

# PERSPECTIVES

## OPINION

### Climate change and the recent emergence of bluetongue in Europe

Bethan V. Purse, Philip S. Mellor, David J. Rogers, Alan R. Samuel, Peter P. C. Mertens and Matthew Baylis

**Abstract** | Bluetongue, a devastating disease of ruminants, has historically made only brief, sporadic incursions into the fringes of Europe. However, since 1998, six strains of bluetongue virus have spread across 12 countries and 800 km further north in Europe than has previously been reported. We suggest that this spread has been driven by recent changes in European climate that have allowed increased virus persistence during winter, the northward expansion of *Culicoides imicola*, the main bluetongue virus vector, and, beyond this vector's range, transmission by indigenous European *Culicoides* species — thereby expanding the risk of transmission over larger geographical regions. Understanding this sequence of events may help us predict the emergence of other vector-borne pathogens.

of up to 100 days<sup>4</sup>. Nevertheless, since its arrival in Europe in 1998, bluetongue (BT), the disease caused by BTV, has caused the deaths of more than one million sheep<sup>5,6</sup>. In addition to morbidity and mortality, BT disrupts the trade in animals and animal products and has been estimated to cause annual losses of US\$125 million in the United States alone<sup>7</sup>.

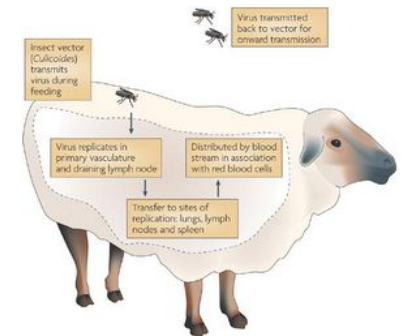
BTV is transmitted between its ruminant hosts almost entirely by the bites of certain species of *Culicoides* biting midges (Diptera: Ceratopogonidae). Susceptibility to infection and the subsequent replication and dissemination of viruses in *Culicoides*, is determined by a range of hereditary and environmental factors<sup>8,9</sup>. So far, less than 1% of more than 1,400 *Culicoides* species described have been incriminated in the transmission of BTV —

Islands from Tunisia or Sardinia. In view of this potential for extremely rapid spread<sup>8</sup> and its serious consequences for the international trade of animals and animal products, BT is classified as a List A disease by the Office International des Epizooties (OIE), the world organization for animal health (see the Online links box for further information).

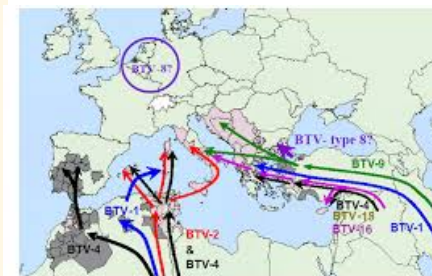
Vector-borne pathogens are particularly sensitive to climate<sup>11</sup>, a fact that has led to widespread and continued speculation that anthropogenic climate change will increase the incidence and intensity of their transmission<sup>12–14</sup>. There is, however, little evidence supporting such speculations<sup>11,15,16</sup>, while at the same time there is an increasing realization that other non-climatic abiotic and biotic factors can also affect disease distribution<sup>17–20</sup>. In this article, we discuss those features of the BTV–*Culicoides* system that make it exquisitely sensitive to changes in climate. We highlight a recent step-change in BTV transmission in Europe and provide evidence to support our conclusion that this has been driven mainly by climate change.

#### The changing pattern of BT in Europe

Sero-surveys indicate that many BTV serotypes have been circulating on the fringes of Europe for several decades — in sub-Saharan Africa<sup>21</sup>,



Nature Reviews | Microbiology



## The Asian tiger mosquito, *Aedes albopictus*



### Main introduction routes



Figure 2. Main *Aedes albopictus* introduction routes: (A) Used tyres. (B),(C) Lucky Bamboo (*Dracaena* spp.).

Scholte & Schaffner, 2007

### Rapid spread worldwide



blue: original distribution, cyan: areas where introduced in the last 30 years.

### Rapid spread in Europe

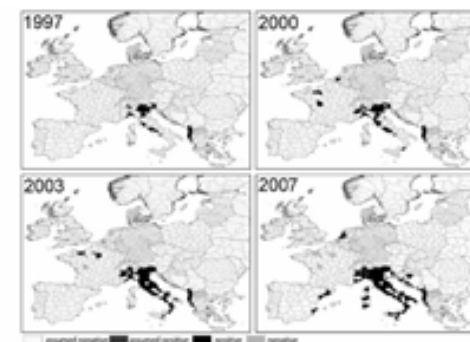
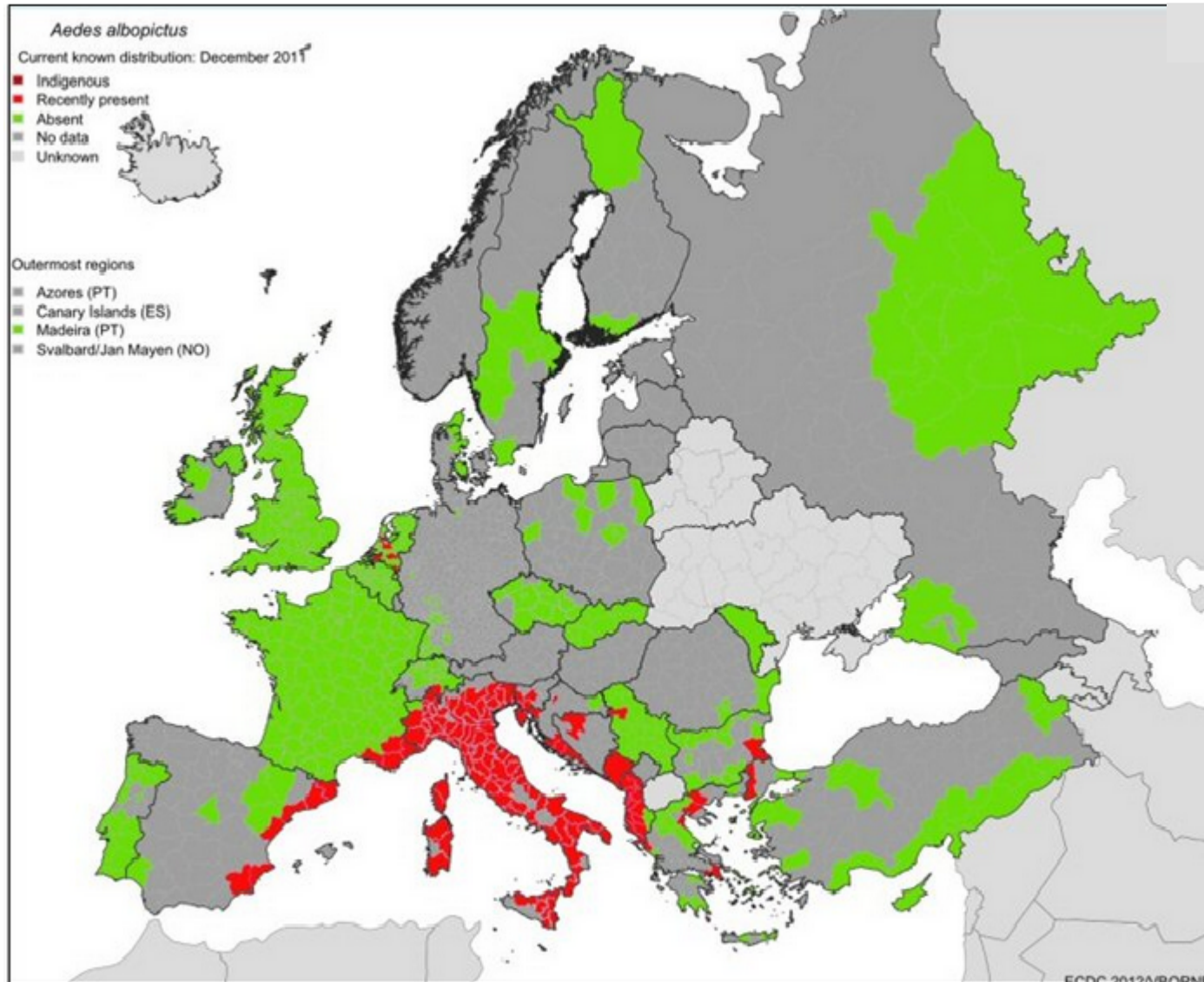


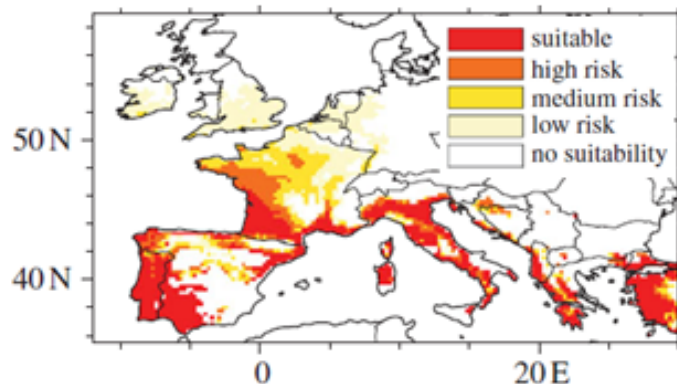
Figure 3. Presence of *Aedes albopictus* in Europe per province for the years 1997-2007. Data to complete this figure were kindly made available by Roberto Romi (Italy), Roger Ertis and David Ruiz (Spain), Eleonora Rocio (Switzerland), Charles Jeannin (France), Anna Klobučar (Croatia), Zoran Lukac (Bosnia and Herzegovina), Igor Rajovic and Dusan Petric (Serbia and Montenegro), Bjorn Pluskota (Germany), Anna Samanidou-Voyadjoglou (Greece). The map was made by Patrizia Scarpulla. The 2007 outbreak of Chikungunya virus in Italy is indicated with an arrow in the 2007 box.

Scholte & Schaffner, 2007

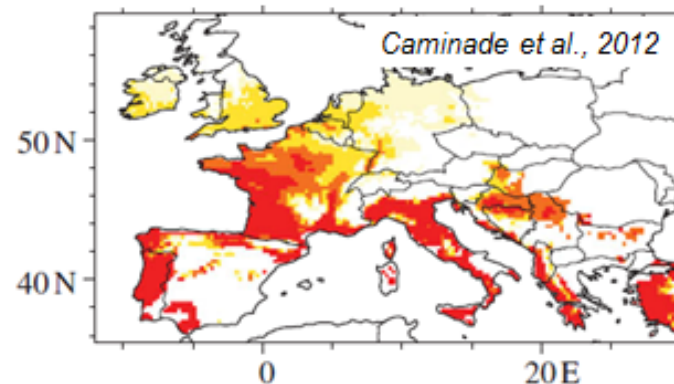


# Simulated climate suitability for the Asian tiger mosquito

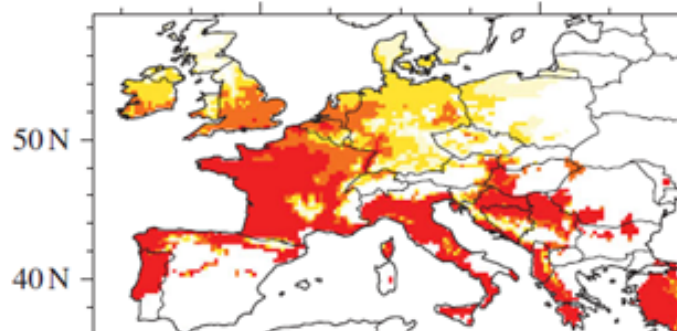
Climate obs 1960-1989



Climate obs 1990-2009



Climate Models 2030-2050



Observation January 2015



Model based on an overwintering criterion ( $T_{\text{January}} > 0^{\circ}\text{C}$ ,  $\text{Rain}_{\text{annual}} > 500\text{mm}$ ) and different thresholds in annual Temperature:

- suitable:  $120 < T_{\text{annual}}$
- high risk:  $110 < T_{\text{annual}} < 120$
- medium risk:  $100 < T_{\text{annual}} < 110$
- low risk:  $90 < T_{\text{annual}} < 100$
- no suitability:  $T_{\text{annual}} < 90$

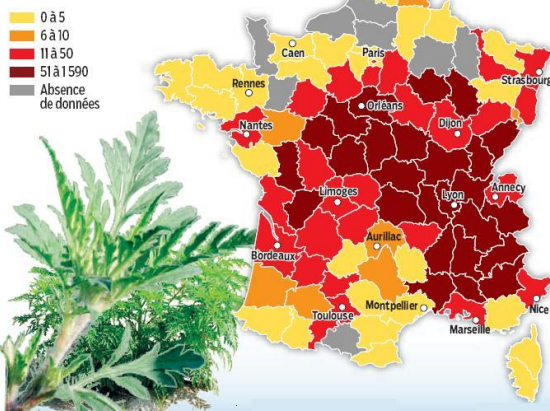
Future risk increase: Benelux, Balkans, western Germany, the southern UK  
 Future risk decrease: Spain and Mediterranean Islands

# Trois exemples où le Changement Climatique est incriminé, peut avoir un rôle, mais où plusieurs autres facteurs interviennent

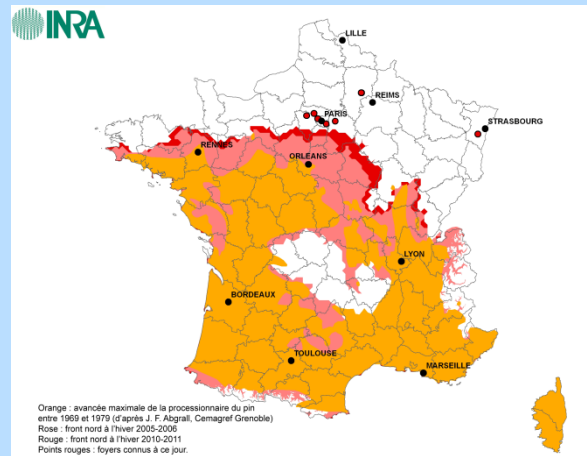
## Ambroisie



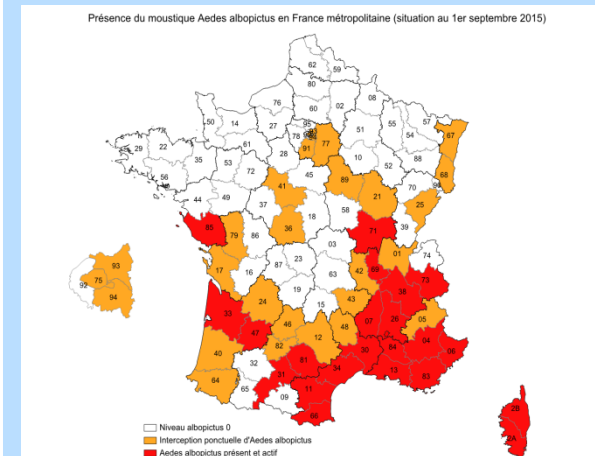
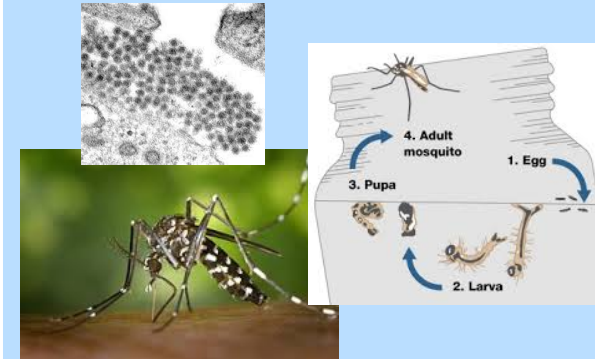
Nombre d'observations de l'espèce par département



## Chenille processionnaire du pin



## Moustique-tigre et maladies infectieuses

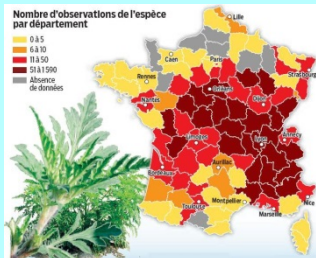
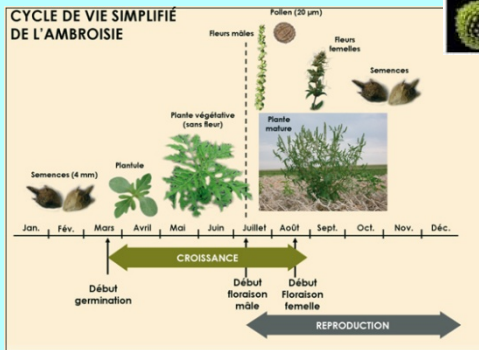


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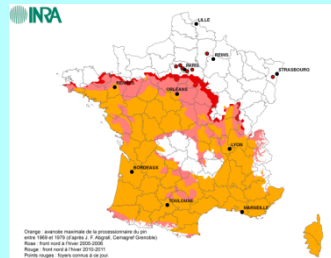
## Ambroisie



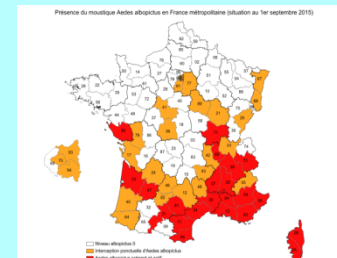
### CYCLE DE VIE SIMPLIFIÉ DE L'AMBROISIE



## Chenille processionnaire du pin



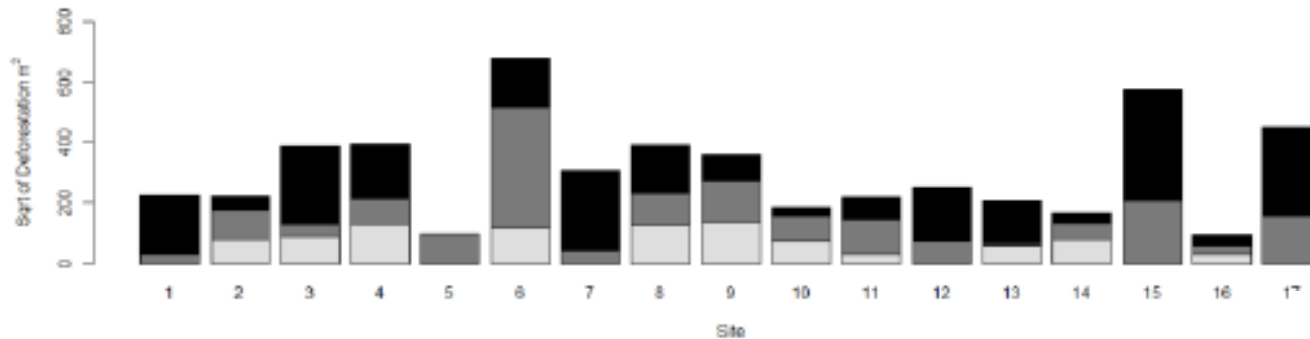
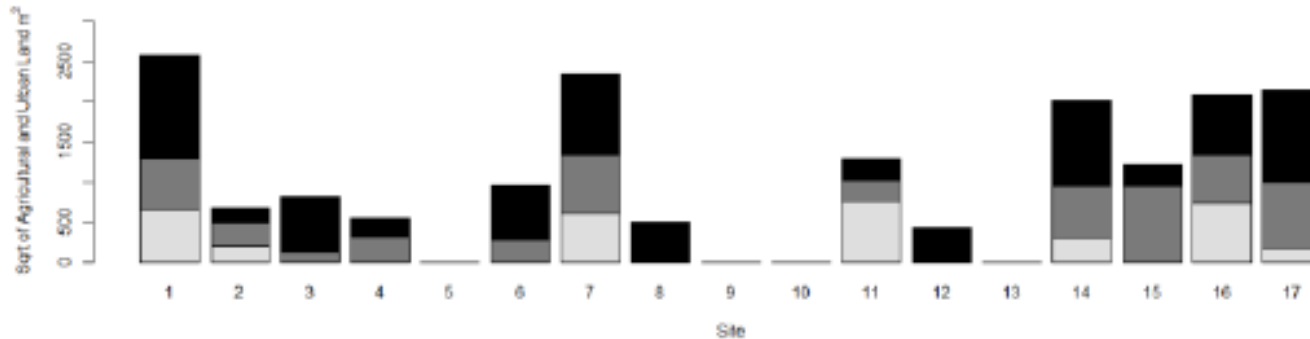
## Moustique-tigre et maladies infectieuses



# Surveillance de 20 sites aquatiques en Guyane française



Top chart shows the m<sup>2</sup> cover of agricultural and urban land around each site (3 buffer zones), and the bottom chart shows the m<sup>2</sup> cover of deforestation within the 3 years prior to the surveys



# Surveillance de 20 sites aquatiques en Guyane française

