The impact of microclimatic temperature on vector-borne disease transmission in Denmark

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The impact of microclimatic temperature on vector-borne disease transmission in Denmark

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Background

Replication of arboviruses within the vector depends on the temperature surrounding the vectors – the microclimatic temperature

The threshold temperature for Bluetongue virus (BTV) replication in Culicoides is approximately 15°C

Most mathematical models for virus development in vectors use the standard meteorological temperature instead of the microclimatic temperature

Objectives

To quantify the difference between the meteorological temperature and the microclimatic temperature

To model the microclimatic temperature of different habitats using standard meteorological parameters as input variables

To compare the impact of the microclimatic and meteorological temperature on vector-borne disease transmission

Methods

Site: Strødam, Denmark
Data Collection: May - October 2015

Fig.1a: Microclimatic temperature recorded by microchips - iButtons at four different habitats, Strødam
Fig.1b: Meteorological temperature recorded by weather stations, Strødam

There were more microclimatic hours with temperatures >15°C compared to the meteorological stations both in cooler (May) and warmer months (August) (Fig.2 and Fig.3)

Fig. 2: In May, a higher no. of microclimatic hours had >15°C and in August, a higher no of microclimatic hours had >25°C compared to meteorological temperature.

Fig. 3: Microclimatic temperature is higher at day and lower at night compared to meteorological temperature.

Fig. 4: Extrinsic Incubation Period (EIP) of Bluetongue virus (the time required for virus to become transmissible to another host after initial infection in a Culicoides): Virus development is more rapid in microclimatic temperature compared to meteorological temperature.

Meteorological vs. Microclimatic temperature

There were more microclimatic hours with temperatures >15°C compared to the meteorological stations both in cooler (May) and warmer months (August) (Fig.2 and Fig.3)

Compared to meteorological temperature, microclimatic temperature showed a faster bluetongue virus development in Culicoides (Fig.4)

Discussion

There are large variations between meteorological and microclimatic temperature

Microclimatic temperature fasten virus development compared to meteorological temperature

Instead of measuring, we can model and thus predict the microclimatic temperature for whole Denmark

Since vectors are short lived, a small differences in virus development time can greatly influences the vector borne diseases transmission