The Arboviruses Next Door: Orphaned and Emerging Arboviruses of the US

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APHL annual meeting

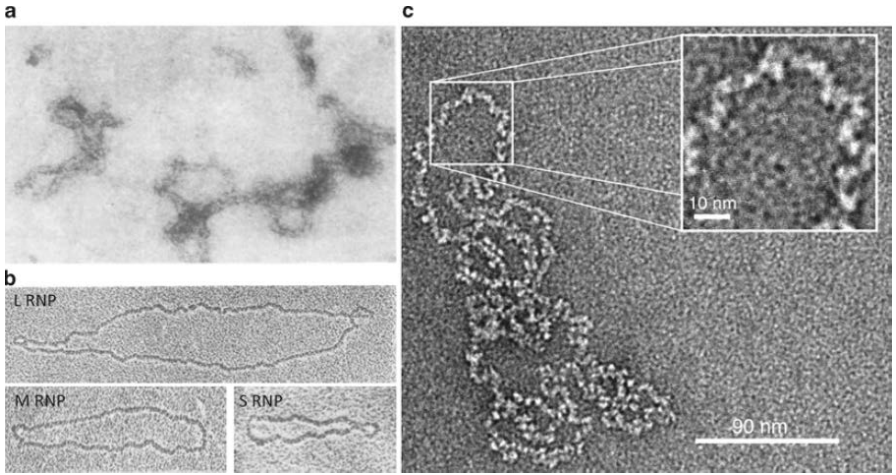
June 3, 2018

Orphaned arboviruses

Orphan ≠ neglected

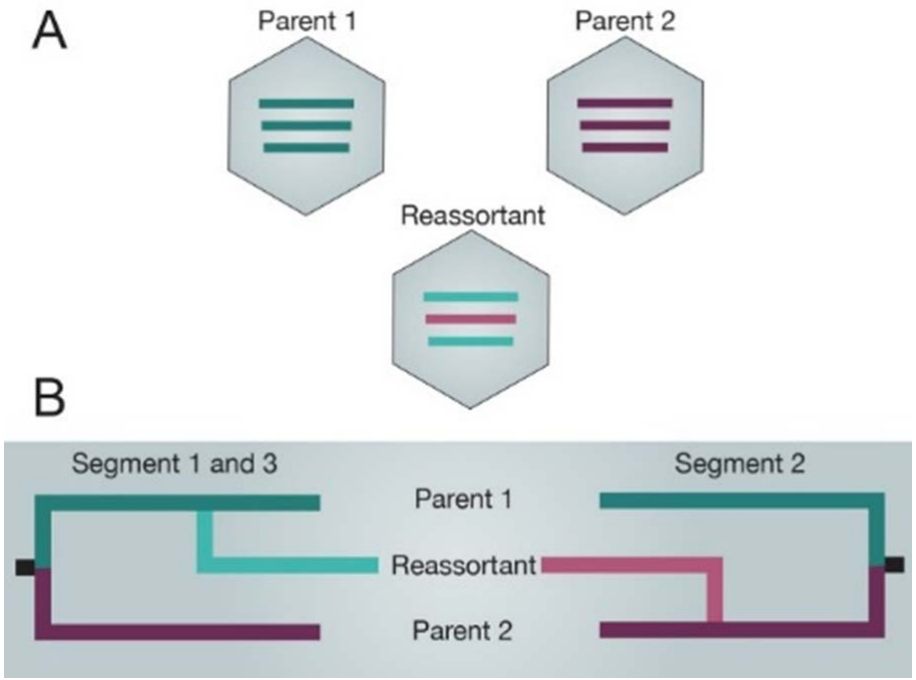
Orthobunyavirus (Order *Bunyavirales,* Family *Peribunyaviridae)*

- Negative sense, single-stranded, segmented, RNA genome
  - Large (L) : RNA-dependent RNA polymerase
  - Medium (M) : structural polyprotein Gn-NSm-Gc
  - Small (S): nucleocapsid and NSs
- 20 serogroups
  - California (US/North America)
  - Bunyamwera (US/North America, South America, Africa)



Guu et al. Bunyavirus: structure and replication. In Advances in Experimental Medicine and Biology. 2012

Segment reassortment (rapid evolution)



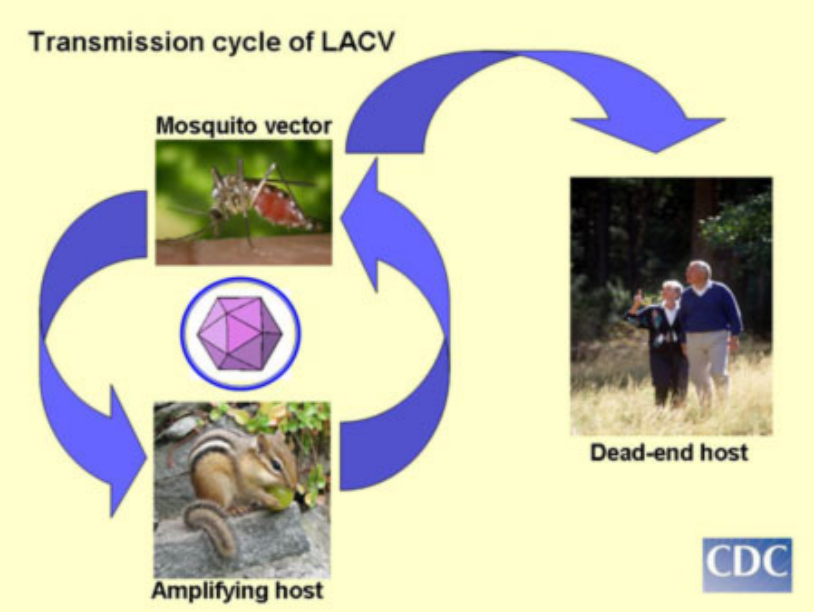
Vijaykrishna, D et al. PLoS Pathog. 2015 Jul; 11(7): e1004902

- **Superinfection of closely related viruses**
  - Mosquitoes
- **Increased pathogenesis**
  - Ngari (Garissa) virus
  - Schmallenberg virus
- **Vector/host expansion**
- **New ecological niches**
- **Prevalent in bunyaviruses**

California serogroup

- Endemic viruses of public health importance
  - La Crosse virus – pediatric encephalitis
  - Jamestown canyon virus
  - Snowshoe hare virus
  - California encephalitis virus
- Human infection
  - Encephalitis
  - Febrile illness
  - Asymptomatic
- Mosquito borne
  - “strict” vector and small mammalian vertebrate host preferences
- Widely distributed

La Crosse virus

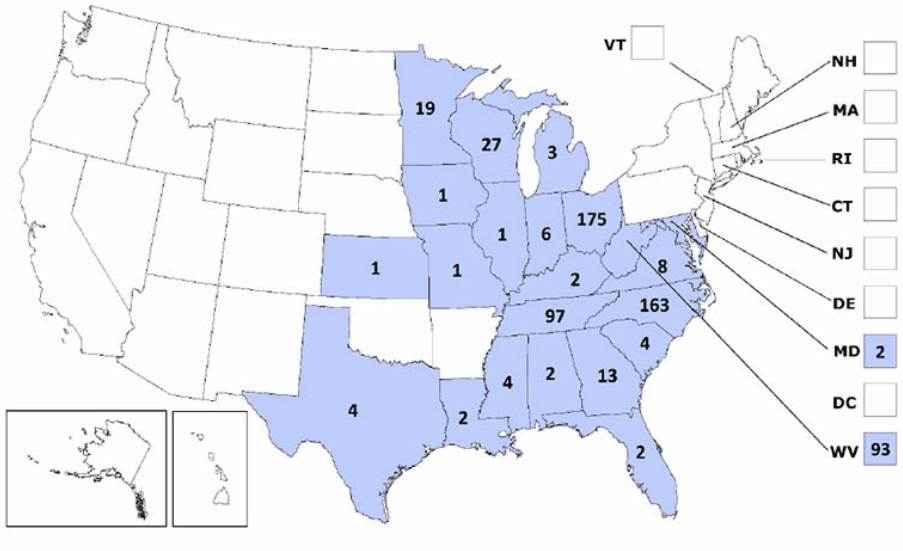


- ***Aedes triseriatus*** **(treehole mosquito)**
  - Aggressive daytime-biting
- **Vertebrate hosts**
  - Chipmunks and squirrels
- **Human infection**
  - Fever (low viremia), headache, nausea
  - Severe neuroinvasive disease

La Crosse virus

- **Changing distribution**
  - Historically upper Midwest, now central Atlantic
  - Widespread Midwest – Southeast
- **Clinical Lab Diagnosis**
  - Difficult to culture and identify with molecular methods
  - Serological diagnosis remains primary method

La Crosse disease 2007-2016 (ArboNet)
(~70 per year)



La Crosse virus

- **Changing distribution**

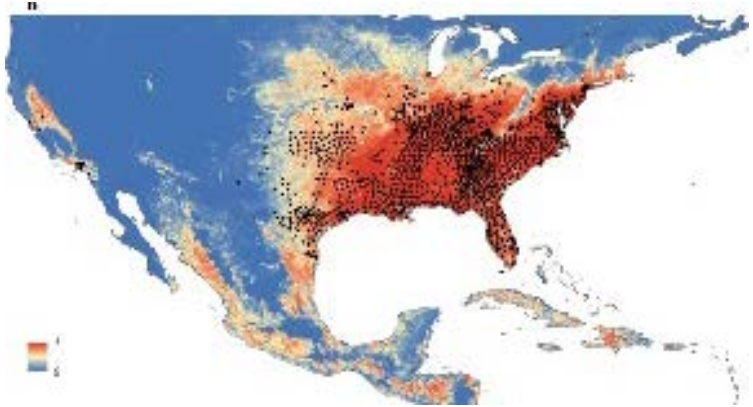
DISPATCHES

La Crosse Virus in *Aedes albopictus* Mosquitoes, Texas, USA, 2009

Amy J. Lambert, Carol D. Blair, Mary D'Anton, Winnann Ewing, Michelle Harborth, Robyn Seiferth, Jeannie Xiang, and Robert S. Lanciotti

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 16, No. 5, May 2010

Predicted occurrence of Ae. albopictus



Kraemer et.al. eLIFE 2015: 4; e08347

Jamestown Canyon virus

- **California serogroup**
- ***Aedes* and *Ochlerotatus***
  - 26 species of mosquito
  - 3 tabanid (horse) flies
- **Vertebrate host**
  - White-tailed deer (likely)
  - Wild ungulates and domestic livestock
- **Human infection**
  - Febrile, headache, nausea, photophobia
  - Respiratory symptoms
    - Not often reported
  - Meningitis and encephalitis
- **Predominantly in adults**

Jamestown Canyon virus

Jamestown Canyon 2000-2013 (31 cases)
Pastula et al. Am. J. Trop. Med. Hyg., 93(2), 2015, pp. 384–389

11 cases (2015), 15 (2016)

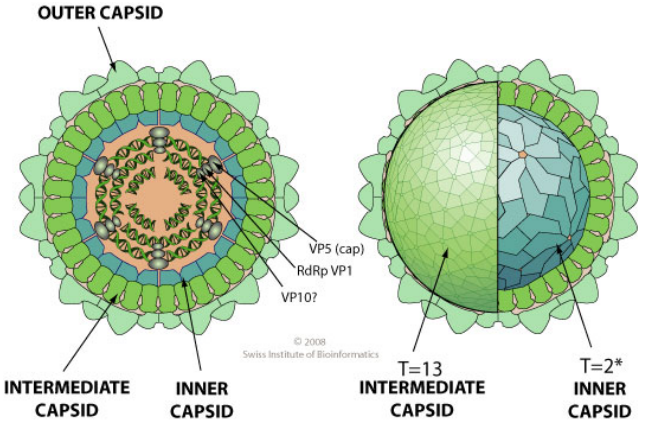
- **Widely distributed**
  - US and Canada
  - Likely under-reported
    - 15 reported in 2016
- **Clinical Lab diagnosis**
  - No human isolations to date
    - RT-PCR of S segment
  - Serological diagnosis primary method
    - Persistent IgM possible

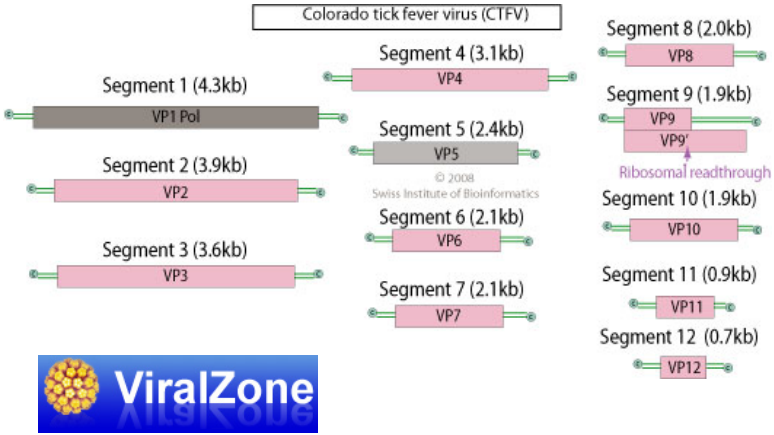
Cache Valley virus

- **Bunyamwera serogroup**
- ***Anopheles***
  - >30 mosquito species
- **Vertebrate host**
  - White-tailed deer
- **Widely distributed**
  - North and Central America
- **Livestock disease**
  - Abortion and still birth
- **Human infection**
  - Neuroinvasive encephalitis
  - 5 human cases identified in US (2015 most recent)
  - 18% seropositive in Yucatan
    - Febrile illness
- **Clinical Lab diagnosis**
  - PRNT primary method
  - Virus isolated from CSF and serum
    - Real-time RT-PCR

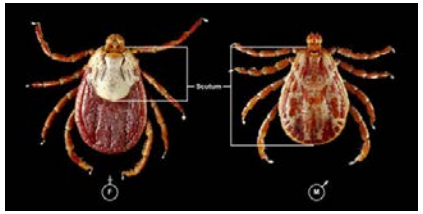
Colorado tick fever (CTF)

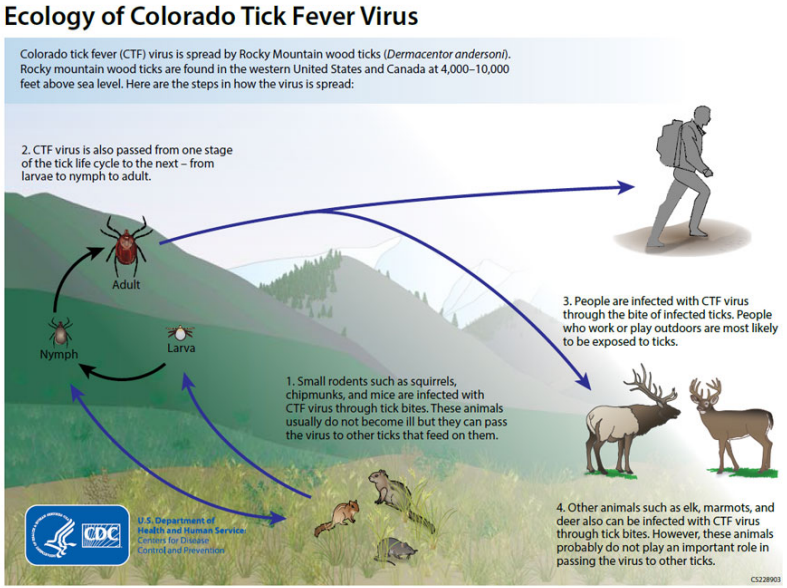
- *Reoviridae*, genus *Coltivirus*
- Non-enveloped virion
- 12 segments
- Double-stranded RNA
- Tropism for hematopoietic stem cells
  - Mature erythrocytes
- Virus found in RBCs ~ 6 weeks after symptom onset





Colorado tick fever (CTF)



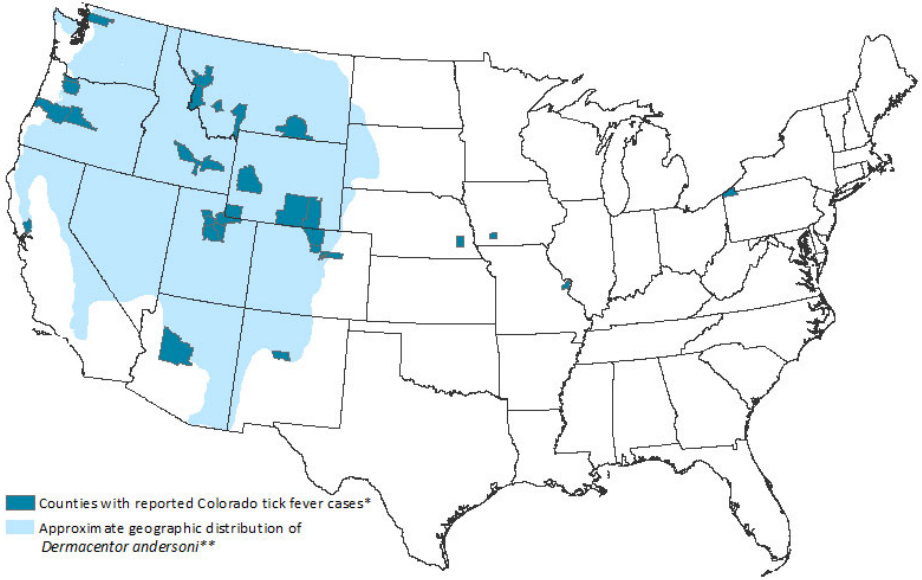


- ***Dermacentor andersoni*** **(Rocky Mountain wood tick)**
- **Vertebrate hosts**
  - Chipmunks, squirrels, and mice
- **Human infection**
  - Febrile, head and body aches
  - Biphasic fever
  - Leukopenia
  - Rarely neuroinvasive

Colorado tick fever (CTF)

- **Distributed widely in Western States (4,000-10,000 feet)**
- **Clinical lab diagnosis**
  - Real-time RT-PCR
    - Sensitive <21 dpo
    - RNA detected up to 42 dpo
  - Delayed antibody response
    - PRNT
    - >15 dpo

Distribution of D. andersoni and CTF cases 2002-2012 (83)

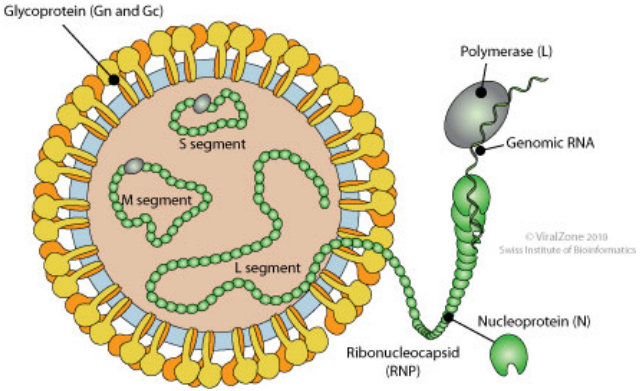


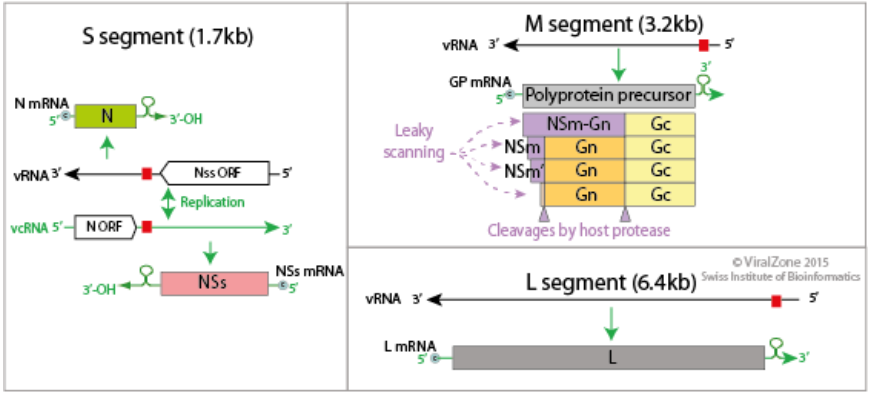
www.cdc.gov/coloradotickfever

Emerging arboviruses

Heartland virus

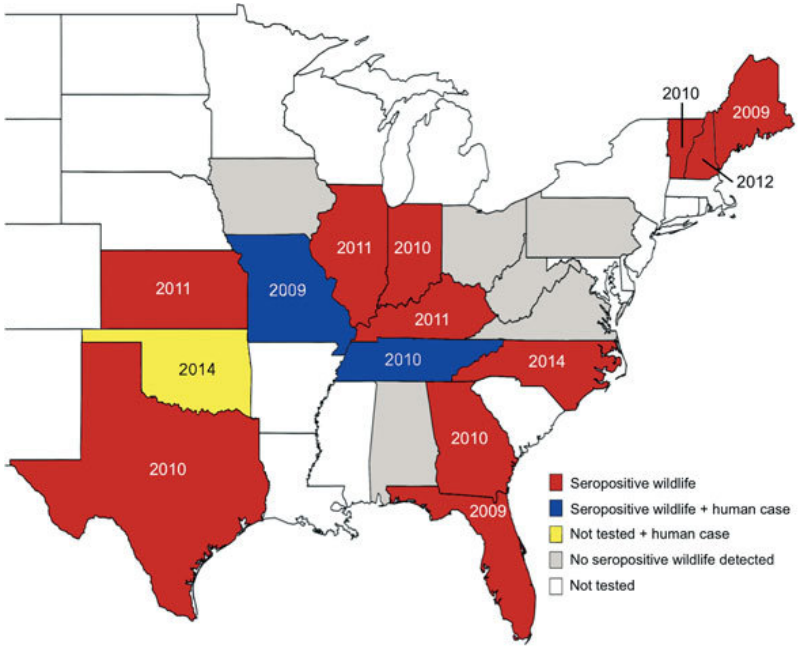
- Order *Bunyavirales,* Family *Phenuiviridae,* genus *Phlebovirus*
  - Ukuniemi serogroup
- 3 segment, negative sense RNA genome
  - Ambisense S segment
- 2009, Missouri
- Genetically similar to Severe Fever with Thrombocytopenia Syndrome virus (SFTS)
  - 2009 China





Heartland virus

- **Tick associated disease**
- ***Amblyomma americanum* (Lone star)**
  - Virus isolation
  - Laboratory transmission
- **Vertebrate host unknown**
  - Seropositive: white-tailed deer, raccoon, coyote, moose

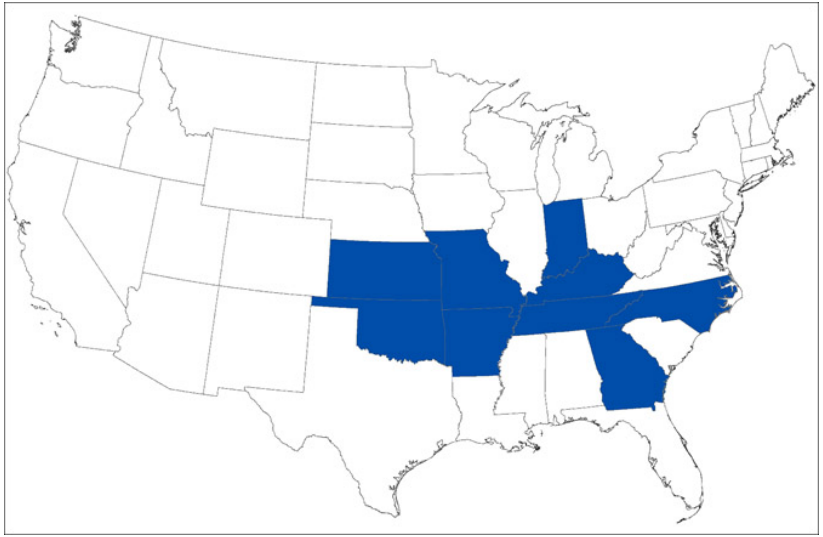


Riemersma and Komar 2015 EID

Heartland virus

- **Human infection**
  - Febrile, headache, nausea, muscle or joint pain, leukopenia, and thrombocytopenia
  - Often confused with ehrlichiosis
- **Clinical lab diagnosis**
  - Real-time RT-PCR
  - Serology

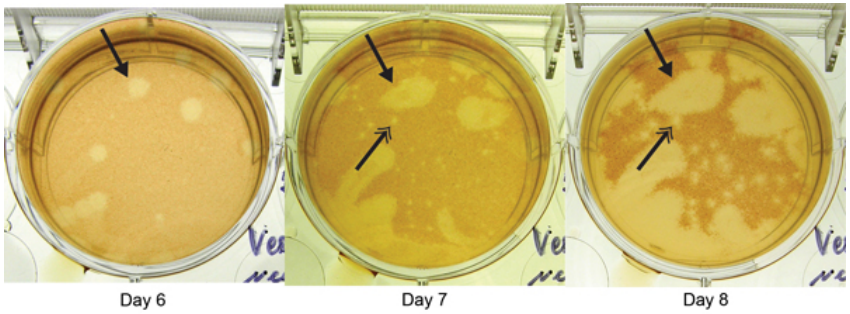
Heartland virus cases as of July 2017 (30)

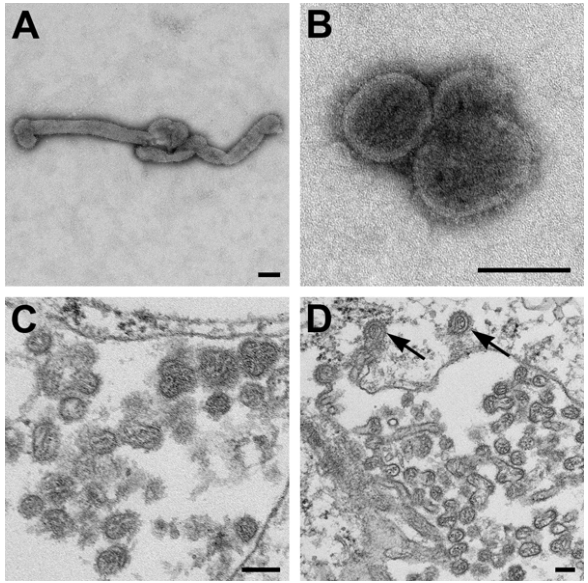


www.cdc.gov

Bourbon virus

- ***Orthomyxoviridae,*** **genus *Thogotovirus***
- **6 segments, negative stranded RNA genome**
- **Thogoto and Dhori viruses known human pathogens**
  - Europe, Asia, Africa
  - Tick transmission
- **Kansas 2014**





Kosoy et.al. 2015 EID

Bourbon virus

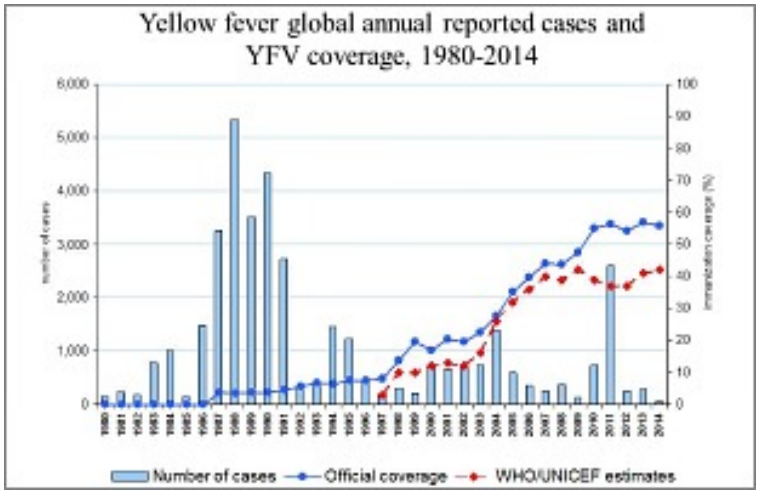
- **Tick associated**
- ***Amblyoma americanum* (Lone star)**
  - Isolated in ticks from MO 2013 and KS 2015
  - Nymph and adult
- **Human infection**
  - Febrile, thrombocytopenia, leukopenia
- **Clinical lab diagnosis**
  - Real-time RT-PCR
  - PRNT

Distribution of *A. americanum*

www.cdc.gov

Yellow fever virus

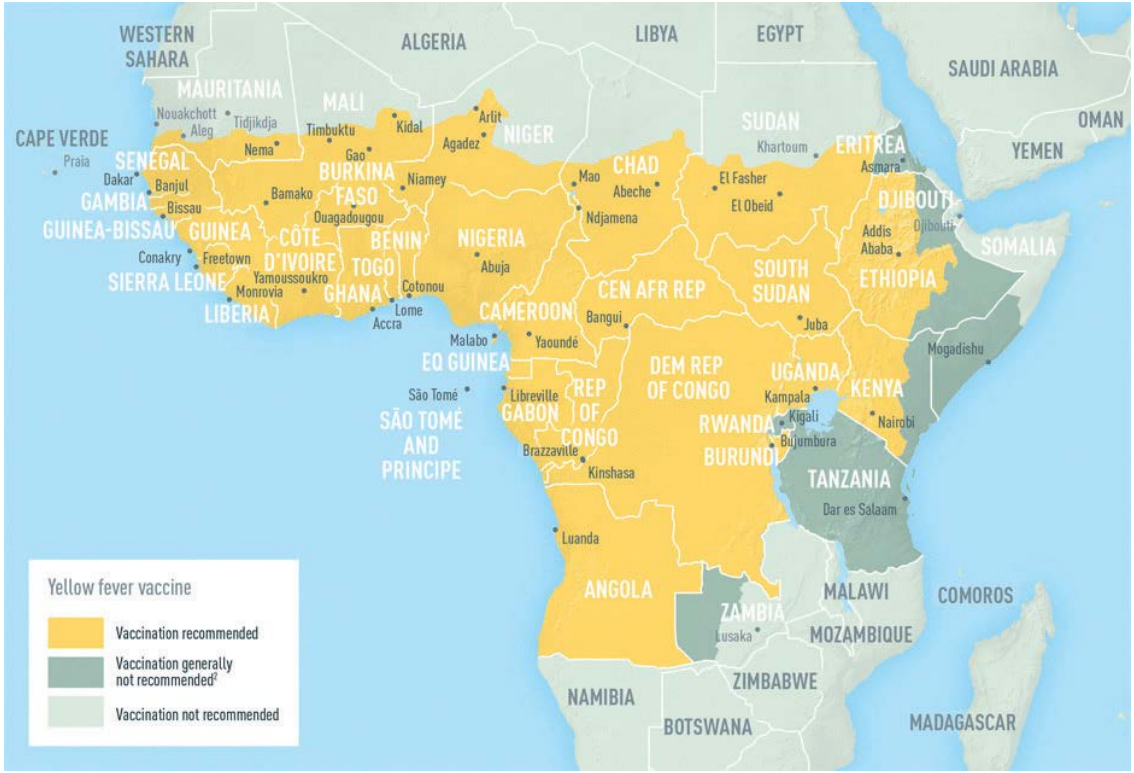
- ***Flavivirus***
  - Positive RNA genome
- ***Aedes aegypti***
  - urban transmission
- ***Haemagogus* and *Sabethes***
  - sylvatic transmission (most common)
- **Human infection**
  - Febrile ILI with jaundice
  - 12-15% severe disease
  - High fever, bleeding, shock, organ failure



www.who.int/emergenices/yellow-fever

- **Clinical lab diagnosis**
  - Serology
  - Real-time RT-PCR

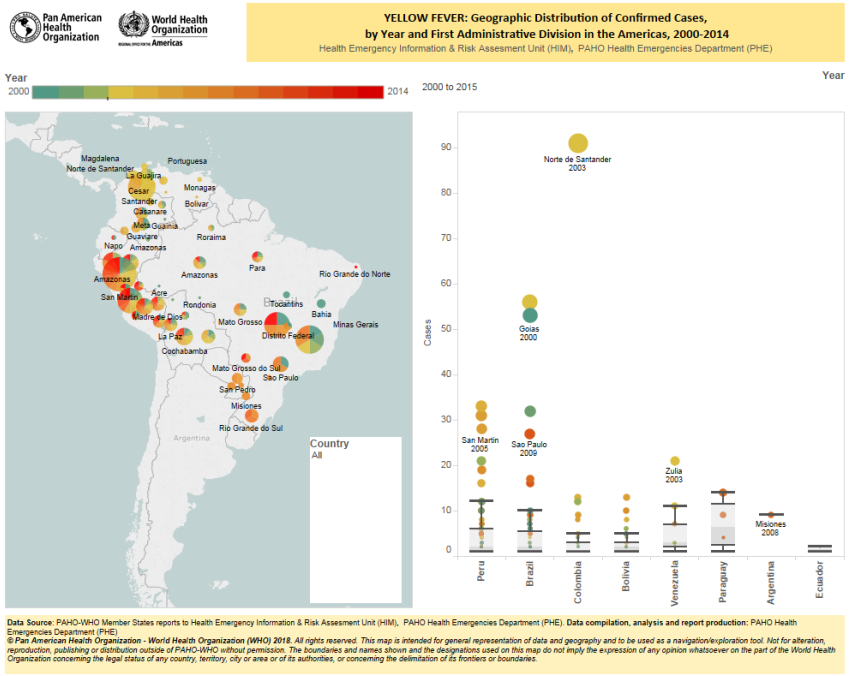
Risk areas (vaccine recommended)



cdc.gov/yellowfever

Yellow fever virus

- **Recent notable outbreaks**
  - 2016 Angola, Democratic Republic of the Congo (3,137 suspect)
  - 2016/2017 Brazil (777 confirmed)
  - 2017 Nigeria (341 suspect)
  - 2018 Brazil (920 confirmed)
    - 11 international travelers



Thank you

Holly Hughes LTR8@cdc.gov

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov