Patterns of host use of *Culicoides* spp. in Florida: Implications for pathogen transmission and vector interventions

Nathan Burkett-Cadena, PhD
UF | IFAS | Florida Medical Entomology Laboratory
BTV
Blue-Tongue Virus

EHDV
Epizootic Hemorrhagic Disease Virus
EHDV:
Transmitted by no-see-ums.
Affects domestic and wild ruminants, especially deer.
Species of no-see-um that transmit EHDV in Florida are not known.
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How can we protect deer against EHDV & BTV?

Treatments?

No! Specific treatments aren’t available.
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Treatments?
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Vaccinate?
No! Current vaccines aren’t protective.
How can we protect deer against EHDV & BTV?

Treatments?
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Vaccinate?
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Vector control?
Yes – if we can determine the vector species!
No-see-ums are diverse!

~50 species of *Culicoides* occur in Florida.
No-see-ums are diverse!

~50 species of *Culicoides* occur in Florida.

Each species has particular breeding and feeding habits.

Examples of breeding habitats:

<table>
<thead>
<tr>
<th>Mud</th>
<th>Stream edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsh</td>
<td>Tree-holes</td>
</tr>
<tr>
<td>Pond edge</td>
<td>Seepage</td>
</tr>
<tr>
<td>Puddle</td>
<td>Sunny sites &amp; shady sites</td>
</tr>
</tbody>
</table>
Larval habitat of *Culicoides* species

**C. stellifer**
- 84% puddle + muddy

**C. haematopotus**
- 90% stream edge + muddy

**C. venustus**
- 63% puddle + muddy
- 31% seepage

Data from E. Blosser
~40 *Culicoides* species collected (of ~50 total in FL)

- C. insignis
- C. floridensis
- C. furens
- C. haematapotus
- C. edeni
- C. stellifer
- C. crepuscularis
- C. arboricula
- C. debilipalpis
- C. pusillus
- C. pallidicornis
- C. paraensis
- C. knowitoni
- C. scanloni
- C. venustus
- C. hinmani
- C. nanus
- C. torreyae
- C. beckae
- C. baueri
- C. biguttatus
- C. guttipennis
- C. tissoti
- C. villosipennis
With all of this diversity, how do we figure out which of these ~50 no-see-um species are important vectors of EHDV in Florida?
Vector “incrimination”

1. An association in time and space between the a suspected vector species and cases of disease: Identify the *Culicoides* species that are present, and abundant, during seasons when deer are becoming infected with EHDV.

2. Evidence of direct contact between the the suspected vector species and the host animals (deer): Identify the *Culicoides* species that bite deer and other susceptible animals.

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1. Identify blood-fed no-see-ums
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1. Identify blood-fed no-see-ums

2. Host DNA extraction
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3. PCR replication of host DNA
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1. Identify blood-fed no-see-ums
2. Host DNA extraction
3. PCR replication of host DNA
4. DNA sequencing

```
AAACTGATCTACCGTGACGAGGCTGTAACACACATACGAACGAG
CTGGTATACACACATAGACGAG
AAGACCTGTGGGCTGTTAAACCAA
AAAACTGATCTACGTCGACAAA
GCTGGTATACTACACATAAGACGAG
GAAGACCCCTGTGGGCTTAAACCAA
```
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```plaintext
AAACTGATCTACCAGTACAAAG
CTGGTATACACACATAAGACGAG
AAGACCCTGTGGAGCTTAAACC
AAAACTGATCTACCAGTACAAAA
GCTGGTATACACACATAAGACGAG
AAGACCCTGTGGAGCTTAAACC
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GCTGGTATACACACATAAGACGAG
GAAGACCCTGTGGAGCTTAAACC
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Determining which *Culicoides* species bite deer and other susceptible animals: Bloodmeal analysis

1. Identify blood-fed no-see-ums
2. Host DNA extraction
3. PCR replication of host DNA
4. DNA sequencing
5. Match DNA sequences to host

- AACTGATCTACCATGACTAAAAG
- CTGGTATACACACATAAGACGAG
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- CTGGTATACACACATAAGACGAG
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- CTGGTATACACACATAAGACGAG
- AAGACCCTGTGGAGCTTAAACC
- GCTGGTATACACACATAAGACGA
- GAAGACCCTGTGGAGCTTAAACC
Vector and host networks

**HOSTS**
- Lizard
- Bird
- Human
- Dog+Raccoon
- Squirrels
- Cow
- Horse
- Wild Boar
- White-tailed deer
- Other big game animals

**POTENTIAL VECTORS**
- C. venustus
- C. stellifer
- C. spinosus
- C. pusillus
- C. paraensis
- C. pallidicornis
- C. insignis
- C. hinmani
- C. haematomplus
- C. floridensis
- C. edeni
- C. debilipalpis
- C. crepuscularis
- C. biguttatus
- C. baueri
- C. arboricola
### Vector and host networks

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### HOSTS

- Lizard
- Bird
- Human
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- Cow
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- **White-tailed deer**
- Other big game animals
Vector and host networks

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Study Sites

Panhandle/North
Quincy

Central Florida
Ocala

Southern Florida
Vero Beach
Lake Placid (MAERC)
LaBelle
Quincy (2 farms)

White-tailed deer, Fallow deer, Axis deer, Elk, Sika deer, Blackbuck, Scimitar oryx, Gemsbok, Nilgai, Bighorn Sheep, Goat, Water buck
Quincy (2 farms)

Data from B. McGregor

arboricola+haematopotus

- **WTD**
- White-tailed deer
- Other big game animal
- Cow
- Human
- Dog+Raccoon
- Squirrels
- Lizards
- Birds
Quincy (2 farms)

Data from B. McGregor

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Data from B. McGregor

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Quincy

Arboricola + Haematopotus

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Quincy (2 farms)

Data from B. McGregor

- BIRDS
- arboricola+haematopotus
  - WTD
  - BIG GAME
    - White-tailed deer
    - Other big game animal
    - Cow
    - Human
    - Dog+Raccoon
    - Squirrels
    - Lizards
    - Birds
Quincy (2 farms)

Data from B. McGregor
Quincy (2 farms)

Data from B. McGregor
Quincy (2 farms)

biguttatus  (n=55)

- White-tailed deer
- Other big game animal
- Cow
- Human
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- Birds

Data from B. McGregor
Quincy (2 farms)

Data from B. McGregor
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Data from B. McGregor
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**BIG GAME**

- (n=68) debilipalpis
  - White-tailed deer
  - Other big game animal
  - Cow
  - Human
  - Dog+Raccoon
  - Squirrels
  - Lizards
  - Birds

**WTD**

- (n=1,200) stellifer
  - White-tailed deer
  - Other big game animal
  - Cow
  - Human
  - Dog+Raccoon
  - Squirrels
  - Lizards
  - Birds

**ANIMALS ON FARMS**

- (n=55) biguttatus
  - White-tailed deer
  - Other big game animal
  - Cow
  - Human
  - Dog+Raccoon
  - Squirrels
  - Lizards
  - Birds

- (n=21) venustus
  - White-tailed deer
  - Other big game animal
  - Cow
  - Human
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  - Lizards
  - Birds

- (n=14) pallidicomis
  - White-tailed deer
  - Other big game animal
  - Cow
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  - Lizards
  - Birds

Data from B. McGregor
Ocala (1 farm)
Hunting preserve
Whitetail deer, Axis deer, Elk, Sika deer, Pere-david deer, Big-horned sheep, and Cows
Ocala (1 farm)

Data from K. Sloyer
Vero Beach
4 locations in southern Indian River County
Not deer ranches
Vero Beach

4 locations in southern Indian River County
Not deer ranches

Vero Beach
(n=119)

Chickens
crepuscularis (n=14)

Deer
Other big game animal

Chickens

Data from K. Sloyer
MAERC: MacArthur Agroecology Research Center
Cattle ranch

Data from K. Sloyer
LaBelle
White-tailed deer

Data from K. Sloyer
Vector and host networks

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Data from K. Sayler & S. Wisely
Data from SCWDS + K. Sloyer
EHDV

- Jan-Mar

C. insignis

Oct-Dec

Apr-Jun

Jul-Sep

Oct-Dec

Data from SCWDS + K. Sloyer
EHDV
○ Jan-Mar

C. arboricola
Oct-Dec

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A management plan for EHDV vectors?

1. Determine no-see-um species that transmit the virus
2. Identify breeding habitats of the vector species
3. Evaluate control strategies for vector species (chemical and physical)
4. Provide best management practices for EHDV vector control
5. Develop capabilities to predict EHDV transmission in space and time
THANK YOU

Dr. Samantha Wisely, CHeRI Director
Dr. Katherine Sayler
Dr. Jason Blackburn
Dr. Erik Blosser
Bethany McGregor
Kristin Sloyer
Alfred Runkel
Dr. Dinesh Erram
John Hill
Mandie Carr
Carisa Boyce
Shannon Moore
Hilda Lynn
Glauber Rocha Pereira
SCWDS (S. Vigil, J. Corn)
Land owners and ranchers
CHeRI, Florida State Legislature