

Emerging and Vector-borne viral diseases

Gaëlle Gonzalez

Deputy Director of the European Union Reference Laboratory for equine diseases

Joint Research Unit Virology
Animal Health Laboratory
ANSES, Maisons-Alfort, France



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Association of Epidemiology & Animal Health
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Major Emerging and Re-emerging Vector-Borne Infectious Diseases

Disease	Pathogen	Primary vector(s)	Primary non-human reservoir (competent) hosts
Malaria	<i>Plasmodium</i> parasite	<i>Anopheles</i> mosquito	Non-human hosts of minor concern
Dengue*	Flavivirus	<i>Aedes aegypti</i> and <i>Aedes albopictus</i> mosquitoes	Non-human hosts of minor concern
Yellow fever	Flavivirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human primates
Zika	Flavivirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human hosts of minor concern
Chikungunya*	Alphavirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human hosts of minor concern
Lymphatic filariasis*	Various filarial nematodes	A variety of mosquito genera	Non-human hosts of minor concern
Schistosomiasis*	<i>Schistosoma</i> trematode	Snail	Non-human hosts of minor concern
Onchocerciasis*	<i>Onchocerca volvulus</i> nematode	<i>Simulium</i> (black fly)	None
Chagas disease*	<i>Trypanosoma cruzi</i> parasite	Triatomine bug	Mammals
Leishmaniasis*	<i>Leishmania</i> parasite	Sand fly	Rodents, dogs, other mammals
Japanese encephalitis	Flavivirus	<i>Culex</i> mosquitoes	Pigs, birds
African trypanosomiasis*	<i>Trypanosoma brucei</i> parasite	<i>Glossina</i> (tsetse fly)	Wild and domestic animals
Lyme disease	<i>Borrelia</i> spirochete	<i>Ixodes</i> ticks	White-footed mouse and other small mammals, birds
Tick-borne encephalitis	Flavivirus	<i>Ixodes</i> ticks	Small rodents
West Nile fever	Flavivirus	<i>Culex</i> mosquitoes	Birds
Epizootic hemorrhagic disease	Orbivirus	Culicoïdes	Deers (white-tailed deers), cattle
African Horse sickness	Orbivirus	Culicoïdes	Equids (horses)
Bluetongue disease	Orbivirus	Culicoïdes	Cattle

EMERGING ORBIVIRUSES IN FRANCE IN 2023



— Class: *Resentoviricetes* Phylum: *Duplornaviricota*

— Order: *Reovirales* Class: *Resentoviricetes*

— Family: *Sedoreoviridae* Order: *Reovirales*

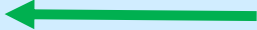


+ Genus: *Cardoreovirus* Family: *Sedoreoviridae*

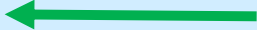
Genus: *Mimoreovirus* Family: *Sedoreoviridae*

Genus: *Orbivirus* Family: *Sedoreoviridae*

Species: *African horse sickness virus* Genus: *Orbivirus*



Species: *Bluetongue virus* Genus: *Orbivirus*



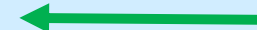
Species: *Changuinola virus* Genus: *Orbivirus*

Species: *Chenuda virus* Genus: *Orbivirus*

Species: *Chobar Gorge virus* Genus: *Orbivirus*

Species: *Corriparta virus* Genus: *Orbivirus*

Species: *Epizootic hemorrhagic disease virus* Genus: *Orbivirus*



Species: *Equine encephalosis virus* Genus: *Orbivirus*

Species: *Eubenangee virus* Genus: *Orbivirus*

Species: *Great Island virus* Genus: *Orbivirus*

Species: *Ieri virus* Genus: *Orbivirus*

Species: *Lebombo virus* Genus: *Orbivirus*

Species: *Orungo virus* Genus: *Orbivirus*

Species: *Palyam virus* Genus: *Orbivirus*

Species: *Peruvian horse sickness virus* Genus: *Orbivirus*

Species: *St Croix River virus* Genus: *Orbivirus*

Species: *Umatilla virus* Genus: *Orbivirus*

Species: *Wad Medani virus* Genus: *Orbivirus*

Species: *Wallal virus* Genus: *Orbivirus*

Species: *Warrego virus* Genus: *Orbivirus*

Species: *Wengen virus* Genus: *Orbivirus*

Species: *Yunnan orbivirus* Genus: *Orbivirus*

Species: *Yunnan orbivirus* Genus: *Orbivirus*

+ Genus: *Phytoreovirus* Family: *Sedoreoviridae*



EHDV

➤ Family *Sedoreoviridae* ; Genus *Orbivirus*

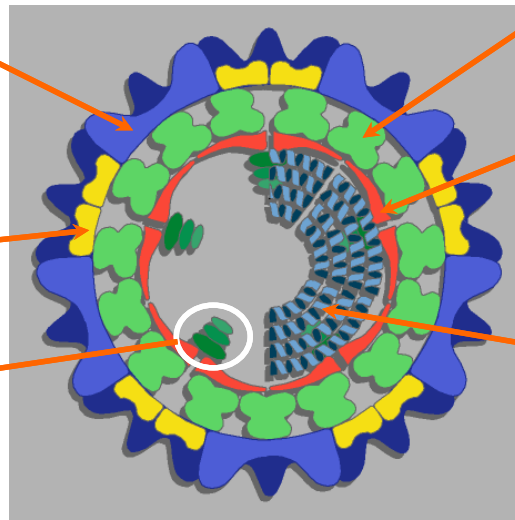
VP2 :

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

VP5 : ■ pénétration

transcription complex :

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



VP7 :

- conserved among serotypes

VP3 :

7 serotypes

Reference strains							
EHDV-1 USA1955/01	EHDV-2 CAN1962/01	EHDV-3[M.Dom1] NIG1967/01	EHDV-4 NIG1968/01	EHDV-5 AUS1977/01	EHDV-6 AUS1981/07	EHDV-7 AUS1981/06	EHDV-8 AUS1982/06

Table 3: Commonly accepted reference strains in the ds RNA virus collection at Institute for Animal Health (IAH) Pirbright, UK and at the Arthropod-Borne Animal Diseases Research Laboratory (ABADRL), USA.

New serotypes?

South Africa



EHDV-9?

Wright, I. M. 2013: Serological and Genetic Characterisation of Putative New Serotypes of Bluetongue Virus and Epizootic Haemorrhagic Disease Virus Isolated From an Alpaca. North-West University, South Africa

Japan (1998)



EHDV-10?



China



EHDV-11 ?

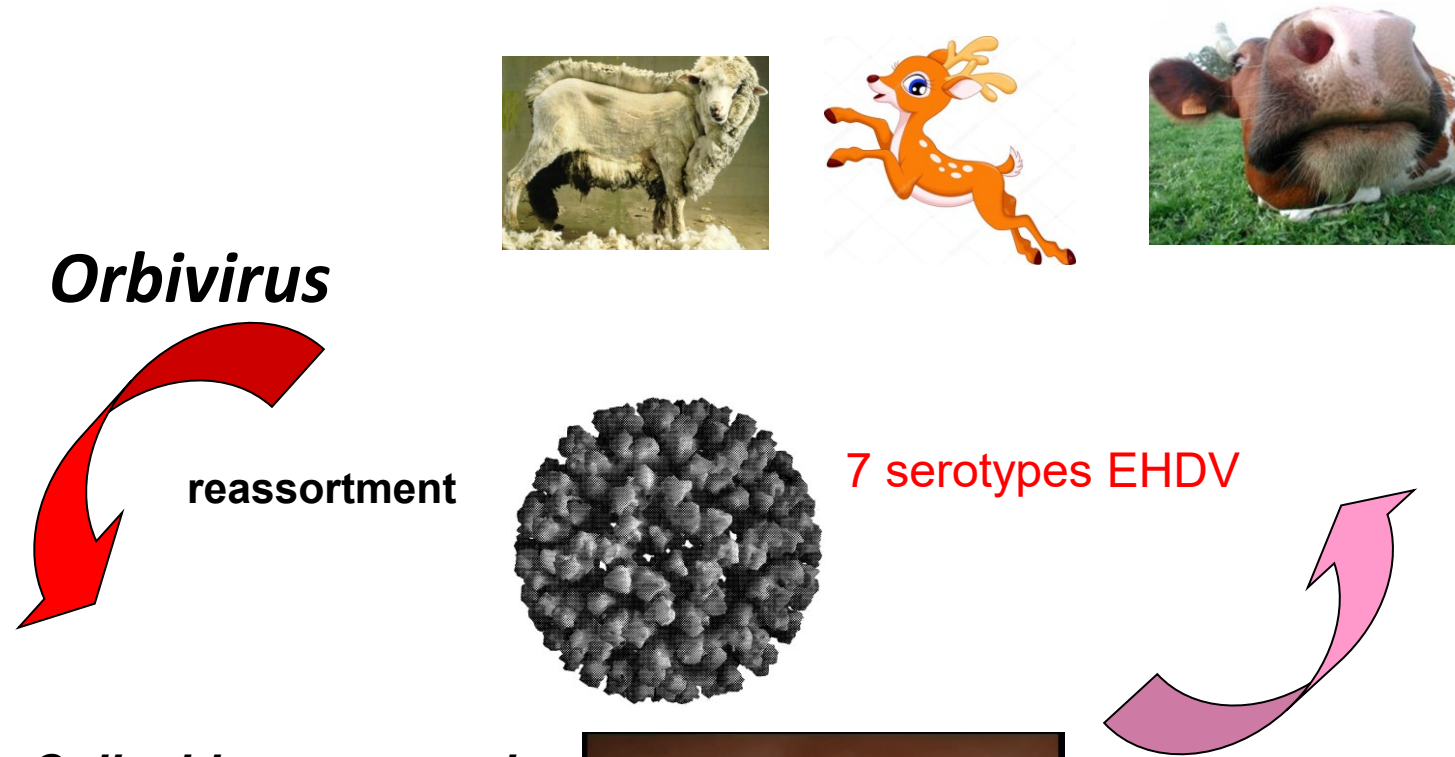
➤ Emerg Infect Dis. 2020 Dec;26(12):3081-3083. doi: 10.3201/eid2612.191301.

Novel Serotype of Epizootic Hemorrhagic Disease Virus, China

Heng Yang, Zhuoran Li, Jinping Wang, Zhanhong Li, Zhenxing Yang, Defang Liao, Jianbo Zhu, Huachun Li

PMID: 33219797 PMID: PMC7706924 DOI: 10.3201/eid2612.191301

EHDV transmission cycle



Transmission by *Culicoides sonorensis*

Other species

C. insignis; *C. mohave*; *C. debilipalpis*

C. obsoletus; *C. scoticus*

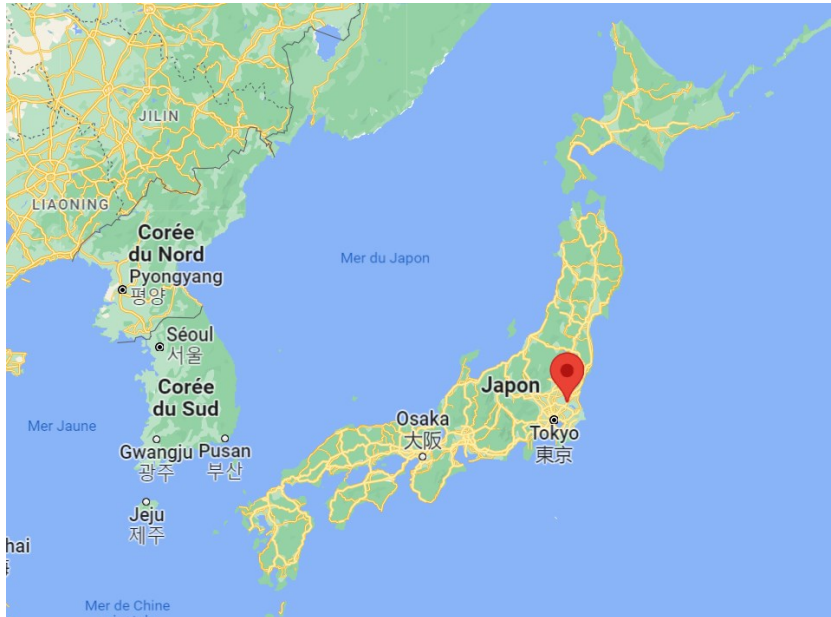
C. paraensis ; *C. spinosus*

C. Stellifer; etc



EHDV emergence

- First description of EHD in **New Jersey in 1955** after a severe outbreak of the disease in **white-tailed deer** (*Odocoileus virginianus*)
- Case reported in **Ibaraki, Japan in 1959: EHDV2** strain isolated from a cattle



Shope R.E., Macnamara L.G. & Mangold R. (1960). – A virus-induced epizootic hemorrhagic disease of the Virginia white-tailed deer (*Odocoileus virginianus*). *J. Experim. Med.*, 111, 155–170

Epizootic haemorrhagic disease N.J. Maclachlan, S. Zientara, G. Savini & P.W. Daniels ; *Rev. Sci. Tech. Off. Int. Epiz.*, 2015, 34 (2), 341-351

Epizootic Haemorrhagic Disease of **DEER** ?





90% mortality

Fever
Weakness
Inappetance
Excessive salivation
Facial oedema
Hyperaemia of the conjunctiva
Mucous membranes of the oral cavity
Coronitis
Stomatitis

Fulminant EHD characterised by excessive bleeding (haemorrhagic diathesis), dehydration, diarrhoea, and death.



EHDV serotypes **1, 2, 6, 7 and 8** induce **clinical signs in cattle**



"The ringing in your ears—I think I can help."



Review

Bluetongue and Epizootic Hemorrhagic Disease in the United States of America at the Wildlife–Livestock Interface

Nelda A. Rivera ^{1,*}, Csaba Varga ², Mark G. Ruder ³, Sheena J. Dorak ¹, Alfred L. Roca ⁴, Jan E. Novakofski ^{1,5} and Nohra E. Mateus-Pinilla ^{1,2,5,*}

Table 1. Reported BTV and/or EHDV infection with or without clinical signs in wild and captive ruminant host species in the USA.

Family	Ruminant Species		Detected (✓)		References
	Common Name	Latin Name	BTV	EHDV	
Cervidae	White-tailed deer	<i>Odocoileus virginianus</i>	✓	✓	[9,10,20,41,51]
	Mule deer	<i>Odocoileus hemionus</i>	✓	✓	[10]
	Black-tailed deer	<i>Odocoileus hemionus columbianus</i>	✓	✓	[20,52]
	Elk (wapiti)	<i>Cervus canadensis</i>	✓	✓	[10,41]
	Rocky Mountain Elk	<i>Cervus elaphus nelsoni</i>	✓	✓	[53–55]
	Axis deer	<i>Axis axis</i>	✓	✓	[10,51]
	Fallow deer	<i>Dama dama</i>	✓	✓	[10,41,51,56]
	Sika deer	<i>Cervus nippon</i>	✓	✓	[10]
	Yaks	<i>Bos grunniens</i>		✓	[57]
	Père David’s deer	<i>Elaphurus davidianus</i>		✓	[41]
	Moose	<i>Alces alces</i>		✓	[58]
Bovidae	Cattle	<i>Bos taurus</i>	✓	✓	[9,56,59]
	Mountain goat	<i>Oreamnos americanus</i>	✓		[9,10]
	Bison	<i>Bison bison</i>	✓	✓	[10,59,60]
	Blackbuck antelope	<i>Antilope cervicapra</i>	✓	✓	[10]
	Gerenuk	<i>Litocranius walleri</i>	✓		[61]
	Bighorn sheep	<i>Ovis canadensis</i>	✓	✓	[9,10,59]
	Dall sheep	<i>Ovis dalli</i>		✓	[58]
	Bongo antelope	<i>Tragelaphus eurycerus</i>		✓	[41]
	Roan antelope	<i>Hippotragus equinus</i>		✓	[41]
	Lesser kudu	<i>Tragelaphus imberbis</i>		✓	[41]
	Dama gazelle	<i>Nanger dama</i>		✓	[41]
Antilocapridae	Pronghorn	<i>Antilocapra americana</i>	✓	✓	[10,62]
Camelidae	Alpaca	<i>Vicugna pacos</i>	✓		[63]

**Epizootic haemorrhagic disease virus (EHDV) mainly
infects deer, but sheep and cattle can also be infected.**

EHDV added to the WOAHA list in **May 2008.**

- Loss of appetite
- Fear of humans lost
- Extensive haemorrhages
- Weakness
- Excessive salivation
- Rapid pulse and respiratory rate
- Fever
- Blue tongue from lack of oxygenated blood
- Breaking of hooves caused by growth interruptions
- Diarrhoea
- Unconsciousness
- Death



Dr Vivien Philis, Lannemezan
Dr Mylène Lemaire-Meyer (LVD09)



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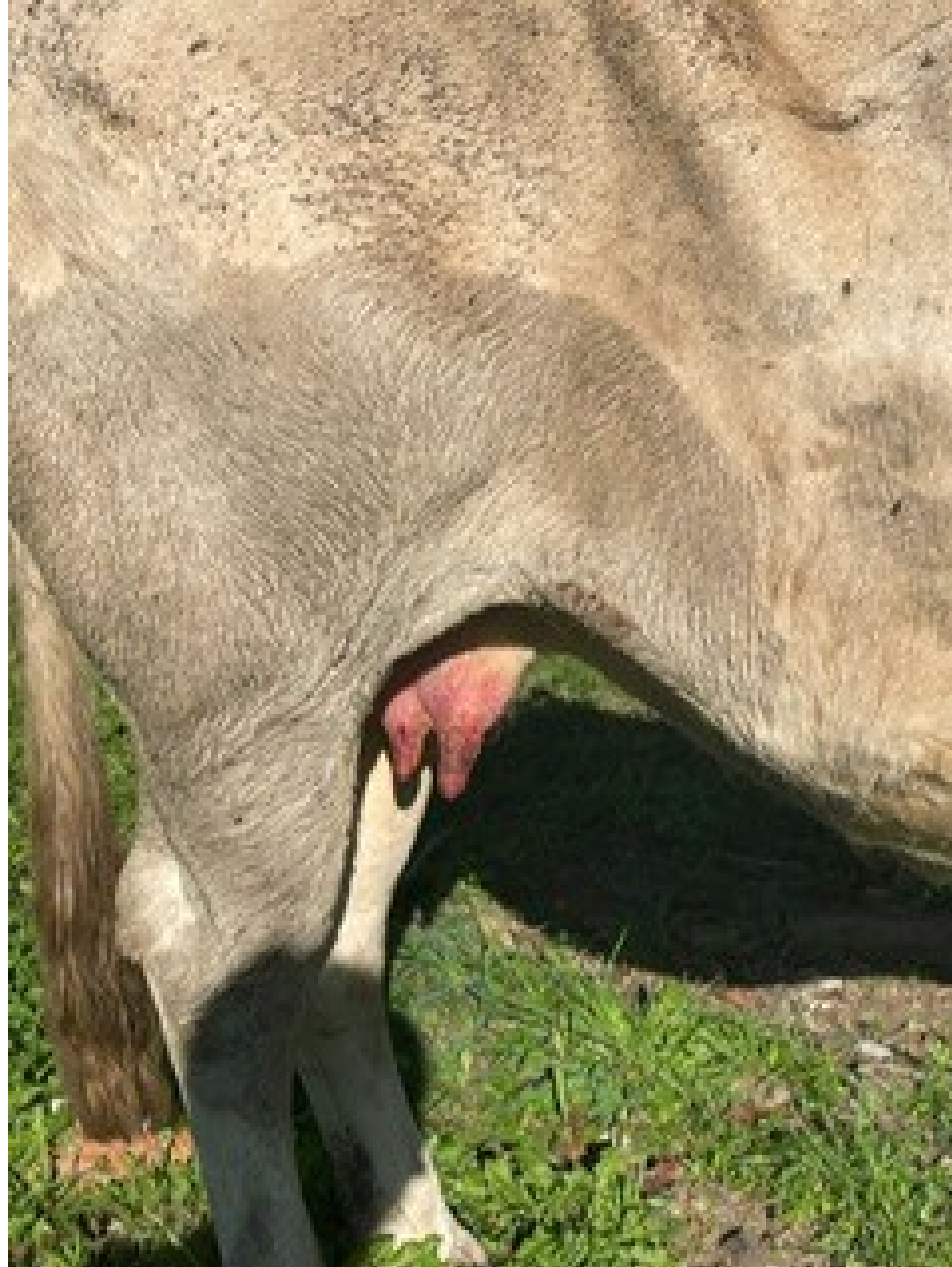
Dr Alberto Jorda Blanco (Aude)
Dr Mylène Lemaire-Meyer (LVD09)



Dr André Desbiaux, Eycheil
Dr Mylène Lemaire-Meyer (LVD09)

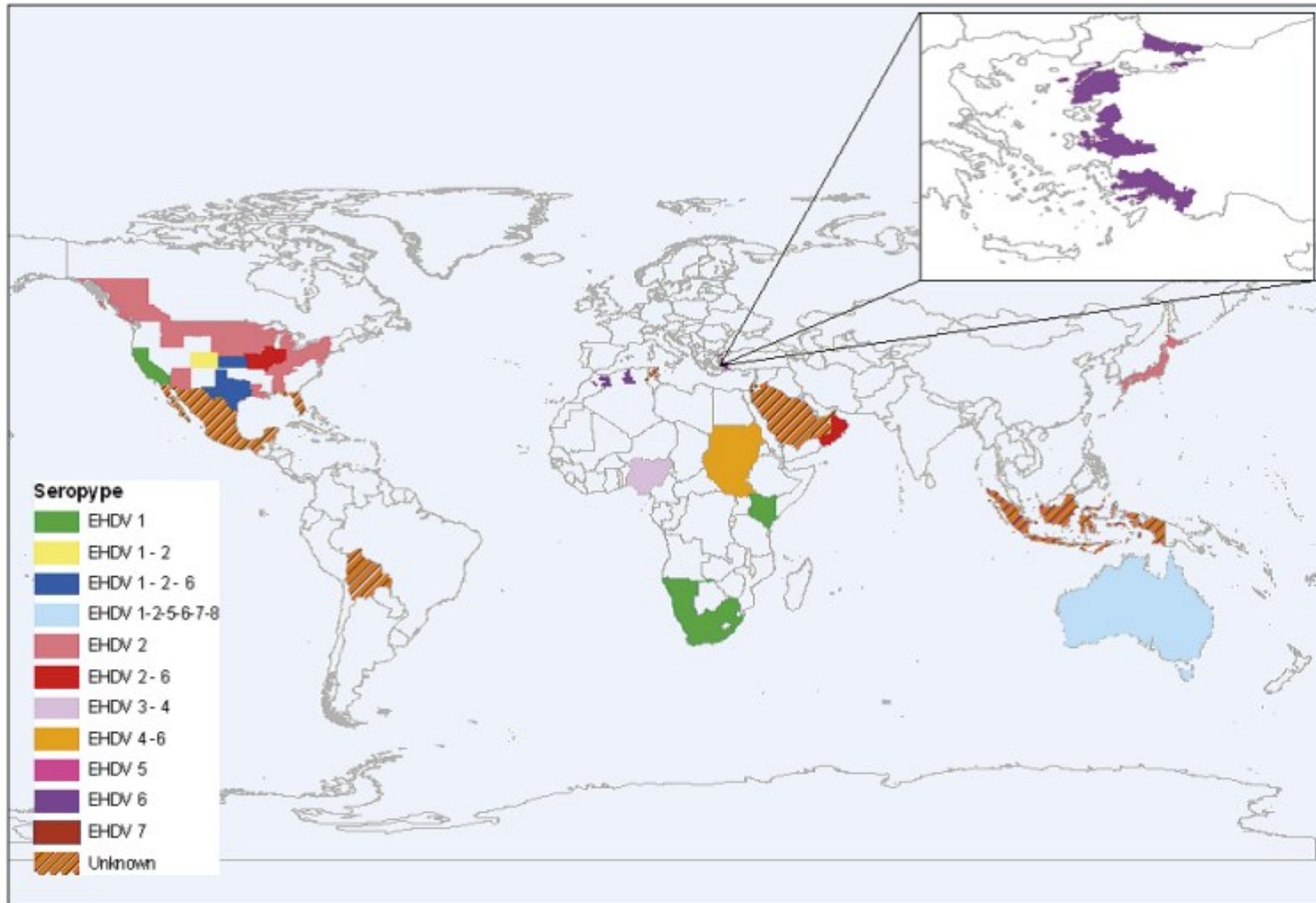


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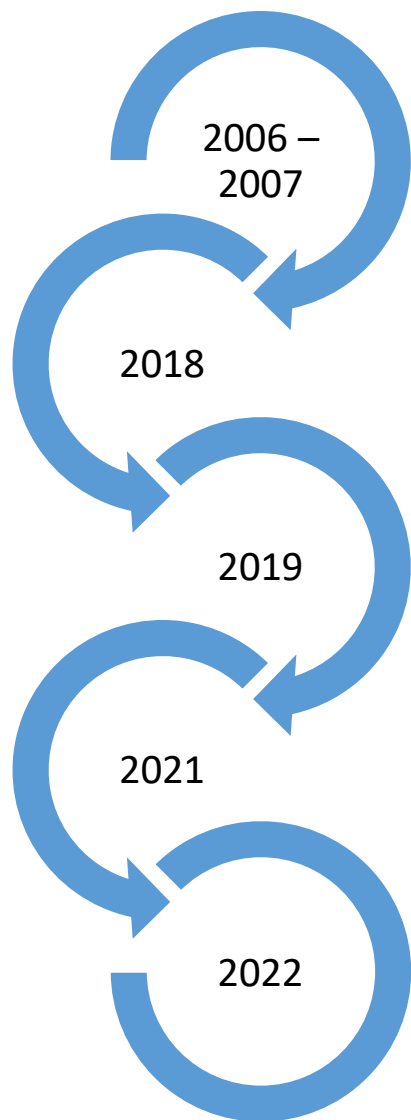
Dr Vivien Philis, Lannemezan
Dr Mylène Lemaire-Meyer (LVD09)

EHDV epidemiology



Reported in :

- Africa
- Asia
- North America
- South America
- Oceania



2006 – 2007
EHDV-6 and EHDV-7
Countries bordering Mediterranean Basin

2018
Tunisia

2019
Reunion / Mayotte

2021
Tunisia (EHDV-8, 200 cases)

2022
USA – Italy (Sardegna – Sicilia) and Spain
(Andalusia (cattle and deers)) (EHDV-8)



Evidence of bluetongue and Epizootic Haemorrhagic disease circulation on the island of Mayotte

Laure Dommergues ^a, Cyril Viarouge ^b, Raphaëlle Métras ^{c, d}, Chouanibou Youssouffi ^a, Corinne Sailleau ^b, Stephan Zientara ^b, Eric Cardinale ^{d, e}, Catherine Cêtre-Sossah ^{d, e}

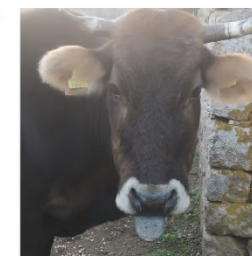


Article

Epizootic Haemorrhagic Disease Virus Serotype 8 in Tunisia, 2021

Soufien Sghaier ¹, Corinne Sailleau ², Maurilia Marcacci ³, Sarah Thabet ¹, Valentina Curini ³, Thameur Ben Hassine ⁴, Liana Teodori ³, Ottavio Portanti ³, Salah Hammami ⁵, Lucija Jurisic ^{3,6}, Massimo Spedicato ³, Lydie Postic ², Ines Gazani ⁷, Raja Ben Osman ⁸, Stephan Zientara ², Emmanuel Bréard ², Paolo Calistri ³, Jürgen A. Richt ⁹, Edward C. Holmes ¹⁰, Giovanni Savini ³, Francesca Di Giallonardo ¹¹ and Alessio Lorusso ^{3,*}

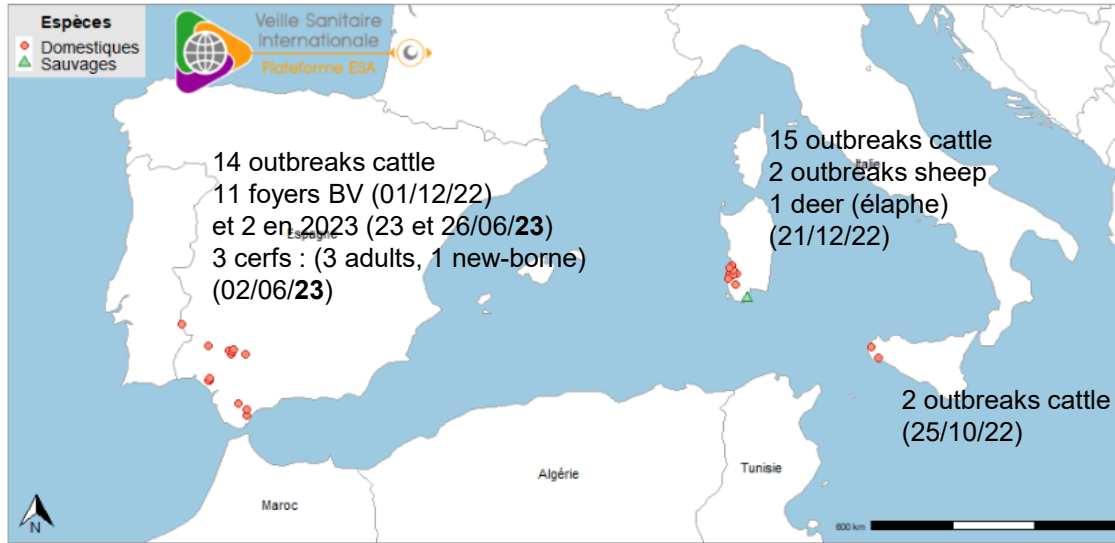
The first infected animal



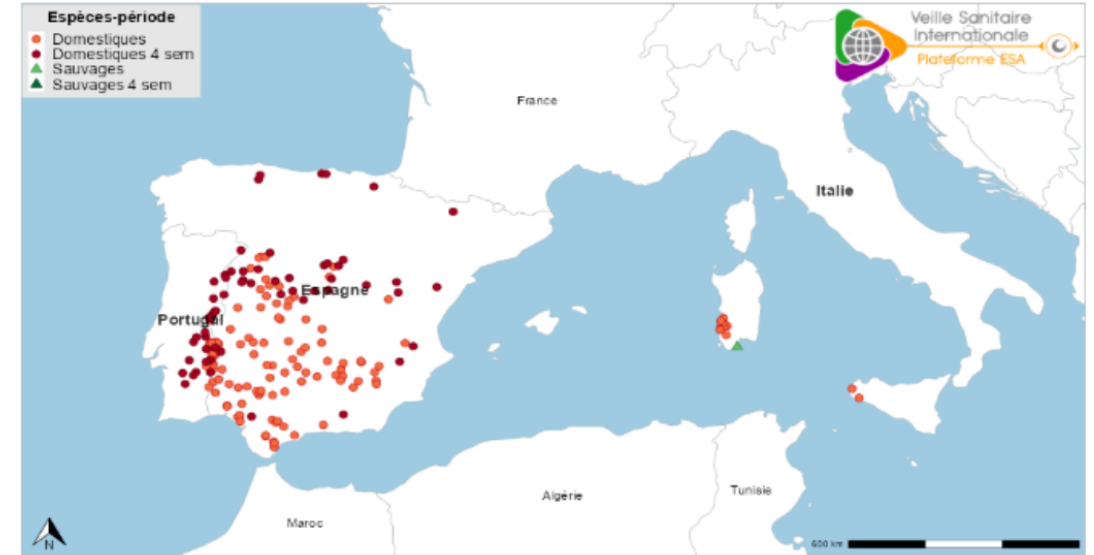
2023



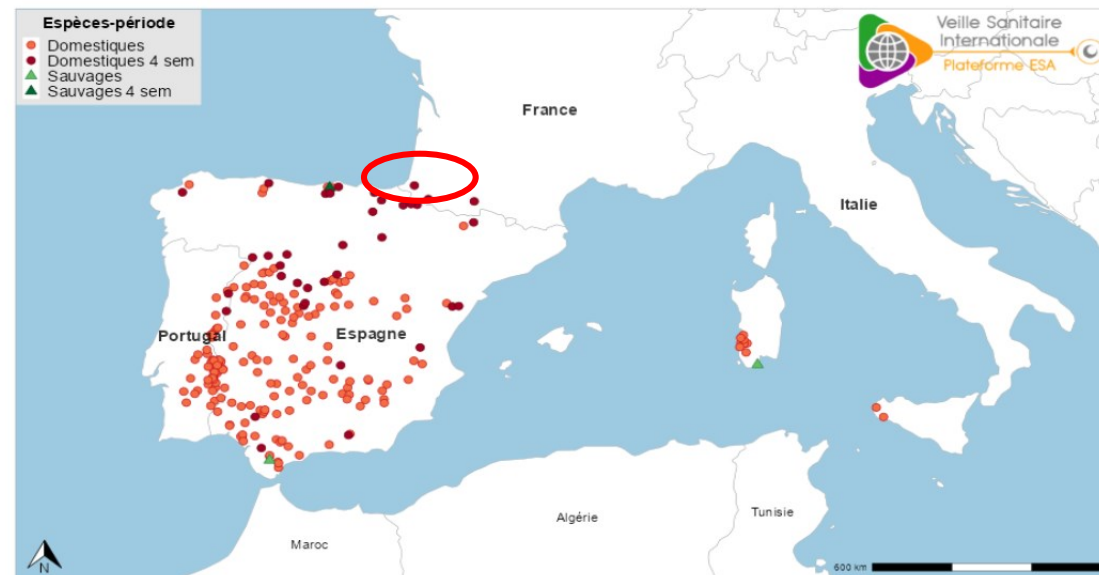
18 July 2023

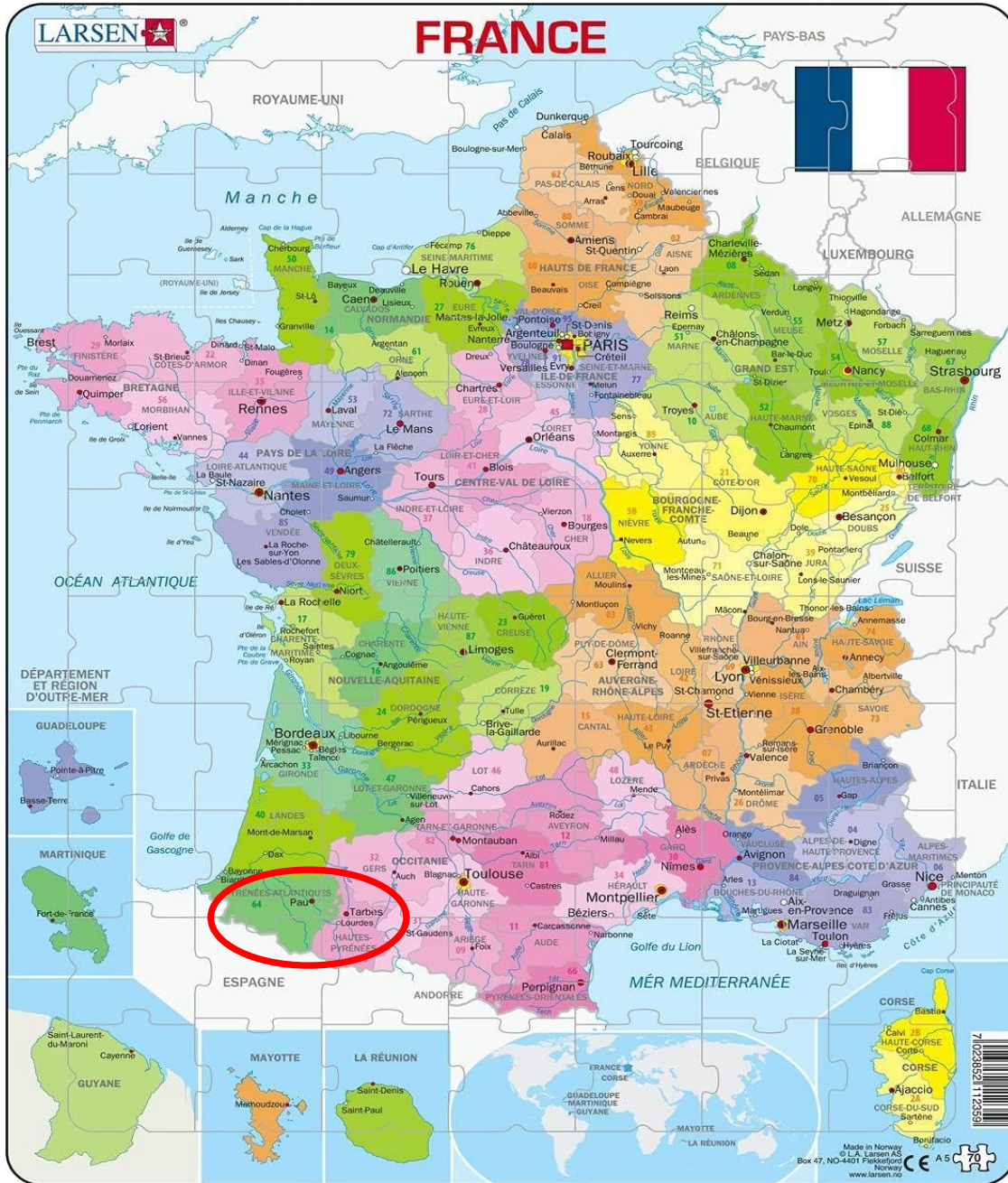


18 September 2023



2 October 2023





Hautes-Pyrénées : détection d'un cas de maladie hémorragique épizootique (MHE) dans un élevage bovin



Bovins et ovins sont atteints d'une nouvelle maladie transmise par les cerfs et le chevreuils, via les pucerons. / DDM - CEDRIC MERAVILLES

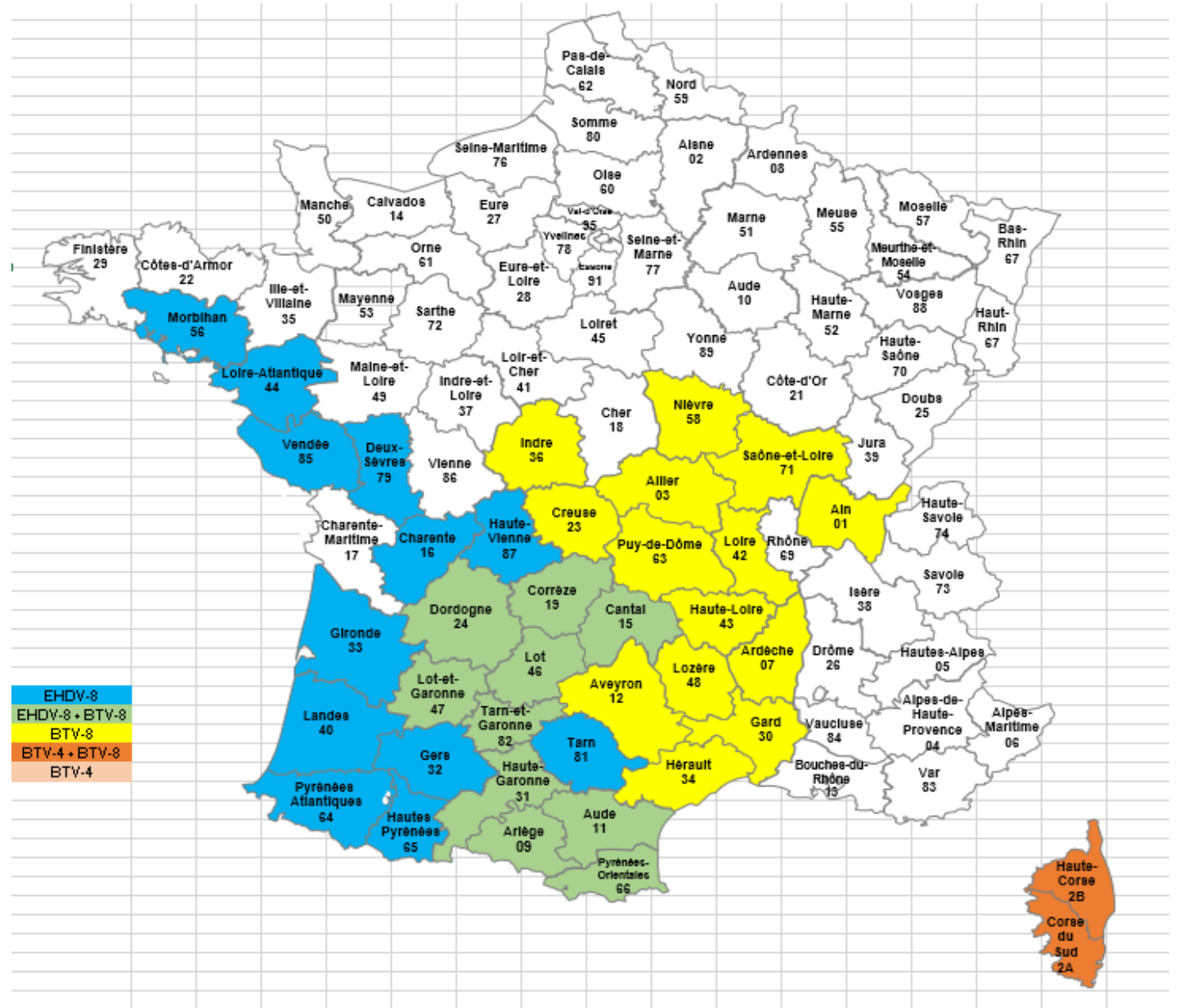
Pyrénées Atlantiques (2), Hautes Pyrénées (1)

9 Janvier 2024

> 4 002 outbreaks

20 EHDV-infected departments:
09, 11, 19, 24, 31, 32, 33, 40, 46, 44,
47, 56, 64, 65, 66, 81, 82, 85, 86, 87

1 izard
2 deer
1 roe deer



January 2024

This map includes information on BTV infection.
Source: CIR (EU) 2021/620

This map is meant purely as a documentation tool and has no legal effect. The relevant legal acts are published in the Official Journal of the European Union

- FREE STATUS**
Source: CIR (EU) 2021/620
- ERADICATION PROGRAMME**
Member States or zones thereof with an approved eradication programme for infection with BTV
Source: CIR (EU) 2021/620
- NO STATUS:** (with additional information on circulating serotypes provided by Member States)
- 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)

EHDV-8
Italy (2022)
Spain
Portugal (77 outbreaks)
France (4 002 outbreaks)

BTV-3
73 outbreaks

BTV-3 ; 7 outbreaks

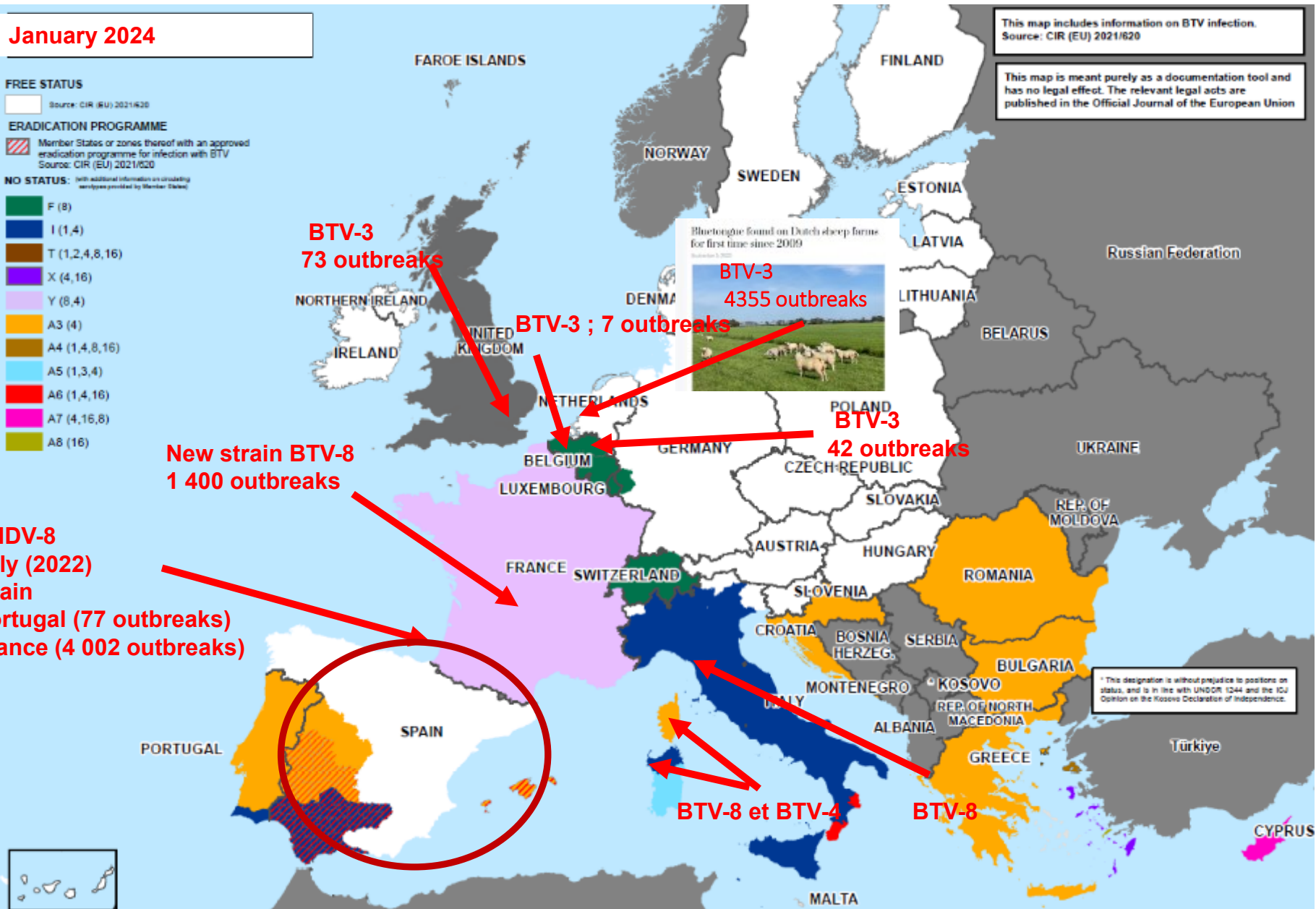
BTV-3
4355 outbreaks

BTV-3
42 outbreaks

New strain BTV-8
1 400 outbreaks

BTV-8 et BTV-4

BTV-8



* This designation is without prejudice to positions on status, and is in line with UNODR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

AFRICAN HORSE SICKNESS VIRUS



African Horse Sickness



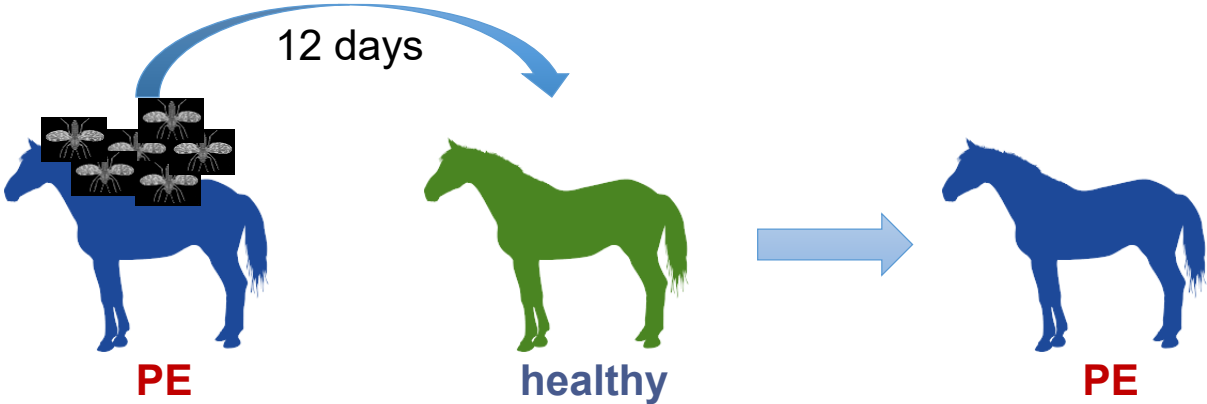
Sir A. Theiler

● « Warm season disease »



F.J. du Toit

● Culicoïdes transmission



African Horse Sickness

EQUIDS

RESERVOIR



Zebras

rarely display clinical signs

ACCIDENTAL/INDICATOR HOSTS



Donkeys

(10% death)



Mules

(50% death)



Horses

(50-95% death)



susceptibility

OTHERS



Dogs

dead-end hosts
highly susceptible
oral ingestion +++



Camels

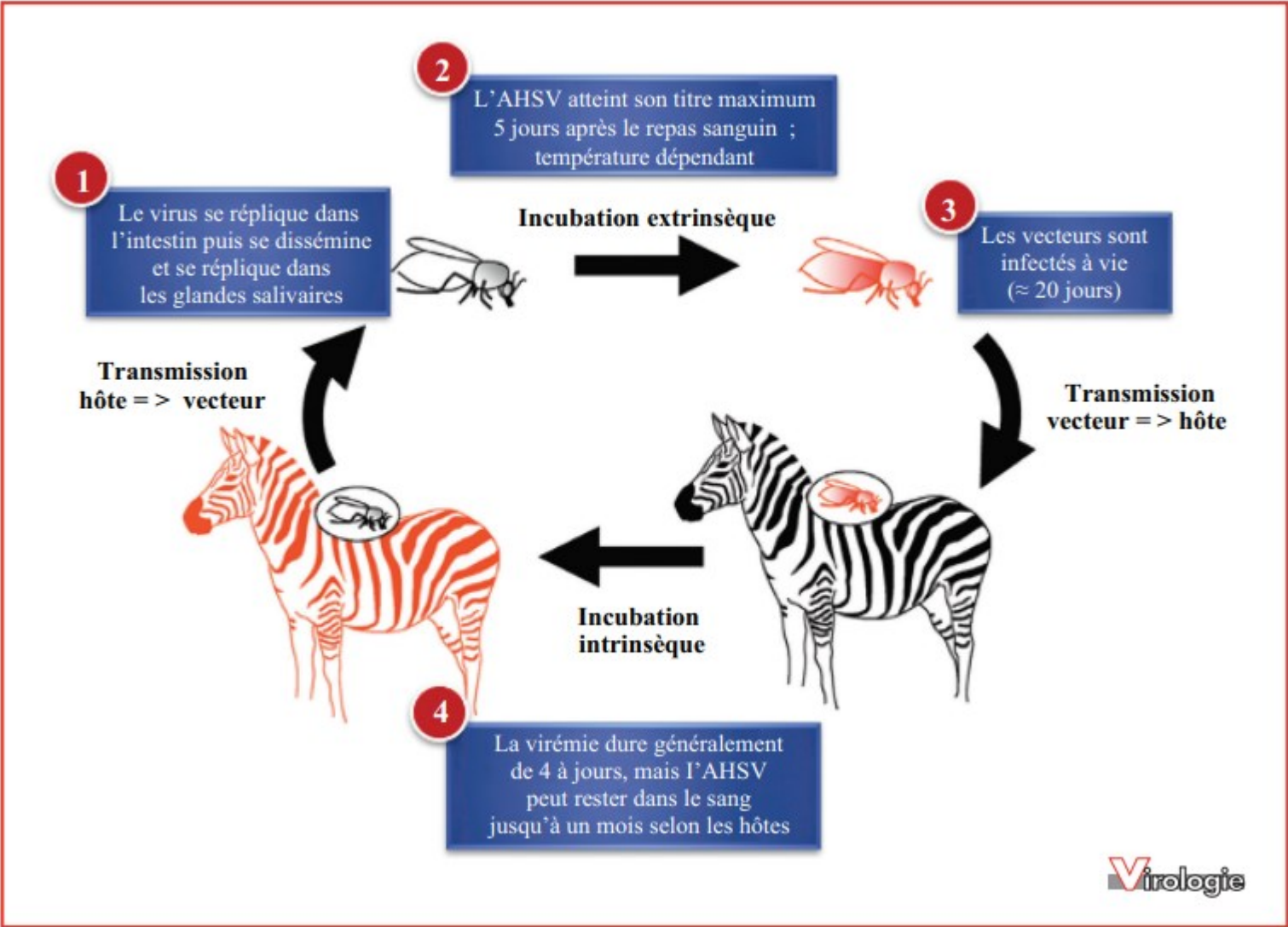
Antibodies detected with inconsistencies in other species ;
limited epidemiological role.



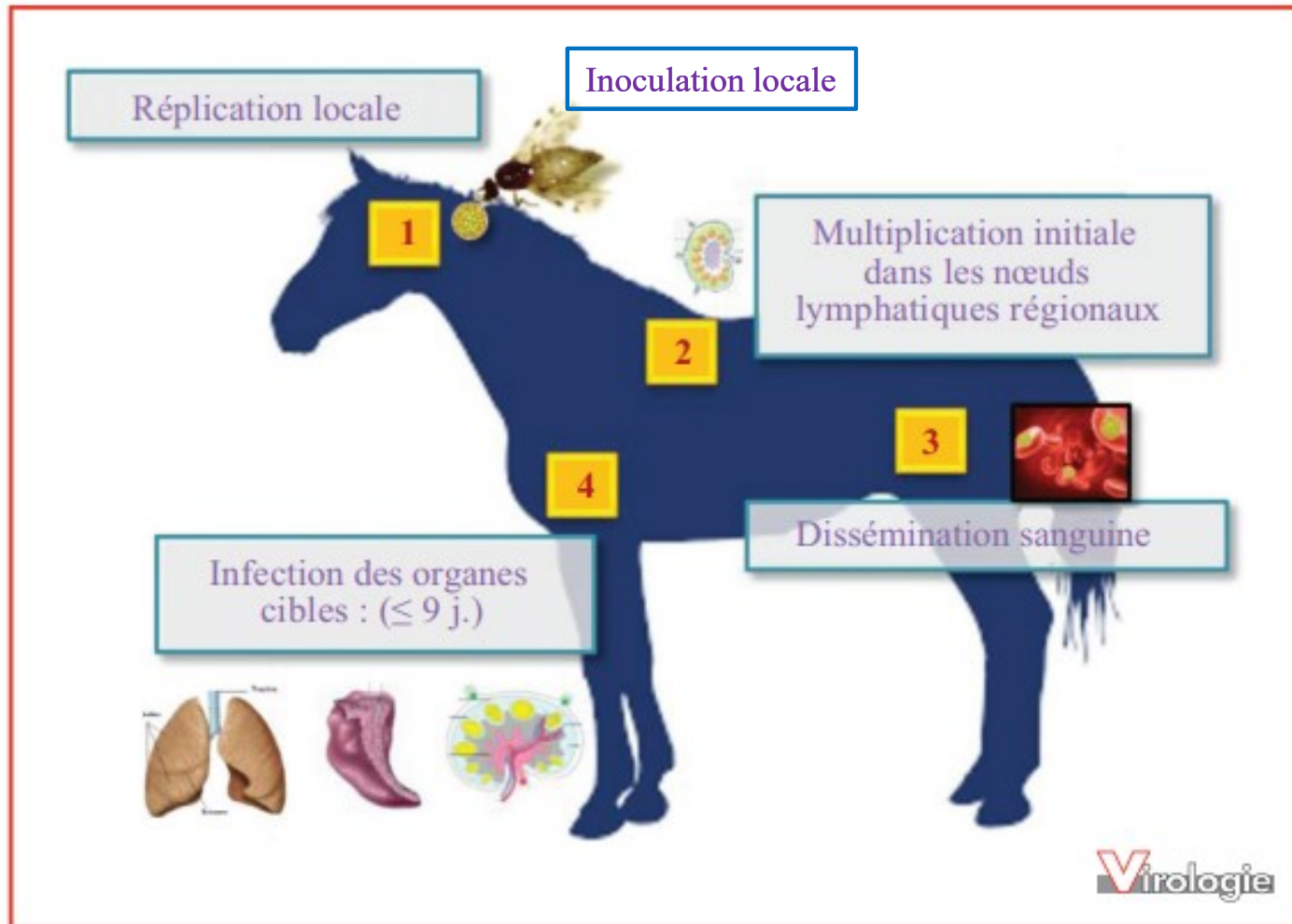
Not zoonotic



AHSV: transmission cycle



AHSV clinical symptoms



Mortality rate



- Pulmonary form: fatal
- Cardiopulmonary form: $>80\%$
- Cardiac form: 50-70%



50%

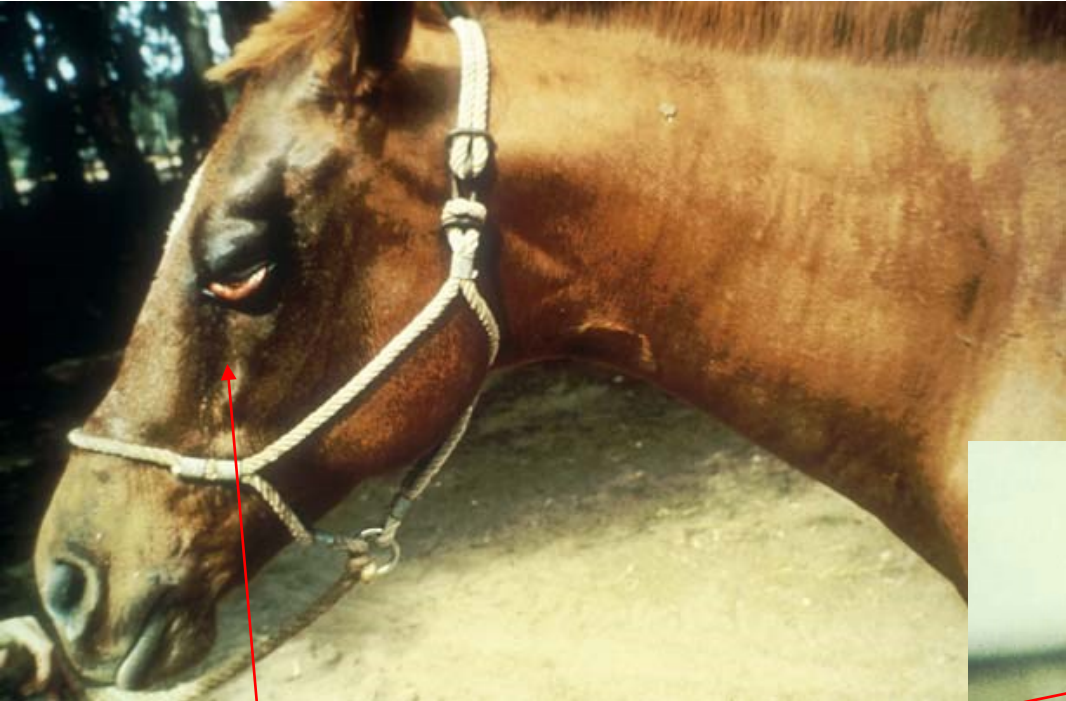


5 à 10%



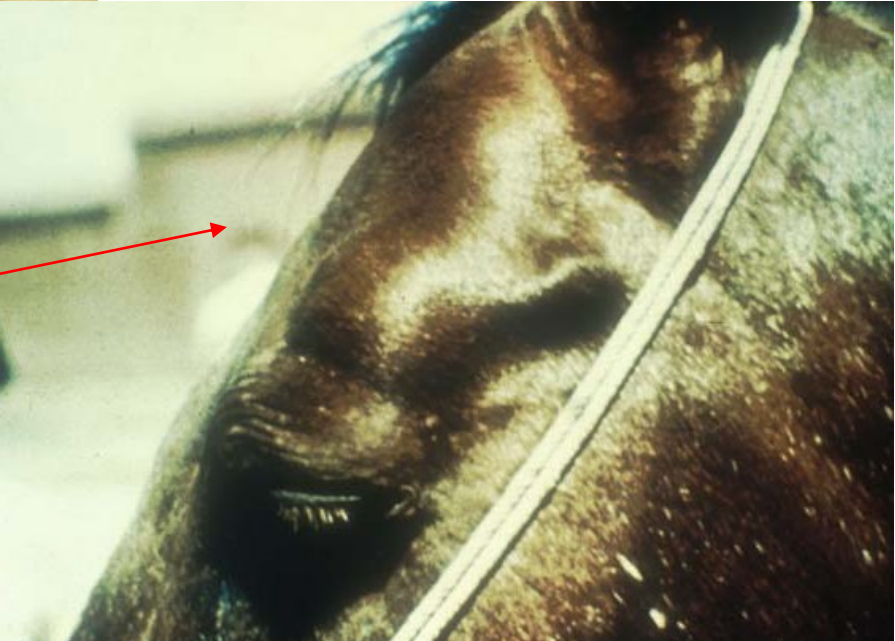
Photo S Zientara

African Horse Sickness: oedematous form



Oedema

extends to the face....



Symptômes : signes généraux et congestion des muqueuses



Febrile general condition

Congestion of the mucous membranes



AHS: pulmonary form



Pulmonary oedema

« the horse drowns in his serum »



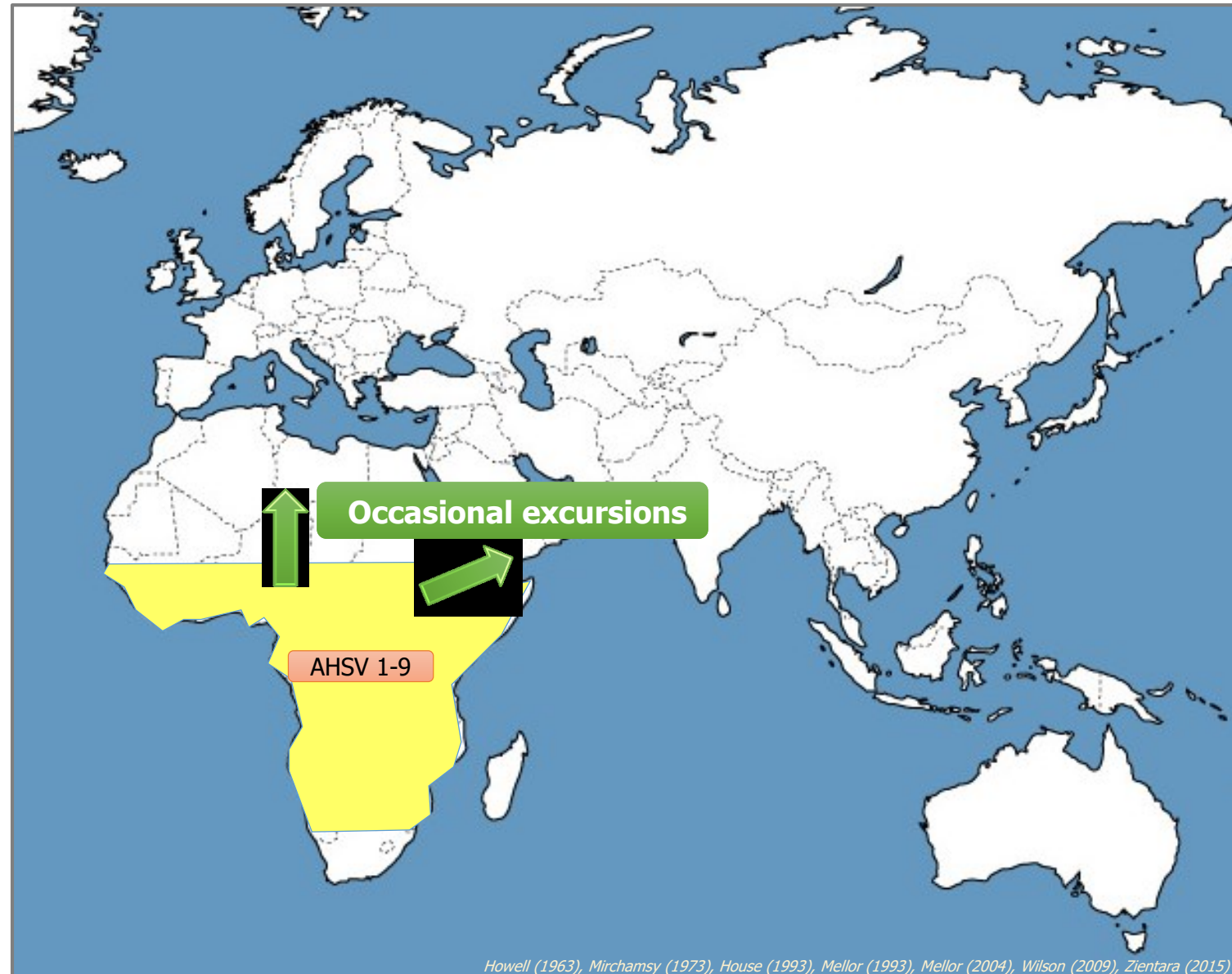


Photo S Zientara

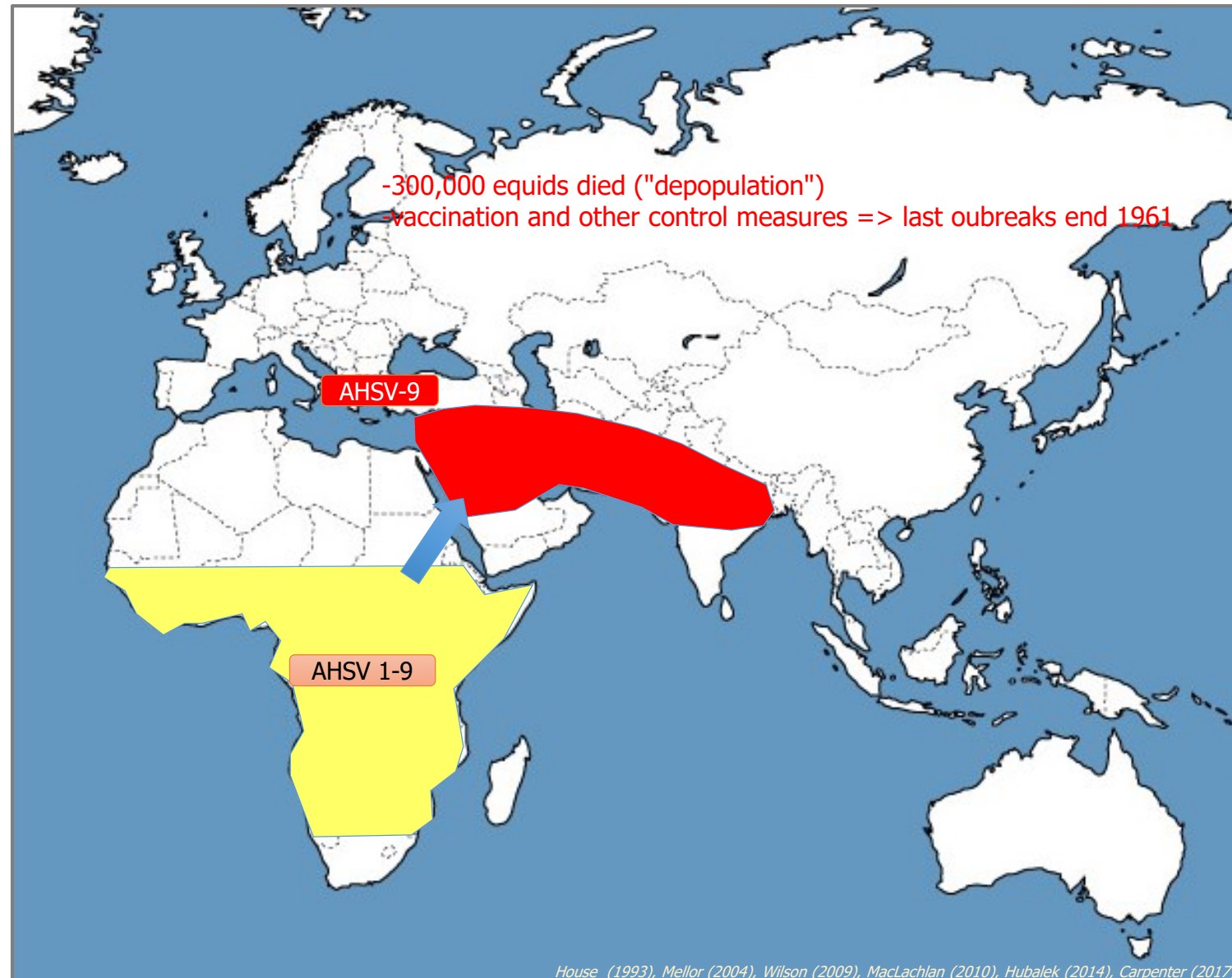


Photo S Zientara

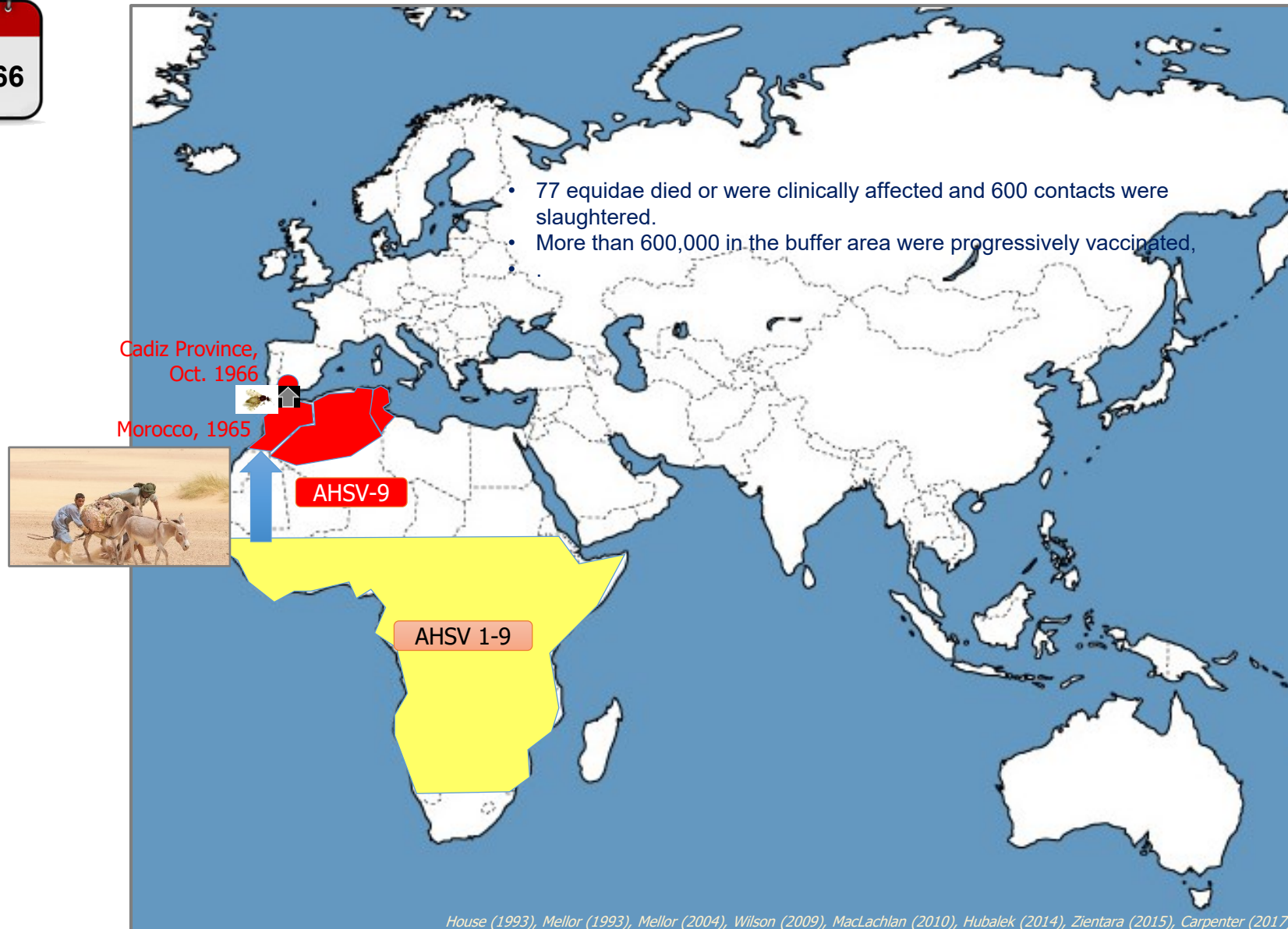
Distribution of African Horse Sickness in the middle of the 20th century



Distribution of African Horse Sickness in the middle of the 20th century



Distribution of African Horse Sickness in the middle of the 20th century



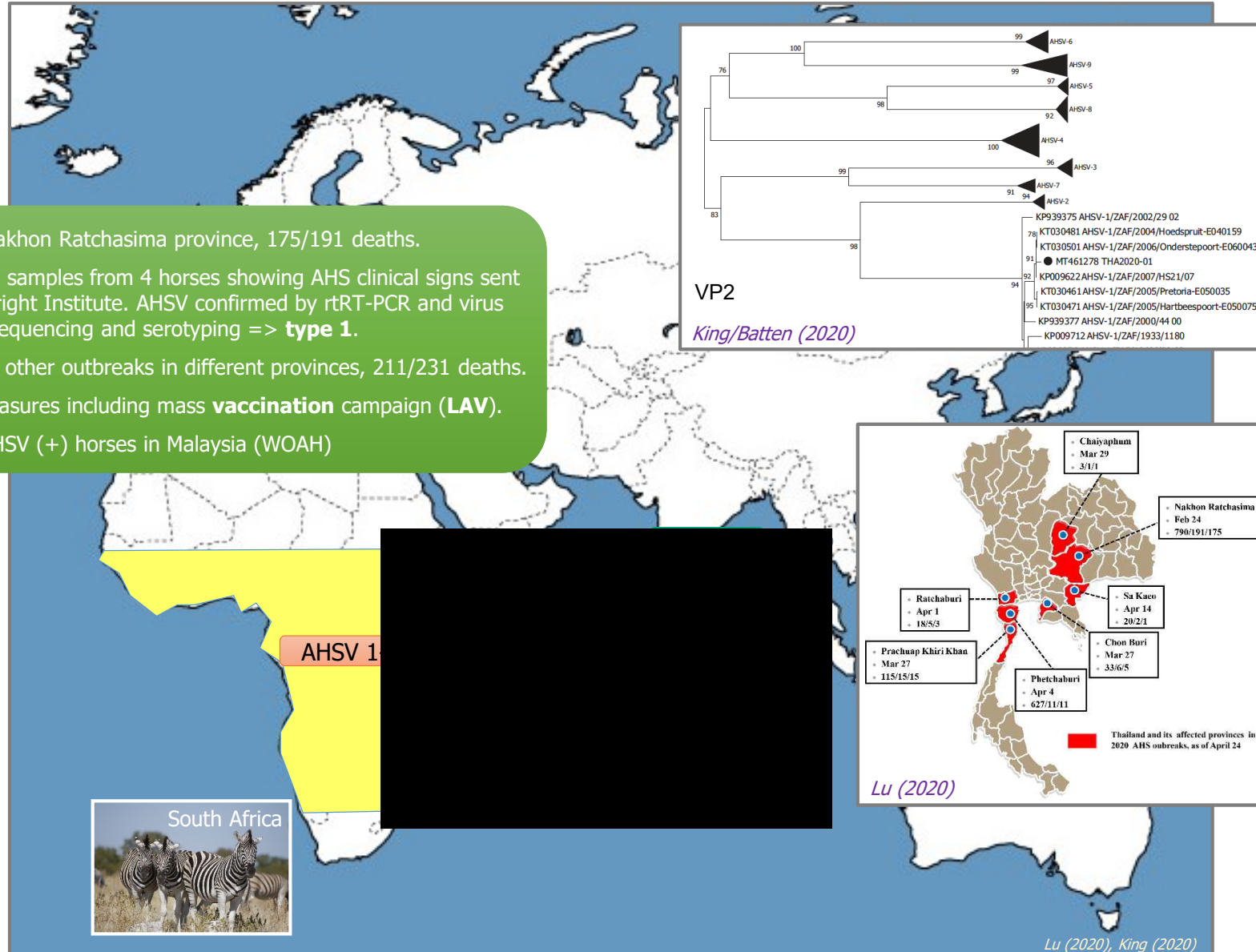
Distribution of African Horse Sickness in the middle of the 20th century

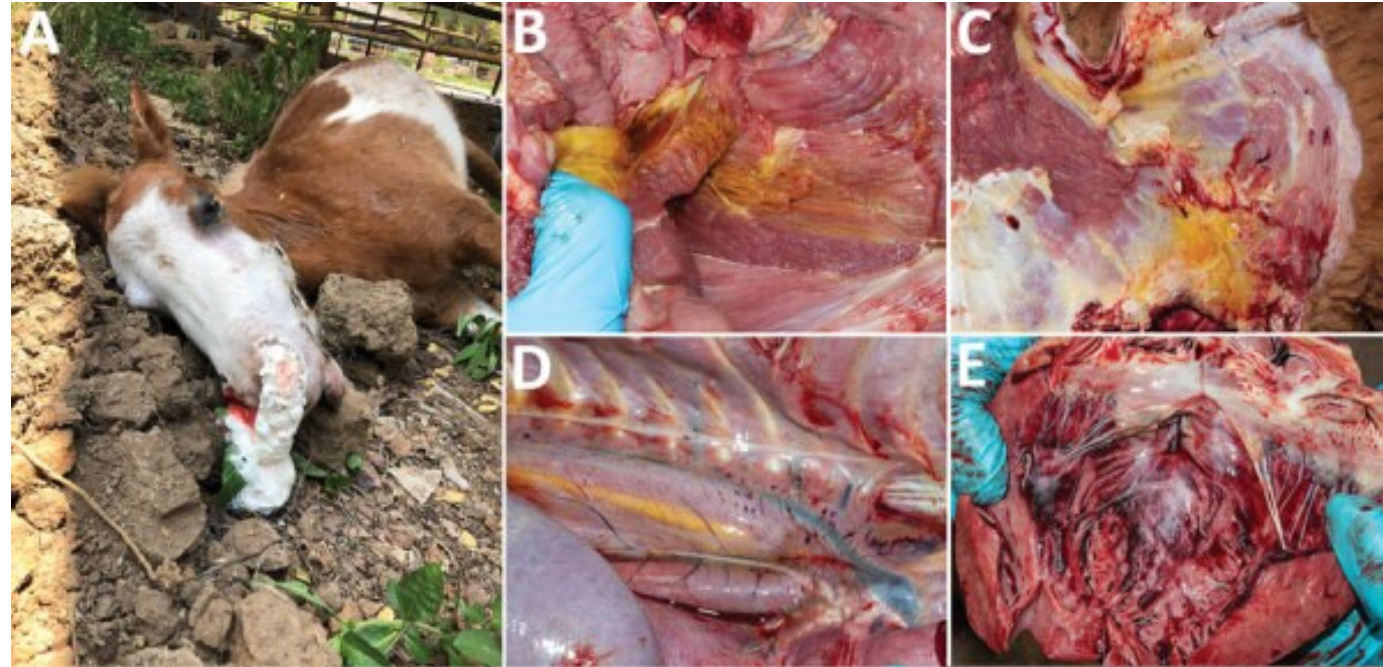


Distribution of African Horse Sickness in the middle of the 20th century



- **Feb. 24** Nakhon Ratchasima province, 175/191 deaths.
- **Mar.** blood samples from 4 horses showing AHS clinical signs sent to the Pirbright Institute. AHSV confirmed by rRT-PCR and virus isolation. Sequencing and serotyping => **type 1**.
- **Apr. 24:** 6 other outbreaks in different provinces, 211/231 deaths.
- Control measures including mass **vaccination** campaign (**LAV**).
- **Aug. 6:** AHSV (+) horses in Malaysia (WOAH)





[Emerg Infect Dis.](#) 2021 Aug; 27(8): 2208–2211.

doi: [10.3201/eid2708.210004](https://doi.org/10.3201/eid2708.210004)

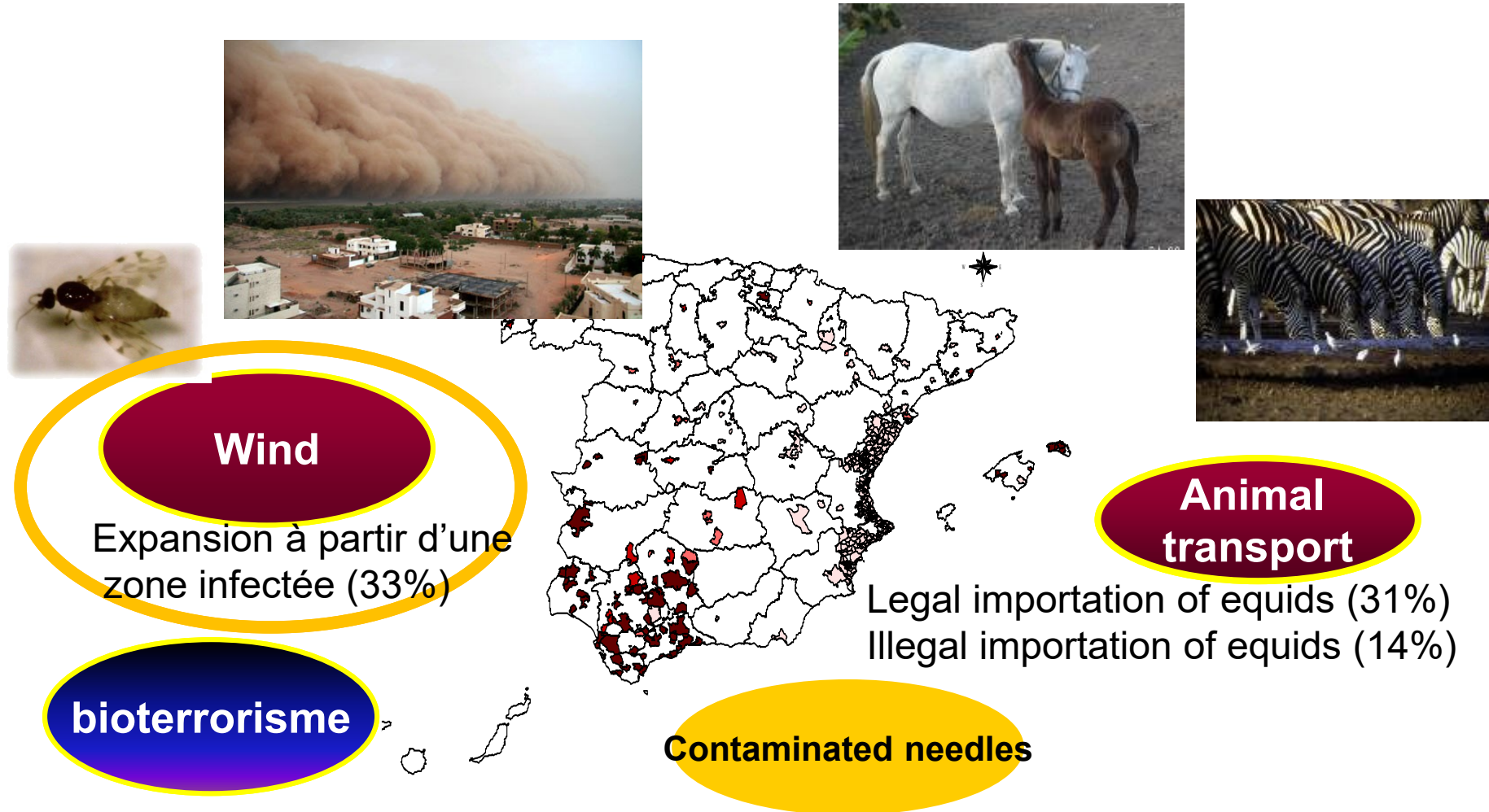
PMCID: [PMC8314833](https://pubmed.ncbi.nlm.nih.gov/PMC8314833/)

PMID: [34287126](https://pubmed.ncbi.nlm.nih.gov/34287126/)

African Horse Sickness Virus Serotype 1 on Horse Farm, Thailand, 2020

[Napawan Bunpapong](#), [Kamonpan Charoenkul](#), [Chanakarn Nasamran](#), [Ekkapat Chamsai](#), [Kitikhun Udom](#), [Supanat Boonyapisitsopa](#), [Rachod Tantilertcharoen](#), [Sawang Kedsangsakonwut](#), [Navapon Techakriengkrai](#), [Sanipa Suradhat](#), [Roongroje Thanawongnuwech](#), and [Alongkorn Amonsin](#)[✉]

How does African Horse Sickness spread?

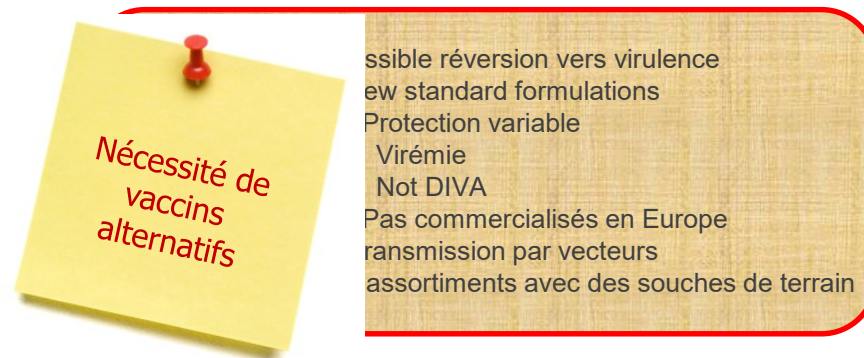


Vaccins against AHS

Vaccin polyvalents





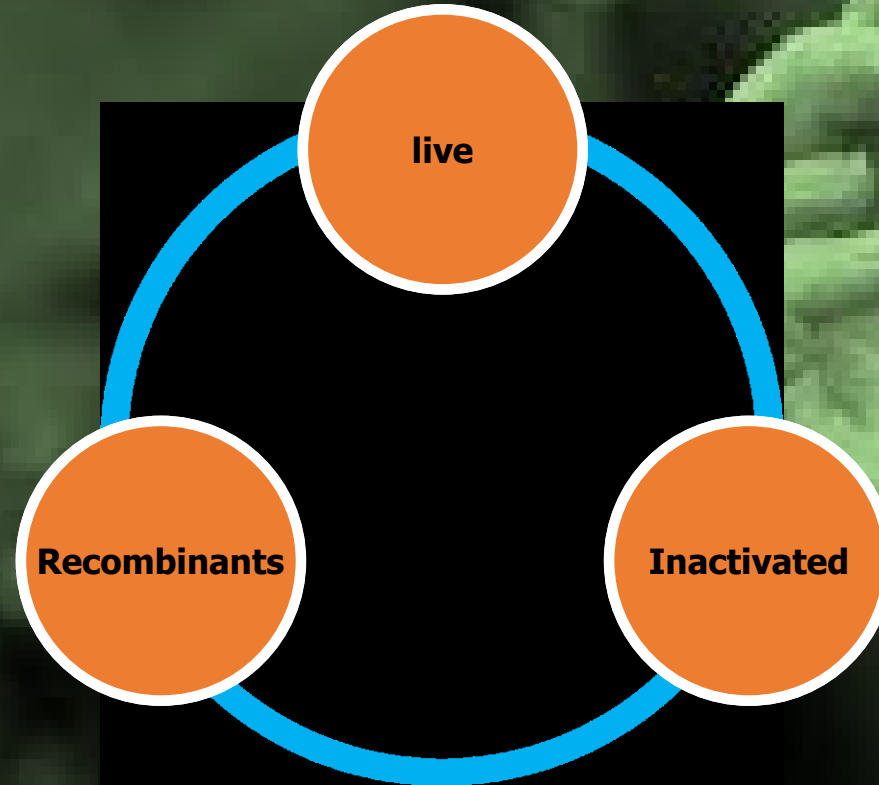
mais...



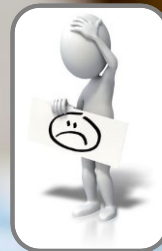
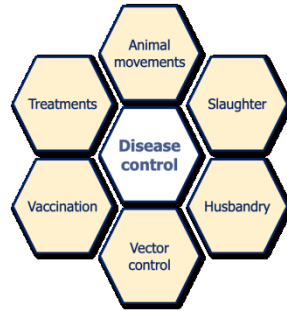
Vaccination



-  Sous-unité
-  Pseudo-particules
-  ADN
-  Virus-vectorisés
-  Génétique inverse



Treatments against AHS



No treatment

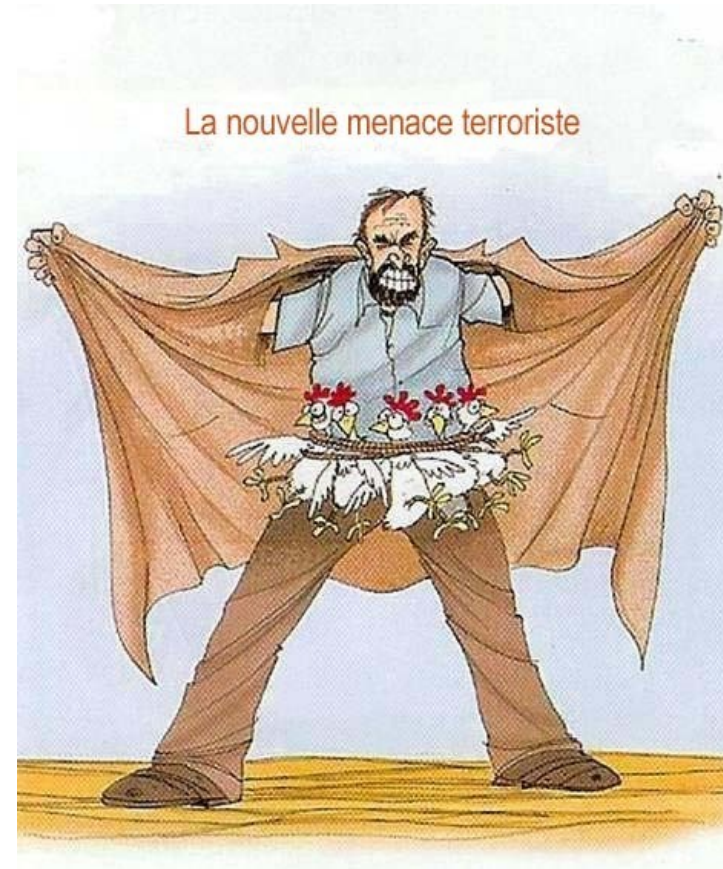
Symptomatic treatment

AHS: terrorist threat?



..... highly unlikely hypothesis

- Arthropod-borne virus
- non-contagious infectious borne disease
- Segmented genome
- No virulence factor identified (reverse genetic)



Emergence of AHS in Europe



- **EU : very high risk**
The question is not « if » but « when »
- Need for
 - Epidemiovigilance
 - Epidemiosurveillance

European Project

- Call Horizon Europe -SPIDVAC (coordination FLI-Anses) – AHSV-FMDV



Safe Priority Infectious Diseases VACCines

Improved control of priority animal diseases:
Novel vaccines and companion diagnostic tests for African horse sickness, peste des petits ruminants and foot-and-mouth disease

ZOONOTIC Arthropod Born flavivirus

Tick Borne Encephalitis Virus (TBEV) and West Nile Virus (WNV)



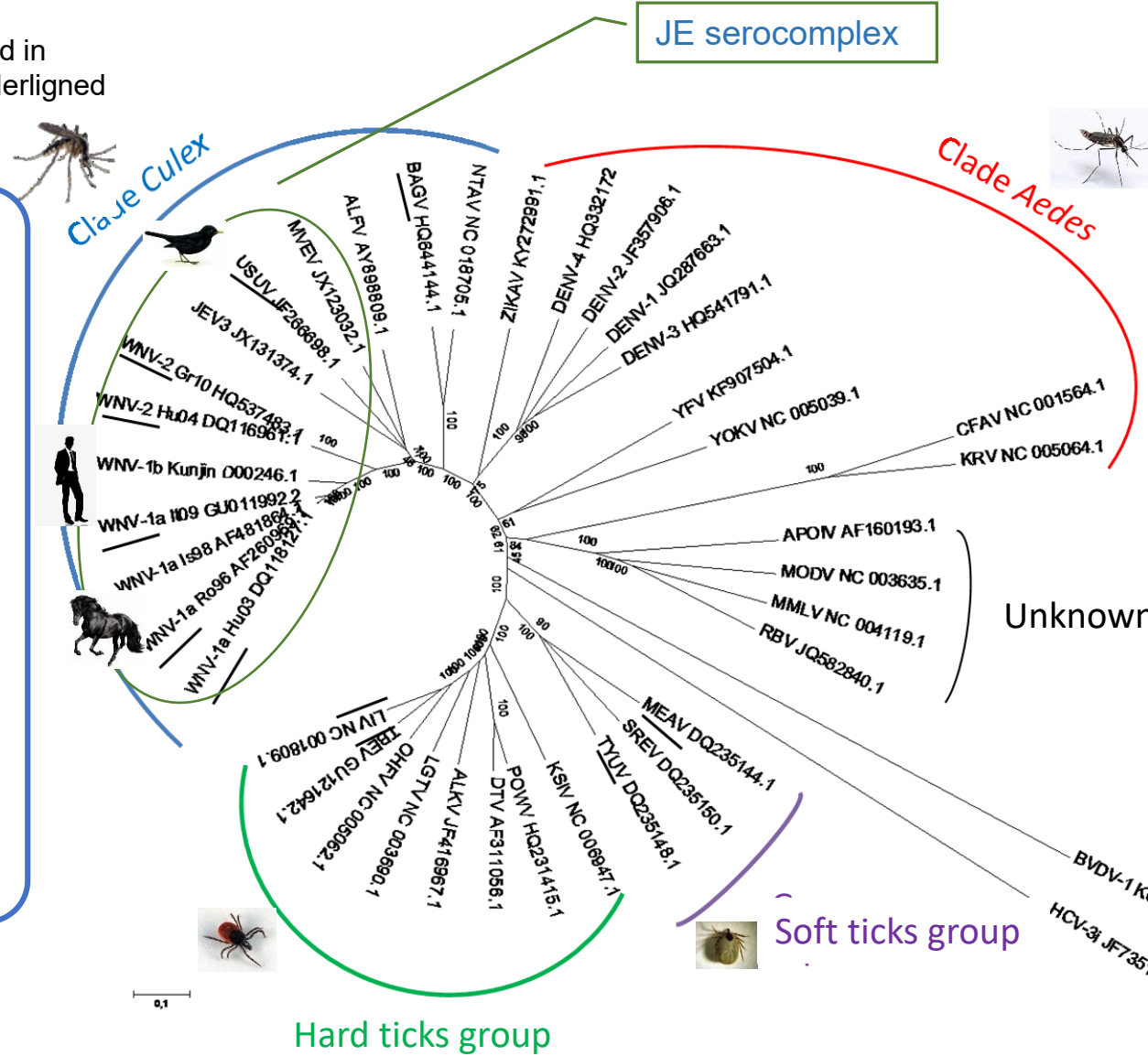
Flaviviridae family, genus Orthoflavivirus

Viruses reported in Europe are underlined

Reservoir:
avifauna
Meningoencephalitis

Réservoir:
rodents
Meningoencephalitis

JE serocomplex



Reservoir
primates
Hemorrhagic fever

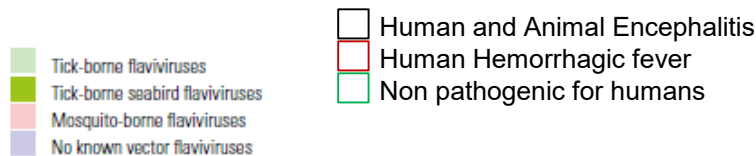
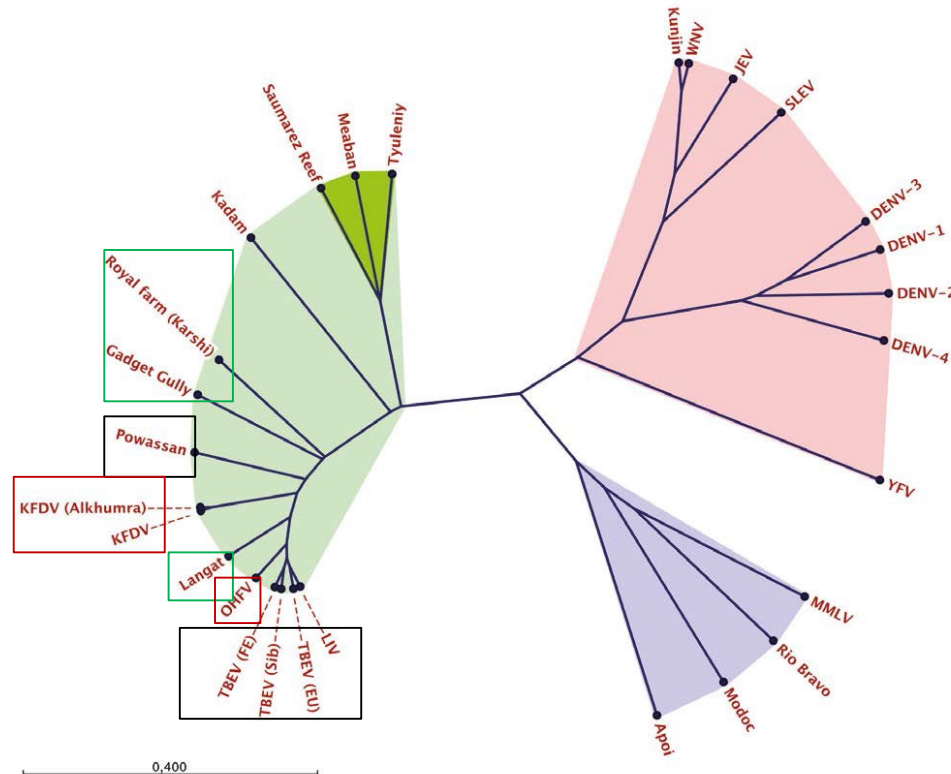
Unknown vector

Soft ticks group

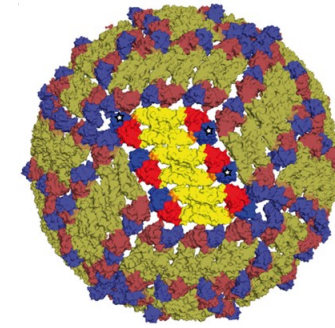
Hard ticks group

Tick-borne Encephalitis viruses

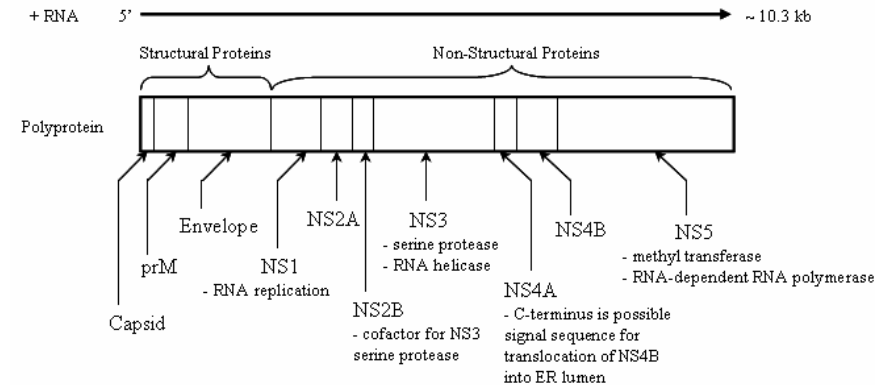
- Arbovirus, Tick-borne virus
- *Flaviviridae* family, *Flavivirus* genus (// Yellow fever, West Nile, Dengue)
- Enveloped Virus, positive single stranded RNA virus
- 1st description 1931 Germany, 1st isolation 1937 Russia



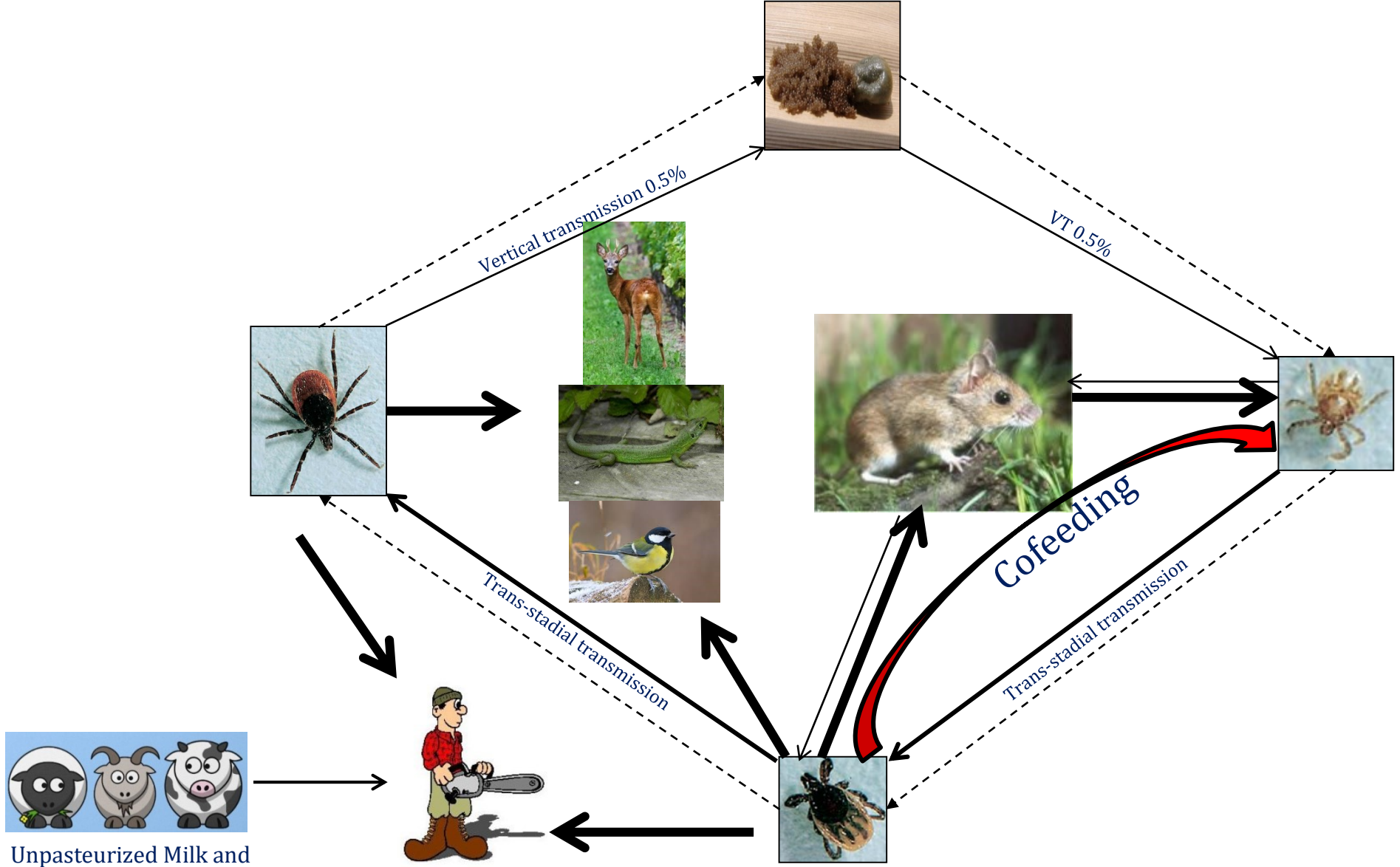
Branch lengths indicate the expected number of nucleotide substitutions per site | (Valarcher et al, 2015)



50nm
(Kiermayr et al. J Virol 2009)

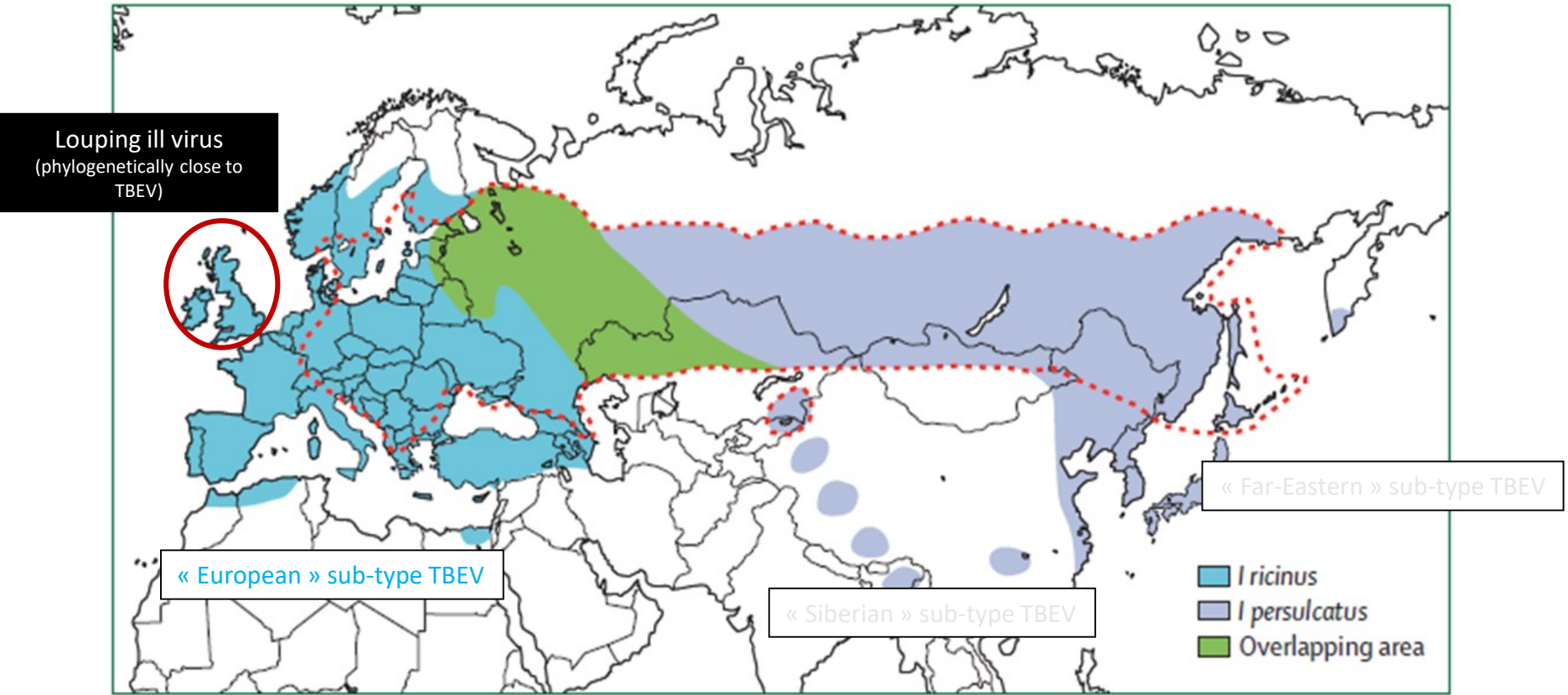


Epidemiological cycle of TBEV



Cofeeding : Labuda et al, 1993
Vertical transmission : Dobler et al, 2011

Geographic Distribution of TBEV



The geographical distribution of *Ixodes* spp, with the western distribution for *I ricinus* and the eastern distribution for *I persulcatus*

(Adapted from Lindquist and Vapalahti *Lancet* 2008)

Main vectors = *I. ricinus*, *I. persulcatus*
 Secondary vectors ? ≥ 14 species found positives for TBEV in nature : *D. reticulatus* (prevalence of 10.8% in Poland) ;
Haemaphysalis longicornis, *H. flava* and *I. nipponensis* (prevalence 0.06%, 0.17%, 2.38% in Korea)

Geographic Distribution of TBEV in Europe

Genetic subtypes

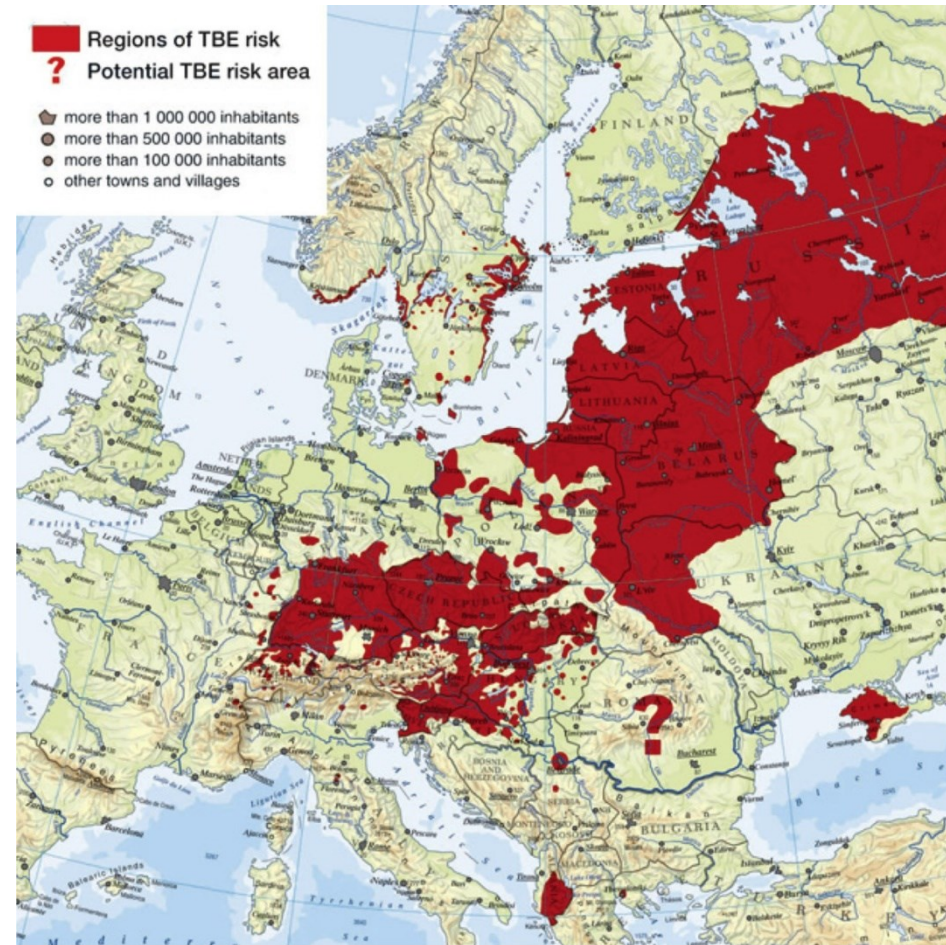
- TBEV-Eu (European)
- TBEV-FE (Far Eastern)
- TBEV-Si (Siberian)

In Europe

➔ TBEV-Eu + TBEV-FE + TBEV-Si

In France

➔ TBEV-Eu (European)



(Estrada-Pena and de la Fuente, *Antiviral Research* 2014)

Tick-borne Encephalitis viruses

Disease (Notifiable disease in France – since september 2020)

→ Symptoms of the first phase

Fever, fatigue, muscle pain, headache, nausea and vomiting

→ Symptomatic in 30 % of cases

Flu like disease, encephalitis, meningoencephalitis, cause long-term neurological sequelae

Incubation period*

TBEV infection through tick bite: 7-14 days

Alimentary transmitted TBE incubation: 3-4 days

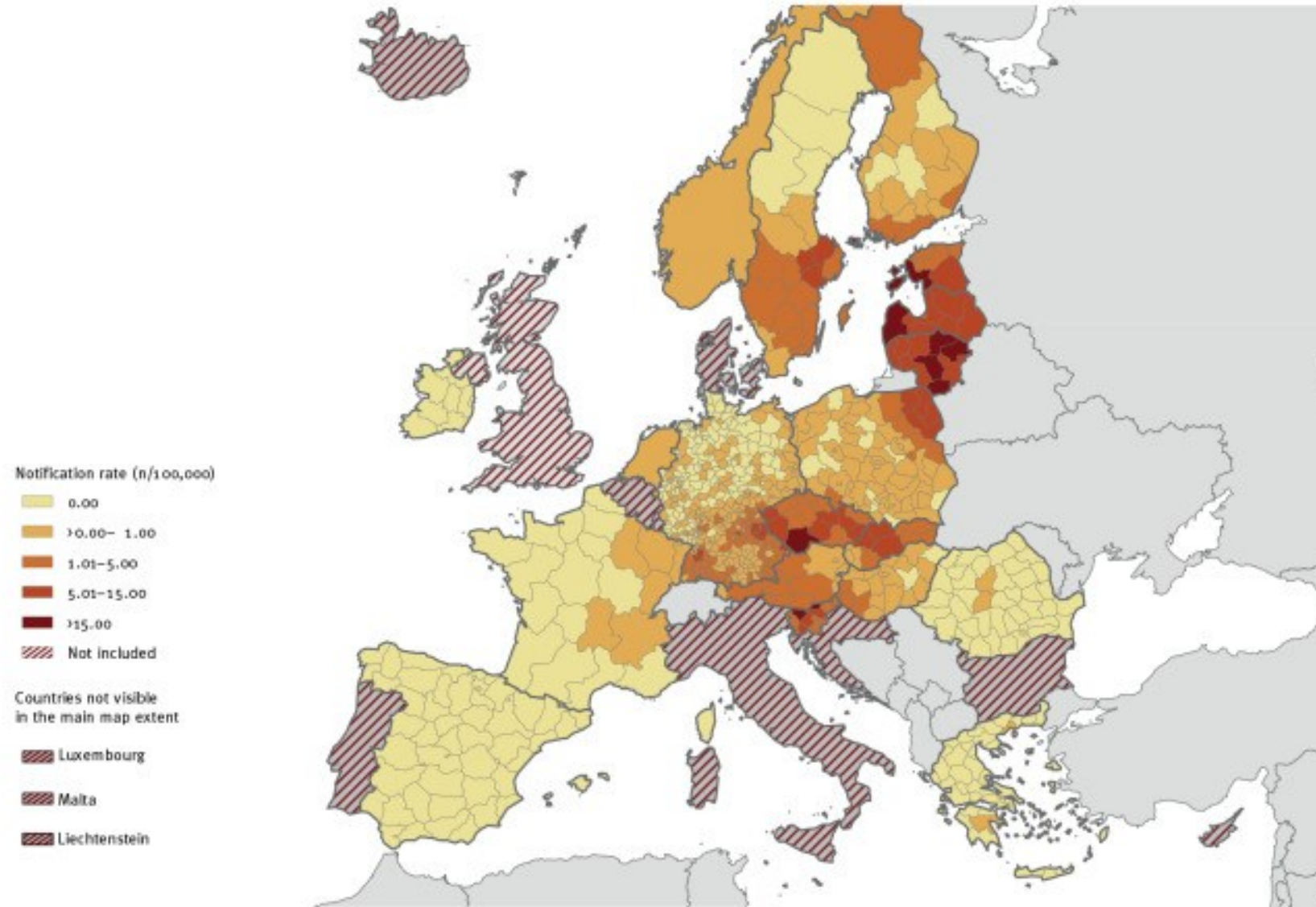
(*Paulsen et al., 2018)

Vaccination:

5 different vaccines produce with : European subtypes (2 produce by Europe) ; Far-Eastern subtypes (2 produce by Russia, 1 by China)

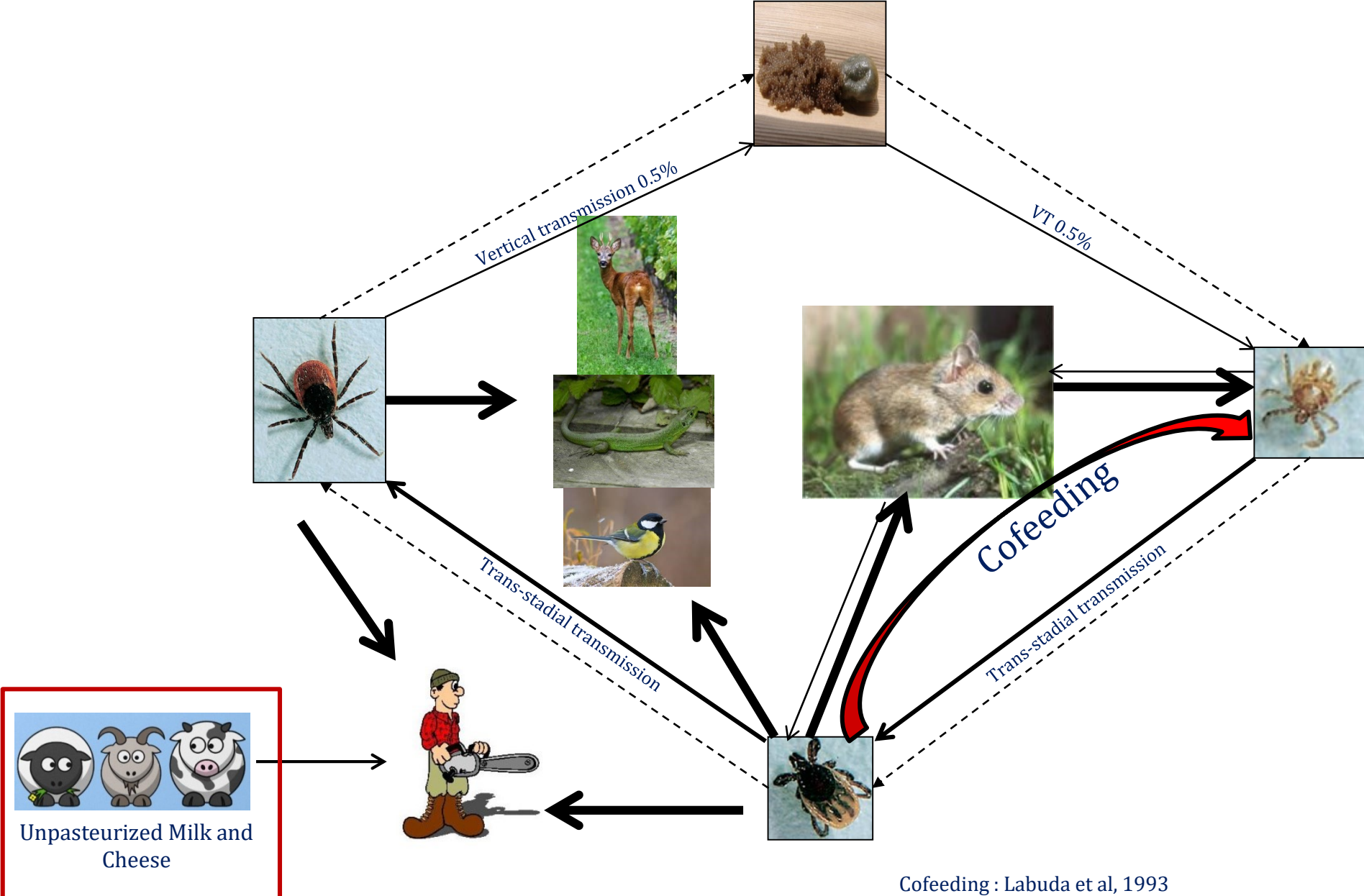
Protection estimated between 96 and 99% for European subtypes

Tick-borne Encephalitis autochthonous cases in Europe (2012 – 2020)



Highest notification rate found in **Baltic countries Estonia, Latvia, and Lithuania, Czechia, Slovenia and Finland**

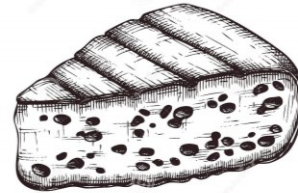
Epidemiological cycle of TBEV



Cofeeding : Labuda et al, 1993
Vertical transmission : Dobler et al, 2011

Foodborne zoonotic transmission

Animals can excrete TBEV into milk for 3-14 days, beginning as early as the second or third day post infection *



Milk and milk products contamination

*Van Tangeren et al., 1955; Gresikova et al., 1958, 1959 ; Lecollinet et al 2020 French cluster under investigation

Milk outbreaks of TBEV in Europe

Slovaquie	2012-2016 (avril à juin en majorité)	110/714/13	Lait ou fromage de chèvre (7/53,8%), lait ou fromage de brebis (5/38,5%), lait ou fromage de vache (1/7,7%)	Dorko et al. 2018
Rép. Tchèque	1997-2008	64/nc/nc	Lait ou fromage de chèvre (56,3%), lait ou fromage de brebis (32,8%), lait ou fromage de vache (10,9%)	Kriz et al. 2009
Hongrie	2007 / août 2011 / septembre - octobre	25/154/1 30/nc/nc	Lait de chèvre Lait de vache	Balogh et al. 2010 Caini et al. 2012
Slovénie	2012 / mai	3/5/1	Lait de chèvre	Hudopisk et al. 2009
Croatie	2015 / mai-juin 2019 / juin	7/10/1 5/nc/1	Lait ou fromage de chèvre Lait de chèvre	Markonovovic et al. 2016 Ilic et al. 2020
Autriche	2008	6/nc/1	Fabrication maison à base de lait de chèvre et de vache	Holzmann et al. 2009
Allemagne	2016 / mai-juin	2/32/1	Lait et fromage de chèvre	Brockmann et al. 2019
Pologne	2017 / juin	4/nc/1	Lait de chèvre	Krol et al. 2019
Estonie	2005 / mai-juin	27/nc/nc	Lait de chèvre	Kerbo et al. 2004
France	2020 / avril - mai	43/nc/1	Fromage de chèvre	Gonzalez et al. 2022
France	2021	nc/nc/nc	Fromage de chèvre	SPF
Autriche	2022 / juin	3/3/1	Lait de chèvre	Mylonaki et al. 2022
France	2022 / septembre	1/1/1	Fromage de brebis	SPF

Cluster of Human TBEV cases in Ain department, France



April to June 2020

French department of Ain

44 human suspect TBEV cases

Investigators :
National center for arboviruses (Isabelle Leparc-Goffart), ARS

33 positive human samples confirmed
→ (ELISA + VNT test)

41 cases reporting consumption of unpasteurized goat cheese from the same goat farm
→ RT-qPCR

TBEV have been detected in cheese (CNR)



Food contamination was confirmed

Animal and animal products survey (Anses)

Sera and EDTA blood from the TBEV-infected goat farm
(serial samplings of 56 goats)

- Detection of TBEV antibodies in sera (ELISA + VNT)
- Absence of viremia (real-time PCR, Gondard et al 2018)

Milk from the TBEV-infected goat farm
(serial samplings of 56 goats)

- Detection of TBEV virus in raw milk samples (real-time PCR, Gondard et al 2018)
- Investigation of TBEV in cheese samples under progress (real-time PCR, Gondard et al 2018)

Environmental survey (Anses)

June 2020 _ Ticks and Rodents collection in the pasture used by the goat farm

→ Detection of TBEV virus in tick samples (RT-qPCR, Gondard et al 2018)

→ No detection of TBEV in rodents but too few samples analyzed

Investigators : Laure Bournez & Franck Boué (Anses, Nancy), Sandrine Lacour, Sara Moutailler (LSAn, Anses, Maisons-Alfort)



Drivers of increased incidence of TBE in humans

- Changing of **behavior/activities**: more contacts with the pathogen in high-risk areas (forest and recreational activities, etc)
- Changing of **eating habits** : consumption of minimally processed and locally produced foods
- Changing of **landscape in the context of global change** (modification of humidity, temperature, etc)
- Information on **vectors** (their control, competency, etc) and **animal reservoirs** (wild species inventory, etc)

Conclusion : TBEV in Europe

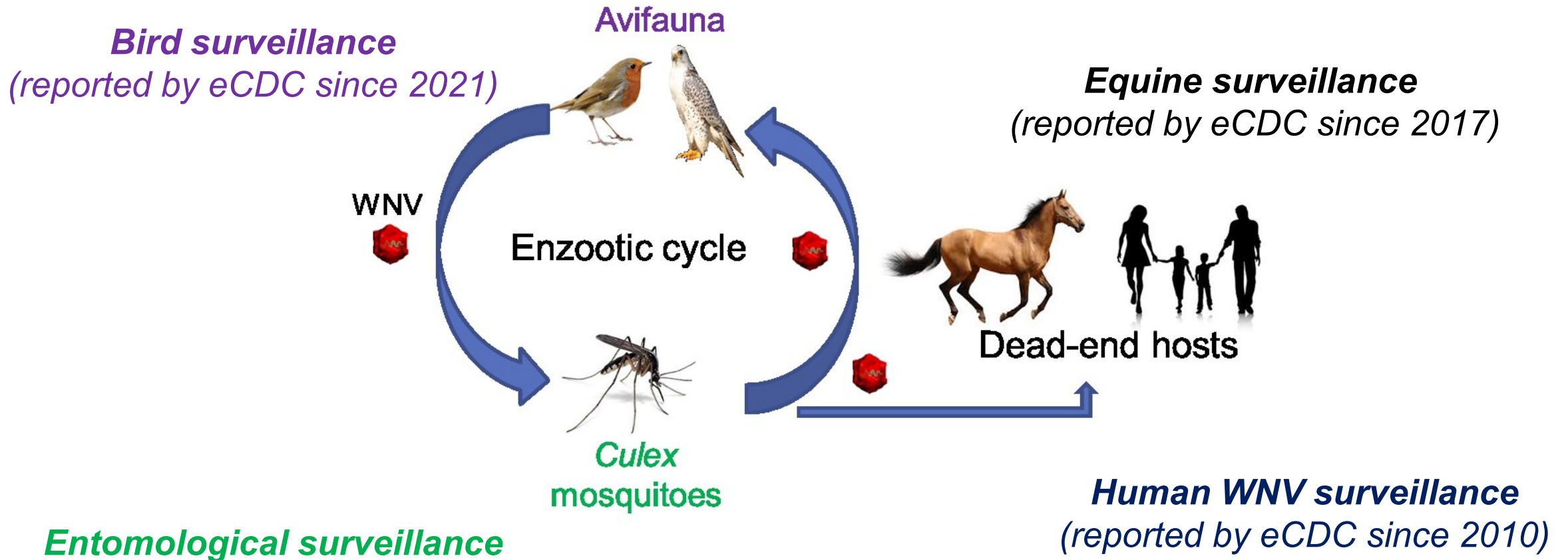
- **Important disease** affecting **travellers**, forest professionals, **general public**
- **Expansion of TBE accros Europe**: increase of TBE-reported cases by EU Member States especially in Western Europe
- **Underestimation** of TBEV-infected cases (transmission cycle, training of professionals, diagnostic methods, etc)

WEST NILE VIRUS

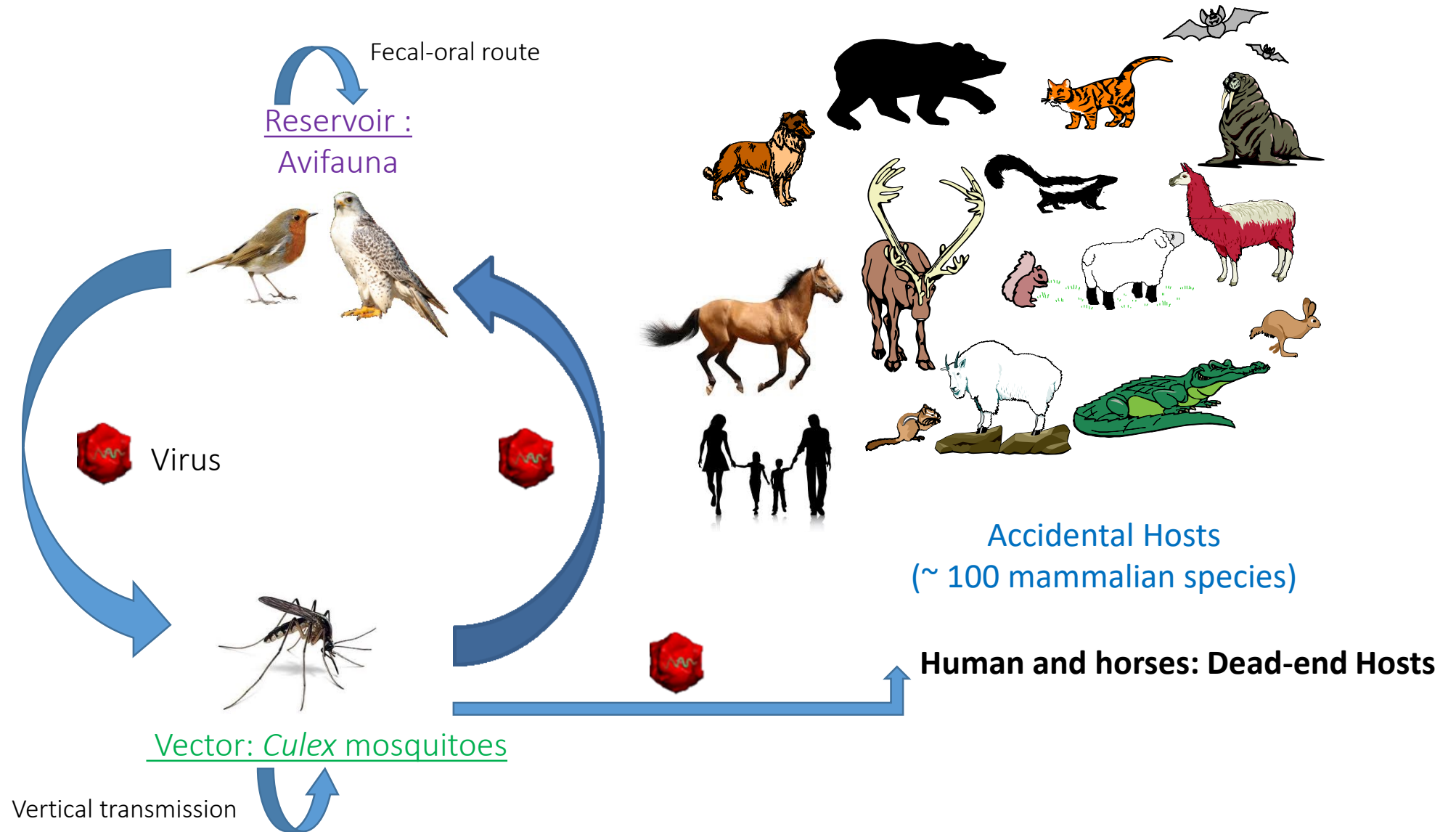


"One health" approach for WNV surveillance in the EU

West Nile virus (WNV) infection is **notifiable** in **humans** and **equids** in the European Union



WNV Transmission cycle

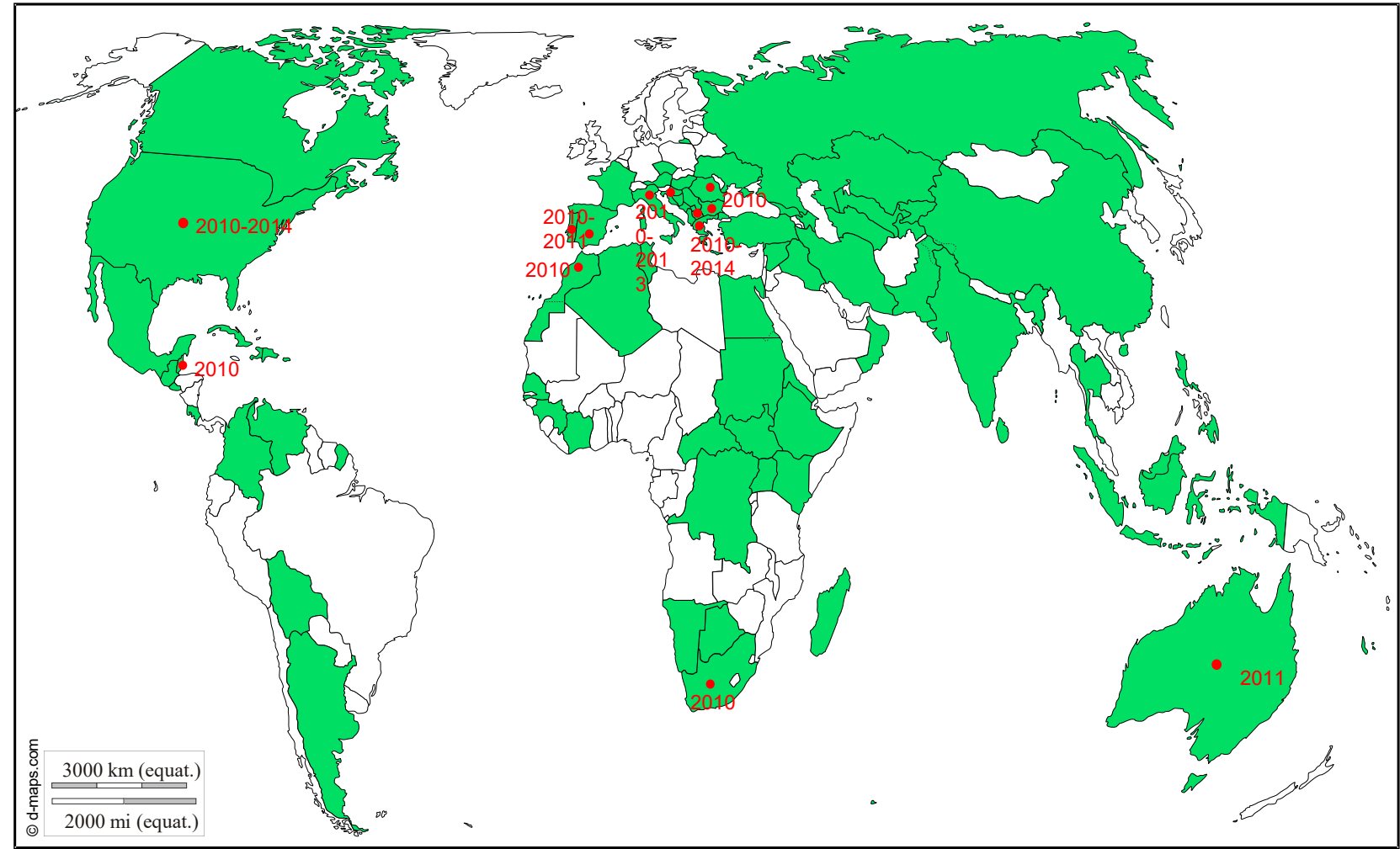


Geographical distribution

Originating from **Africa**

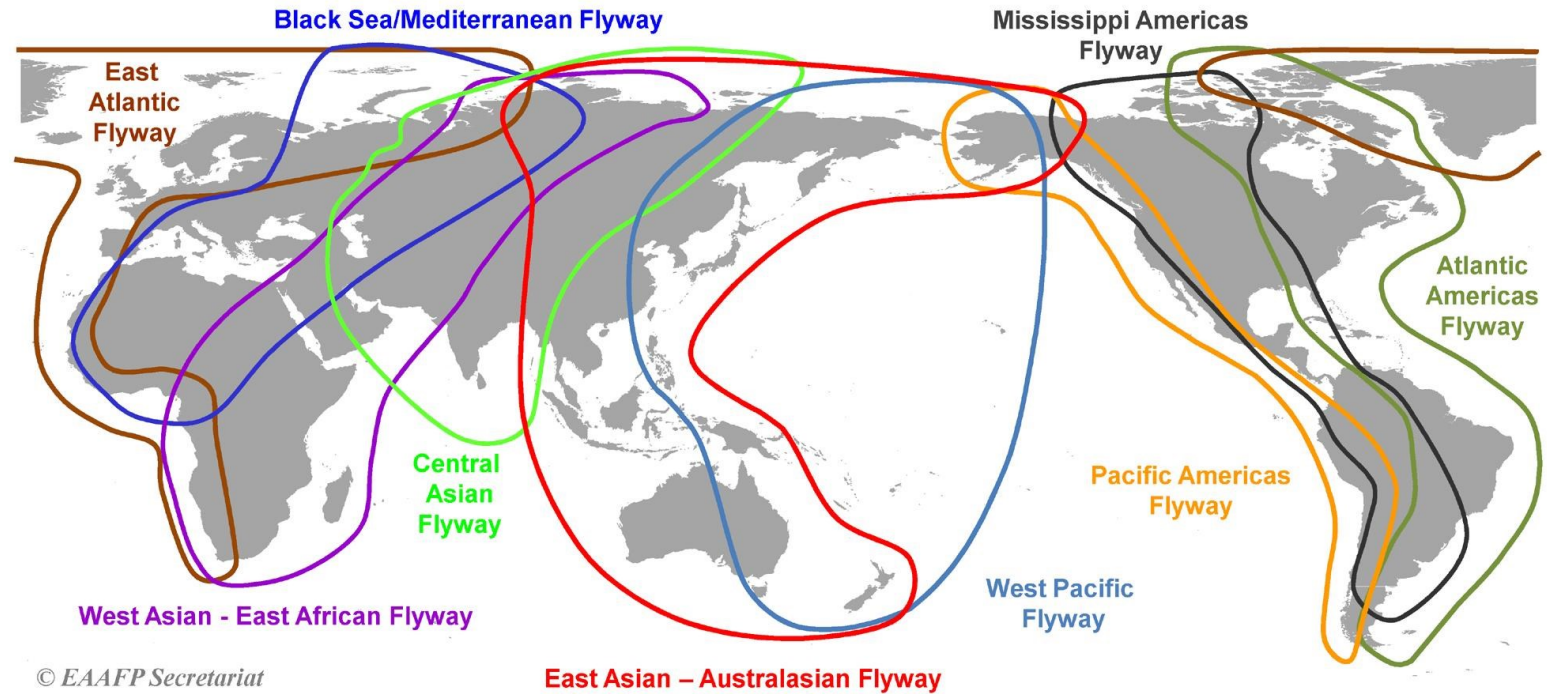
Discovered in **1937** in Uganda

Circulating on the 5 continents
(except Antarctica)

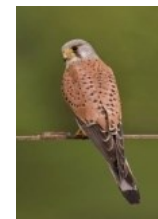


Avifauna: key role in long distance transport of the virus and local amplification

Viruses regularly introduced from the African cradle

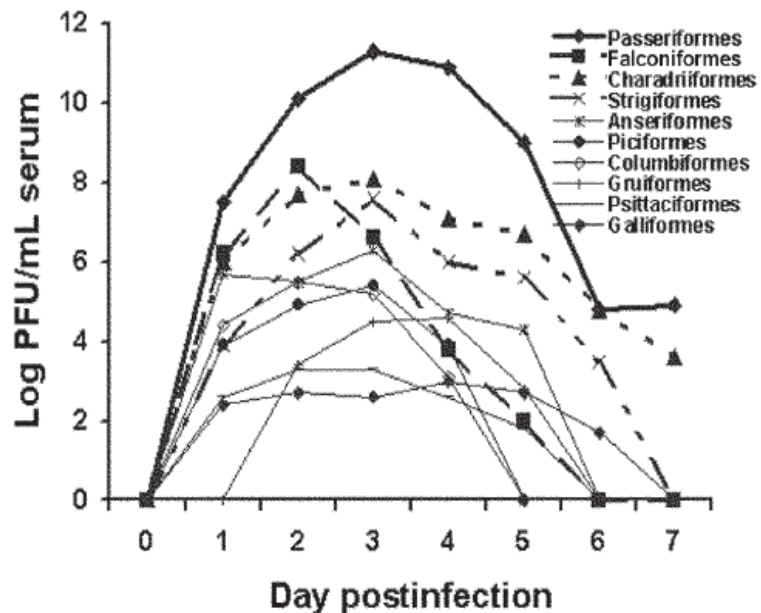


In Europe: **rare** and **isolated mortalities** (corvids, other passerines, diurnal raptors)



Disease in birds

- Weakness, lethargy
- Emaciation
- Sedentary lifestyle
- Difficulty balancing, shaking
- Difficulty walking, perching or flying
- Inadequate response to danger



More than **250 species infected** in the USA but some are resistant to the infection (Galliformes (chicken, turkey), Pigeons, Cranes)



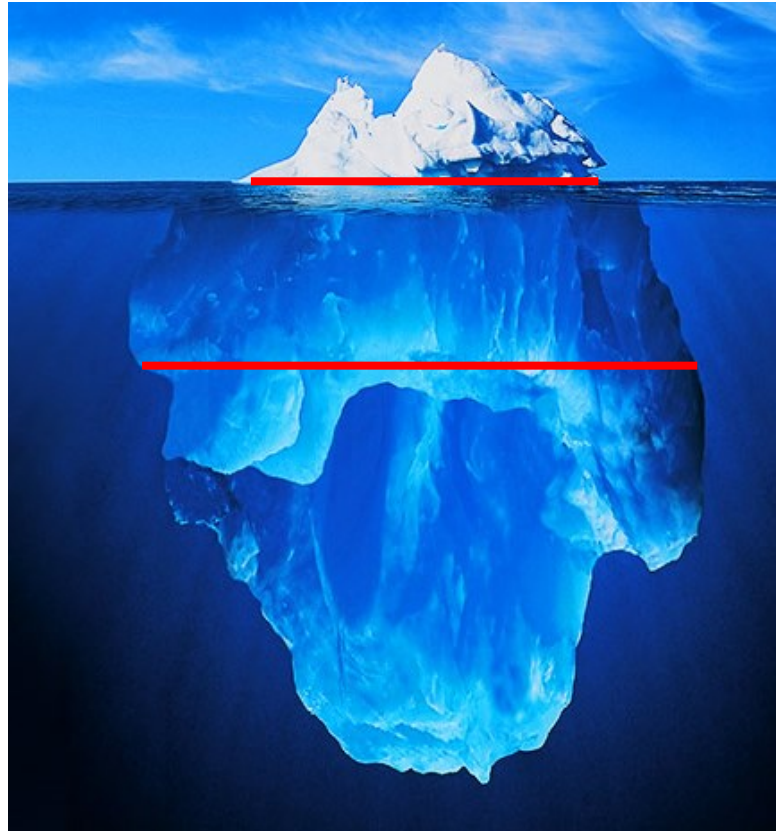
Disease in Horses

Incubation period: 3 – 15 days

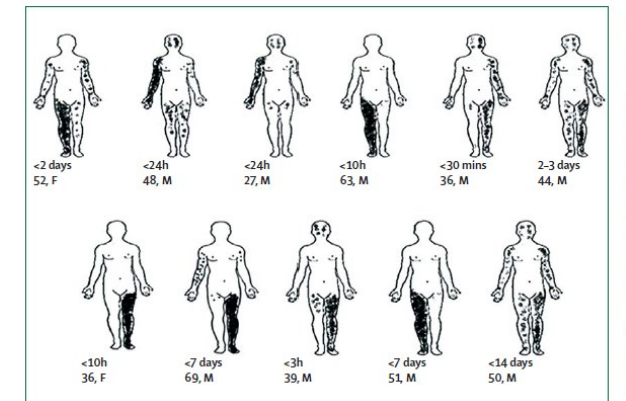
Neurological symptoms (WNND) : 1-10%
Lethality rate: 20-57% (horse), 10% (humans)
Ataxia, Paralysis, etc.

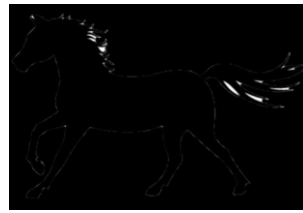
Mild illness: < 20%
Flu-like symptoms (West-Nile Fever)

Subclinical infection: 70-79%



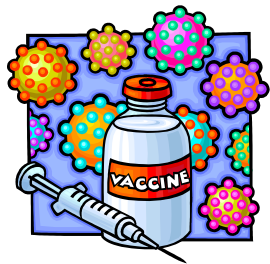
Dr P. Garcia, 2015





No antiviral treatment available

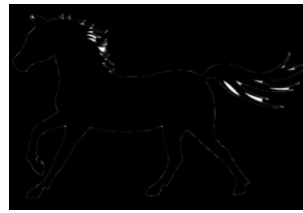
Symptomatic and comfort treatment (infusion, anti-inflammatory, protection and care against self-harm...)



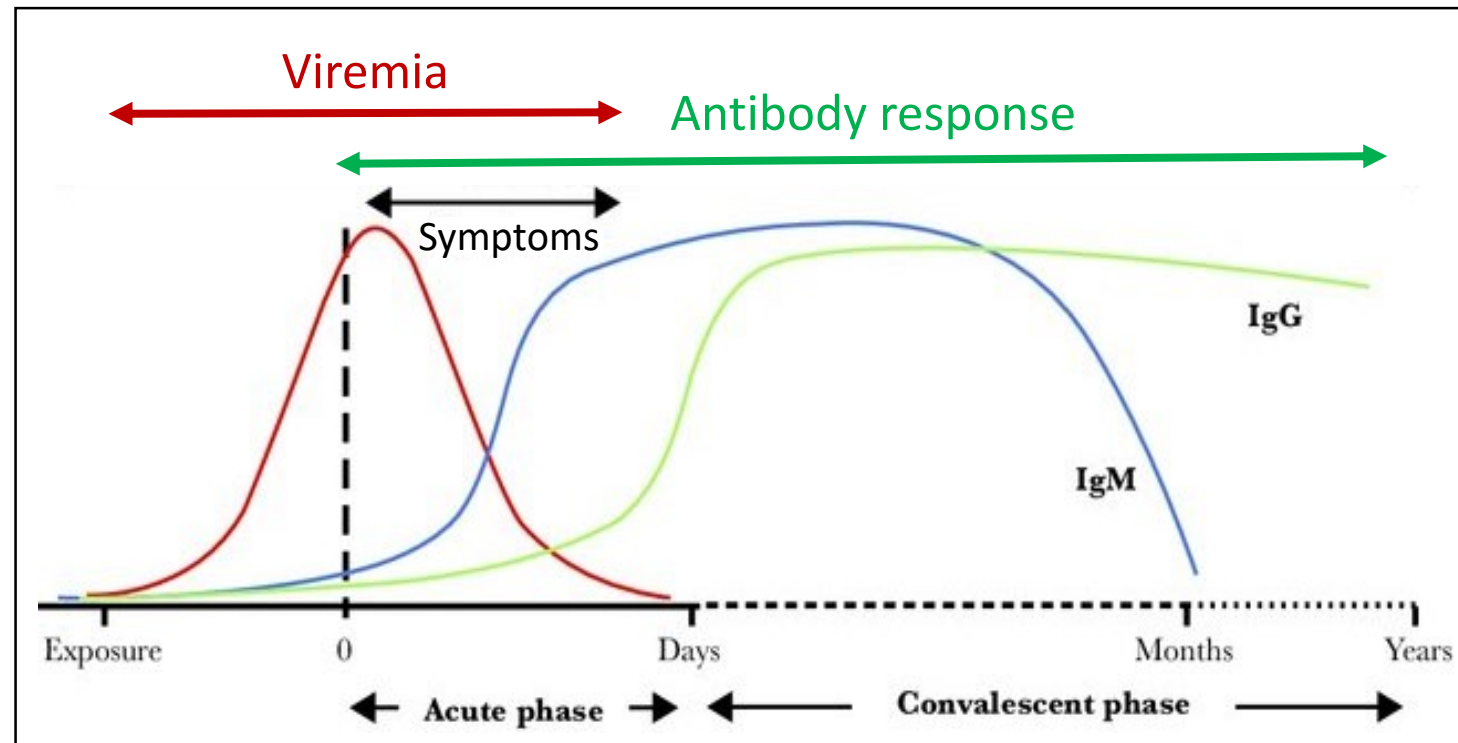
3 inactivated vaccins available in Europe



Disease in Horses



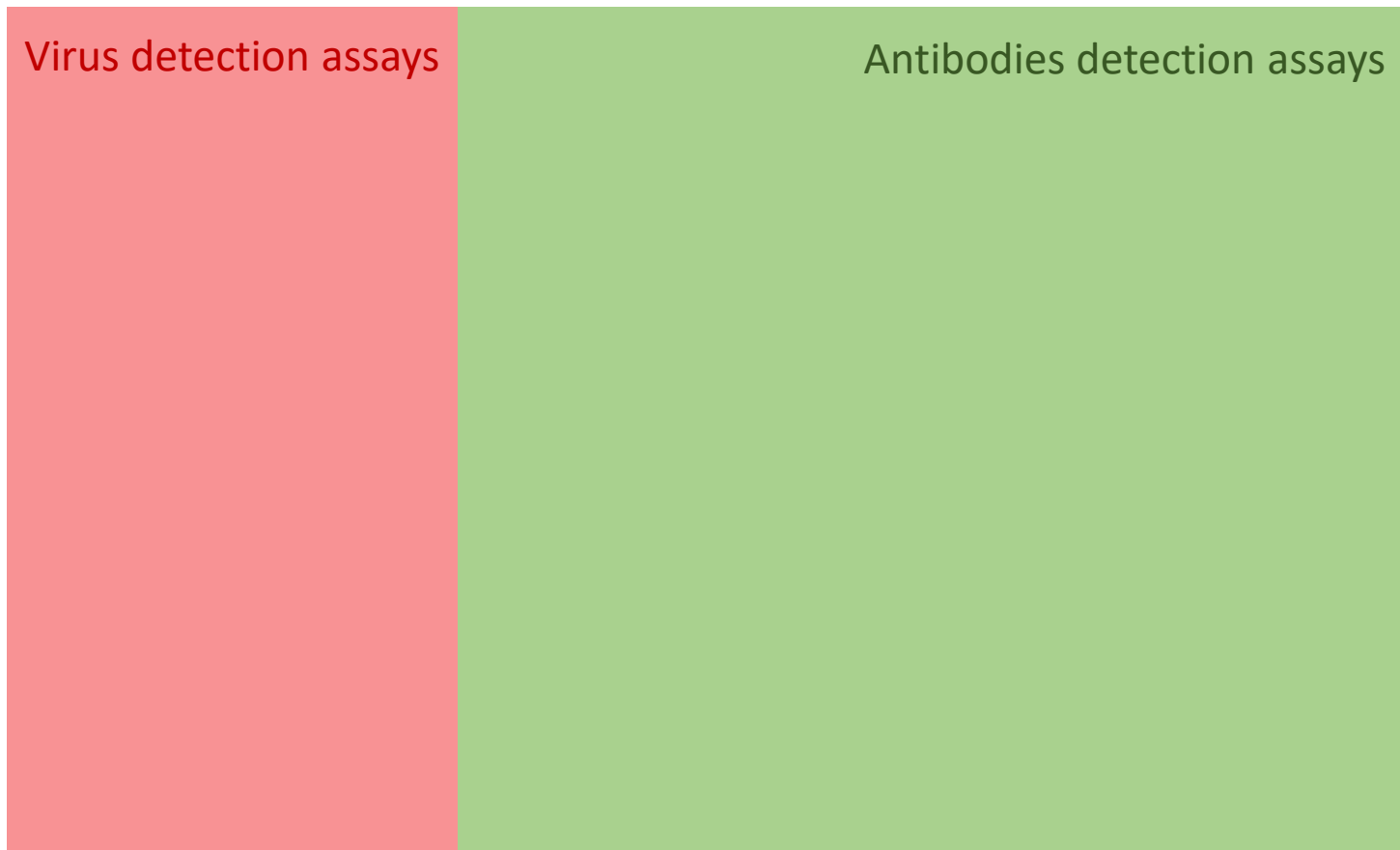
- Short viremia (3 to 7 days post-infection)



Schematic representation of the typical kinetics of flaviviral infections

(adapted from Goncalves A. et al., 2017)

Diagnostic of WNV infection



(adapted from Goncalves A. et al., 2017)

Diagnostic of WNV infection

**Blood-EDTA,
Cerebrospinal fluid
Urines
Brain**

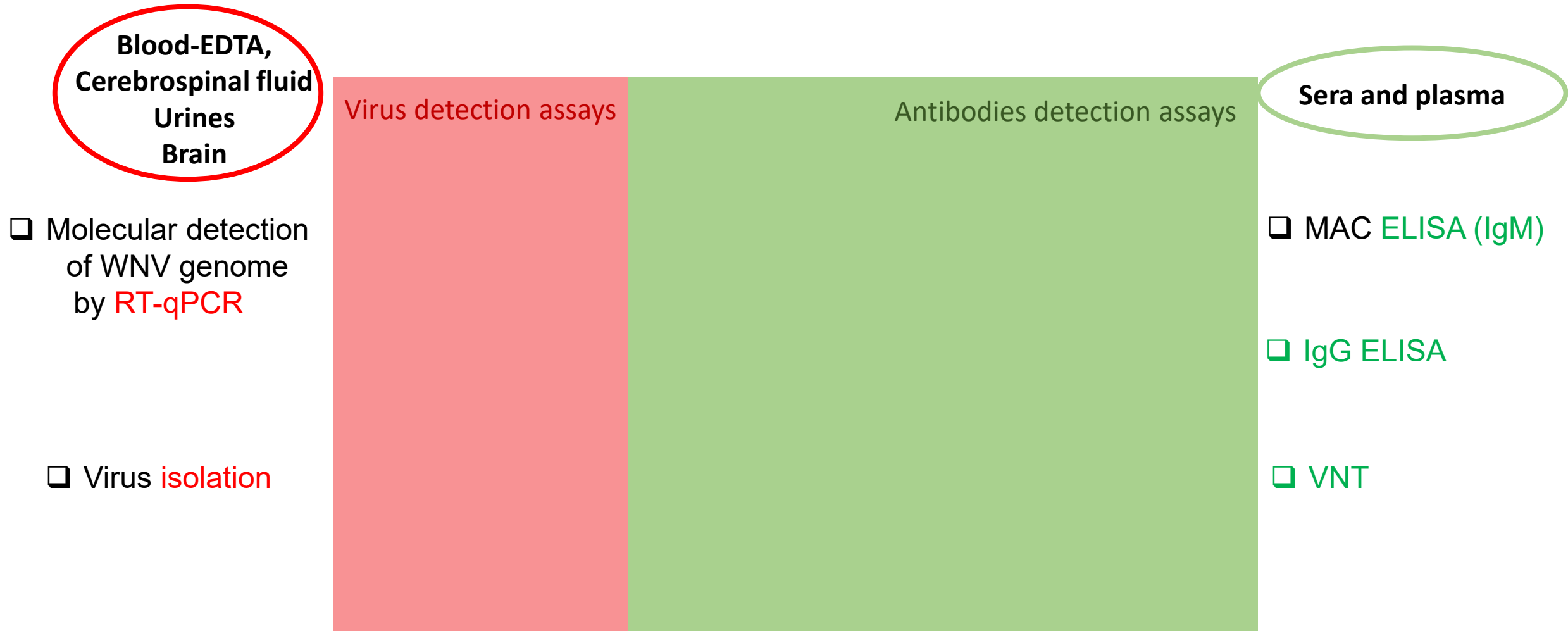
Virus detection assays

Antibodies detection assays

Sera and plasma

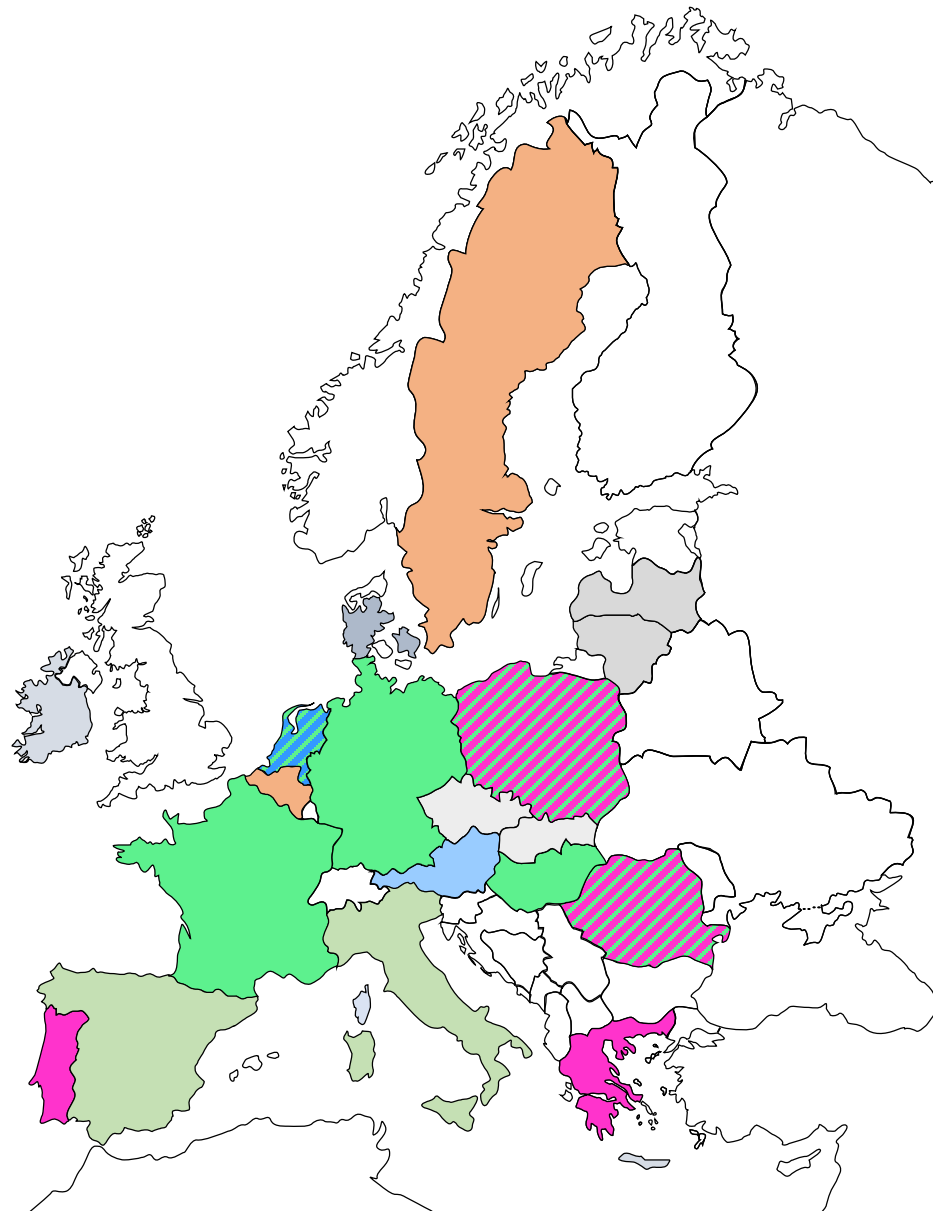
(adapted from Goncalves A. et al., 2017)

Diagnostic of WNV infection

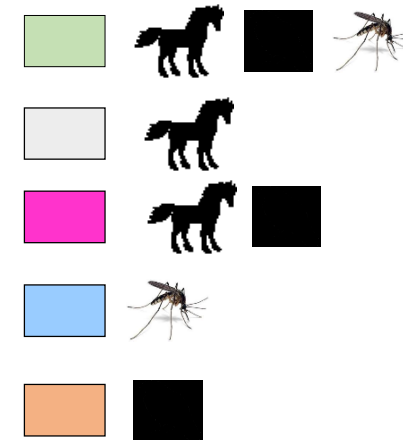


(adapted from Goncalves A. et al., 2017)

Monitoring system implemented in the EU



Active surveillance

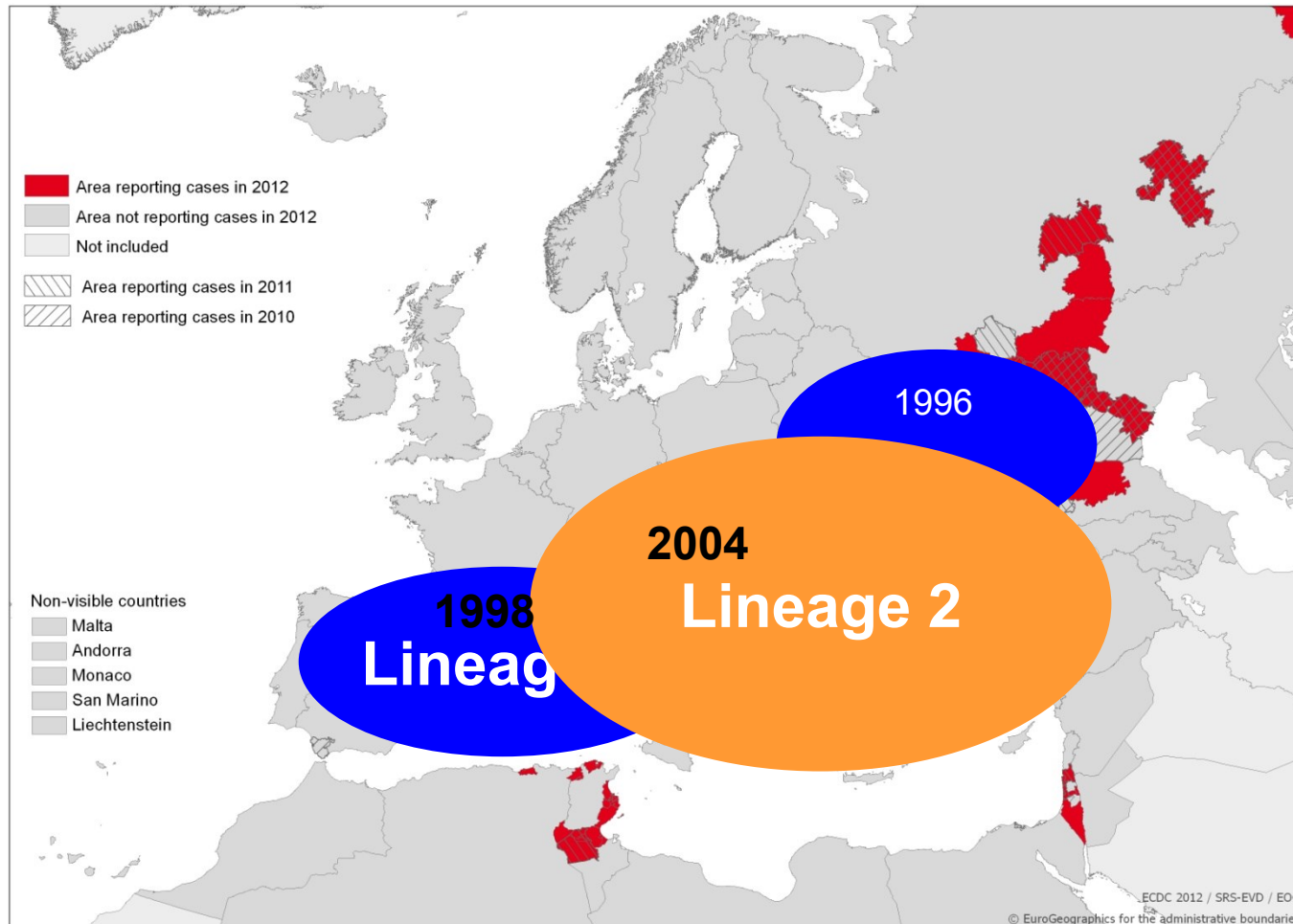


 Passive surveillance

 No surveillance

WNV in Europe

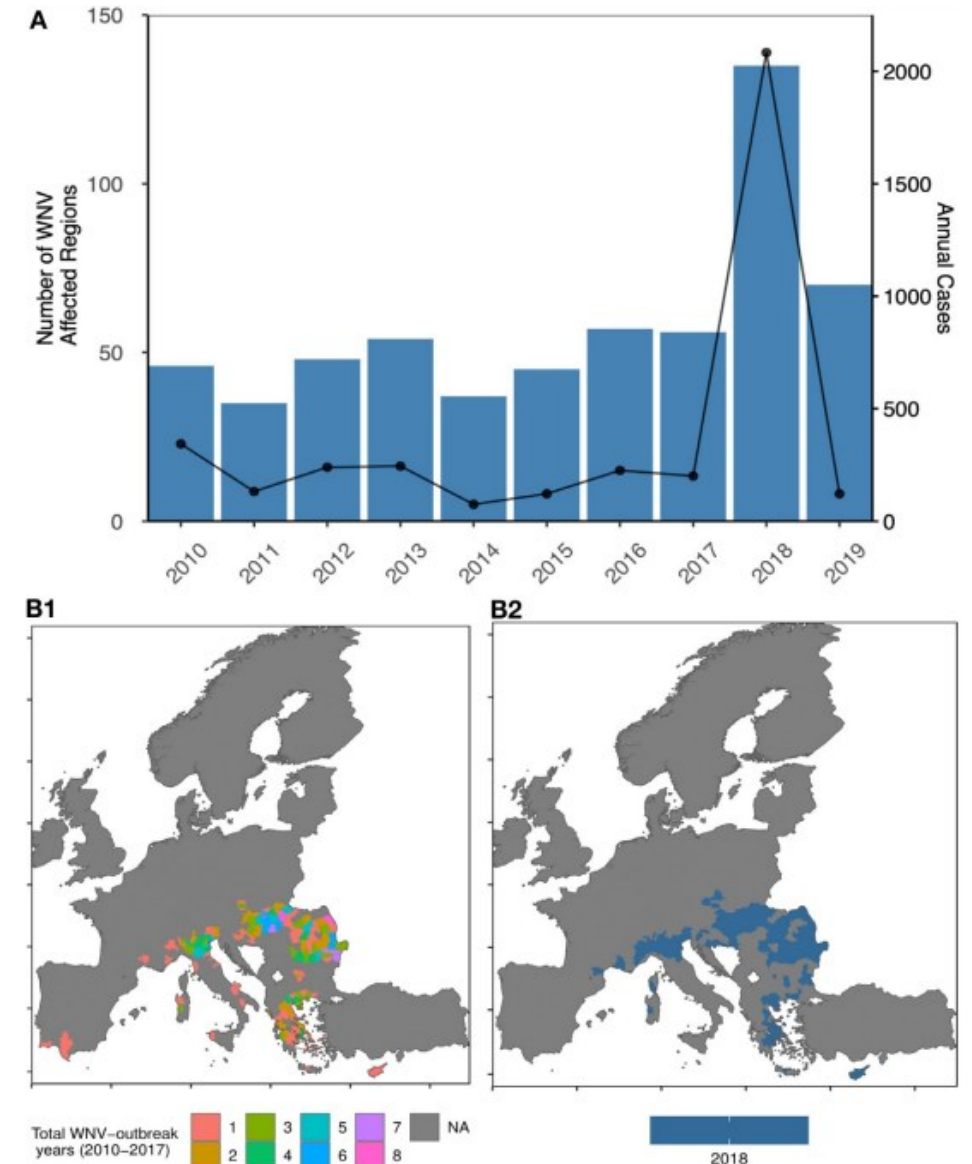
- 1996 et 1998: Emergence of **WNV lineage 1** in Romania et Italy
- 2004: Emergence de **WNV lineage 2** in Hungary



Rapid expansion of the geographical distribution of WNV-lineage 2 in Greece (2010), Italy, Romania, Spain

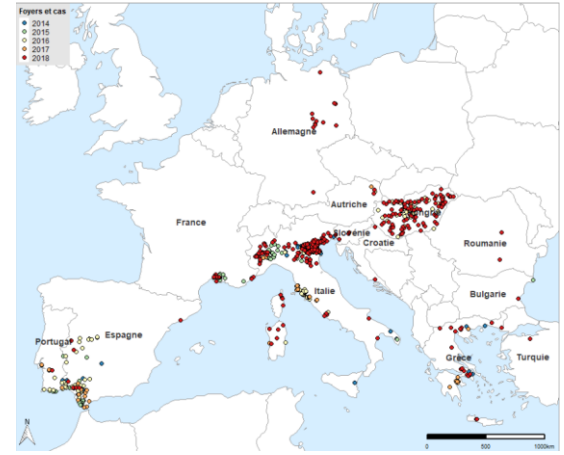
WNV in Europe

- Since 2010, increase of equine and human outbreaks incidence
- **2018**, geographical extension to Northern and central Europe
 - First equine and bird cases detected in Germany in 2018
 - First cases detected in wild avifauna in The Netherlands in 2020
 - First case detected in the UK in 2022

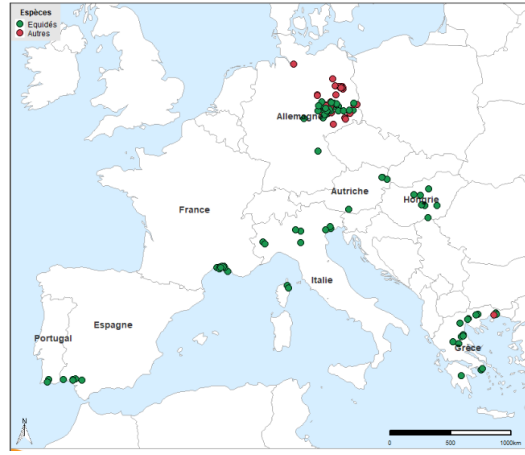


Extension of WNV circulation in Europe

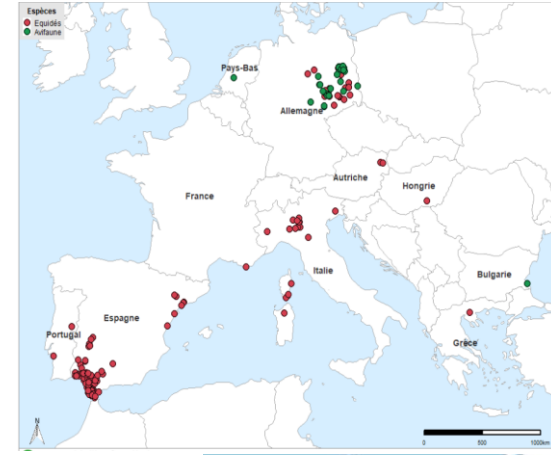
2014-2018



2019



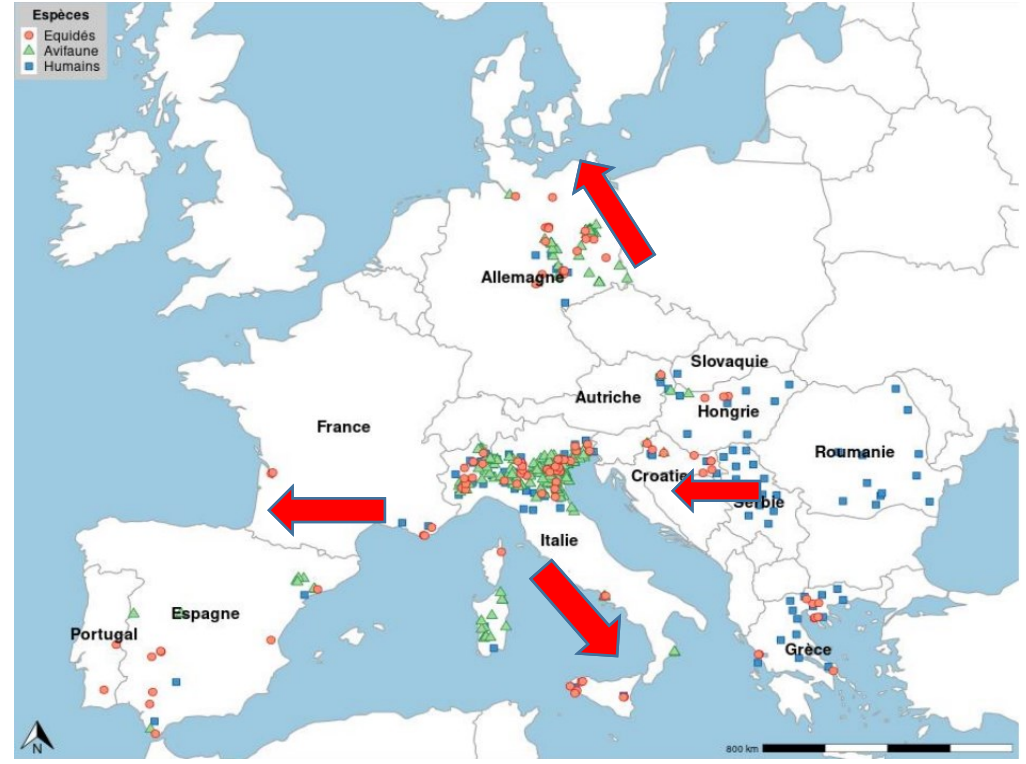
2020



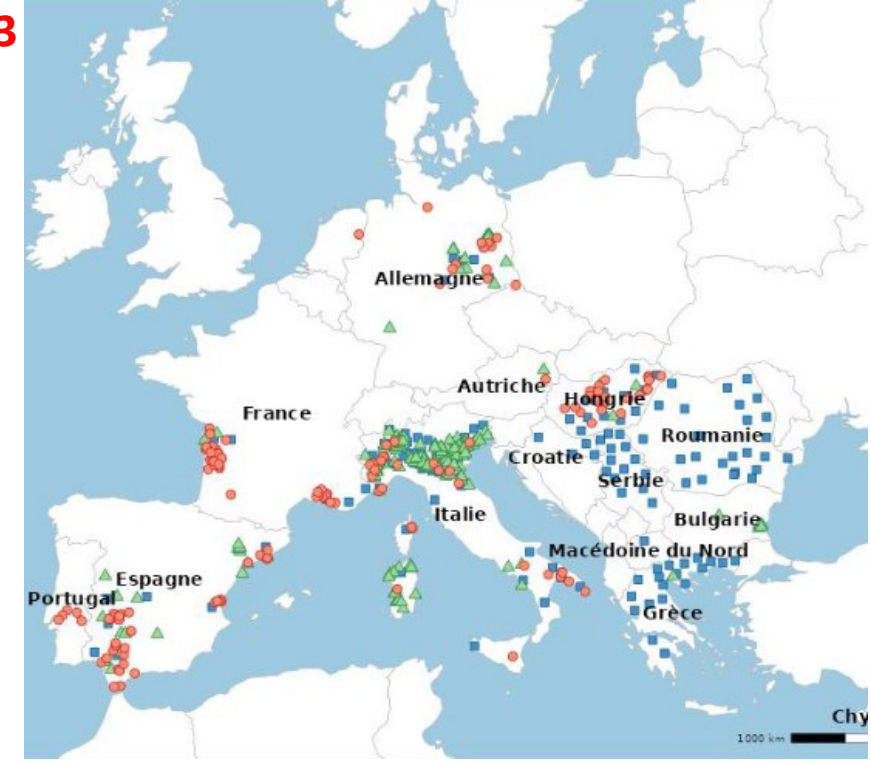
2021



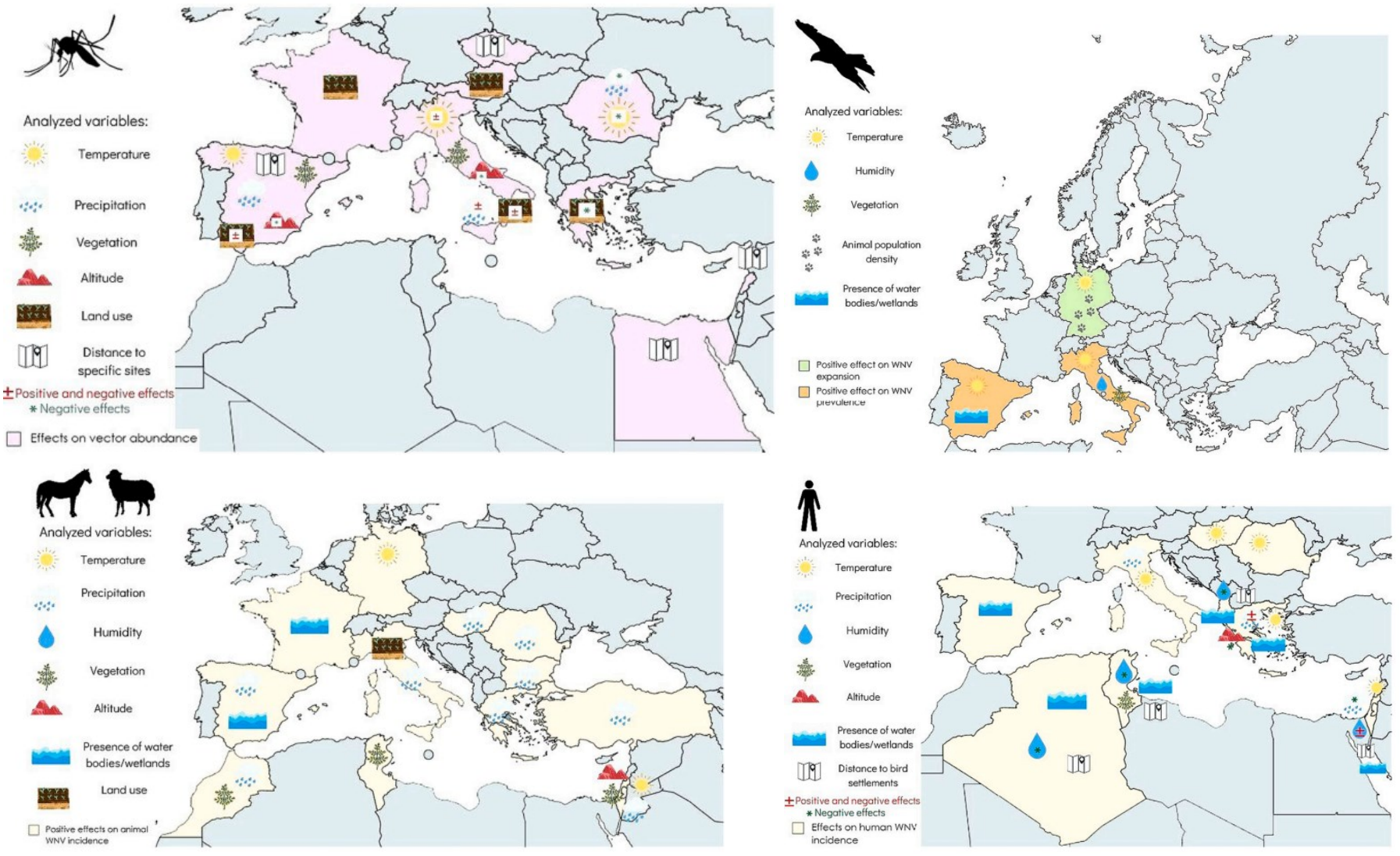
2022



2023

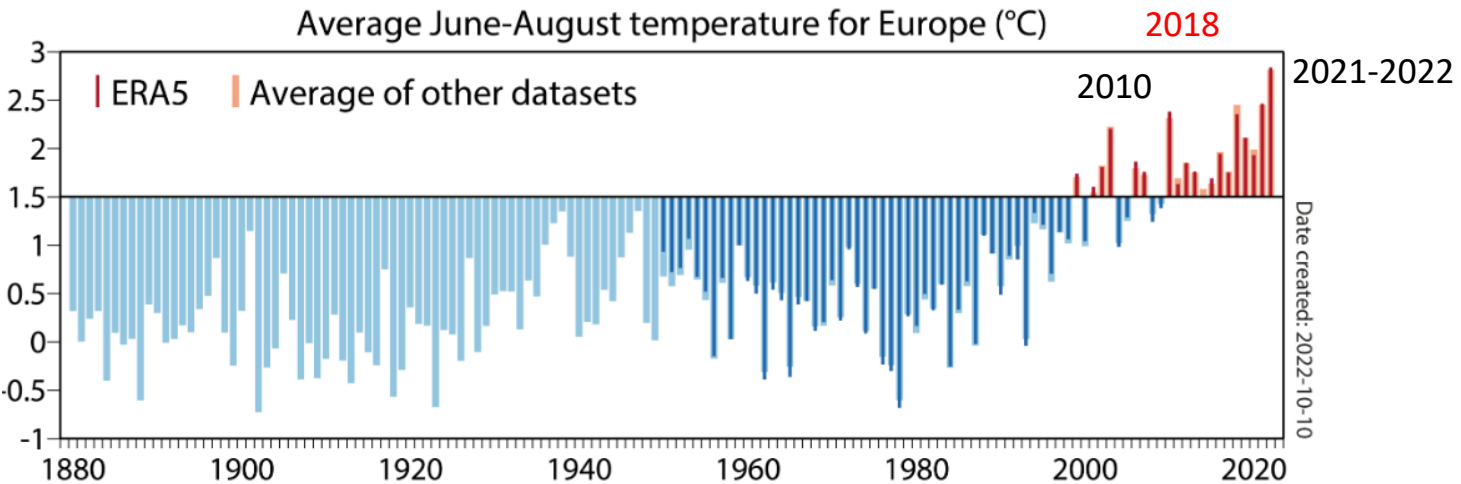


Identification of environmental factors involved in WNV increased incidence



Correlation between WNV epidemics and climatic conditions: temperature, rainfall and vegetation

2018 and 2022: Abnormal climatic conditions



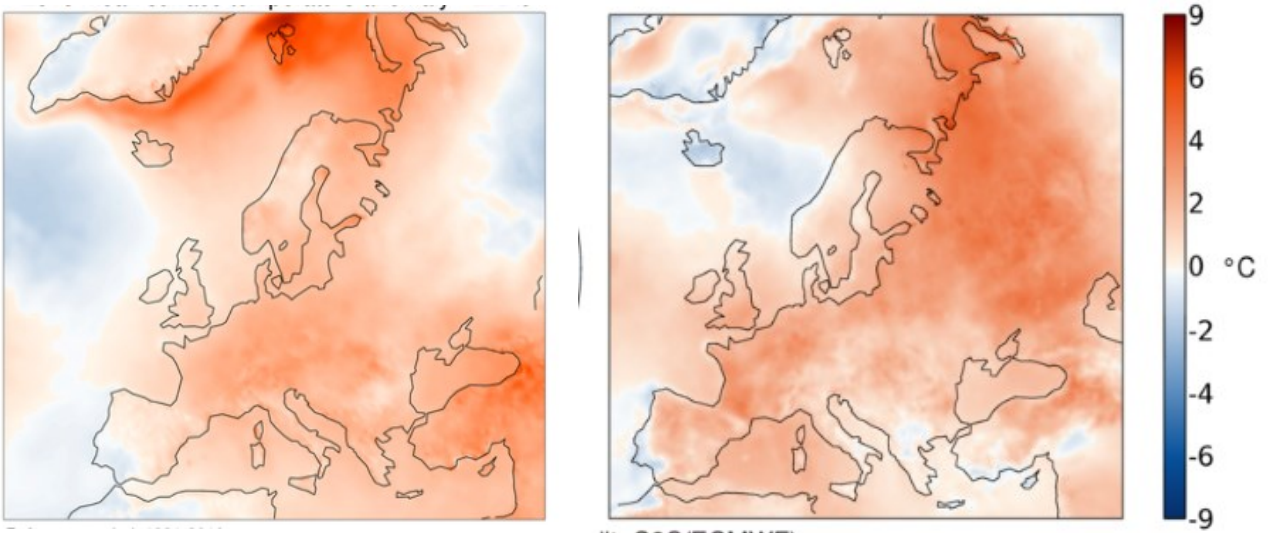
(Data: ERA5, Berkeley Earth, GISTEMP, HadCRUT5 and NOAA GlobalTemp. Reference period: 1881-1910. Credit: C3S/ECMWF)



Anomalies de l'air en surface

été 2018

été 2022



- Warm long springs
- Dryness
- flow

Conclusions: need to move towards more integrated One Health-type surveillance

- Evolution of WNV epidemiology in Europe due to climate change
- Consider a longer transmission season?
- Convergent action of operational research alongside surveillance, involving all stakeholders: anticipation and preparation for future emergencies

FUTURE EPIDEMICS:

moving AND blurry TARGETS

discussion

HUMAN-ANIMAL INTERFACE



RISK: HOW DO WE DECIDE WHAT TO SURVEIL? WHAT ARE KNOWLEDGE GAPS? WILL A ZOOLOGICAL EVENT ALWAYS PRECEDE HUMAN EVENT? CAN WE ID COMMON PATHWAYS?

1 IDENTIFY 1st CASES

2 EARLY DETECTION NEEDS PATHWAY KNOWLEDGE

3 DATA: MORE SCIENCE

- ✓ PRECISE EPIDEMIOLOGY
- ✓ FIELD WORK
- ✓ GOOD DATA
- ✓ INVEST IN HUMAN RESOURCES

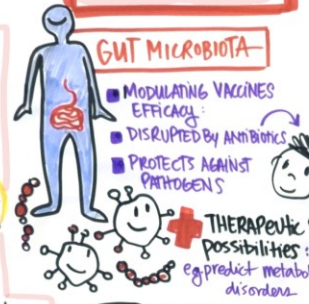
MANAGING RISKS AT ANIMAL LEVEL



How do we RAISE LIVESTOCK? Better communication: institutionally + cross sector

Early warning system

MICROBIOME RESEARCH



PROBIOTICS Insect microbiota fecal transplants

MICROBIOMES- RESPIRATORY DISEASE



NOTE: ALSO spread of disease by MOSQUITOS

How do we EDUCATE & reimagining the WORKFORCE?

VETERINARIANS AGRICULTURE RURAL AREAS

is it Really this BAD? Spread of stories on social media

PAY ATTENTION TO VETERINARY SECTOR

Known about microbiomes IN Treatment for a long time

ECOSYSTEM SURVEILLANCE



THE ANSWERS WILL BE LOCAL

Prevention: outbreaks INEVITABLE, EPIDEMICS ARE NOT!

ECOLOGICAL DRIVERS

land use climate change

BEHAVIOURAL DRIVERS

bush meat consumption animal/human inter. globalization

BIOLOGICAL DRIVERS

reassortment genetic drift

How do we EDUCATE & reimagining the WORKFORCE?

VETERINARIANS AGRICULTURE RURAL AREAS

is it Really this BAD? Spread of stories on social media

PAY ATTENTION TO VETERINARY SECTOR

Known about microbiomes IN Treatment for a long time

get AHEAD OF THE CURVE Means:



SHARING INFO

can we match hot Spot to New Hs, Ns?

Lower the viral load

Challenges 1 pathogen, 1 disease

Use large gathering to identify

animal value chains are crucial

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F. Boué

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Campus Vétérinaire de Lyon



ÉCOLE NATIONALE
VÉTÉRAIRE
ALFORT
Paris - 1765



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F. Vorimore



la science pour la vie, l'humain, la terre



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