CFIA CVBD Overview

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CFIA Lethbridge: A National Centre for Animal Diseases
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Current Areas of Research

• *Culicoides* Biting Midges of Canada
• Soft Ticks of Canada – African Swine Fever Virus
• Asian Longhorned Tick – (*Haemaphysalis longicornis*), a new resident in the US, originating from eastern Asia and the Pacific Islands – Australia – New Zealand
Biting Midges as Vectors of Animal Disease Agents

Family: Ceratopogonidae
Worldwide: 5000 species in 60+ genera
~1,400 species in genus *Culicoides*
In Canada: 180 species in family, the main genus is *Culicoides* ~ 61 spp.

“One biting midge is an entomological curiosity, 1000 can be hell” Kettle 1962
# Principal Disease Pathogens Vectored by *Culicoides* Biting Midges

<table>
<thead>
<tr>
<th>Pathogen or Disease</th>
<th>Main vector species</th>
<th>Vertebrate hosts</th>
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</thead>
<tbody>
<tr>
<td>Akabane</td>
<td><em>Culicoides imicola</em></td>
<td>Cattle</td>
</tr>
<tr>
<td>African horse sickness</td>
<td><em>C. imicola</em></td>
<td>Equids and dogs</td>
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<tr>
<td>Epizootic hemorrhagic disease</td>
<td><em>C. sonorensis</em>, <em>C. schultzi</em>, &amp; <em>C. kingi</em></td>
<td>Deer, cattle &amp; sheep</td>
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<tr>
<td>Bluetongue</td>
<td><em>C. sonorensis</em> &amp; &gt;10 <em>Culicoides</em> spp.</td>
<td>Ruminants</td>
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<tr>
<td>Nematodes: <em>Onchocerca</em></td>
<td><em>Culicoides</em> spp.</td>
<td>Ruminants</td>
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Schmallenberg Virus (SBV)

Orthobunyavirus (ss RNA) - causes congenital malformations and stillbirths in cattle, sheep, goats, and possibly others, initially reported in 2011

Transmitted by Culicoides spp., mainly C. obsoletus/scoticus complex, as well as C. punctatus and C. pulicaris

Named after Schmallenberg, Germany, where it was first identified. Now found in 18 countries in Europe: Austria, Azerbaijan, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, and The United Kingdom

Another example of our having the vectors and hosts, but not the pathogen in Canada
A Study of the Indigenous Fauna of Culicoides Midges in Canada
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Abstract
Several vector-borne diseases are expanding their ranges as a result of climate change, advances in transportation and geographic and host factors. Culicoides midges occur throughout most of the inhabited world, and serve as vectors for many important animal pathogens including bluetongue, epizootic haemorrhagic disease, African horse sickness, Schmallenberg and Akabane viruses. The Culicoides fauna of Canada is poorly understood. Knowledge of Culicoides species composition, distribution, and seasonality are critical for understanding the epidemiology of Culicoides-borne diseases, risk assessment of possible Culicoides-borne disease outbreaks and policy development. A small-scale targeted Culicoides survey was conducted across Canada from 2014-2016. Ultraviolet LED CDC traps were set up at various locations in Okanagan Valley, BC; Abbotsford, BC; Lethbridge, AB; Saskatchewan, SK; Winnipeg, MB; Brandon, MB; Guelph, ON; Peterborough, ON; Ottawa, ON; Laval, QC, Truro, NS; and St John’s, NL. With the help of volunteers (veterinarians, entomologists and producers) field-samples were collected and shipped to the CFIA-Lethbridge Laboratory for identification. At the Lethbridge Laboratory, the trap-collections were sorted and Culicoides samples were morphologically identified. In addition, cytochrome c oxidase subunit I (COI), internal transcribed spacer (ITS) and elongation factor 1 alpha (EF-1alpha) sequences from representative samples from Culicoides species identified were amplified and sequenced. To date, four subgenera, two species groups and 23 Culicoides species have been morphologically and/or genetically identified, including two known vectors of bluetongue virus (C. sonorensis and C. obsoletus) and several suspected vectors (C. biguttatus, C. stelleri, C. venustus, C. sanguinipes, and members of the pulicaris Species Group). Following three consecutive vector seasons, the CFIA Lethbridge Laboratory has amassed a reference collection of over 113,000 Culicoides midges and developed reference databases for microscopy images, genetic sequences, and slide-mounted specimens.

Methodology
A. Insect Collection Workflow
B. Sorting Culicoides from other Insects
C. Distinguishing Female vs Male Culicoides
D. Identification of Culicoides species/groupings

Figure 1. Workflow strategies for a targeted survey of Culicoides species in Canada. (A) Insect trap samplings were collected from selected sites in both Western and Eastern Canada for morphological and molecular identification of Culicoides. (B) Trap samples were sorted and Culicoides biting midges were separated from other insects. (C) Female and male specimens were identified by morphological characteristics. (D) Wing patterns were used to identify Culicoides to species groups. (E) Sequencing of genetic markers was undertaken to identify closely-related Culicoides species.

B. Sorting Culicoides from other Insects

D. Identification of Culicoides species/groupings

E. Molecular Characterization

Results

Figure 2. Distribution and Identification of Culicoides species in Canada. (A) Comparison of species distribution between Western (left) and Eastern (right) provinces in Canada. (B) Morphological identification of known and suspected Culicoides vectors in Canada. (C) Phylogenetic tree representing the molecular identification of the Subgenus Monoculicoides by ITS sequencing.

Conclusions
- A small-scale targeted Culicoides survey was conducted across Canada from 2014-2016, resulting in a reference collection of over 113,000 Culicoides midges.
- The distribution of Culicoides species varied in both species composition and numbers of midges between Western and Eastern Canada.
- Known vector species for BTV and EHDV were identified in both Western and Eastern Canada.
- Morphological identification solely by wing patterns was useful to identify unrelated Culicoides species and molecular identification using genetic markers helped to identify closely-related Culicoides species.

Acknowledgments
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**Culicoides of Ontario (in preparation)**

**Culicoides venustus** Hoffman, 1925

*Culicoides venustus* is closely related to *C. inamollae* Fox and Hoffman that is not found in Ontario, but they are distinguished by the r-m crossvein. *C. venustus* has a completely light r-m vein whereas *C. inamollae* does not. *C. venustus* has very elongate distal 5 antennal segments, just like *C. travisi*, but they have widely different wing patterns that allow them to be differentiated from each other.

Diagnosis: Thorax yellow and brown, and eyes narrowly separated (Hoffman, 1925). 3<sup>rd</sup> palpal segment intermediately swollen and triangular with a small sensory pit (Root and Hoffman, 1937). Proximal 8 antennal segments barrel shaped, and distal 5 antennal segments very elongate. Two round spermatheca with a short neck (Root and Hoffman, 1937). Average length of wing 1.5 mm (Hoffman, 1925). CS1 narrow and extending to the top margin of the wing, and CS2 large and spreading into the r2+3 cell. Very distinct wing pattern with a very dark spot in r5, and an irregular pale spot that reaches the margin of the wing distally beside the dark spot. Macrotrichia on the distal third of the wing, and halters are yellow at base, and the base of the tip and the knob are brown (Hoffman, 1925).

Distribution: Found in New York and Connecticut (Foot and Hoffman, 1937). The Wirth et al. (1985) wing atlas extends this range from Nebraska south to Louisiana and Florida. In Canada, it can be found from Ontario to Nova Scotia (Borkent and Grogan, 2009).
Ticks of Canada

I. Hard Ticks - Ixodidae
33 Species in 4 Genera
*Ixodes* (most), *Dermacentor*, *Haemaphysalis*, *Rhipicephalus*

II. Soft Ticks - Argasidae
7 Species in 4 Genera
*Argas, Carios, Ornithodoros, Otobius*

“A Handbook to the Ticks of Canada”
FREE download - Biological Survey of Canada
Soft Ticks and African Swine Fever Virus
(highly contagious & fatal to pigs)
African Swine Fever Virus & Ticks

• In Africa, ASFV is maintained in wart hogs and bush pigs and *Ornithodoros porcinus* (also known as *O. moubata porcinus*).
• In Spain and Portugal, *O. (Pavlovskyella) erraticus* (also known as *O. maroncanus*) became a biological vector and was able to infect swine for up to 8 years.
• *Ornithodoros* spp. ticks can live for up to 11 years.
• ASFV introduced to the Caribbean region in 1978, where several species of *Ornithodoros* are resident.

The New Tick in North America

The Asian Longhorned Tick, *Haemaphysalis longicornis*
- First reported to the USDA in November, 2017 (NJ), but records indicate 2010 (WV)
- In 2020, reported from 12 US states, including NY and PA, and 96 counties
- Origin: E Asia, New Zealand, Australia
- Parthenogenetic: Can reproduce without males, & does so rapidly
- Wide Host Range, including birds, livestock, companion animals, wildlife, people
- Can transmit a wide range of pathogens, including protozoa, bacteria, and viruses
- Implicated in red meat allergy
- Very similar in appearance to the three native *Haemaphysalis* spp.

*Will it come to Canada?* Probably, as it has invaded temperate regions of the US, so we could see it appear in Ontario next season.
Haemaphysalis longicornis
The Asian Longhorned Tick

Photo credit: James Gathany (CDC)
Haemaphysalis longicornis (Asian longhorned tick), an exotic East Asian tick, has never previously established a population in the United States. It is a known serious pest of livestock in the Australasian and Western Pacific Regions where it occurs. It is an aggressive biter and frequently builds intense infestations on domestic hosts causing great stress, reduced growth and production, and severe blood loss.

The tick can reproduce parthenogenetically (without a male); as such, a single fed female tick can create a population. It is also a known/suspected vector of several viral, bacterial, and protozoan agents of livestock and human diseases. This three-host tick can spread pathogens among a diverse host range, on which it feeds side-by-side with other tick species. The detections detailed here are the first reports of this tick out of quarantine in the United States.

**States with confirmed local Asian longhorned tick populations with number of counties in each state**

- Virginia: 30
- West Virginia: 17
- Pennsylvania: 10
- New Jersey: 9
- North Carolina: 8
- Tennessee: 8
- New York: 6
- Maryland: 3
- Delaware: 2
- Arkansas: 1
- Connecticut: 1
- Kentucky: 1

96 counties in 12 US States
Summary

Worldwide, arthropods have key role in transmission of pathogens to livestock, companion animals, wildlife, and humans.

In Canada, the sparsity of competent vector species and discontinuous activity limit vector-borne diseases.

The potential for introduction and establishment of vector-borne foreign diseases is persistent and increasing but remains relatively low (for now).

In multiple scenarios, we have the hosts and competent vectors. All that is missing is the pathogen, so what is the answer? Prevention through Vigilance