

Réchauffement climatique, échanges internationaux et conséquences en santé animale

Global warming, international trade and consequences in animal health



Stéphan Zientara
UMR Anses/INRAe/ENVA

Colloque santé globale 15 décembre 2020



Global warming, international trade and consequences in animal health

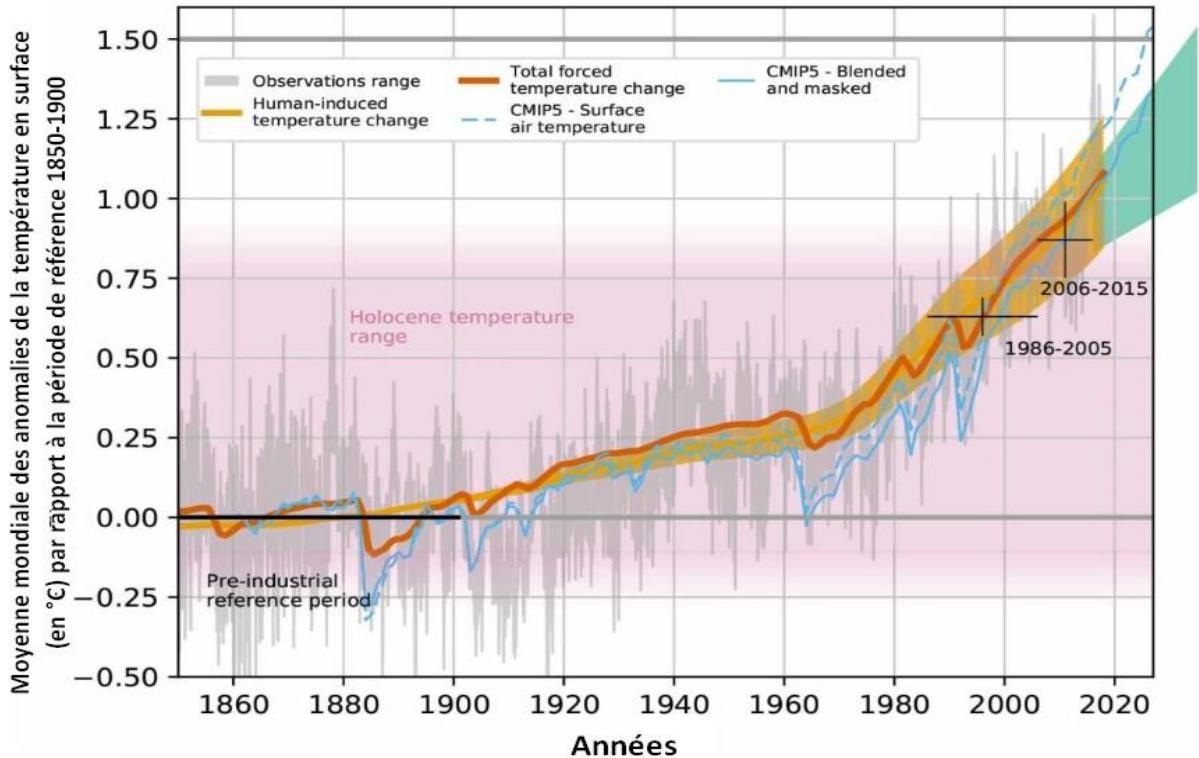
Examples of emergence of viral vector-borne diseases de maladies virales vectorielles in Europe : BT, WN, SBV and USU

- Fièvre catarrhale ovine (Bluetongue)
- West Nile
- Schmallenberg
- Usutu

Increase of international trade and travels







Lignes grises : fluctuation moyenne mensuelle de GMST

Jaunes : contribution des activités humaines aux changements de GMST

Orange : contribution totale (activités humaines + forçage naturel)

Bleues : température modélisée de la surface de l'air



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climate change diseases



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2020



Global warming, international trade and consequences in animal health

Examples of emergence of viral vector-borne diseases de maladies virales vectorielles in Europe : BT, WN, SBV and USU

- **Fièvre catarrhale ovine (Bluetongue)**
- West Nile
- Schmallenberg
- Usutu



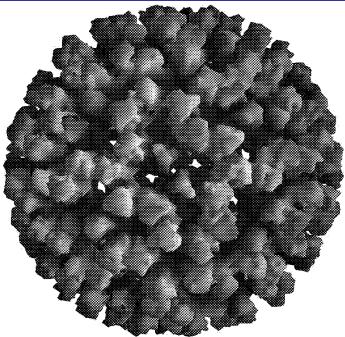
Identity card BTV



Grimes J.M., Burroughs J.N., Gouet P., Diprose J.M., Malby R., Zientara S., Mertens, P.P.C. & Stuart D.I. (1998). The atomic structure of the bluetongue virus core. *Nature*, 395, 470-478.



Orbivirus



> 27 (29) serotypes BTV

Vectors: Culicoïdes
(> 1 300 species)



Novel Bluetongue Virus in Goats, Corsica, France, 2014

Stéphan Zientara, Corinne Sailleau,
Cyril Viarouge, Dirck Höper, Martin Beer,
Maria Jenckel, Bernd Hoffmann, Aurore Romey,
Labib Bakkali-Kassimi, Aurore Fablet,
Damien Vitour, and Emmanuel Bréard



Culicoides imicola



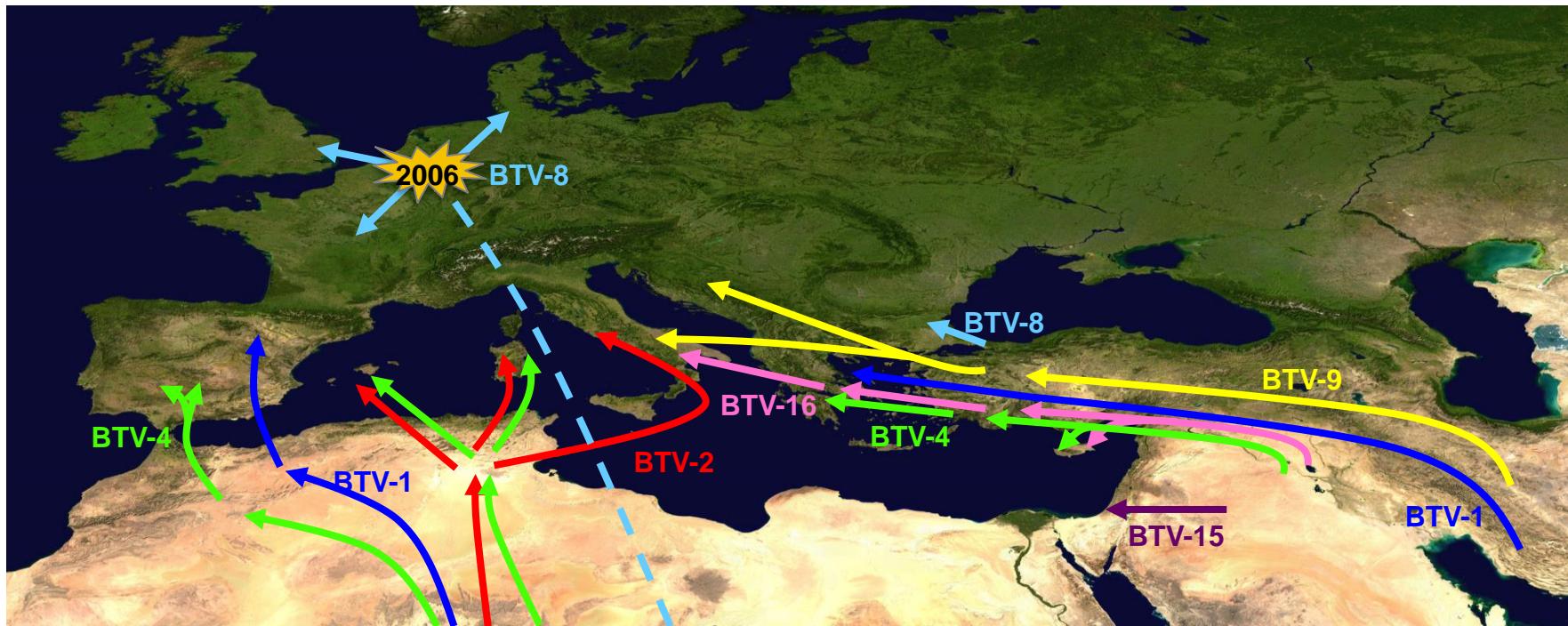
© IAH, UK

P Mellor, IAH

BT in Europe from 1979 to 1998...



BT in Europe from 1998

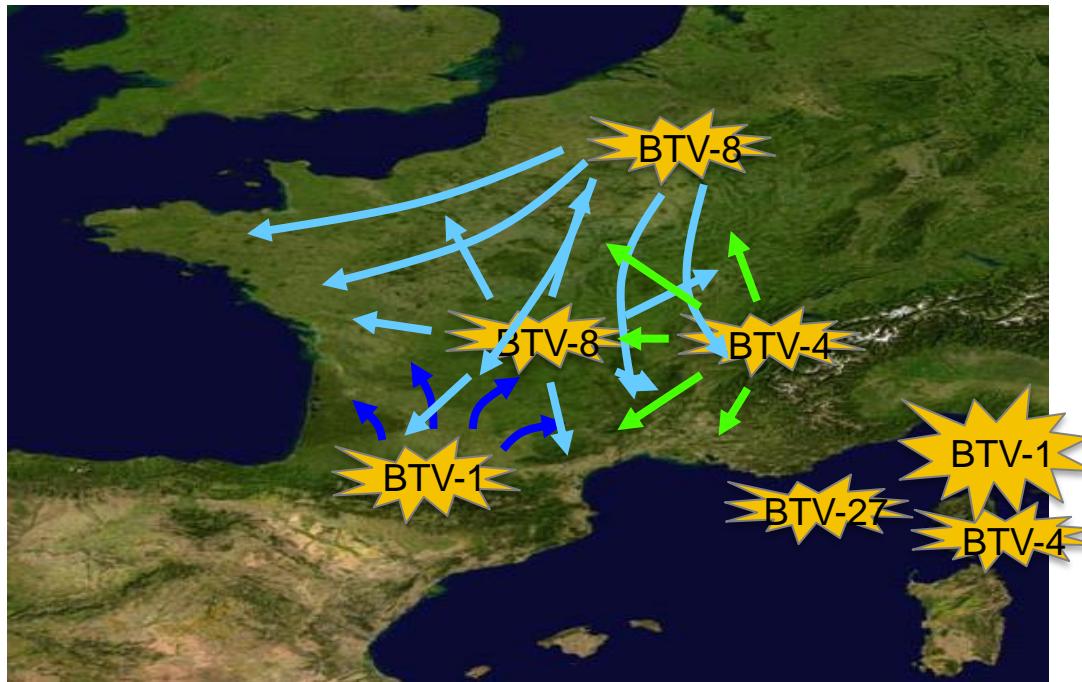


Introduction

Emergence of BTV-8 in the North of Europe in 2006

to 2006

BT in France

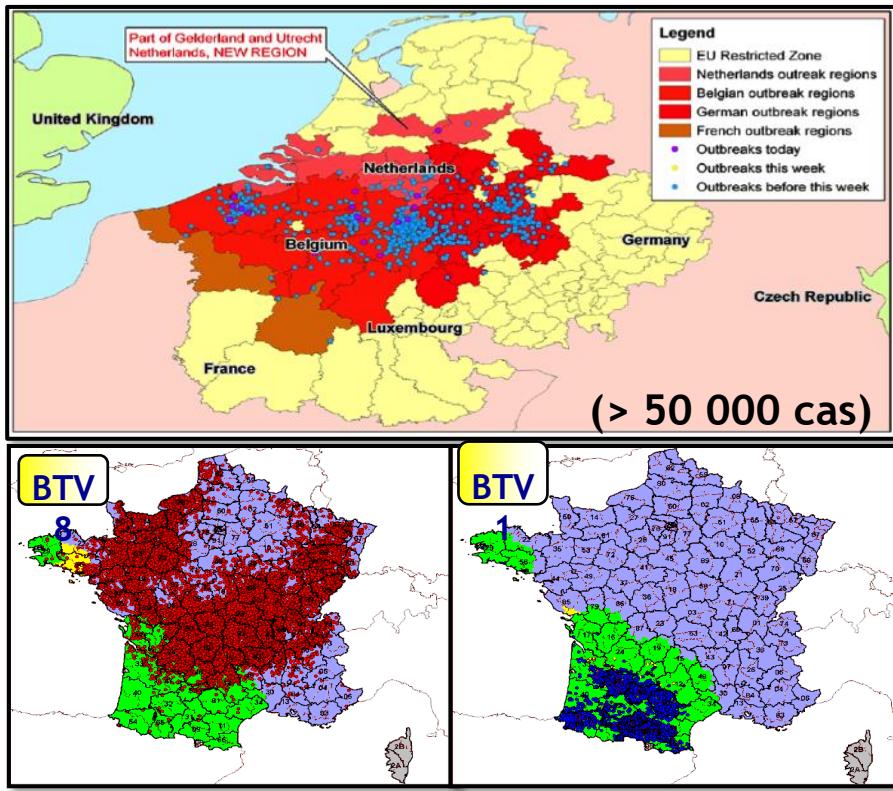


2013 : Emergence of BTV-1 in Corsica

2014 : Detection of BTV-27 in Corsica

2015 : Re-emergence of BTV-8 in continental France

2016-2017 : Emergence of BTV-4 in Corsica and in continental France



In 2007, estimation of the financial cost in France and in the Netherlands: **US\$ 1.4 MM**

2009 and 2010: compulsory vaccination BTV-1 + 8

State budget: **98 millions €** in 2010

European Commission: **200 millions €** in 2010

Economic impact of Bluetongue: a review of the effects on production

Jonathan Rushton^{1*} & Nick Lyons²

¹ Royal Veterinary College, Hawkshead Lane, Hatfield, AL9 7TA, United Kingdom.

² Pirbright Institute, Pirbright Laboratory, Ash Road, Pirbright, Surrey, GU24 0NF, United Kingdom.

* Corresponding author at: Royal Veterinary College, Hawkshead Lane, Hatfield, AL9 7TA, United Kingdom.
Tel.: +44 1707 667094, e-mail: rushton@rvc.ac.uk.

Answers?

BT vaccines



Evaluation of humoral response and protective efficacy of two inactivated vaccines against bluetongue virus after vaccination of goats

E. Bréard ^{a, b, c}, G. Belbis ^b, C. Hamers ^c, V. Moulin ^d, T. Lilin ^e, F. Moreau ^e, Y. Millemann ^b, C. Montange ^c, C. Sailleau ^a, B. Durand ^f, A. Desprat ^a, C. Viarouge ^a, B. Hoffmann ^e, H. de Smit ^d, S. Goutebroze ^c, P. Hudelet ^c, S. Zientara ^a

^a ANSES, UMR Virology 1161, Laboratoire de Santé Animale, Maisons-Alfort, France

^b ENVA, Unité de Pathologie du Bétail, Maisons Alfort, France

^c Merial S.A.S., Saint-Vulbas, France

^d Intervet/Schering-Plough Animal Health, Boxmeer, The Netherlands

^e ENVA, Centre de Recherches Biomédicales, Maisons Alfort, France

^f ANSES, Unité EPI, Laboratoire de Santé Animale, Maisons-Alfort, France

^g Institut für Virusdiagnostik, Greifswald-Insel Riems, Germany

Received 8 September 2010, Revised 14 December 2010, Accepted 16 December 2010, Available online 21 January 2011.



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ELSEVIER

Vaccine

Volume 33, Issue 4, 15 January 2015, Pages 512-518



Evaluation of adaptive immune responses and heterologous protection induced by inactivated bluetongue virus vaccines

Emmanuel Breard ^{a, 1, b, c}, Guillaume Belbis ^b, Cyril Viarouge ^a, Kyriaki Nomikou ^c, Andy Haegeman ^d, Kris De Clercq ^d, Pascal Hudelet ^e, Claude Hamers ^f, Francis Moreau ^g, Thomas Lilin ^g, Benoit Durand ^h, Peter Mertens ^e, Damien Vitour ^a, Corinne Sailleau ^a, Stéphan Zientara ^a

^a ANSES, UMR 1161 Virologie ANSES-INRA-ENVA, 23 avenue du Général de Gaulle, 94704 Maisons-Alfort, France

^b Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, Unité de Pathologie du Bétail, 7 avenue du Général de Gaulle, 94704 Maisons-Alfort, France

^c Vector-Borne Diseases Programme, The Pirbright Institute, Pirbright, Woking, Surrey GU24 0NF, United Kingdom

^d CODA-CERVA, Department of Virology, Ukkel, Belgium

^e Merial S.A.S., 254 Rue Marcel Mérieux, 69007 Lyon, France

^f Merial S.A.S., P.I. Plaine de l'Ain, Allée des Cyprès, 01150 Saint-Vulbas, France

^g Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, Centre de recherche biomédicale, 7 avenue du Général de Gaulle, 94704 Maisons-Alfort, France

^h ANSES, unité Épidémiologie, 23 avenue du Général de Gaulle, 94704 Maisons-Alfort, France

2006 : 7 cases

2007: 14 000 cases

2008 : 38 000

Compulsory vaccination
Inactivated vaccines
BTV-1 and 8

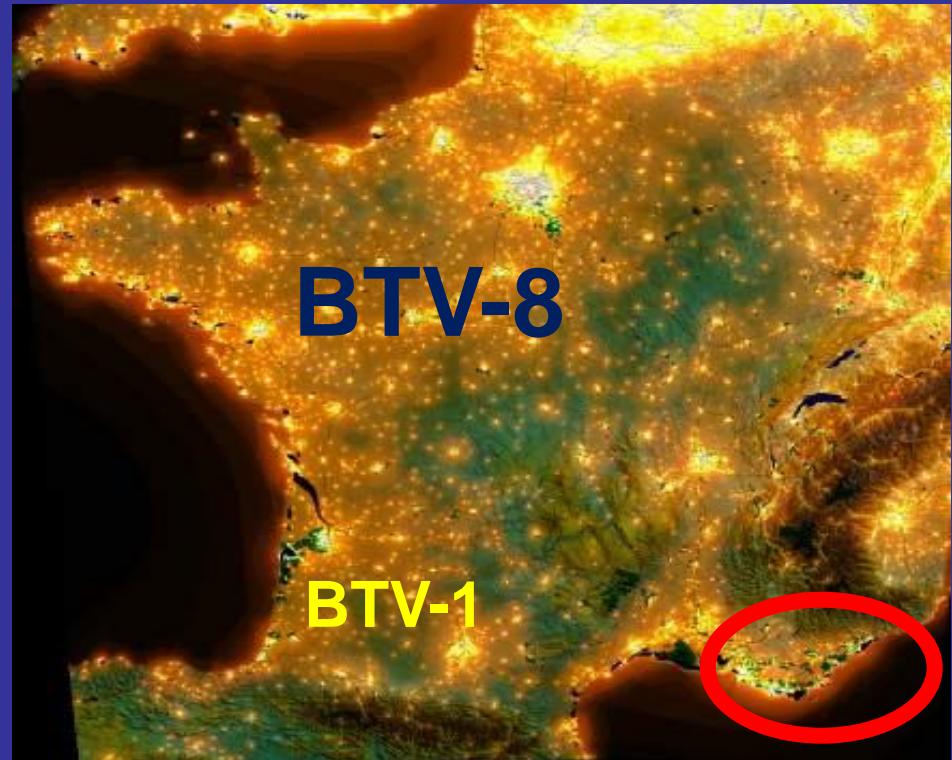
2009 : 83 cases

2010 : 1 case

2011: 0

2012 : 14 Décembre : free status

2010



From 2012 to 2015

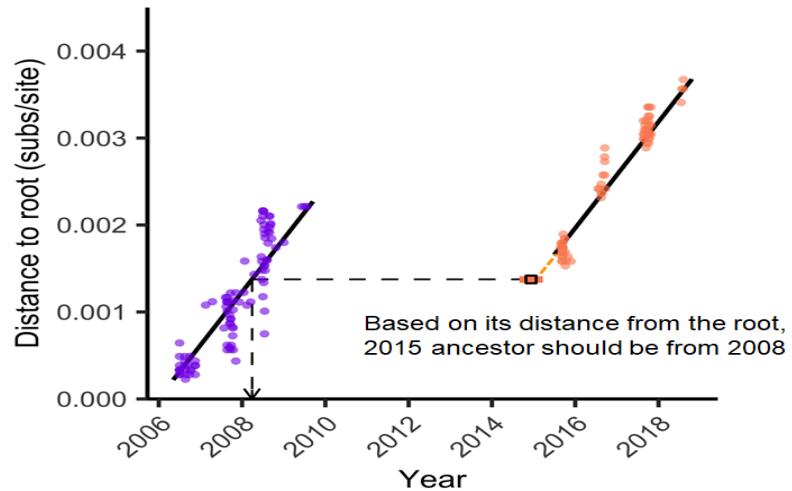


Allier « département »

2015



Genetic evolution of BTV-8 from 2006 to 2019



Pascall et al, *PLoS Biology*, accepted

PLOS BIOLOGY

OPEN ACCESS PEER-REVIEWED

SHORT REPORTS

“Frozen evolution” of an RNA virus suggests accidental release as a potential cause of arbovirus re-emergence

David J. Pascall , Kyriaki Nomikou , Emmanuel Bréard, Stephan Zientara, Ana da Silva Filipe, Bernd Hoffmann, Maude Jacquot, Joshua B. Singer, Kris De Clercq, Anette Bøtner, Corinne Sailleau, Cyril Viarouge, Carrie Batten, [...], Massimo Palmarini  [view all]



2017

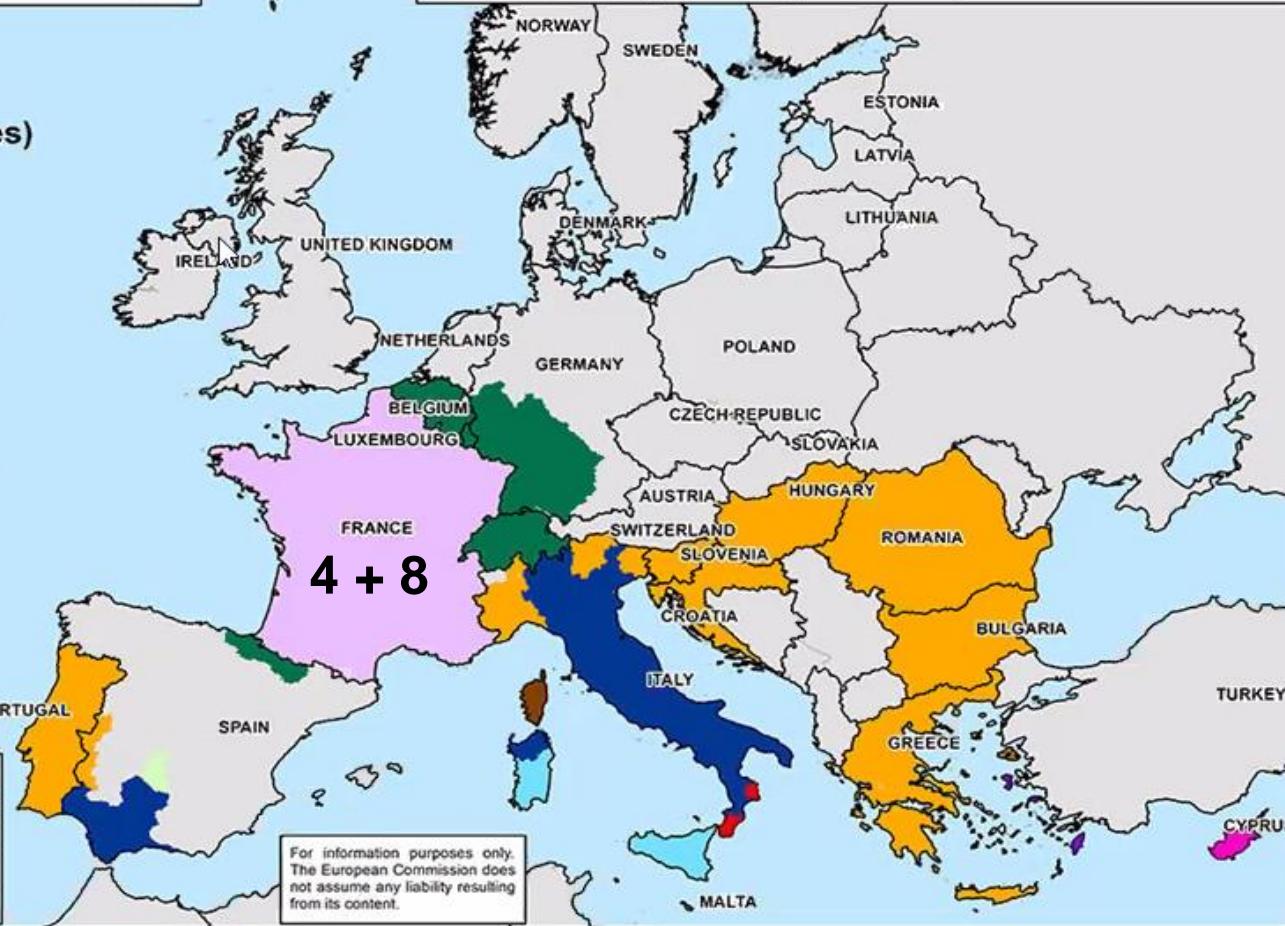
Bluetongue

Restricted zones* as of 04 November 2020

This map includes information on the bluetongue virus serotypes circulating in each restricted zone, which permits, for the purposes of Articles 7 and 8 of Regulation No 1266/2007, the identification of the restricted zones demarcated in different Member States where the same bluetongue virus serotypes are circulating.

Zone (serotypes)

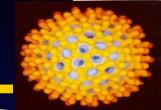
- F (8)
- I (1,4)
- J (1)
- T (1,2,4,8,16)
- X (4,16)
- Y (8,4)
- A3 (4)
- A4 (1,4,8,16)
- A5 (1,3,4)
- A6 (1,4,16)
- A7 (4,16,8)
- A8 (16)



Answers?

BT diagnosis

Bluetongue virus (BTv)



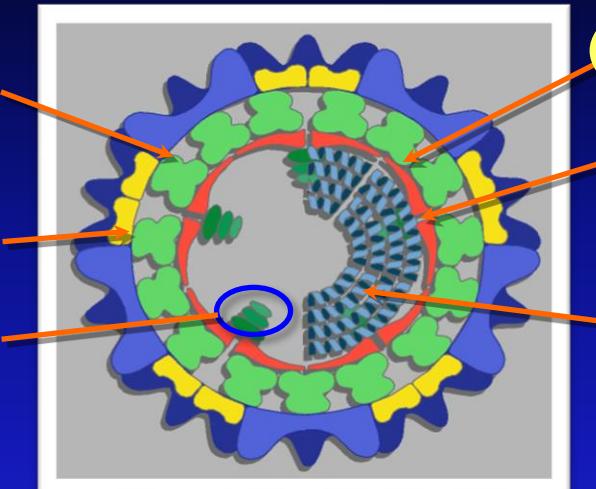
VP2 :

- binding to the receptor, virus entry
- neutralisation, type specificity

VP5 : ▪ pénétration

transcription complex :

- VP1 : RNA polymerase
- VP4 : capping enzyme
- VP6 : RNA helicase



4 non structural proteins (NSP)

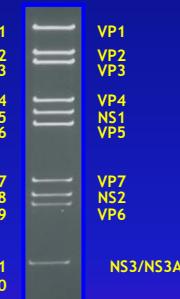
VP7 :

- conserved among serotypes

VP3 :

virus genome:

10 segments
dsARN

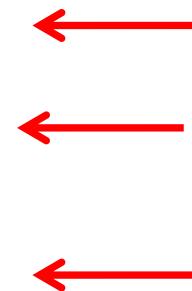


Institut Pourquier

IdVet

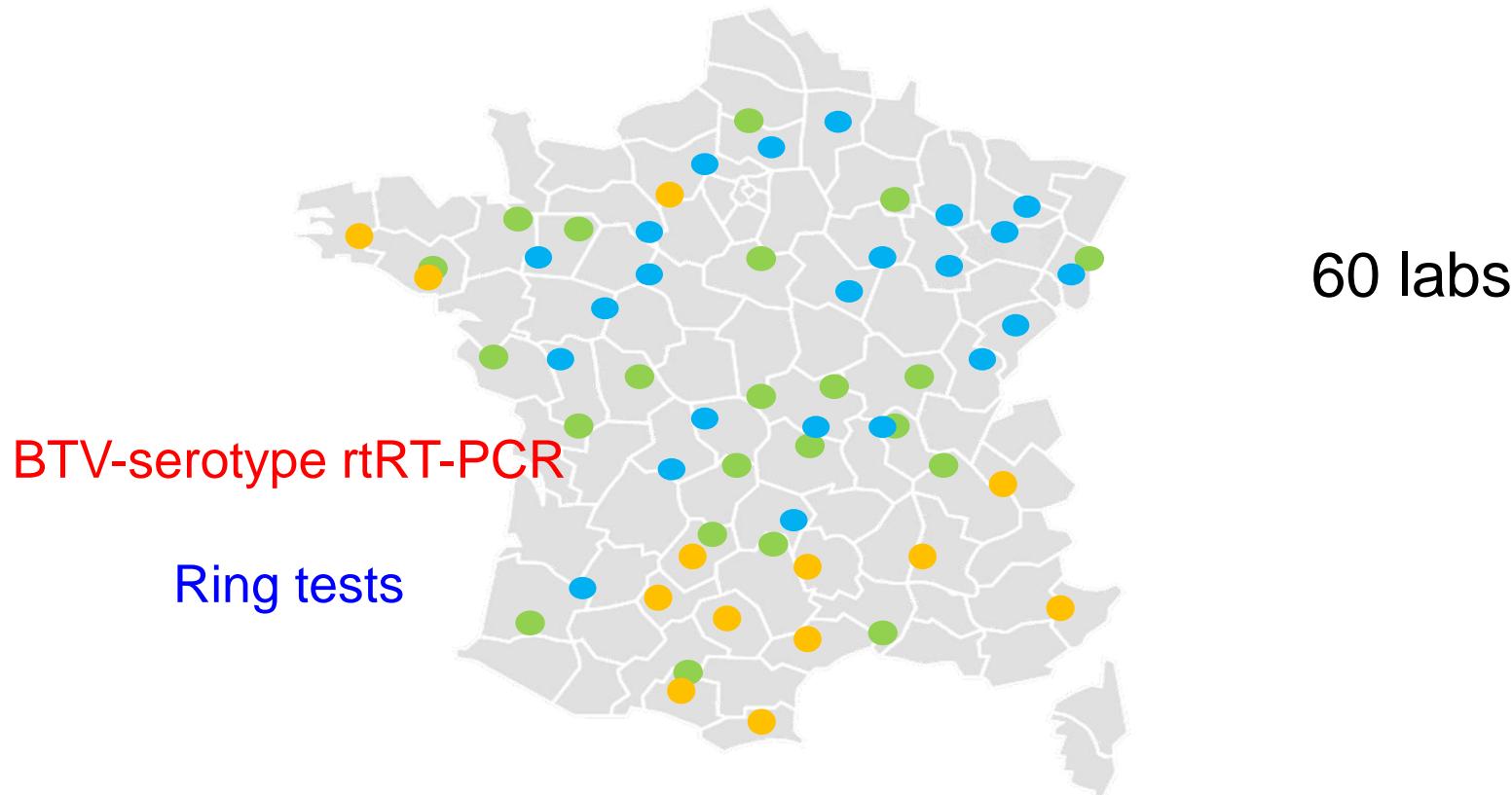


	kits
Dépistage de groupe « tout génotype » (RT-PCR duplex)	VetMax™ BTV NS3 All Genotypes kit (Applied Biosystems) ADIAVET™ BTV Real Time (BioX) ID Gene® BlueTongue duplex (IDVet Genetics) Bio-T kit® BTV all genotypes (BioSellal)
Dépistage de génotype (RT-PCR duplex)	VetMax™ BTV 1 typing-IAH (Applied Biosystems) VetMax™ BTV 8 typing-IAH (Applied Biosystems) LSI VetMax™ BTV 4 typing-IAH (Applied Biosystems) ADIAVET™ BTV type 1 Real Time (ADI391 - BioX) ADIAVET™ BTV type 8 Real Time (ADI381 - BioX) ADIAVET™ BTV TYPE 4 Real Time (ADI541-BioX) ID Gene™ Bluetongue genotype 8 Duplex (IDVet Genetics) Bio-T kit® BTV-8 (BioSellal) Bio-T kit® BTV-1 (BioSellal) Bio-T kit® BTV-4 (BioSellal)
Dépistage de groupe + génotype (RT-PCR triplex)	VetMax Triplex BTV 1 (Applied Biosystems) VetMax Triplex BTV 8 (Applied Biosystems) Adiavet BTV All+Type 1 (ADI411 - BioX) Adiavet BTV All+Type 8 (ADI401 - AES)
Dépistage de type 4 +8 (RT-PCR triplex)	ID Gene™ Bluetongue genotypes 8/4 Triplex (IDVet Genetics)



Validated BTV RT-PCR and used in France
(Biosellal, ADIAVET, IdVet, ...)

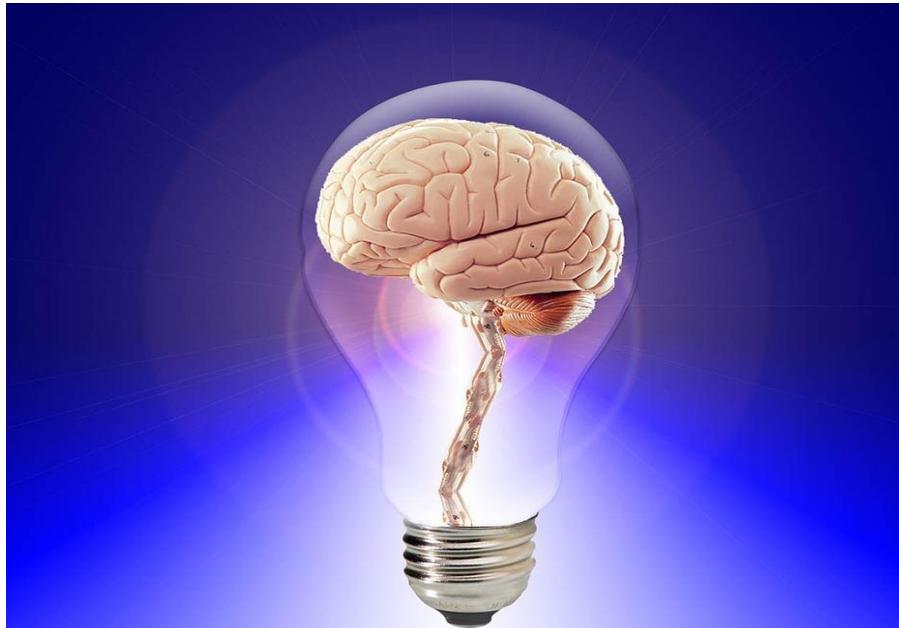
French network of local labs for BTV-1 and BTV-8 typing



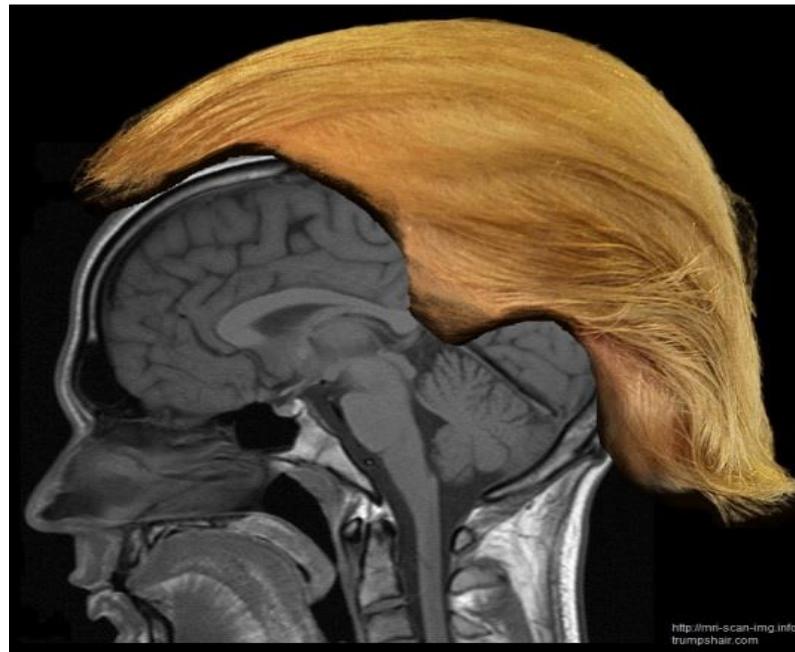
2018



Cerebral abnormalities induced by BTV-8

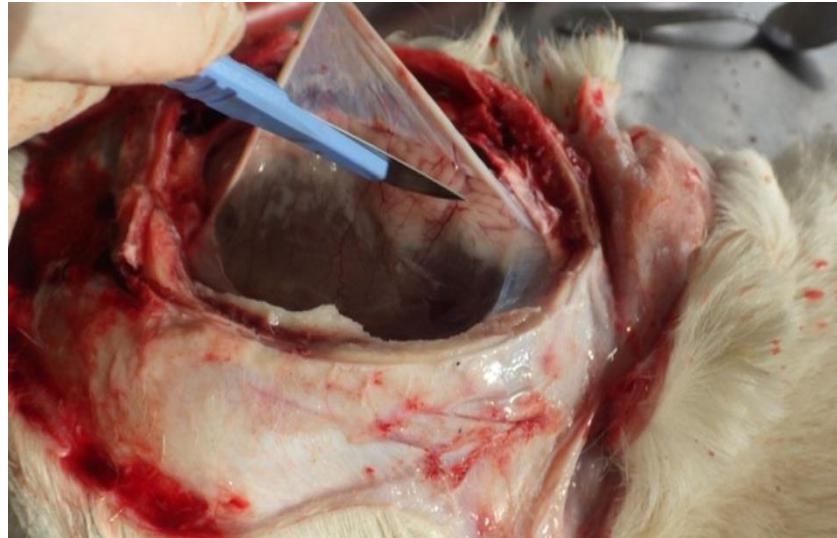


2019



<http://mrni-scan-img.info>
trumpshair.com

2019



Many cases of hydranencephaly

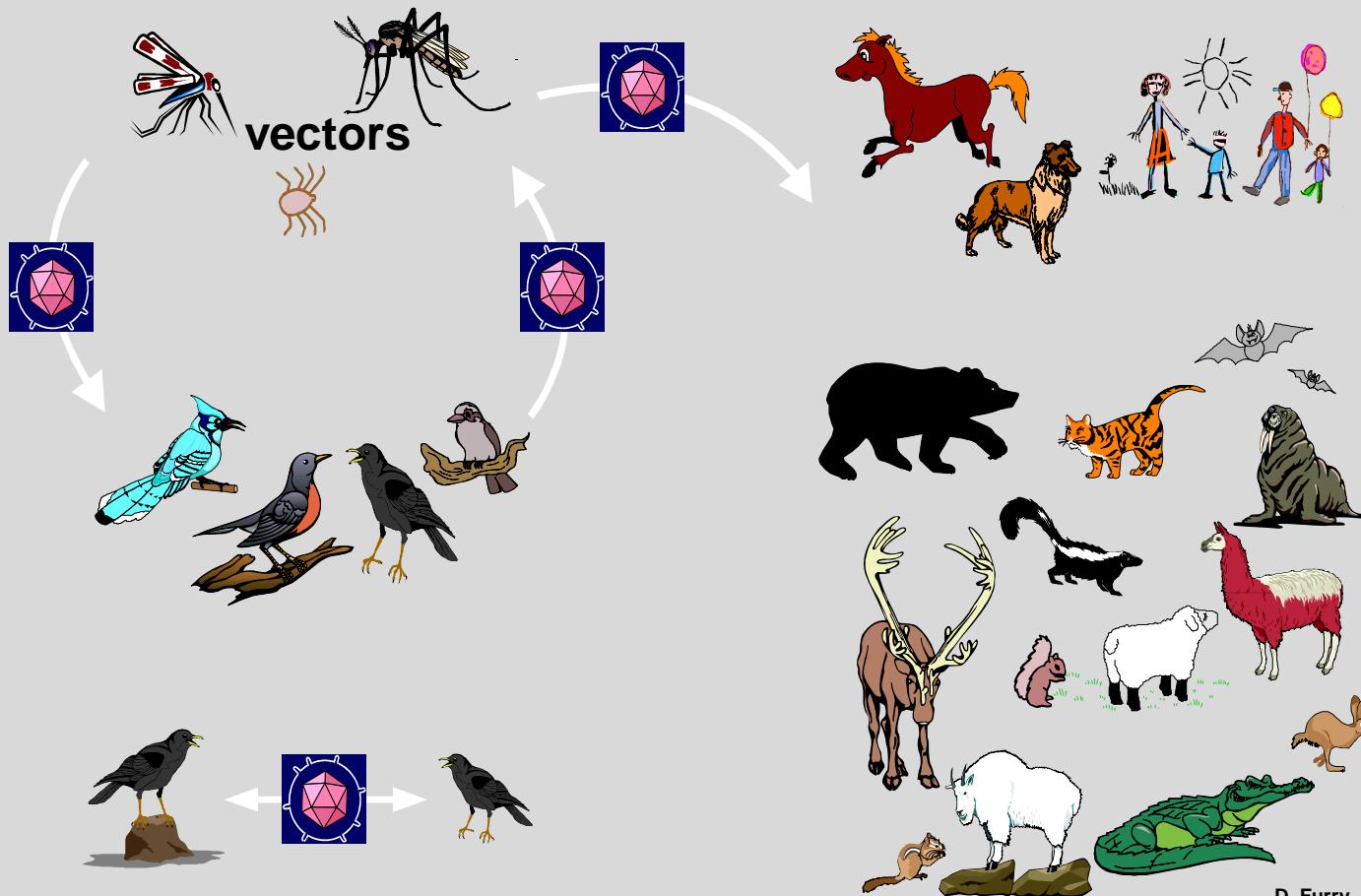
Wolgust Valerie, ENVA

Global warming, international trade and consequences in animal health

Examples of emergence of viral vector-borne diseases de maladies virales vectorielles in Europe : BT, WN, SBV and USU

- Fièvre catarrhale ovine (Bluetongue)
- **West Nile**
- Schmallenberg
- Usutu

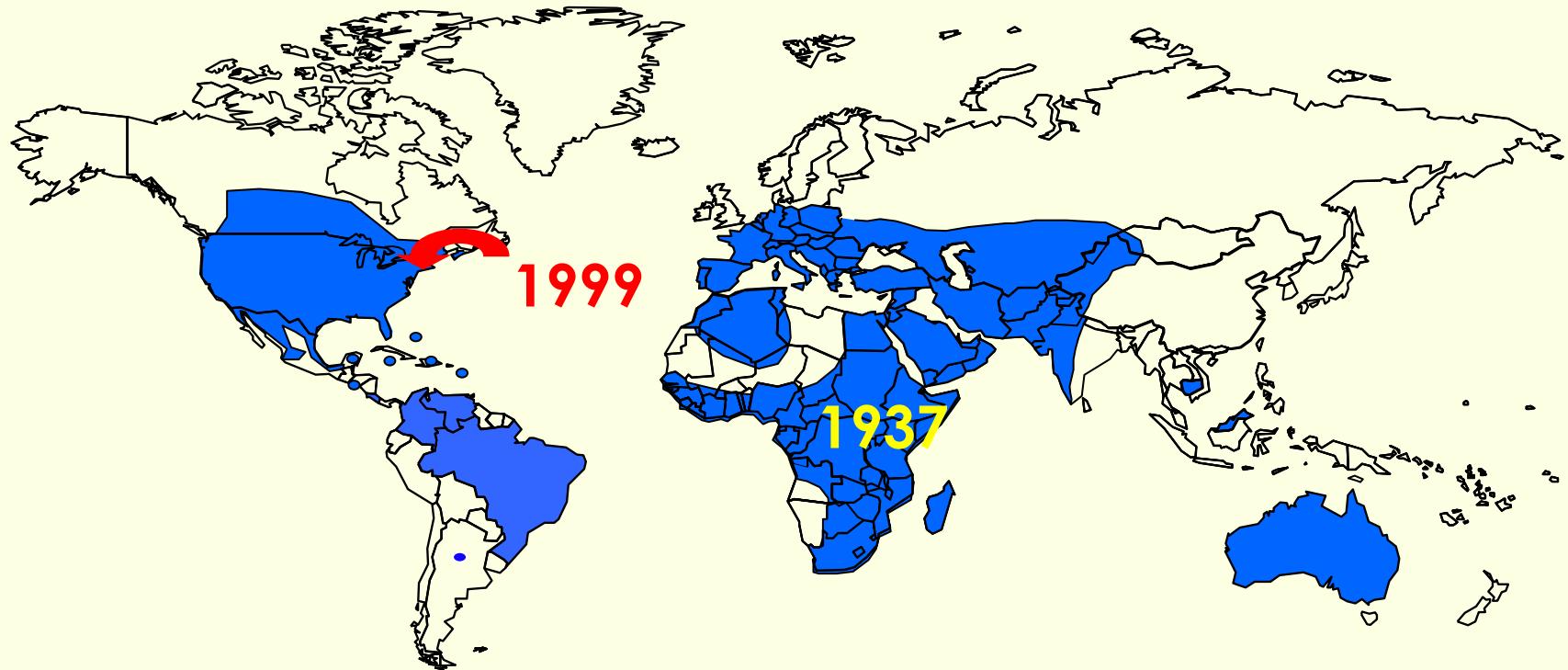
Transmission cycle

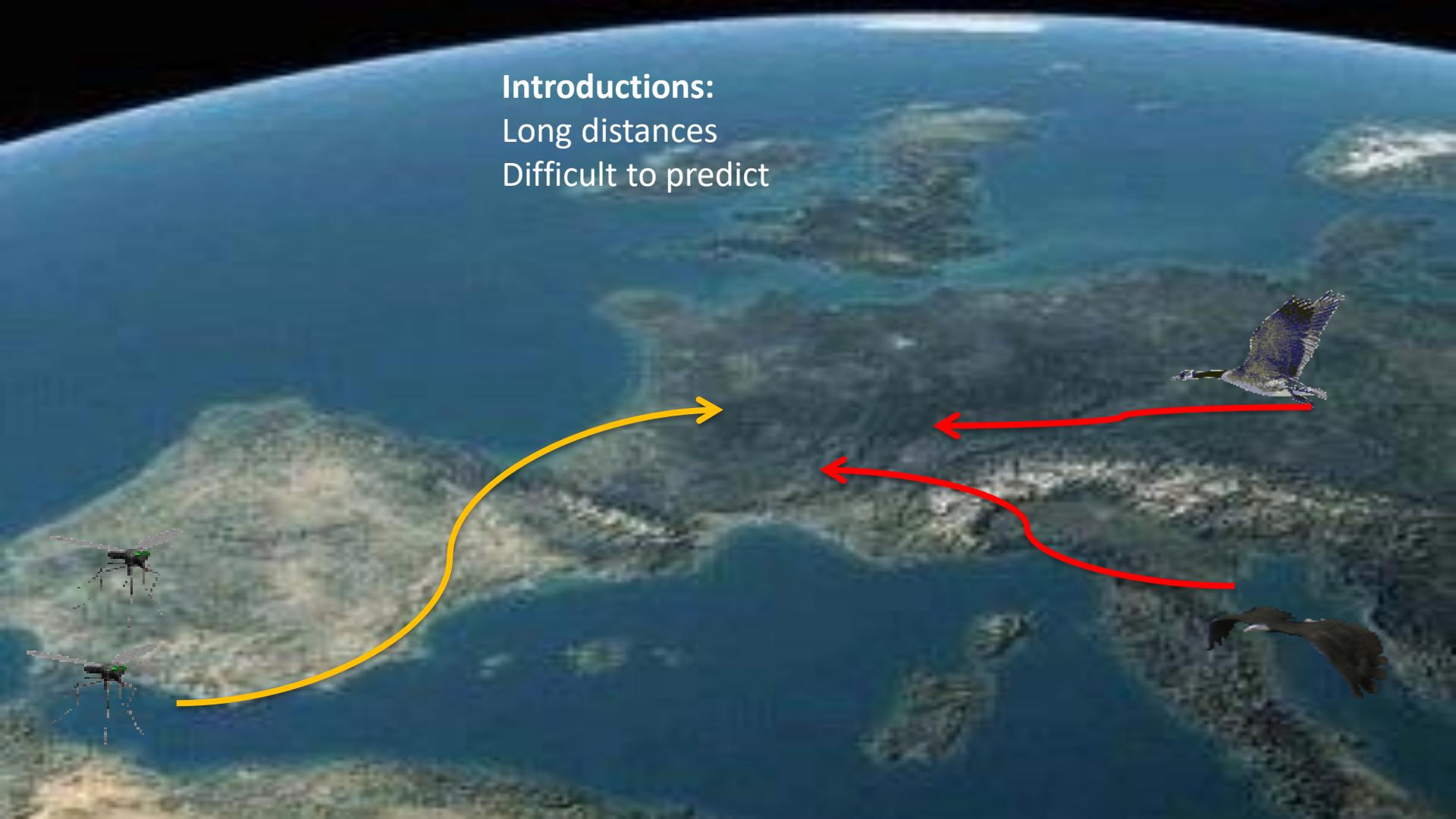


Vector *Culex*



West Nile





Introductions:
Long distances
Difficult to predict



West Nile in France



A satellite-style aerial photograph of a coastal region. The land is a mix of green vegetation and brownish, possibly dry or dead, areas. The coastline curves from the bottom left towards the top right, meeting a body of water that has varying shades of blue and green. Overlaid on this image are several yellow circles and text labels indicating years.

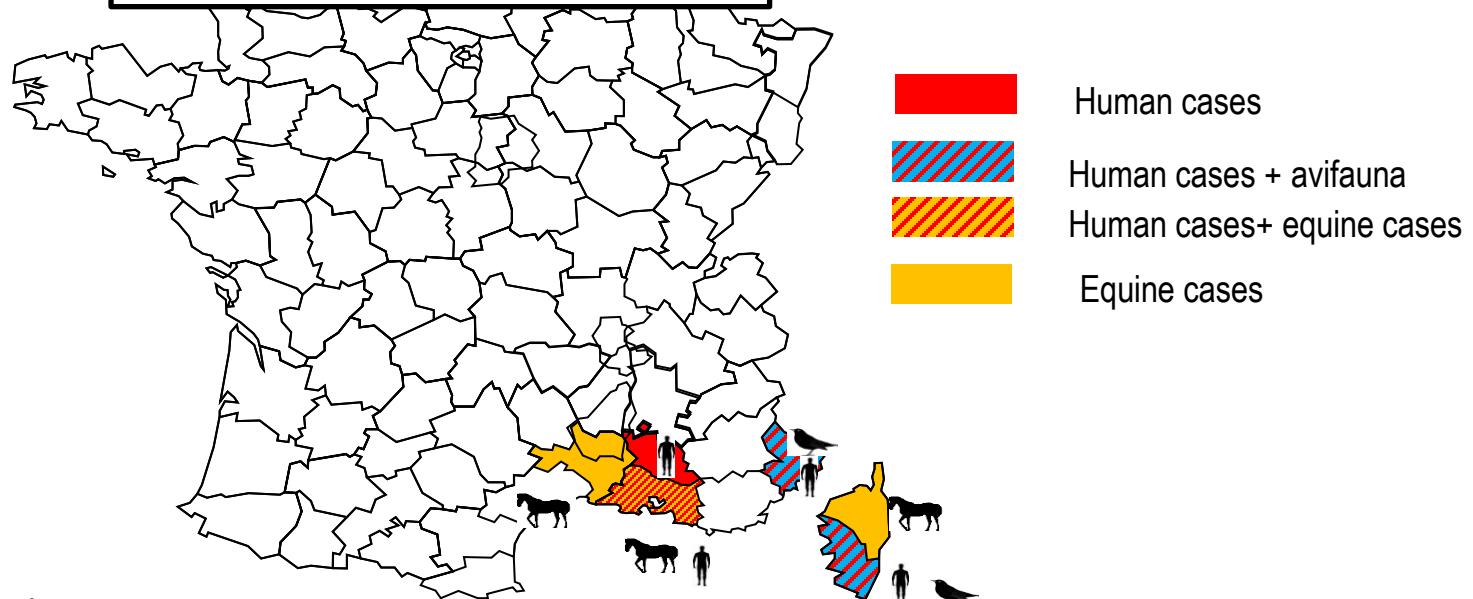
2006 1962-65
2000 2004
...
2015
2018
2019
2020

2003

WN Human cases in France in 2018

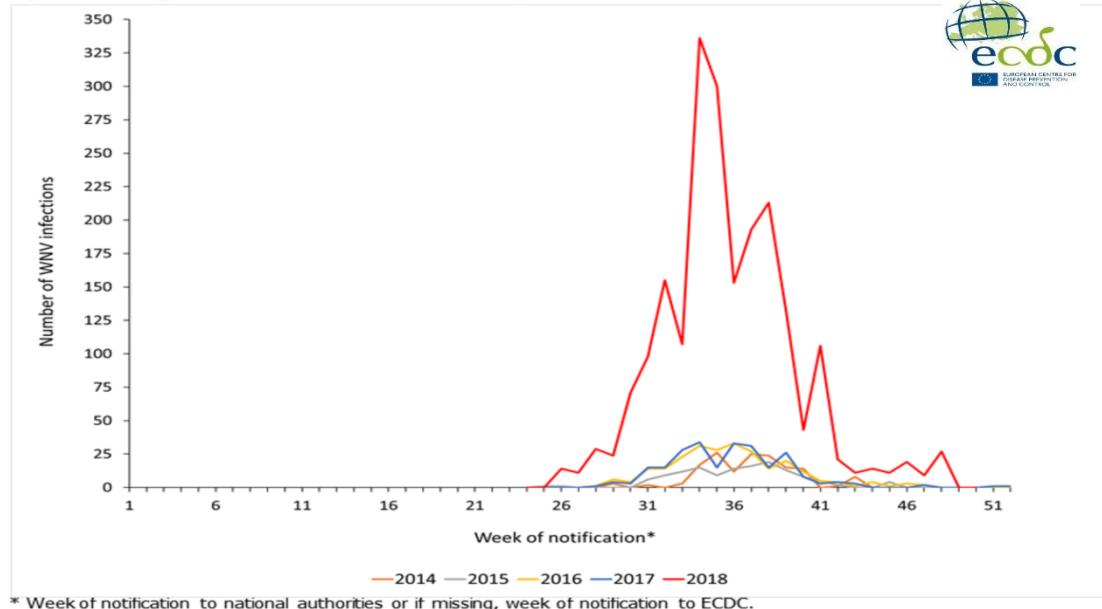
- ✓ 5 départements (07/07-12/11)
- ✓ 27 autochtonous human cases (24 cases in region PACA with 21 cases in Alpes-Maritimes) ; 7 neuroinvasive forms

Bilan au 28/11/2018



Increase of WNV circulation in Europe : human cases

Number of WNV infections in EU/EEA and EU enlargement countries by epidemiological week of notification*, 2014-2018.



In 2018 :

2,083 human cases

- 1 503 cases in EU: Italy (576), Grèce (311), Romania (277), Hungary (215)...
 - 580 cas humains dans les pays voisins : Serbie (415)...
- ➔ 7,8 fois plus qu'en 2017

181 deaths

285 equine cases

In EU, more cases in 2018 than in the 7 years before

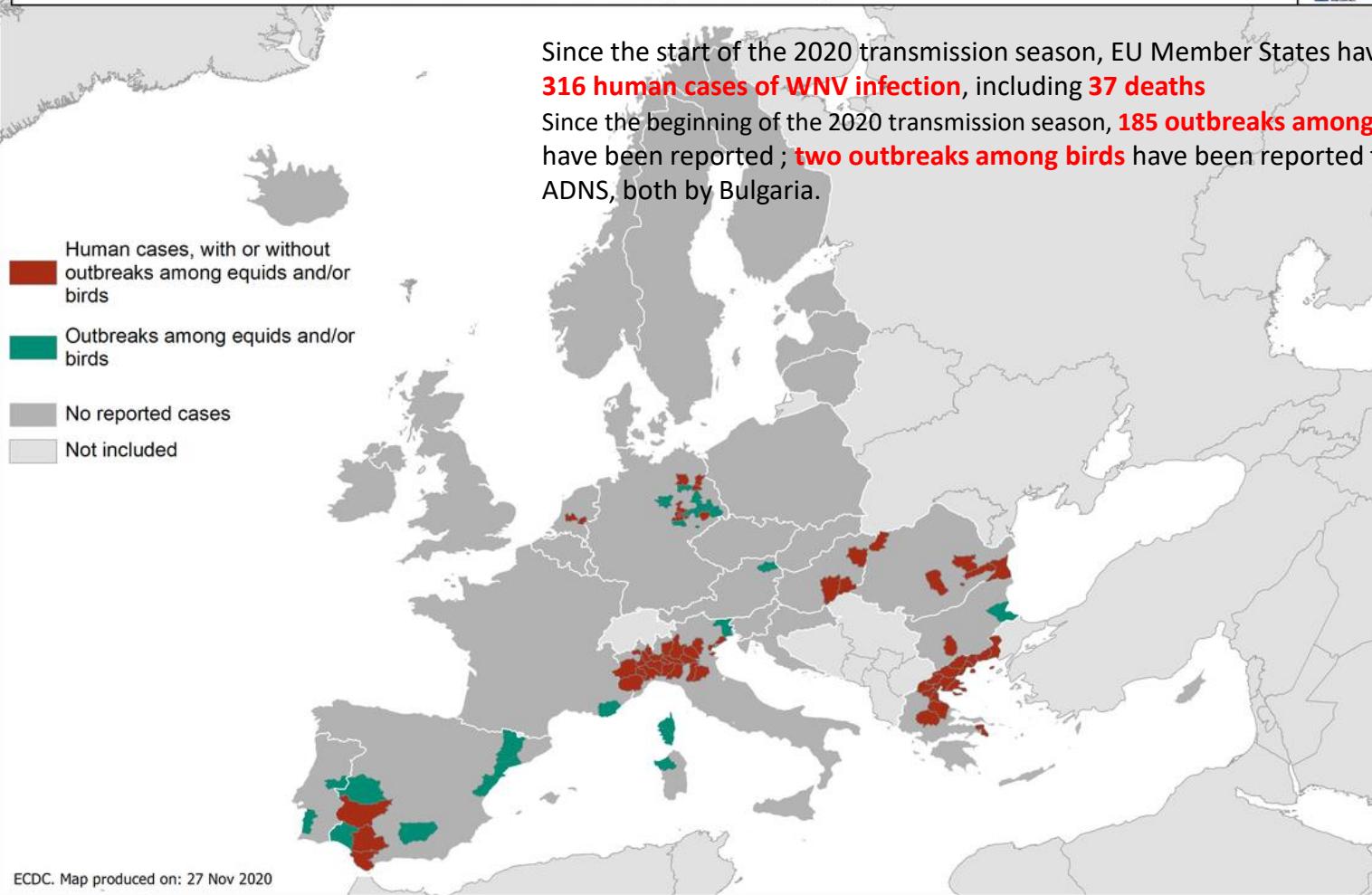
Distribution of West Nile virus infections among humans and outbreaks among equids and/or birds in the EU
Transmission season 2020; latest data update 26 Nov 2020

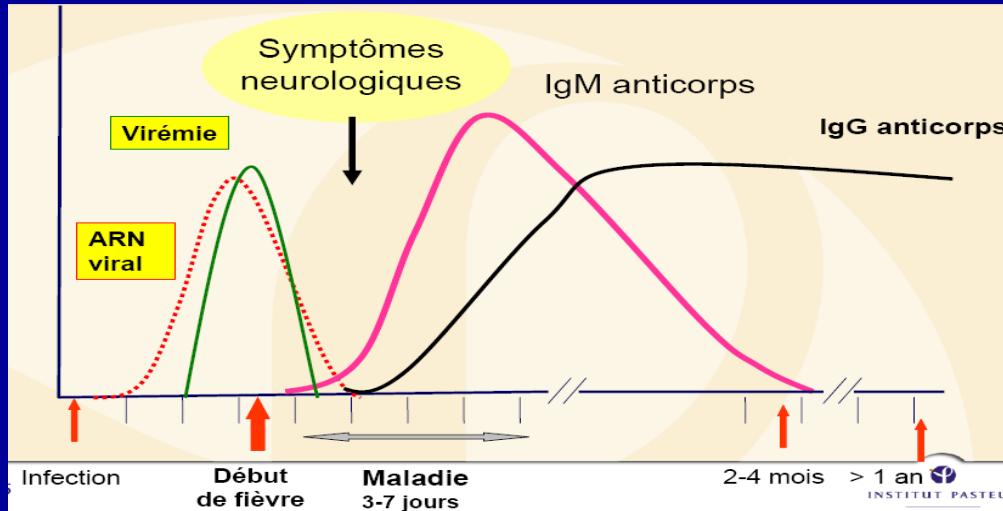


Since the start of the 2020 transmission season, EU Member States have reported
316 human cases of WNV infection, including **37 deaths**

Since the beginning of the 2020 transmission season, **185 outbreaks among equids**
have been reported ; **two outbreaks among birds** have been reported through
ADNS, both by Bulgaria.

- █ Human cases, with or without outbreaks among equids and/or birds
- █ Outbreaks among equids and/or birds
- No reported cases
- Not included





Serology ELISA (IgM, IgG)

Network of regional labs

Virology

rt-RT-PCR

Network of regional labs

Global warming, international trade and consequences in animal health

Examples of emergence of viral vector-borne diseases de maladies virales vectorielles in Europe : BT, WN, SBV and USU

- Fièvre catarrhale ovine (Bluetongue)
- West Nile
- **Schmallenberg**
- Usutu



Métagénomique



Mélange de 3 échantillons de sang (animaux malades) + 1 sang animal indemne

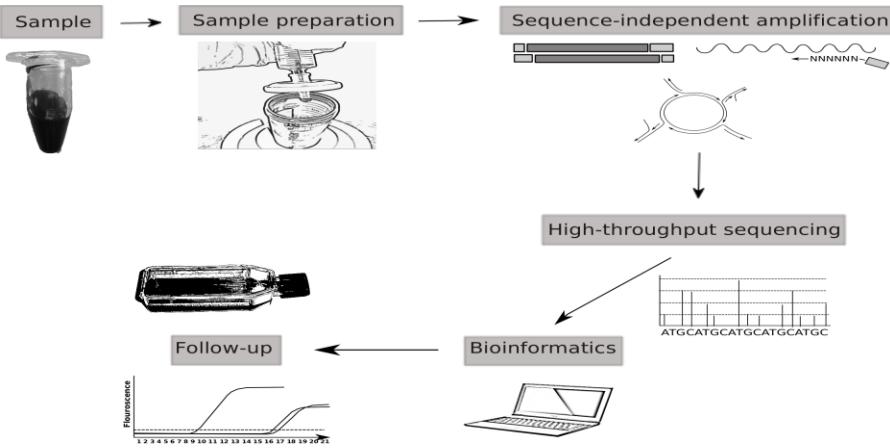
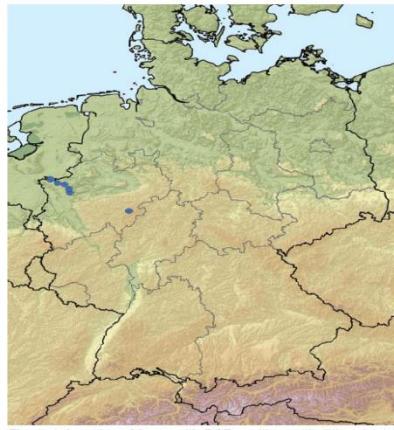
séquençage sans a priori

Novel Orthobunyavirus in Cattle, Europe, 2011

Bernd Hoffmann,¹ Matthias Scheuch,¹ Dirk Höper,
Ralf Jungblut, Mark Holsteg, Horst Schirrmeier,
Michael Eschbaumer, Katja V. Goller,
Kerstin Wernike, Melina Fischer,
Angela Breithaupt, Thomas C. Mettenleiter,
and Martin Beer¹

In 2011, an unidentified disease in cattle was reported in Germany and the Netherlands. Clinical signs included fever, decreased milk production, and diarrhea. Metagenomic analysis identified a novel orthobunyavirus, which subsequently was isolated from blood of affected animals. Surveillance was initiated to test malformed newborn animals in the affected region.

In summer and autumn 2011, farmers and veterinarians in North Rhine-Westphalia, Germany, and in the Netherlands reported to the animal health services, local diagnostic laboratories, and national research institutes an unidentified disease in dairy cattle with a short period of clear clinical signs, including fever, decreased milk production, and diarrhea. All classical endemic and emerging viruses, such as pestiviruses, bovine herpesvirus



Name: Virus Schmallenberg



Weekly incidence

LE VIRUS SE PROPAGE TRÈS VITE



- Ovins
- Caprins
- △ Bovins
- ◆ Foyer confirmé
- ◆ Suspicion non confirmée

52



[end Decembre 2011 – beginning April 2012]
(per week)

Après l'Allemagne, le virus de Schmallenberg se propage en France

Le Monde.fr avec AFP | 01.02.2012 à 14h47 • Mis à jour le 01.02.2012 à 20h49

Abonnez-vous
à partir de 1 €

Réagir ★ Classer Imprimer Envoyer

Partager   

 Recommander

 Envoyer

 61 personnes le recommandent. Inscription pour voir ce que vos amis recommandent.



La maladie de Schmallenberg progresse dans les élevages français

Le Monde.fr avec AFP | 14.02.2012 à 11h37 • Mis à jour le 14.02.2012 à 19h41

Abonnez-vous
à partir de 1 €

Réagir ★ Classer Imprimer Envoyer

Partager    



Un vétérinaire pratique une autopsie sur un agneau atteint de la maladie de Schmallenberg. | AFP/FEDERICO GAMBARINI

+ embargo on animal international (Russia, China, ...)

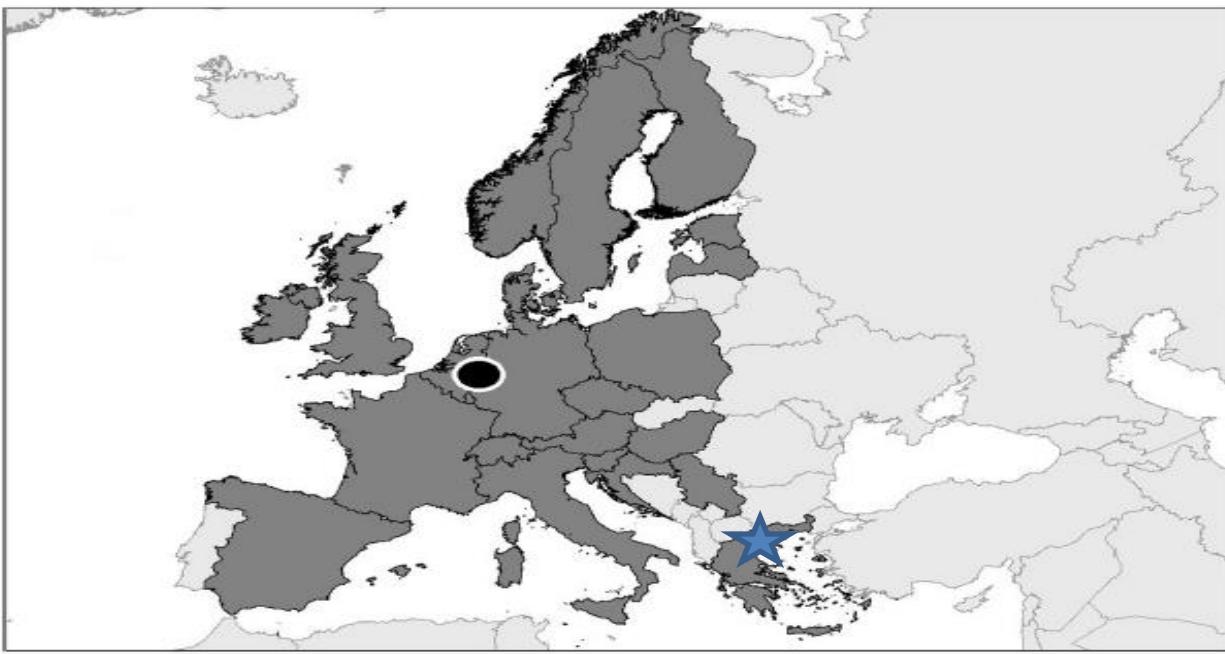


Fig. 5. European countries affected by Schmallenberg virus by September 2013. The area, where the epidemic started in 2011 is marked by a dot.



Contents lists available at [ScienceDirect](#)

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed



Schmallenberg virus—Two years of experiences

Kerstin Wernike^a, Franz Conraths^b, Gina Zanella^c, Harald Granzow^d,
Kristel Gache^e, Horst Schirrmeyer^a, Stephen Valas^f, Christoph Staubach^b,
Philippe Marianneau^g, Franziska Kraatz^a, Detlef Höreth-Böntgen^b,
Ilona Reimann^a, Stéphan Zientara^h, Martin Beer^{a,*}

Culicoides imicola



©

UK

P Mellor, IAH

Neonatal abnormalities



a



b



Arthrogryposis hydranencephaly syndrome

c



d



Answers?

SBV Diagnosis

rt-RT-PCR

FLI RT-PCR number 1 :

- segment L

FLI RT-PCR number 2 :

- segment S

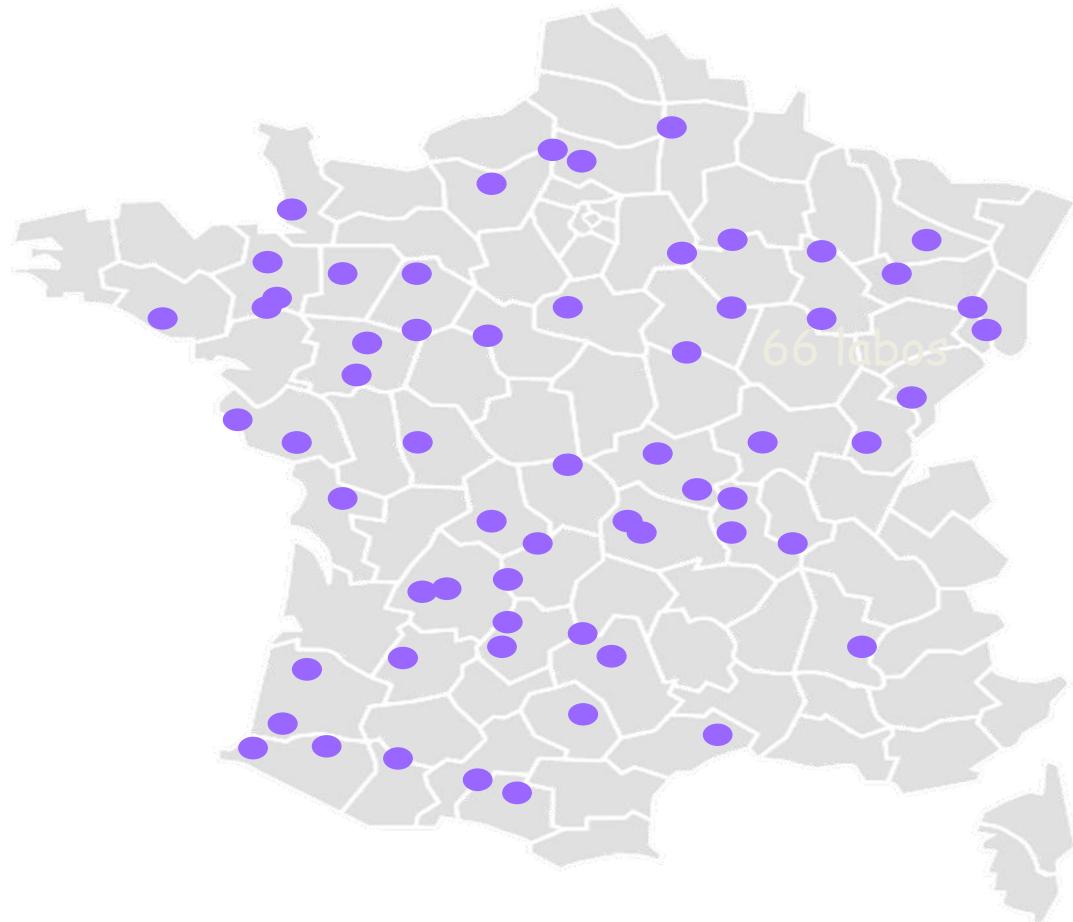
2 kits commercial kits validated

- Duplex : SBV and GAPDH

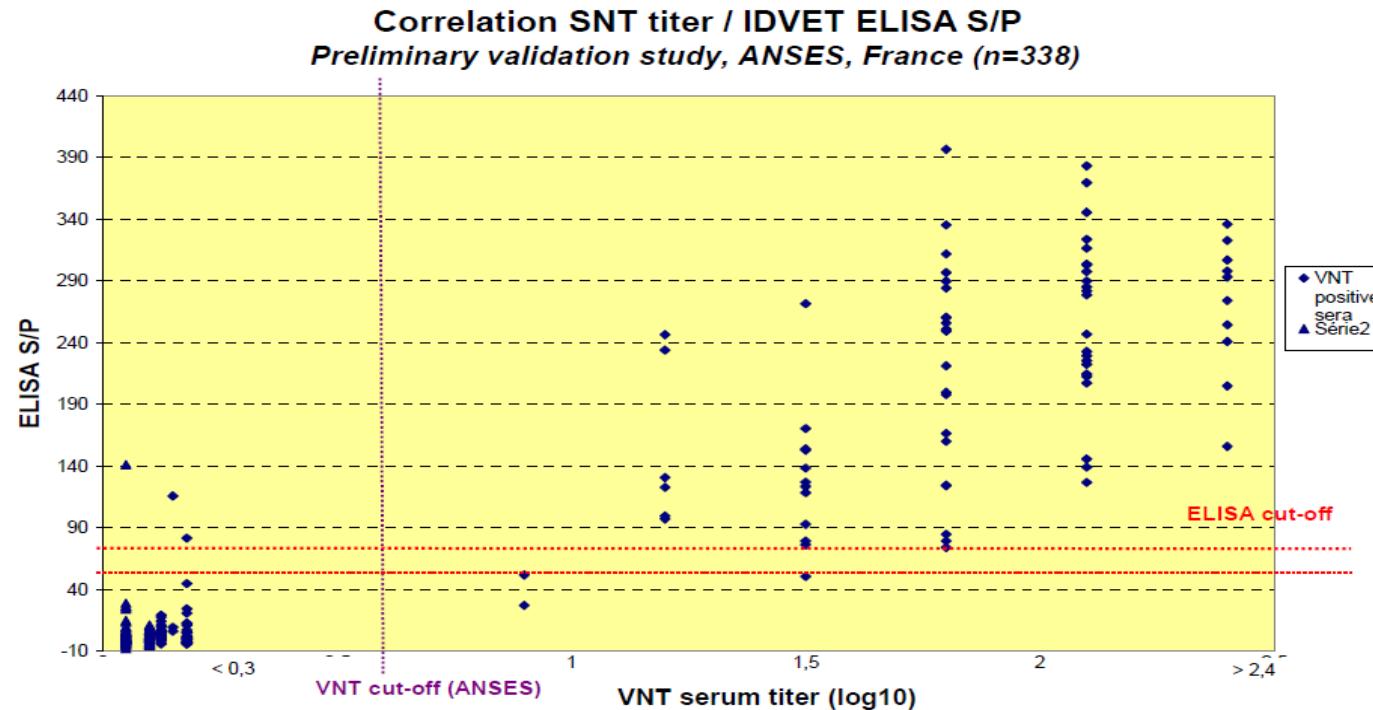
- (or beta Actine)

- RNA amplification

**AES - ADIAGENE
LSI (Life technologies)**



Serological diagnosis



ID.vet
Innovative Diagnostics

+ kit IDEXX

► 5 avril 2012 : annonce Promed de la validation ANSES

-----Message d'origine-----

De : owner-promed-ahead@promed.isid
[mailto:owner-promed-ahead@promed.isid] Objet :
owner-promed-ahead@promedmail.org

SCHMALLEMBERG VIRUS - EUROPE (33):

A ProMED-mail post

<<http://www.promedmail.org>>

ProMED-mail is a program of the International Society for Infection

Date: Thu 5 Apr 2012

From: Emmanuel Breard <Emmanuel.BREARD@veterinaires.fr>

Schmallenberg virus (SBV) is a virus reported in November 2011, it has spread to United Kingdom and Spain, where it affects sheep, and goats.

Serological testing is essential for virus neutralization and immunofluorescence of samples, and do not offer standar

This week, the animal health laboress has approved an indirect ELISA, based on the Schmallenberg virus (SBV) antibodies.

This kit is currently being evaluated.

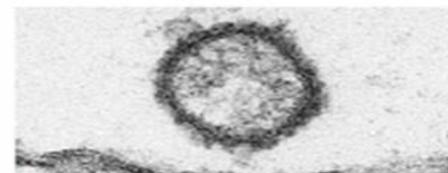
Wednesday 11/04/2012
SPECIAL ANALYTICA 2012

CLINICAL DIAGNOSTICS

First ELISA to detect Schmallenberg virus

Philippe Poirier (IDvet, Montpellier)

Schmallenberg virus (SBV) is the same that's been given to a vector-transmitted arbovirus that was initially reported in November 2011 on the issue of congenital fetal malformations and stillbirths in cattle, sheep, and goats. The pathogen has since been detected in France, Germany, Italy, Austria, Switzerland, Luxembourg, and the United Kingdom, and looks set to be a major veterinary concern in Europe, both in 2012 and beyond. Specialist in veterinary diagnostics IDvet is launching the first commercial ELISA for the detection of SBV antibodies.



The Schmallenberg virus is causing anomalies in livestock across western Europe.

The reason for the sudden appearance of SBV in the same countries that suffered from bluetongue in 2006 and 2007, and again in 2010, is still unknown, but this pathogen will probably be one of the major veterinary concerns in Europe in 2012 and beyond.

While the bluetongue virus (BTV) first appeared in Europe in 1958, commercial RT-PCR diagnostic tests were available by 1990. But the Schmallenberg virus is a new one. No diagnostic methods existed prior to its discovery in November 2011, and teams around the world have

been working hard to develop both new, validated, and cost-effective RT-PCR diagnostic tests.

PCR can be used to detect recent infections, but it is unsuitable for disease surveillance and prevalence studies, as RNA is rapidly and rapidly eliminated from the animal. In contrast, antibodies may remain long after infection. For this, indirect diagnostic techniques have developed virus neutralisation (VN) and immunofluorescence (IFAT) tests. These techniques, however, are time-consuming, difficult to interpret,

and for large numbers of samples, and require other standardized result interpretation.

Promed Biotechnology company IDvet develops, manufactures and sells veterinary diagnostic kits, mainly focusing on the IFA and ELISA markets. Founded in 2004, the company has rapidly grown and, today, the company's diagnostic products are protecting over 50 countries around the globe. The firm's close relationship with leading veterinary universities worldwide puts it in the cutting-edge of veterinary diagnostics.

Impact on disease management

IDvet is pleased to announce the launch of the first commercial ELISA for the detection of Schmallenberg antibodies. This test, which identifies antibodies developed early in disease, is currently being prepared to reference laboratories in Europe, including the French National Reference Laboratory (CIR) in Germany and the French agency for Food, Environmental and Occupational Health Safety (ANSES). Preliminary results are very encouraging, showing high test specificity and cross-reactivity with other closely related viruses. The test is rapid, cost effective, and reliable, allowing for high throughput testing.

The availability of such rapid serodiagnostic tests for SBV are key both to understanding the spread and the transmission of the disease and an accurate test for the authorities in disease management. The first diagnostic kit was actively used during the BTV outbreaks in 2006. Once again, the company is proud to contribute to the development of veterinary diagnostics through the rapid development of the first commercial ELISA test for Schmallenberg virus.

Contact
Philippe Poirier
IDvet Biotechnology, France
tel: +33 4 6744 42 00
philippe.poirier@idvet.com
www.idvet.com

Wednesday 11/04/2012
redi 6 avril 2012 03:57 à :

nd Akabane viruses. Initially France, Luxembourg, Italy, the and stillbirths in cattle,

e antibodies can be detected by to implement for large numbers

, after a collaborative study, and produced by IDvet.

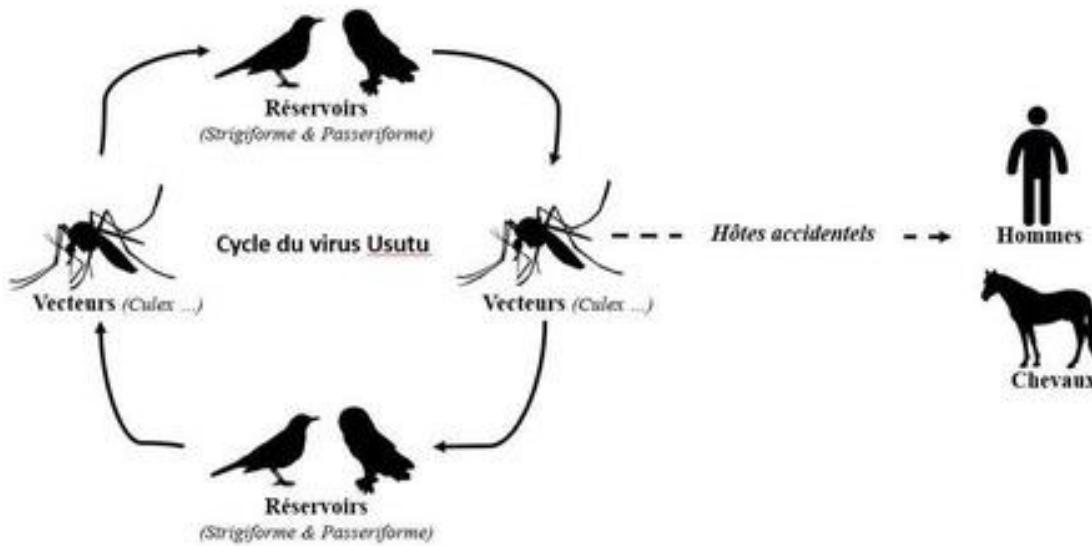
Global warming, international trade and consequences in animal health

Examples of emergence of viral vector-borne diseases de maladies virales vectorielles in Europe : BT, WN, SBV and USU

- Fièvre catarrhale ovine (Bluetongue)
- West Nile
- Schmallenberg
- **Usutu**

1959:
1st identification
in Africa
(Swaziland,
River valley Usutu)

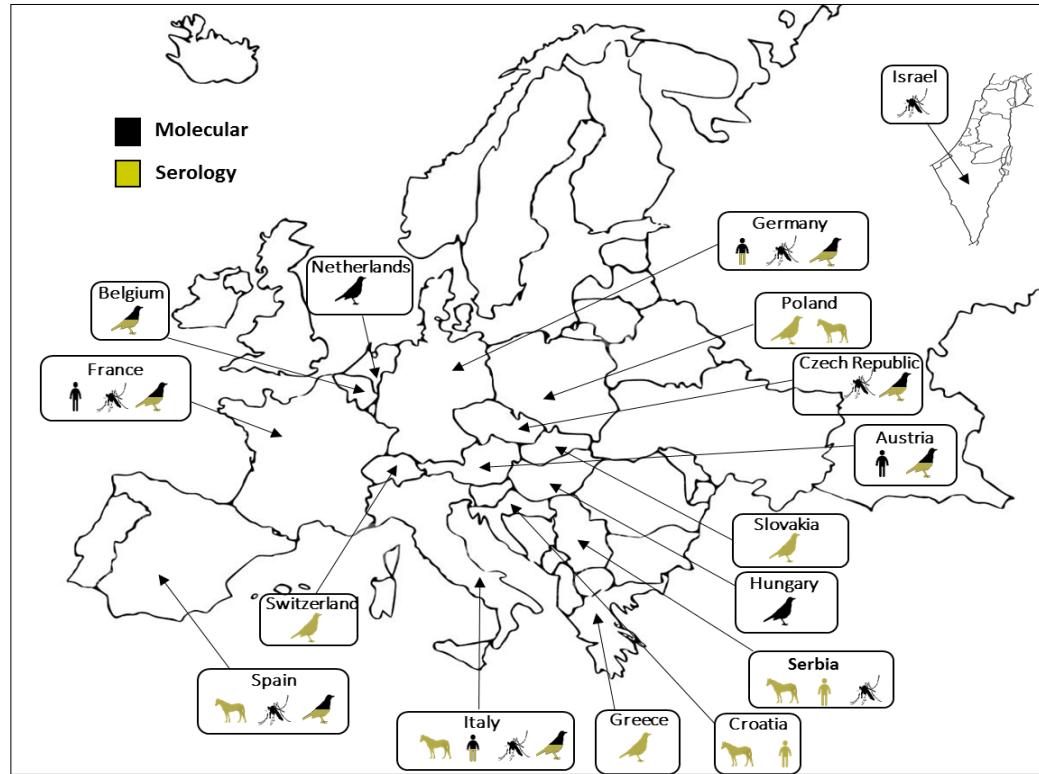




Recent emergence of USUTU virus in Europe

1996 : 1st detection
in Europe

Identification of 3
different lineages
lignées
(Europe 1-5, Afrique
1-3)



Emerg Infect Dis. 2016 Dec;22(12):2225. doi: 10.3201/eid2212.161272.

Dual Emergence of Usutu Virus in Common Blackbirds, Eastern France, 2015.

Lecollinet S, Blanchard Y, Manson C, Lowenski S, Laloy E, Quenault H, Touzain F, Lucas P, Eraud C, Bahouon C, Zientara S, Beck C, Decors A.

Virus Usutu : premier cas en France d'infection humaine par un moustique

Publié le 14/06/2018 à 7h30. Mis à jour à 14h12 par SudOuest.fr.

S'ABONNER À PARTIR DE 1€



COMMENTAIRES SUSPENDUS



▲ Le virus Usutu est transmis par les moustiques Culex, les plus répandus en France. ©ILLUSTRATION SUD OUEST

2016, facial paralysis

2018



blackbird

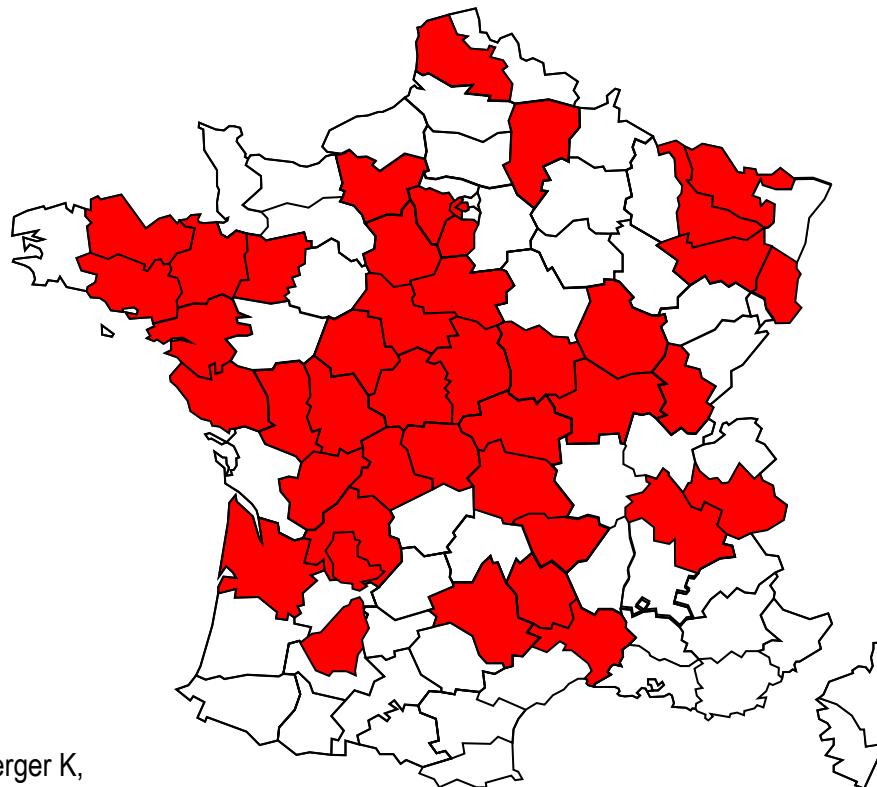
2018

Virus Usutu (USUV)

- ✓ 46 départements
- ✓ High mortality in blackbirds and owls (in zoos)
- ✓ 3 lineages



Detection of USUV

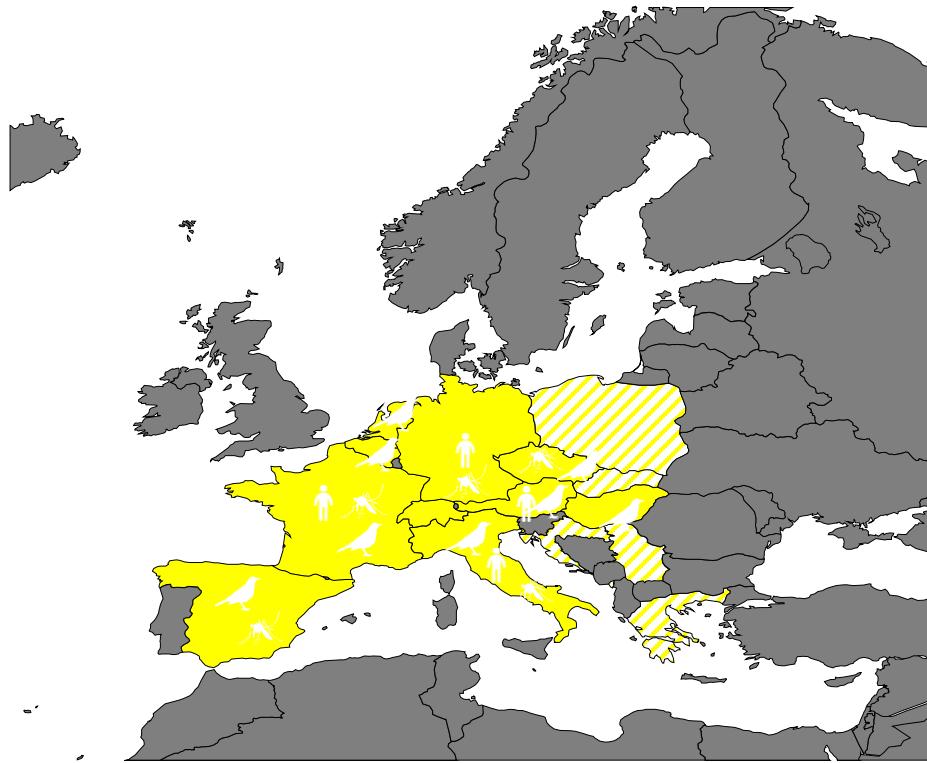


Référence : Beck C, Gonzalez G, Decors A, Lemberger K, Lowenski S, Dumarest M, Lecollinet S. Surveillance épidémiologique d'USUV . Virologie 2018; 22(5) : 261-63
doi:10.1684/vir.2018.0751

EPIDEMIOLOGY

USUV in Europe in 2018

- Virus isolated
- Serological detection
- Human: molecular detection
- Birds: molecular detection
- Mosquitoe: molecular detection



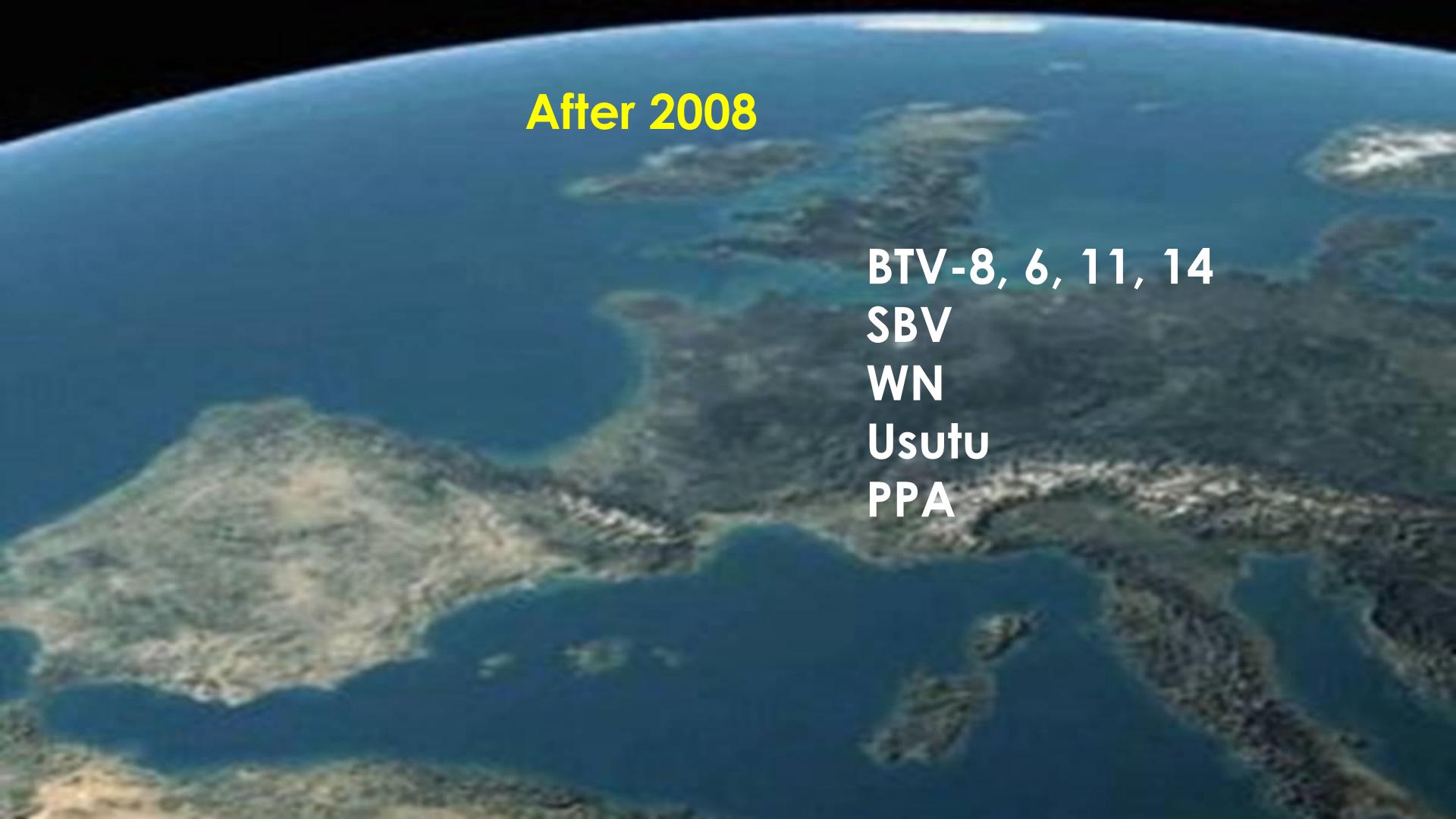
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- Schmallenberg
- Usutu
- Conclusion



Before 1998

An aerial photograph of a coastal landscape, likely a wetland or marsh area. The terrain is a mix of dark green vegetation and lighter, tan-colored areas, possibly indicating dry land or specific plant species. The coastline curves to the right, meeting a body of water that has a darker, bluish-green hue. In the upper left foreground, there is a small, isolated cluster of trees or a group of buildings. The overall scene suggests a coastal ecosystem under observation.

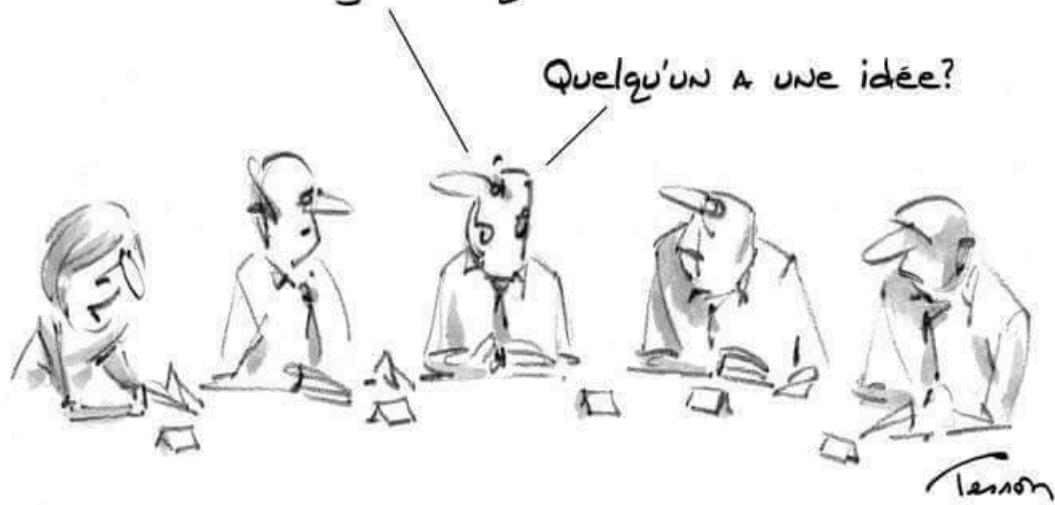
After 2008

BTV-8, 6, 11, 14
SBV
WN
Usutu
PPA

COP21

BON, il faut sauver la planète mais sans contrarier
le système qui la détruit.

Quelqu'un a une idée?



Acknowledgements

Orbivirus

Corinne Sailleau
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Cyril Viarouge
Damien Vitour
Grégory Caignard

... et coll

Flavivirus

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Cécile Beck
Gaelle Gonzalez
Marine Dumarest
Rayane Amaral



AVERTISSEMENT

LES PERSONNES
NON PREVENUES
PEUVENT CONSIDERER
QU'ELLES LE SONT
A PARTIR DE
MAINTENANT

Thank you for your attention