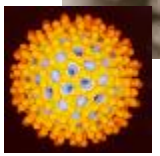
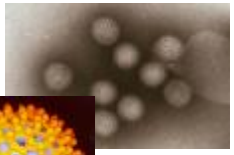


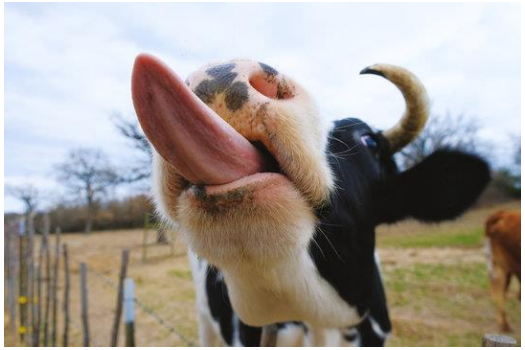



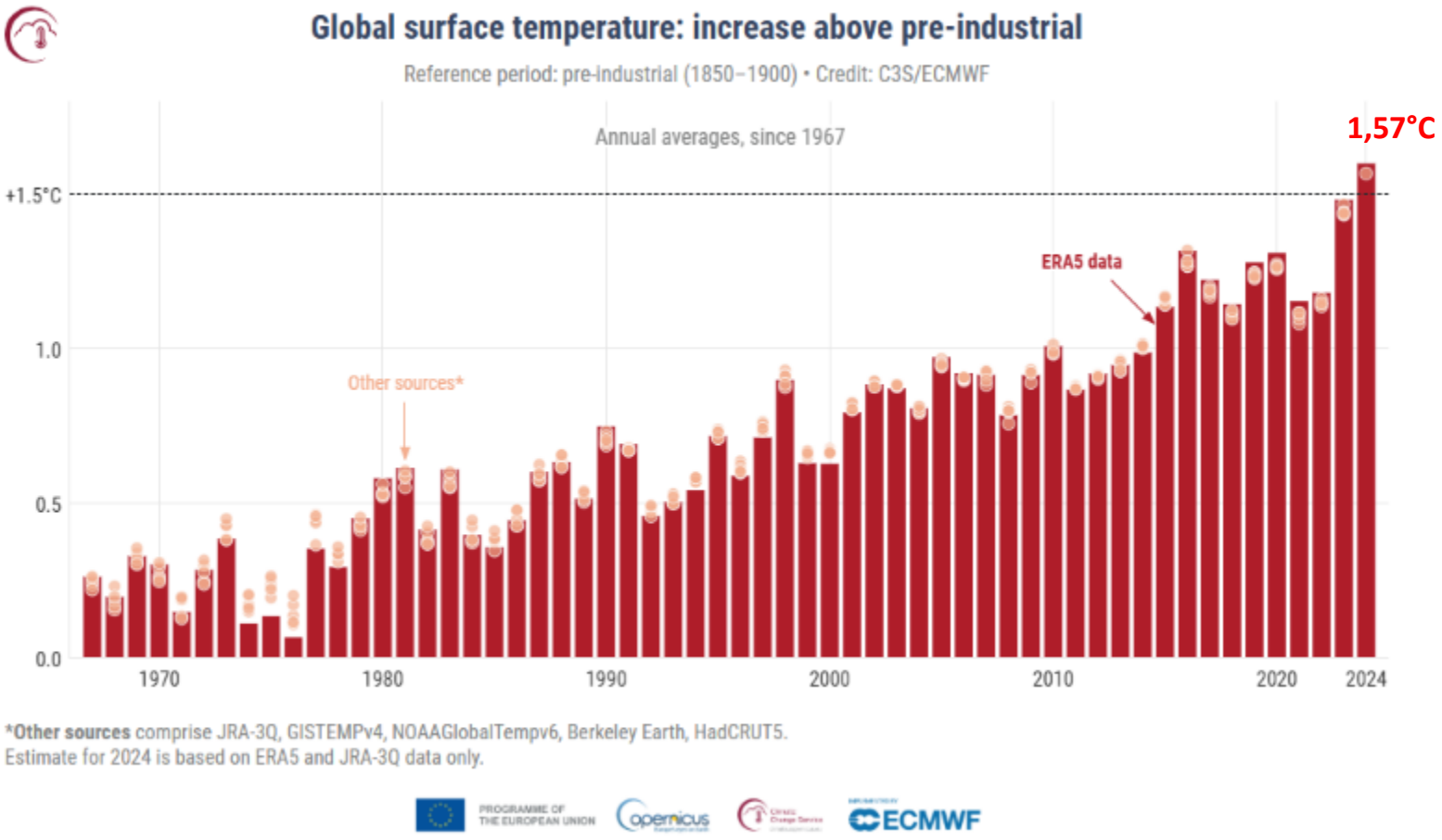
GLOBAL WARMING AND EMERGENCE OF VECTOR BORNE DISEASES IN EUROPE

STEPHAN ZIENTARA

ANSES - ANIMAL HEALTH LABORATORY, FRANCE

EU/WOAH/FAO REFERENCE LAB ON FMD
EU REFERENCE LAB ON EQUINE DISEASES
WOAH REFERENCE LAB ON EHDV

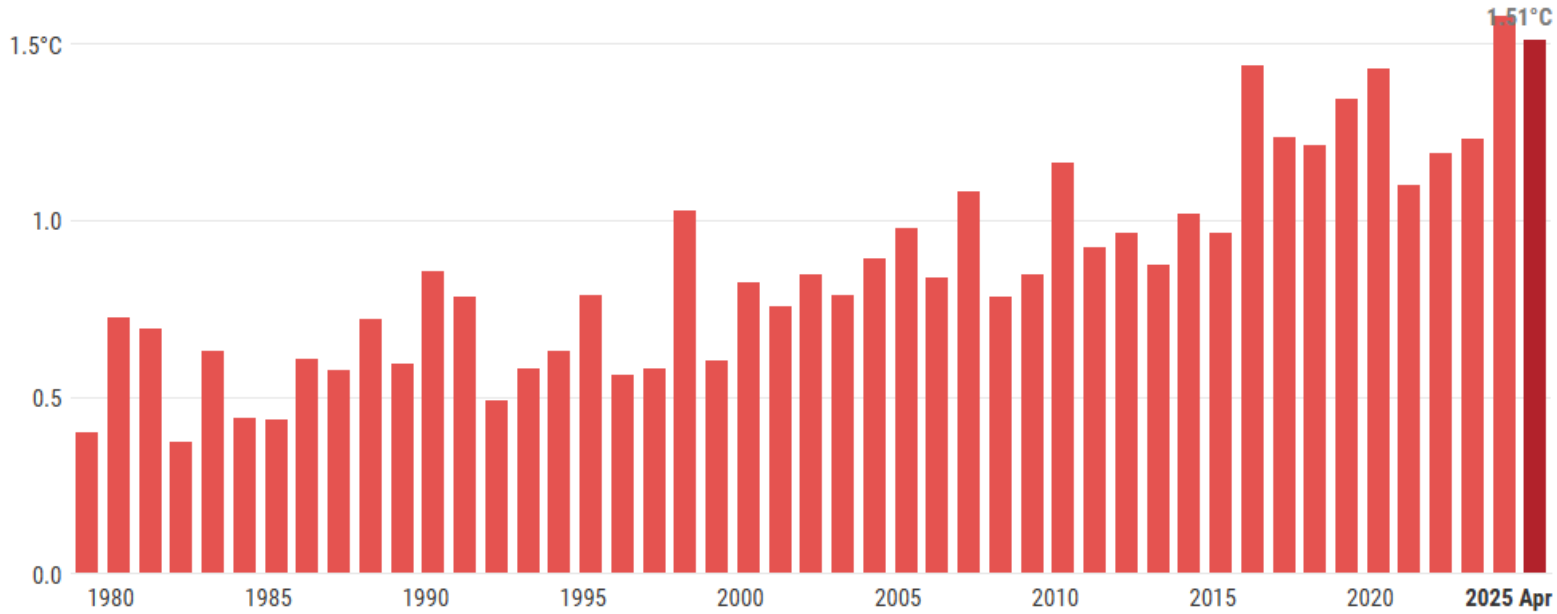




Global surface temperature: increase above pre-industrial
Reference period: pre-industrial (1850–1900) • Credit: C3S/ECMWF
Annual averages, since 1967
1,57°C
+1.5°C
1.0
0.5
0.0
ERA5 data
Other sources*
1970
1980
1990
2000
2010
2020
2024
*Other sources comprise JRA-3Q, GISTEMPv4, NOAAGlobalTempv6, Berkeley Earth, HadCRUT5.
Estimate for 2024 is based on ERA5 and JRA-3Q data only.
PROGRAMME OF THE EUROPEAN UNION
opernicus
ECMWF

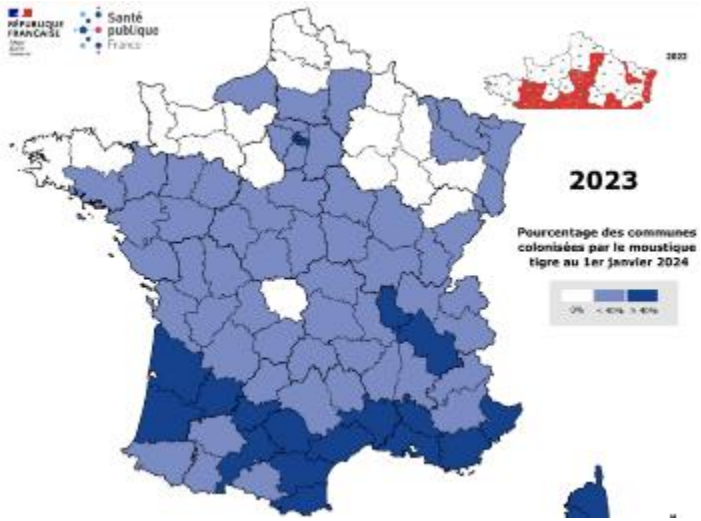
April 2025

Global surface air temperature anomalies for April

Data source: ERA5 • Reference period: pre-industrial (1850–1900) • Credit: C3S/ECMWF



Emergence in 2004



2023

En ce moment | Guerre en Ukraine | Covid-19 | Procès de l'attentat de Nice | Crise énergétique

Accueil / Santé / Maladies

Plusieurs cas autochtones de dengue identifiés dans le sud de la France

Plusieurs départements du sud de la France ont identifié des cas autochtones de dengue depuis la mi-août. Cette maladie transmise par le moustique tigre provoque notamment de forte fièvre et des douleurs musculaires.

Ouest-France
avec AFP
Publié le 24/08/2022 à 17h00

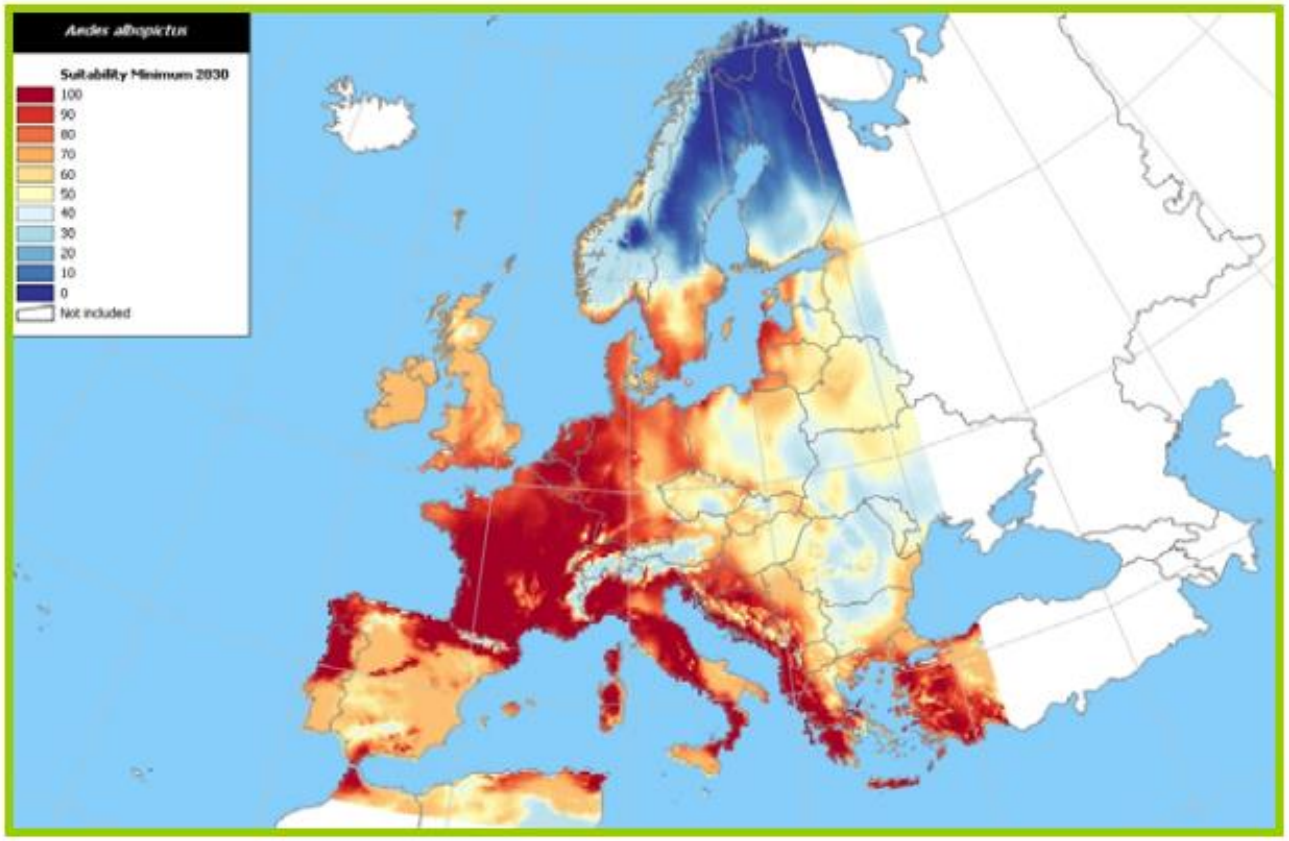
Abonnez-vous

Number of autochtonous dengue cases in France since 2020

Year	imported cases	autochtonous cases	TOTAL
2024	3938	83	4018
2023	2524	45	2569
2022	378	65	443
2021	164	2	166
2020	1357	13	1370

Prediction in 2030

Figure 7b (i). Prospective impact of climate change on *Aedes albopictus* distribution in Europe: minimal impact, long-term change scenario



Source ECDC

Around fifty animal pathogenic arboviruses from 7 different viral families identified worldwide

Arboviruses Pathogenic for Domestic and Wild Animals

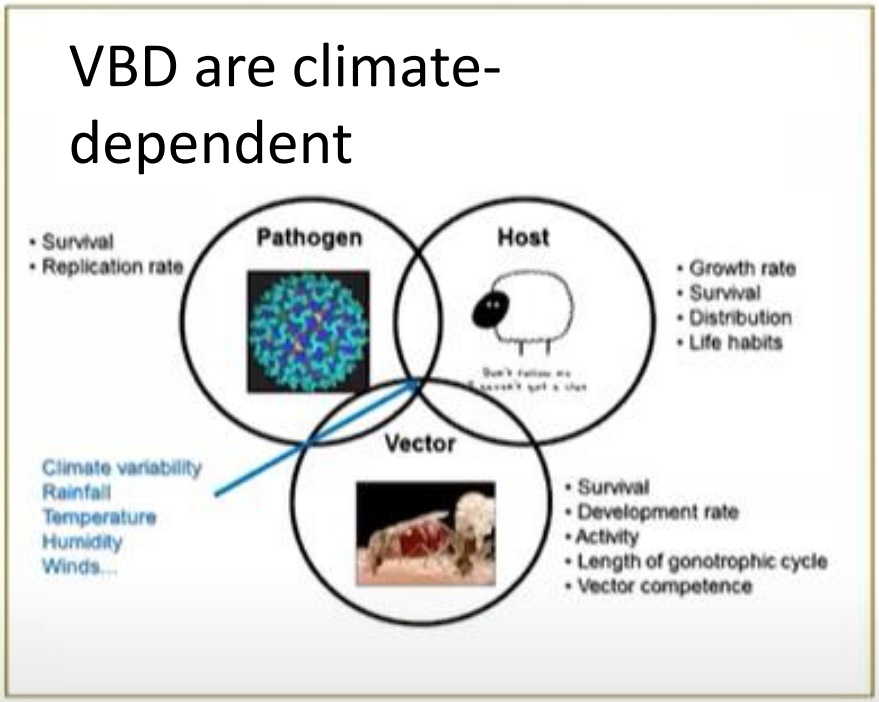
tick-borne (louping ill and tick-borne encephalitis, Omsk hemorrhagic fever, Kyasanur Forest disease, Tyuleniy fever, Nairobi sheep disease, Soldado fever, Bhanja fever, Thogoto fever, African swine fever),

mosquito-borne (Eastern, Western, and Venezuelan equine encephalomyelitides, Highlands J disease, Getah disease, Semliki Forest disease, yellow fever, Japanese encephalitis, Murray Valley encephalitis, West Nile encephalitis, Usutu disease, Israel turkey meningoencephalitis, Tembusu disease/duck egg-drop syndrome, Wesselsbron disease, La Crosse encephalitis, Snowshoe hare encephalitis, Cache Valley disease, Main Drain disease, Rift Valley fever, Peruvian horse sickness, Yunnan disease), sandfly-borne (vesicular stomatitis—Indiana, New Jersey, and Alagoas, Cocal disease),

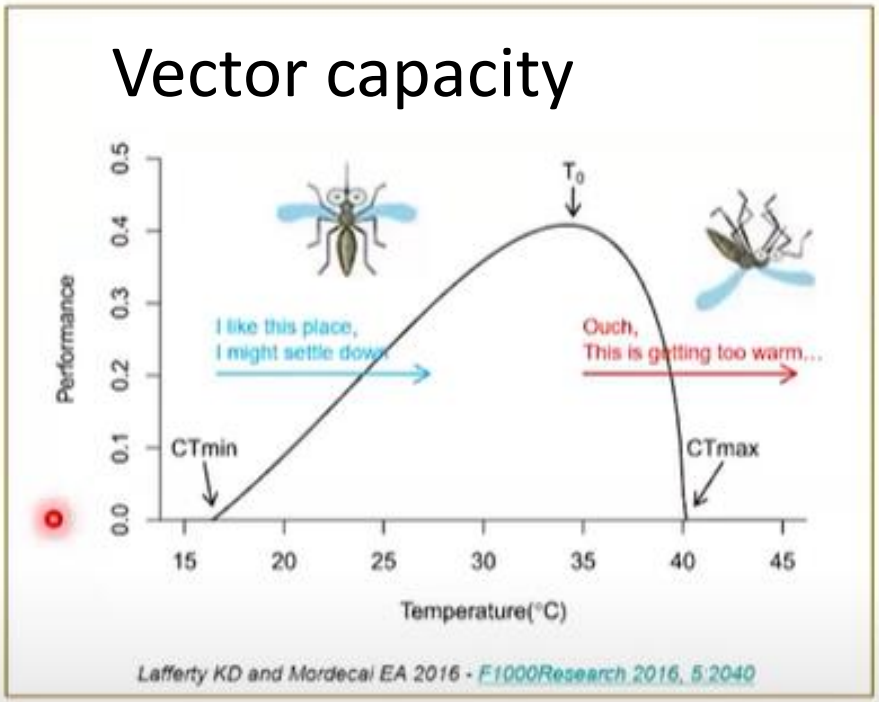
midge-borne (Akabane disease, Aino disease, Schmallenberg disease, Shuni disease, African horse sickness, Kasba disease, bluetongue, epizootic hemorrhagic disease of deer, Ibaraki disease, equine encephalosis, bovine ephemeral fever, Kotonkan disease), and cimicid-borne (Buggy Creek disease).

Climate and vector-borne diseases

VBD are climate-dependent



Vector capacity



Cyril Caminade

increased trade and international business

Orbiviruses:

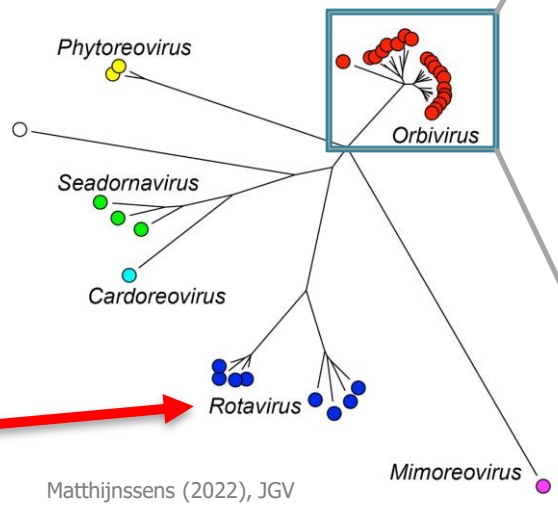
- **Bluetongue**

- **EHD**

-hypotheses on the factors of introduction

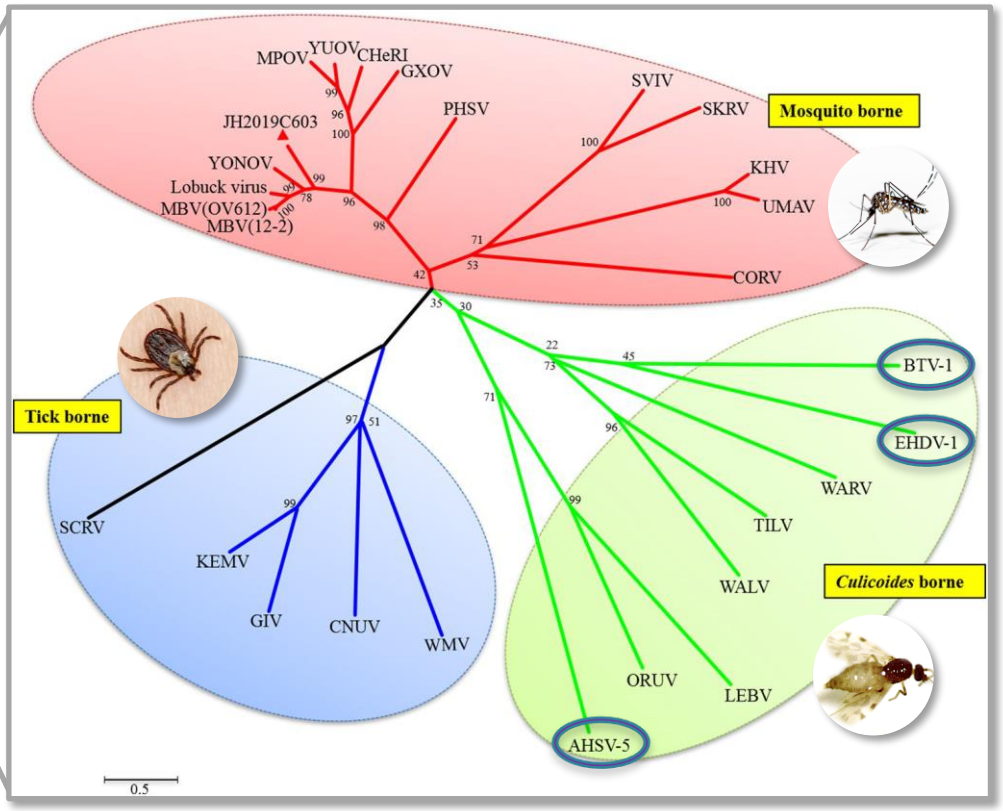
Orbiviruses

Family *Sedoreoviridae*



Matthijnssens (2022), JGV

Genus *Orbivirus*: 22 species



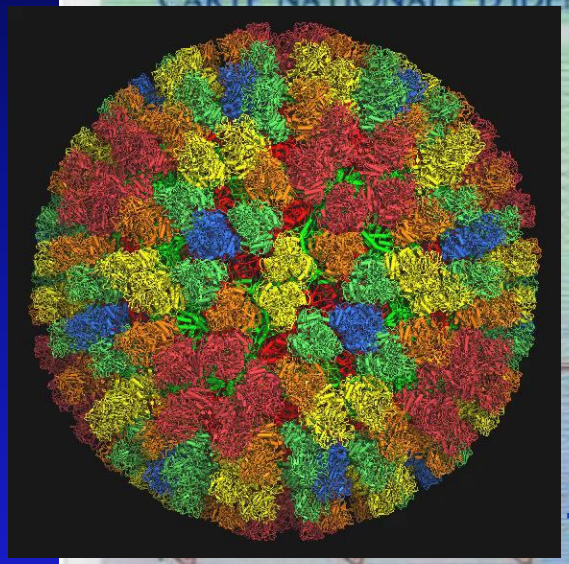
Yang (2021), Virus genes

World Organisation for Animal Health
Founded as OIE

- 3 important diseases
  - **BTV:** Bluetongue virus (FCO)
  - **EHDV:** Epizootic hemorragic disease virus (MHE)
  - **AHSV:** African horse sickness virus (Peq)

Bluetongue

Identity card BTV



RÉPUBLIQUE FRANÇAISE

CARTE NATIONALE D'IDENTITÉ N° : 050995201874 Nationalité Française

Famille : *Sedoreoviridae*

Genre : Orbivirus (22 species)

Noms : Bluetongue, BTV

Nombre de Sérotypes : 36

Génome : dsRNA, 10 segments

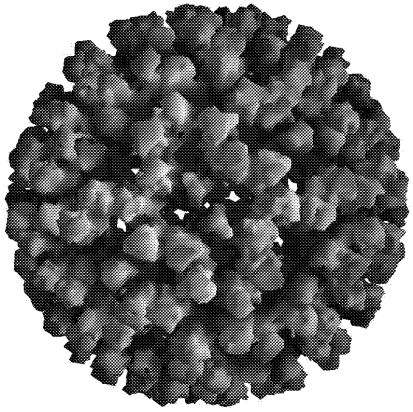
Taille : De 800pb à 4Kb

IDFRAPETE<<<<<<<<<<<<<<<<<<<<<<952042

0509952018746NICOLAS<<PAUL<8206152M3

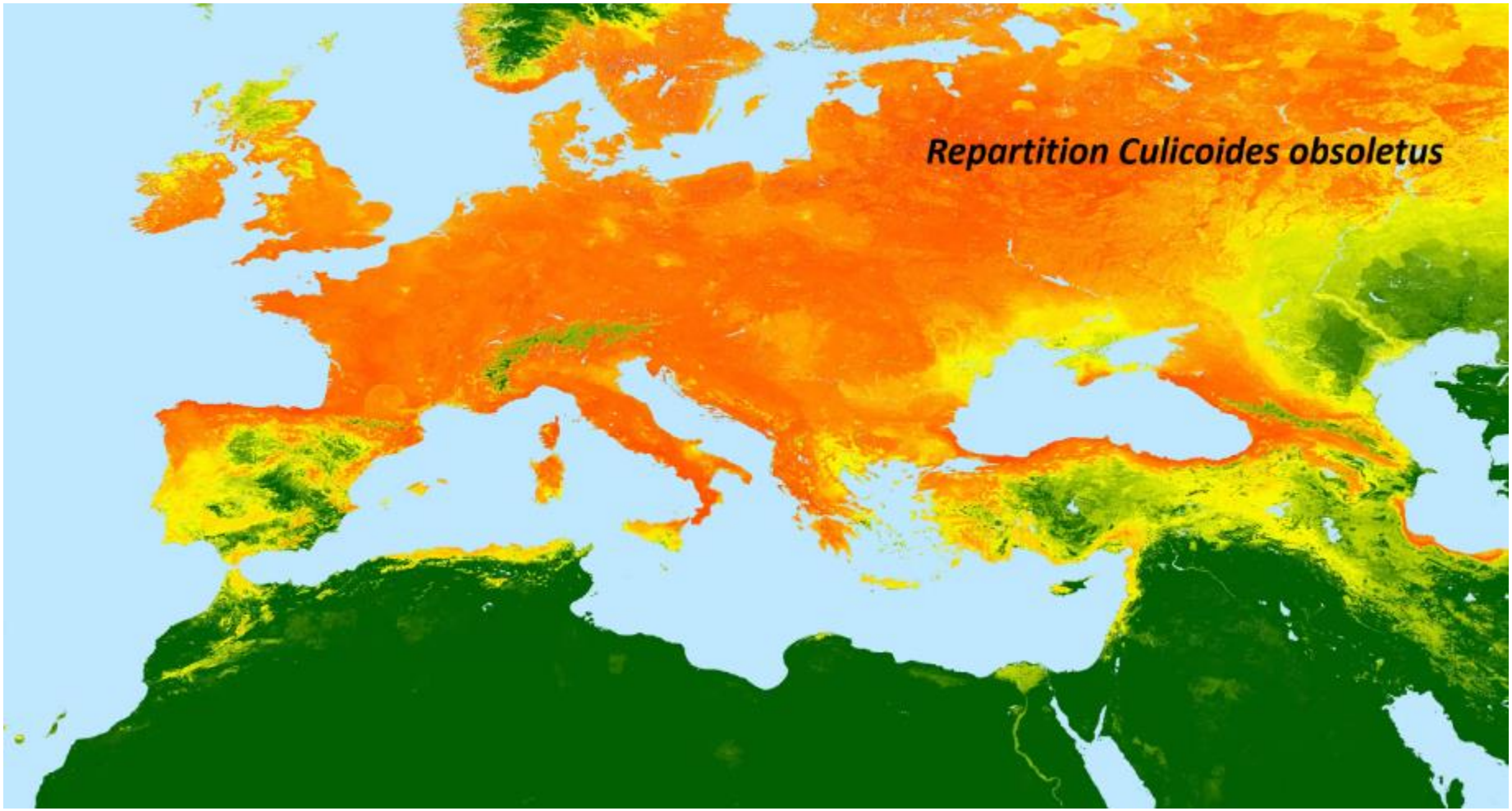
Grimes J.M., Burroughs J.N., Gouet P., Diprose J.M., Malby R., Zientara S., Mertens, P.P.C. & Stuart D.I. (1998). The atomic structure of the bluetongue virus core. *Nature*,

Orbivirus



- **36 serotypes BTV**
  - **1 - 24 biting midges**
  - **25 - 36: non-vector transmission**

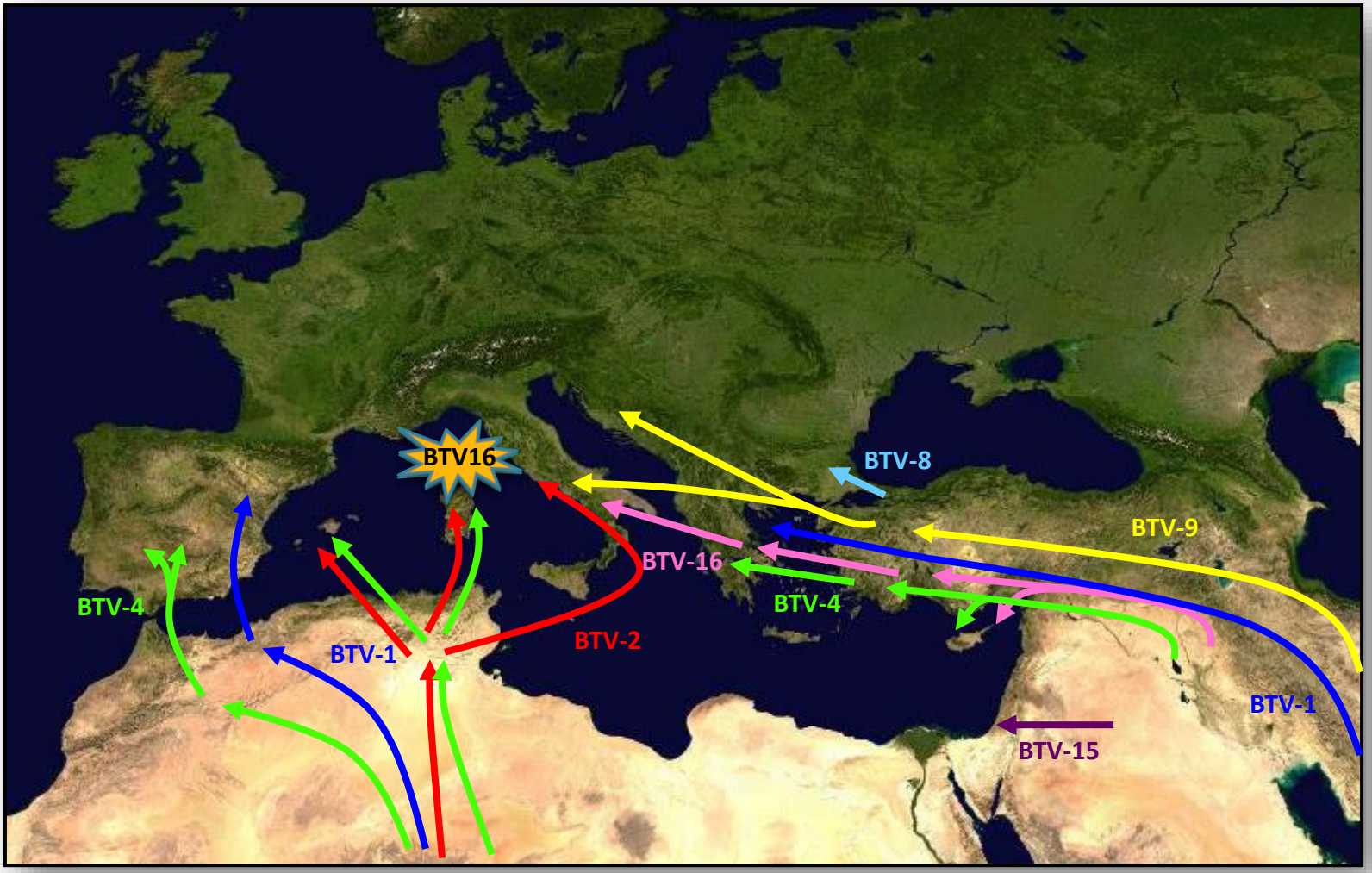
Vectors: *Culicoïdes (imicola, obsoletus,…)*


Repartition Culicoides obsoletus


BT in Europe before 1998…
FREE


Orbiviruses will never come to Europe
by the way, I'm your father!

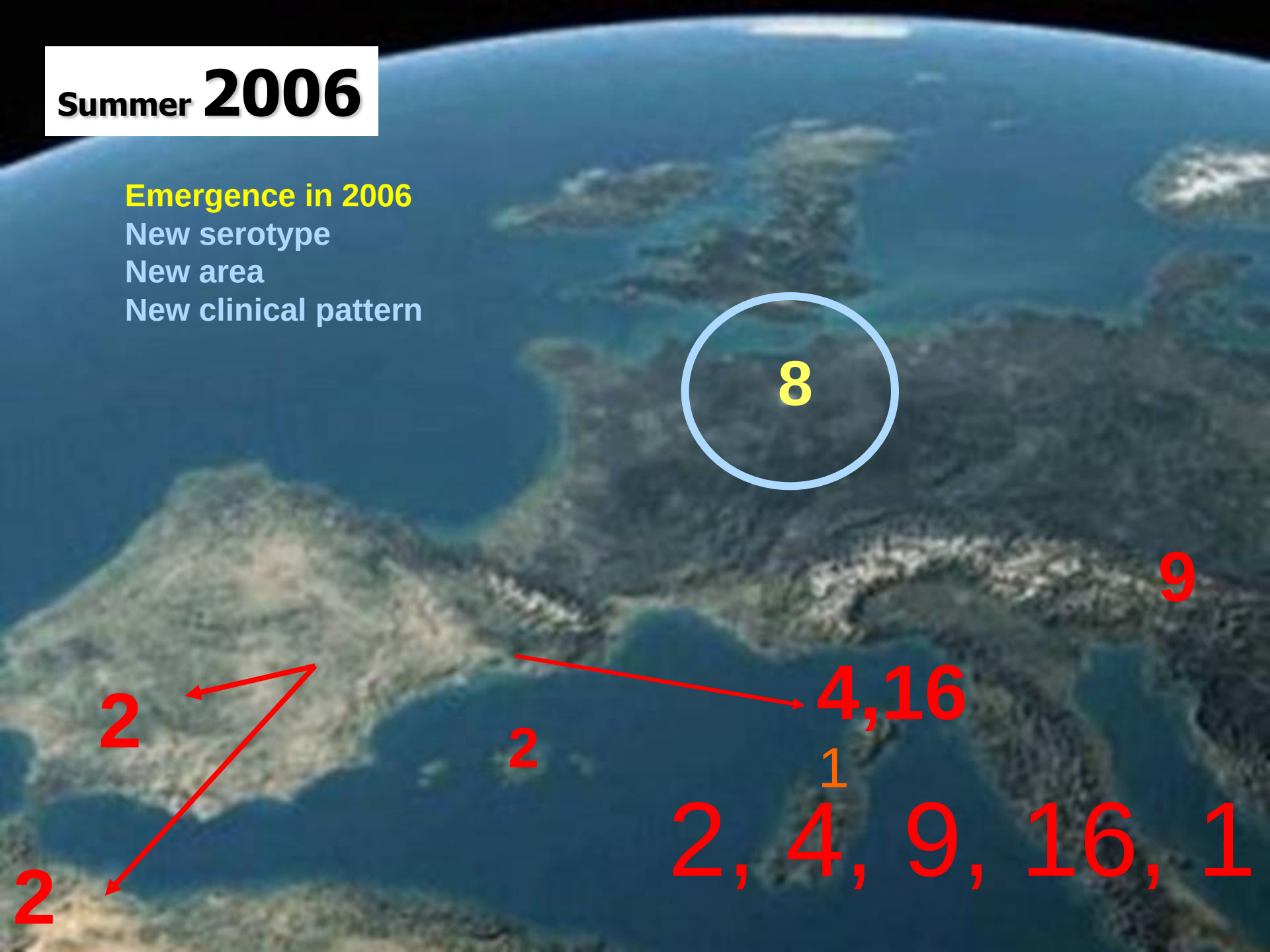
1998-2006: circulation in the South of Europe



2000-01 — **BTV2** Corsica

2003 — **BTV4** Corsica

2004 — **BTV16** Corsica


Summer 2006
Emergence in 2006
New serotype
New area
New clinical pattern
8
9
4,16
2
2
1
2, 4, 9, 16, 1
2

2007

Bluetongue virus distribution in Europe in 2007.

2006 : 7 cases

2007: 14 000

2008 : 38 000

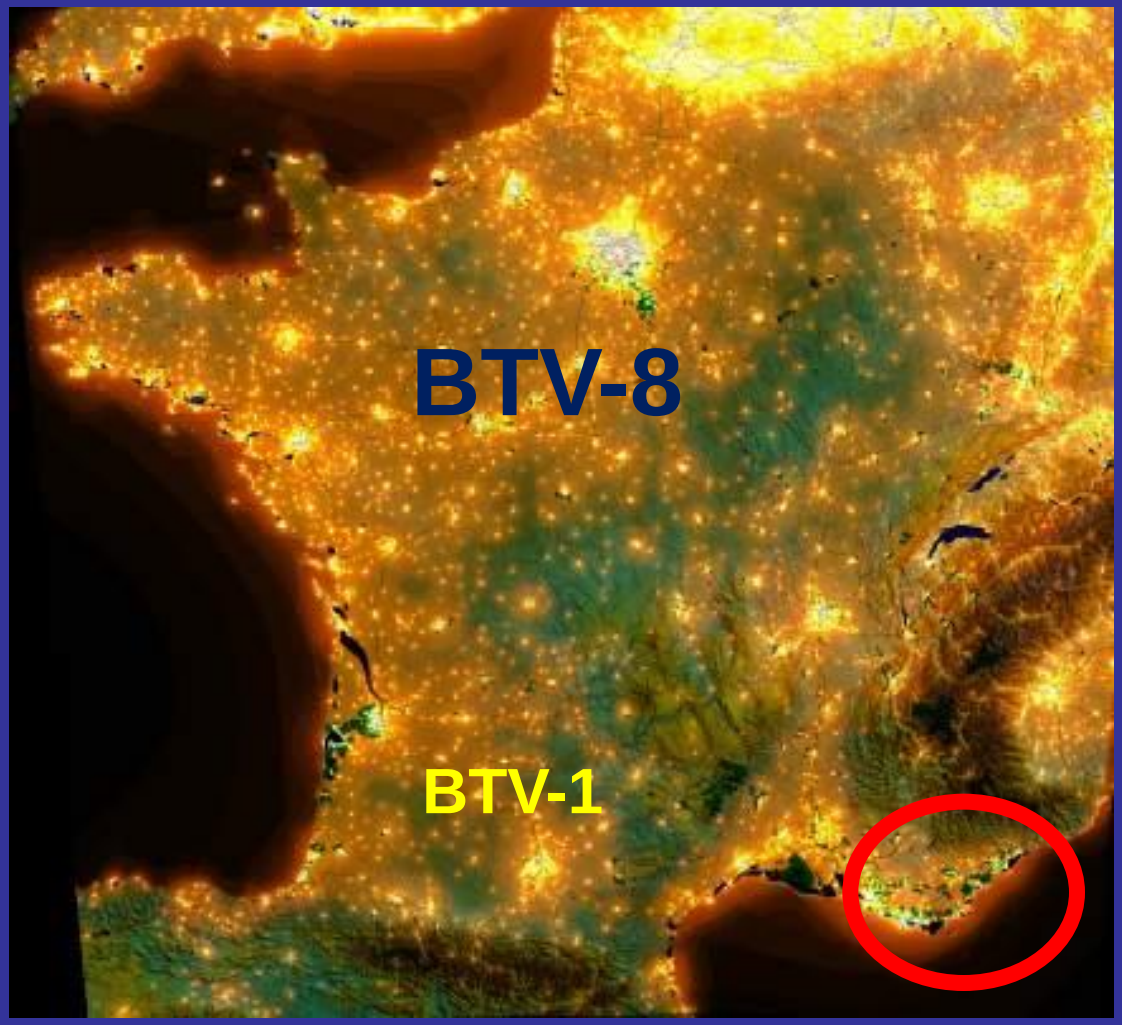
Compulsory vaccination
Inactivated vaccines
BTV-1 and 8

2009 : 83

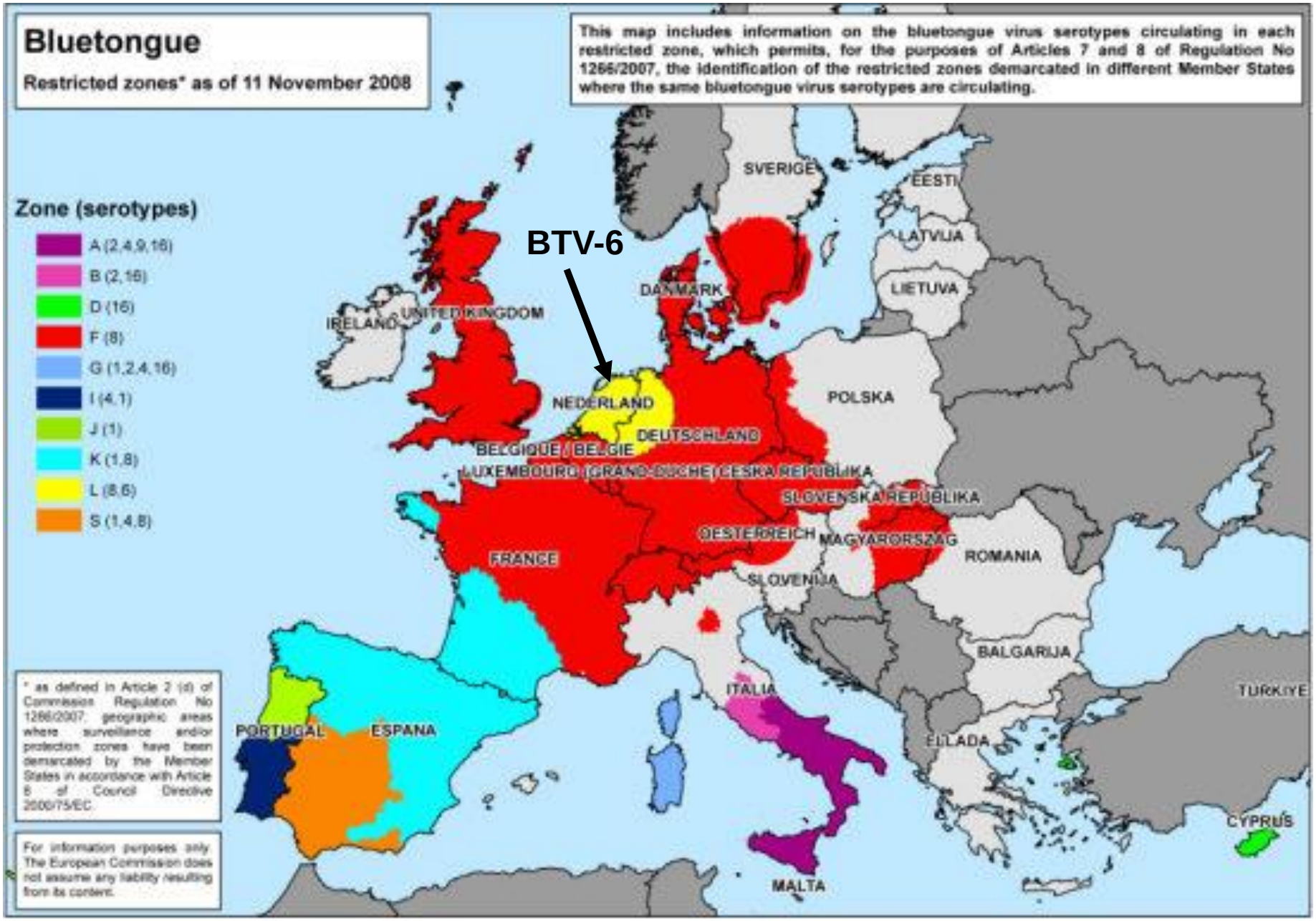
2010 : 1

2011: 0

2010



2012 : 14 of December: free status


Bluetongue
Restricted zones* as of 11 November 2008
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)
A (2,4,9,16)
B (2,16)
D (16)
F (8)
G (1,2,4,16)
I (4,1)
J (1)
K (1,8)
L (8,6)
S (1,4,8)
BTV-6
SVERIGE
EESTI
LATVIJA
LIETUVA
DANMARK
IRELAND
UNITED KINGDOM
NEDERLAND
DEUTSCHLAND
POLSKA
BELGIQUE / BELGIE
LUXEMBOURG (GRAND-DUCHE)
CESKA REPUBLIKA
SLOVENSKA REPUBLIKA
OESTERREICH
MAGYARORSZAG
FRANCE
ROMANIA
SLOVENIJA
BALGARIJA
ITALIA
TURKIYE
PORTUGAL
ESPANA
ELLADA
CYPRUS
MALTA
* as defined in Article 2 (d) of Commission Regulation No 1266/2007: geographic areas where surveillance and/or protection zones have been demarcated by the Member States in accordance with Article 6 of Council Directive 2000/75/EC.
For information purposes only. The European Commission does not assume any liability resulting from its content.

2015

The Nobel Prize in Physiology or Medicine 2015
William C. Campbell, Satoshi Ōmura, Youyou Tu

The Nobel Prize in Physiology or Medicine 2015

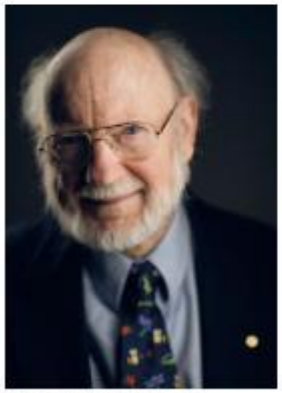


Photo: A. Mahmoud
William C. Campbell
Prize share: 1/4

Photo: A. Mahmoud
Satoshi Ōmura
Prize share: 1/4

Photo: A. Mahmoud
Youyou Tu
Prize share: 1/2

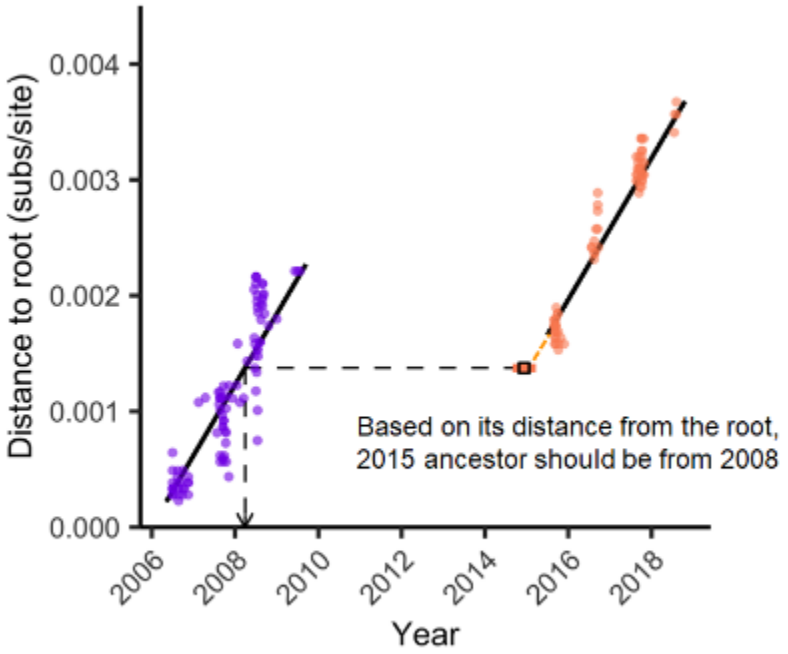
their discoveries concerning a novel therapy against infections caused by roundworm parasites"

Allier « département »

2015

Genetic evolution of BTV-8 from 2006 to 2019

European collaboration



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]

Récolte de semence

Assurance production

La récolte est faite en présence d'une vache en chaleur, avec un vagin artificiel. C'est la méthode qui se rapproche le plus des conditions naturelles et qui est la plus fiable.

› **Toutes races de taureaux**

Contrôle fertilité

Analyse du sperme au microscope :

- Motilité
- % de vivant

Analyse au spectro-photomètre :

- Concentration (nb spz/mm3)

› **Contrôle qualité de semence en frais**

Prod

private seed production

viruses

MDPI

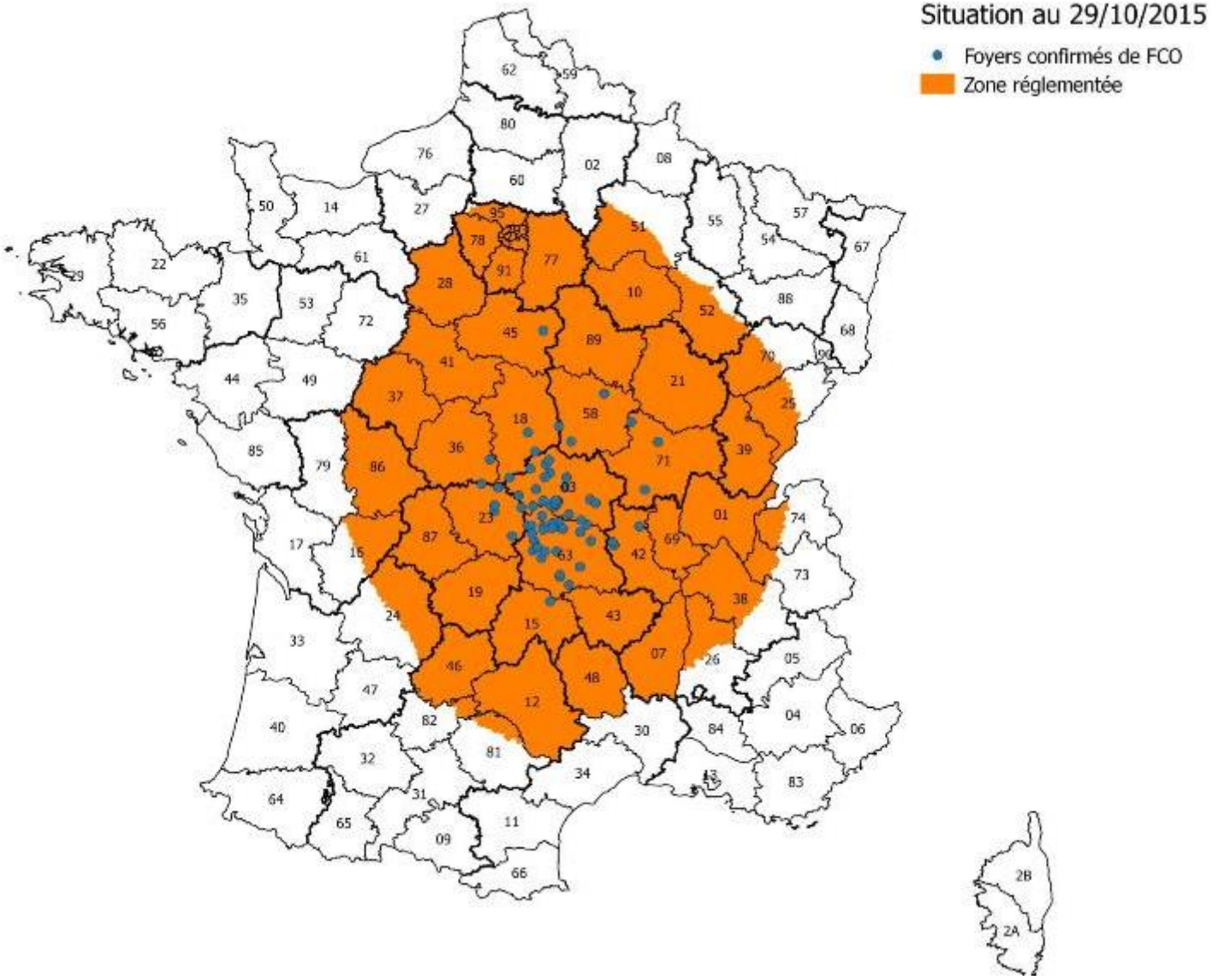
Article

Transmission of Bluetongue Virus Serotype 8 by Artificial Insemination with Frozen–Thawed Semen from Naturally Infected Bulls

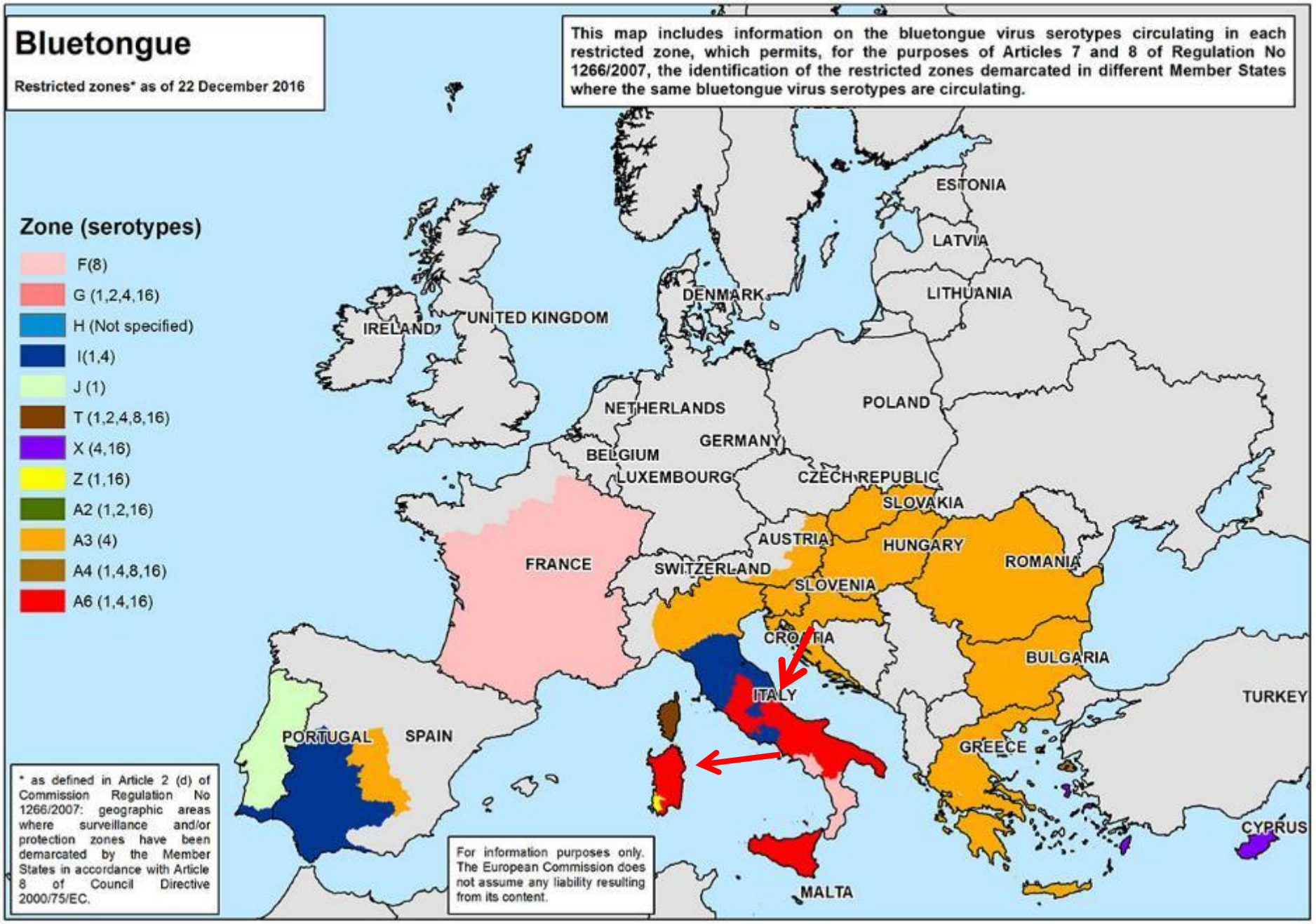
Kris De Clercq [1,*,†], Leen Vandaele [2,†], Tine Vanbinst [1], Mickaël Riou [3], Isra Deblauwe [4], Wendy Wesselingh [2], Anne Pinard [3], Mieke Van Eetvelde [2], Olivier Boulesteix [3], Bart Leemans [2], Robert Gélineau [3], Griet Vercauteren [5], Sara Van der Heyden [5], Jean-François Beckers [6], Claude Saegerman [7], Donal Sammin [8], Aart de Kruif [2] and Ilse De Leeuw [1]

9 April 2021

October 30, 2015



2016

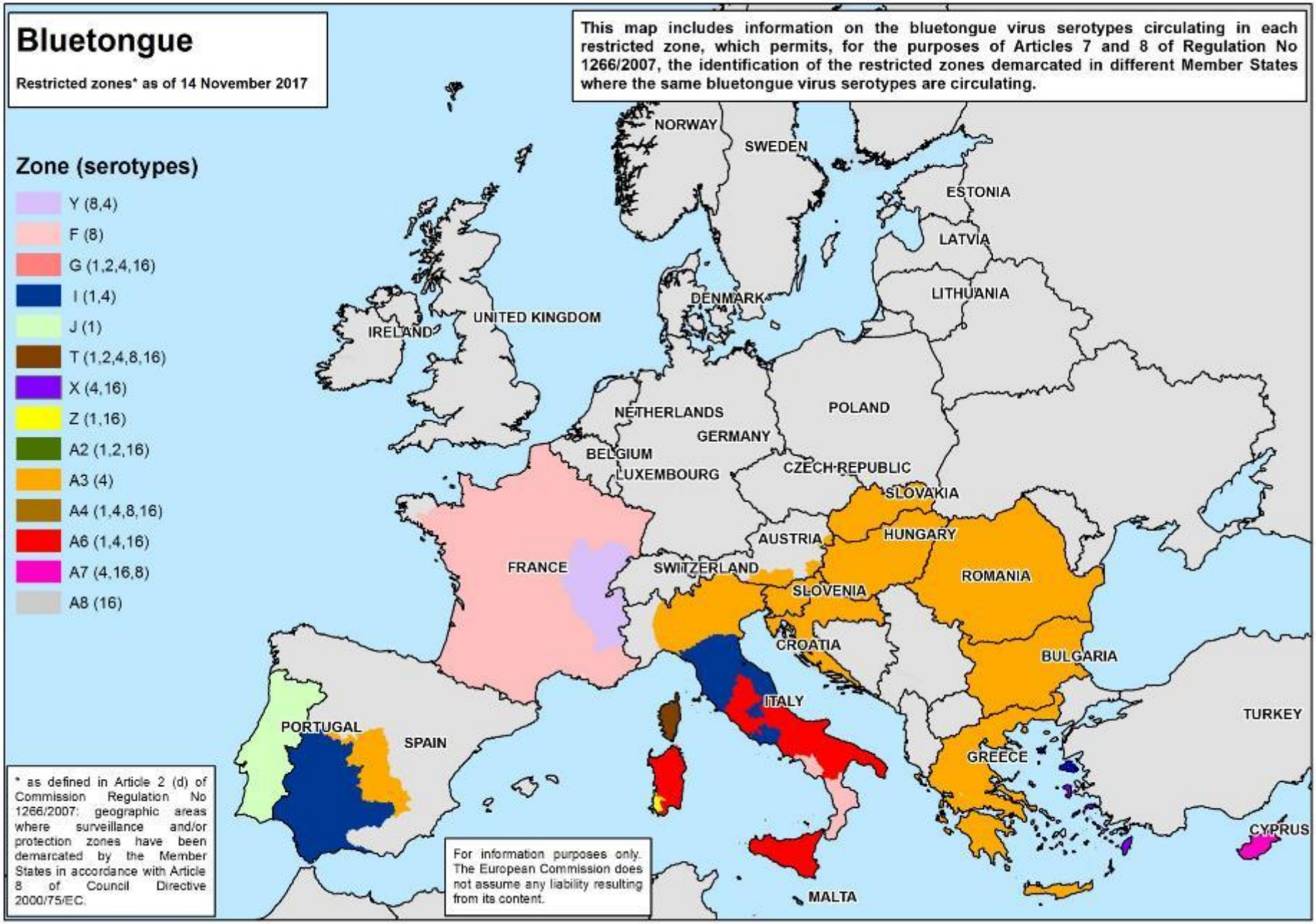

Bluetongue
Restricted zones* as of 22 December 2016
This map includes information on the bluetongue virus serotypes circulating in each restricted zone, which permits, for the purposes of Articles 7 and 8 of Regulation No 1266/2007, the identification of the restricted zones demarcated in different Member States where the same bluetongue virus serotypes are circulating.
Zone (serotypes)
F(8)
G (1,2,4,16)
H (Not specified)
I(1,4)
J (1)
T (1,2,4,8,16)
X (4,16)
Z (1,16)
A2 (1,2,16)
A3 (4)
A4 (1,4,8,16)
A6 (1,4,16)
ESTONIA
LATVIA
LITHUANIA
DENMARK
IRELAND
UNITED KINGDOM
NETHERLANDS
POLAND
GERMANY
BELGIUM
LUXEMBOURG
CZECH REPUBLIC
SLOVAKIA
AUSTRIA
HUNGARY
ROMANIA
FRANCE
SWITZERLAND
SLOVENIA
CROATIA
BULGARIA
ITALY
TURKEY
PORTUGAL
SPAIN
GREECE
CYPRUS
MALTA
* as defined in Article 2 (d) of Commission Regulation No 1266/2007: geographic areas where surveillance and/or protection zones have been demarcated by the Member States in accordance with Article 8 of Council Directive 2000/75/EC.
For information purposes only. The European Commission does not assume any liability resulting from its content.

2017

Bluetongue

Restricted zones* as of 14 November 2017

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.



* as defined in Article 2 (d) of Commission Regulation No 1266/2007: geographic areas where surveillance and/or protection zones have been demarcated by the Member States in accordance with Article 8 of Council Directive 2000/75/EC.

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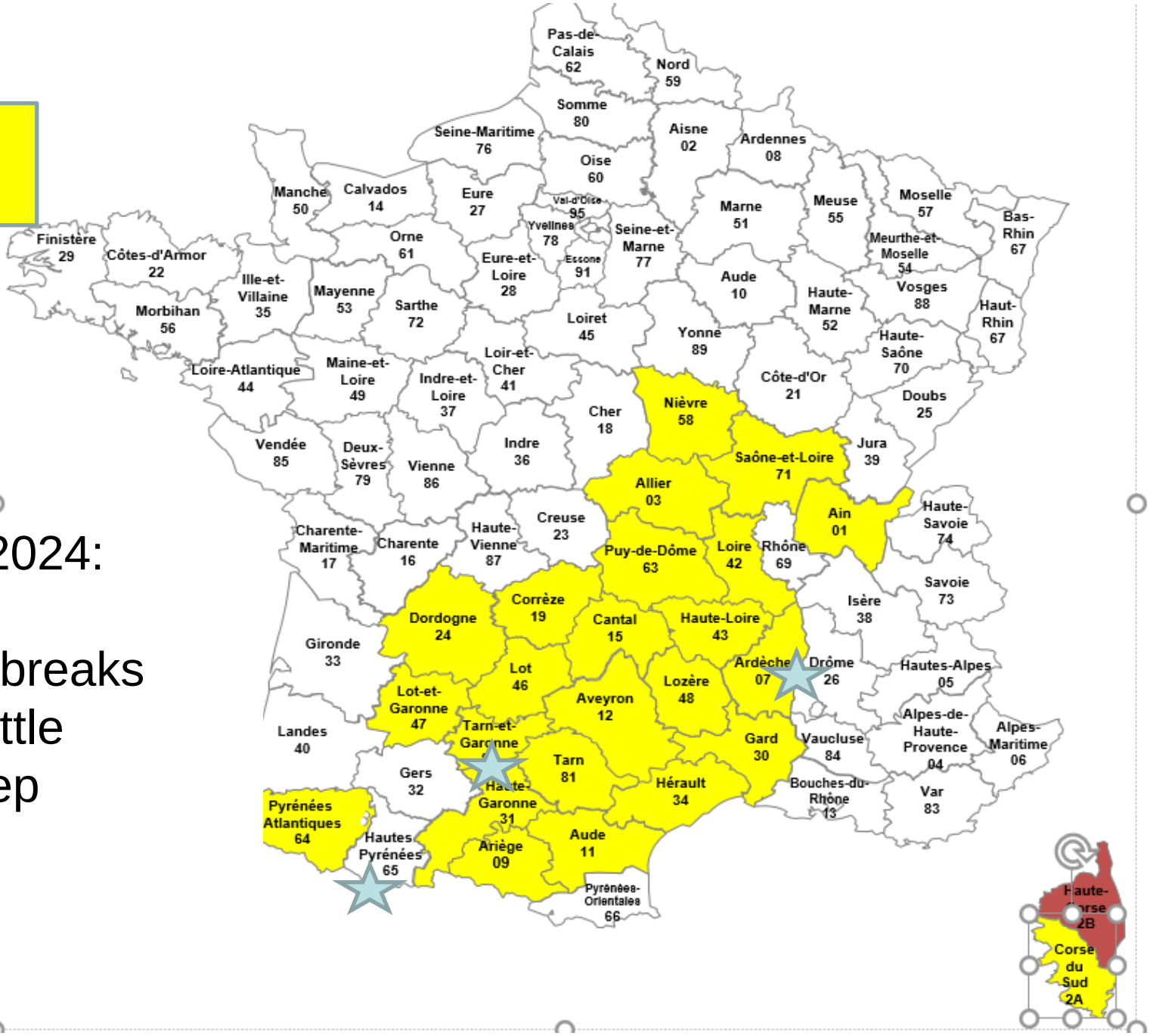
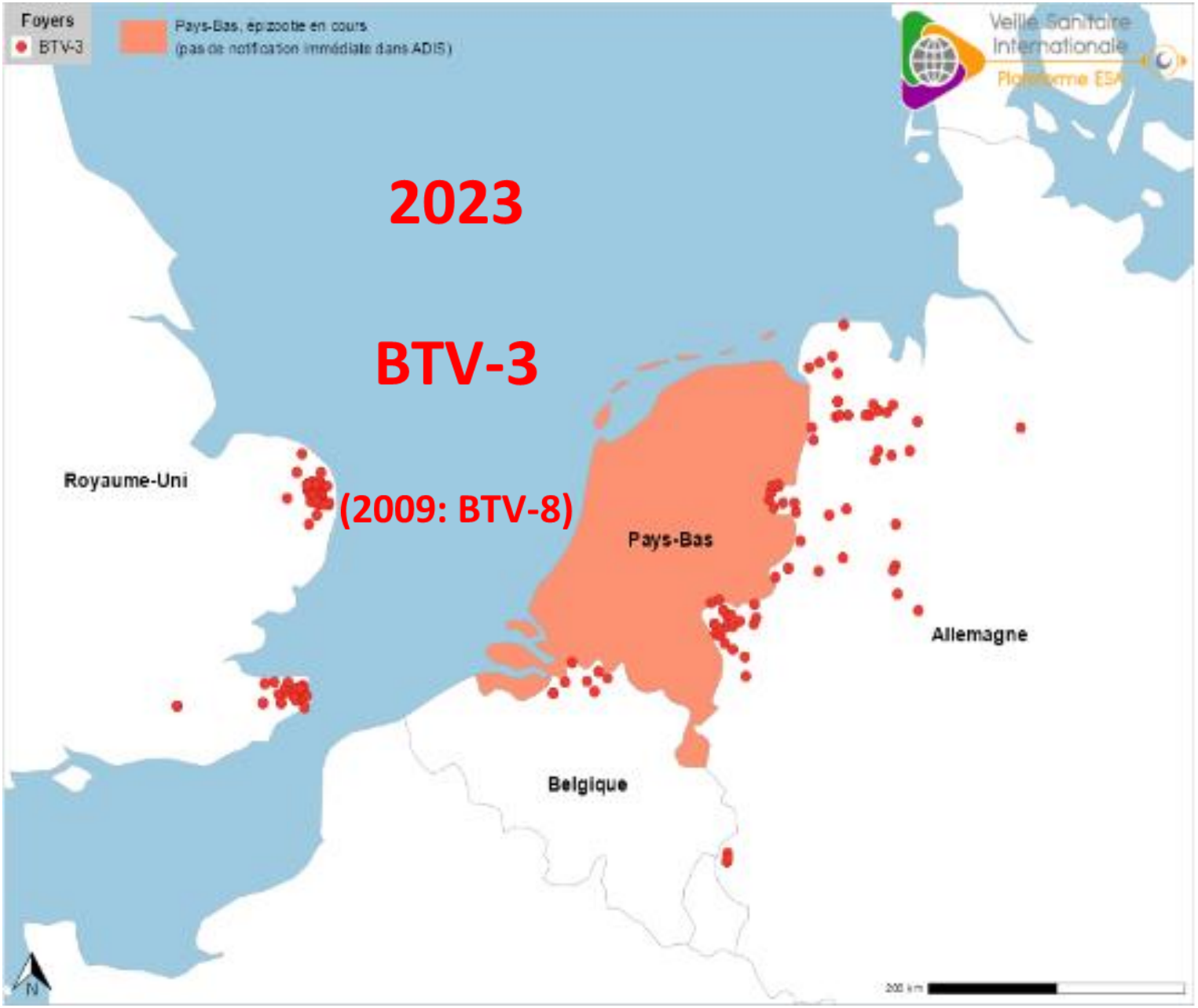
2023

BTV-8

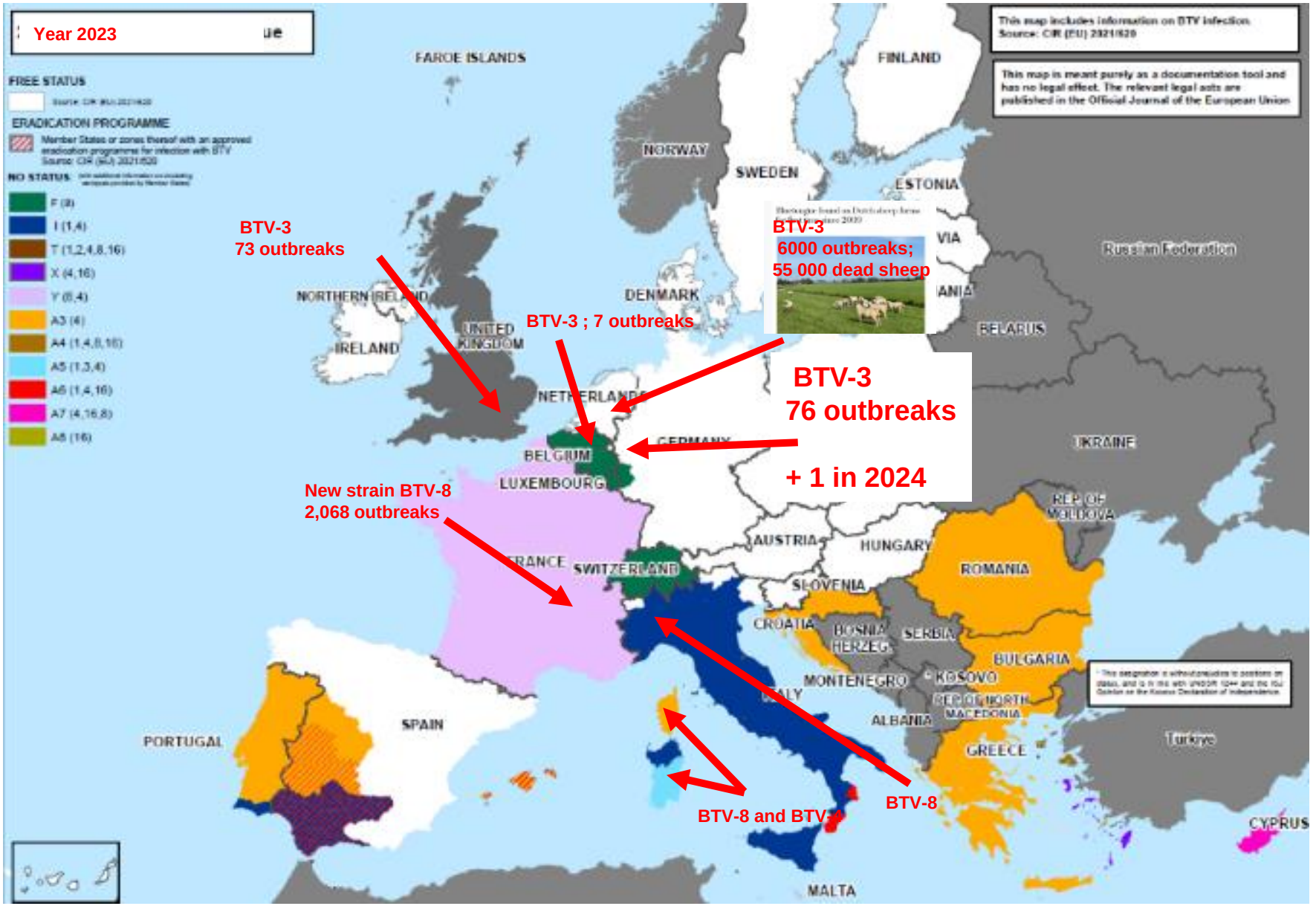


January 2024:

2,068 outbreaks
-1,537 cattle
-531 sheep


Foyers
BTV-3
Pays-Bas, épizootie en cours
(pas de notification immédiate dans ADIS)
Veille Sanitaire Internationale
2023
BTV-3
(2009: BTV-8)
Royaume-Uni
Pays-Bas
Allemagne
Belgique
N
200 km

21/05/24


Year 2023
FREE STATUS
ERADICATION PROGRAMME
NO STATUS
F (8)
I (1,4)
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)
This map includes information on BTV infection.
This map is meant purely as a documentation tool and has no legal effect.
FAROE ISLANDS
FINLAND
NORWAY
SWEDEN
ESTONIA
BTV-3
73 outbreaks
BTV-3
6000 outbreaks;
55 000 dead sheep
Russian Federation
NORTHERN IRELAND
IRELAND
UNITED KINGDOM
DENMARK
BTV-3 ; 7 outbreaks
BELARUS
BTV-3
76 outbreaks
+ 1 in 2024
NETHERLANDS
GERMANY
UKRAINE
BELGIUM
LUXEMBOURG
New strain BTV-8
2,068 outbreaks
REP. OF MOLDOVA
AUSTRIA
HUNGARY
FRANCE
SWITZERLAND
ROMANIA
SLOVENIA
CROATIA
BOSNIA HERZEG.
SERBIA
BULGARIA
MONTENEGRO
KOSOVO
ITALY
REP. OF NORTH MACEDONIA
ALBANIA
SPAIN
PORTUGAL
GREECE
Turkiye
BTV-8 and BTV-4
BTV-8
CYPRUS
MALTA

2024

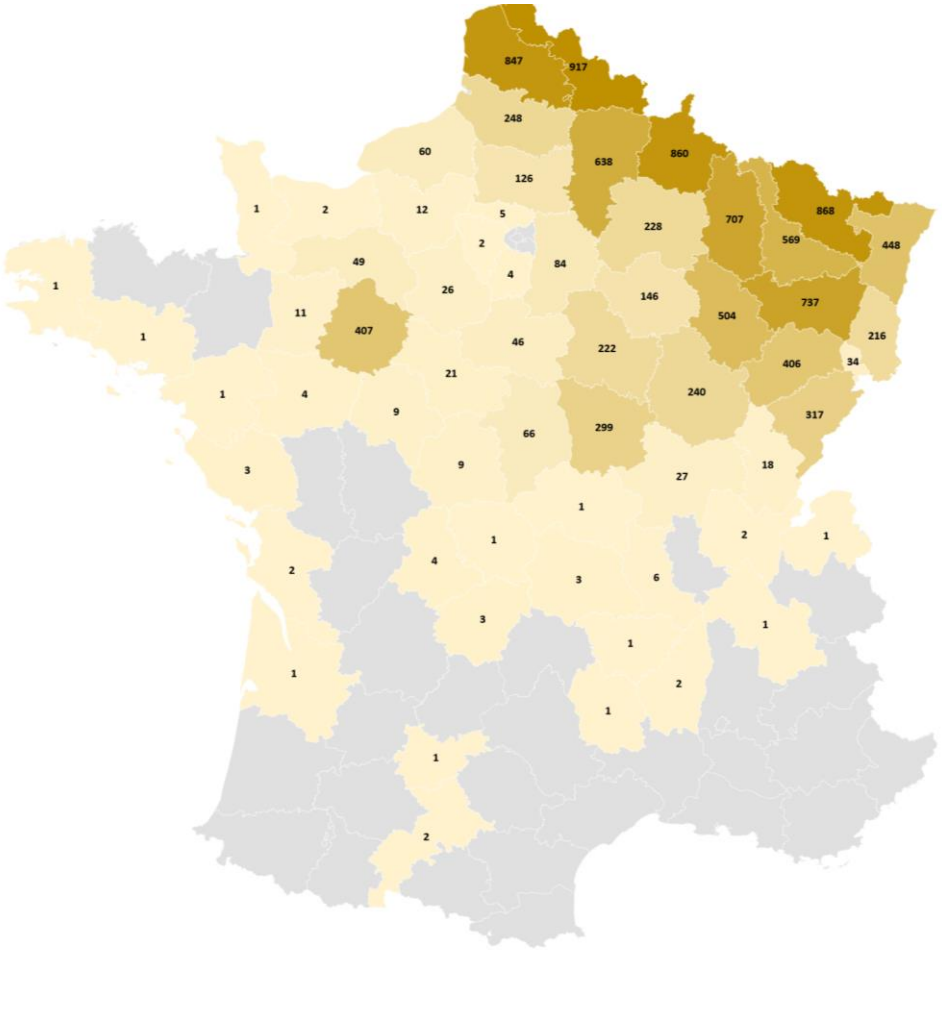
10/10/2024


Foyers
BTV-3 > 4 sem
BTV-3 < 4 sem
Epizootie en cours
(pas de notification immédiate dans ADIS)
Veille Sanitaire Internationale
Plateforme ESA
Norvège
Suède
Danemark
Royaume-Uni
Pays-Bas
Allemagne
Belgique
Luxembourg
Tchéquie
Autriche
Suisse
France
Espagne
Portugal
N

Year 2024

BTV-3

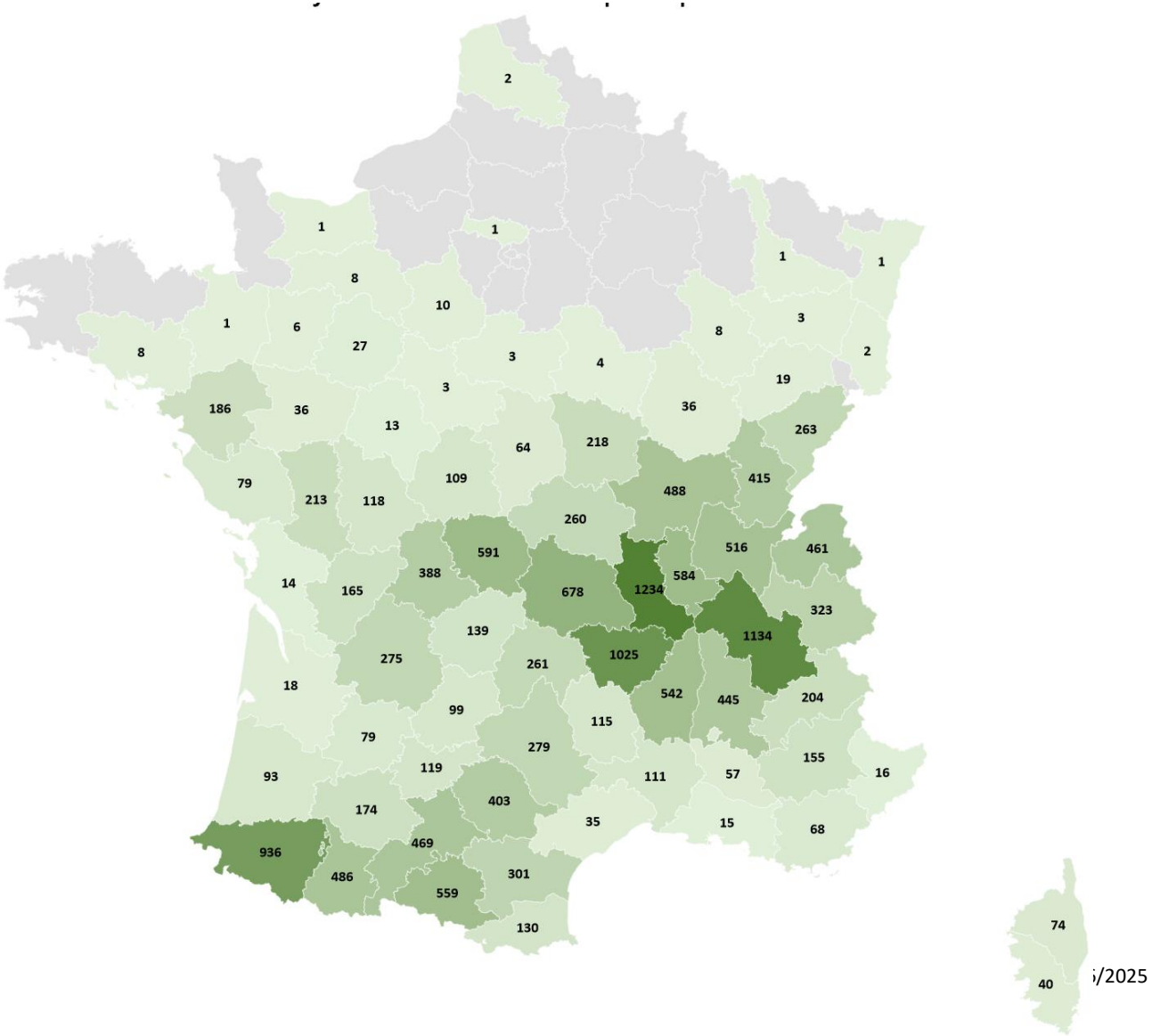
10,521 outbreaks

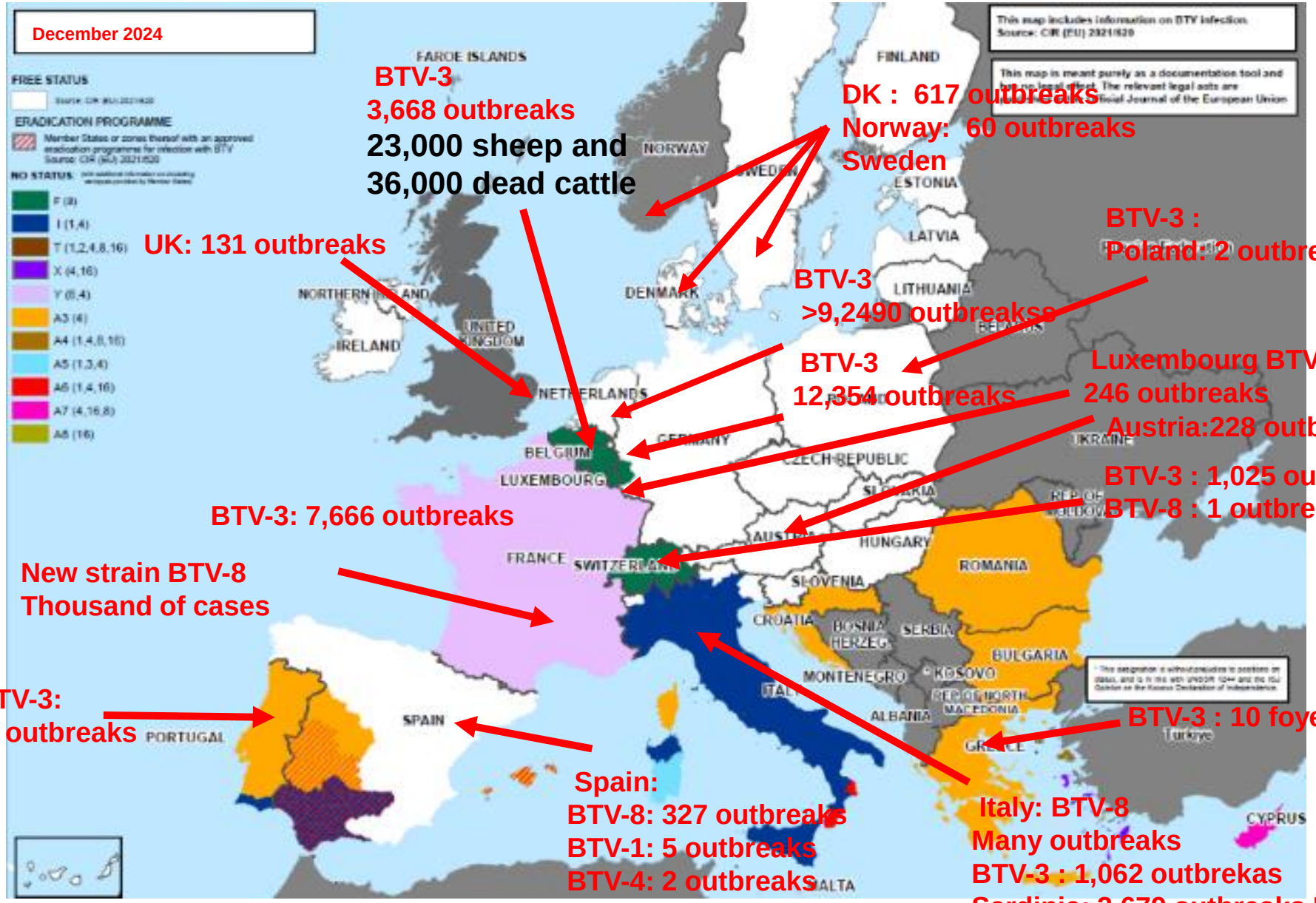


Year 2024

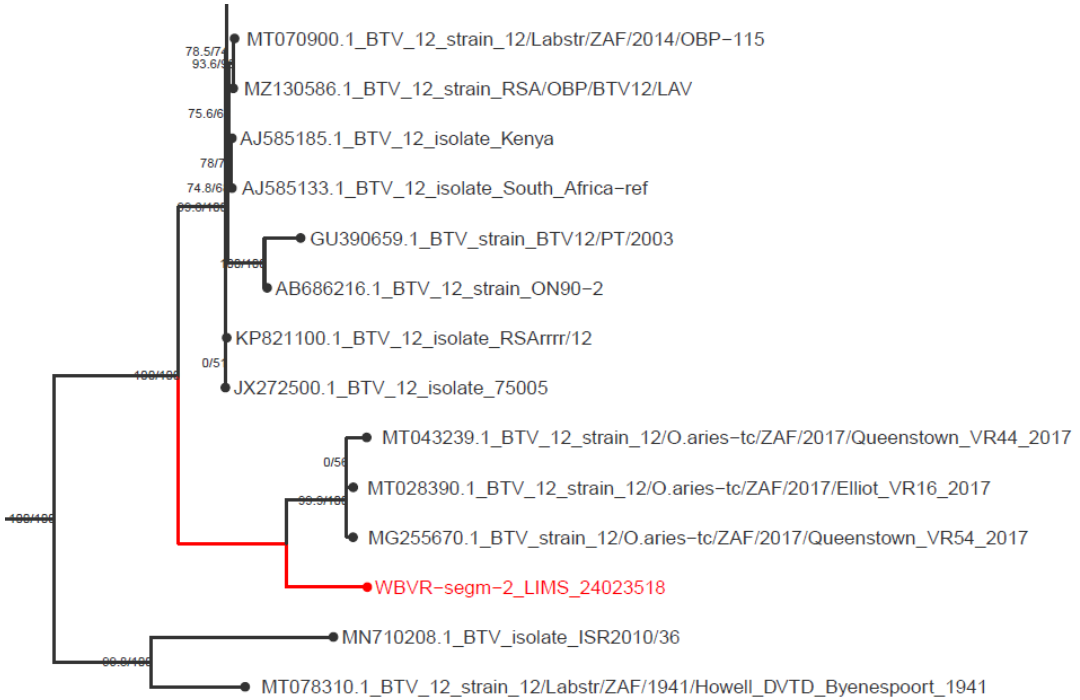
BTV-8

16,478 outbreaks




December 2024
FREE STATUS
ERADICATION PROGRAMME
NO STATUS
BTV-3
3,668 outbreaks
23,000 sheep and
36,000 dead cattle
DK : 617 outbreaks
Norway: 60 outbreaks
Sweden
UK: 131 outbreaks
BTV-3 :
Poland: 2 outbreaks
BTV-3
>9,2490 outbreakse
BTV-3
12,354 outbreaks
Luxembourg BTV-3
246 outbreaks
Austria:228 outbreak
BTV-3 : 1,025 outbrea
BTV-8 : 1 outbreaks
BTV-3: 7,666 outbreaks
New strain BTV-8
Thousand of cases
BTV-3:
3 outbreaks
BTV-3 : 10 foyers
Spain:
BTV-8: 327 outbreaks
BTV-1: 5 outbreaks
BTV-4: 2 outbreaks
BTV 3 : 783 outbreaks
Italy: BTV-8
Many outbreaks
BTV-3 : 1,062 outbrekas
Sardinia: 2,679 outbreaks BTV-
FAROE ISLANDS
NORWAY
FINLAND
ESTONIA
LATVIA
LITHUANIA
DENMARK
IRELAND
UNITED KINGDOM
NETHERLANDS
BELGIUM
LUXEMBOURG
FRANCE
SWITZERLAND
AUSTRIA
HUNGARY
SLOVENIA
CROATIA
SERBIA
ROMANIA
BULGARIA
MONTENEGRO
KOSOVO
ALBANIA
SPAIN
PORTUGAL
ITALY
MALTA
CZECH REPUBLIC
UKRAINE
CYPRUS
Türkiye

3 octobre 2024



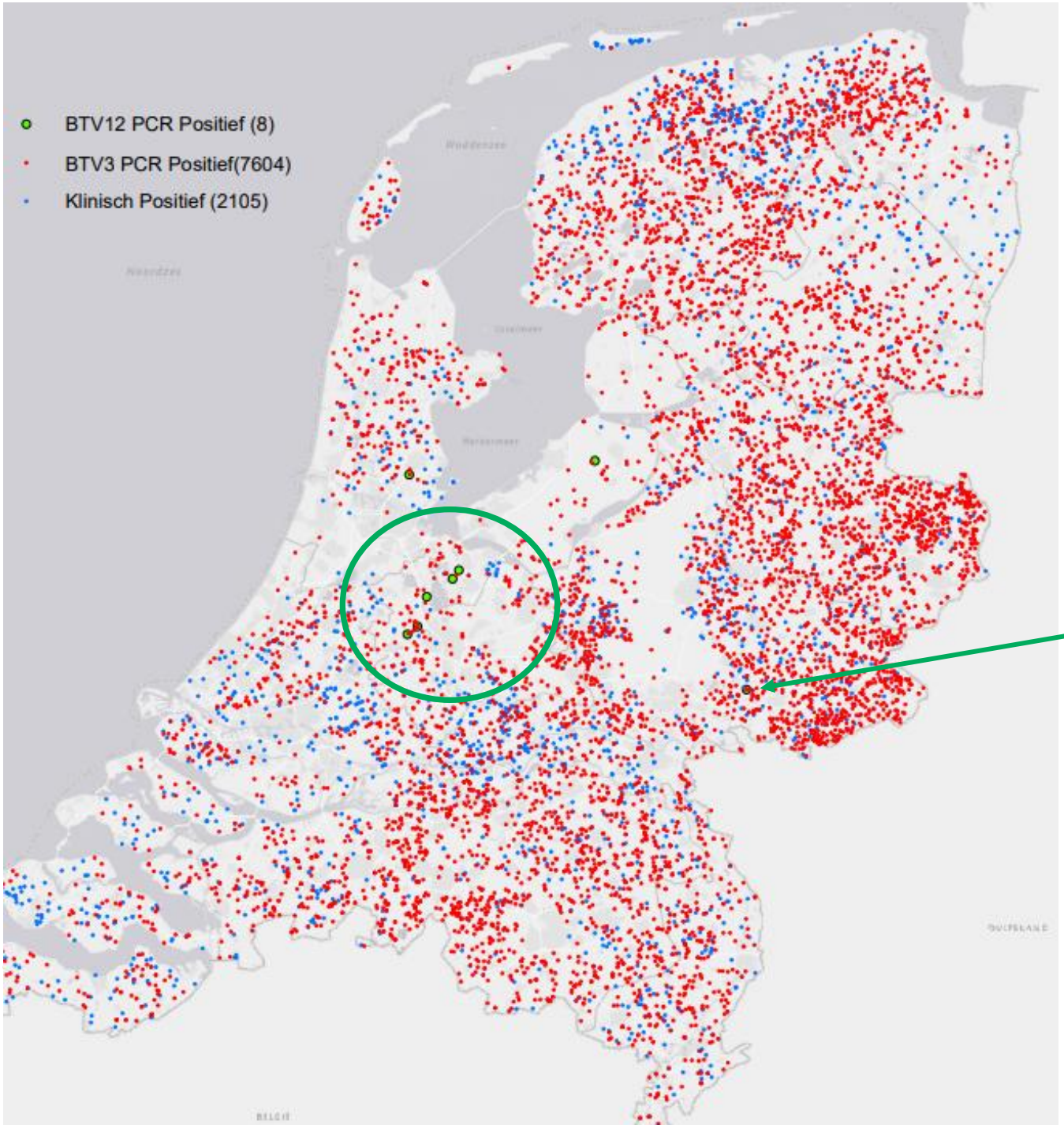
One sheep Ct = 22

20 km from the 1st case of BTV-3 in 2023
1 cattle at 5 km

Segment	Virus protein	% identity with LIMS 24023518	Isolate name	GenBank accession
Segm-1	VP1	98.08	BTV-24/ISR2009/02_2009	MN710085.1
Segm-2	VP2	96.56	BTV-12/O.aries-tc/ZAF/2017/Queenstown_VR54_2017	MG255670.1
Segm-3	VP3	97.11	BTV-3/ISR-2019/13_2013	MG344982.1
Segm-4	VP4	97.87	BTV-3/ISR-2153/16_2016	MG344993.1
Segm-5	NS1	98.01	BTV-1/LIB2007/06_2007	KP821370.1
Segm-6	VP5	96.60	BTV-12/O.aries-tc/ZAF/2017/Queenstown_VR44_2017	MT043243.1
Segm-7	VP7	97.58	BTV-12/O.aries-tc/ZAF/2017/Queenstown_VR54_2017	MG255675.1
Segm-8	NS2	96.89	BTV-12/O.aries-tc/ZAF/2017/Elliot_VR16_2017	MT028396.1
Segm-9	VP6/NS4	97.58	BTV-4/IT(L)_2003	JN255890.1
Segm-10	NS3/NS3a	n.a.		

BTV-12 !!!!!!!!!!

Melle Holwerda, WUR



BTV-12

12 outbreaks

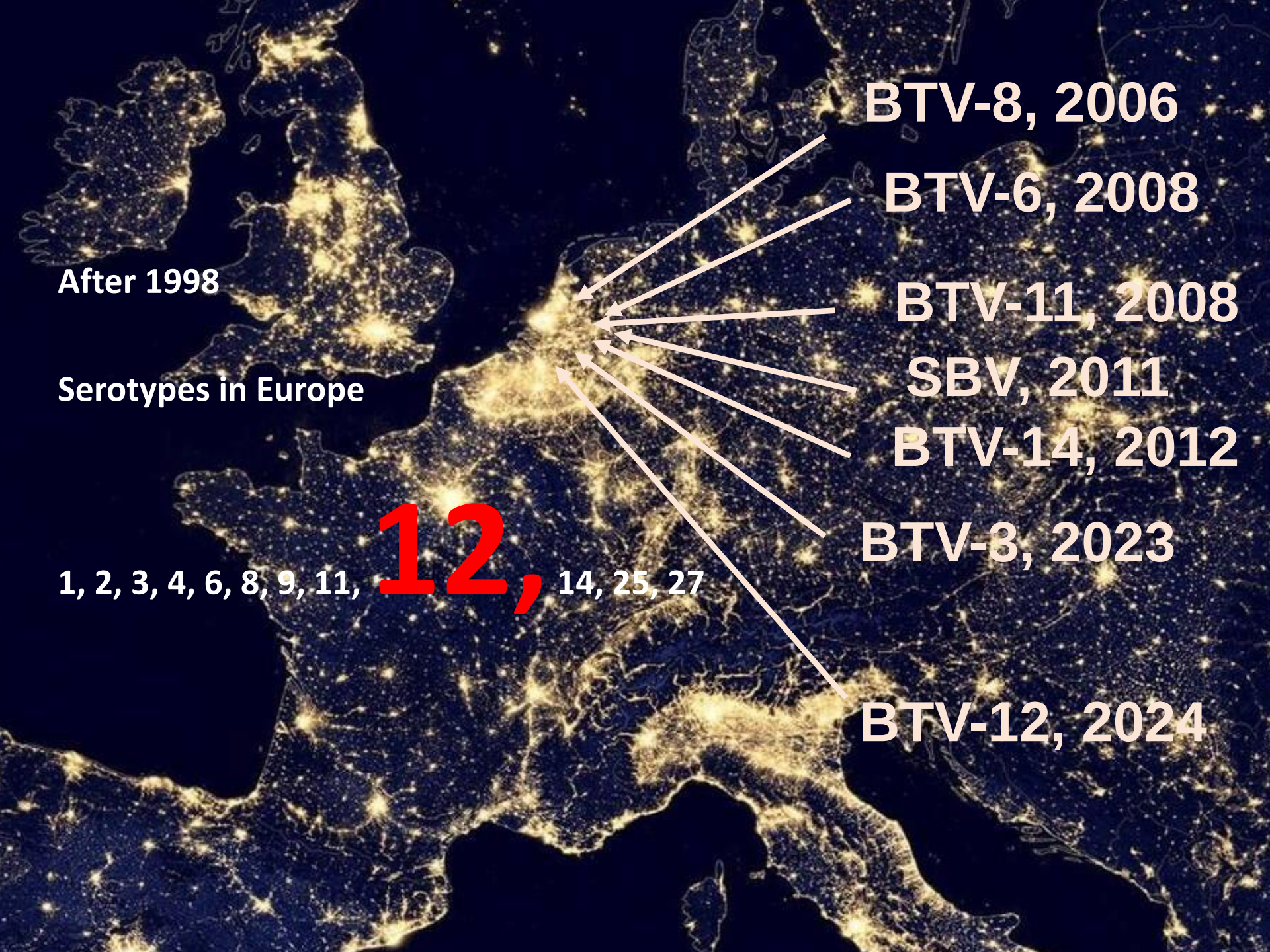
Source: NVWA

25/11/2024


BTV-12
cattle
4/02/2024
IRLANDE DU NORD
Sligo
Île de Man
Ireland
Drogheda
Great Britain
Liverpool
Manchester
Dublin
Irlande
Limerick
Tralee
Waterford
Cork
PAYS DE GALLES
ANGLETERRE
Birmingham
Norwich
Cambridge
Oxford
Cardiff
Bristol
Exeter
Bournemouth
Plymouth
Manche (mer)
Mer Celtique
Guernesey
Jersey
Caen
Rouen
Paris
Saint-Malo
Brest
Rennes
Le Mans
Lorient
Nantes
Tours
Les Sables-d'Olonne
Poitiers
France
Amsterdam
Pays-Bas
Rotterdam
Dortmund
Anvers
Bruxelles
Cologne
Lille
Belgique
Luxembourg
Strasbourg
Bâle
Dijon
Suisse


Before 1998


After 1998
Serotypes in Europe
1, 2, 3, 4, 6, 8, 9, 11, 12, 14, 25, 27


BTV-8, 2006
BTV-6, 2008
BTV-11, 2008
SBV, 2011
BTV-14, 2012
BTV-3, 2023
BTV-12, 2024
After 1998
Serotypes in Europe
1, 2, 3, 4, 6, 8, 9, 11, 12, 14, 25, 27

Orbiviruses:

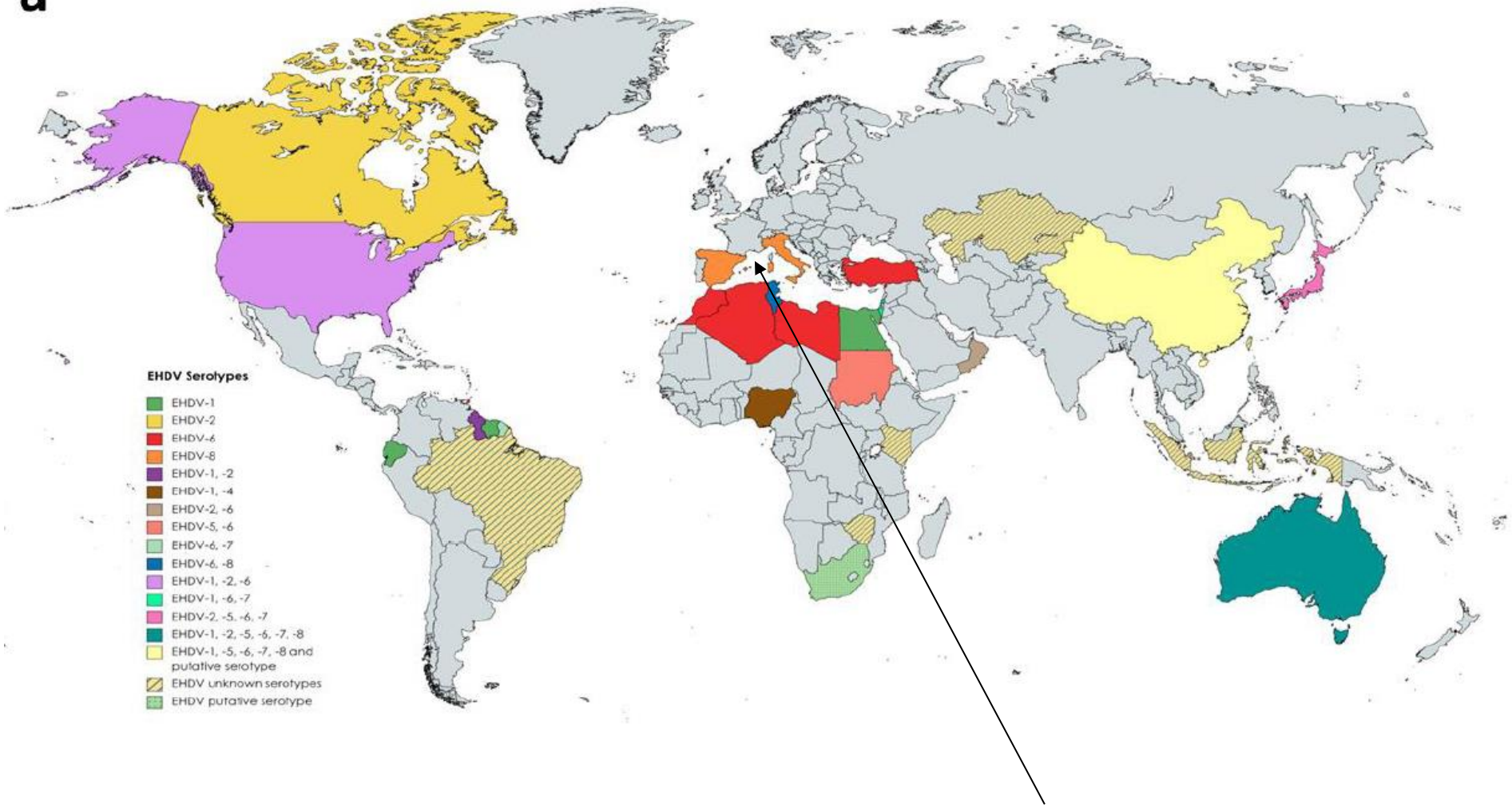
- Bluetongue

- EHD

-hypotheses on the factors of introduction


90% fatal in deer

a



microorganisms

MDPI

2022 ; 2023 ; 2024

Review

Epizootic Hemorrhagic Disease Virus: Current Knowledge and Emerging Perspectives

Luis Jiménez-Cabello, Sergio Utrilla-Trigo, Gema Lorenzo, Javier Ortego and Eva Calvo-Pinilla *

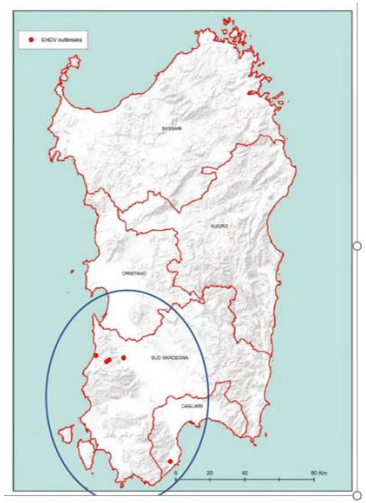
2022

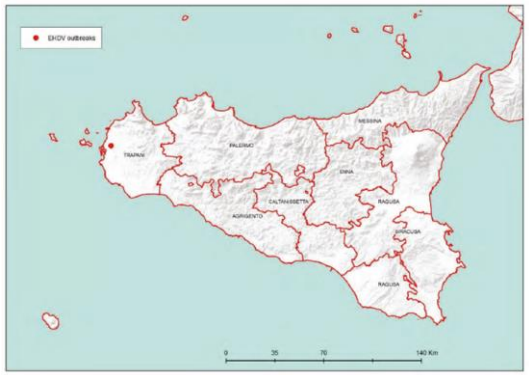
From 28 Octobre 2022

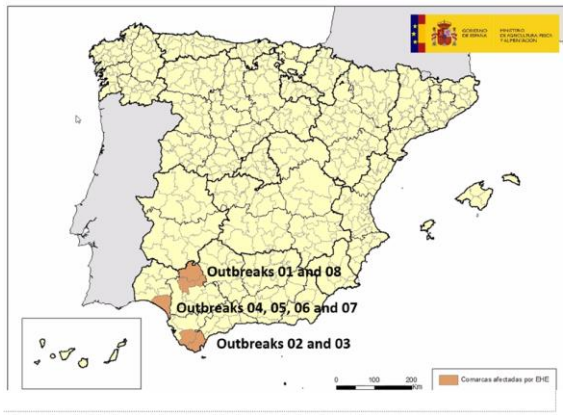
Clinical signs

- Cattle and a deer in Sardinia and Sicily (morbidity rate 5 to 10 %)
- Cattle in Andalusia (morbidity rate 10 to 15 % ; mortality rate <1%)

→ Confirmation EHDV-8

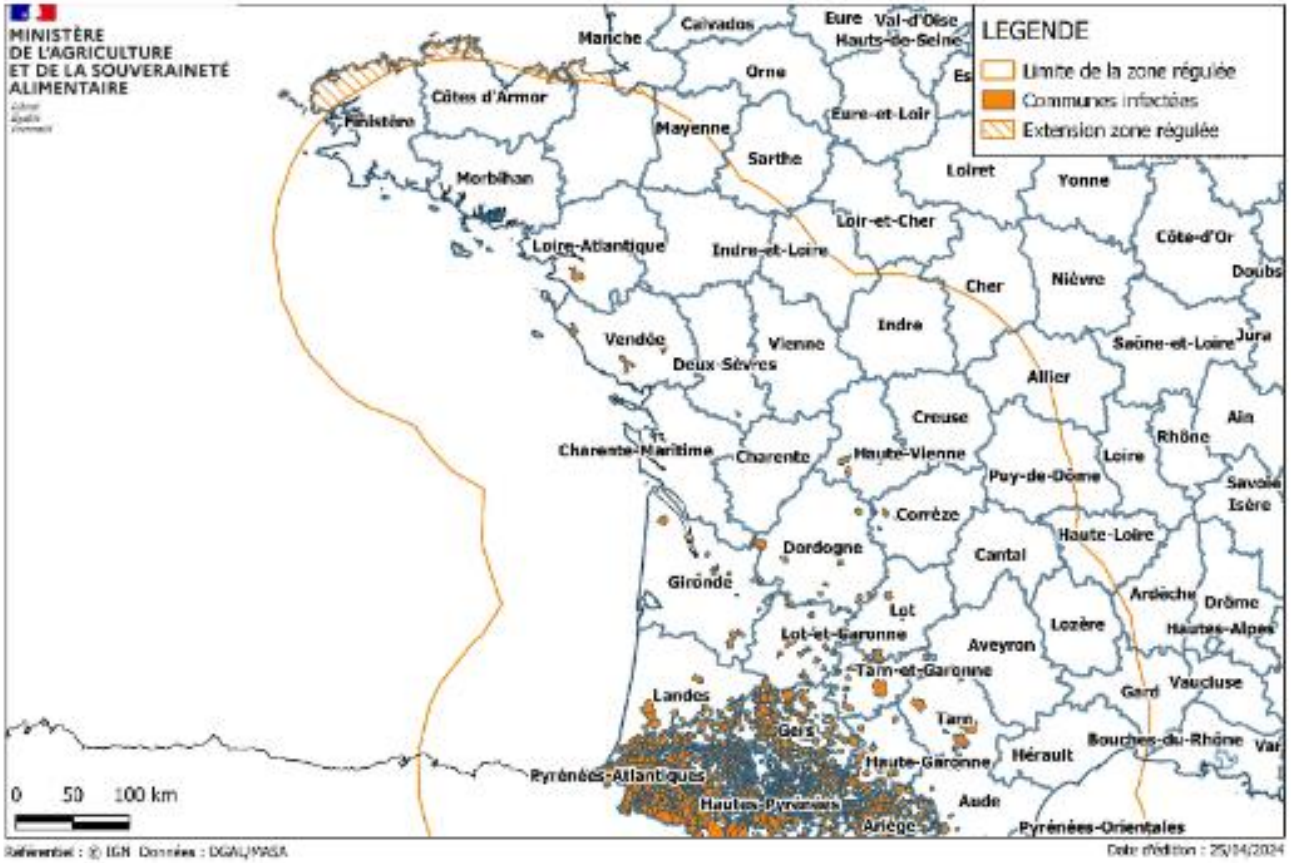






2023

> 4,330 outbreaks



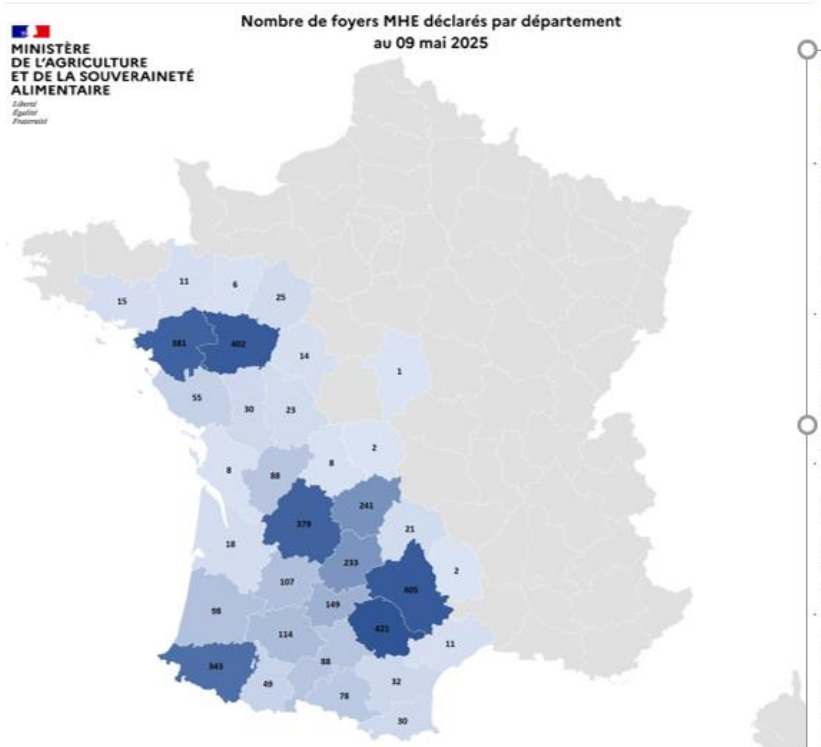
National Library of Medicine
National Center for Biotechnology Information

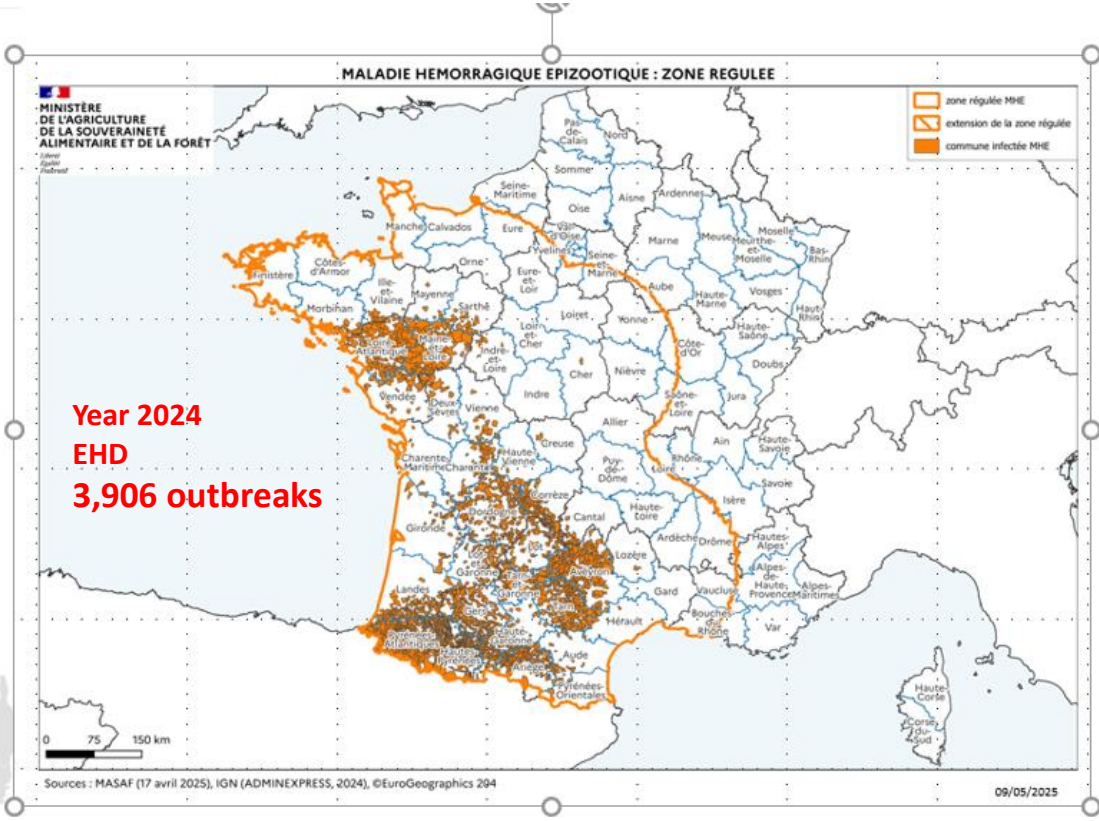
> Virologie (Montrouge). 2024 Feb 1;28(1):1-2. doi: 10.1684/vir.2024.1035.

Emergence of Epizootic Hemorrhagic Disease in France in 2023: Impacts and Future Prospects

Stéphan Zientara, Corinne Sailleau, Pascal Dujardin, Emmanuel Bréard, Damien Vitour

2024

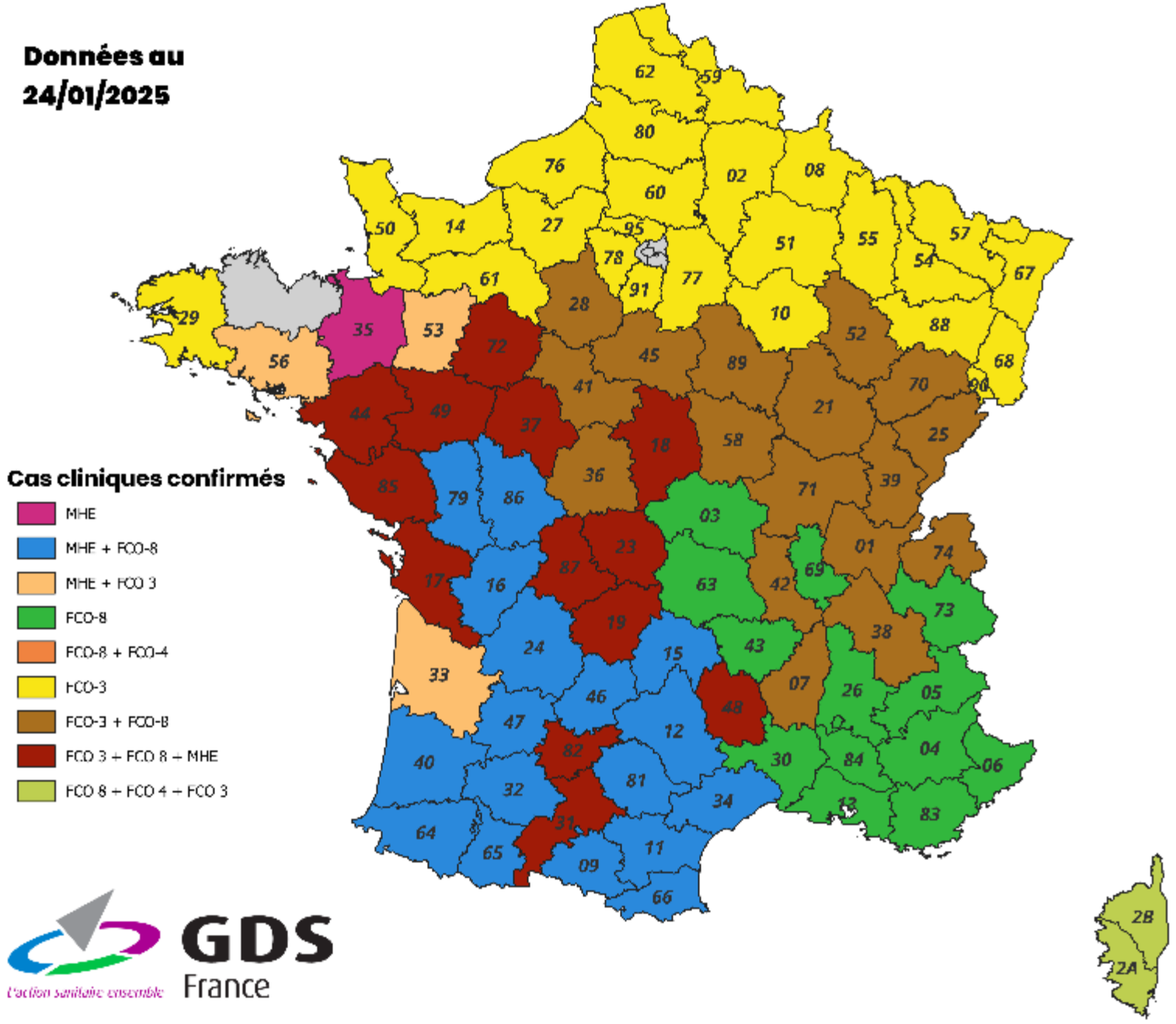




Direction générale de l'alimentation

09/05/2025

Données au 24/01/2025



GDS France

L'action sanitaire ensemble

Source : GDS France

2025?

Orbiviruses:

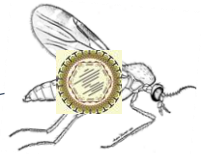
- Bluetongue
- EHD

-hypotheses on the factors of introduction

Factors of introduction

Semen, embryos

Domestic animals, Wildlife (zoo animals)

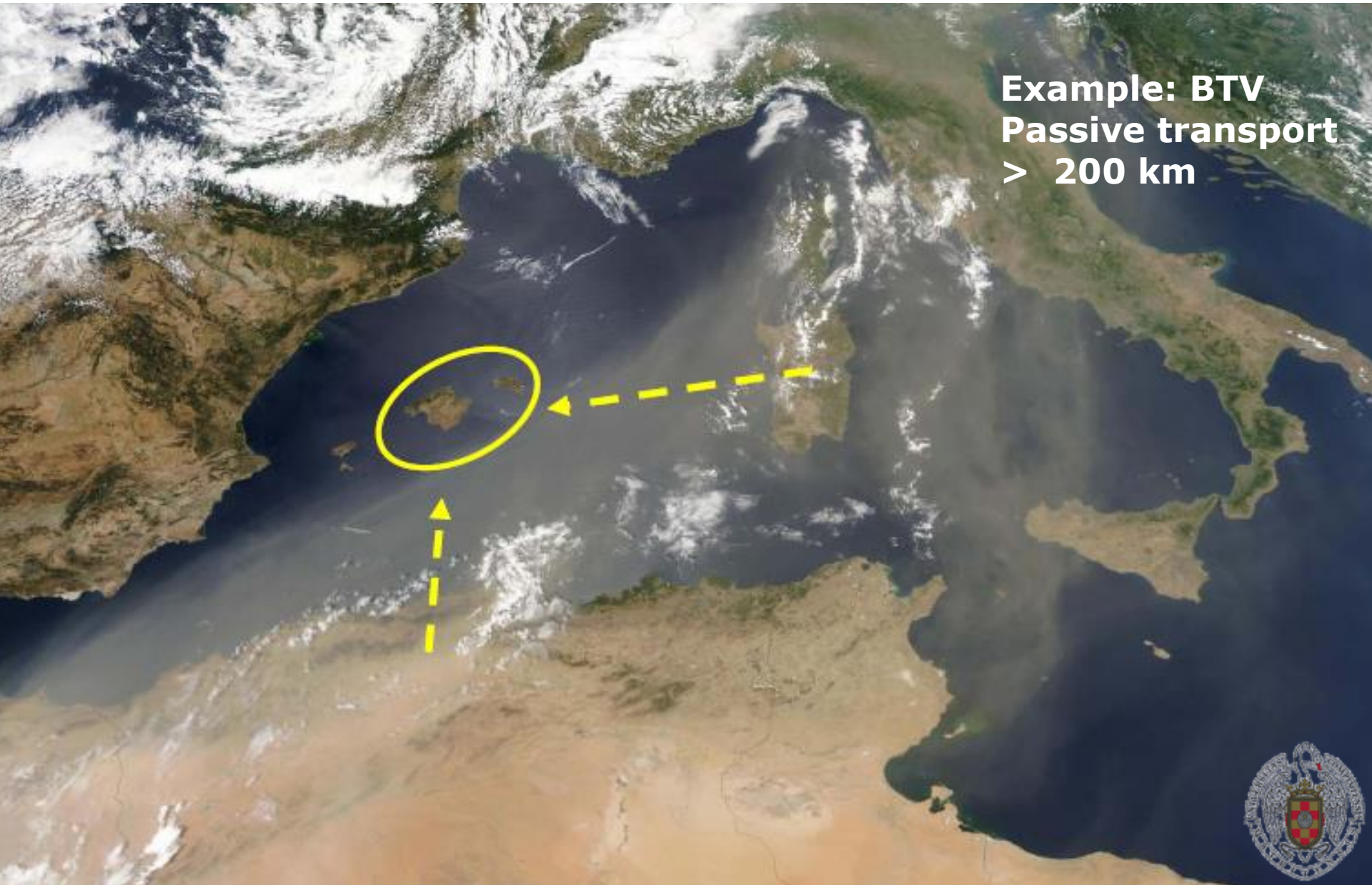


wind

Domestic animals, Wildlife

Justine Corre, ANSES


Jerez
Cádiz
60 km
104 km
Gibraltar
36 km
32 km
Tanger
Tétouan


Example: BTV
Passive transport
> 200 km

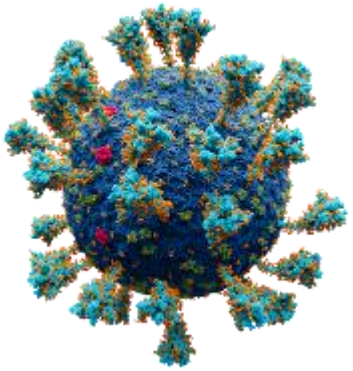
Control and prevention

Vector control

Surveillance:
Collaborations in Europe

Detection/diagnosis

Vaccine platform



Antiviral molecules