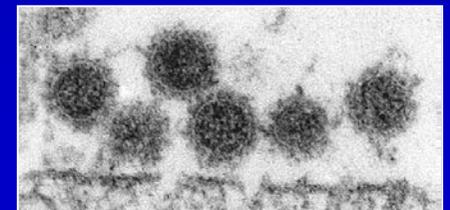

Jamestown Canyon Virus Revisited: Are We Neglecting and Under Recognized Mosquito-Borne Disease

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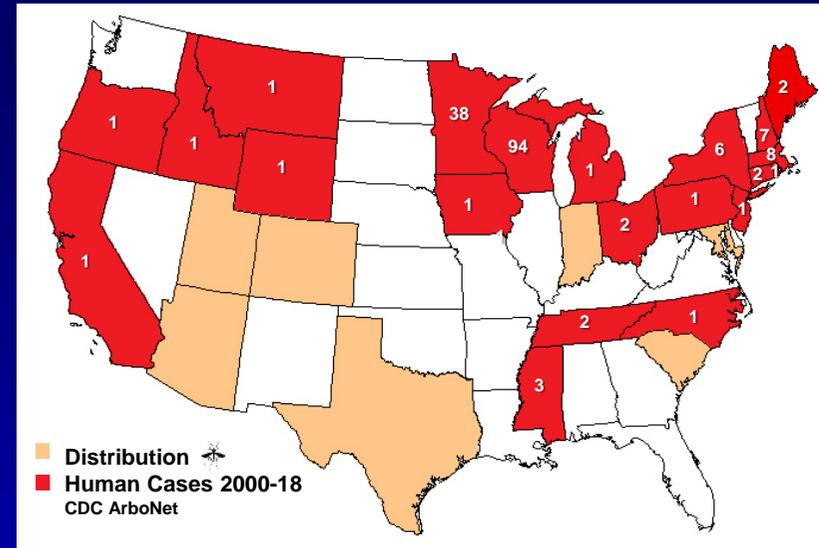
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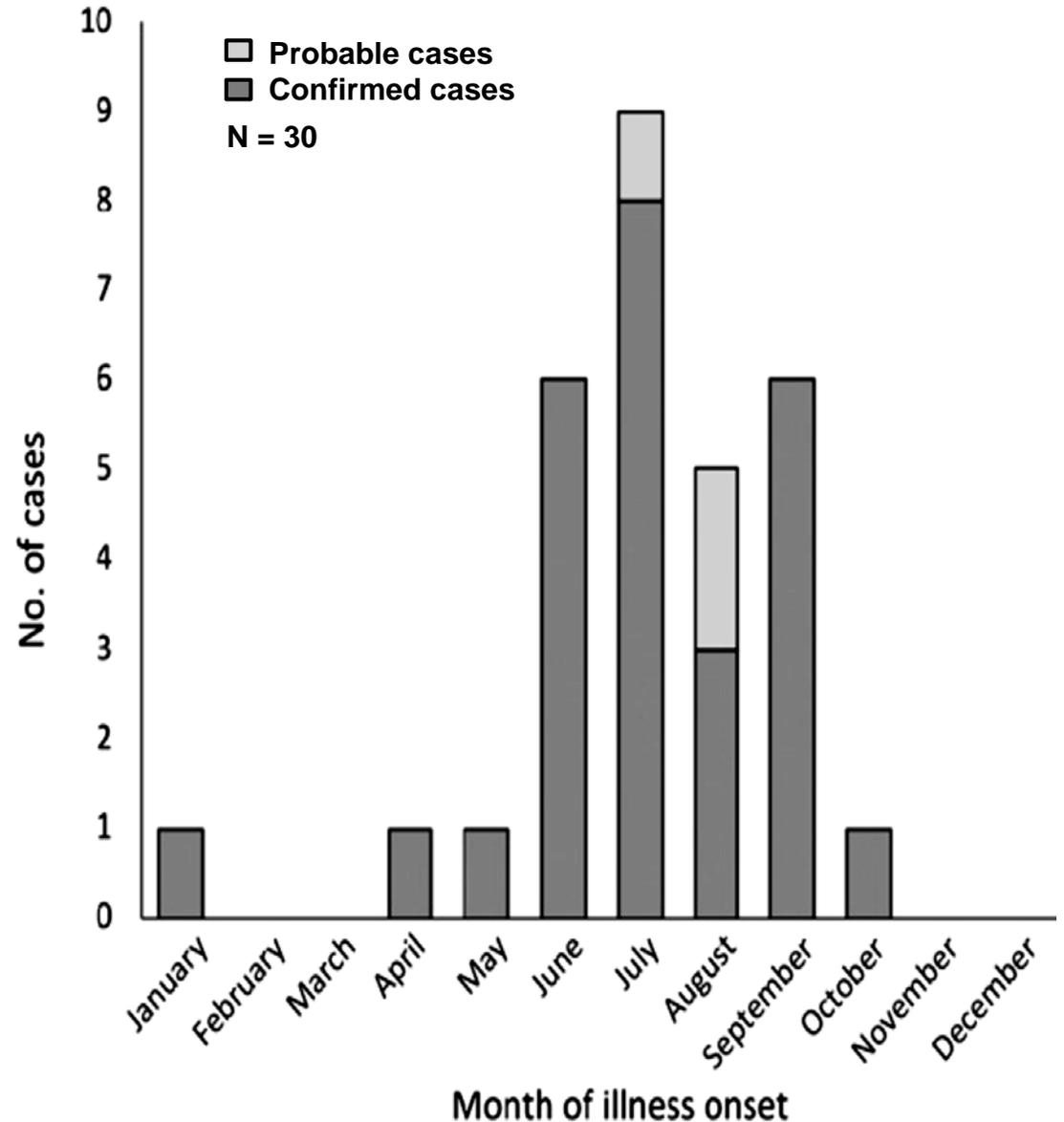


JAMESTOWN CANYON VIRUS

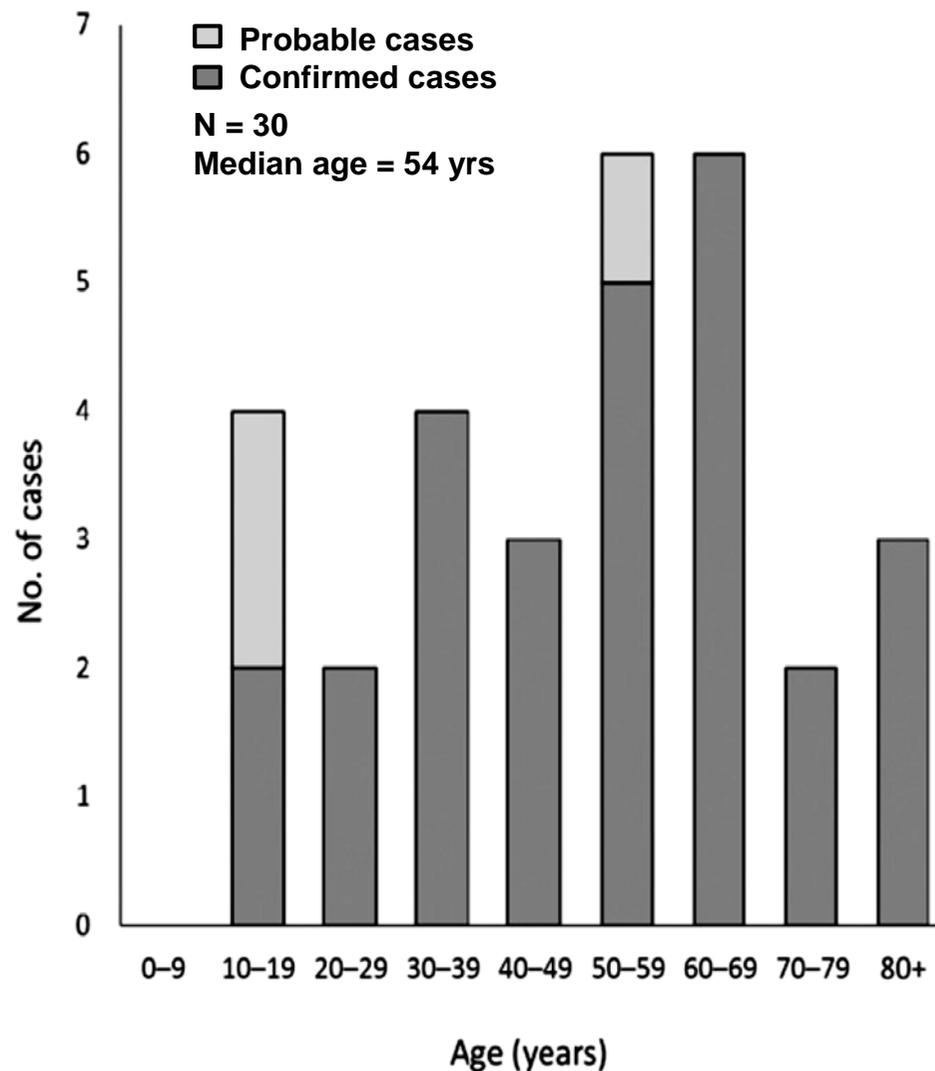
- Mosquito-borne *Orthobunyavirus* (ss-RNA) found throughout much of temperate North America
- First isolated in 1961 from *Culiseta inornata* in CO
- Human cases are comparatively rare but appear to be on the rise (166 cases from 2004 – 2018)
- Mostly in Midwestern and Northeastern states
- Sero-prevalence = 6.7% - 48.2% - “Under Recognized”
- Causes acute febrile illness, fever, meningitis, or meningoencephalitis
- Infects a variety of free ranging ungulates - deer, moose, bison, elk (sero-prevalence: 21% in CT, 77% in WI)
- White-tailed deer recognized as principal amplification hosts (experimental infections and prevalence of Ab)
- Isolated from 26 mosquito species, mostly boreal *Aedes*
- Vertically transmitted in mosquitoes



<i>Clinical manifestations of patients with JCV disease</i>	
Fever	83%
General weakness	70%
Headache	66%
Nausea	37%
Neck rigidity	30%
Altered mental status	23%
Dizziness	16%
Photophobia	13%
Tremors	13%
Arthralgia	13%
Seizures	6%



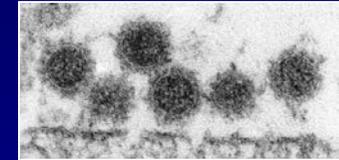
Characteristics of patients with JCV disease	
Age Range	10-84 yrs.
Median Age	54 yrs.
Males	56%
Outdoor exposure	73%
History of mosquito bite	56%
No travel out of state	80%
Hospitalized	47%
Neuroinvasive	50%
Fatality	3%



OBJECTIVES

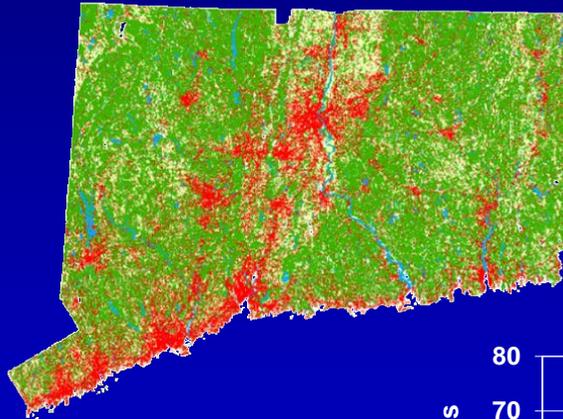
Examine the spatial and temporal patterns of Jamestown Canyon virus activity in the Connecticut as a function of:

- Vector mosquito abundance and distribution with identification of key vectors



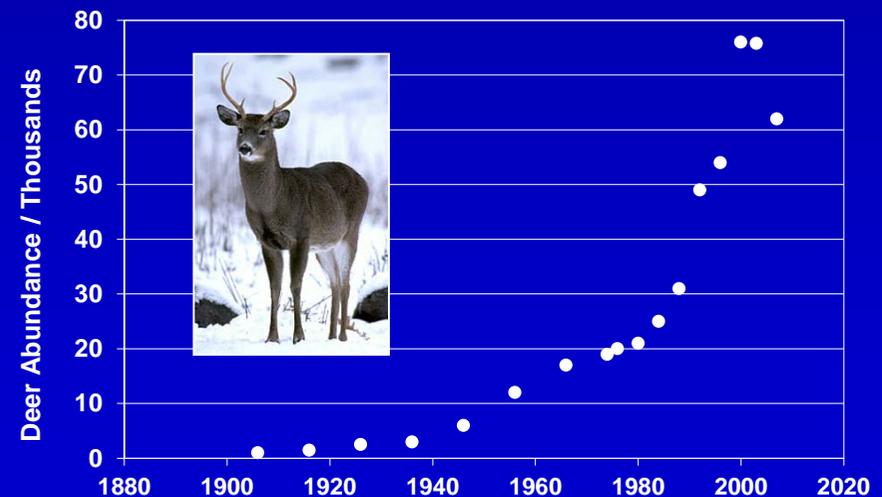
- Land use characteristics

Agriculture/Grass
Forest
Developed
Wetland



- Distribution and abundance of white-tailed deer, *Odocoileus virginianus*, reservoir vertebrate host

- Exponential increase with reforestation throughout the northeastern US since 1900



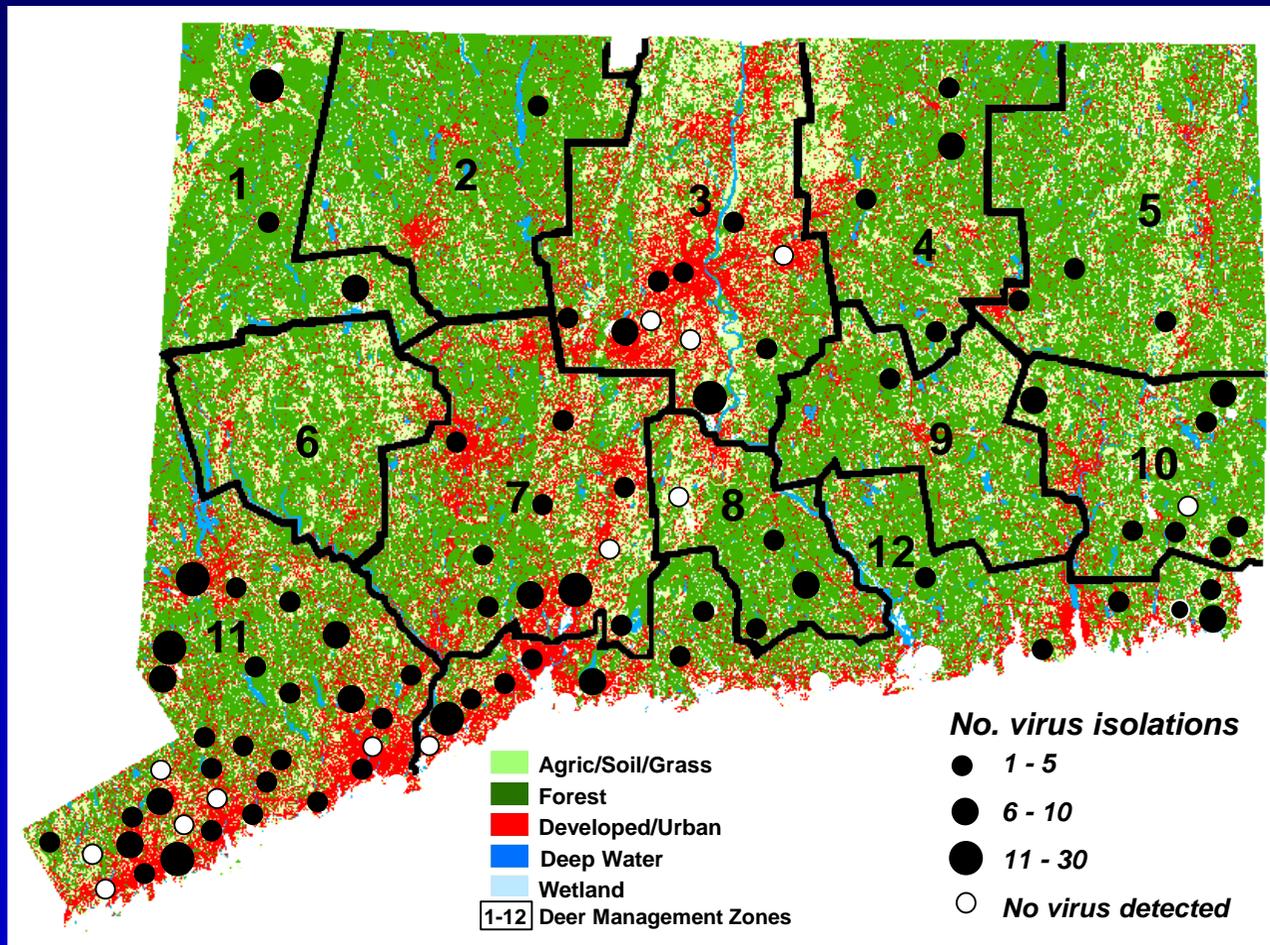
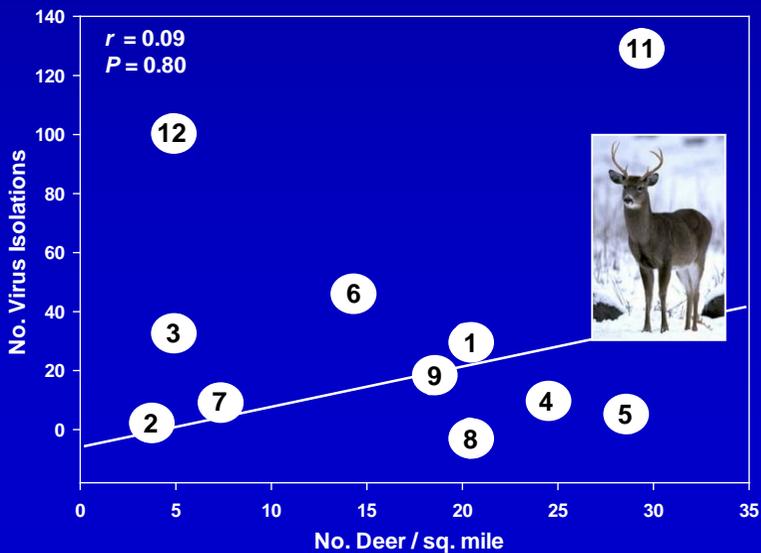
Mosquito Collection and Arbovirus Isolation Methods

- Data gleaned from our State-wide *Mosquito/Arbovirus Surveillance Program*
- 20 year period: 1997 to 2017
- Conducted from June - October
- 92 permanent trapping stations (trap weekly)
- CO₂-baited CDC light trap and gravid traps
- Mosquitoes identified to species (45 species)
- Pooled by species and site (Maximum of 50)
- Virus isolation in Vero cell cultures (BSL 3)
- Virus identification by real time PCR or RT-PCR



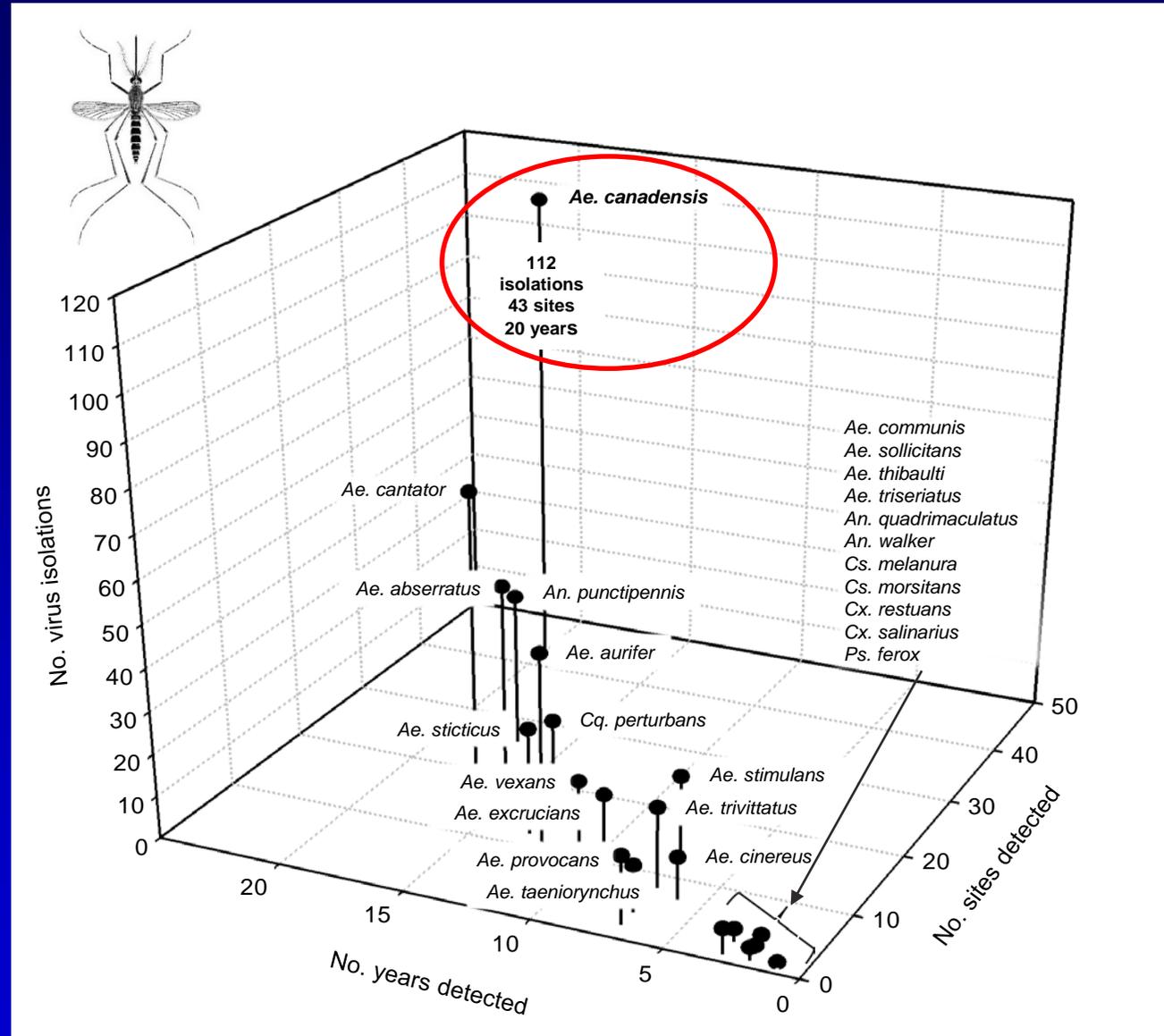
Jamestown Canyon Virus – Spatial Geographic Distribution

- Virus detected in 84 of 91 sites (92%) 1997-2017
- Equally distributed throughout urban, suburban and rural locales
- No significant association with any land cover categories ($r = 0.17$)
- No significant relationship to white-tailed deer abundance



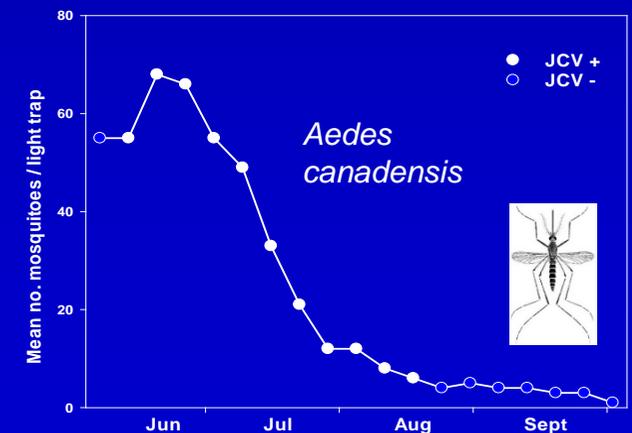
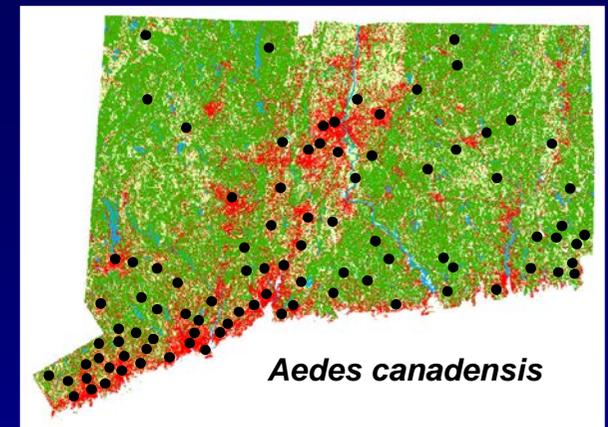
Jamestown Canyon Virus – Isolations from Mosquitoes 1997 - 2017

- 478 virus isolations from 25 of 45 (55%) mosquito species collected
 - Mostly *Aedes* and *Anopheles*
 - 5 species incriminated as most important vectors based on:
 - Number of years detected
 - Number of sites detected
 - Number of virus isolations
 - ***Aedes canadensis****
 - *Aedes cantator*
 - *Aedes abserratus*
 - *Anopheles punctipennis**
 - *Aedes aurifer*
- * Competent lab vector



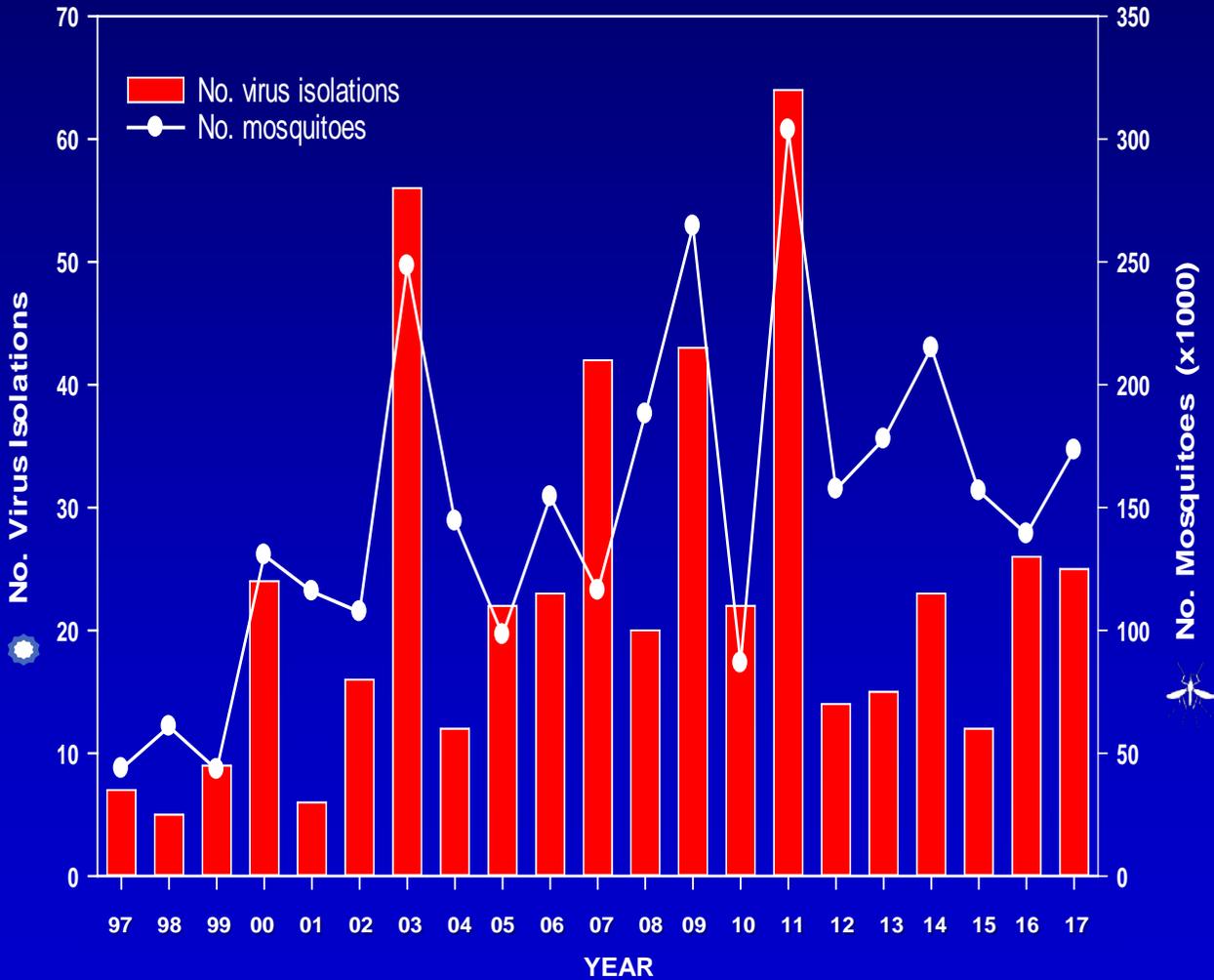
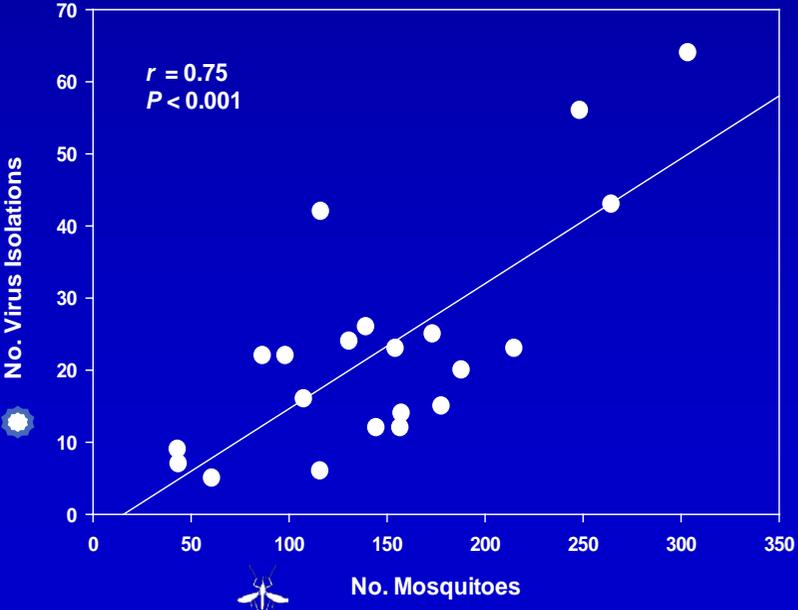
Aedes canadensis

- Among the most abundant and widely distributed species in the state
- Larvae develop in a variety of freshwater habitats
 - Temporary leaf-lined pools in wooded areas
 - Roadside ditches
 - Vernal pools in open fields
 - Permanent swamps
- Univoltine – peak populations in June - July
- Feed on a variety of animals but mostly mammals (98%) including humans (Molaei et al *JME* 2008)
- White-tailed deer - 95% of mammalian blood meals
- Competent vector of JCV (Heard et al *JAMCA* 1991)



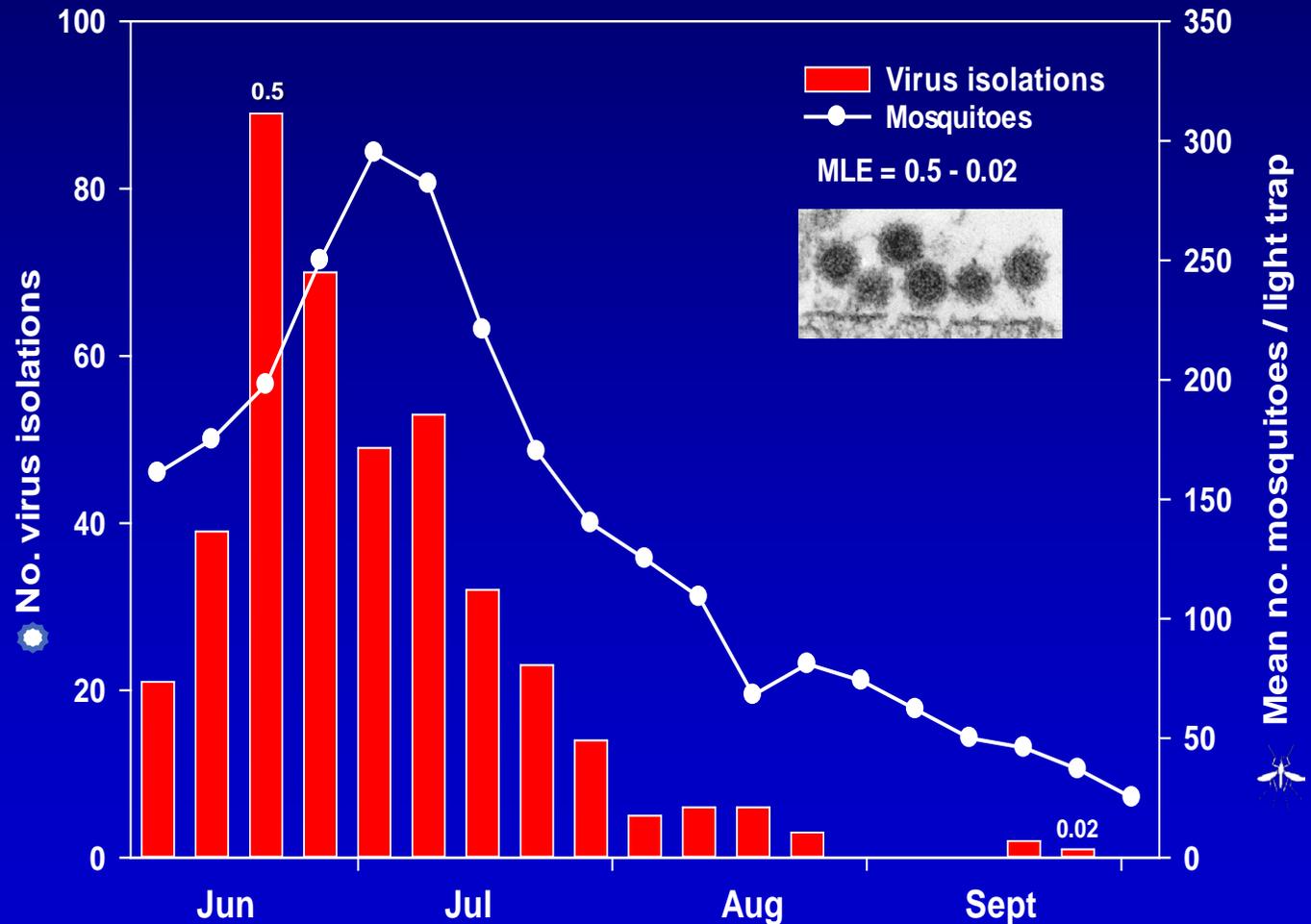
Jamestown Canyon Virus – Yearly Activity 1997 - 2017

- Consistently detected every year
- Infection rates range from 0.05 - 0.36 (MLE/1000) mean = 0.16
- Yearly virus activity is directly related to overall mosquito abundance



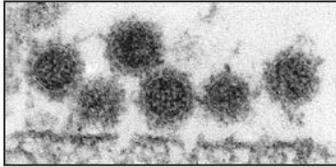
Jamestown Canyon Virus – Seasonal Prevalence

- Infected mosquitoes detected from June through September
- Virus isolations parallel overall mosquito abundance
- Greatest number of virus isolations: mid - June through mid - July
- Correspondingly high infection rates (MLE) during same time (0.5)
- Consistent with vertical transmission

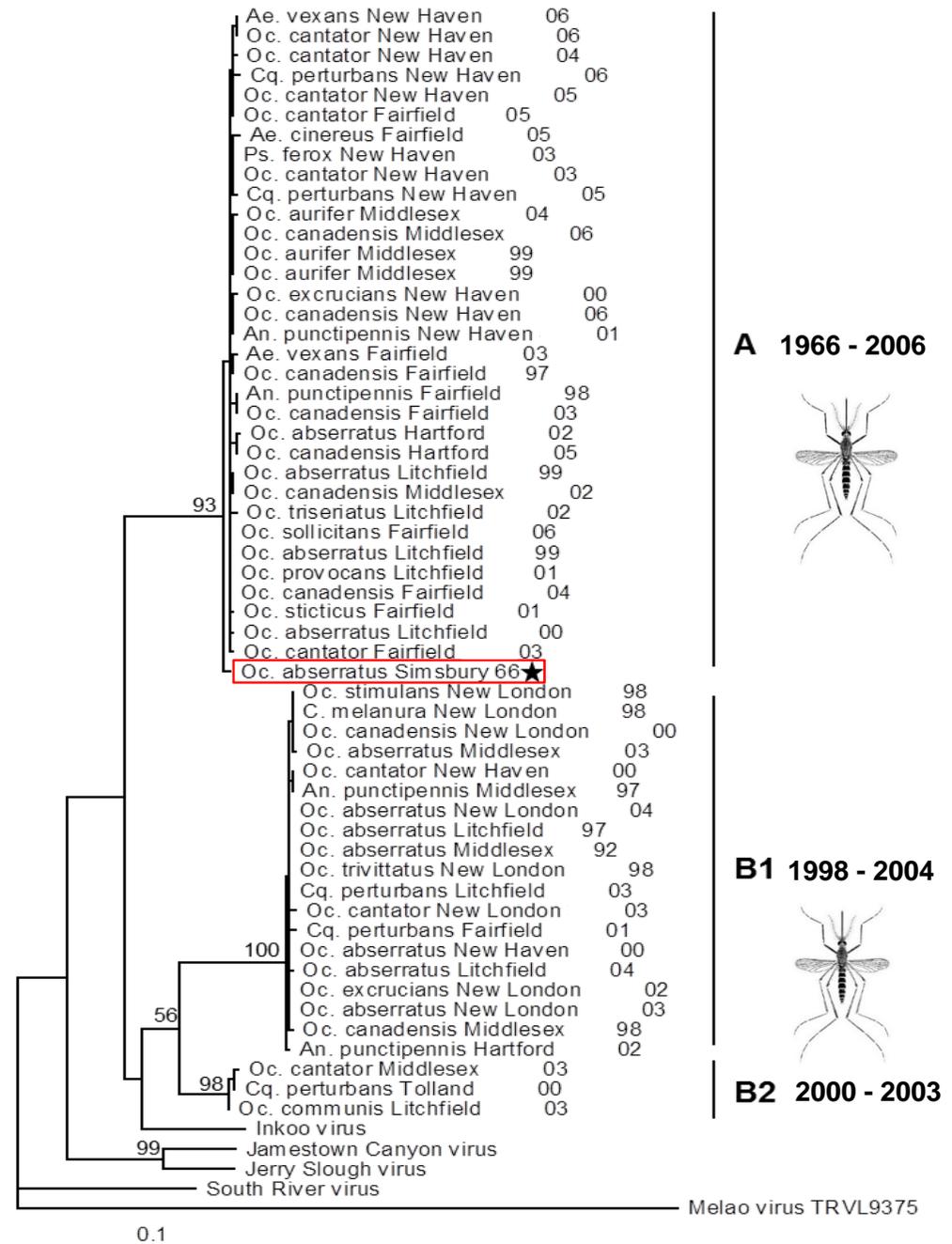


Genetic Relationships of Jamestown Canyon Virus Strains Infecting Mosquitoes Collected in Connecticut

Philip M. Armstrong and Theodore G. Andreadis

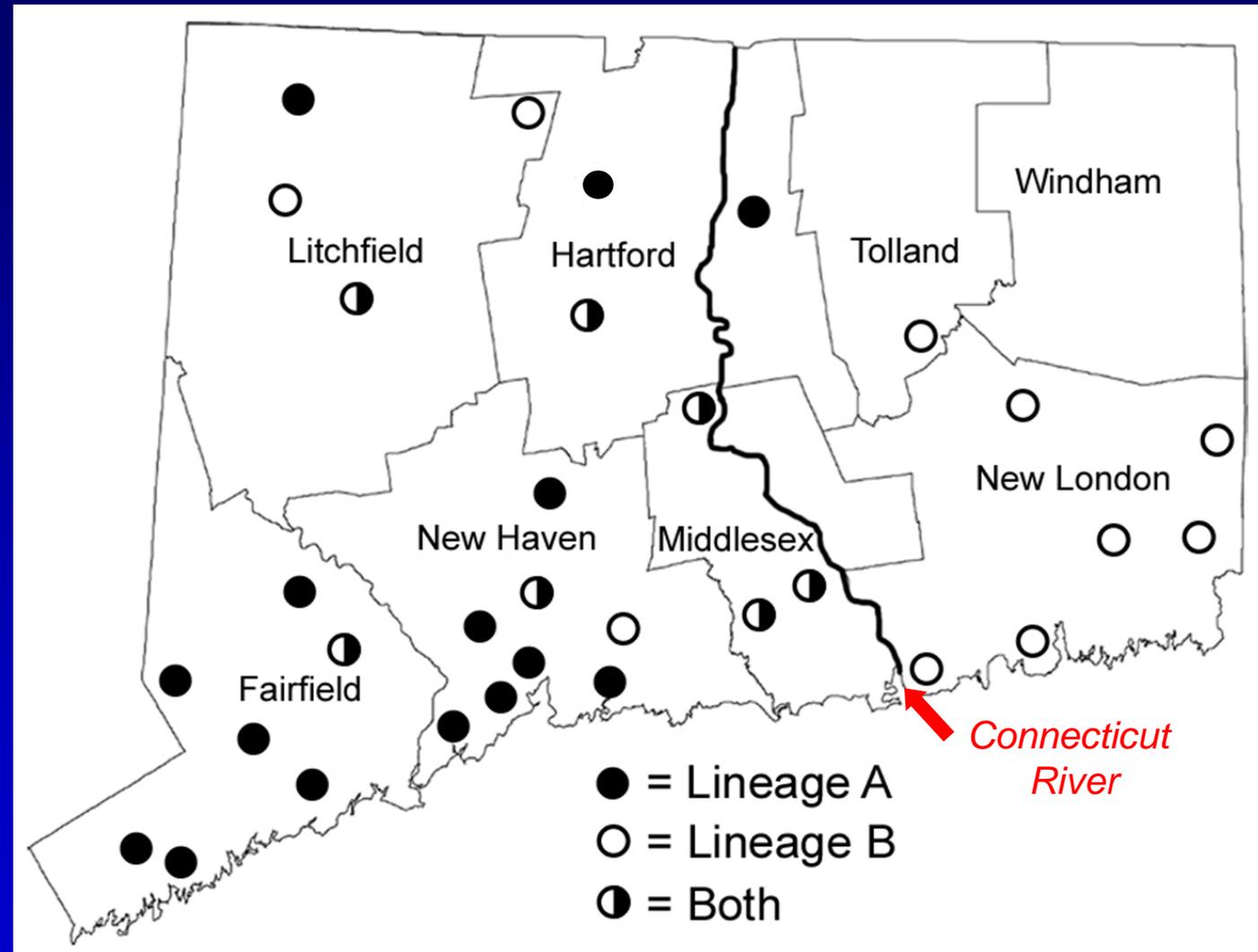


- Sequenced 56 JCV isolates from Connecticut 1966 - 2006
- Analysis of nucleotide sequences from the S segment (nucleocapsid) (maximum likelihood)
- Two Major Lineages in Connecticut
 - Lineage A 1966 - 2006
 - Lineages B1 and B2 1998 - 2004
- Lineages did not group by year of isolation or mosquito species
- Very little change over time



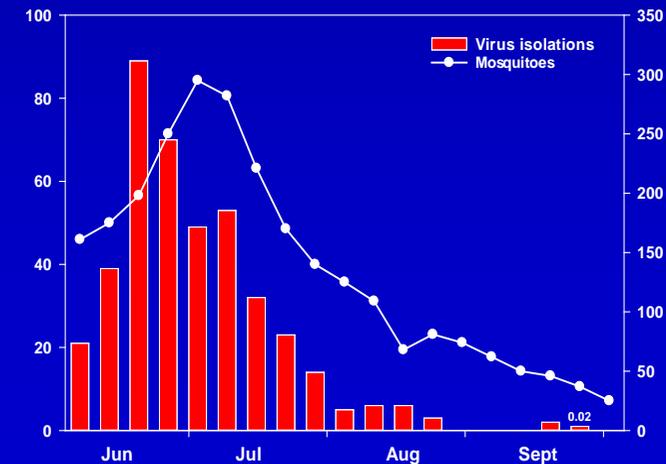
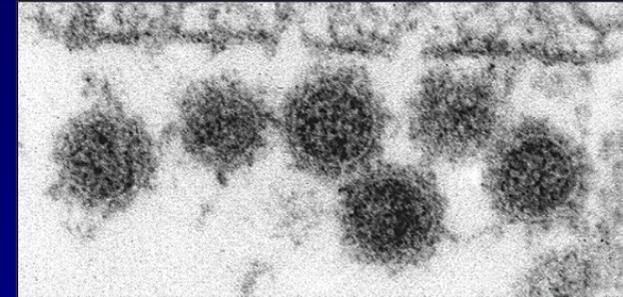
Distribution of Jamestown Canyon Virus Lineages in Connecticut

- Geographically structured
 - Lineage A (west)
 - Lineage B (east)
- Both lineages in some sites
- Long term maintenance of local populations of JCV suggests local overwintering and persistence of virus
- JCV appears to be evolving slowly by random mutation (genetic drift)
- No evidence for genetic reassortment among lineages A and B (genetic shift)



Summary

- JCV is widely distributed in CT and consistently amplifies each year
- Activity occurs from June to September with peak from late June through mid July
- Activity is a function of mosquito abundance
- Vectors are largely univoltine woodland species
- *Aedes canadensis* appears to be principal vector
- The virus is very stable suggesting local overwintering in mosquitoes via transovarial transmission with long term persistence
- Human exposure is likely to be moderate to high
- Clinicians should consider JCV infection in differential diagnosis when an arboviral infection is suspected to be causing febrile neurological illness and WNV testing is inconclusive or negative





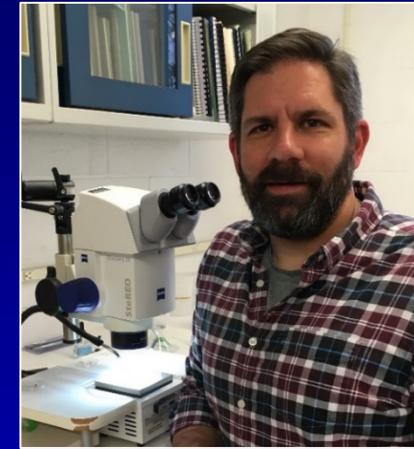
CAES Center for Vector Biology & Zoonotic Diseases NE Regional Center for Excellence in Vector-Borne Diseases



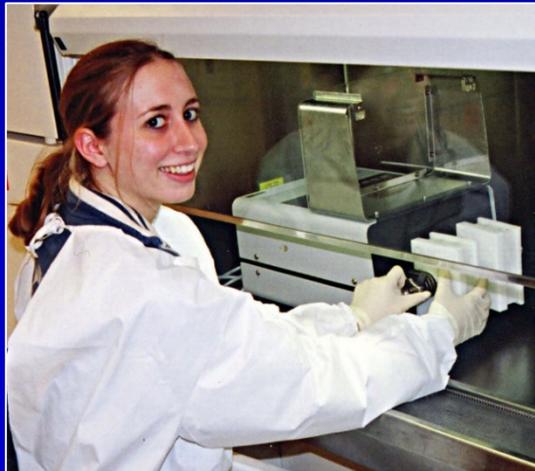
Dr. Philip Armstrong



Dr. John Anderson



John Shepard



Angela Bransfield



Michael Micensik



Tanya Pertruff

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- State of Connecticut



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- CDC
- ELC cooperative agreement

Questions?



Alexander Skochkov "Old Mosquito"

