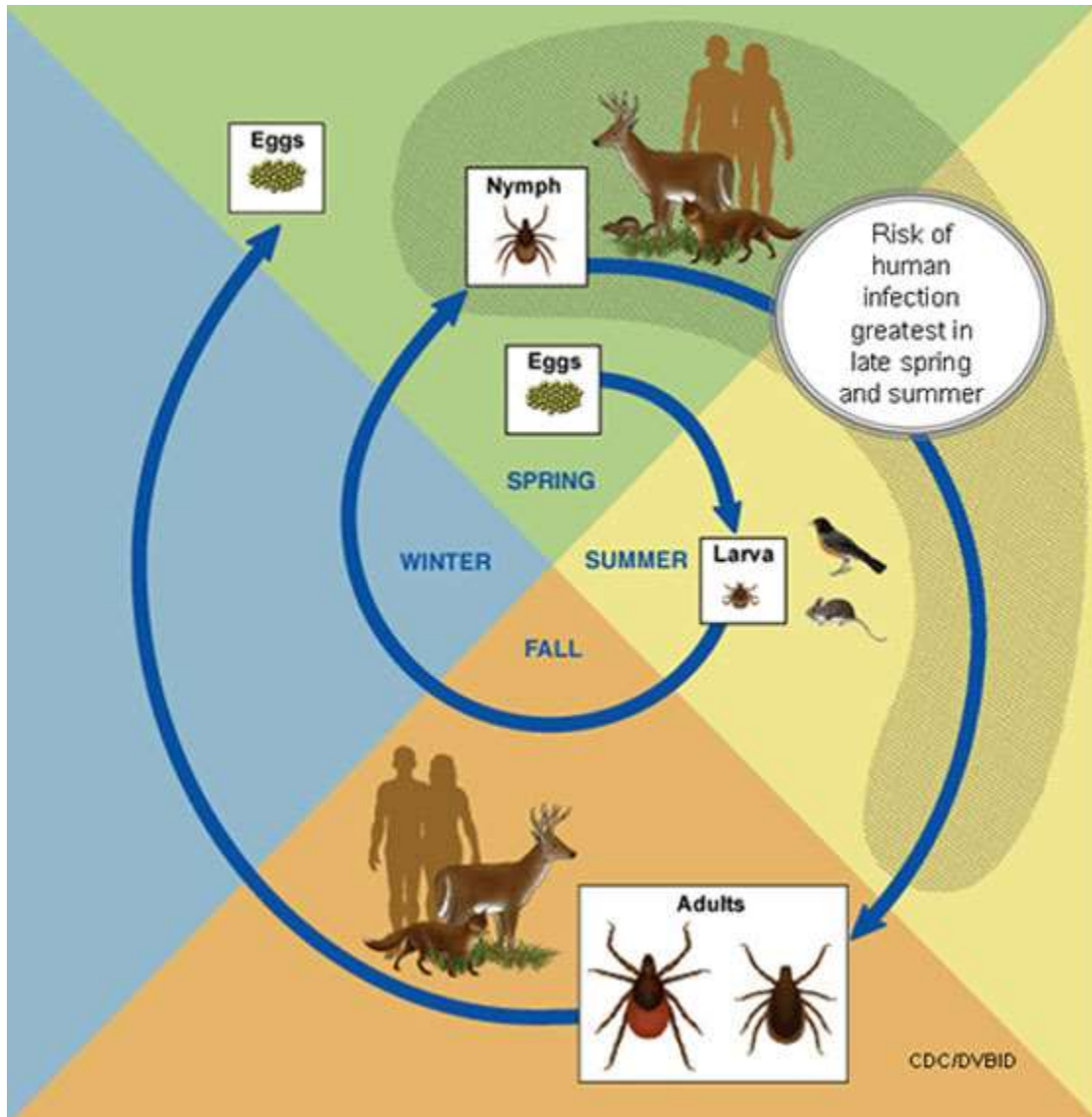
Triatominae (Kissing Bug)



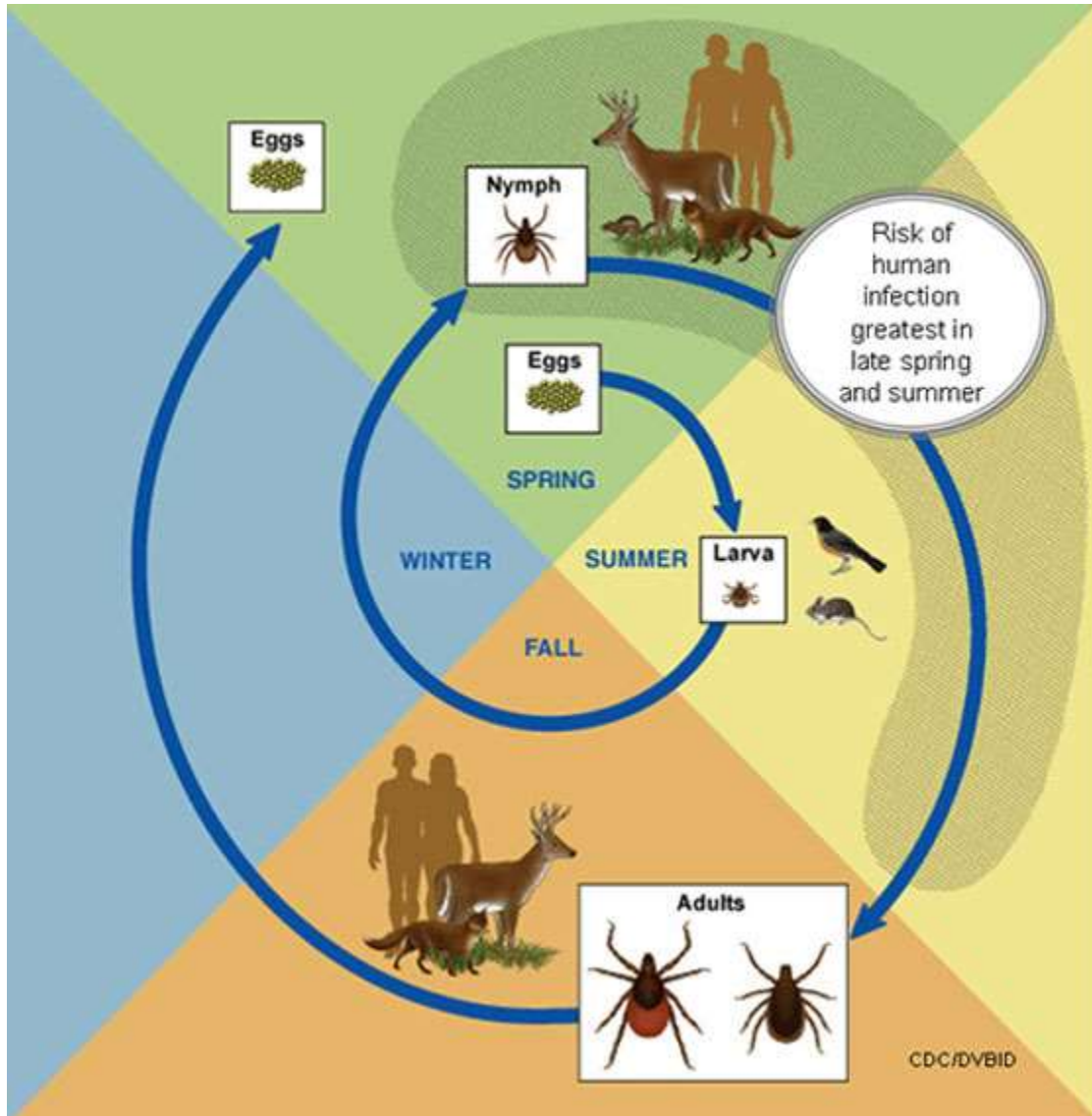
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Understanding Lyme Disease Risk

Understanding Lyme Disease Risk



Understanding Lyme Disease Risk



Blacklegged Tick (*Ixodes scapularis*)



Ticks can be the size of a poppy seed. Can you spot all 5 ticks in this photo? Learn how to prevent tick bites. bit.ly/2rjox6U



3:30 PM · May 4, 2018

Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

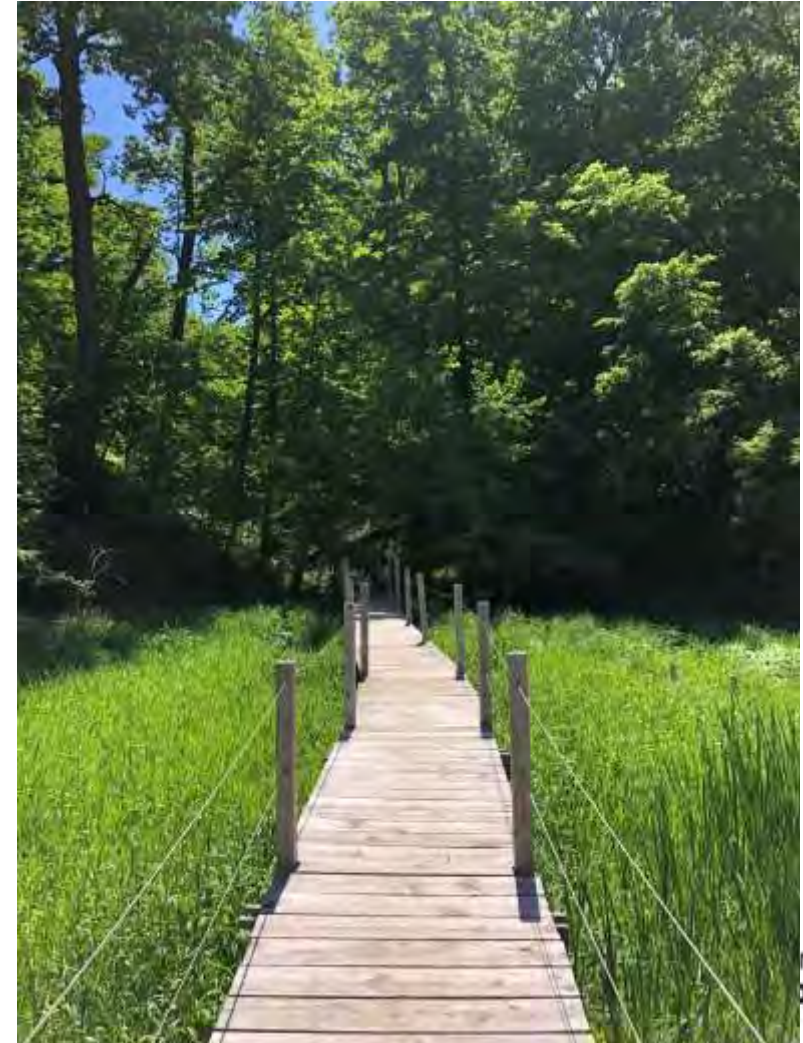
-Long pants with socks tucked in



Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

- Long pants with socks tucked in
- Avoid “ticky” habitats



Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective transmission.

- Long pants with socks tucked in
- Avoid “ticky habitats”
- Permethrin treated clothing/DEET based repellent

TREAT CLOTHING WITH PERMETHRIN



Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

- Long pants with socks tucked in
- Avoid “ticky habitats”
- Permethrin treated clothing/DEET based repellant
- Conduct tick checks

Host infection rate and tick attachment time				Number of infected animals/total animals (%)						
Study	Tick species	Host	Borrelia species	<16 hrs	<24 hrs	<36 hrs	<42 hrs	<48 hrs	<72 hrs	<96 hrs
Piesman et al ²⁵	<i>I. dammini</i> (now <i>I. scapularis</i>)	Golden Syrian hamsters, white footed mice	Bb JDI		1/14(7%)			5/14(33%)	13/14(93%)	
Piesman ³⁵	<i>I. dammini</i> (now <i>I. scapularis</i>)	Male ICR outbred mice	Bb JDI			1/14(7%)	3/12(25%)	6/8 (75%)		
Shih and Spielman ³⁶	<i>I. dammini</i> (now <i>I. scapularis</i>)	CDI mice	Bb JDI	0/8 (0%)	0/9 (0%)	1/7 (14%)		10/10 (100%)		

Tick Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

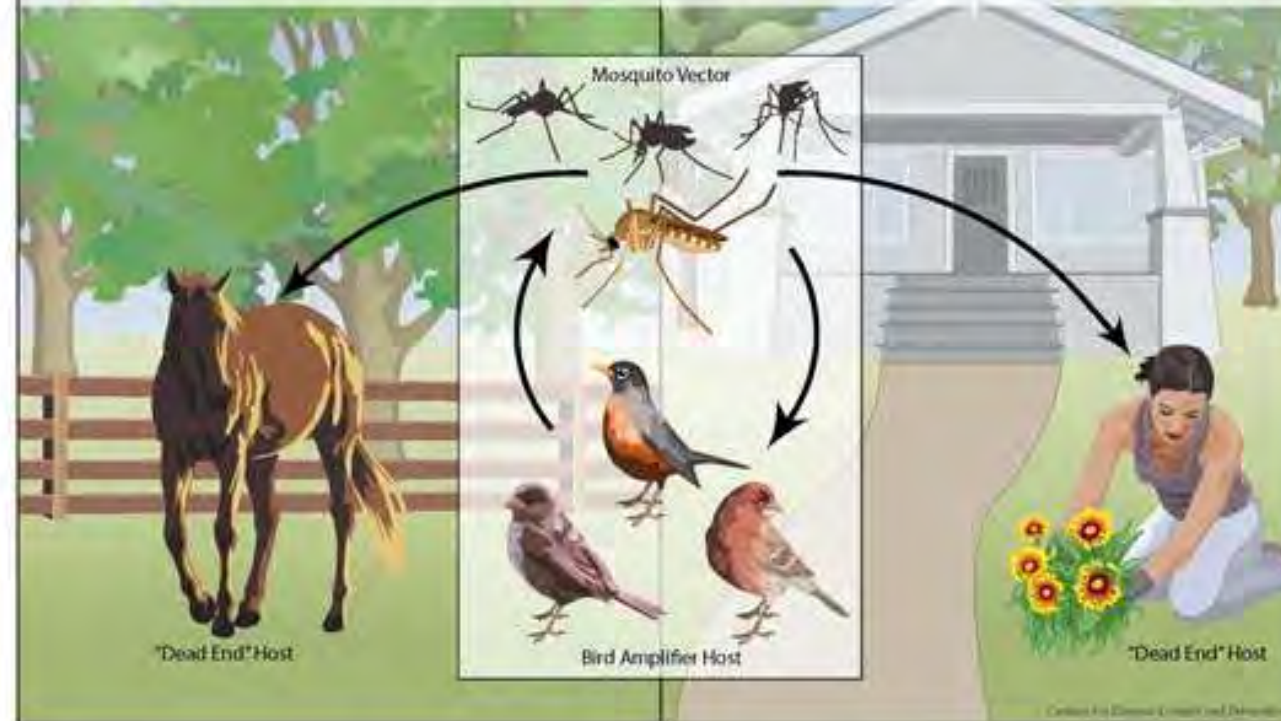
- Long pants with socks tucked in
- Avoid “ticky habitats”
- Permethrin treated clothing/DEET based repellant
- Conduct tick checks
- Communicate to the public the risk of tick-borne diseases!

Understanding West Nile Virus Risk

West Nile Virus Transmission Cycle

In nature, West Nile virus cycles between mosquitoes (especially *Culex* species) and birds. Some infected birds, can develop high levels of the virus in their bloodstream and mosquitoes can become infected by biting these infected birds. After about a week, infected mosquitoes can pass the virus to more birds when they bite.

Mosquitoes with West Nile virus also bite and infect people, horses and other mammals. However, humans, horses and other mammals are 'dead end' hosts. This means that they do not develop high levels of virus in their bloodstream, and cannot pass the virus on to other biting mosquitoes.



Mosquito Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

Mosquito Bite Prevention

As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

-Personal protection



Mosquito Bite Prevention

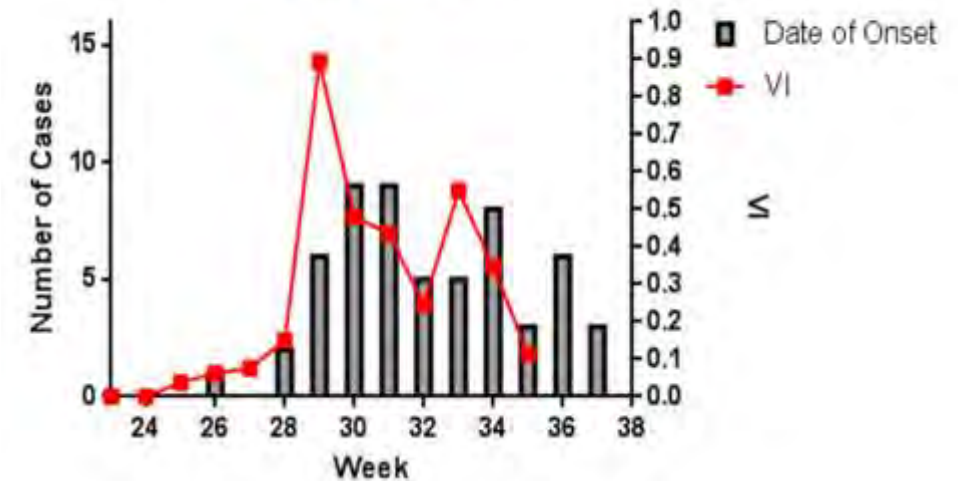
As with all VBDs, prevention of vector bites is the most effective way to prevent transmission.

- Personal protection
- Mosquito abatement



$$VI = \sum \bar{N}_i \hat{P}_i$$

Human Cases 2007



Summary

- Vector-borne diseases are common throughout the world
- Historically, they have been hugely problematic in the US
- The incidence of VBDs is increasing in the US
- Mosquitoes and ticks are the primary vectors of concern in the US
- Preventing vector bites remains the best way to combat VBDs around the world

Questions?

Get in touch: jfauver@unmc.edu