

# Endo/exophagy and circadian rhythm of *Culicoides* biting midges (Diptera: Ceratopogonidae), vectors of bluetongue virus

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# Culicoides biting midges and transmission of bluetongue virus

Culicoides biting midges and transmission of BTV

Objective and strategy

Circadian rhythm and endo/exophagy

- Materials & methods  
- Results

Discussion

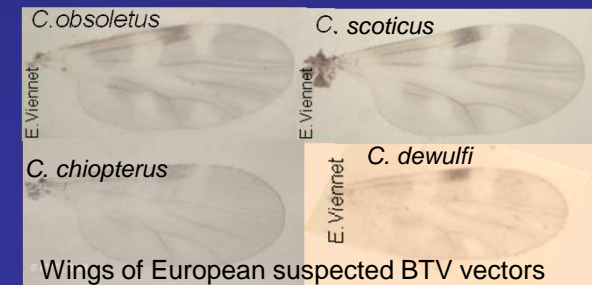
Perspectives

- Among the smallest hematophagous insects known (Diptera: Ceratopogonidae)
- Vectors of several arboviruses: Oropouch, African horse sickness, bluetongue viruses



Mosquito and *Culicoides*

- Emergence and spread of bluetongue virus (BTV) in Western Europe in 2006-2008 with disastrous consequences on livestock
- Lack of knowledge in bio-ecology, especially in vector-host contact (key step in virus transmission) for suspected vector species
- Few studies using animal baited traps due to methodological difficulties to identify and sample *Culicoides* populations



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*Discussion*

*Perspectives*

## Objective

to describe circadian rhythm and endo/exophagy behaviours  
of the suspected BTV vectors throughout the year

## Strategy

Indoor vs. outdoor collections using drop traps and suction traps during spring,  
summer and autumn

## Collection methods

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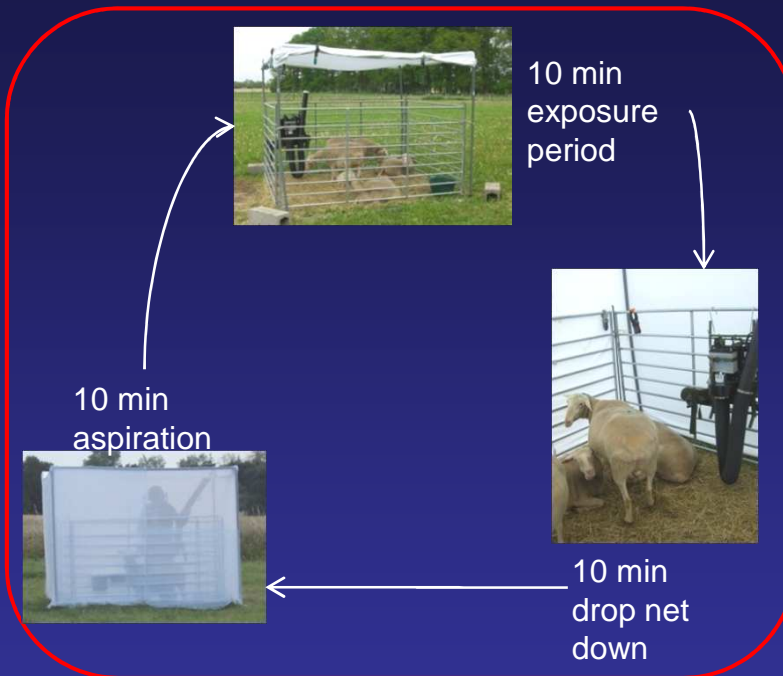
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### **Drop trap (DT)**

Usual host-baited trap, 48 collections of  
30 min during 24 consecutives hours



### **Suction trap (ST)**

Passive aspiration, 48 collections of  
30 min during 24 consecutives hours

# Study site and experimental design

INRA – Tours



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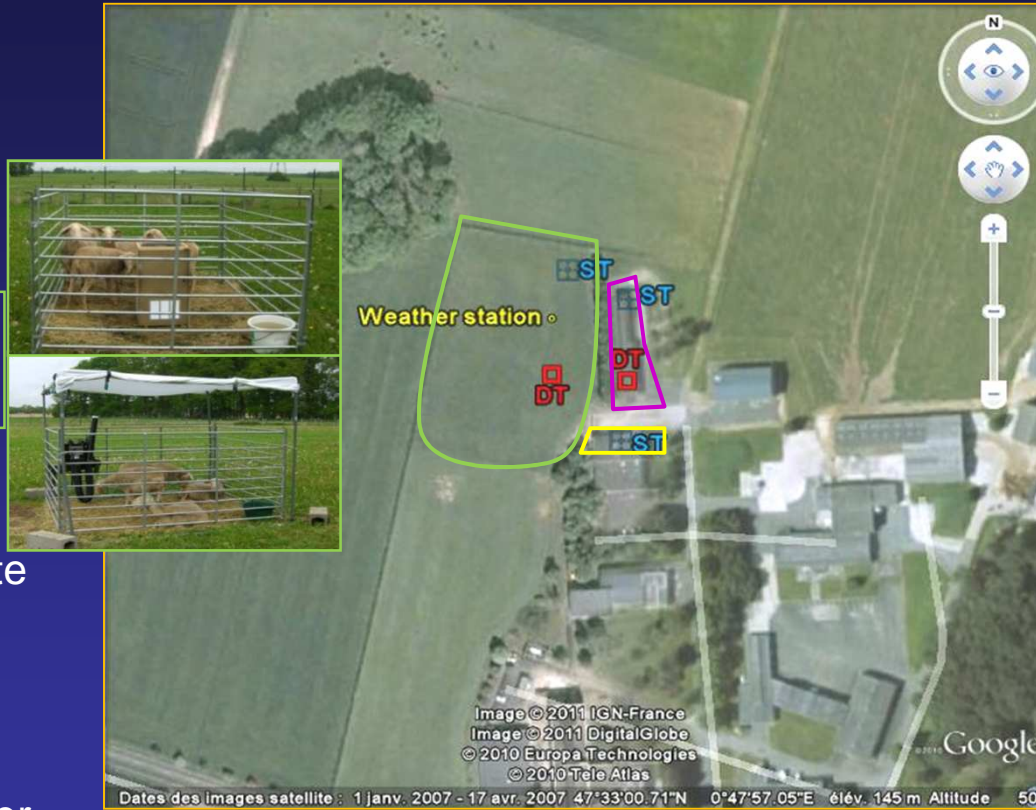
Discussion

Perspectives

Field pasture:  
1 ST  
1 DT

4 sheep per site

6 collection sessions from 12:00 to 12:00 per season (spring, summer, autumn)



Building:  
1 ST  
1 DT



Largely open building :  
1 ST

## Culicoides identification

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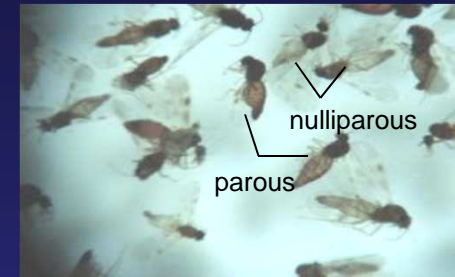
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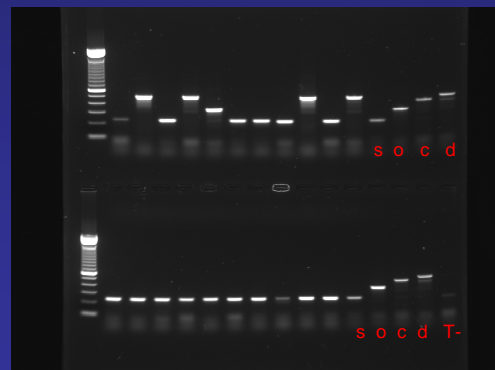
Discussion

Perspectives

- Collected *Culicoides* specimens identified to species using morphological key (Delécolle *et al.* 1985), sorted by sex and physiological stage for female (nulliparous, parous, bloodfed and gravid)



- Confirmation and identification of members of Obsoletus Group using species-specific PCR method (Nolan *et al.* 2007)



Electrophoresis gel of *Culicoides* sample.  
s: *C. scoticus*, o: *C. obsoletus*, c: *C. chiopterus*,  
d: *C. dewulfi*

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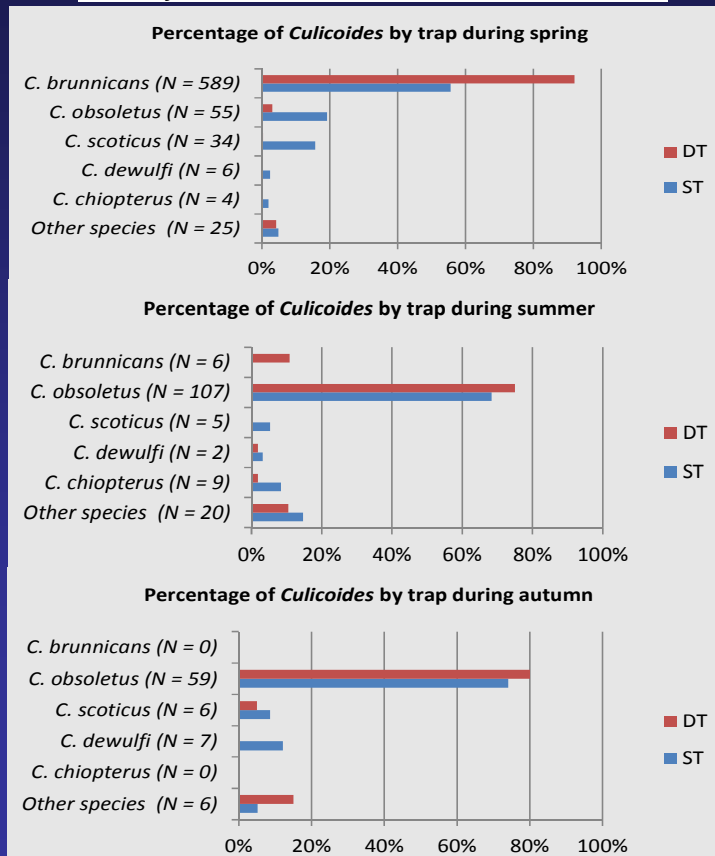
- Results (1)

Discussion

Perspectives

# 1. Abundance and diversity of Culicoides

	Spring	Summer	Autumn
<b>No. Culicoides</b>	720	151	78
<b>Diversity</b>	9	11	6



- **Abundance: higher during spring (76%)** than during summer (16%) and autumn (8%); **diversity: maximal during summer (11 species vs. 9 during spring and 6 during autumn)**

- *C. brunnicans*: the dominant species during spring, and then disappeared.

- Suspected BTV vectors present throughout the year: *C. obsoletus*, *C. scoticus*, *C. dewulfi* and *C. chiopterus*

- DT collected more *C. brunnicans* and less specimens of other species than ST

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- Results (2)

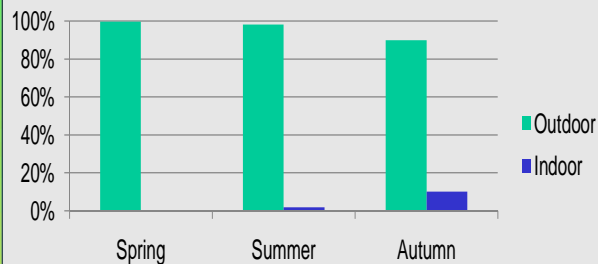
Discussion

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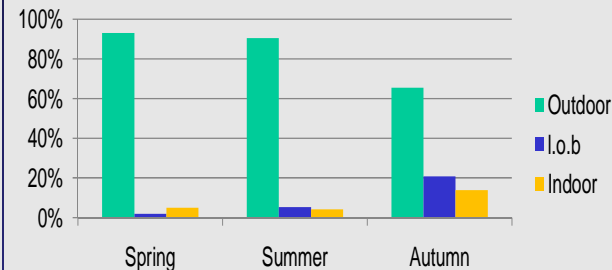
## 2. Endo/exophagy

### a. Abundance

Percentage of *Culicoides* by sites over the season in the Drop trap



Percentage of *Culicoides* by sites over the season in the Suction trap



### b. Diversity

- Certain species found almost strictly **exophagic**:
  - only 1 *C. brunnicans* collected indoor by DT (N = 476) and 1 by ST (N = 112) during spring
  - *C. dewulfi* and *C. pulicaris* never found inside shed, but in low abundance (N = 17 and N = 8)
- Some other species were able to enter into shed:
  - Up to 20 % of *C. obsoletus* specimens can be found inside shed with ST (N = 39, 65 and 43)
  - Single specimens of *C. scoticus* and *C. chiopterus* were found inside shed

- In both traps, specimens collected in higher proportion outdoor whatever the seasons
- Indoor collections seem to be in higher proportion during autumn

### 3. Circadian rhythm

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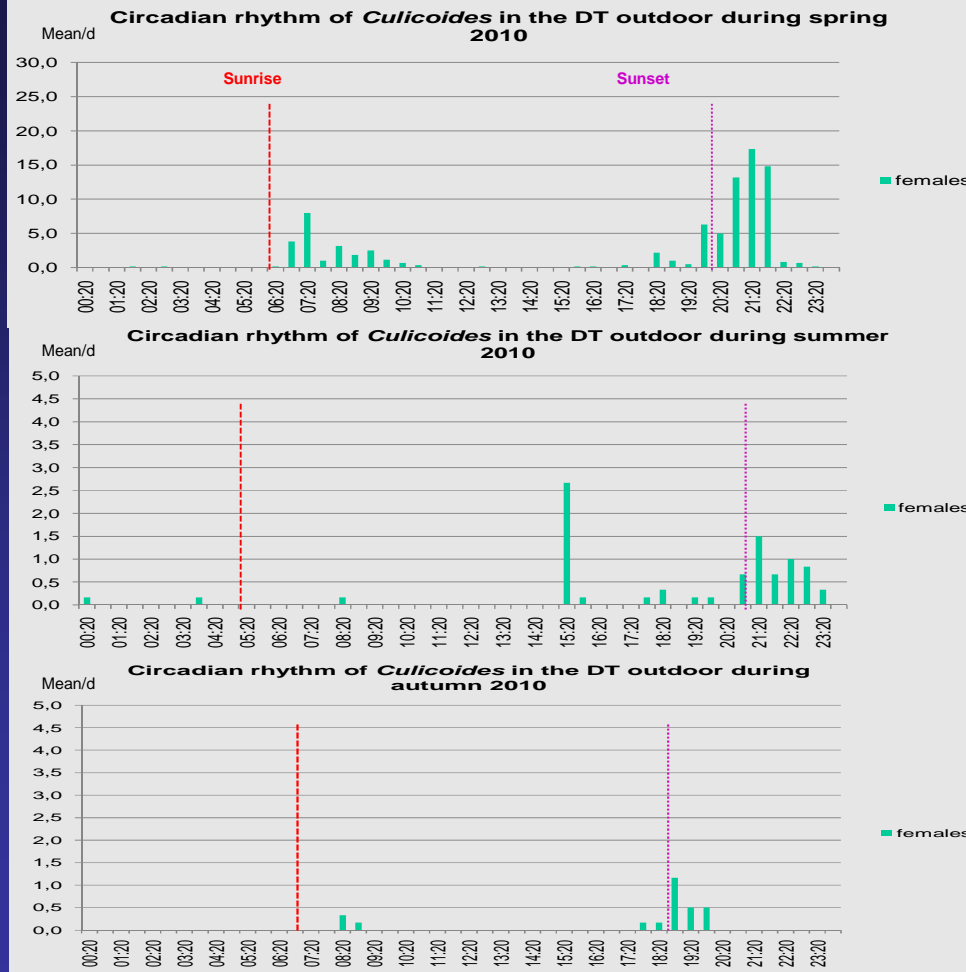
Circadian rhythm and endo/exophagy

- Materials & methods

- Results (3)

Discussion

Perspectives



- *Culicoides* host-seeking females: active slightly after sunrise and around sunset during spring versus only around sunset during summer and autumn
- Exceptional diurnal and nocturnal activity
- During spring, activity peak in the morning correspond exclusively to *C. brunnicans*
  - *C. brunnicans*: the only species exhibiting 2 activity peaks
  - Suspected BTV vectors in Europe: contact with host mainly around sunset

## Discussion

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### Discussion (1)

*Perspectives*

*Culicoides* feeding behaviour remained poorly described; few studies with standardized sampling methods

We used:

- **animal-baited collections**
- **during 24 consecutive hours**
- **in 3 different seasons**
- **with molecular identification of sibling species**

- *Abundance and diversity of Culicoides*

Animals are attacked by different *Culicoides* species depending on the season

Diversity of collected species: roughly the same between drop trap and suction trap

**Suction trap** can thus be a **good alternative** to the **drop trap** regarding the regular human manipulation it requires

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# Discussion

- *Endo/exophagy*

***C. brunnicans***: clearly **exophagic**

Among the Obsoletus Group:

*C. obsoletus* appears to be partially endophagic (up to 20%)

single individuals of *C. scoticus* and *C. chiopterus* found inside shed (low abundance)

can not conclude on *C. dewulfi* behaviour (too low abundance)

In **north of Europe**, in **autumn**, **large amount of *Culicoides*** collected **indoors** (Meiswinkel *et al.* 2008, Baldet *et al.* 2008)

- **UV black light trap** do not correctly assess the biting rate on animals (Carpenter *et al.* 2008, Gerry *et al.* 2009)
- Light attraction might lead to an overestimation of the *Culicoides* endophagy.

Our study: **lower difference** between **outdoor** and **indoor** catches in autumn than during the rest of the year (58.7 in spring, 23.5 in summer vs. 4.7 in autumn)

Same trend found in northern Europe (Baylis *et al.* 2010).

Livestock housing may be used to protect valuable animals from the bites of *Culicoides* and thus to decrease the BTV transmission risk compared to outside animals especially during spring/summer

## Discussion

- *Circadian rhythm*

*Culicoides* described active mainly around sunset (Mellor *et al.*, 2000)

But, only one study quantified rigorously host-seeking behaviour of European *Culicoides* using host-baited collections through the diel (van der Rijt *et al.* 2008).

Few others restricted to sunset collections (Gerry *et al.*, 2009) or to limited period (Service, 1969)

We showed that some abundant species (*C. brunnicans*) exhibited 2 activity peaks: the main around sunset and a secondary one after sunrise.

Species of the *Obsoletus* group showed only 1 activity peak around sunset, but in higher abundance they may exhibit a second one.

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## Perspectives

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**Perspectives**

Can consider to:

- use Suction trap in other regions concerned by BTV, about other vectors as *C. imicola*
- realize this work on other animals
- realize this work in other contexts as African Horse Sickness (in Senegal)

**Thank you for your attention...**