

La Crosse Encephalitis Risk Persists at the Residential level



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Environmental
Health

- **Zoonotic**

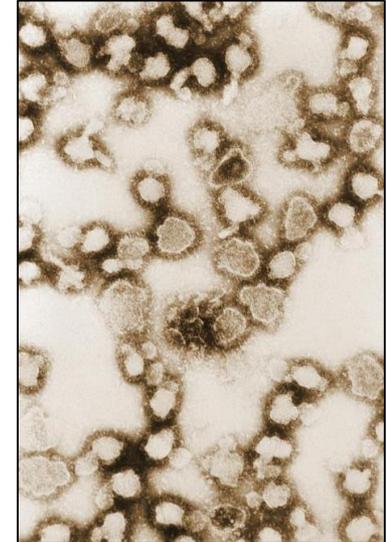
- (Animal-Mosquito-Human)

- La Crosse virus*

- West Nile virus

- Eastern Equine Encephalitis virus

- Saint Louis Encephalitis virus



- **“Anthroponotic”**

- (Human-Mosquito-Human)

- Chikungunya*

- Dengue*

- Malaria

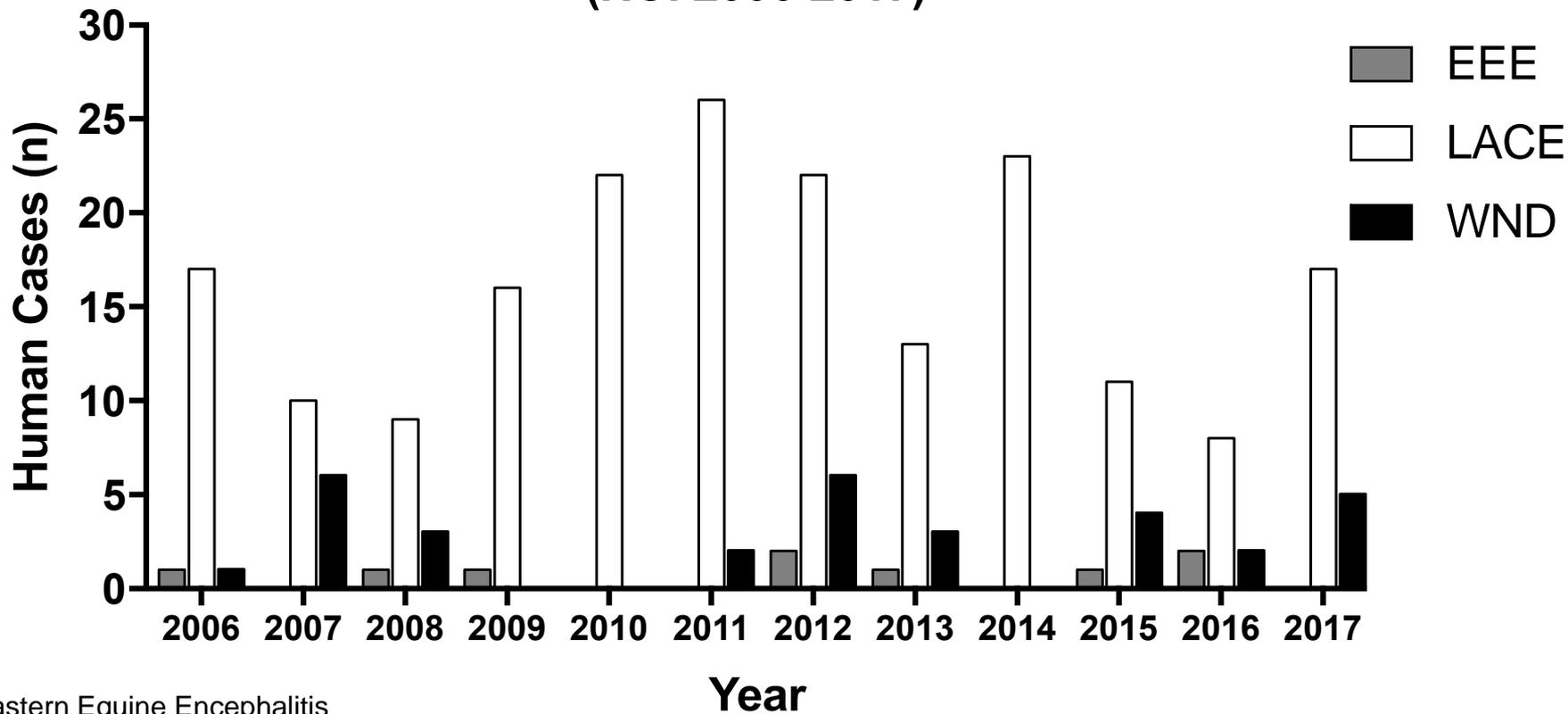
- Zika*



*Transmission is primarily by container-inhabiting *Aedes*

Arboviral Disease: Zoonotic

Mosquito Transmitted Arboviral Disease (NC: 2006-2017)



EEE: Eastern Equine Encephalitis

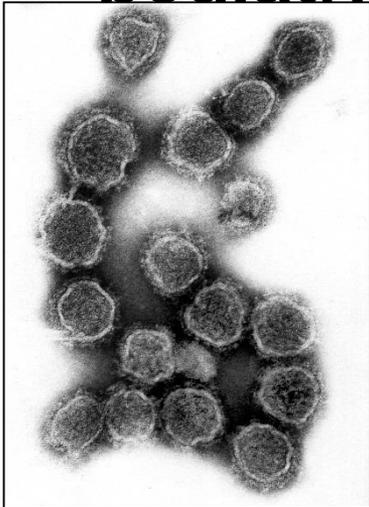
LACE: La Crosse Encephalitis

WND: West Nile Neuroinvasive Disease

Not shown: 3 SLE Cases (2009)

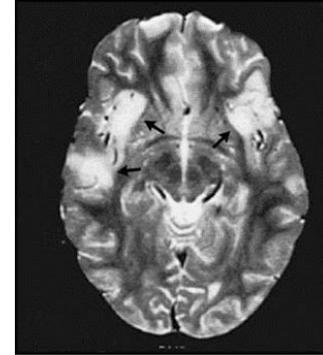
La Crosse Virus

- **Isolated in 1960's in La Crosse, Wisconsin**
 - Bunyavirus (California serogroup virus)
- **Acquired through the bite of a mosquito**
 - Eastern-tree hole mosquito (principle vector; daytime active)
- **LACv is the most common arboviral cause of pediatric encephalitis in the US**



- **Symptoms**

- Incubation Period: 5-15 days
- Fever, Headache, Vomiting, Fatigue, Lethargy
- Severe neuroinvasive disease occurs mostly in children under 16 years
- Seizures during acute illness are common; fatal cases are rare (~1%)



- **Neurologic Sequelae**

- Vary in duration and severity
- Recurrent seizures, hemiparesis, and cognitive and neurobehavioral abnormalities

LACE (Acute)



<http://wlos.com/news/local/burnsville-boy-almost-dies-all-because-of-a-mosquito>

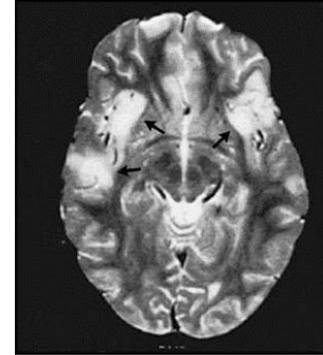
<http://www.wsocv.com/news/local/nc-boy-fighting-for-life-after-contracting-la-cross-virus-from-mosquito-bite/421409113>

LACE (Recovery)



- **Treatment**

- No vaccine
- No specific antiviral treatment
- Supportive treatment only
- “Prevention is the Cure”

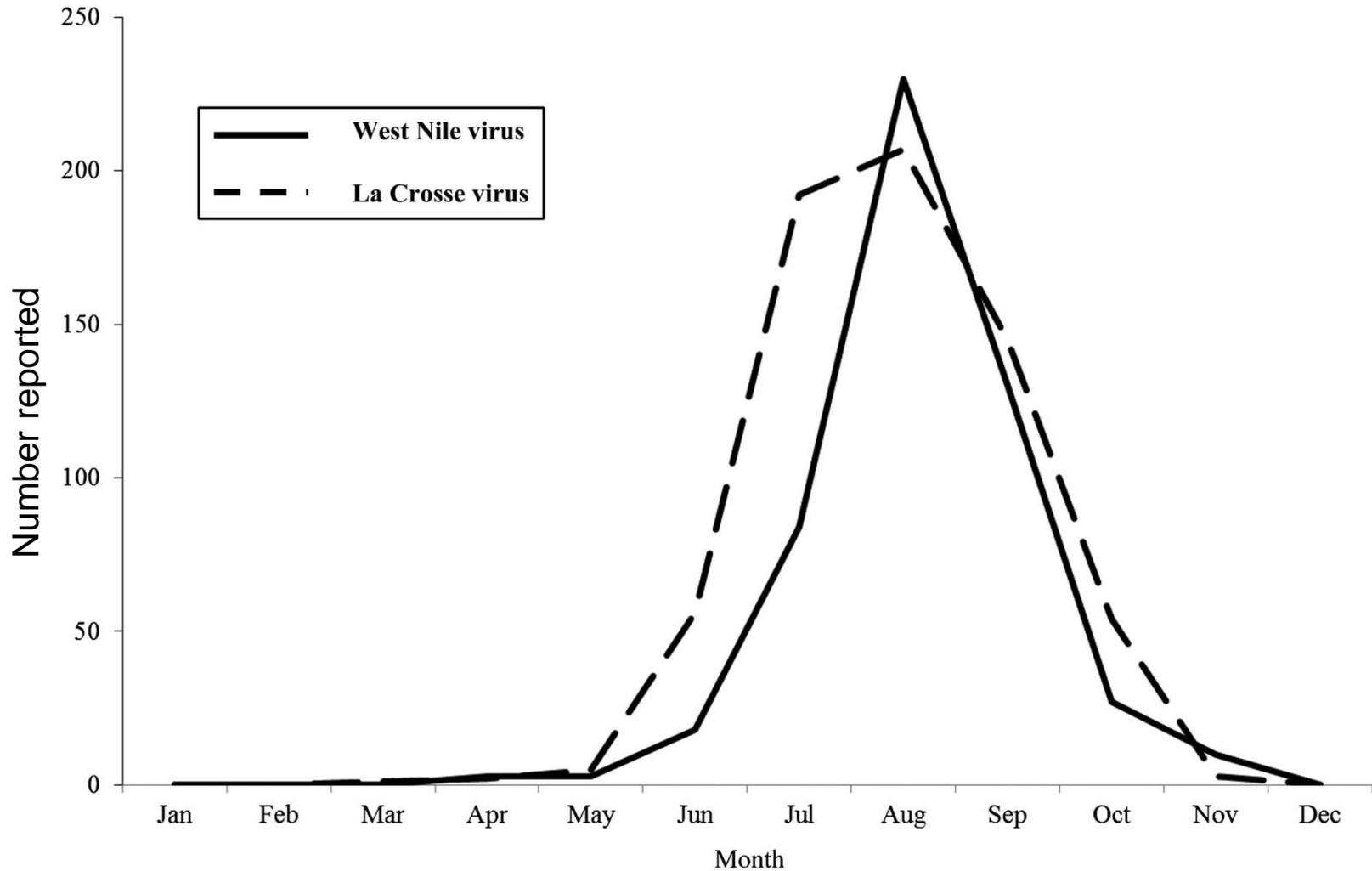


- **Economic and Social Impacts: High**

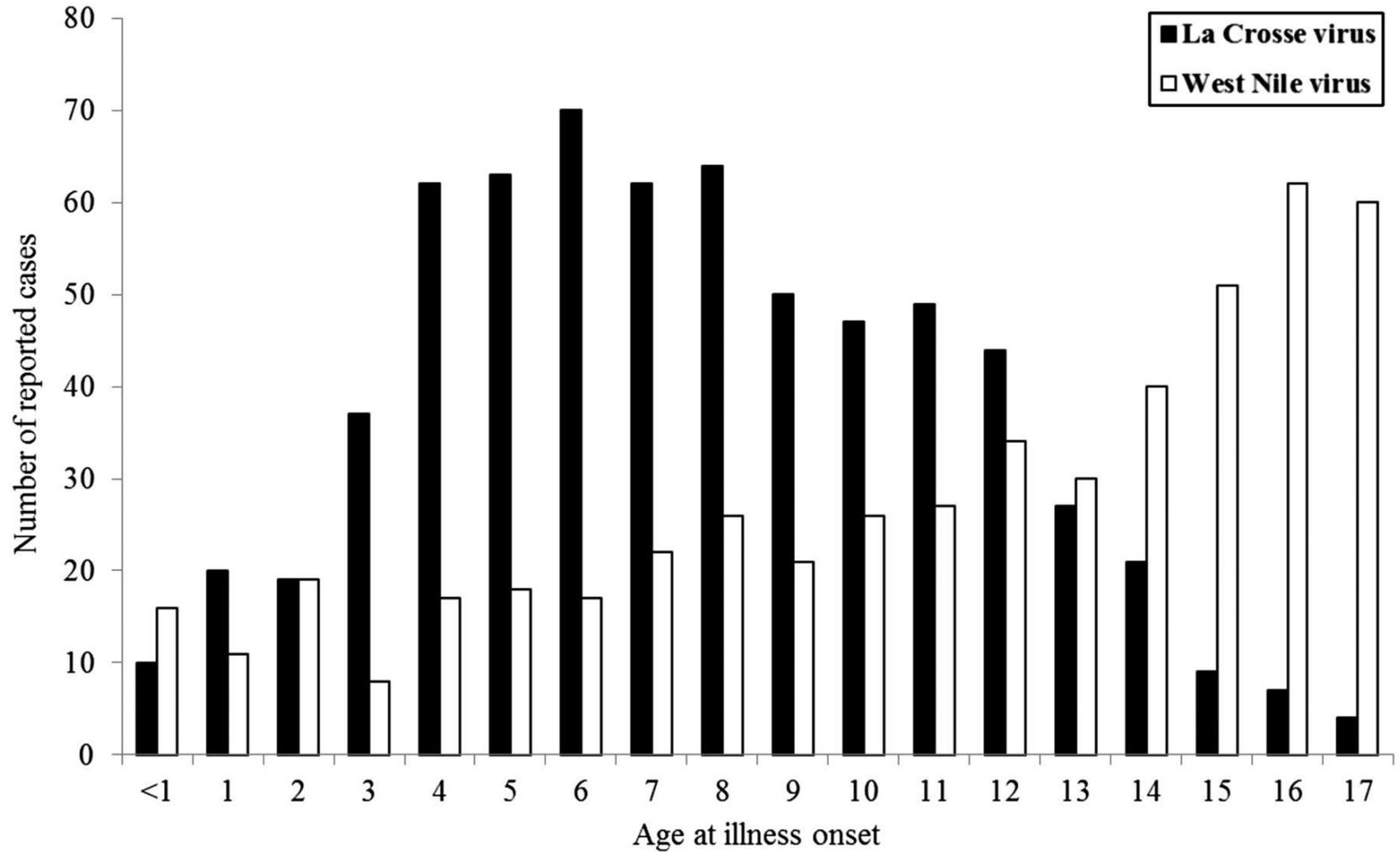
- Direct and Indirect Medical Costs
 - \$7,521-\$175,586 (mean= \$32,974)*
- Lifelong Neurologic Sequelae
 - \$48,775-\$3,098,798*

*2003 USD Value

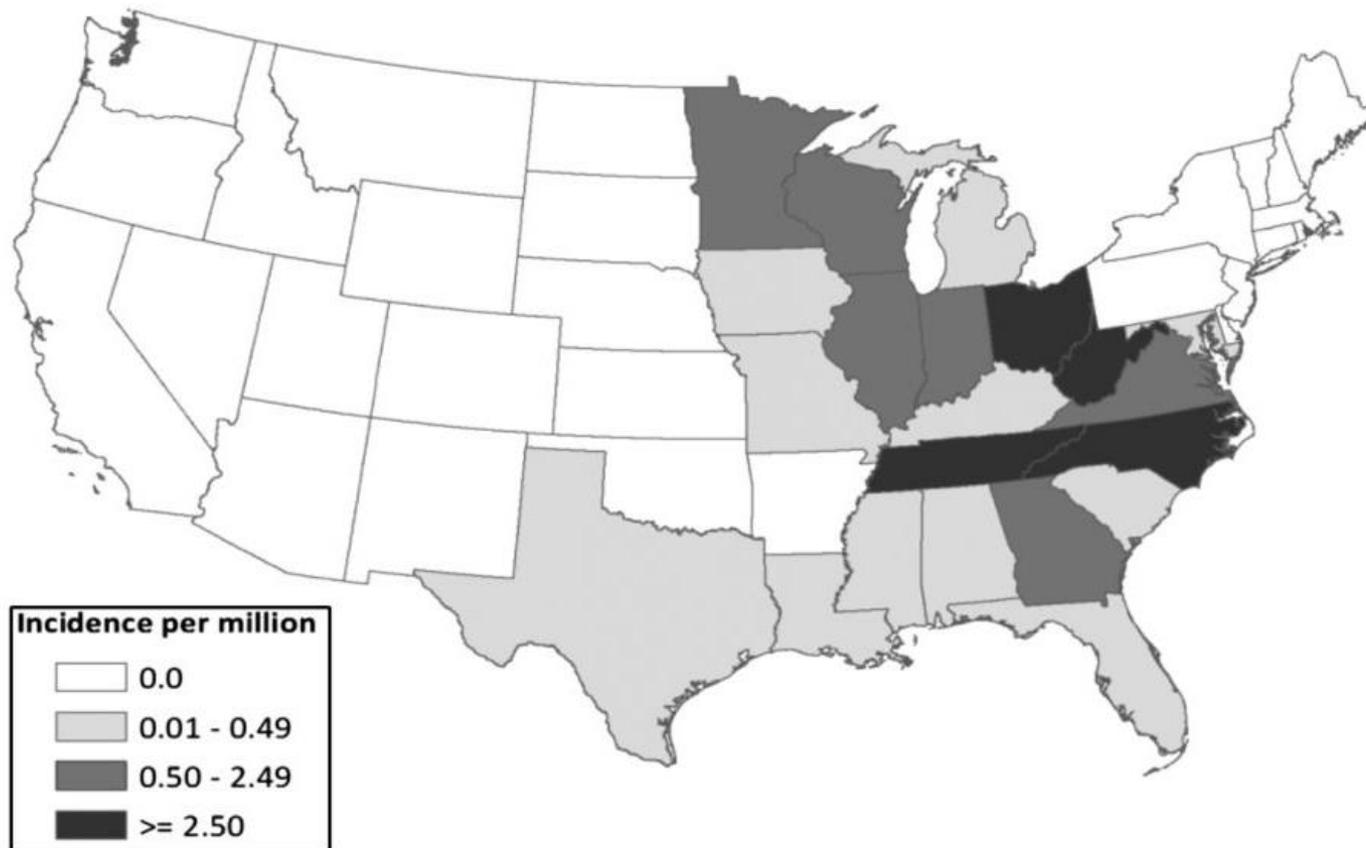
Number of reported pediatric neuroinvasive arboviral disease cases due to La Crosse and West Nile viruses, by month of illness onset: United States, 2003–2012.



Number of reported pediatric neuroinvasive arboviral disease cases due to La Crosse and West Nile viruses, by age at illness onset: United States, 2003–2012.



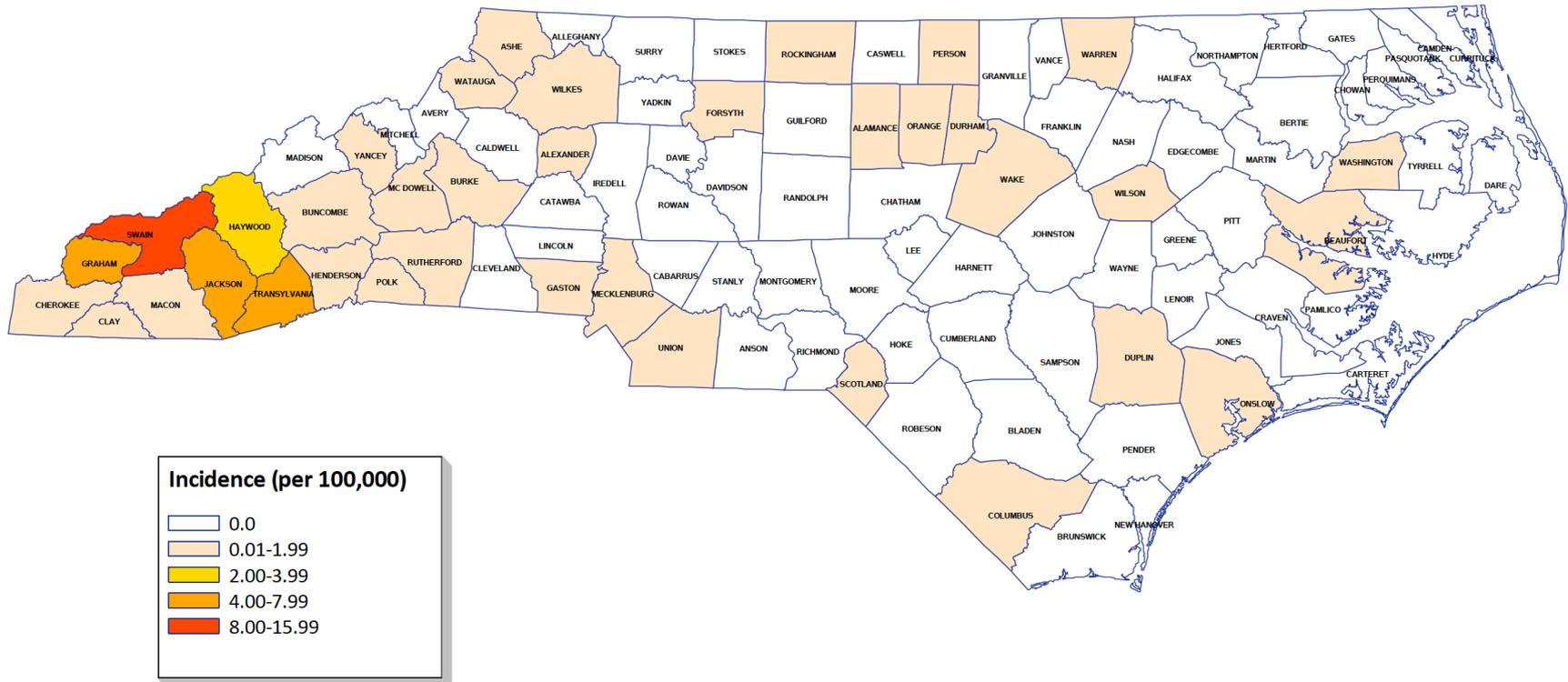
LACE (2003-2012)



Although LACE was historically found throughout the Midwest, burden has shifted to Appalachian region: 81% reported from Ohio, West Virginia, North Carolina, and Tennessee

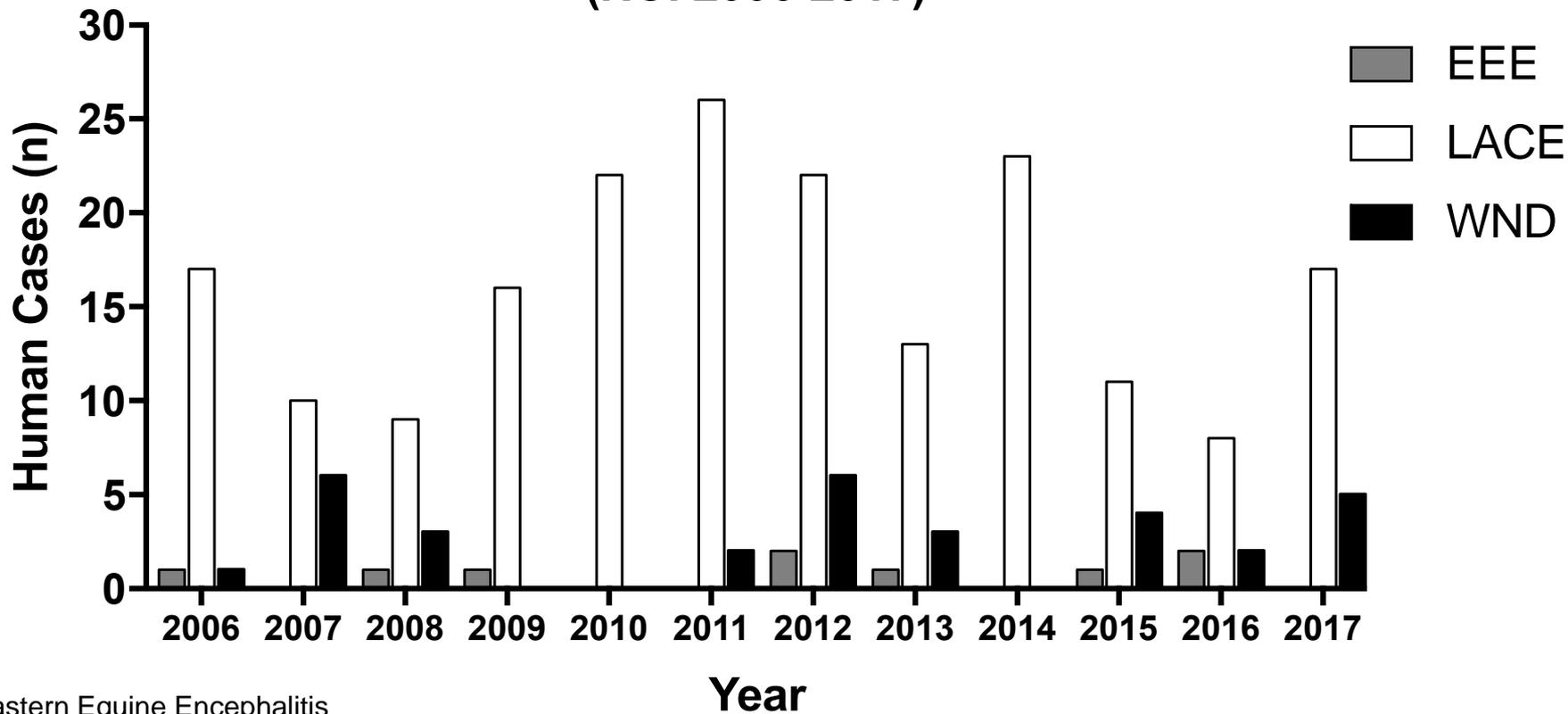
(Gaensbauer et al., 2014)

LACE (NC: 1997-2016)



Arboviral Disease: Zoonotic

Mosquito Transmitted Arboviral Disease (NC: 2006-2017)



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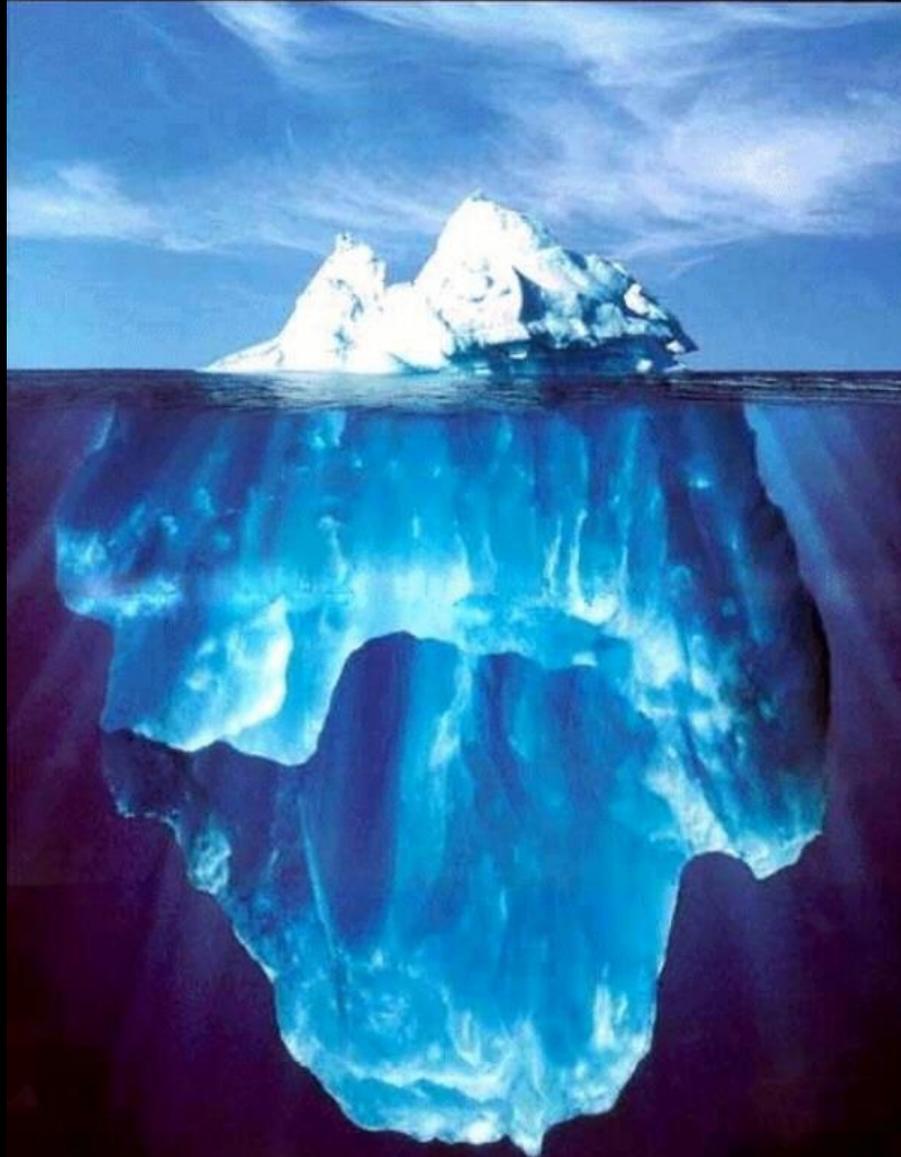
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Tip of the Iceberg: 1 recognized LACE case



Jackson Co. NC
4.9% (2.5%-8.6%)

*Szumlas, 1996

Iceberg: est.100-300 individuals exposed to LACV

- Time spent outdoors
- Residence near one or more tree holes
- Abundance of the Asian Tiger mosquito





Tree holes and *Ae. triseriatus* larvae



Tree hole at LACE Case Residence

Treehole Communities



Aedes triseriatus
Aedes albopictus
Aedes japonicus
Orthopodomyia signifera
Toxorhynchites sp.
Anopheles barberi

Artificial Containers

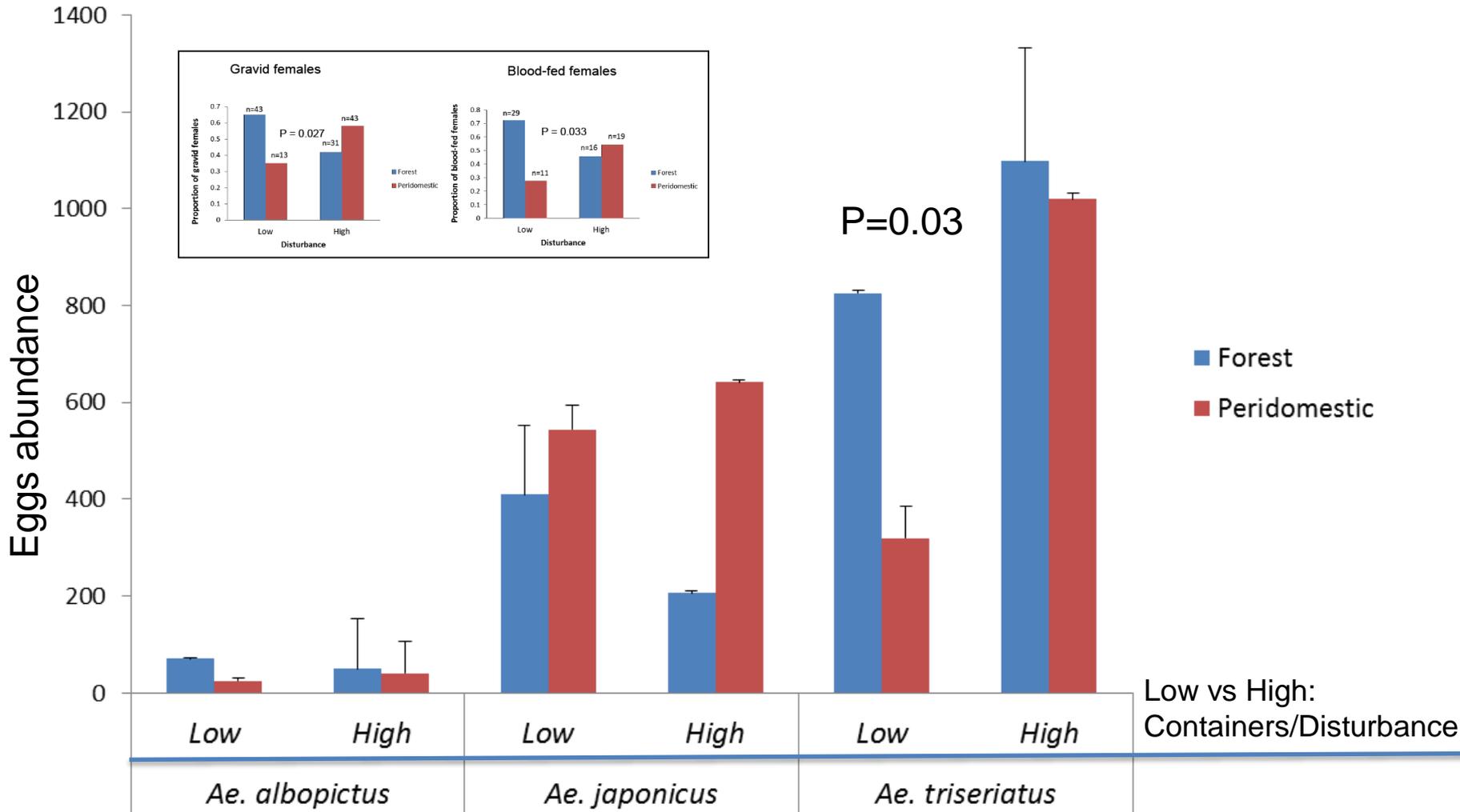


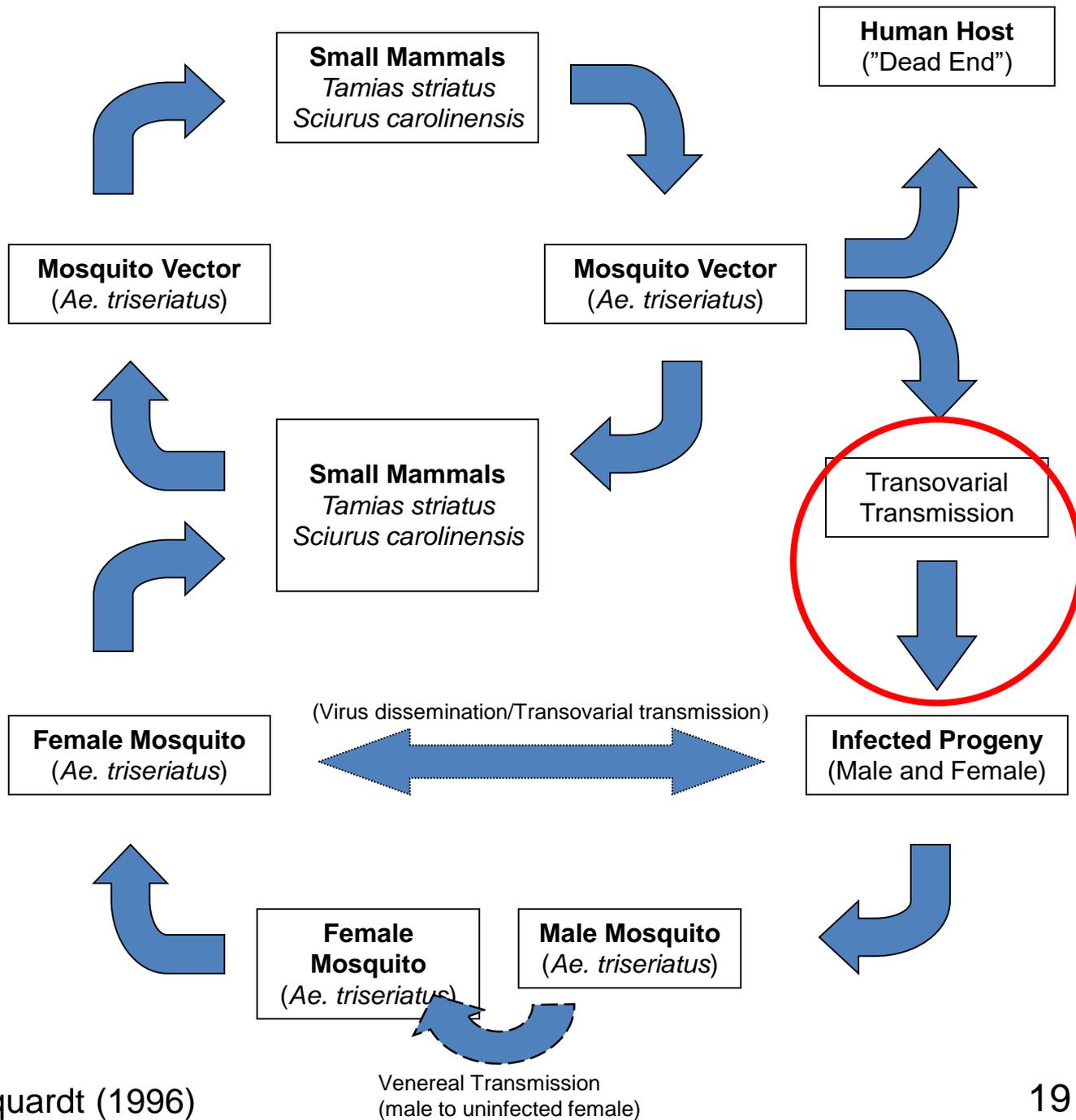
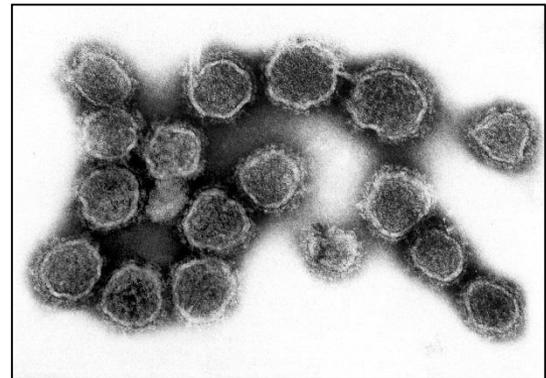
LACE Case Residence

Mosquito Larvae
 $n=62$ *Ae. albopictus*



Peridomestic Artificial Containers Increase the abundance of *Aedes triseriatus*







Aedes albopictus: “Asian Tiger Mosquito”

- Can transmit La Crosse virus
- Readily feeds on Humans
- Aggressive, Daytime Feeder



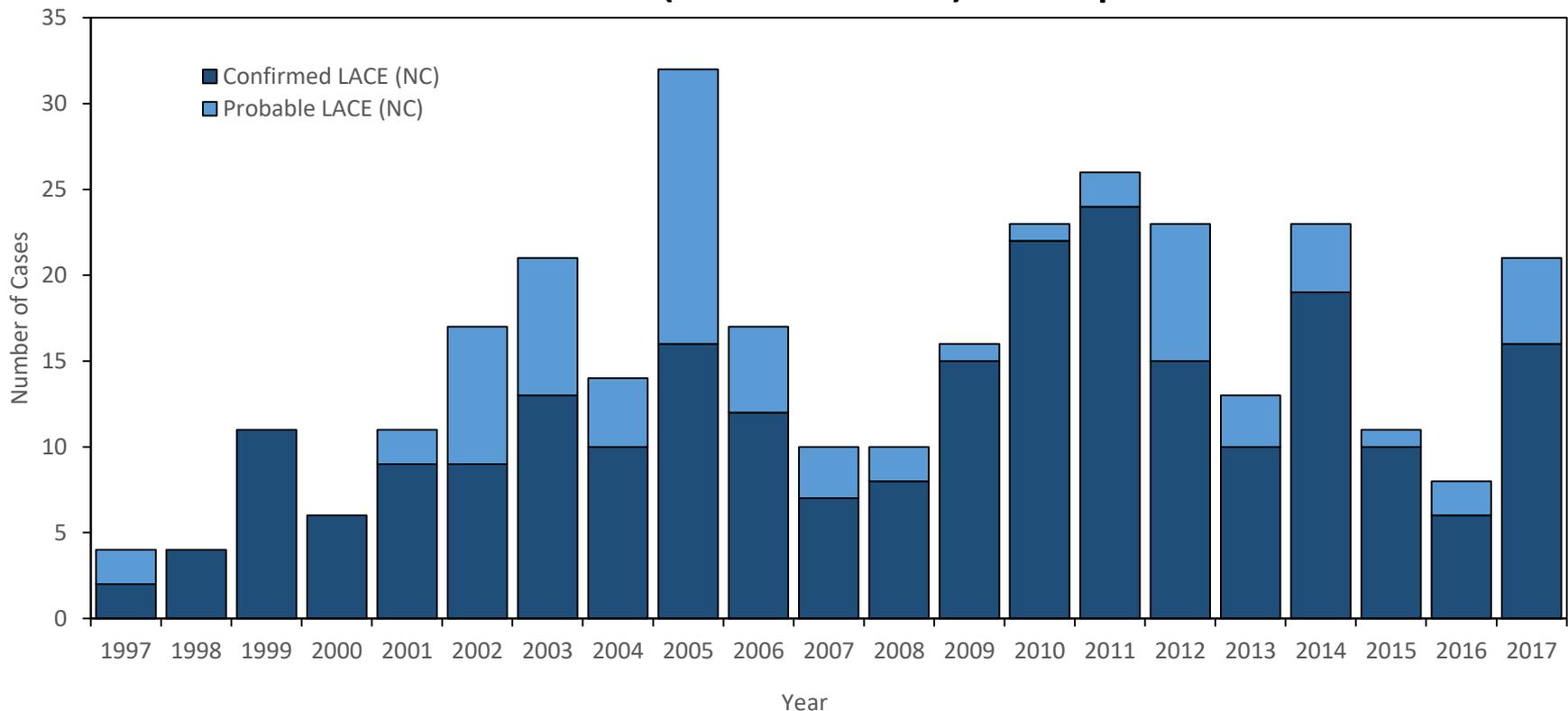
Aedes japonicus: “Asian Bush Mosquito”

- Can transmit La Crosse virus
- Feeds on Humans
- Less Aggressive, Daytime/Evening Feeder

East TN: LACv IRs for *Ae. japonicus* (0.63) were lower than *Ae. triseriatus* (2.72) and *Ae. albopictus* (3.01) (Westby et al., 2015)

Co-incident LACE

- Coincident disease may be a factor of shared: 1) residential risk, 2) behavioral risk, 3) familial/genetic predisposition, or other factors.
- Coincident LACE cases are expected to be rare. A review of surveillance records (1997-2017) was performed.



Coincident LACE

Coincident or Spatially Associated La Crosse Virus Disease Cases — North Carolina

---Coincident Cases---

Year (Onset Week)	Age (Sex)	Association	Laboratory evidence*	Outcome
2017 (30/31)	2 (M) 11 (M)	Sibling pair residing at same residence	LACV IgM ELISA positive (CSF and serum) LACV IgM ELISA and PRNT positive (serum)	Survived Survived
2011 (34)	5 (M) 8 (F)	Sibling pair residing at same residence	LACV IgM ELISA and PRNT positive (CSF and serum) LACV IgM ELISA and PRNT positive (serum) LACV RT-PCR positive (CSF)	Survived Died
2010 (37)	4 (M) 6 (F)	Sibling pair residing at same residence	LACV IgM ELISA positive (CSF and serum) LACV IgM ELISA positive (CSF and serum)	Survived Survived
2002 (25/26)	8 (F) 32 (F)	Caregiver and child residing at same residence	LACV IgM and IgG IFA positive (serum) LACV IgM and IgG IFA positive (serum x 2)	Survived Survived

---Spatially Linked Asynchronous Cases---

Years	Age (Sex)	Association	Laboratory evidence*	Outcome
2015 (29)	8 (F)	Sibling pair residing at same residence	LACV IgM ELISA and PRNT positive (serum)	Survived
2011 (36)	6 (M)		LACV IgM ELISA positive (CSF and serum)	Survived
2012 (27)	4 (M)	No familial relationship, linked by residence (Homeownership changed)	LACV IgM ELISA positive (CSF and serum)	Survived
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- These data suggest
 - Disease risk is focal and may be residentially-linked
 - Disease can occur coincidentally or asynchronously at the same physical residence
 - LHD outreach and environmental modifications at LACE residences may reduce further disease
 - Personal protection measures
 - Installing and repairing window or door screens
 - Removing containers of standing water

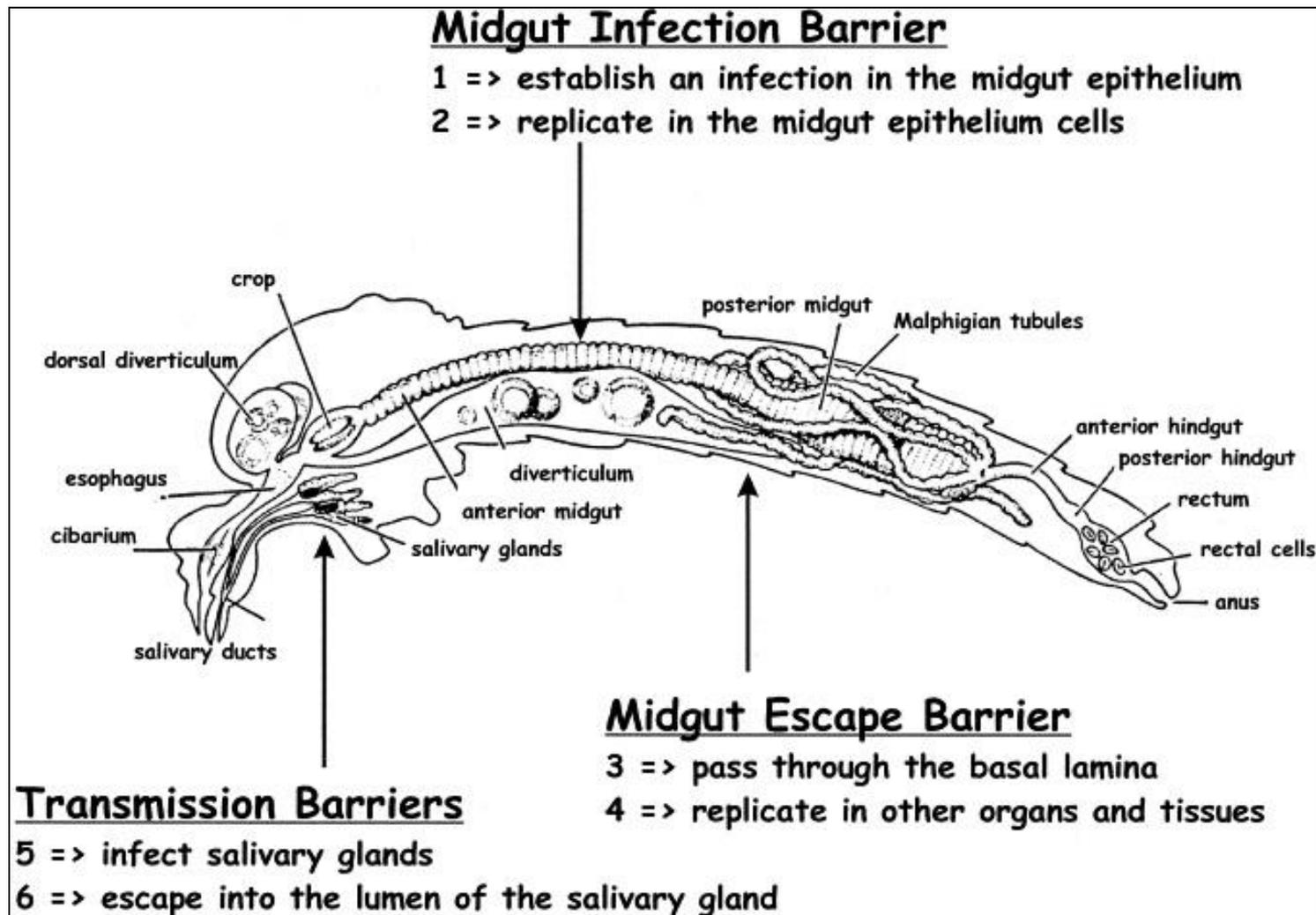
- Evidence-based control interventions should be evaluated
 - Physical modifications (tree hole management)
 - Barrier insecticide treatments
 - Autodissemination approaches (e.g., In2Care)
 - Passive “sink” traps (e.g., AGO, GAT)
- Methods that reduce entomologic risk should be recommended as a coordinated response to LACE cases

- We describe residentially-linked LACE cases that occurred coincidentally and asynchronously.
- Case Series: MMWR (Oct. 5th, 2018; Byrd et al.)
- Public health agencies should recommend risk reduction measures to all persons living at the residence of a LACE case.
- **Evidence-based mosquito control interventions that target LACV vectors should be evaluated in LACE endemic areas.**

Questions?

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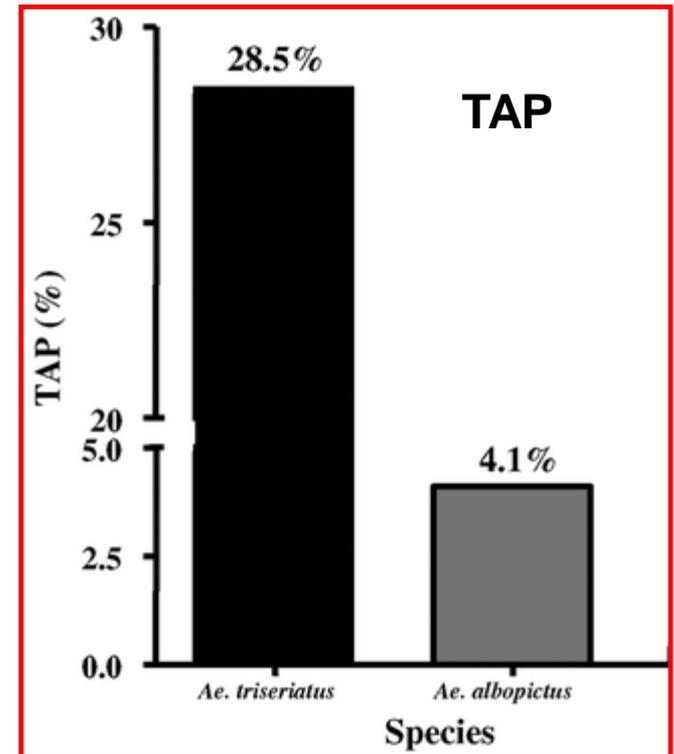
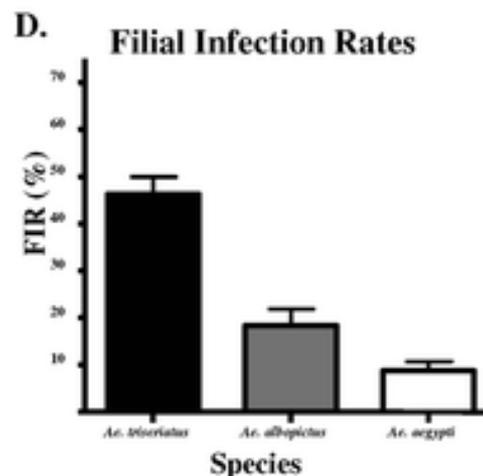
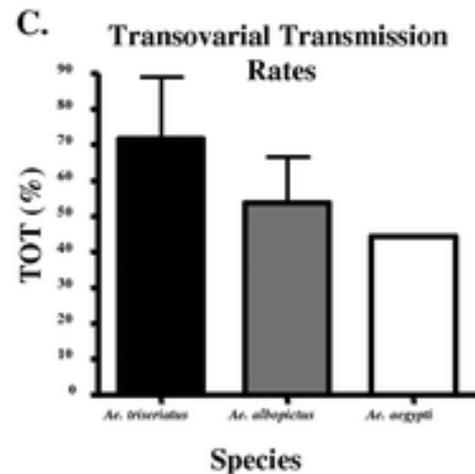
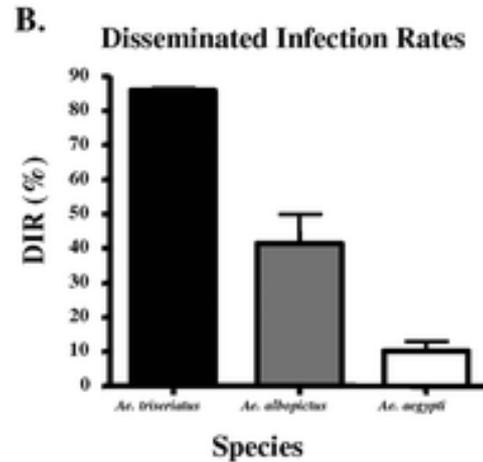
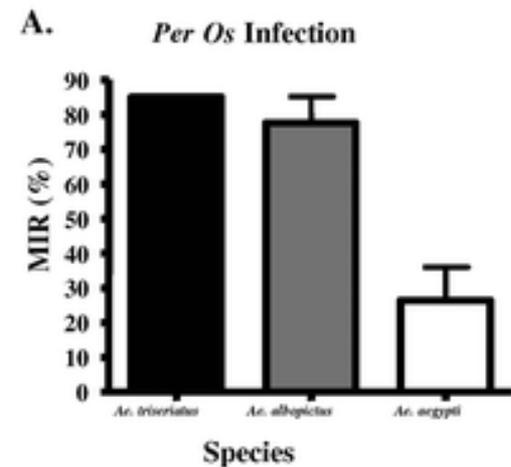




The proportion of infected mosquitoes that are orally exposed (infected) and then become infectious (virus in saliva) is called the vector competence.

The time period from exposure to infectious is called the extrinsic incubation period.

Transmission Amplification Potential



Hughes MT et al. Comparative potential of *Aedes triseriatus*, *Aedes albopictus*, and *Aedes aegypti* (Diptera: Culicidae) to transovarially transmit La Crosse virus. J Med Entomol. 2006 Jul;43(4):757-61.