

Les maladies infectieuses sous le prisme des changements globaux ; une illustration du concept « un monde, une santé »

Pascal Boireau

Directeur du Laboratoire de santé animale, Campus d'Alfort-EnvA

Global changes and consequences for infectious diseases/ MACROBIOTE

- Climate change (temperature, rainfall, geographical and temporal scales)
- Globalization (trade, economic and political impacts)
- « Practices »
- Health consequences (infectious diseases and chemical risks)
- Diversity of pathogens and numerous drivers

Toward Global virome strategy?



111 viral families have been discovered globally to date.



Of these 111 viral families, the GVP will target **25** containing viruses known to infect (or to have substantial risk of infecting) people.



In these 25 families, an estimated **1.67 million** unknown viruses exist in mammals and birds—hosts that represent 99% of the risk for viral emergence.

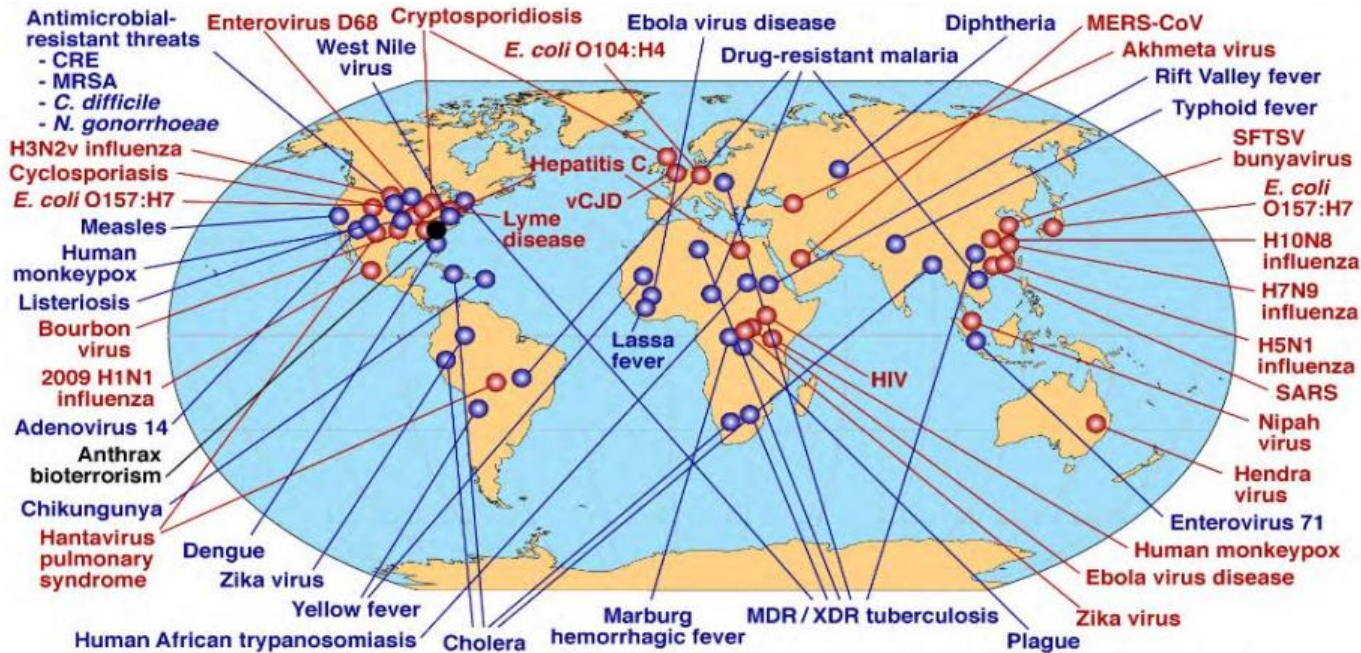


Of these 1.67 million viruses, an estimated **631,000 to 827,000** likely have the capacity to infect people.

For example, for every known coronavirus, there are currently thousands of unknown coronaviruses circulating in wildlife

The same is likely true for other viral families

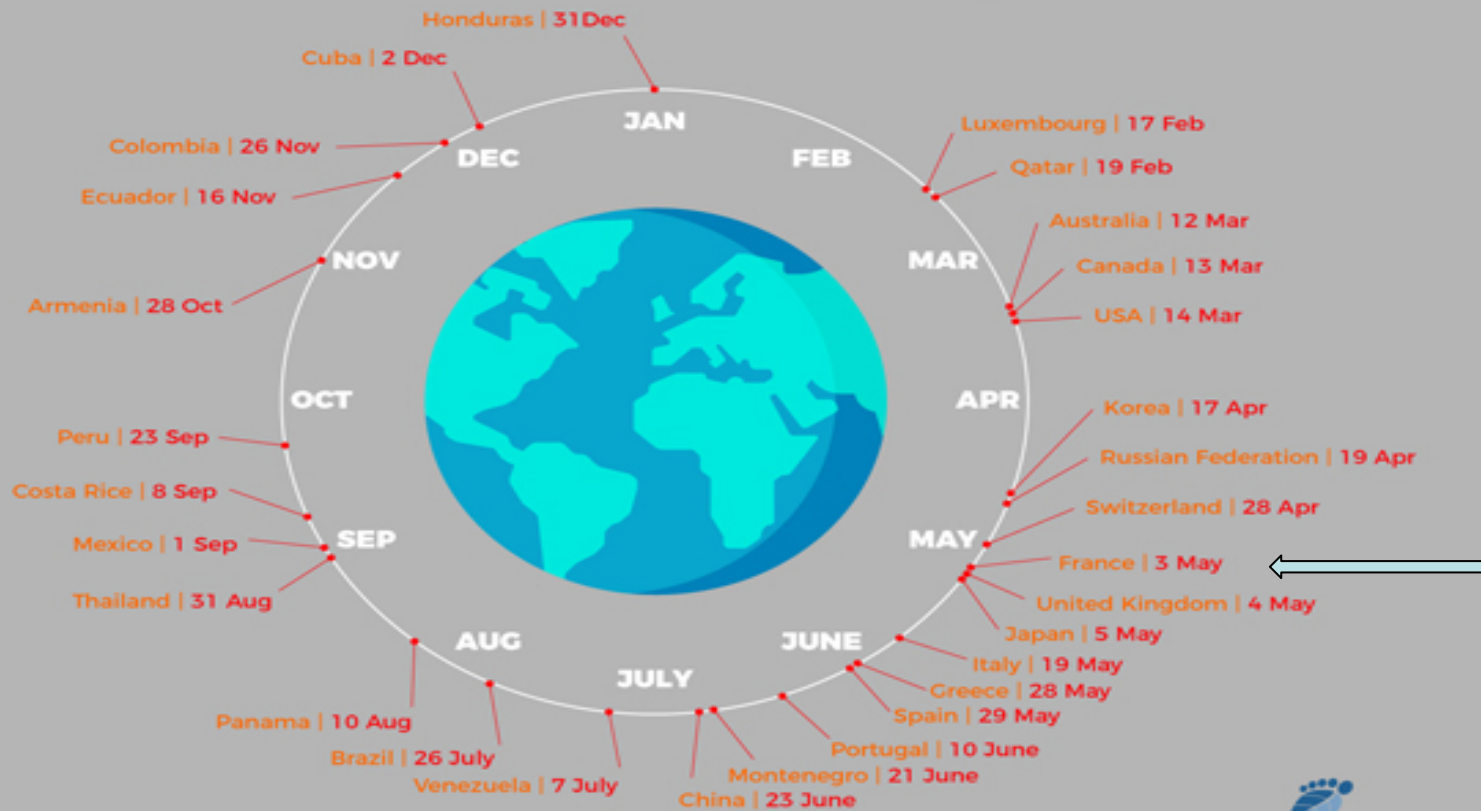
Emerging infectious diseases between 1940 and 2004



● Newly emerging ● Re-emerging/resurging ● “Deliberately emerging”

Country Overshoot Days 2017

When would Earth Overshoot Day land if the world's population lived like...



Source: Global Footprint Network National Footprint Accounts 2017

Toward One health Concept



A short story on
**One
Health
Concept**



- **If environment is bad**
- **Animal health is bad**
- **Human health too**

**Two kinds of molecules are used to treat animals in more than
65% of clinical cases**

Antiinflammatory drugs

Antibiotics



Ballet of Vultures

to find a **Dead** animal



India , 1990

DICLOFENAC

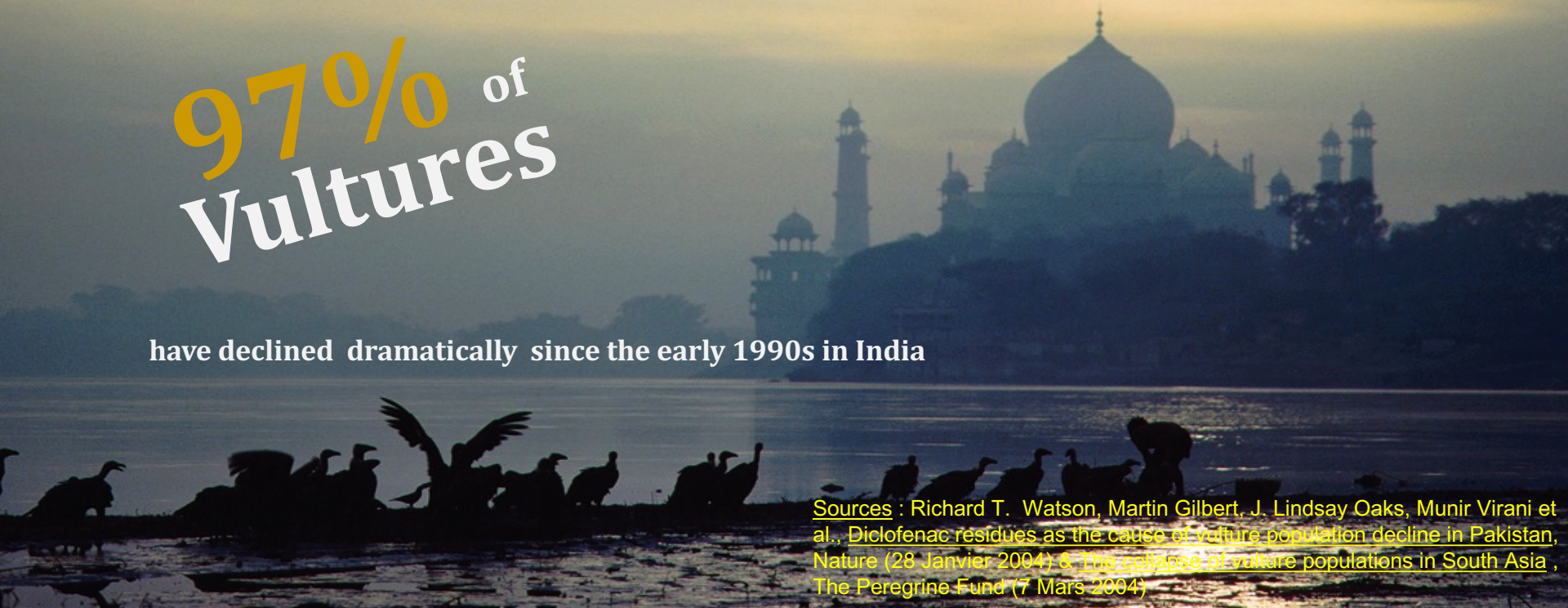
- SINGLE CAUSE





97% of
Vultures

have declined dramatically since the early 1990s in India



Sources : Richard T. Watson, Martin Gilbert, J. Lindsay Oaks, Munir Virani et al., [Diclofenac residues as the cause of vulture population decline in Pakistan](#), Nature (28 Janvier 2004) & [The collapse of vulture populations in South Asia](#), The Peregrine Fund (7 Mars 2004)

How will carrion Disappear in India ?





Other Carnivorous





Several 1000 of death per year

+35%

Stray Dogs



RABIES



In India during the last 20 years

- **+5Mi feral dogs, 38Mi bites, 1death of rabies/1000bites, >40000 people die. Estimated cost 34billion \$**
- **Necessity to kill carnivorous also**



AT THE END



THE alternative SOLUTION

WHO Causes of Human Mortality

31%

**CARDIOVASCULAR
Diseases**

40

New drugs
since 1970

25%

INFECTIOUS DISEASES

45% in low-income African and Asian countries
63% among children under age five globally

1480

New drugs
since 1970

13% **CANCERS**

11% **INJURIES**

9% **RESPIRATORY AND DIGESTIVE**

5% **MATERNAL**

6% **OTHER**

Climate change ...but



Climate change and health risks

Can we isolate the climate from other factors ?

Demographic
Political
and economic developments

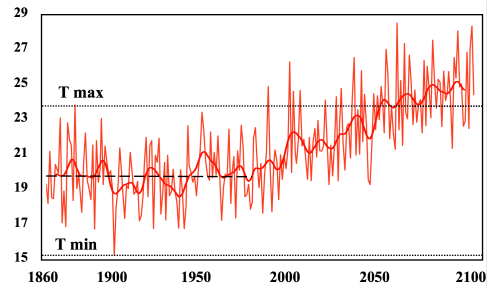
Changes in human behavior

Conséquences
on human and animal health

EXEMPLES WILL BE TAKEN
WITH INFECTIOUS DISEASE



Températures de Juillet en France, simulée de 1860 à 2100



EXEMPLES WILL BE TAKEN
WITH INFECTIOUS DISEASE



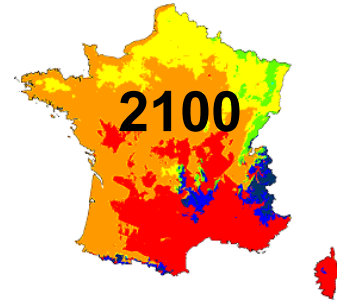
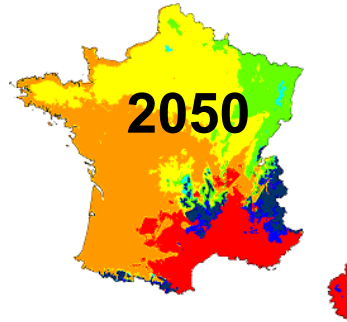
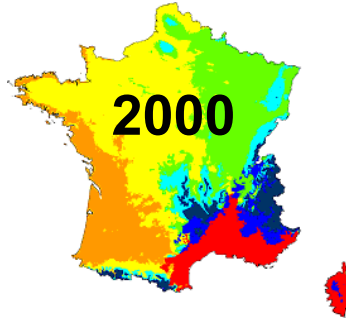
Climate change and health risks








Can we isolate the climate from other factors ?

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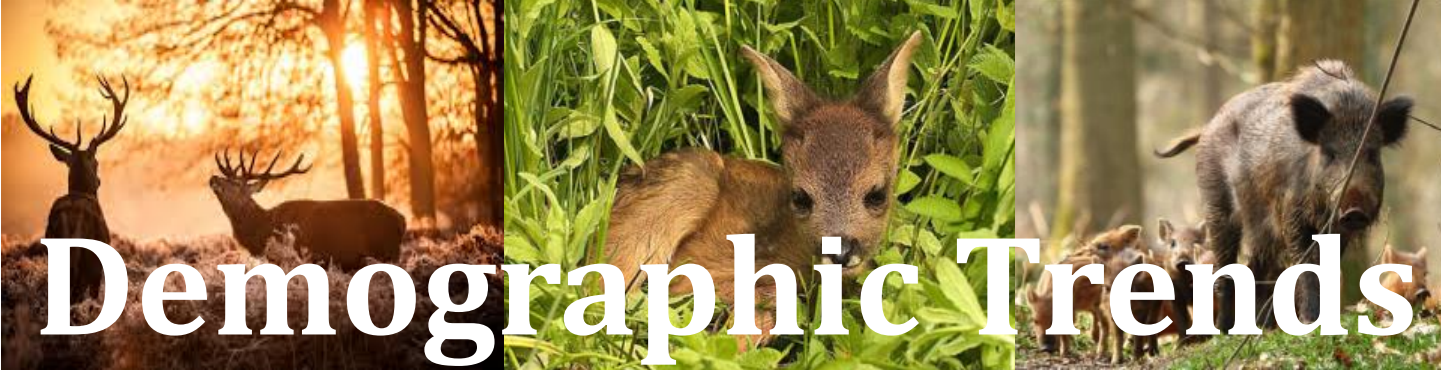


-  group 1: green alder (*Alnus viridis*)
-  group 2: grey alder (*Alnus incana*)
-  group 3: silver fir (*Abies alba*)
-  group 4: beech (*Fagus sylvatica*)
-  group 6: Spanish chestnut (*Castanea sativa*)
-  group 7a: maritime pine (*Pinus pinaster*)
-  group 8: evergreen oak (*Quercus ilex*)

Possible evolution of forest cover to 2100

Source
INRA Nancy





Demographic Trends

Wild mammals in France



Deers

X 3.8 IN 20 YEARS

Roes

X 3.2 IN 20 YEARS

Boars

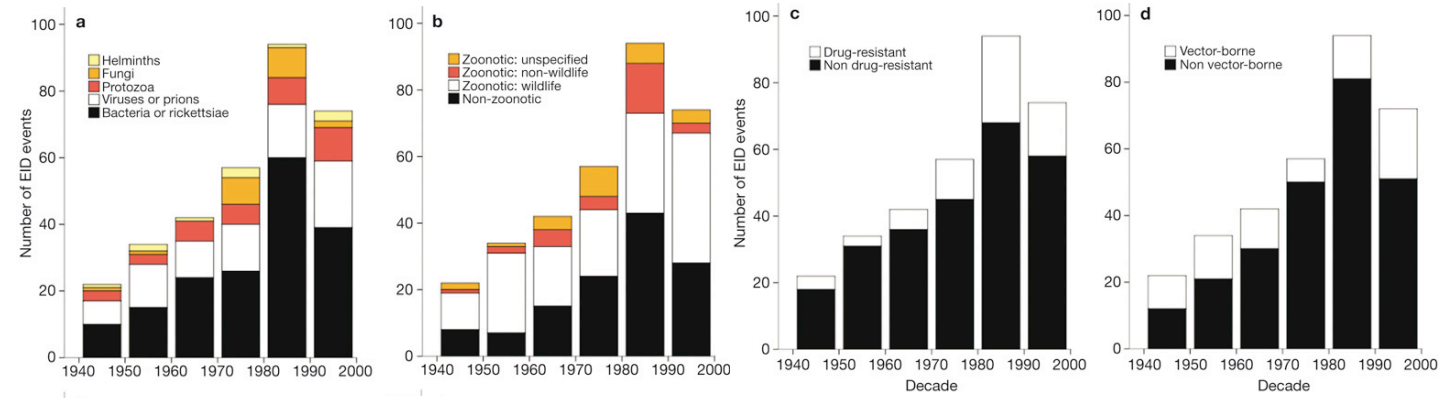
X 4.7 IN 20 YEARS



What the impact today



PATHOGENS ZOOBOTIC DRUG RESISTANCE VECTOR BORNE DISEASES

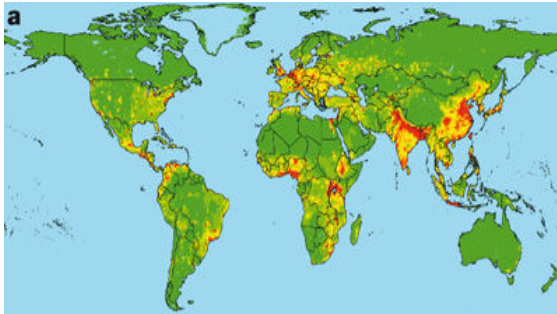


Global trends in emerging infectious diseases
 Kate E. Jones, Nikkita G. Patel, Marc A. Levy, Adam Storeygard, Deborah Balk, John L. Gittleman & Peter Daszak
 Nature 451, 990-993 (21 February 2008)

Zoonoses : 60% of which 72% are due to wildlife
54%: bacteria or rickettsia and 23% vector borne diseases



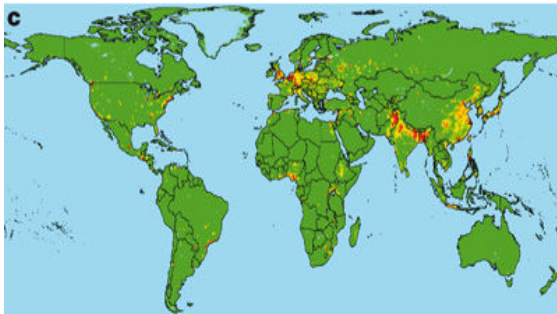
ZOONOSE WILD ANIMAL



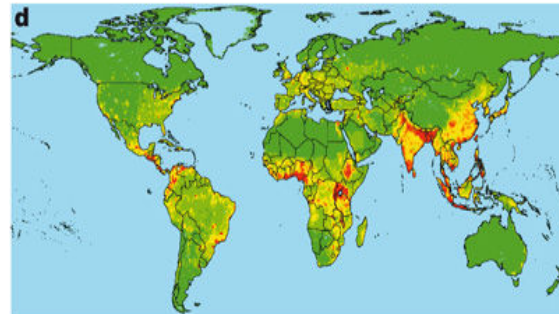
ZOONOSE OTHER



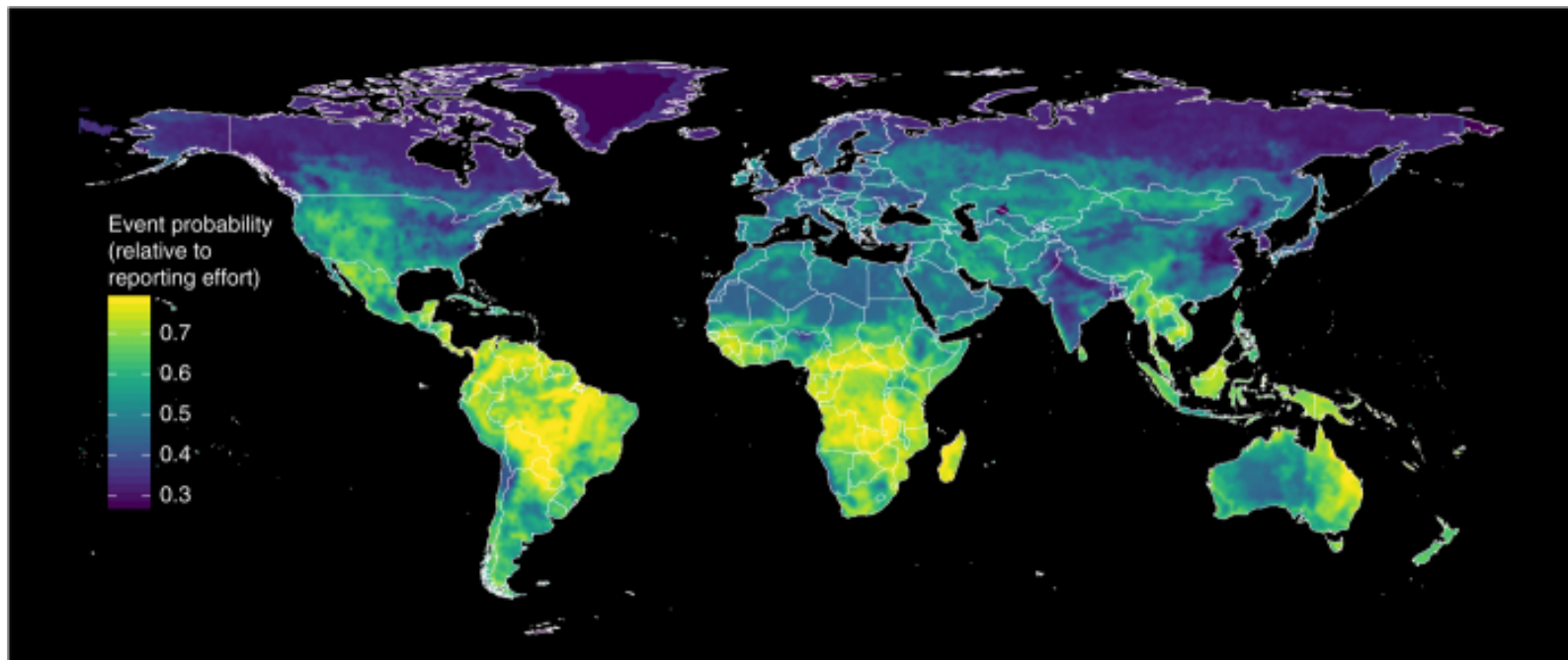
PATHOGEN RESISTANT TO ANTIBIOTICS



VECTOR BORNE DISEASES

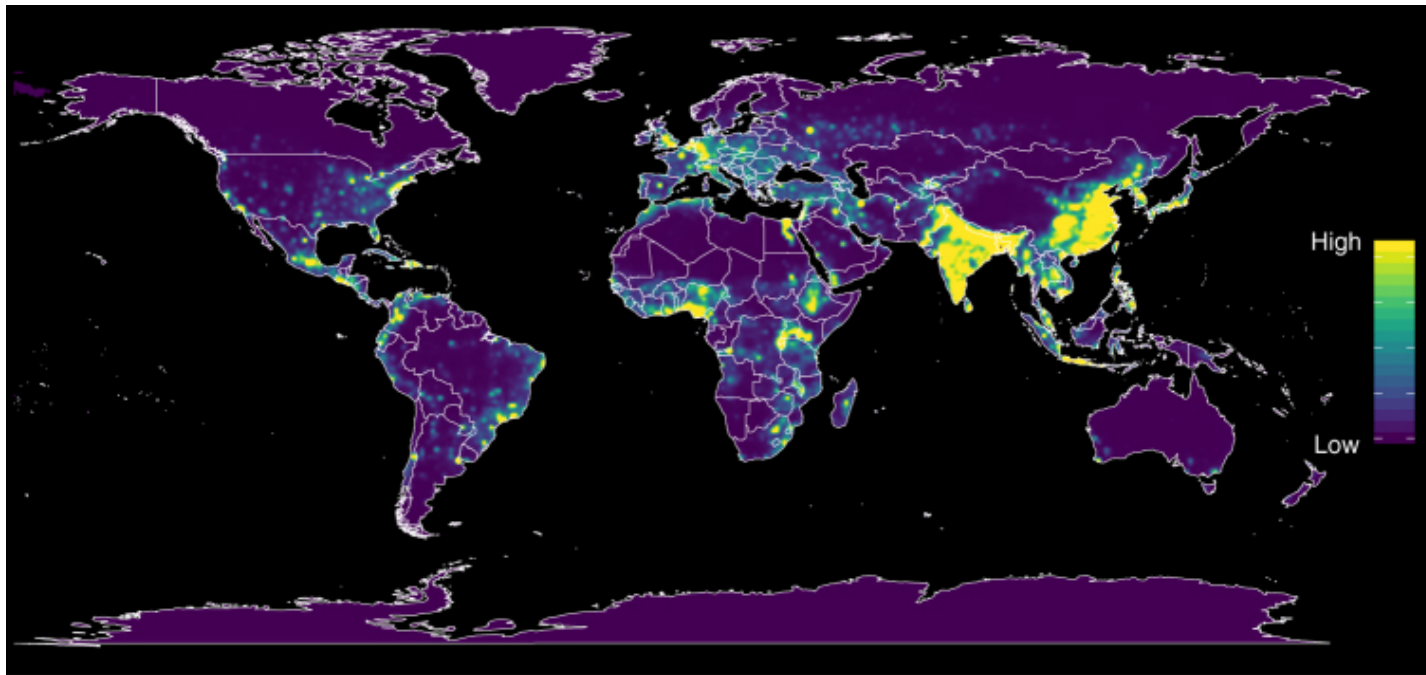


Relative risk of emergence



[Toph Allen et al, Nat Commun. 2017; 8: 1124.](#)

Relative risk of spreading

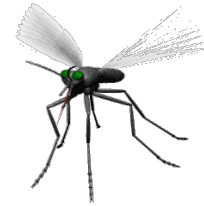


[Toph Allen et al, Nat Commun. 2017; 8: 1124.](#)

What are we doing???
Emerging animal pathogens
and vector borne diseases



MOSQUITOES



Distribution mondiale des flavivirus

World-wide:

- Alfyu virus
- Apoi virus
- Aroa virus
- Bagaza virus
- Banzi virus
- Batu Cave virus
- Bouboul virus
- Bukalasa bat virus
- Bussuquara virus
- Cacipacora virus
- Carey Island virus
- Cell fusing agent virus
- Cowbone Ridge virus
- Dakar bat virus
- Dengue virus
- Edge Hill virus
- Entebbe bat virus
- Gadgets Gully virus
- Iguape virus
- Ilheus virus
- Israel turkey meningoencephalomyelitis virus
- Japanese encephalitis virus

- Jugra virus
- Jutiapa virus
- Kadam virus
- Karshi virus
- Kedougou virus
- Kakobera virus
- Koutango virus
- Kunjlin virus
- Kyasanur Forest disease virus
- Langat virus
- Louping ill virus
- Meaban virus
- Modoc virus
- Montana myotis leucoencephalitis virus
- Murray Valley encephalitis virus
- Naranjal virus
- Negishi virus
- Ntaya virus
- Omsk hemorrhagic fever virus
- Phnom Penh bat virus
- Potiskum virus
- Powassan virus
- Rio Bravo virus

- Rocio virus
- Saboya virus
- Saj Vieja virus
- San Perilla virus
- Soumaraz Reef virus
- Sepik virus
- Sokoluk virus
- Spondweni virus
- St. Louis encephalitis virus
- Stratford virus
- Tamana bat virus
- Tembusu virus
- Tick-borne encephalitis virus
- Tyulenly virus
- Uganda S virus
- Usutu virus
- Wesselsbron virus
- West Nile virus
- Yaounde virus
- Yellow fever virus
- Yokose virus
- Zika virus



**Importance of tick borne diseases
In animal health**



Ticks and tick borne diseases

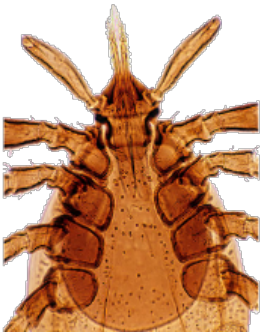
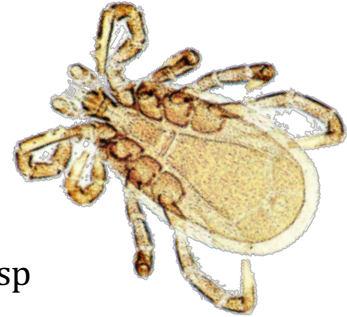
TRANSMISSION OF A WIDE VARIETY OF PATHOGENS THAN TICKS ACQUIRE DURING THEIR BLOOD MEAL ON MANY ANIMAL SPECIES

Virus Tick Borne Encephalitis Virus

Bacteria

Borrelia spp, Rickettsia spp, Ehrlichia spp, Anaplasma sp

Parasites Babesia spp, Theileria spp



Encephalitis with ticks : Tick Borne Encephalitis Virus : 3.000 cases / year
Other diseases due to "new" pathogens discovered in the last 20 years - Rickettsia spp., Babesia spp.
Anaplasma spp., Bartonella spp., Candidatus Neohrlichia mikurensis. Very poorly or not diagnosed

Ixodes Ricinus

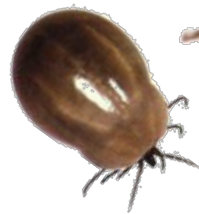


The **most** important

tick

in terms of **public health**

in **Europe**





Ixodes ricinus

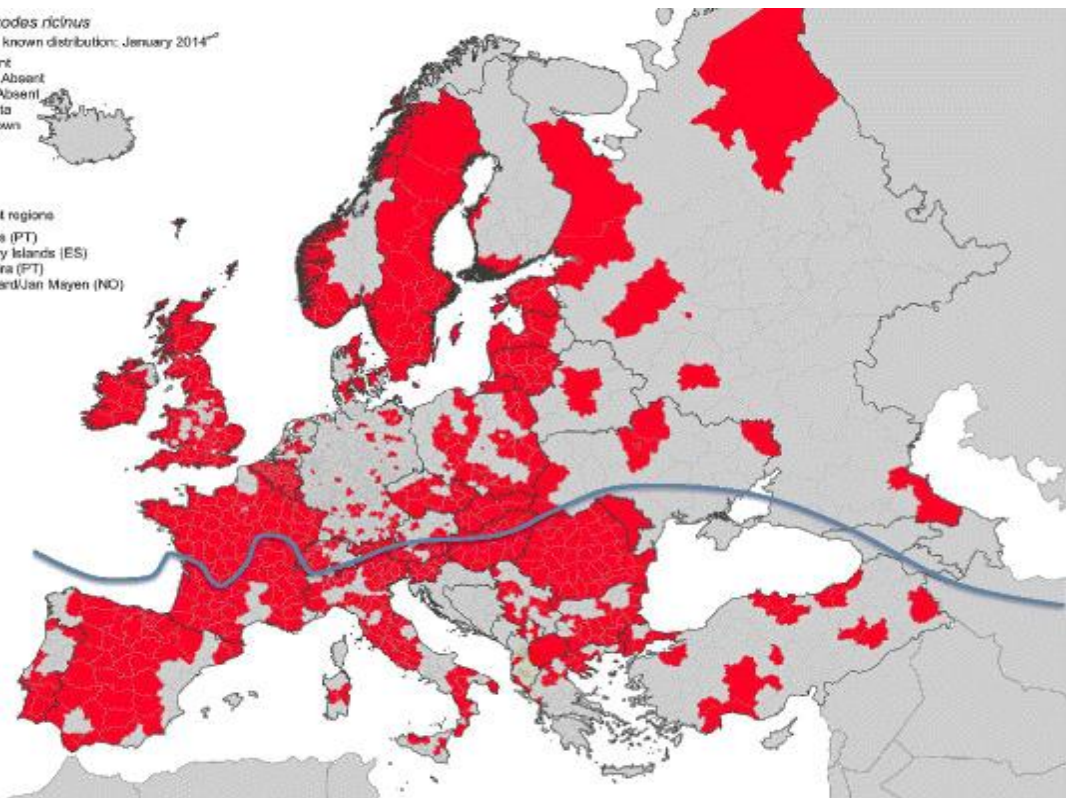
Current known distribution: January 2014¹

- Present
- Antic. Absent
- Obs. Absent
- No data
- Unknown



Outermost regions

- Azores (PT)
- Canary Islands (ES)
- Madeira (PT)
- Svalbard/Jan Mayen (NO)



Thématiques et Objectifs de l'équipe

Microbiote interactions

And survey



PCR Microfluidic
- Epidemiology



Competence

Eco health

Adapation

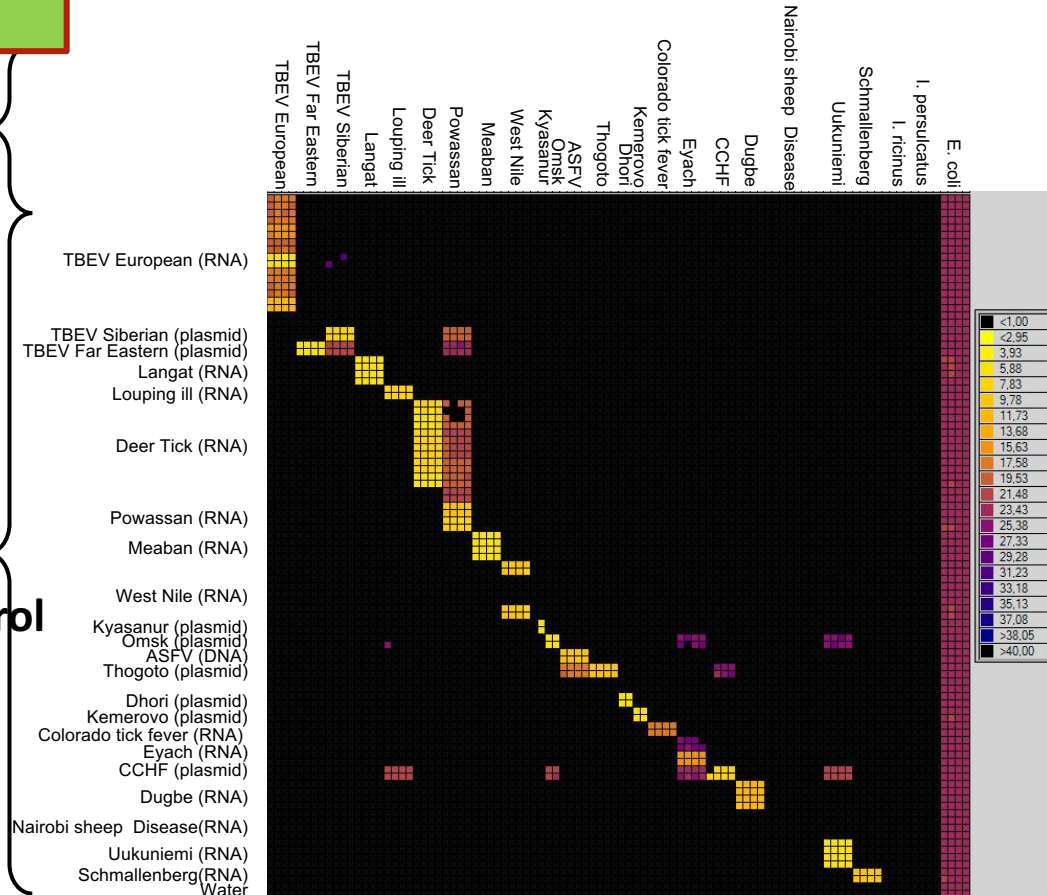


BioMark™ Dynamic array 48.48: specificity

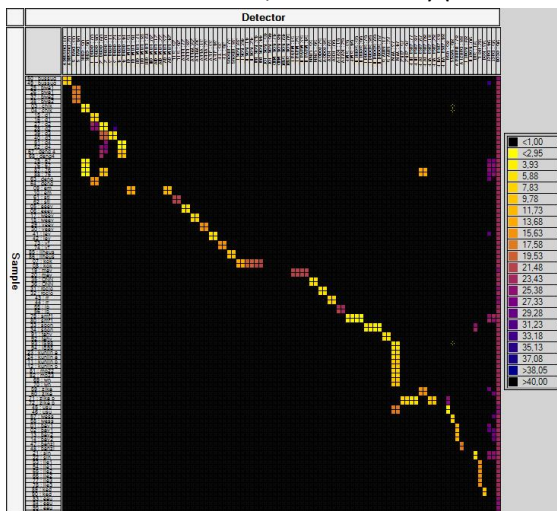
Viruses

22 Assays
(primers and
probe)

22 ref mat
And 2 neg control



- ✓ **Adaptation of the system to viruses transmitted by mosquitoes: Screening of 58 viral species (130 available designs targeting different genotypes)(PTR ANSES-IP Paris ; Lena Yousfi) (*Moutailler et al., in prep*)**



- ✓ **Identification of mosquito vectors of Zika virus collected in epidemic and endemic areas(Guyane, Guadeloupe, Brésil, Gabon) (WP6 H2020, ZIKALLIANCE, Coord. Inserm X. De Lamballerie, Coll. > 50partners, PI. S. Moutailler) (*Moutailler et al, in prep*)**

Other factors for EID....



HUMAN FACTORS

- Population growth
- Transportation of goods and people
- Lifestyle changes (leisure, professional activities, travel, food)
- Economic and political developments
- Sanitary environment
- Health systems



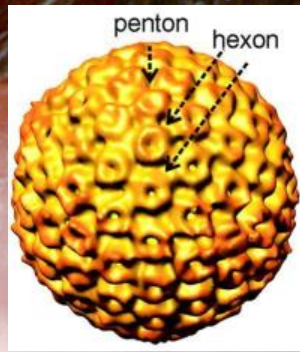
BLUE TONGUE VIRUS

Bluetongue is a contagious viral disease transmitted by biting midges of the genus *Culicoides* family Ceratopogonidae, affecting wild or farmed ruminants, but mainly sheep, less often goats, bovines, deer, camels and antelopes.

Reoviridae, Orbivirus
27 serotypes
Sheep, other ruminants
Ceratopogonidae, *Culicoides* spp.
Mediterranean Area



Ceratopogonidae, Culicoides spp



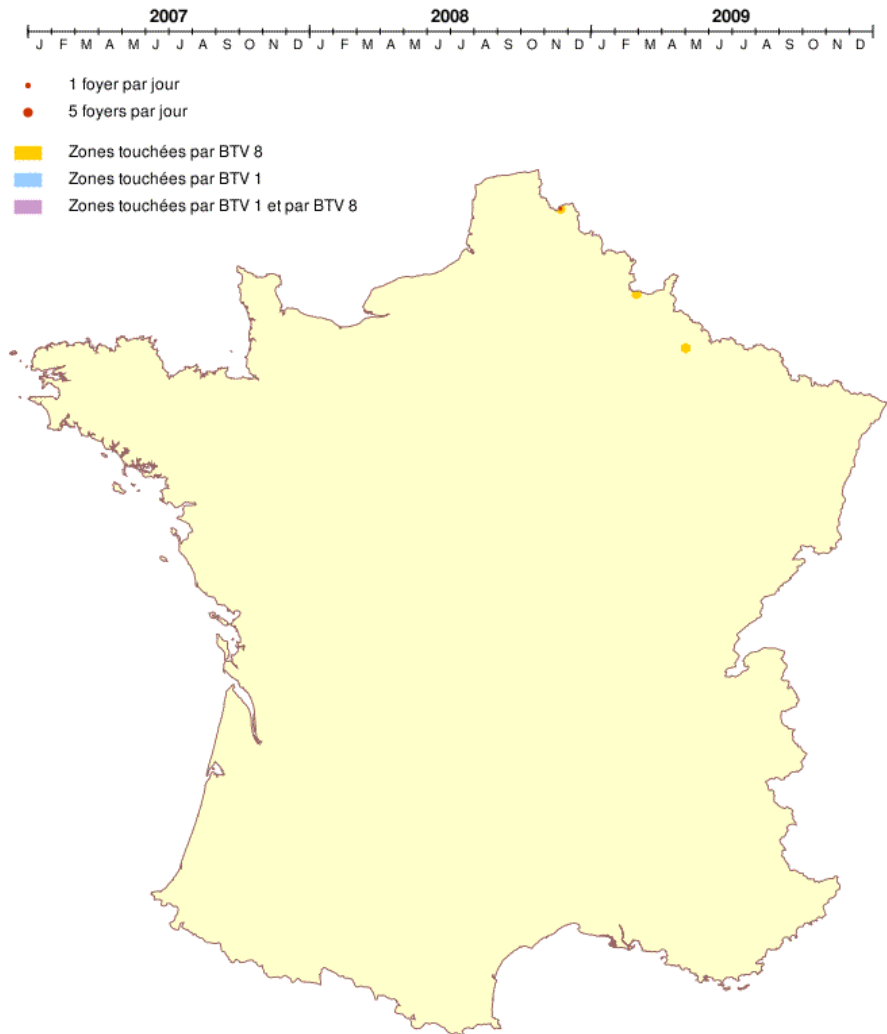
Go back

**To our blue
tongue virus
spreading**

**Two viruses
occured in fact**

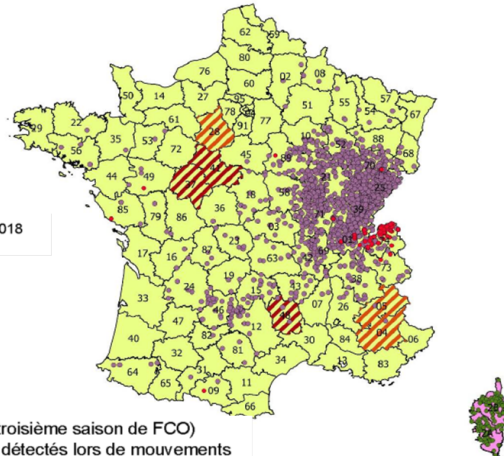
**Only 27
serotypes**

B. Durand et al, EID, 2011



Emergence du virus de la fièvre catarrhale ovine à sérotype 4 en France continentale en oct 2017

France : BTV-8 et 4



BTV-4

97 foyers avec 20 nouveaux foyers depuis le 1^{er} janvier 2018

BTV-8

1852 foyers depuis le 24 mai 2017 (début de la troisième saison de FCO)
Dont 439 depuis le 1^{er} janvier 2018. La plupart détectés lors de mouvements d'animaux

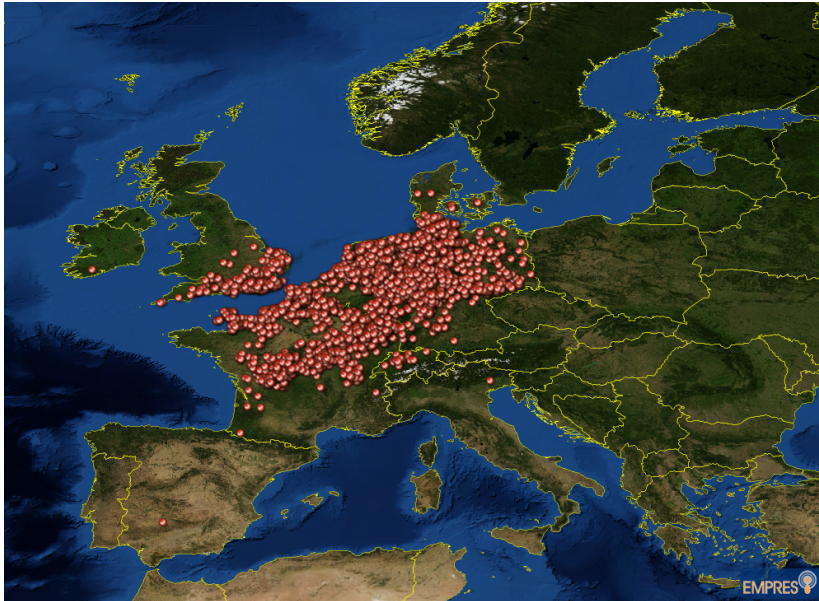
121 foyers cliniques entre le 16 août 2017 et le 01 mars 2018

262 foyers BTV4
depuis 2016

**Identification du BTV-4
par le LNA FCO du LSA
le 6 novembre 2017**
Typing and vaccine
development



SCHMALLENBERG



Schmallenberg-virus in Europe - 2012/2013, source OIE

Schmallenberg virus appeared in Europe in 2011 and affects livestock (cattle, sheep and goats) causing fetal congenital diseases and stillbirths.

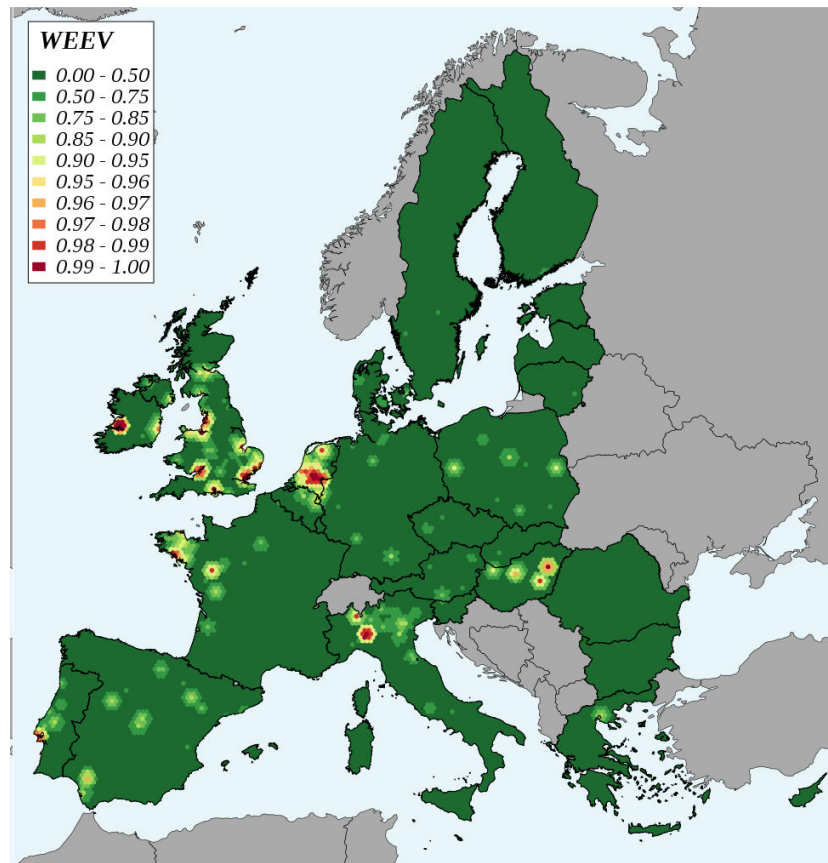
Transmission seems to be ensured by midges (*Culicoides* spp.) That were likely very active in spreading the infection during the summer and fall of 2011.

Genus Orthobunyavirus do not present a zoonotic risk .

Several hundred of bunyavirus in the world.



« Points chauds » générant un fort risque de contamination d'un insecte vecteur lors d'introduction de virus avec un animal vivant importé. Benoît Durant et al, Plos One, 2013



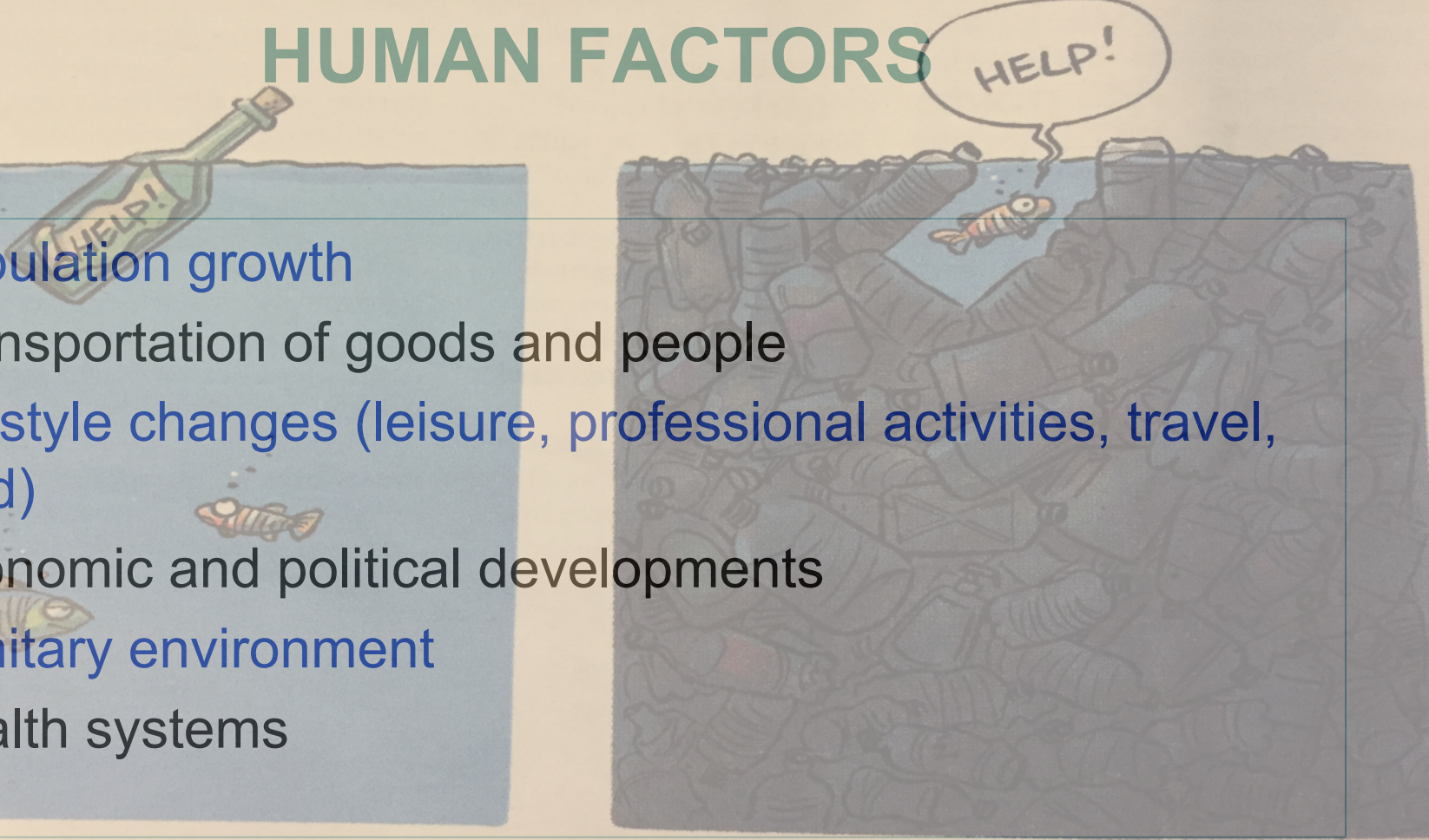
HUMAN FACTORS

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19TH CENTURY

Courier Int fev 2017

21ST CENTURY



Important challenges

-Vector-borne diseases account for 16% of the estimated global burden of infectious diseases in humans (worse in animals). High diversity of pathogens/huge reservoir.

Importance of their microbiote.

- Global changes: potential impact on the epidemiology of several infectious diseases (distribution and incidence, variable according to region, role of vectors)

- Alternative treatments: reduce collateral effect

Particularly reducing impact on microbiote

- Importance of Microbiote in front of emerging pathogens. How biodiversity of microbiote can be of great importance in front of diversity of pathogens.



<https://dim1health.sciencesconf.org>

“1health call”.

Info : dim1health@anses.fr

www.dim1health.com

joint IDMIT and DIM1HEALTH Symposium

One Health & Infectious Diseases



27-28 June 2018