

To Bite Or Not To Bite: **Mosquitoes and Transmission of West Nile and Eastern Equine Encephalitis Viruses in Connecticut**



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The Connecticut Agricultural Experiment Station



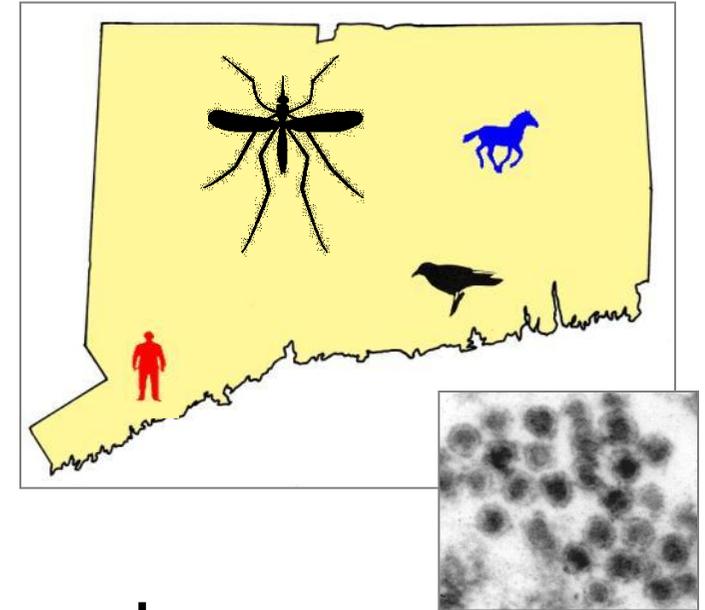
Connecticut Surveillance Program

- Primary Objectives

- Quantify level of virus activity
- Assess human risk
- Provide early warning of epidemic threats

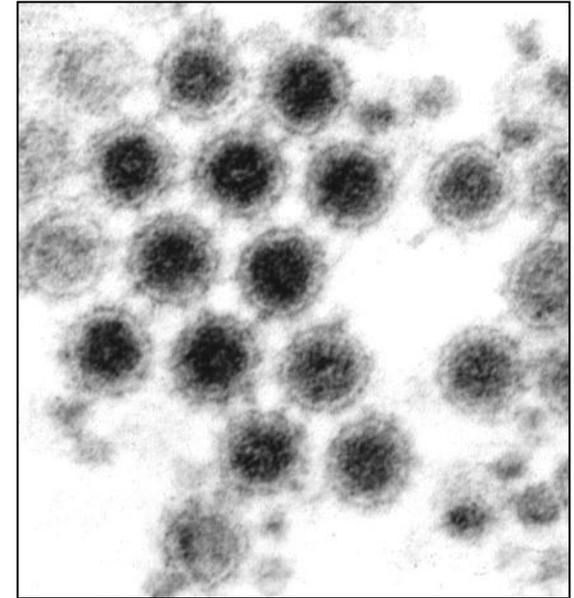
- Goals

- Prevent a sustained local outbreak
- Reduce the risk of human and domesticated animals' infections



Viruses Transmitted by Mosquitoes in Connecticut

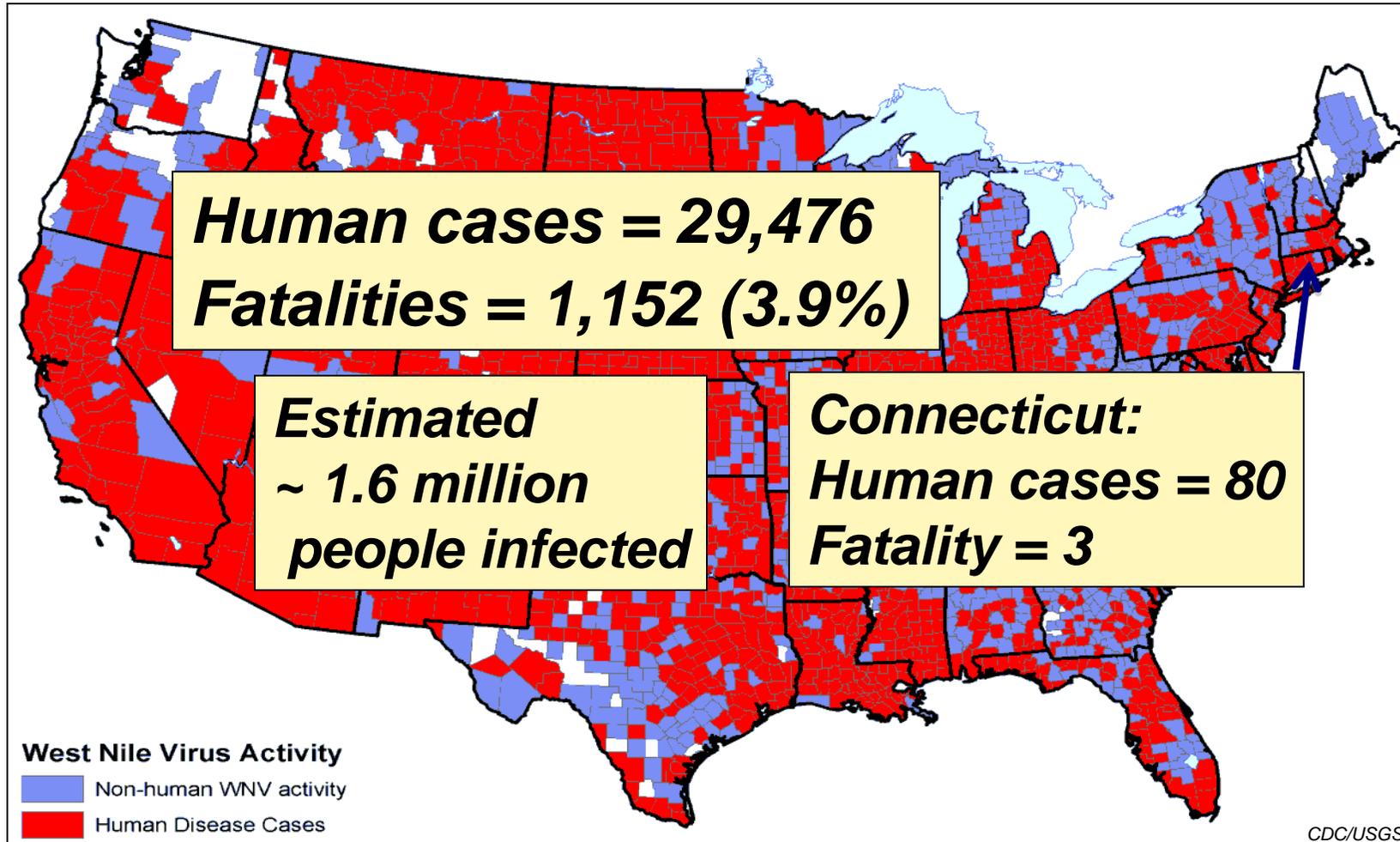
- West Nile Virus
- Eastern Equine Encephalitis
- Jamestown Canyon
- Cache Valley
- La Crosse Human Disease
- Highlands J
- Potosi
- Trivittatus
- Flanders



Photographed by Michael Thomas

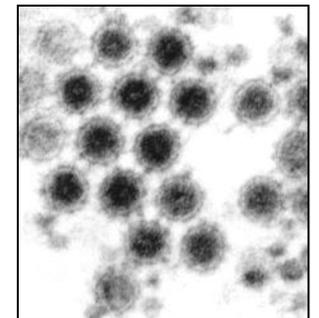
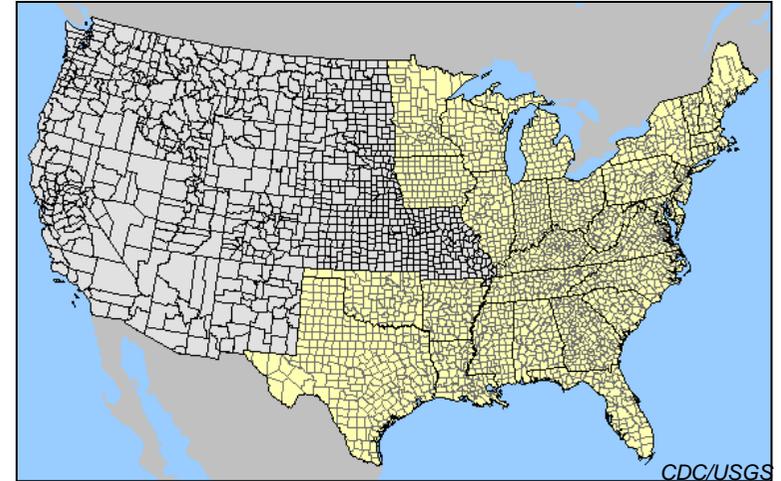


West Nile Virus Activity: 1999-2010

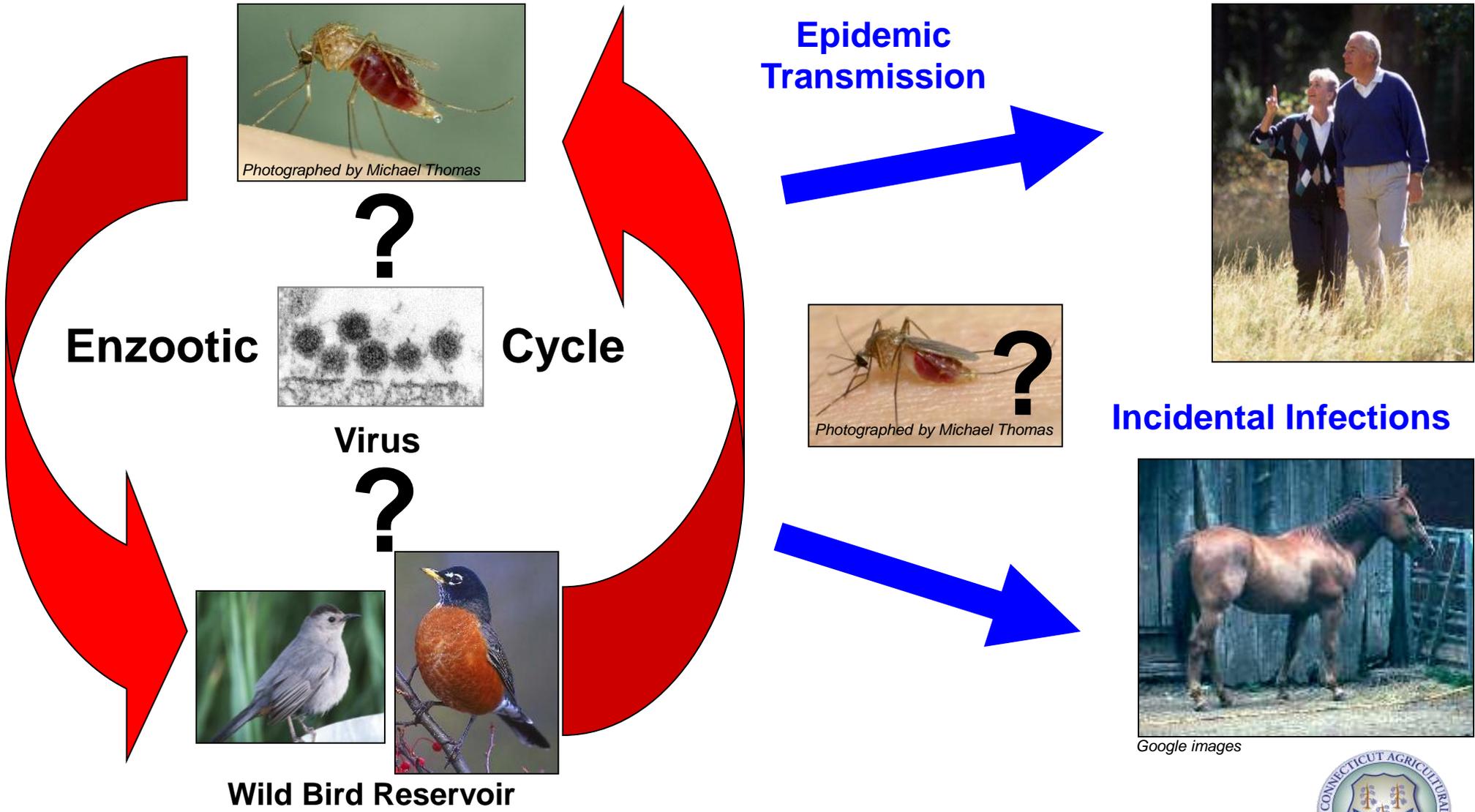


Eastern Equine Encephalitis Virus

- Geographic distribution
 - Eastern US
 - South America
- Disease
 - Encephalitis in humans and equines
 - 40% case fatality-rate
 - About 10 human cases each year in US
- Transmission
 - Maintained in a bird-mosquito cycle
 - Occurs in fresh-water hardwood swamps



WNV and EEEV Transmission Cycle



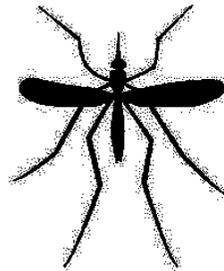
Primary and **Secondary** Mosquito Vectors of WNV and EEEV

WNV

Culex pipiens

Culex restuans

Culex salinarius



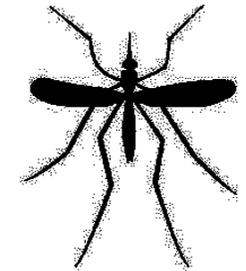
Aedes vexans

Culiseta melanura

EEEV

Culiseta melanura

Culiseta morsitans



Coquillettidia perturbans

Ochlerotatus canadensis

Incriminating Evidence Against Mosquitoes

- Abundant



- Physiologically competent



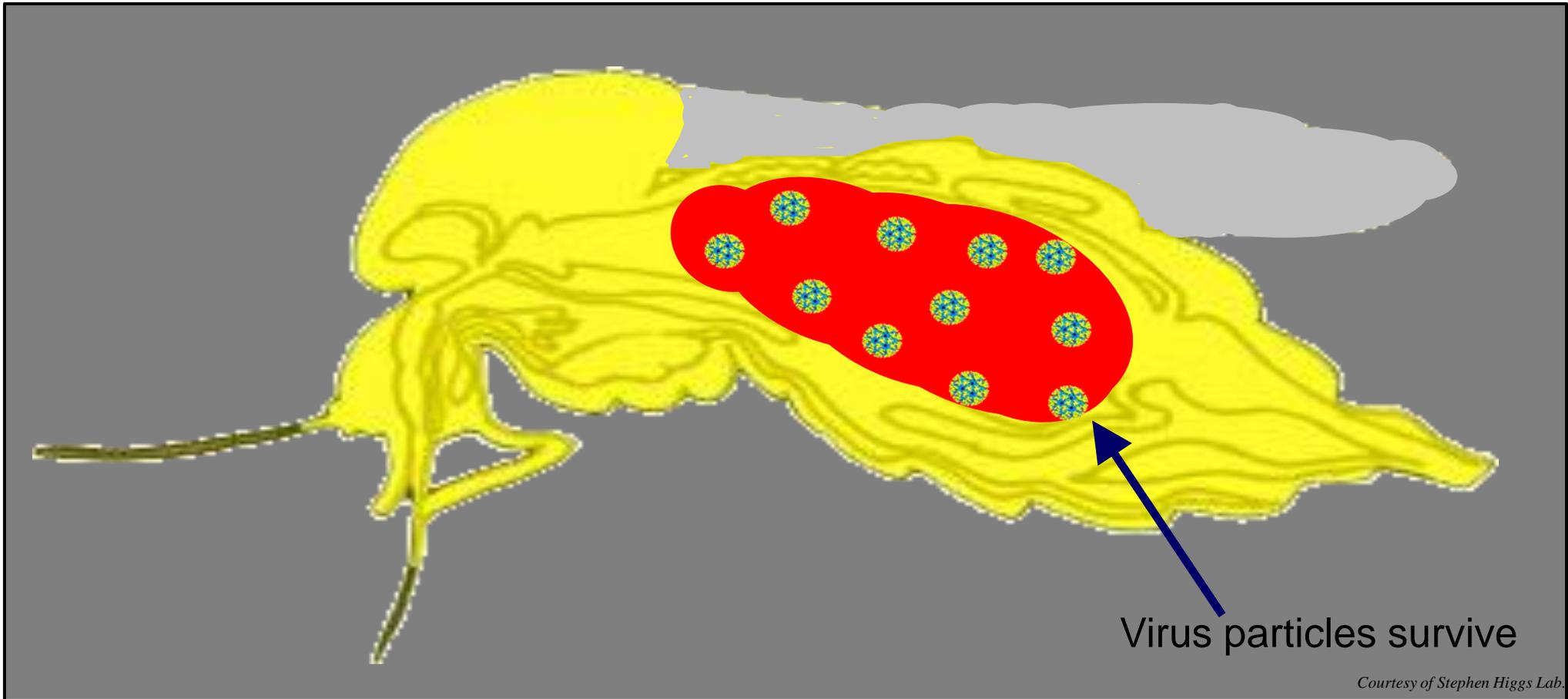
Photographed by Michael Thomas

Infection of Mosquito Feeding on a Viremic Animal



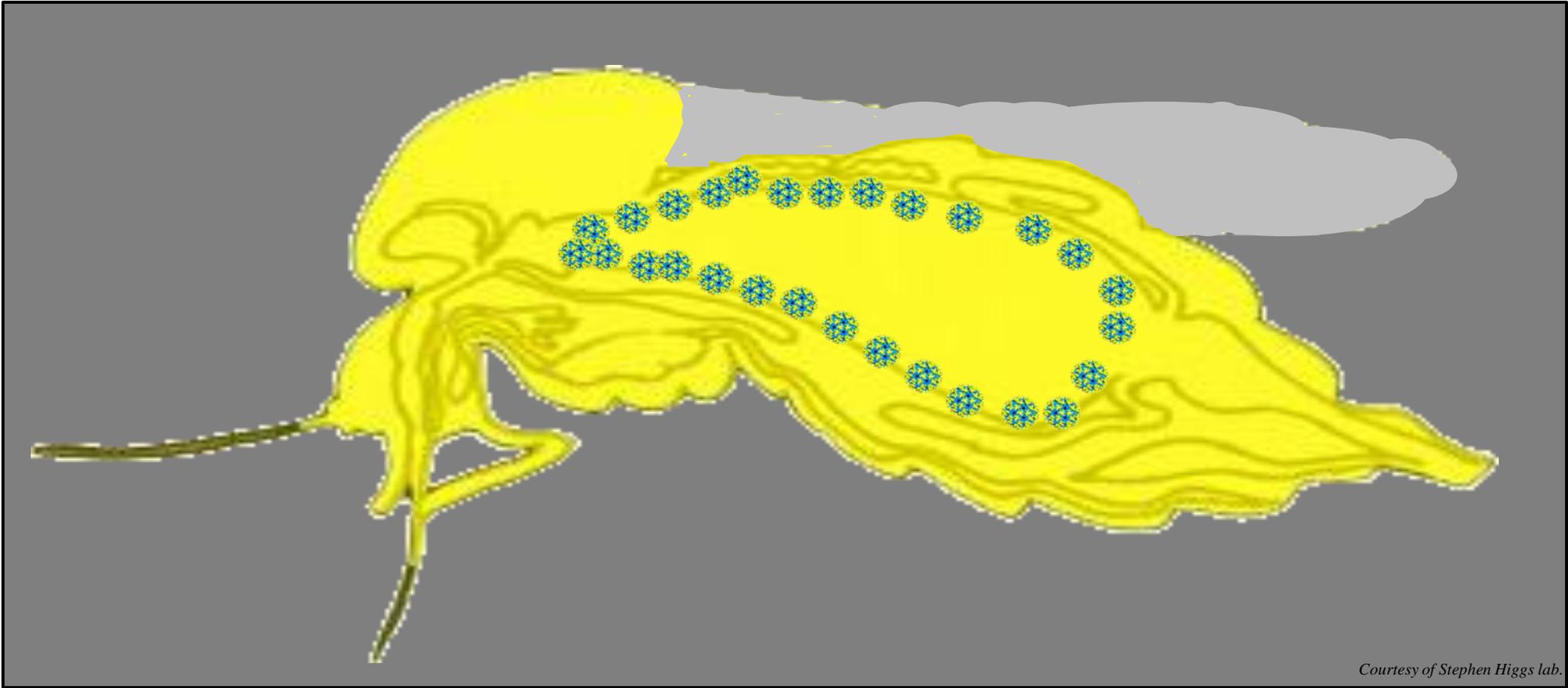
Virus particles in blood

Digestion of Blood



Courtesy of Stephen Higgs Lab.

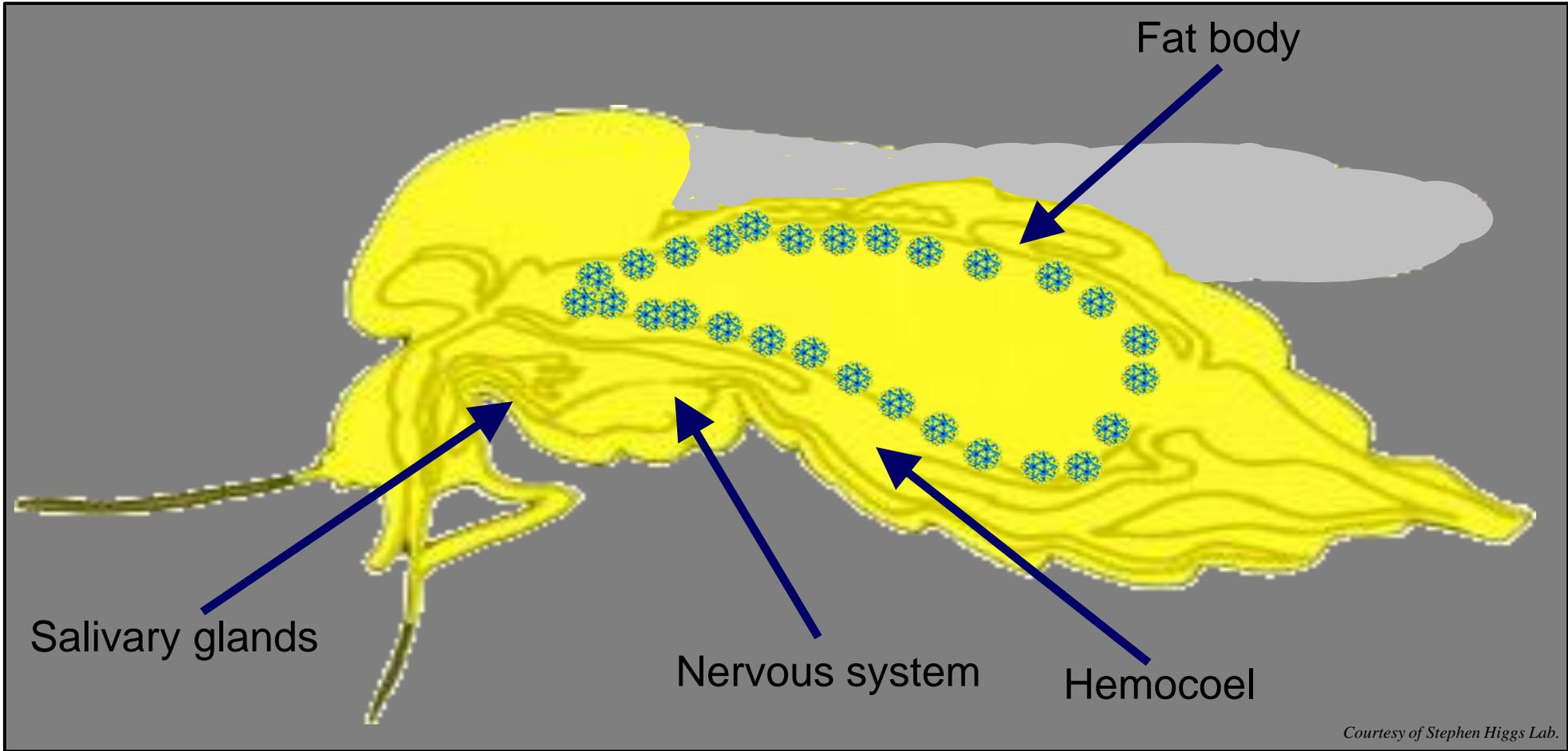
Replication of Virus within Midgut



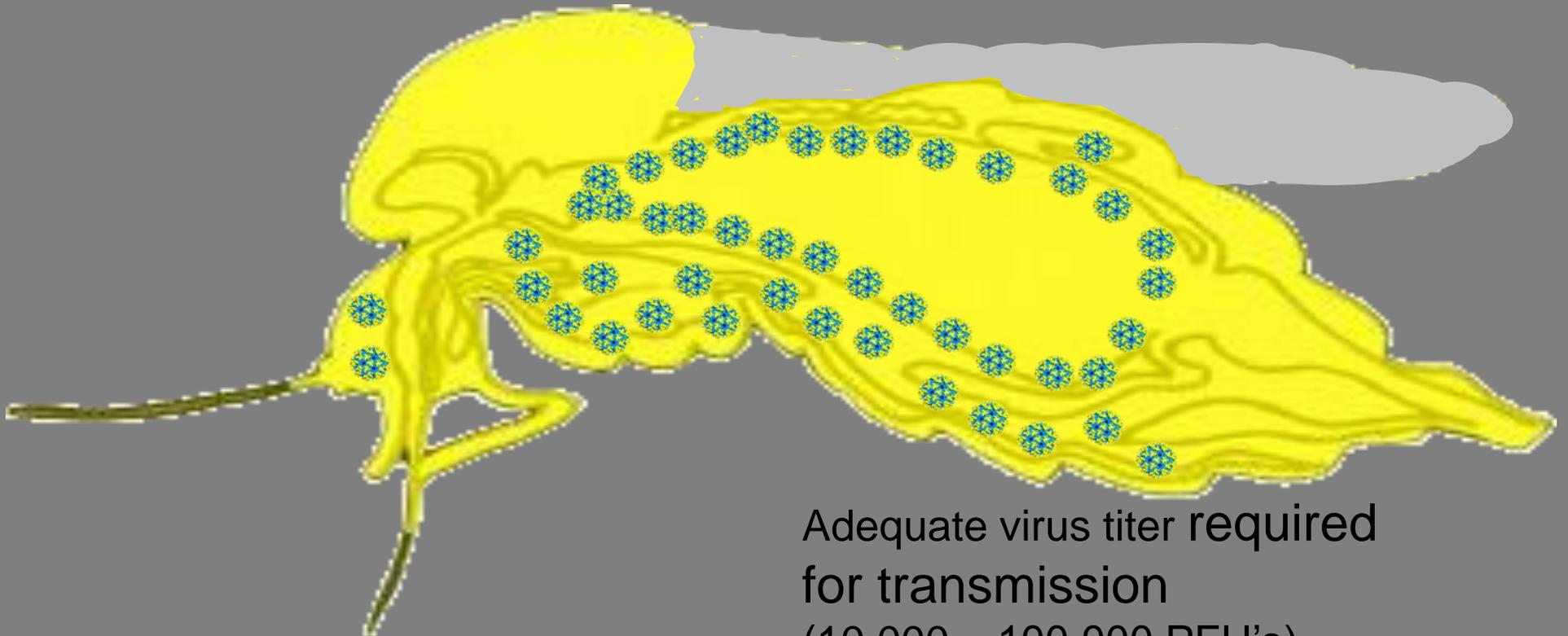
Courtesy of Stephen Higgs lab.



Dissemination from the Midgut into Secondary Tissues



Virus Replication in Secondary Tissues in Body

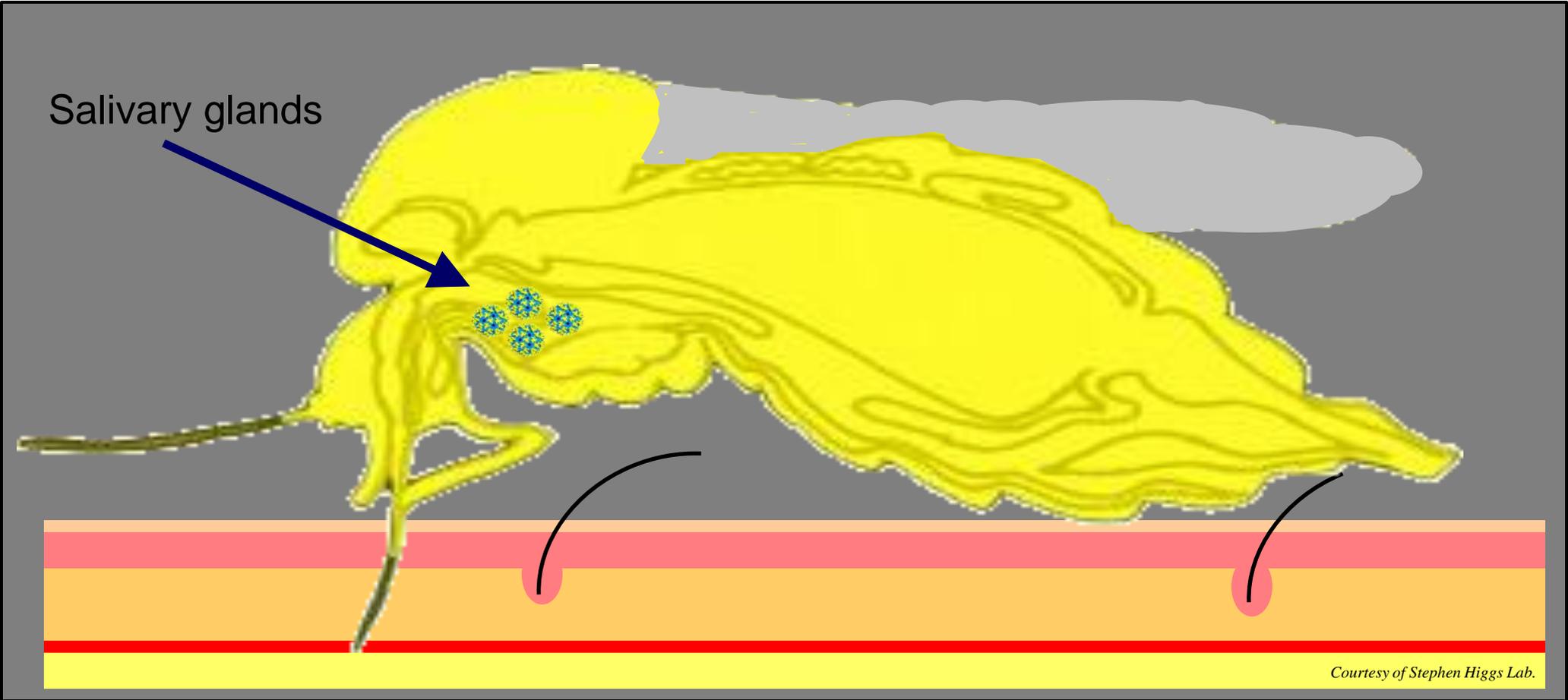


Adequate virus titer required
for transmission
(10,000 – 100,000 PFU's)

Courtesy of Stephen Higgs Lab.



Transmission of Virus from Mosquito to New Host



Incriminating Evidence Against Mosquitoes

- Abundant
- Physiologically competent

- Frequent infection in nature



Number and Percentage of Virus Isolates from Mosquito Vectors of WNV (1999-2010)

WNV

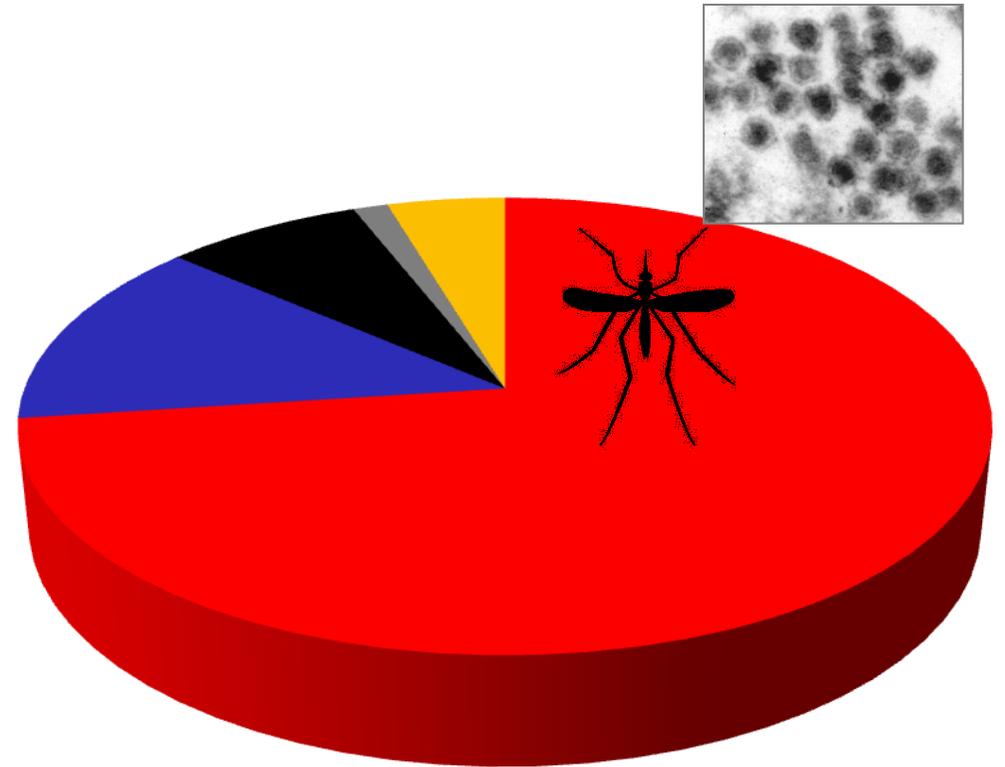
Culex pipiens (704, 70.3%) 

Culex restuans (129, 12.9%) 

Culex salinarius (74, 7.4%) 

Aedes vexans (13, 1.3%) 

Culiseta melanura (44, 4.4%) 



Number and Percentage of Virus Isolates from Mosquito Vectors of EEEV (1996-2010)

EEEV

Culiseta melanura (189, 57.6%)



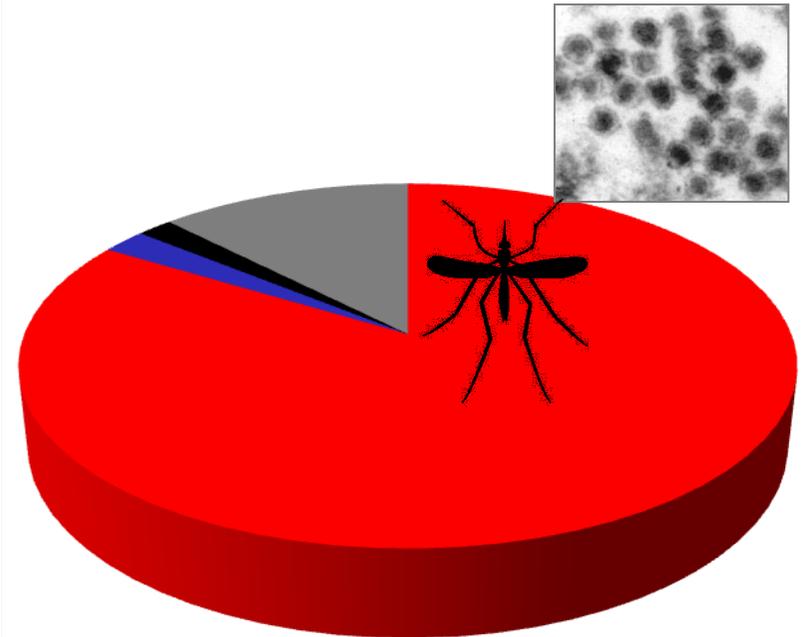
Culiseta morsitans (5, 1.5%)



Coquillettidia perturbans (4, 1.2%)



Ochlerotatus canadensis (28, 8.5%)

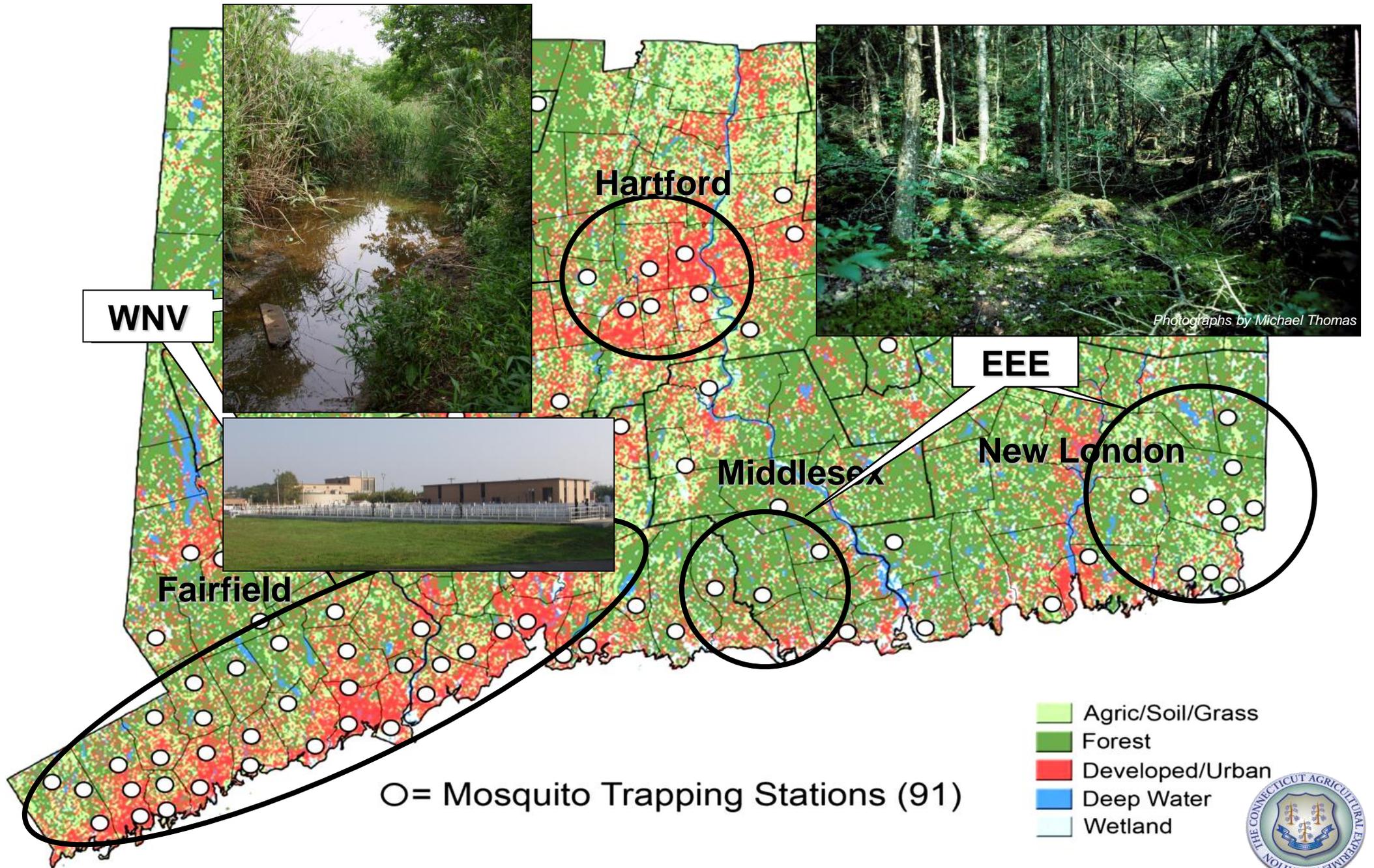


Incriminating Evidence Against Mosquitoes

- Abundant
- Physiologically competent
- Frequent infection in nature



- Acquire blood meals frequently from key vertebrate hosts



CO₂-baited CDC Light Trap



Gravid Trap



Backpack Aspirator





Photographed by Michael Thomas

Mosquito Resting Box



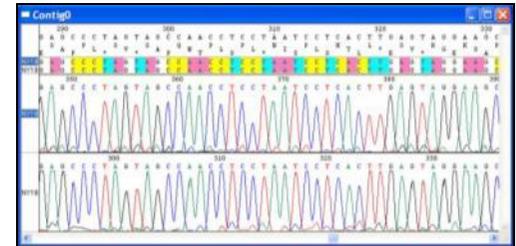
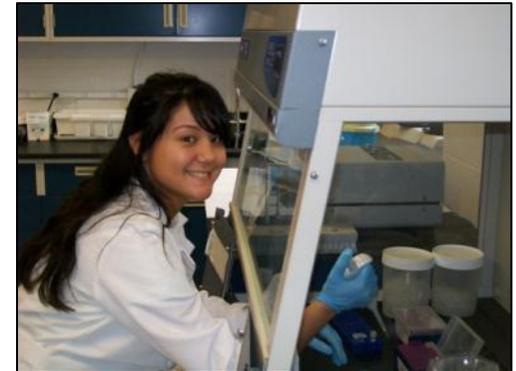


Photographed by Michael Thomas

Mosquito Resting Box (Nursery Pot)

Mosquito Blood Feeding Studies-Materials and Methods

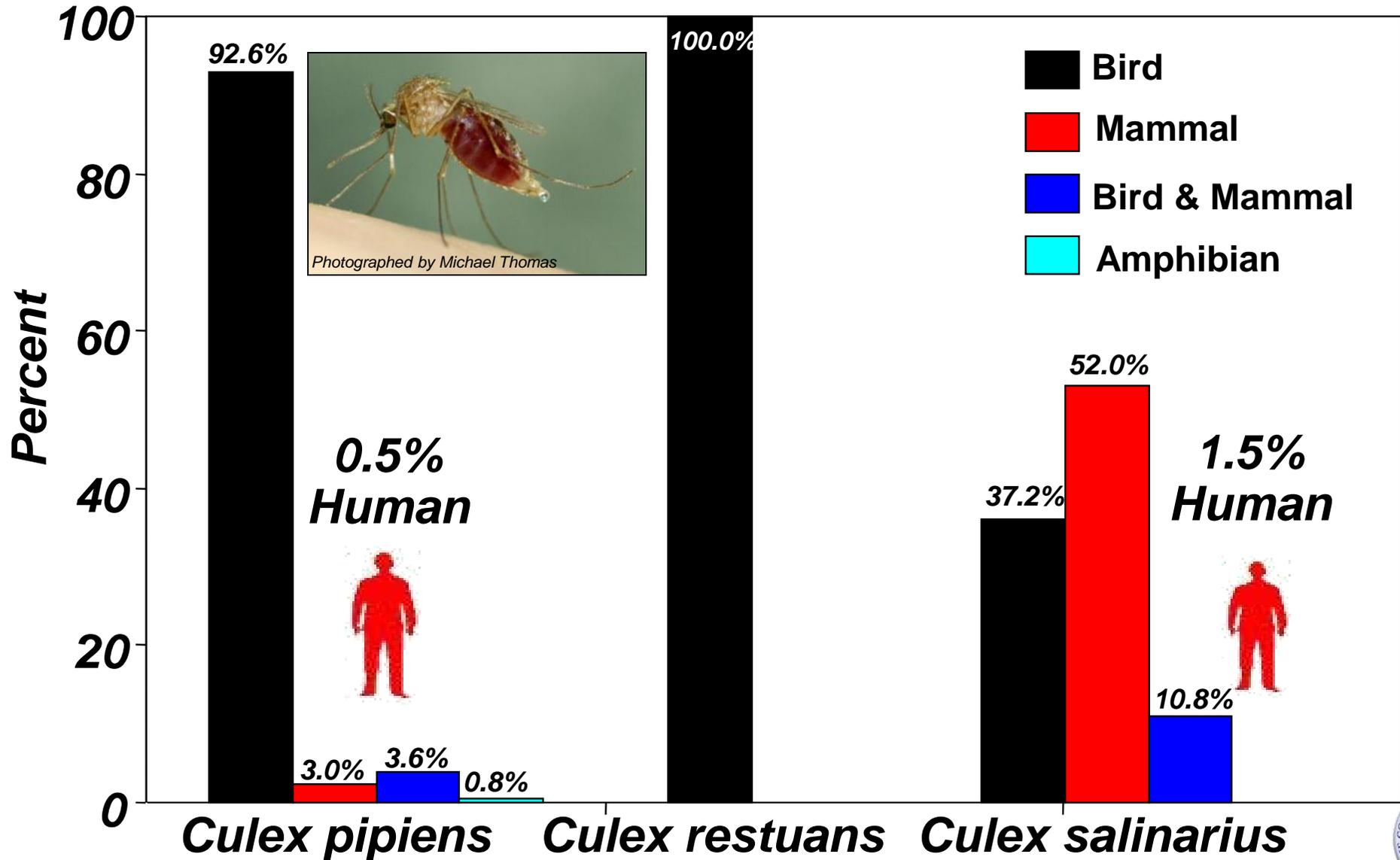
- Abdomens were removed and used for DNA isolation.
- DNAs from blooded abdomens were screened (by PCR) for a gene that is diagnostic for identification of birds and mammals.
- Bird and mammal hosts were identified to species by comparing DNA sequences to the GenBank® sequence data base.



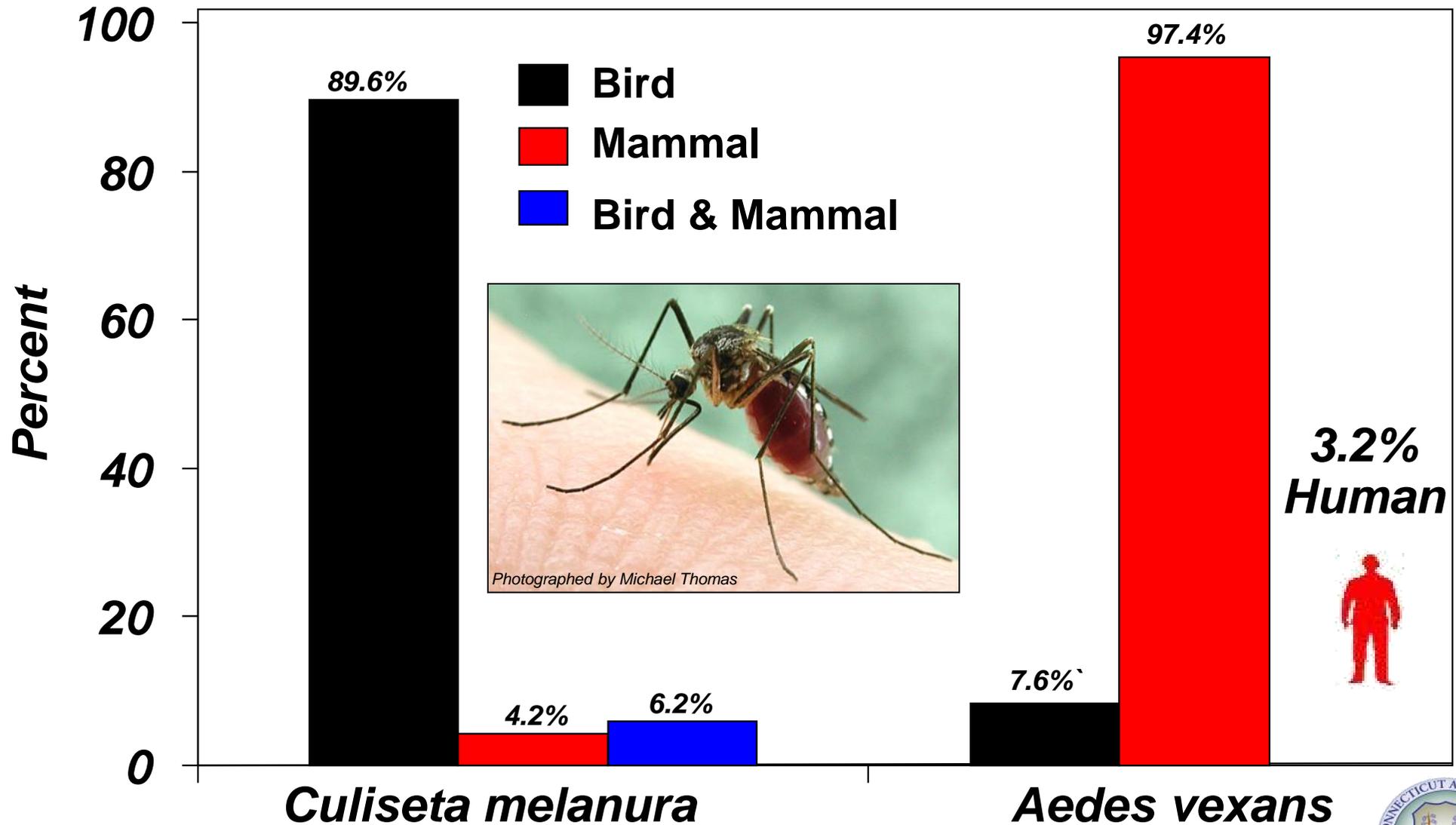
nucleotide-nucleotide **BLAST**



Blood-Feeding of WNV Primary Vectors

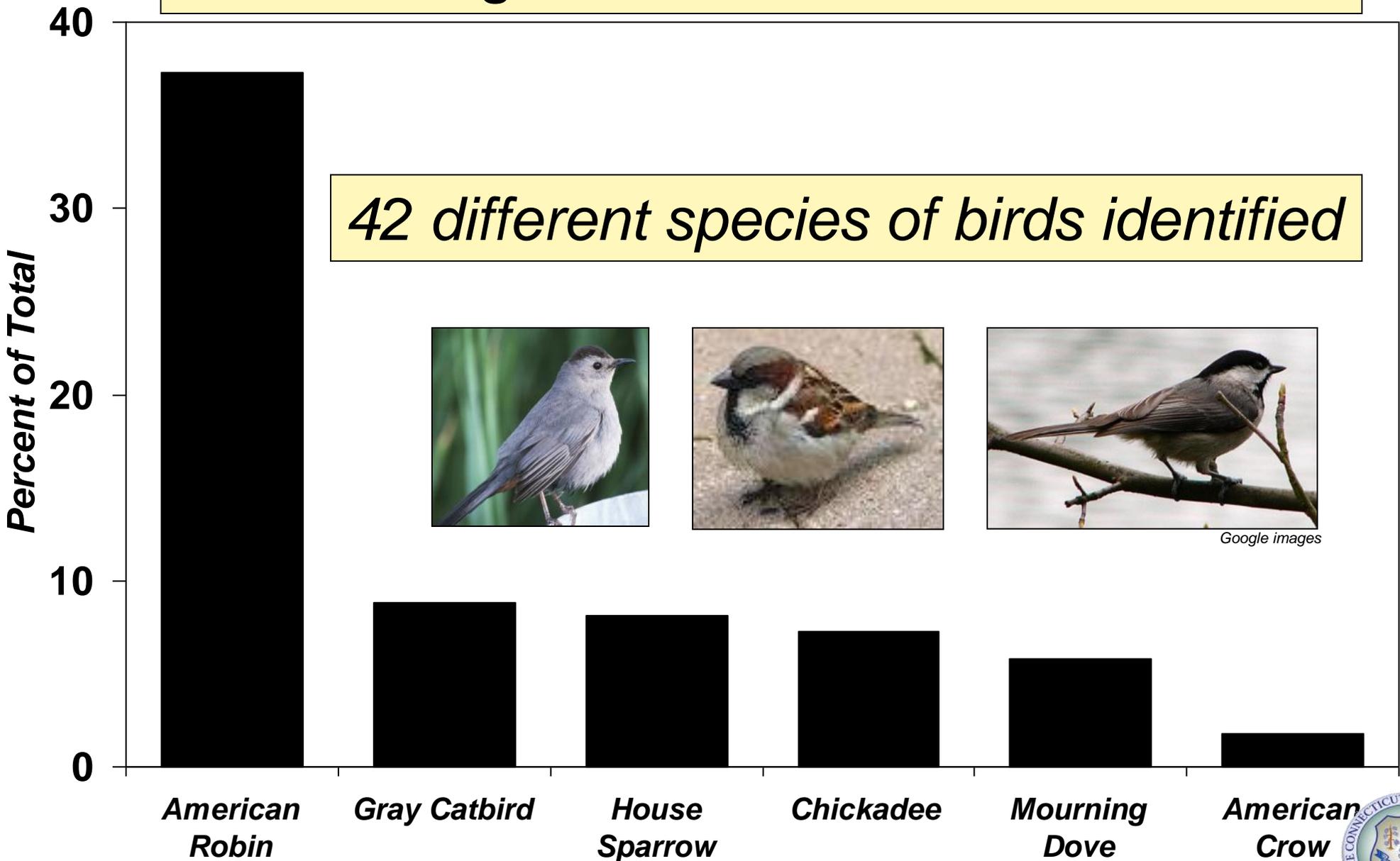


Blood-Feeding of WNV Secondary Vectors



Percentage of Bird-Derived Blood Meals

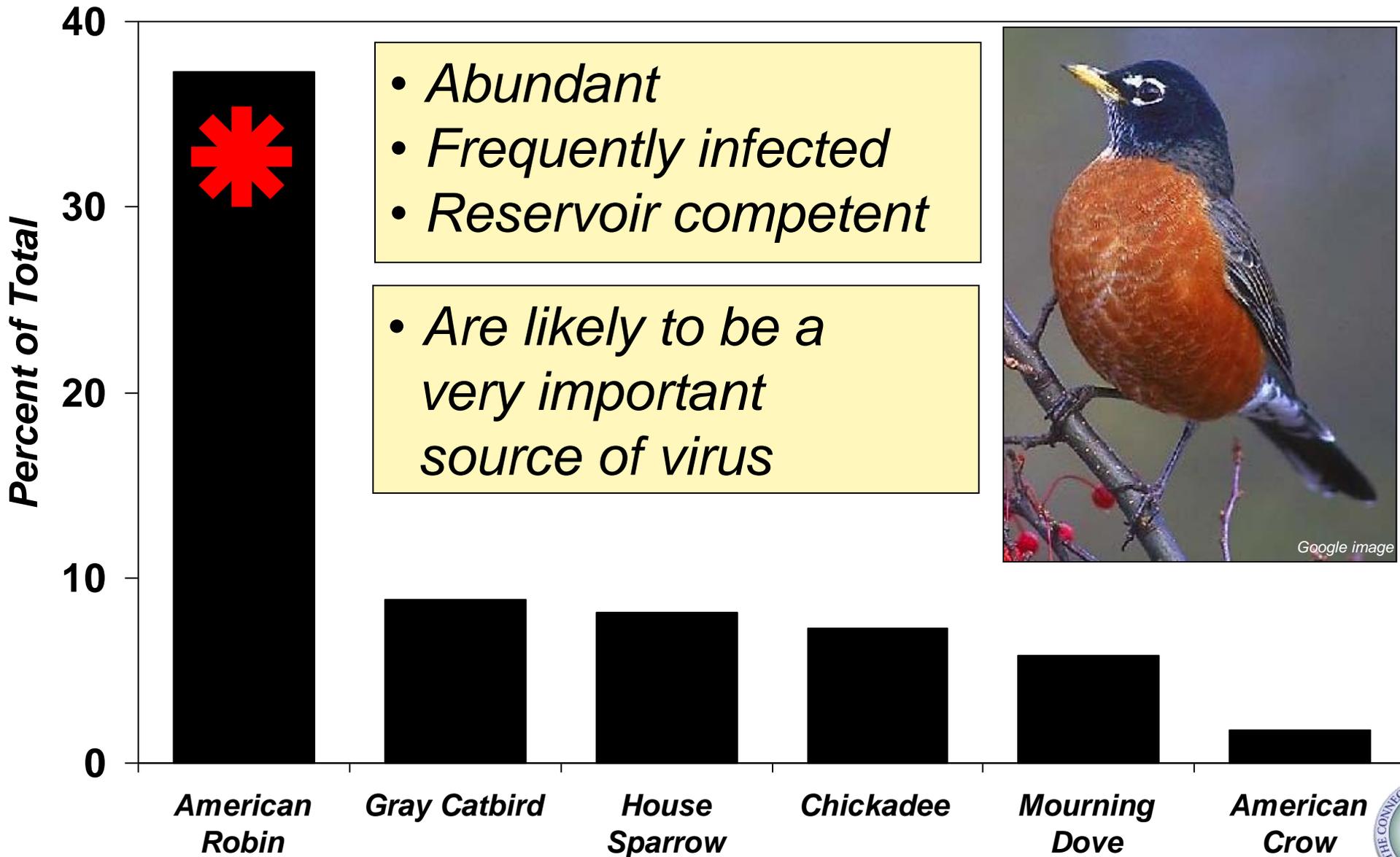
42 different species of birds identified



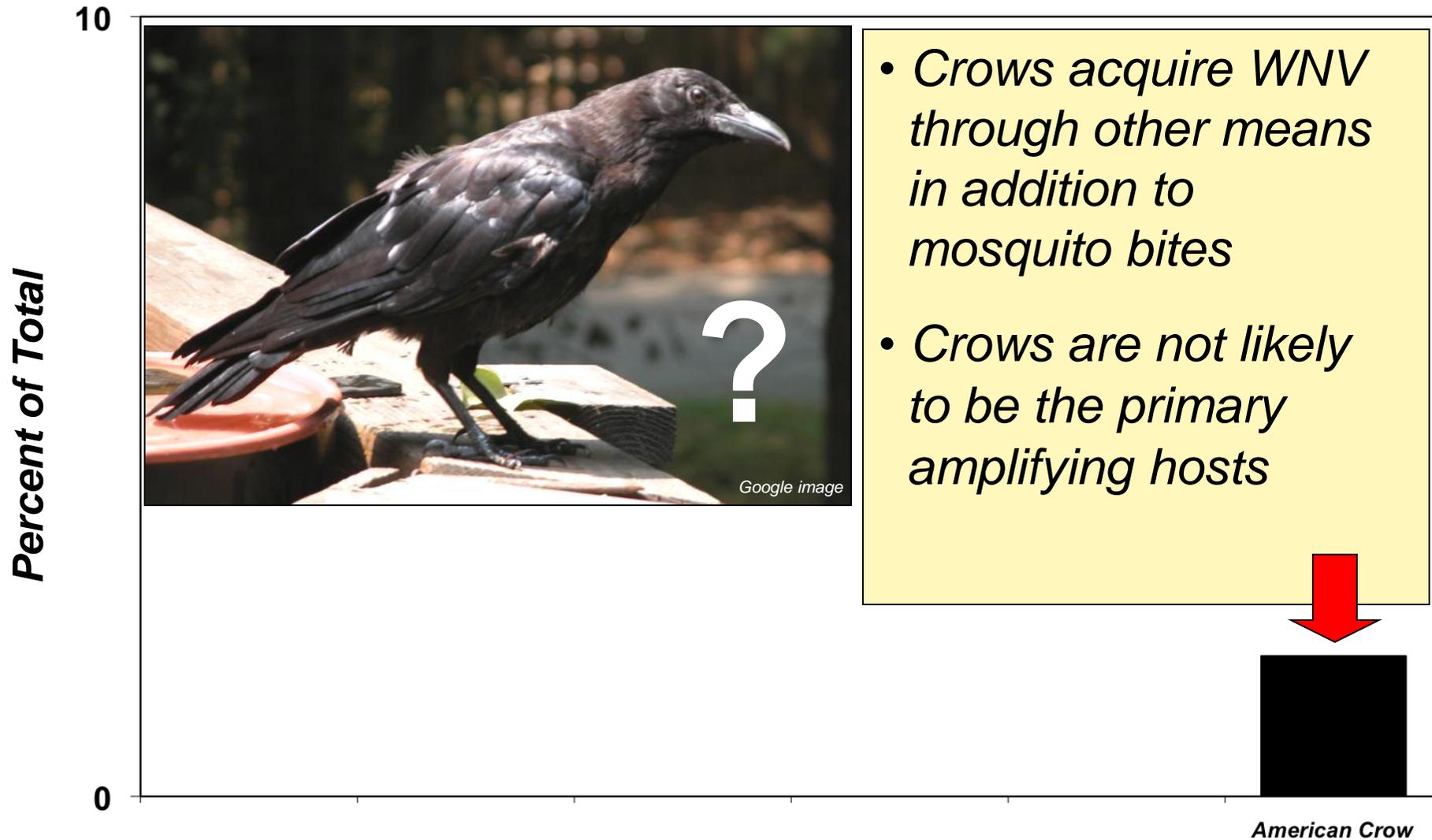
Google images



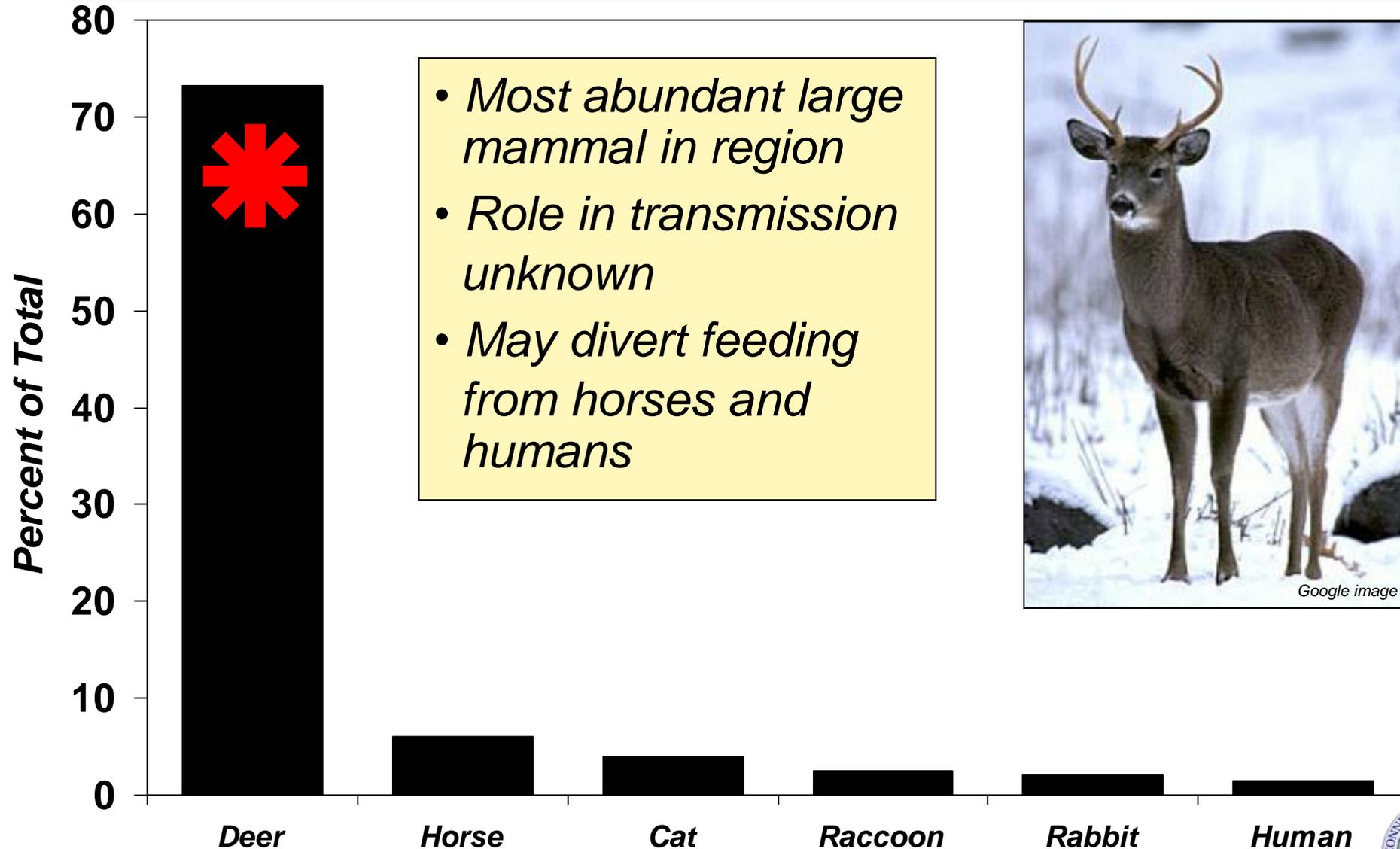
Percentage of Bird-Derived Blood Meals



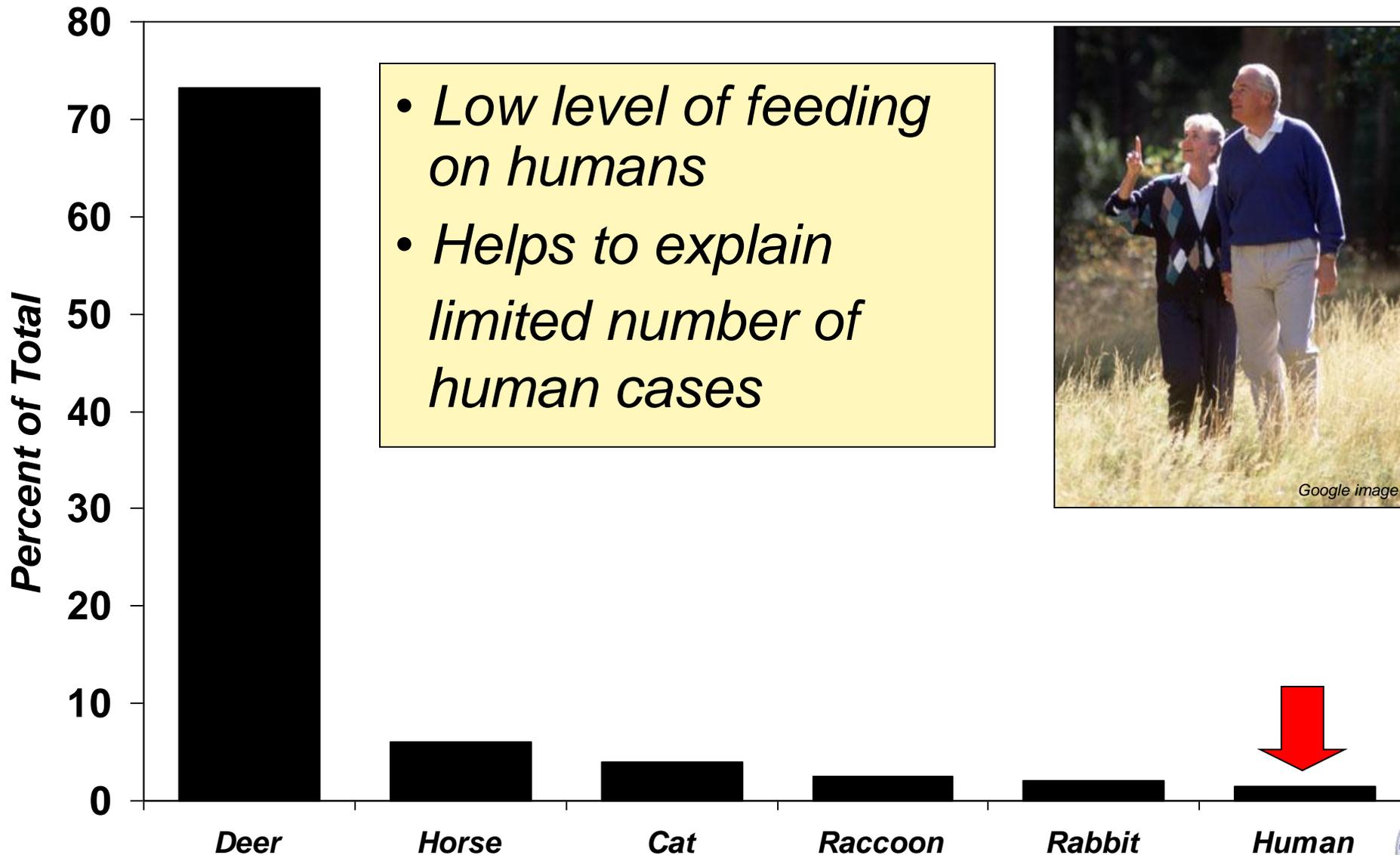
Percentage of Bird-Derived Blood Meals



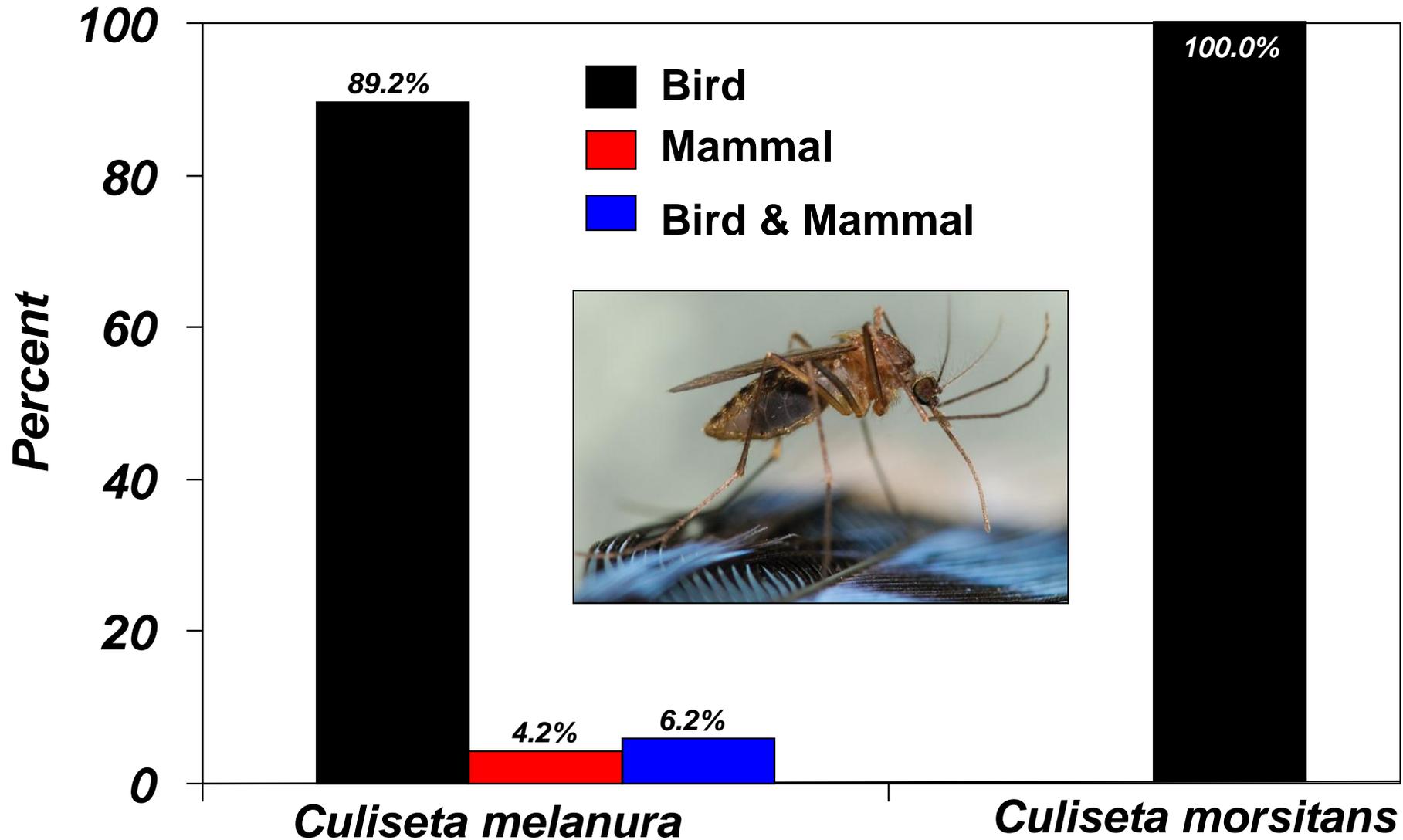
Percentage of Mammal-Derived Blood Meals



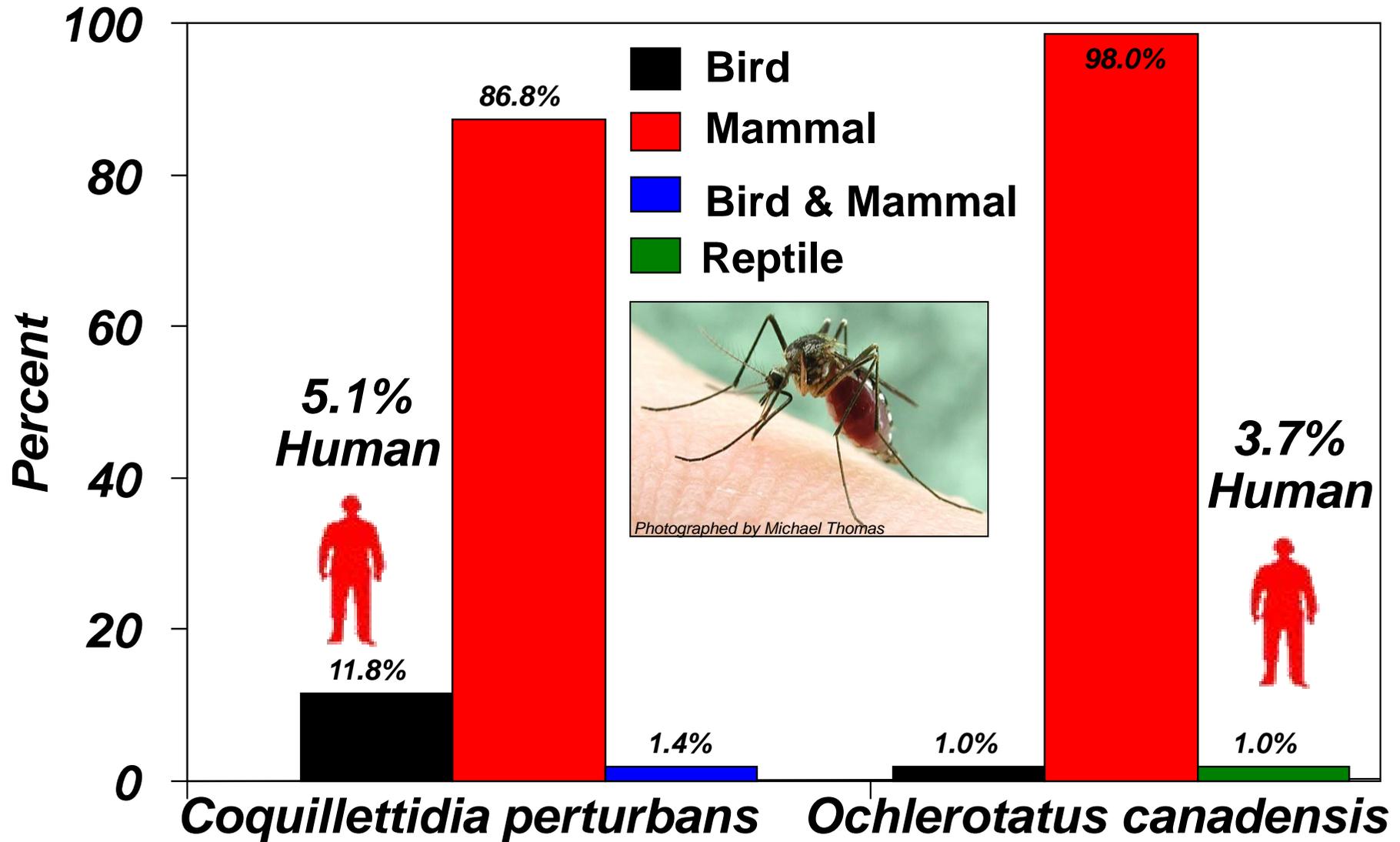
Percentage of Mammal-Derived Blood Meals



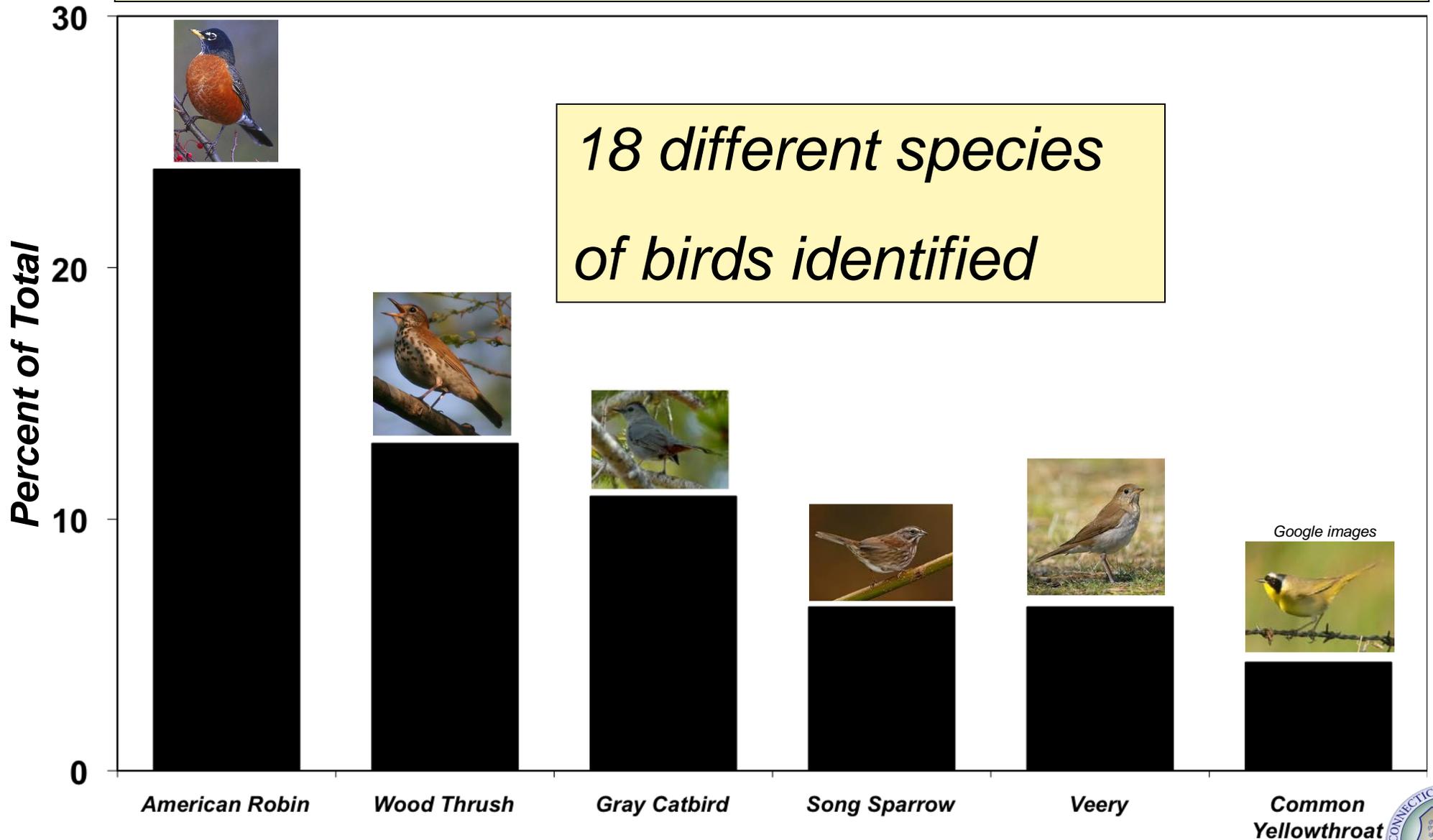
Blood-Feeding of EEEV Primary Vectors



Blood-Feeding of EEEV Secondary Vectors



Bird-Derived Blood Meals in EEEV Vectors



Northeastern US WNV Transmission Cycle

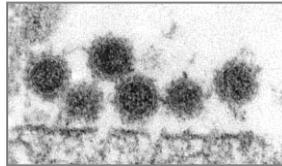


■ ■ ➔ **Overwinter**



Photographed by Michael Thomas

Culex pipiens
Culex restuans
Culiseta melanura



Virus

**June
to
October**

**Enzootic
Cycle**



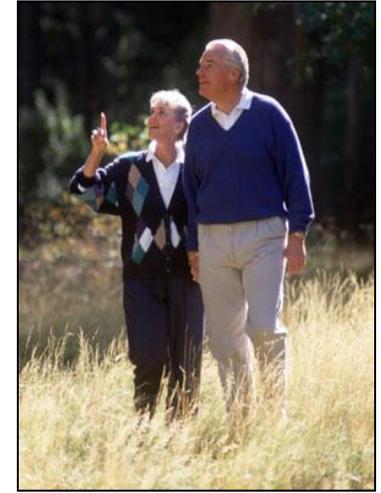
**Wild Bird Reservoir and
Amplifying Hosts**

**Epidemic
Transmission**

Culex salinarius
Culex pipiens
Aedes vexans



Photographed by Michael Thomas



Incidental Infections



Google images

August to October



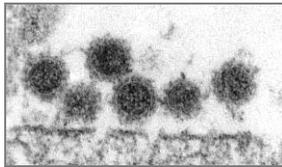
Northeastern US EEEV Transmission Cycle



■ ■ ➔ *Overwinter ?*



Culiseta melanura
Culiseta morsitans



Enzootic Cycle

June to October

Virus

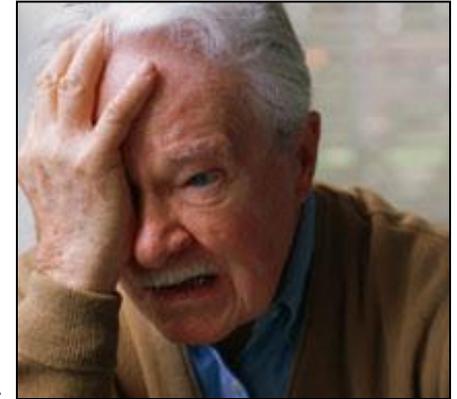


Wild Bird Reservoir and Amplifying Hosts

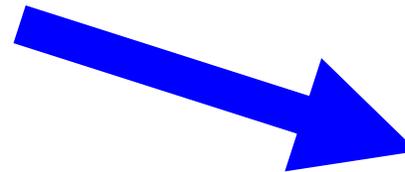
Epidemic Transmission



Coquillettidia perturbans
Ochlerotatus canadensis



Incidental Infections



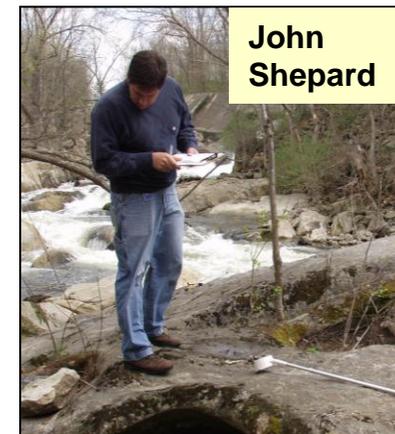
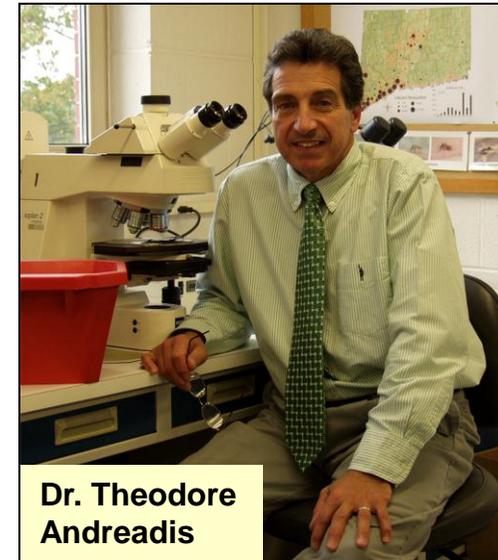
August to October



Google images



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**Bonnie
Hamid**



**Michael
Vasil**



**Michael
Micensik**



**Angela
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Thank you



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