Better Training for Safer Food
BTSF

Programme Animal Health Prevention and Control of Emerging Animal Diseases

Emerging animal diseases – relevant examples incl Schmallenberg virus infection

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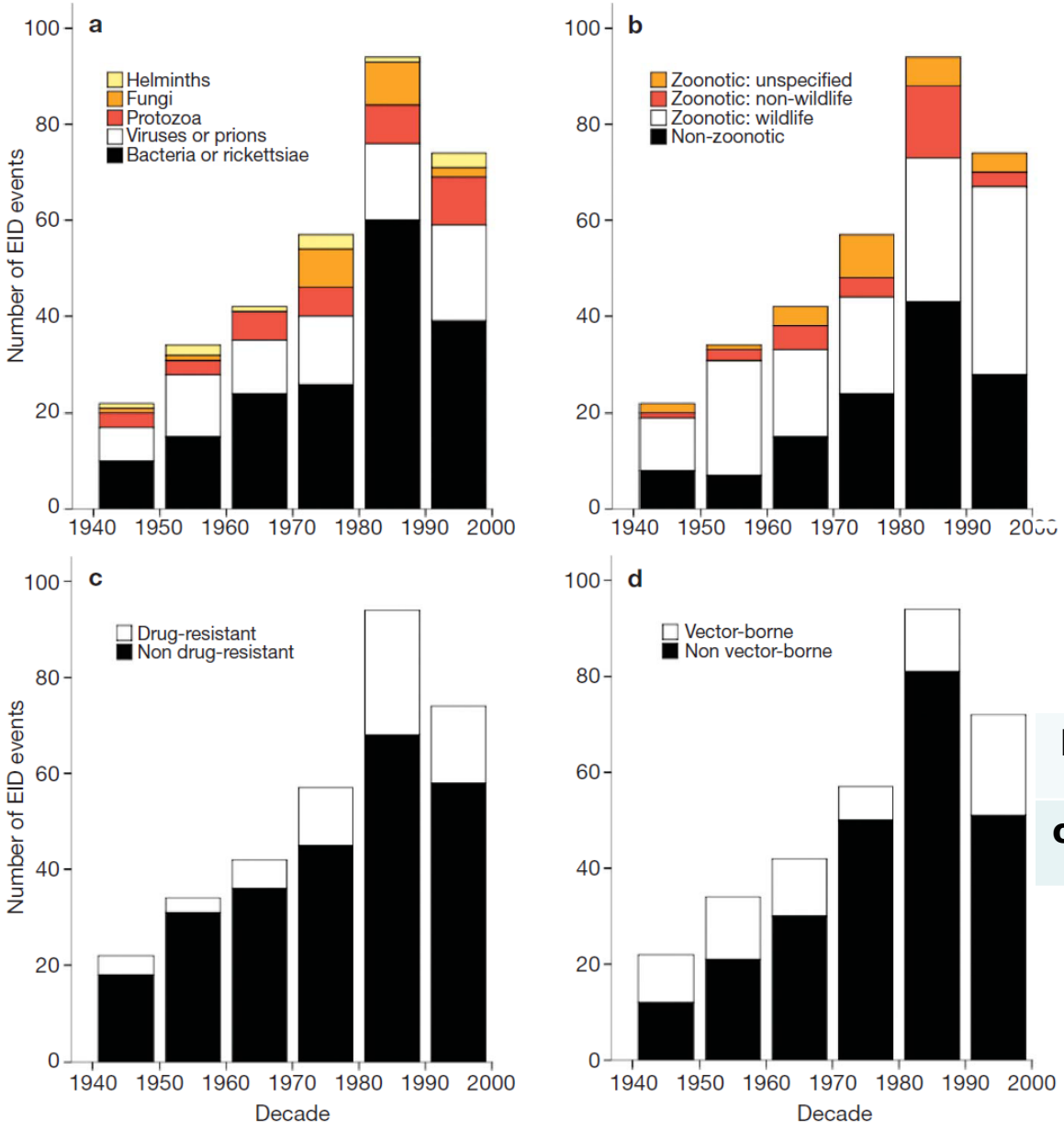
Emergence

European Commission

Botticelli, the birth of Venus, 1486

Emerging infectious diseases (EID) : number per decades



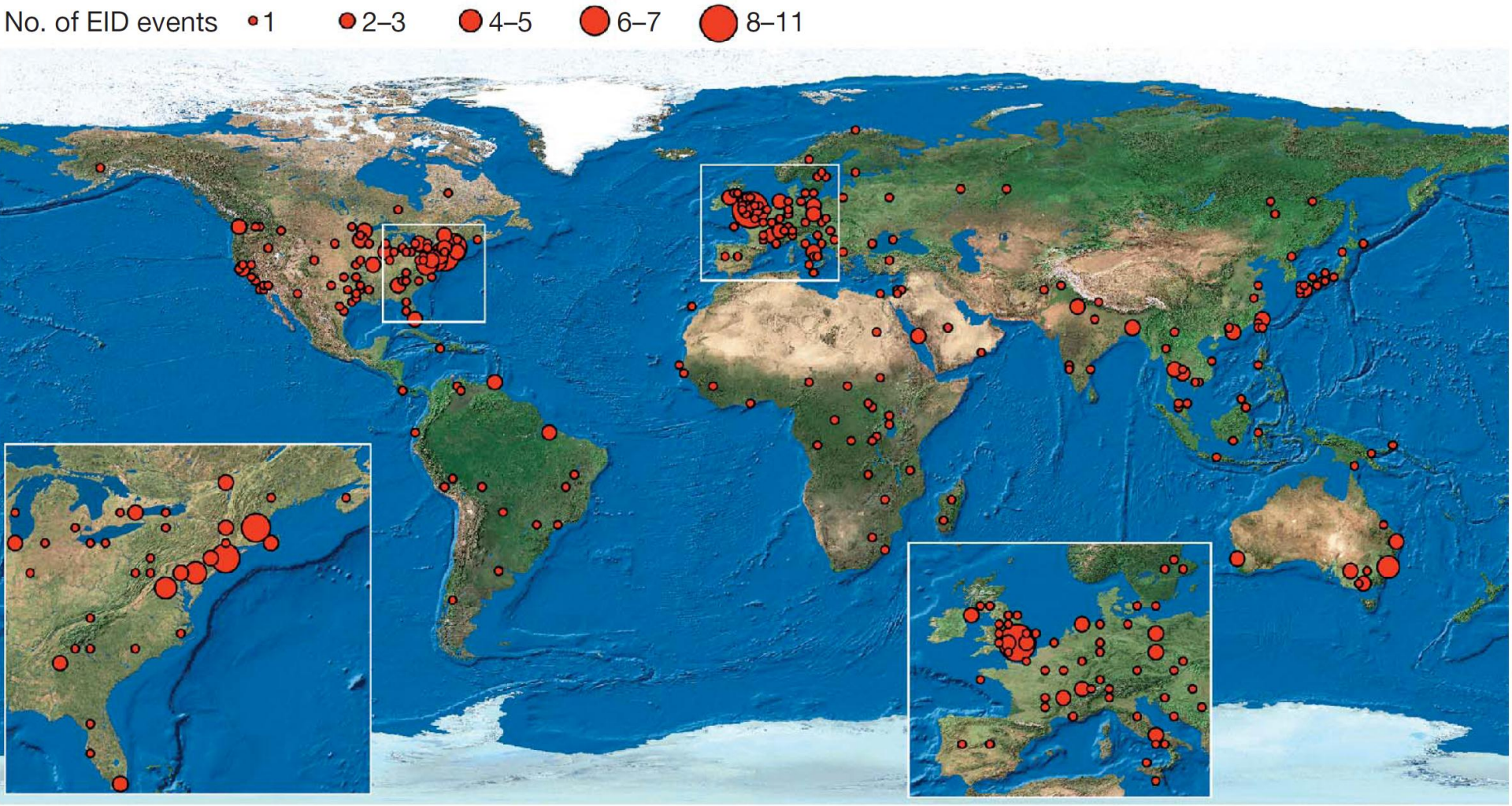
Different impact of viruses and bacteria as source of EID following 2 studies

	Viruses and prions	Bacteria inc Rickettsia
here	25.4%	54.3%
other	37-44 %	10-30 %

Jones et al., Nature, 2008, 451| doi:10.1038/nature06536

Global richness map of the geographic origins of EID events from 1940 to 2004

European Commission



Jones et al., Nature, 2008, 451| doi:10.1038/nature06536

Agenda

- *What is an emerging disease?*
  - **Definition**
  - **Different types of emerging diseases**
- *Examples of emerging diseases*
  - **Zoonotic and vector-borne emerging diseases**
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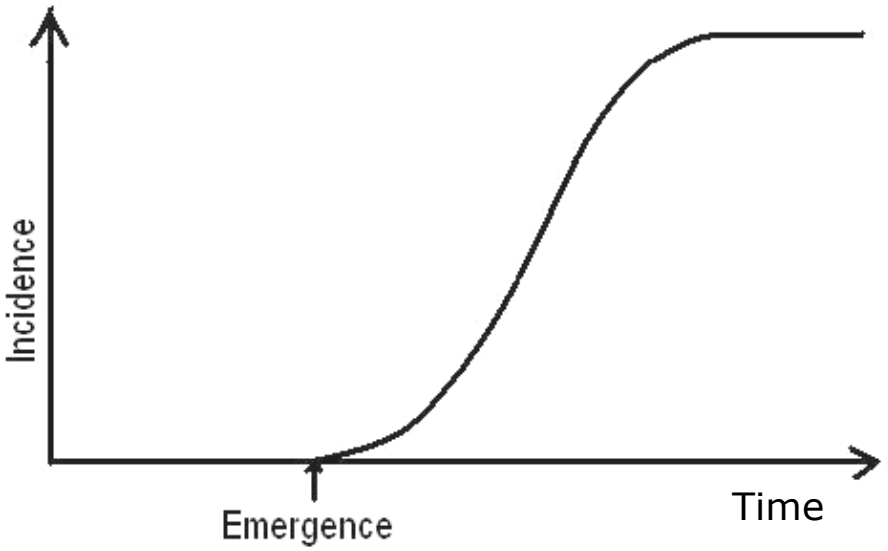
Definition of emerging disease

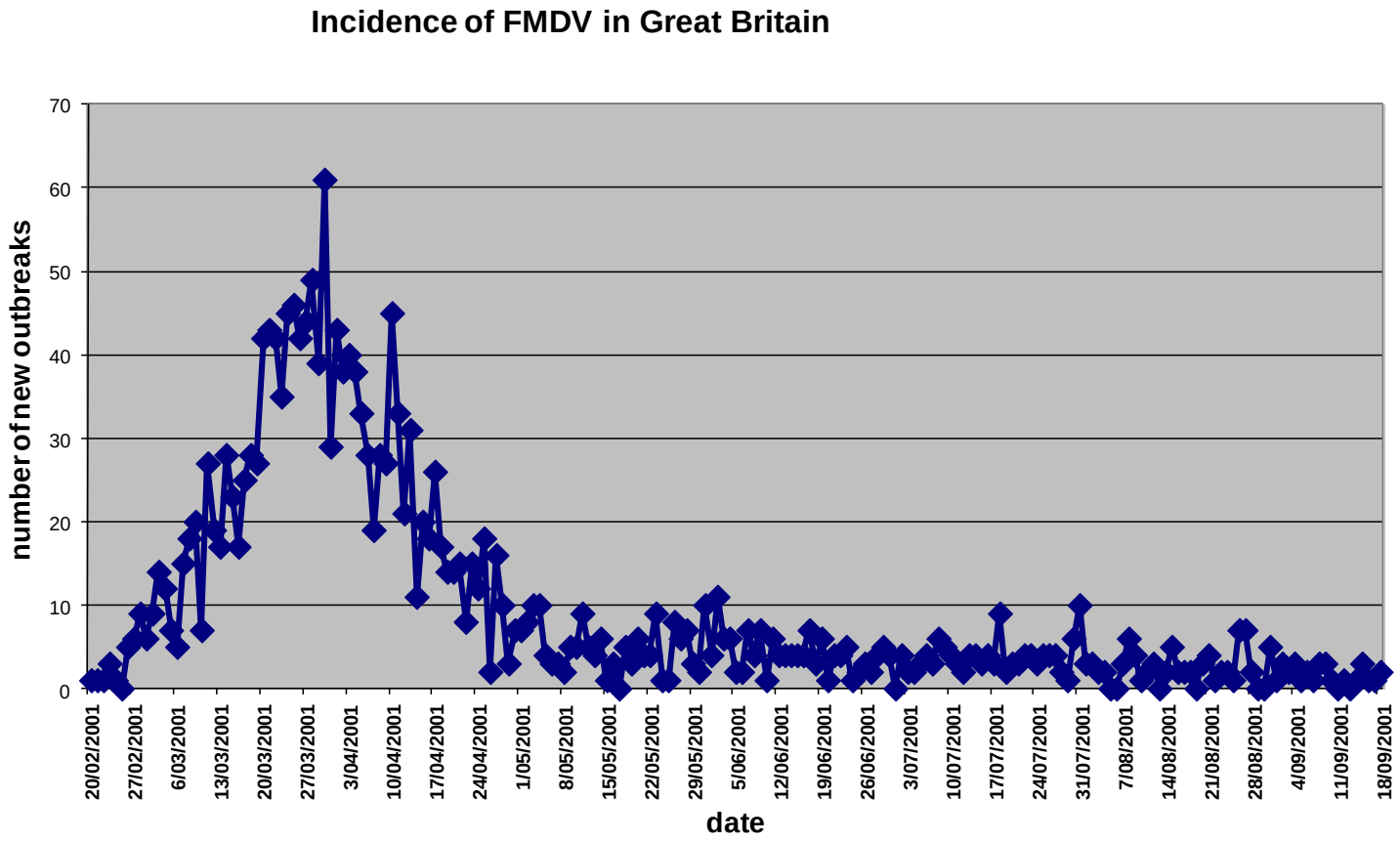
An emerging disease is a new disease whose incidence truly increases in a given population at a given time



Toma and Thiry, *Epidémiol. Santé anim.*, 2003, 44, 1-11

Example of (re-)emerging infection

- *Foot-and-mouth disease in Great Britain (2001)*



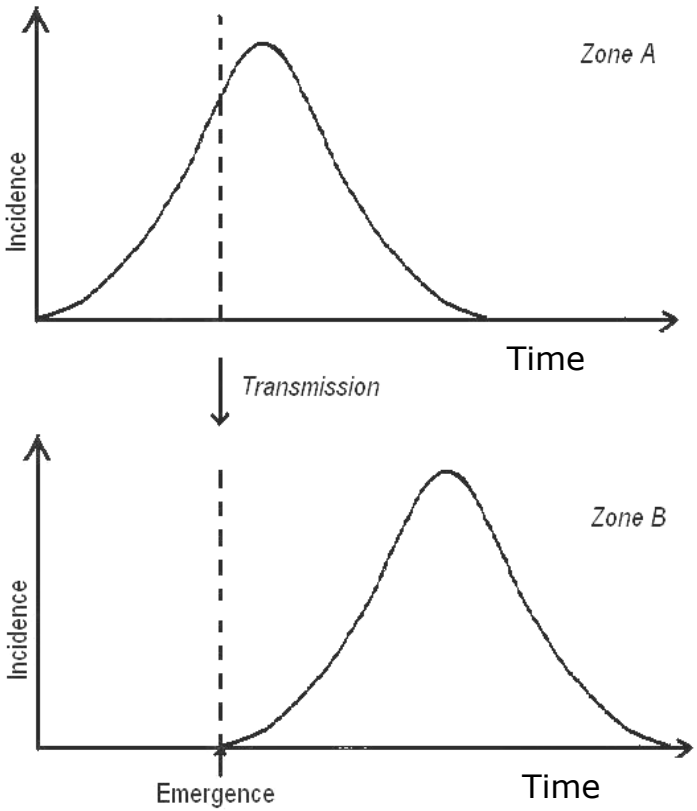
Epidémiol. Santé anim., 2003, 44, 1-11.

Definition of a reemerging disease

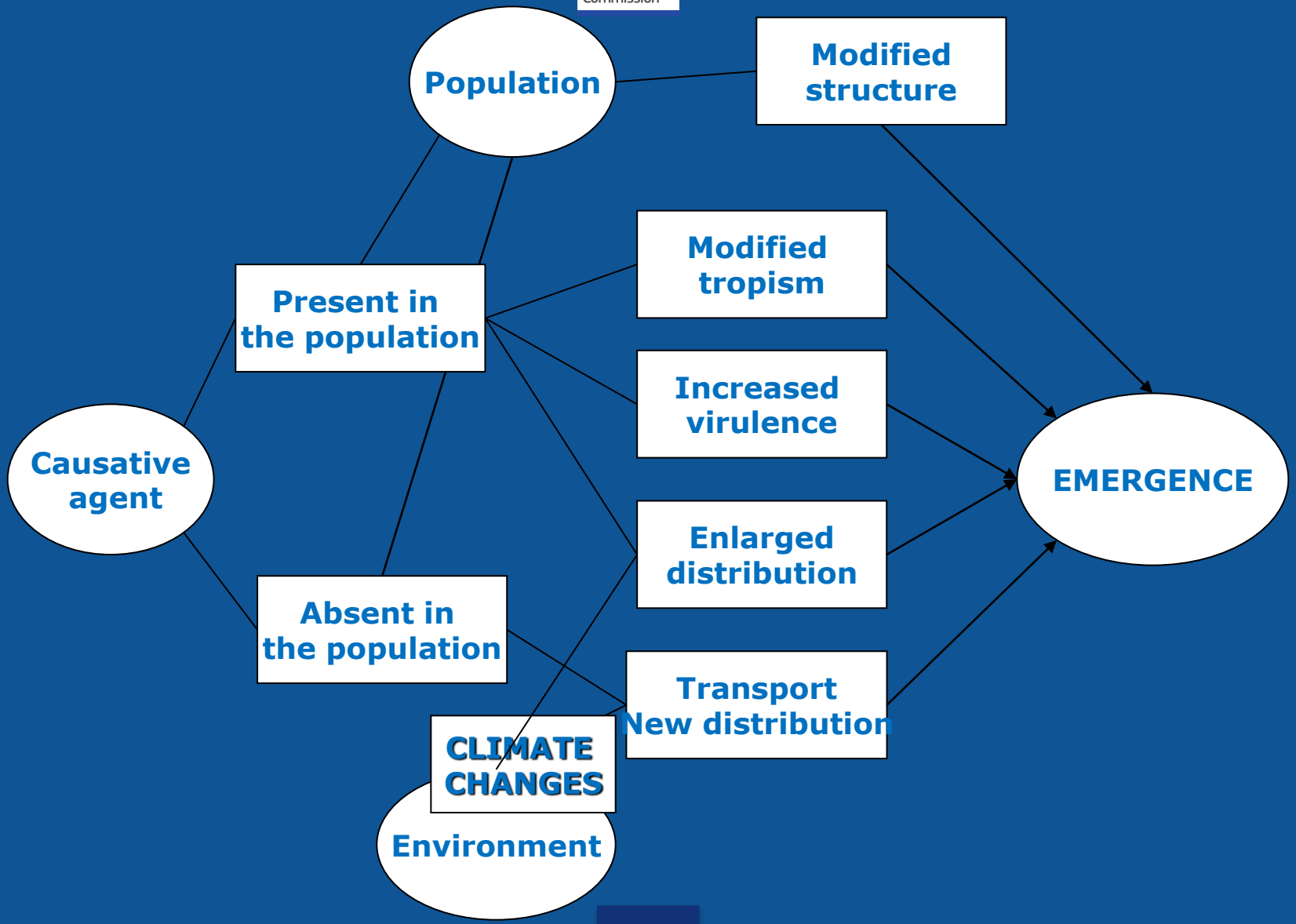
A reemerging disease is a disease that already emerged and disappeared in a given population et whose incidence truly increases in this population at a given time

Toma and Thiry, *Epidémiol. Santé anim.*, 2003, 44, 1-11

Re-emerging foot-and-mouth disease in Europe (UK, 2001)



Toma and Thiry, *Epidémiol. Santé anim.*, 2003, 44, 1-11


Population
Modified structure
Present in the population
Modified tropism
Increased virulence
Causative agent
EMERGENCE
Enlarged distribution
Absent in the population
Transport New distribution
CLIMATE CHANGES
Environment

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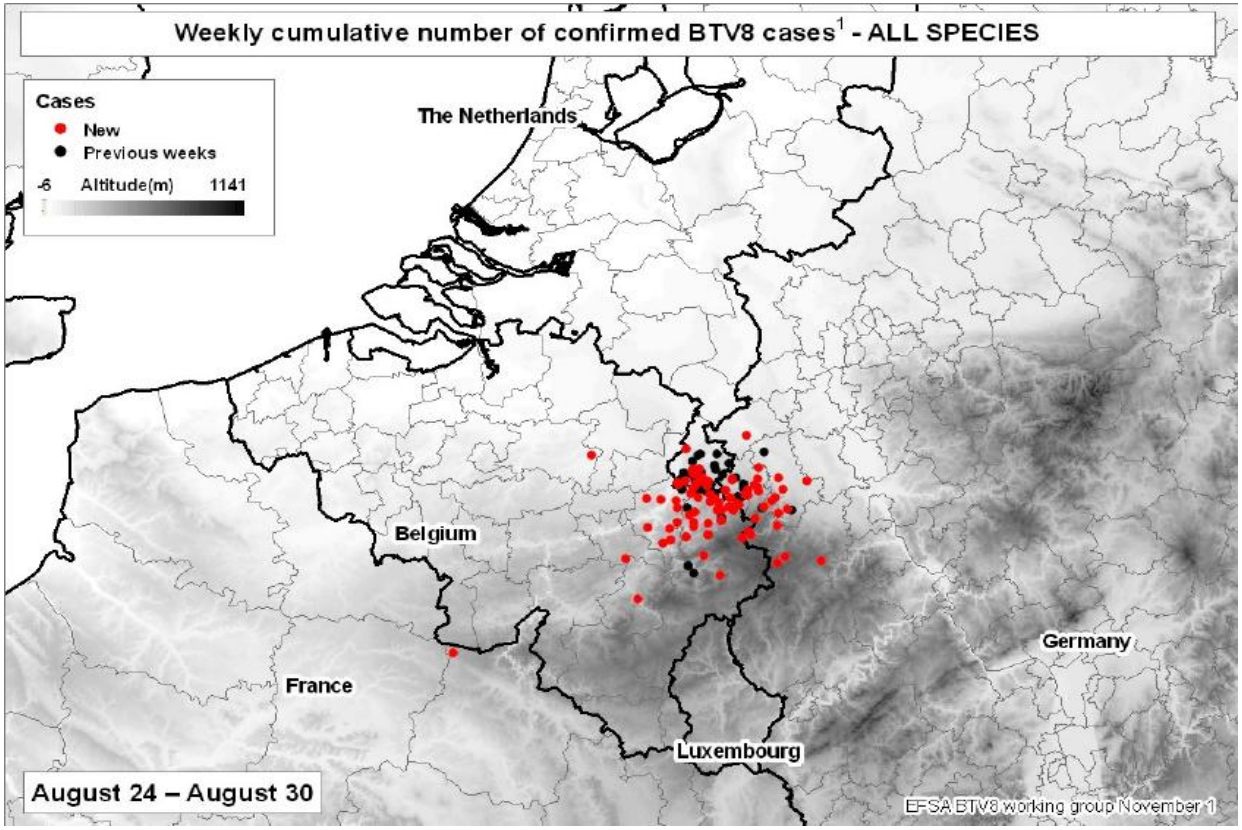
Types of emerging (infectious) diseases (EID)

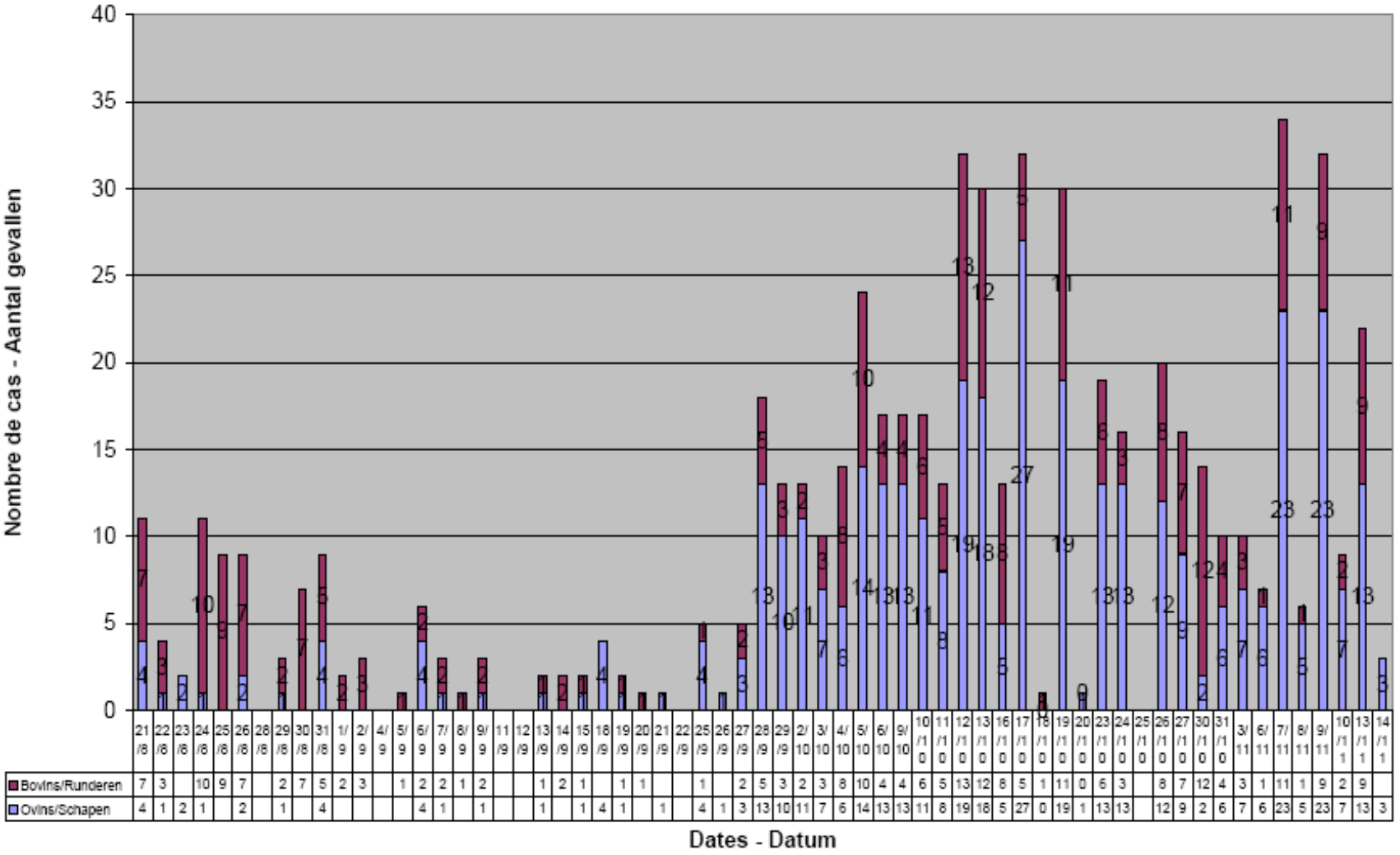
- *Emergence in a new geographic area*
- *New variant*
  - **Adaptation to a new animal species**
  - **Increased or modified virulence in the same species**
- *New pathogen*
- *Re-emerging pathogen*

Types of emerging infectious diseases
Emergence in a new geographic area

- *Bluetongue in Northern Europe (2006)*



Bluetongue outbreaks in Belgium
August-November 2006



14/11/2006

Types of emerging infectious diseases
New variant (1)

- *In the same species*
  - **Equine influenza**
    H3N8 subtype antigenic variants
  - **Pantropic canine coronavirus**
    Same virus as the enteric canine coronavirus
    Different pathogenesis

Types of emerging infectious diseases
New variant (2)

- *Crossing the species barrier*
  - **Canine influenza (H3N8)**
    Infection of dog with equine influenza A virus
    Adaptation to the dog, and virus with specific « canine » profile
  - **H1N1 pandemic influenza virus in carnivores (cat, dog, ferret)**
    Multi reassortant virus (swine-avian-human)
    Easy infection of carnivores
    No stable infection in carnivore species

Types of emerging infectious diseases
New pathogen: Schmallenberg virus

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, Angele Breithaupt, Thomas C. Mettenleiter, and Martin Beer

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 type 1, foot-and-mouth disease virus, bluetongue virus,

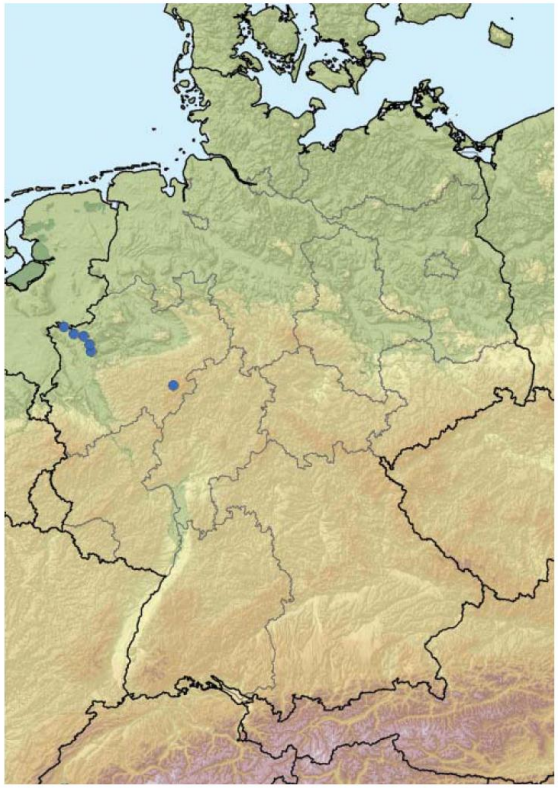
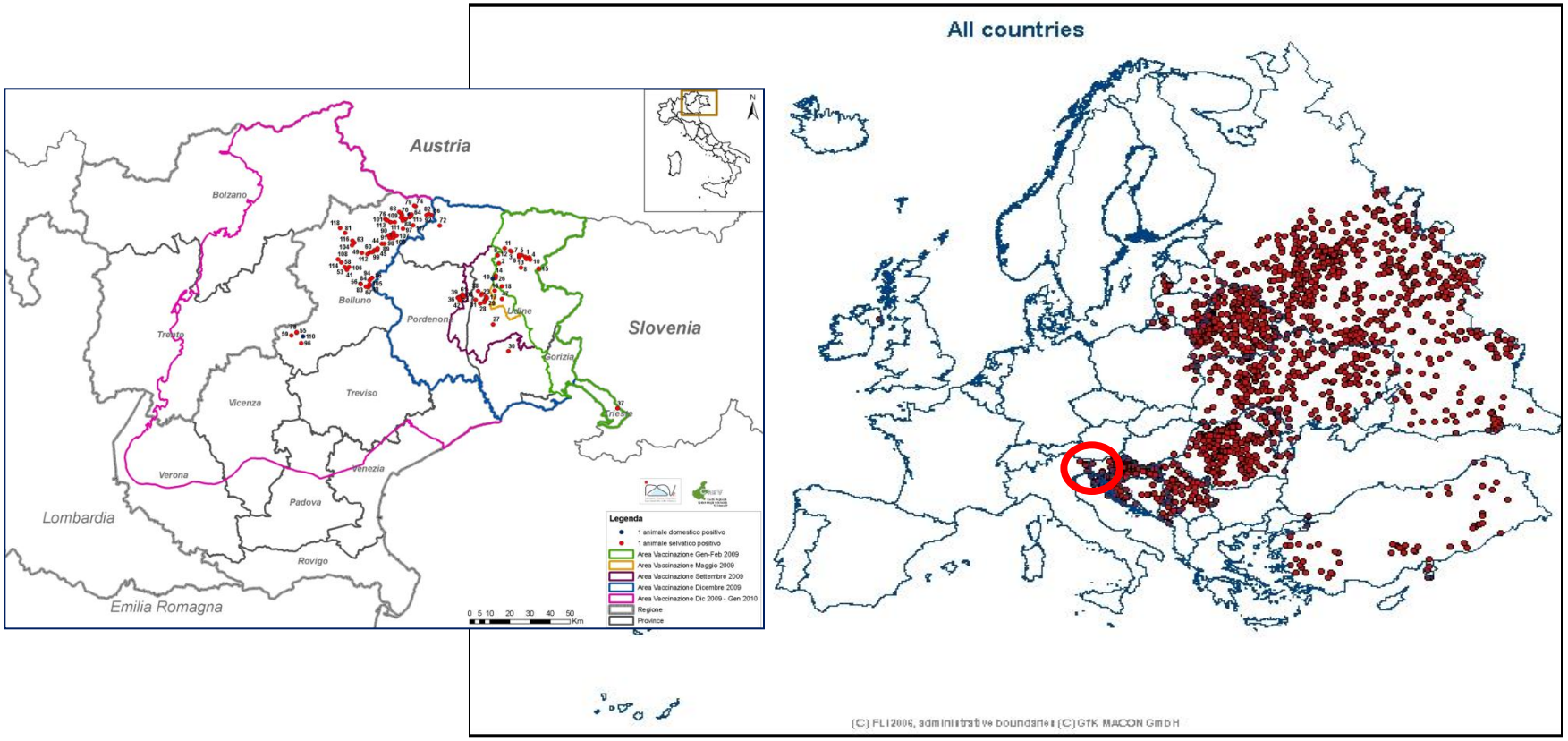


Figure 1. Location of farms with PCR-positive cattle (blue dots) in North Rhine-Westphalia, Germany.

Types of emerging infectious diseases re-emerging pathogen

- *Fox rabies Italy (2009)*



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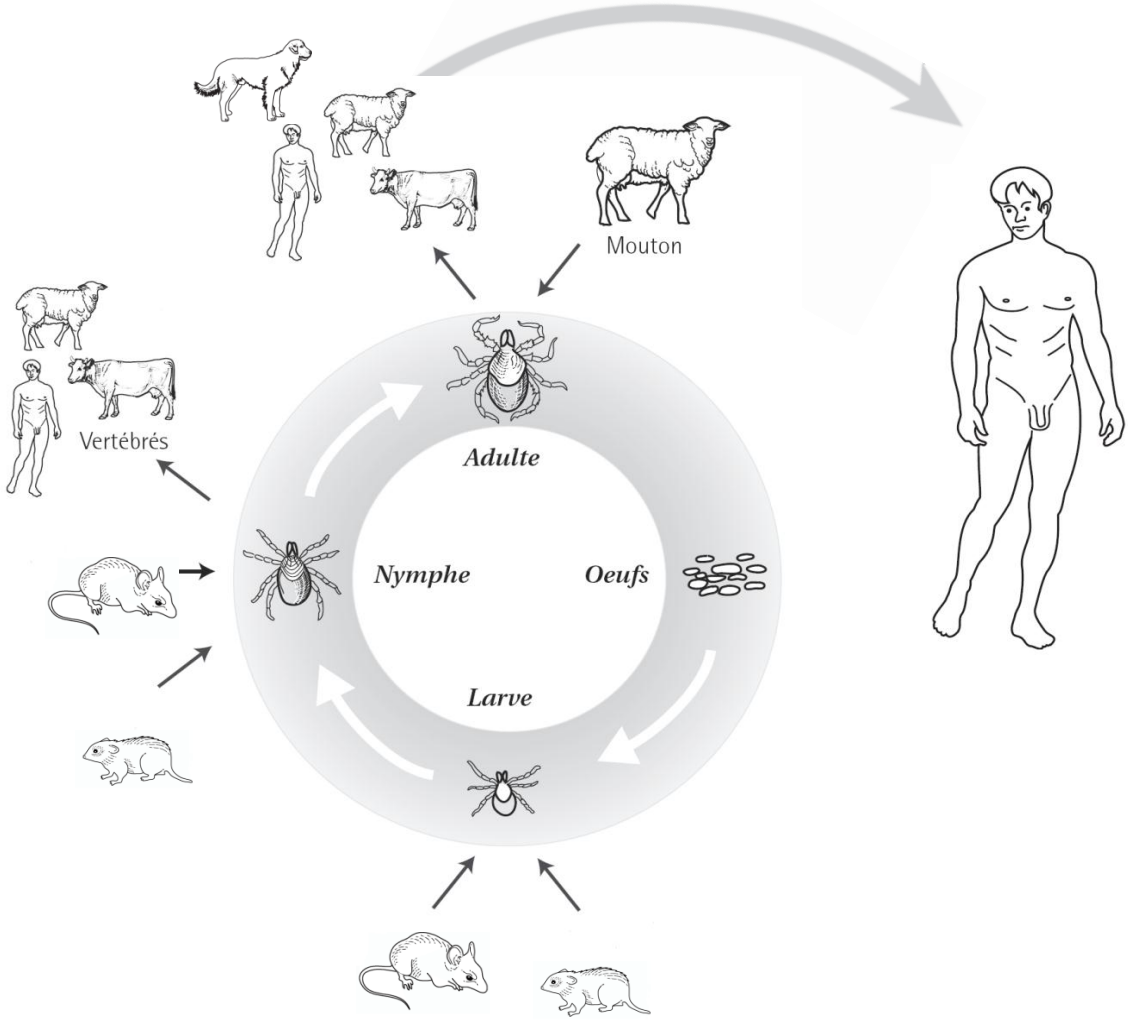
Zoonotic and vector-borne emerging infectious diseases

- *Crimean-Congo hemorrhagic fever (*Bunyaviridae, Nairovirus*)*
- *Rift Valley fever (*Bunyaviridae, Phlebovirus*)*
- *West Nile fever (*Flaviviridae, Flavivirus*)*

Zoonotic and vector-borne emerging infectious disease

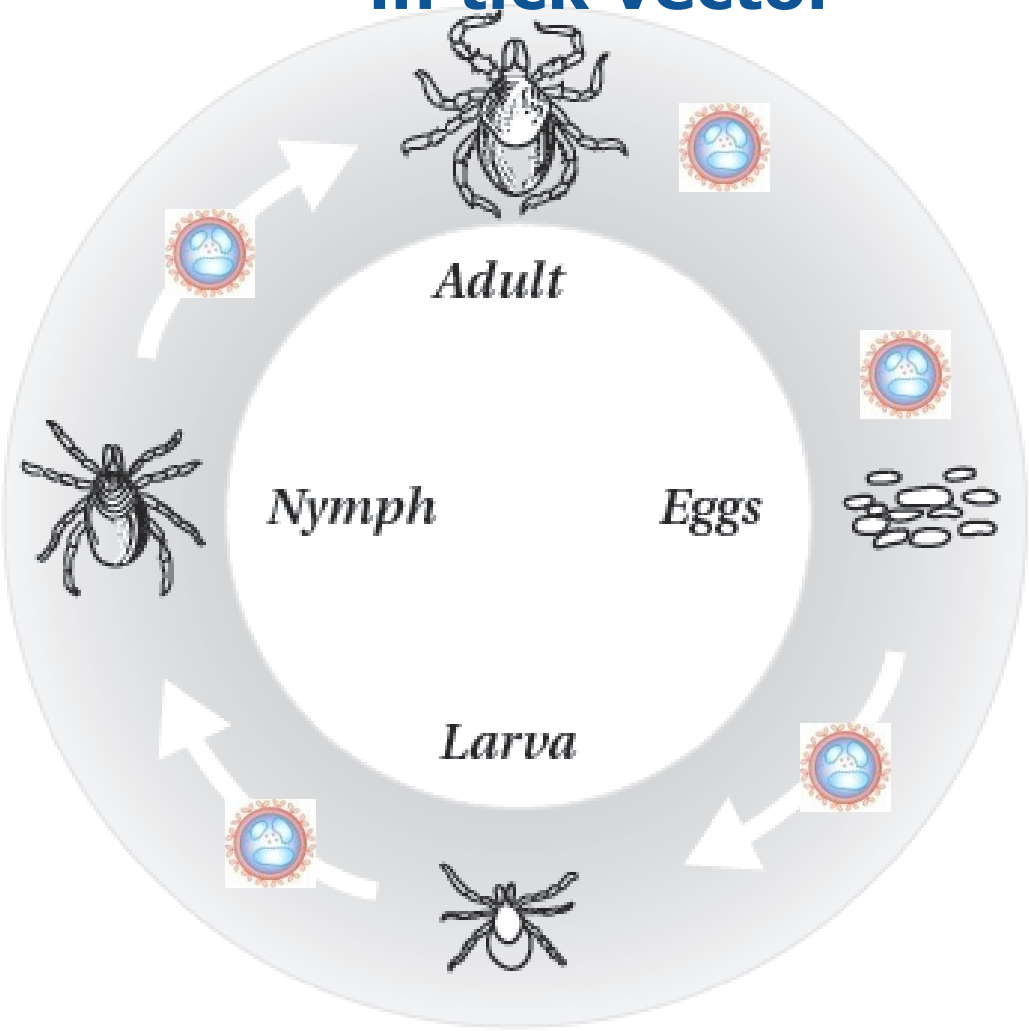
CRIMEAN CONGO HEMORRHAGIC FEVER (CCHF)

Epidemiological cycle - CCHFV

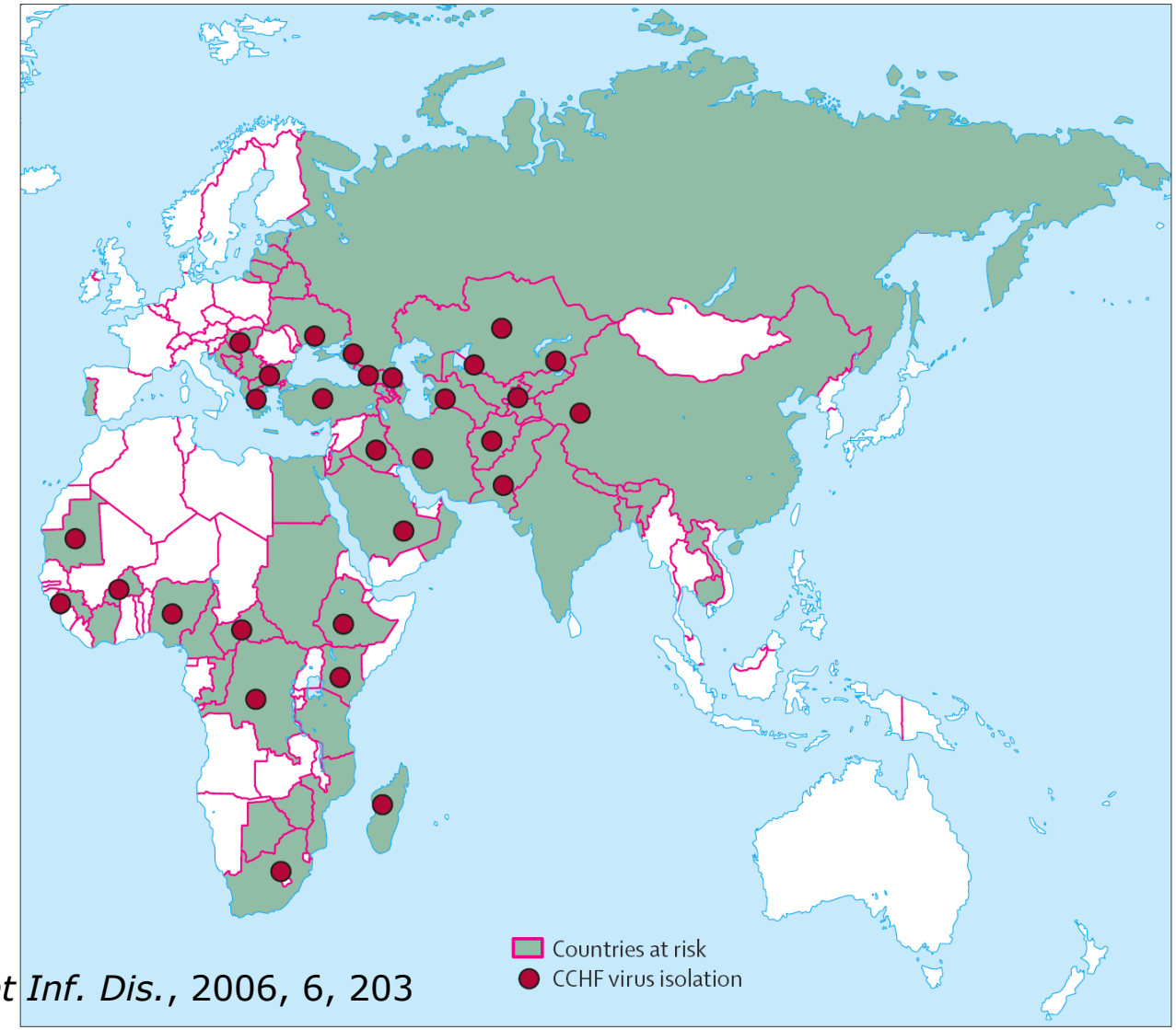


Hyalomma (marginatum) Rhipicephalus (sanguineus), Dermacentor (marginatus), Ixodes ricinus

Transovarian and trans-stadial virus transmission in tick vector



CCHF : global distribution



Ergonul, *Lancet Inf. Dis.*, 2006, 6, 203

Human cases of CCHF in Europe

Location	Years	Number of cases*	Case fatality rate (%)	Occupation
Southeast Europe				
Crimea	1944–45[1]	200	10	Military members
Astrakhan	1953–63[1]	104	17	Agricultural workers
Rostov	1963–69[1]	323	15	Agricultural workers
Bulgaria	1953–74[2]	1105	17	Agricultural workers, health-care workers
	1975–96[16]	279	11	Agricultural workers
	1997–03[16]	138	21	Agricultural workers
Albania	2001[17]	7	0	Agricultural workers, health-care workers
Kosovo	2001[18]	18	33	Agricultural workers
Turkey	2002–05[9]	500	5	Agricultural workers

Ergonul, *Lancet Inf. Dis.*, 2006, 6, 203

CCHF in Europe and around Europe

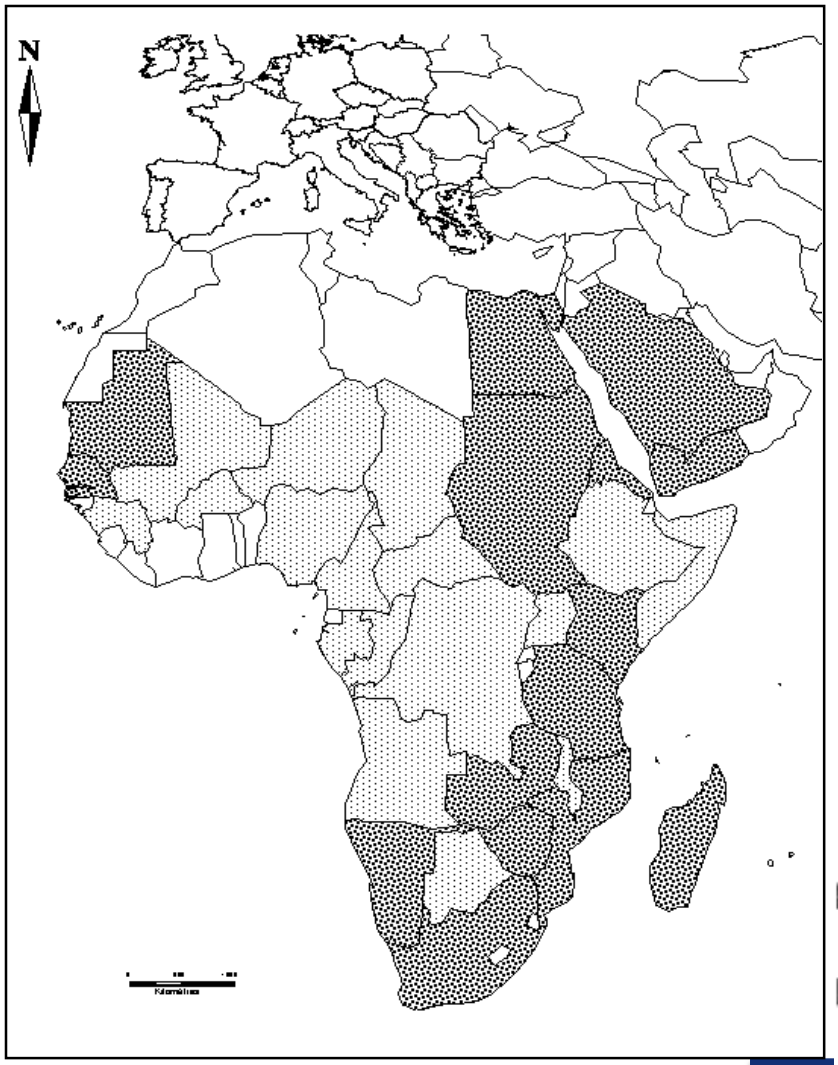
- *Disease demonstrated in human cases:*
  - **Greece**
  - **Turkey**
  - **Kosovo**
  - **Russia**
  - **Georgia**
- *Positive serologies (few cases)*
  - **France**
  - **Portugal**

European Commission

Zoonotic and vector-borne emerging infectious disease

RIFT VALLEY FEVER (RVF)

Rift Valley fever: géographical distribution



Enzootic or epizootic/epidemic

Sporadic and/or viral isolation and/or serology

RVF: main human epidemics

Year	Country	Estimated number of cases	Fatalities
1951	South Africa	20 000	nd
1977-1978	Egypt	18 000	623
1987	Senegal, Mauritania	nd	224
1997-1998	Kenya	27 000	170
2000	Saudi Arabie /Yemen	20 000	95
2007	Tanzania	264	109
2006-2007	Kenya	684	155
2007	Somalia	114	51
2007	Sudan	601	211

RVF: transmission

- *Ruminant infection*
  - **Vector-borne**
  - **Inter-ruminant transmission through virulent matters (placenta, abortus)**
- *Human infection*
  - **By insect bites: theroretically possible**
  - **Handling of and contact with carcasses, tissues and organs, blood of viremic animals (aérosol)**

FVR : mosquito-borne transmission

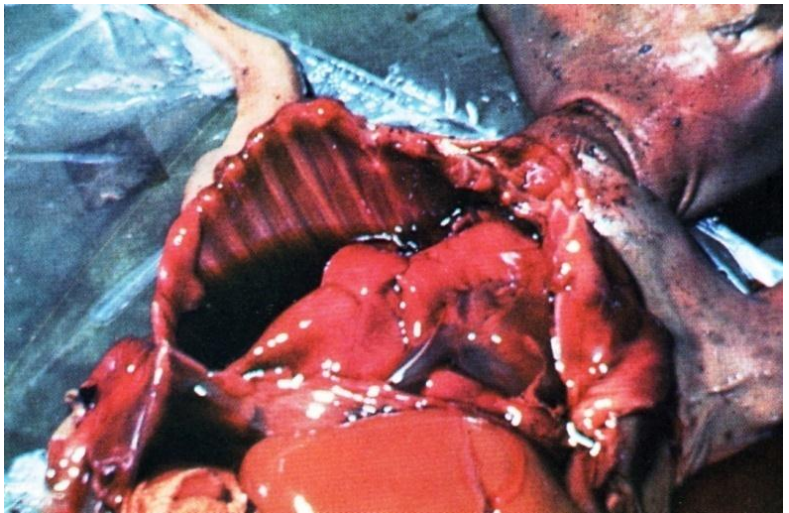
- *More than 30 mosquito species are competent*
- *Aedes*
  - **Vertical transmission to eggs, resistant to dessiccation**
  - ***Aedes vexans arabiensis, Ae. caballus Ae. aegypti, Ae. Albopictus***
- *Culex*
  - ***Culex theileri, Culex pipiens, Culex tritaeniorhynchus***
- *Other genera: Anopheles, Eretmapodites and Mansonia*

European Commission

Abortion storms

Liver: hypertrophy, hemorrhages, necrosis

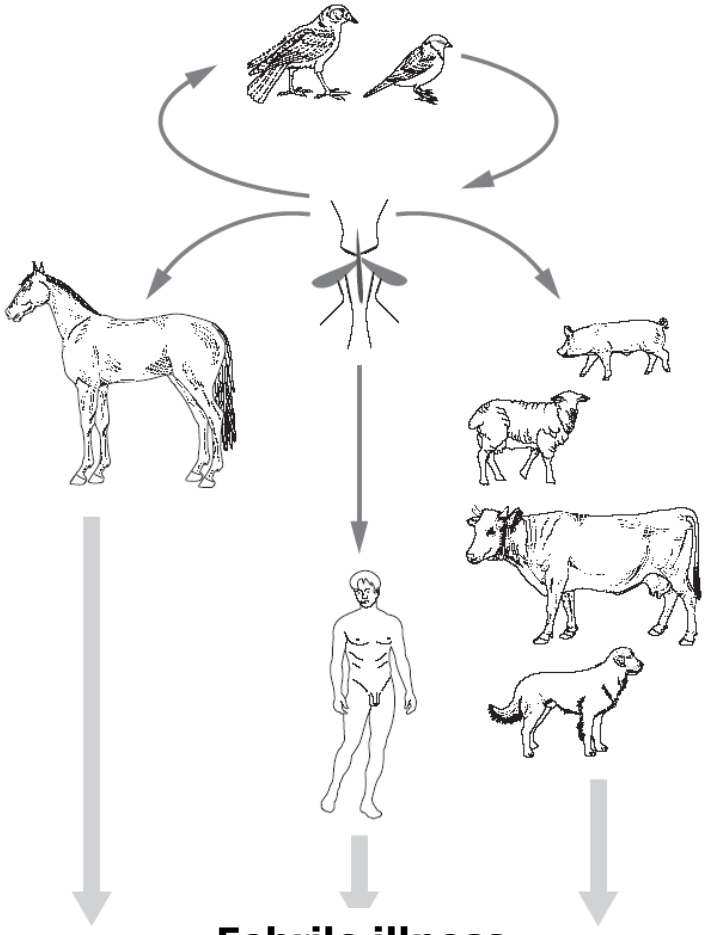
Diffuse hemorrhages



Zoonotic and vector-borne emerging infectious disease

WEST NILE FEVER (WNF)

WNF: epidemiological cycle

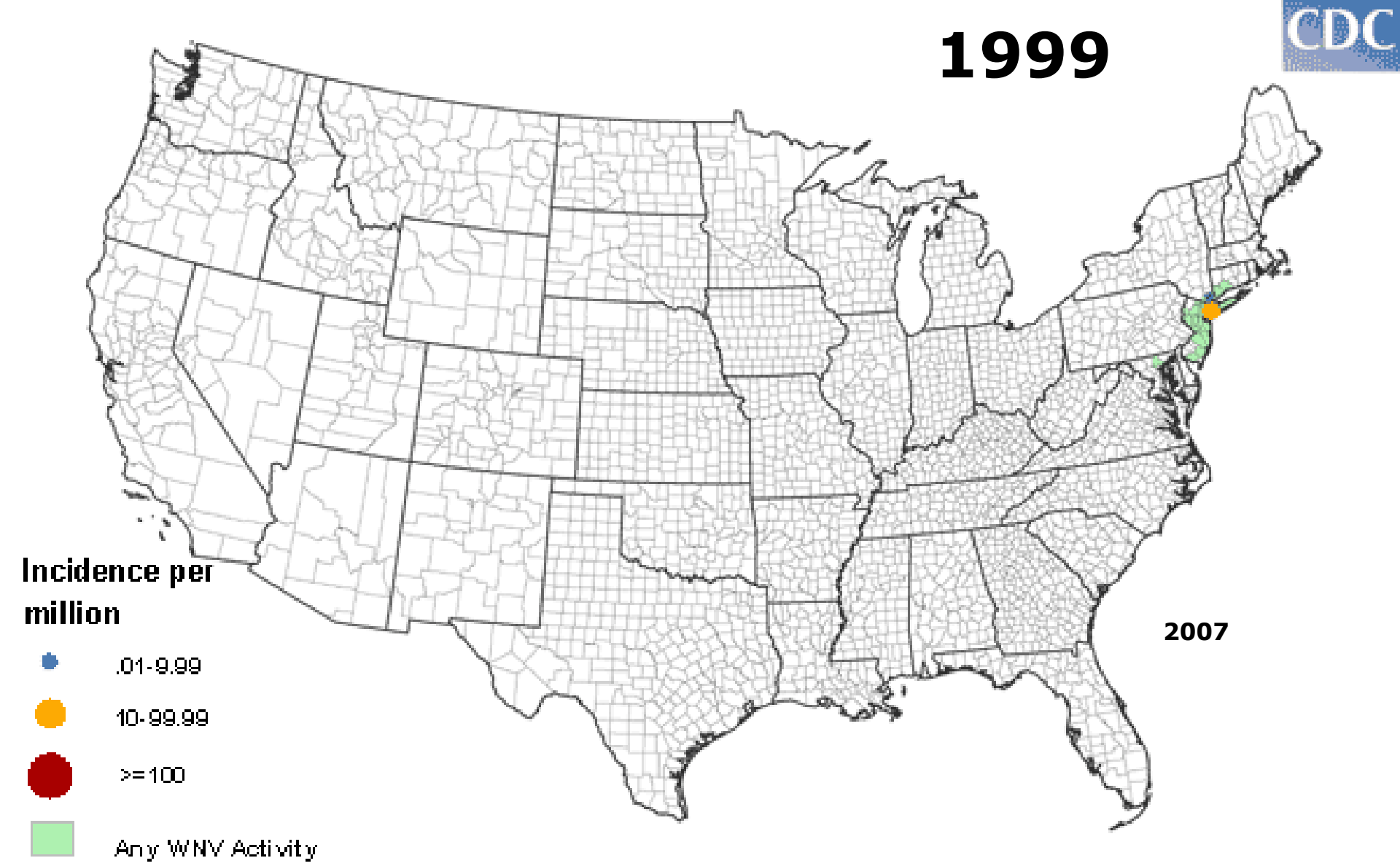


Culex pipiens
Culex modestus
Numerous competent species of *Culex* and *Aedes*

Encephalitis

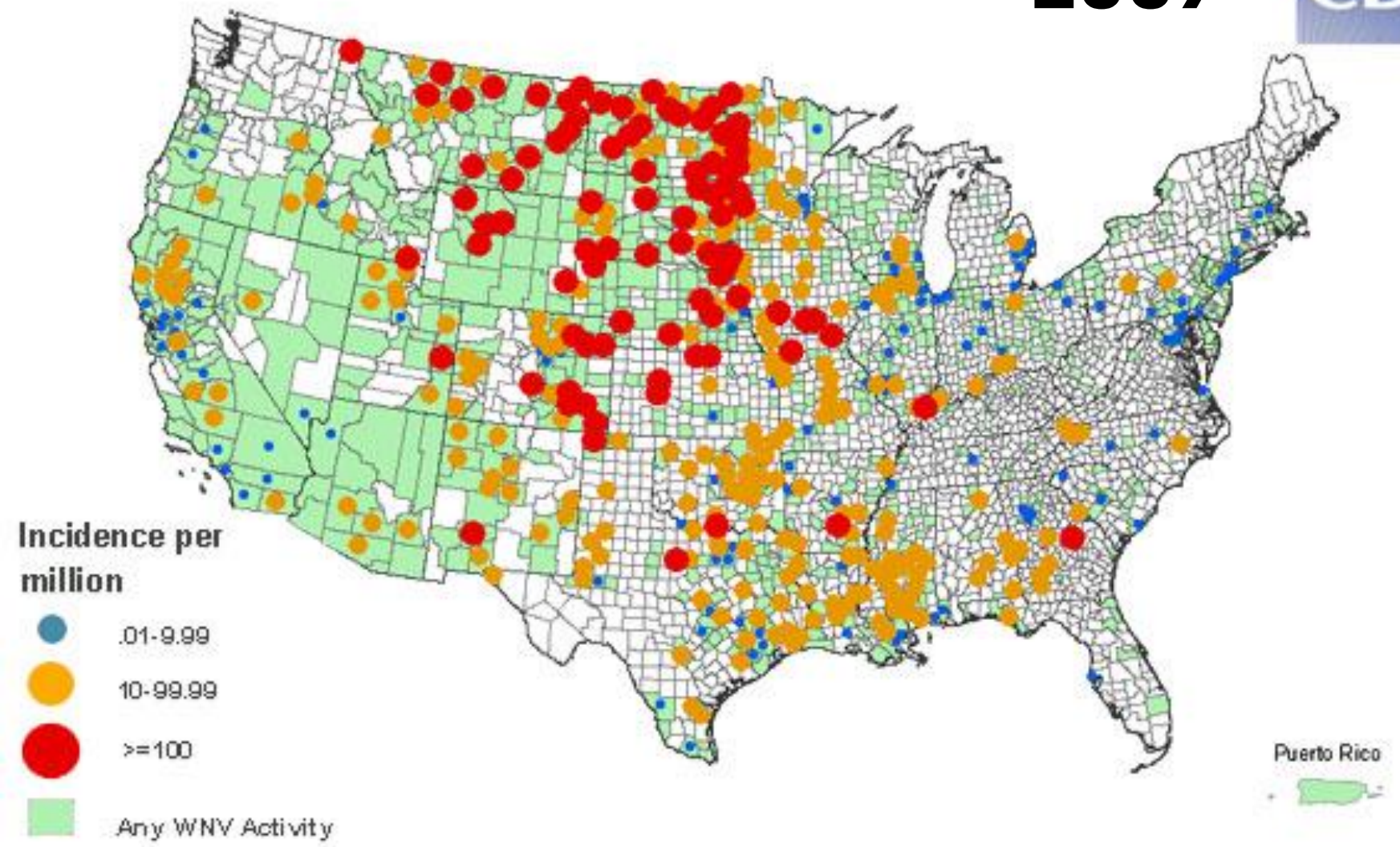
Febrile illness (rare) meningo-encephalitis

Subclinical infection



Emergence in North America

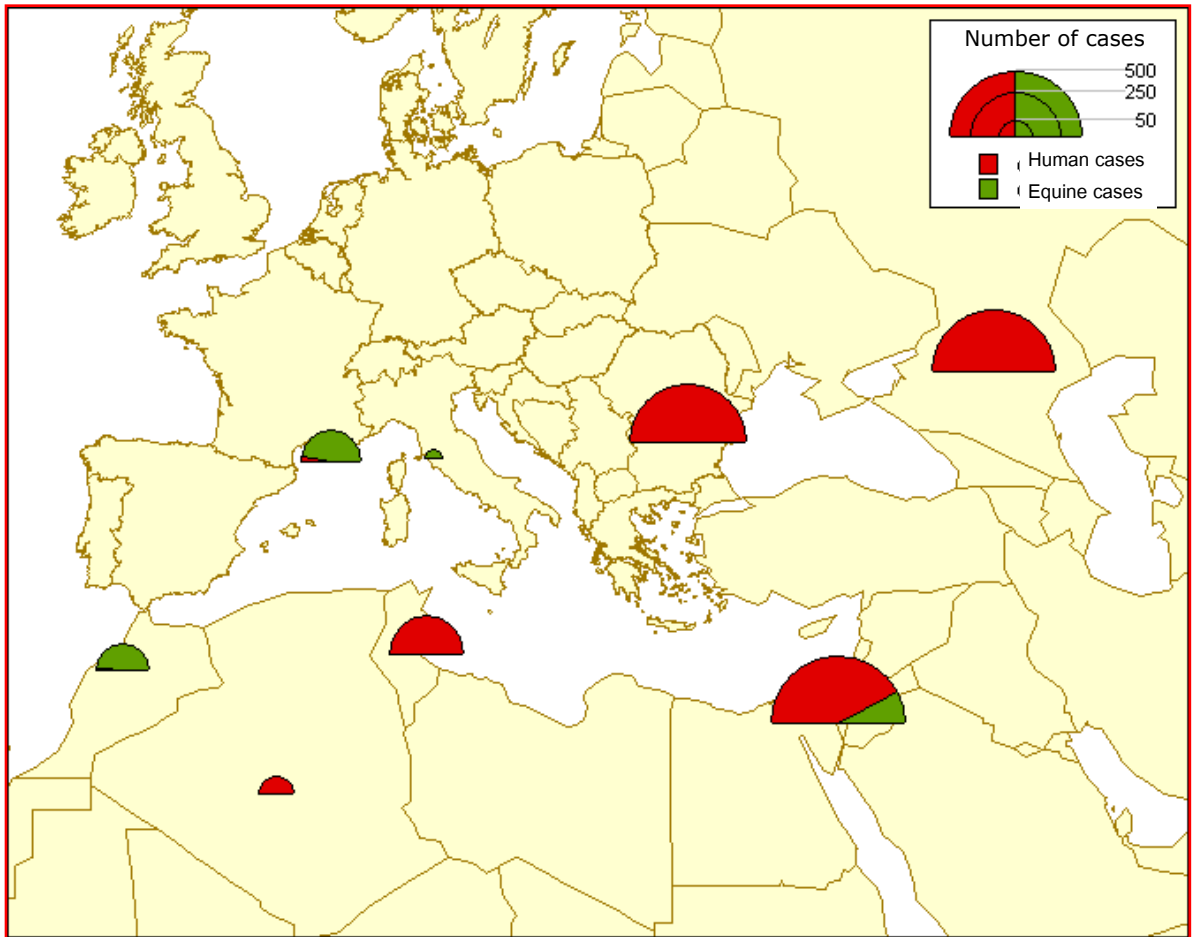
2007


Incidence per million
.01-9.99
10-99.99
>=100
Any WNV Activity
Puerto Rico

Human cases in USA

Year	Cases	Fatalities
1999	62	7
2000	21	2
2001	66	9
2002	4156	284
2003	9862	264
2004	2539	100
2005	3000	119
2006	4268	177
2007	3510	109

WNF outbreaks in Europe and Mediterranean area since 1994



Dauphin et al., Virologie, 2006

Country	Year	Human cases	Human deaths	Equine cases	Equine deaths
Czech Rep	1997	2	0		
France	2000			76	21
	2003	7	0	4	1
	2004			32	7
	2006			5	1
Italy	1998			14	8
	2008	3	0	68	ND
Spain	2004	1	0		
Portugal	2004	2	ND		
Hungary	2003	14	0		
	2008	12	0	10	2
Romania	1996	393	17		
	1997	15	0		
	1998	5	0		
	1999	7	0		
	2000	13	0		
	2008	2	0		
Russia	1999	826	40		
	2000	56	ND		
	2001	64	ND		
	2004	3	0		
	2005	90	3		
	2006	6	0		
	2007	54	2		

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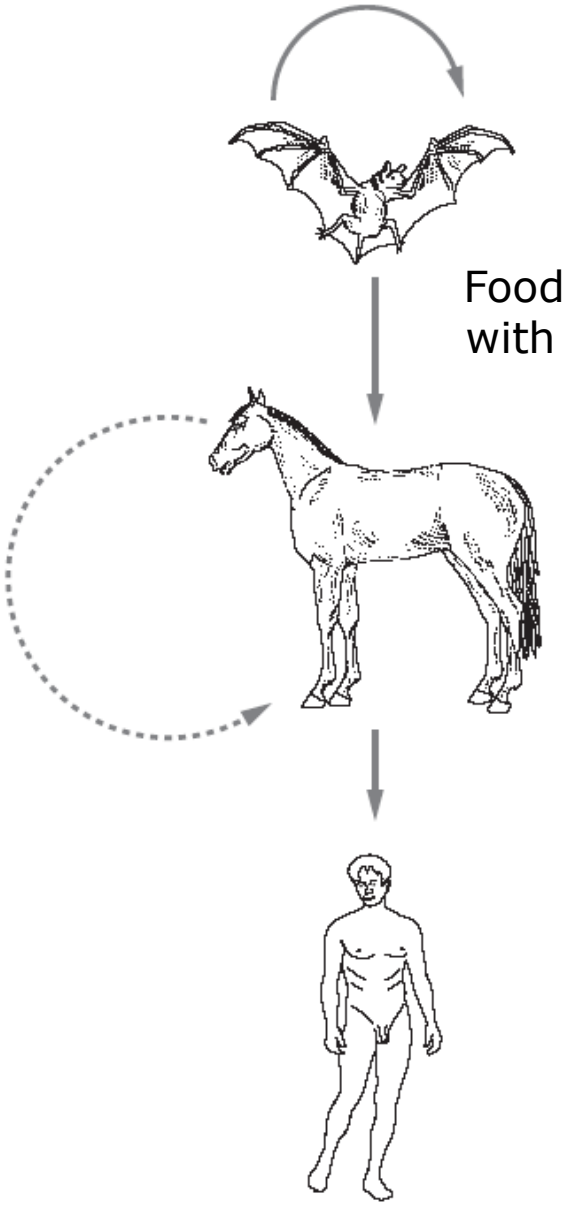
Zoonotic emerging infectious diseases

HENIPAVIRUS INFECTIONS: NIPAH AND HENDRA

PARAMYXOVIRIDAE
HENIPAVIRUS

Hendra and Nipah viruses: bats are reservoir



Flying foxes
Pteropus

Hendra virus: zoonotic aspects

- *Contact with an infected horse*
- *Respiratory infection*
- *Myalgia*
- *Fever*
- *Coma*
- *Meningo-encephalitis*
- *Death*

Nipah disease: zoonotic swine disease

- *1998-1999*
- *Malaysia*
- *Pigs*
  - **Respiratory signs (cough, dyspnea)**
  - **Nervous signs, seizures**
  - **Deaths**
- *Humans*
  - **Clinical signs similar to Japanese encephalitis**
  - **1997: dealy fatal encephalitis in a worker**
  - **1998 : 10 deaths**
  - **1999 : over 20 workers: 7 ill and 5 dead**

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Vector-borne animal emerging infectious disease

AFRICAN SWINE FEVER (ASF)

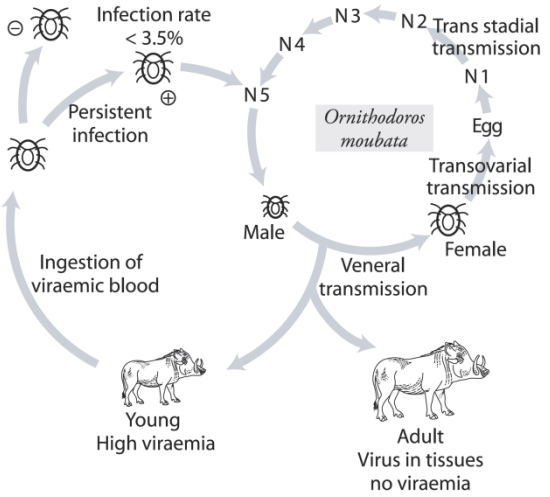
ASFARVIRIDAE
ASFIVIRUS

AFRICAN SWINE FEVER IN BELGIUM IN 1985

The virus is highly resistant and remains infective in fresh and frozen pig meat and other pork products. An epidemic of African swine fever started in Belgium in March 1985. The first outbreak occurred on a small farm. The boar had been fed with waste provided by a neighbour who had returned from holiday in Spain. It is probable that this was the origin of the epidemic. Eleven outbreaks were recorded. The virus was transmitted via contaminated syringes and needles, as well as by animal movement. Despite the high resistance of the ASF virus, the absence of tick vectors and the efficacy of the sanitary measures meant that the epidemic was rapidly brought under control. The disease was eradicated in September of the same year.

(Thiry, 2005)

African swine fever: A systemic hemorrhagic disease



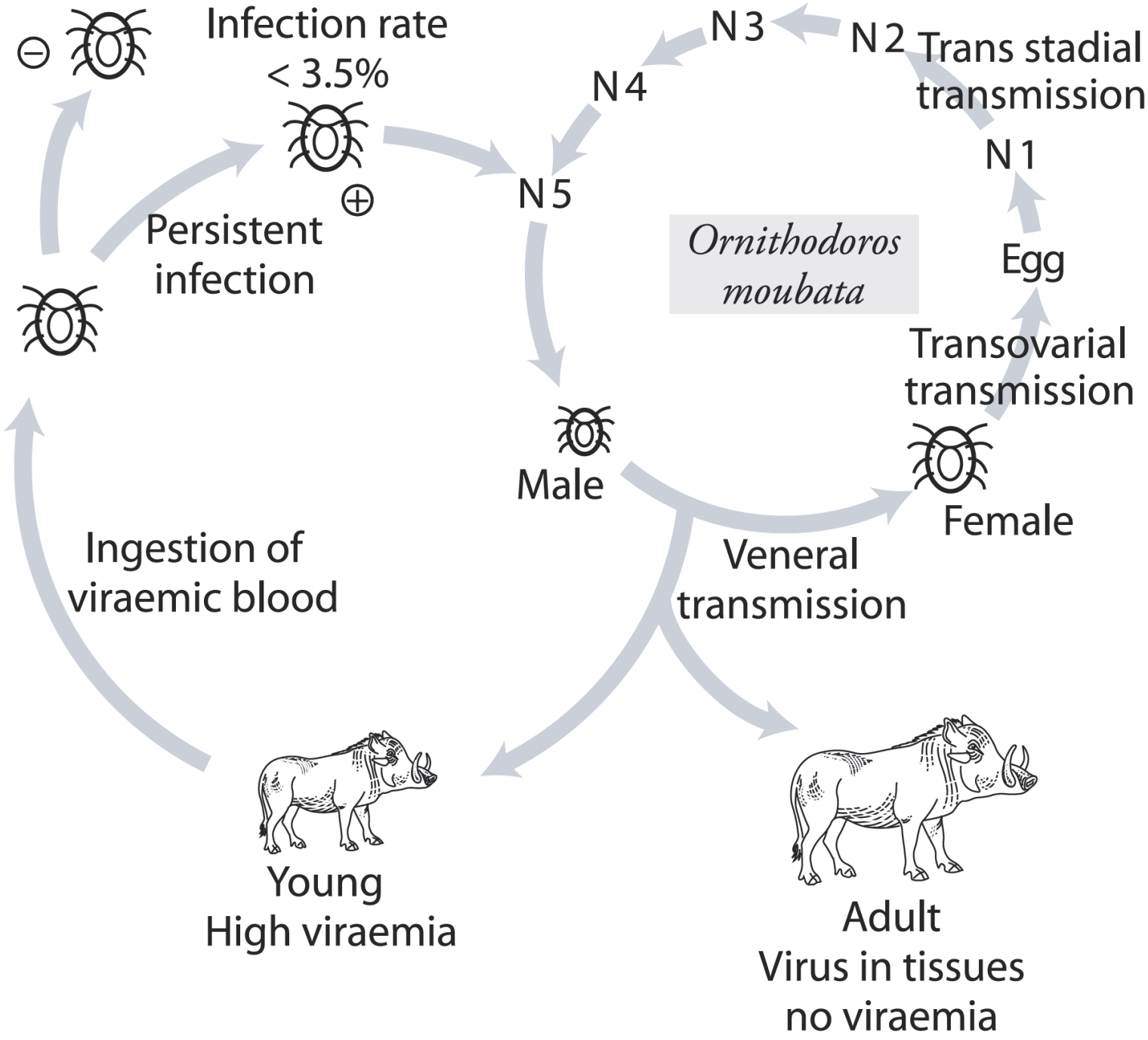
Epidemiology: transmission

- *Vector carriage: soft ticks*
  - **Iberic peninsula: *Ornithodoros erraticus* (pigs in oak forests)**
  - **Africa : *Ornithodoros moubata porcinus***
- *Asymptomatic reservoirs : wild suids*

  Warthog *(Phacochoerus oethiopicus)*
  Bush pig *(Potamochoerus porcus)*
  Giant forest hog *(Hylochoerus meinertzhageni)*
- *Contacts between pigs*
- *Ingestion of contaminated food*
- *Iatrogenic route*

Epidemiology: virus cycle

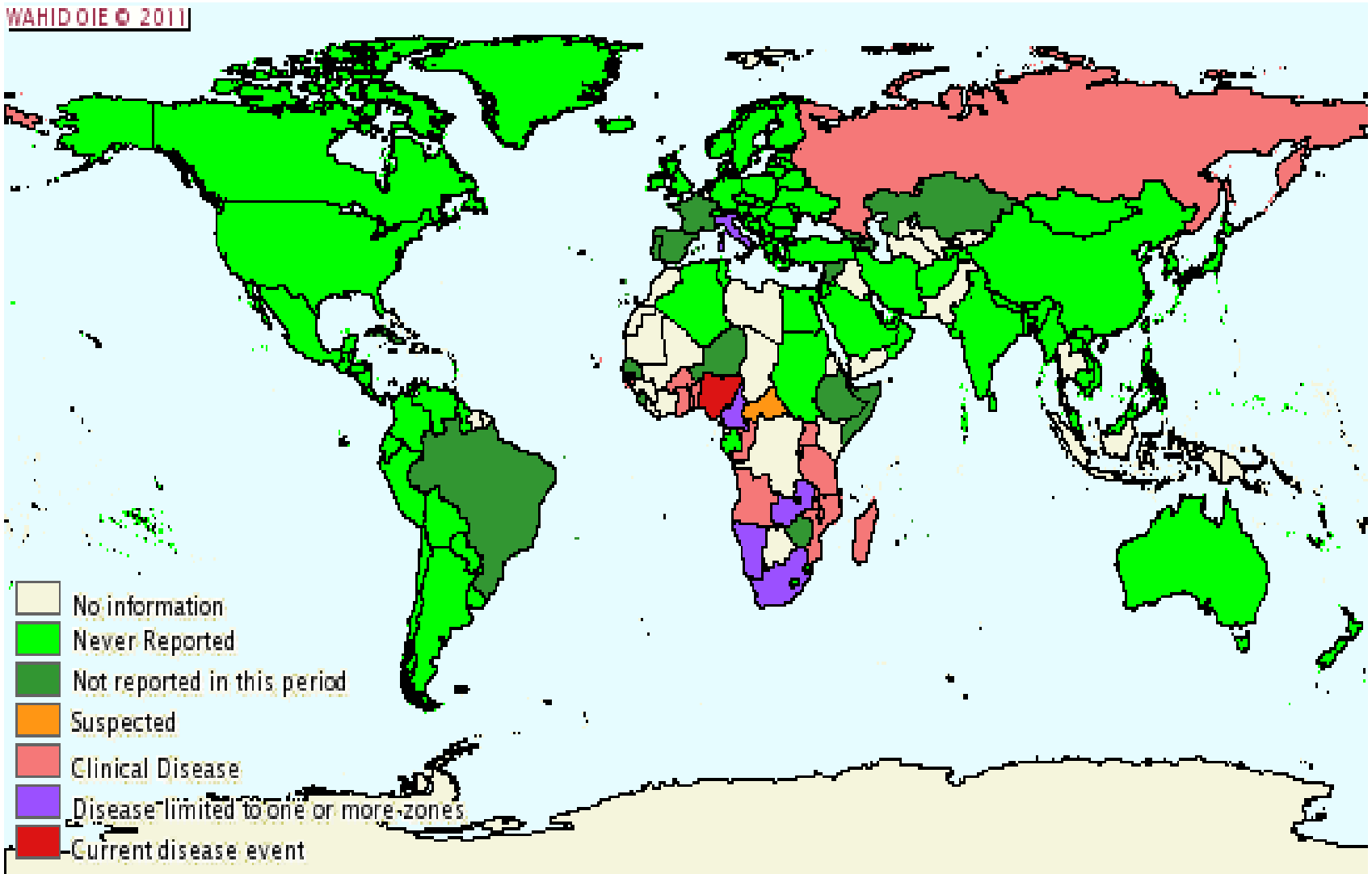
- *Sylvatic cycle:*
  - **Tick**
  - **Wild suid (chronic persistent infection)**
- *Intersect between sylvatic cycle and domestic pigs*
  - **Onset of outbreaks**
- *Outbreaks within pigs*
  - **Sustained by a transmission in the absence of vector**
  - **Can be initiated without any sylvatic cycle**
  - **Importance of feed contamination**


Infection rate
< 3.5%
Persistent
infection
N 5
N 4
N 3
N 2
N 1
Trans stadial
transmission
Egg
Transovarial
transmission
Female
Male
Veneral
transmission
Ingestion of
viraemic blood
Young
High viraemia
Adult
Virus in tissues
no viraemia
Ornithodoros
moubata

(Thiry, 2005)

European Commission

ASF geographical distribution 2009



Blue face

Blue ears

Cyanosis of the bottom of the body

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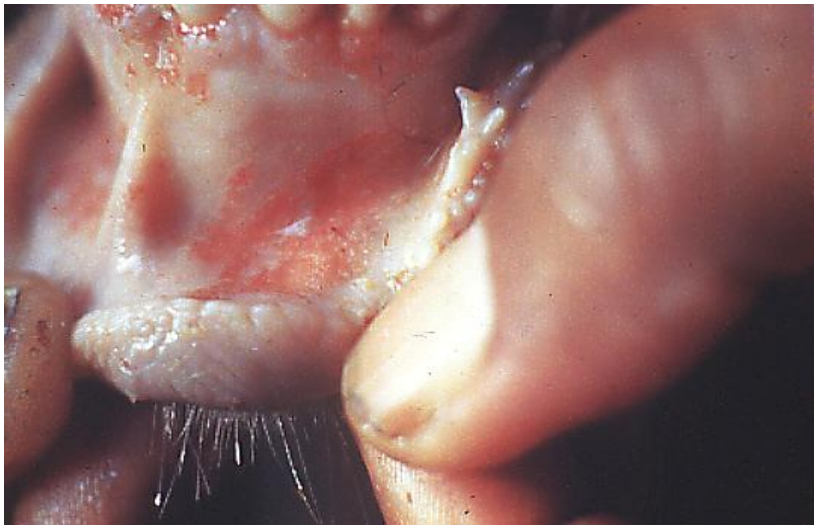
Animal emerging infectious disease

PESTE DES PETITS RUMINANTS (PPR)

PARAMYXOVIRIDAE
MORBILLIVIRUS

Clinical expression of PPR

- *Peracute form*
  - **Nasal discharge, diarrhea**
  - **Mortality 100%**
- *Acute form*
  - **Nasal discharge, diarrhea, oral lesions, abortions**
- *Subacute and chronic forms*
- *Differentiation with rinderpest (eradicated)*



GLOBAL RINDERPEST ERADICATION PROGRAMME

Why action now... ...is more important than ever

WITHIN the next decade there is a very real prospect that rinderpest will become, like smallpox in humans, a disease of the past. Today, as we enter a new millennium, progress made by the Global Rinderpest Eradication Programme (GREP), has limited the disease to a small number of sites in eastern Africa, South Asia and the Middle East. But the spectre of cattle plague, with its devastating epidemics of the past, continues to be a threat as long as these few small areas continue to harbour rinderpest. So, intensified action for these remaining pockets of rinderpest infection is being promoted and co-ordinated by FAO under GREP.

Eradication by 2010

GLOBAL RINDERPEST ERADICATION PROGRAMME FAO/AGA

GREP

THE END OF RINDERPEST

ON

28 JUNE 2011 A DEADLY DISEASE WILL BE OFFICIALLY ERADICATED FROM THE EARTH.

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European Commission

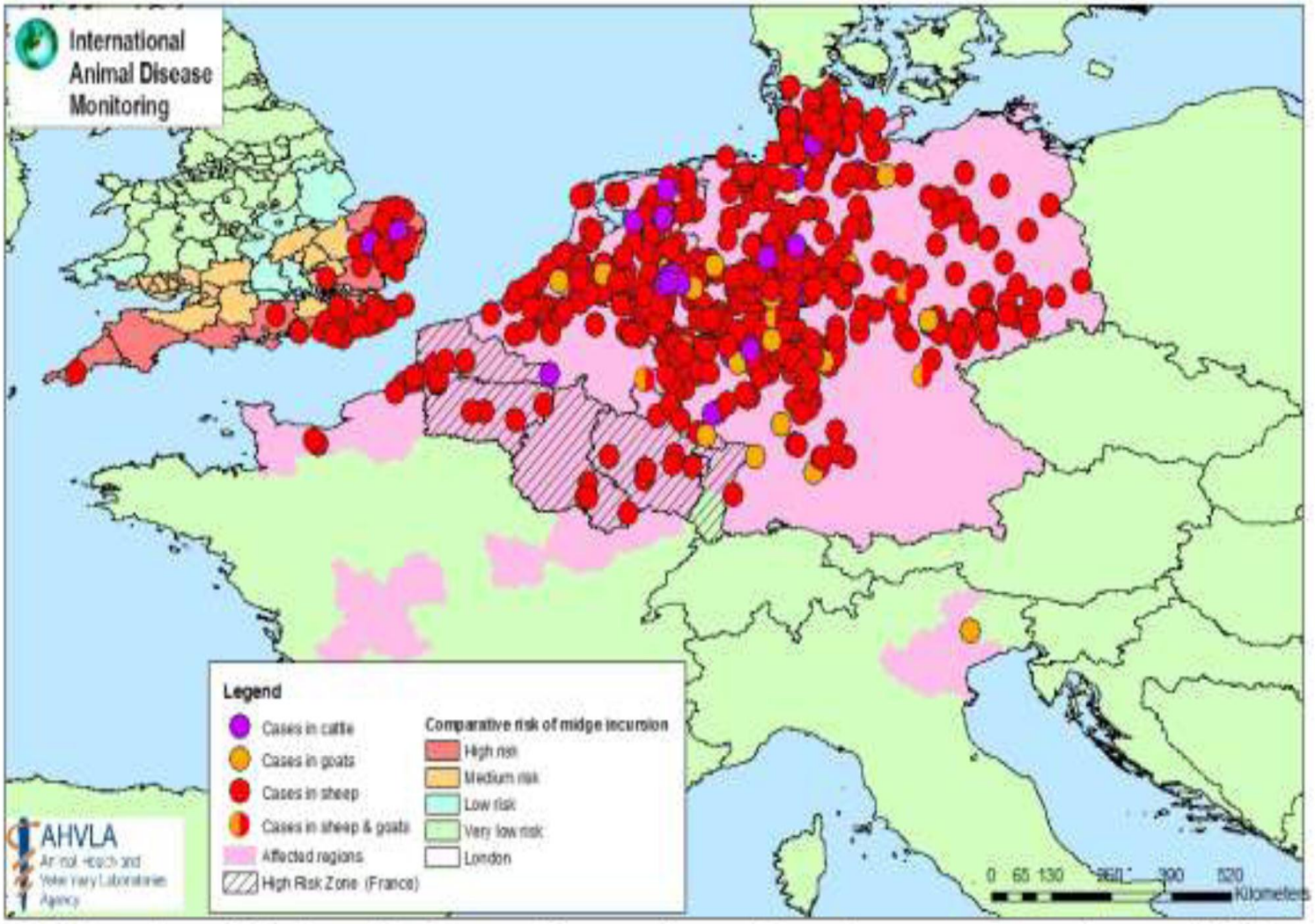
Vector-borne animal emerging infectious disease

SCHMALLENBERG VIRUS INFECTION

BUNYAVIRIDAE
ORTHOBUNYAVIRUS

Geographical distribution of Schmallenberg virus infection

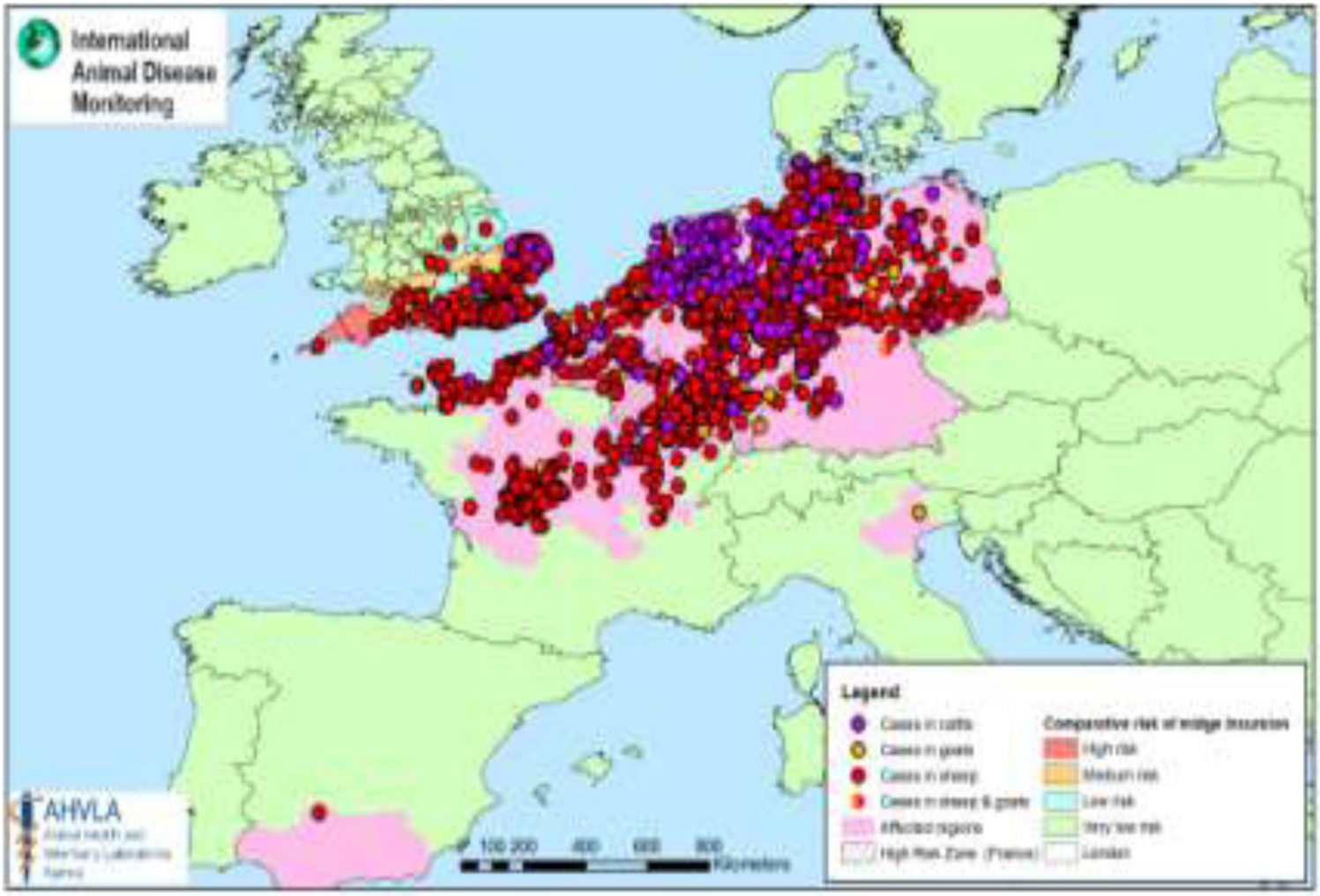
(22 February 2012)



http://www.defra.gov.uk/animal-diseases/monitoring/

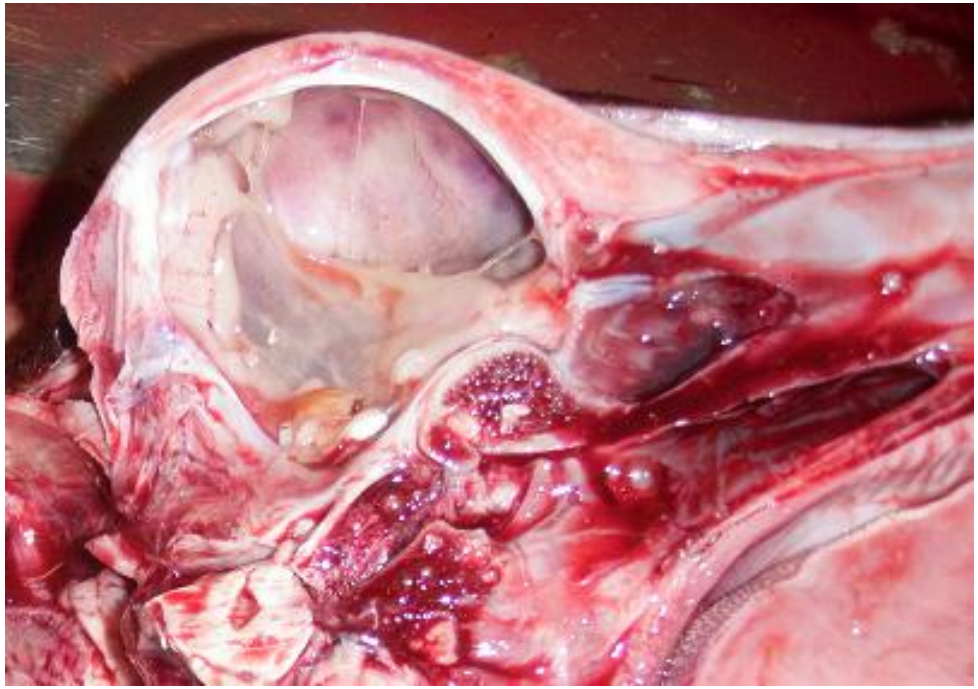
Geographical distribution of Schmallenberg virus infection

(26 March 2012)



http://www.defra.gov.uk/animal-diseases/monitoring/

Congenital abnormalities in lambs and calves (fetuses)



Hydranencephaly

Arthrogryposis

Incidence of Schmallenberg virus infection
(26th March 2012)

Country	Sheep	Cattle	Goat
Netherlands	104	102	5
Belgium	161	121	2
Germany	825	201	44
France	824 (2)	59	9 (2)
Italy			1
Luxemburg	5 (1)	1	(1)
UK	203	20	
Spain	1		1

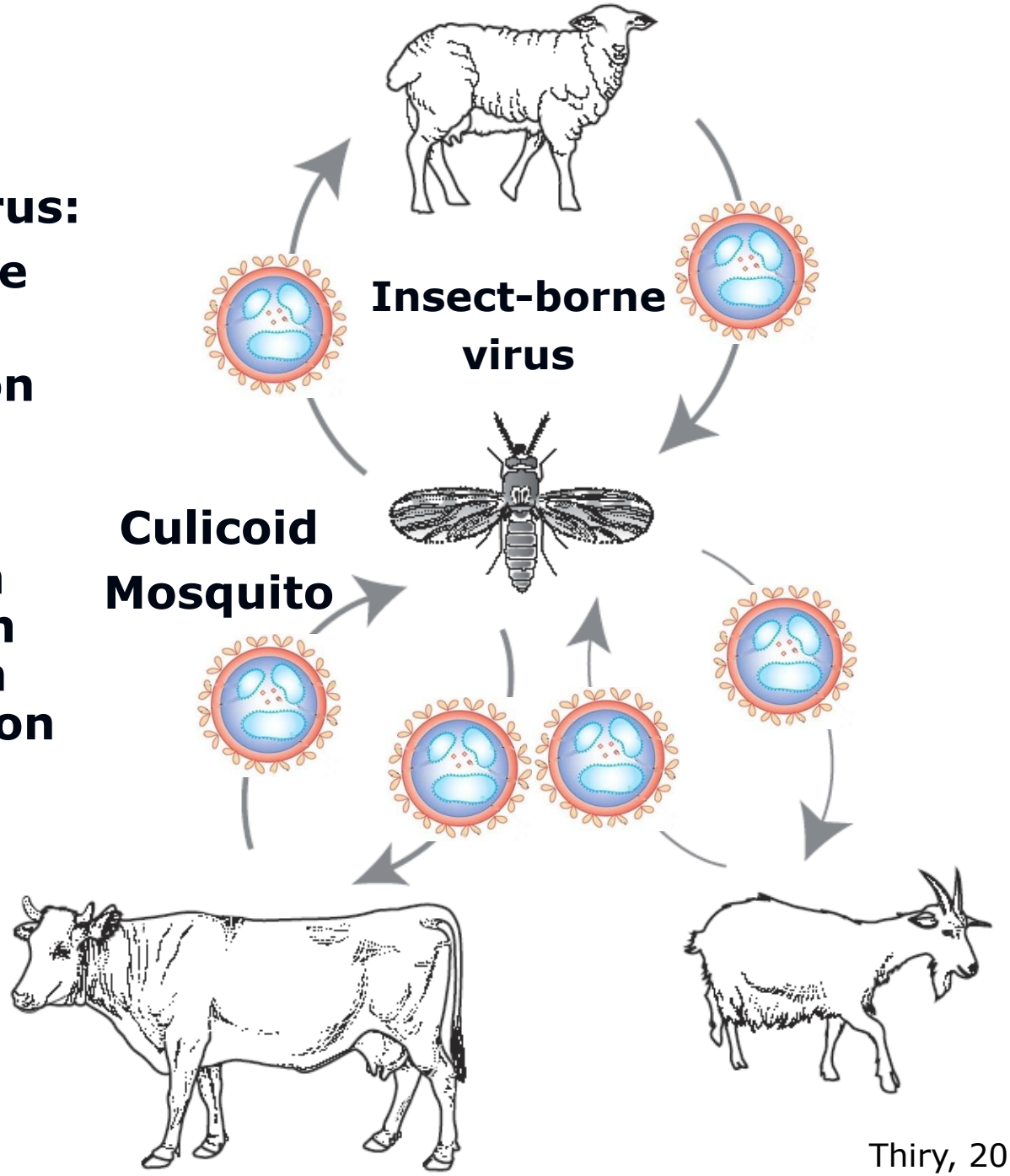
Ruminant orthobunyavirus:

in vertebrate host:

lytic infection

In the arthropod:

transovarian and venerean transmission chronic infection



Thiry, 2007

Orthobunyavirus

- *170 isolated viruses*
  - **48 species**

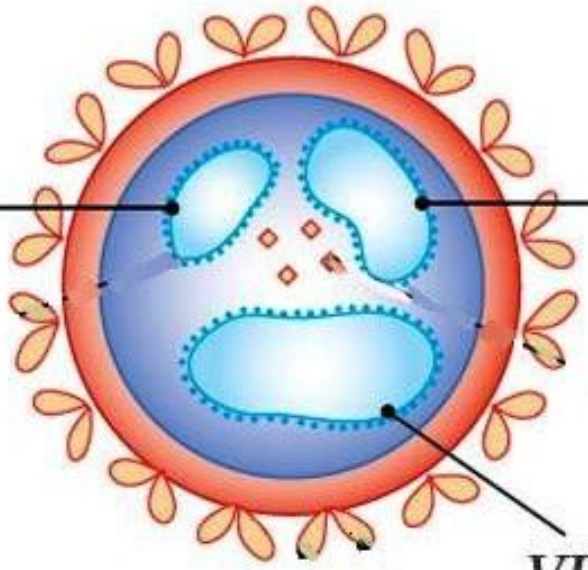
    18 serogroups
- *Serogroup Simbu (genetic characterisation)*
  - **Zoonotic viruses: virus Iquitos and Oropouche**
  - **Ruminant viruses**

    Akabane virus (Asia; Australia)

    Aino virus (Asia; Australia)

    Shamonda virus (Nigeria; Japan)
  - **+ Schmallenberg virus**

Schmallenberg virus



VIRAL RNA SEGMENT S

96% similarity with Shamonda virus

VIRAL RNA SEGMENT M

48% similarity with Aino virus

VIRAL RNA SEGMENT L

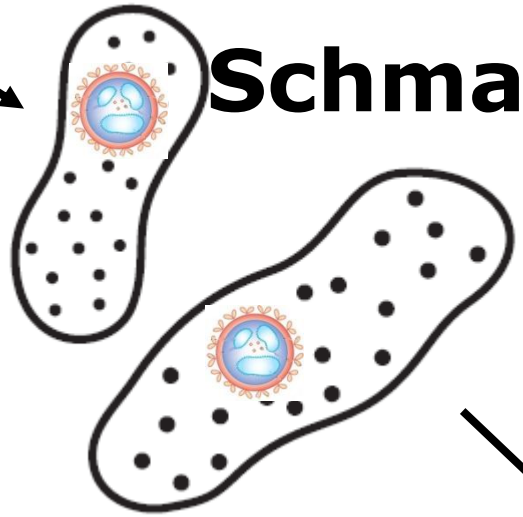
70% similarity with Akabane virus

3 RNA segments: REASSORTMENT possible

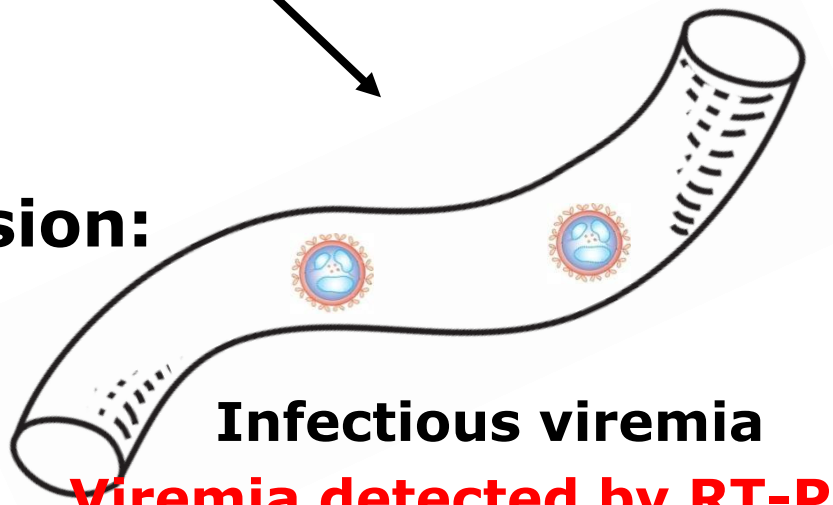
Thiry, 2007

Pathogenesis of infection with Schmallenberg virus

Culicoid (or mosquito) bite



Regional lymph nodes



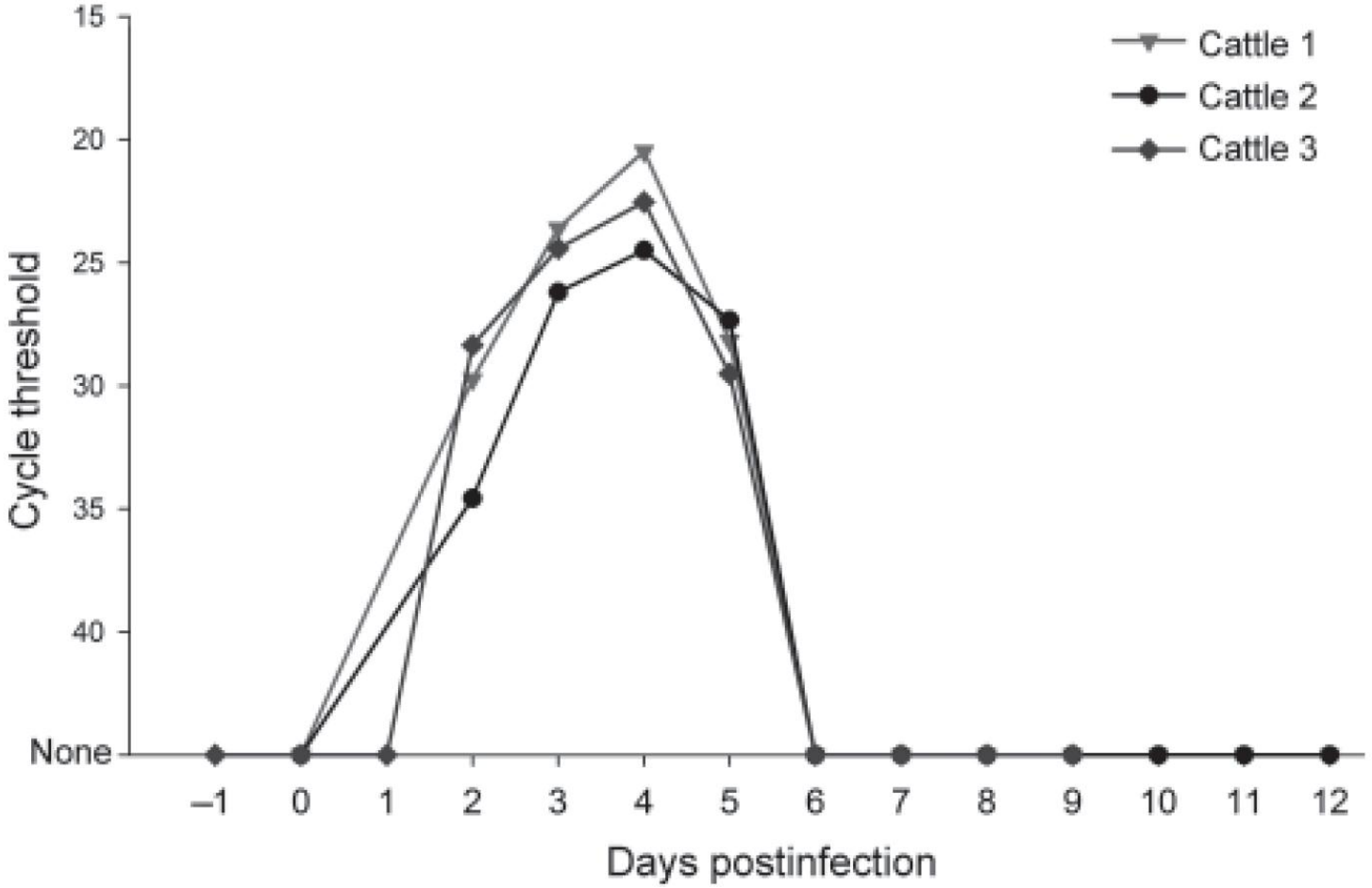
Infectious viremia

Other route of transmission:
-Transplacental

Viremia detected by RT-PCR

Short duration (2 to 5 days)

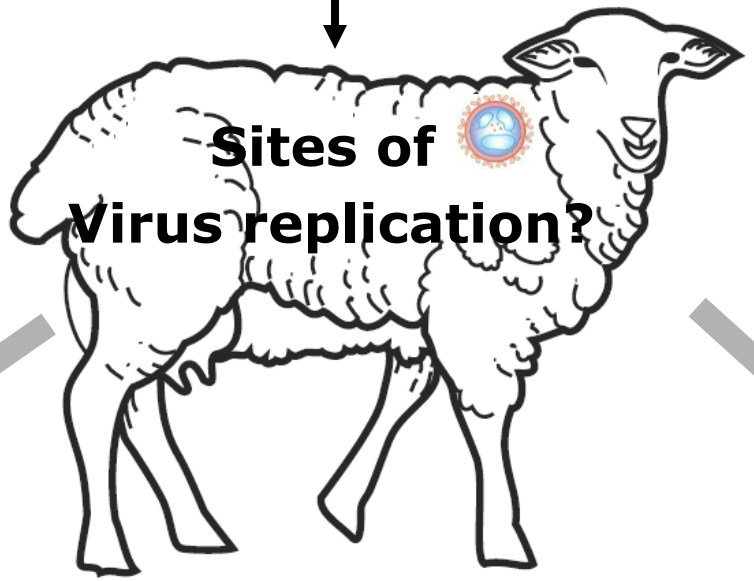
Viremia (RNA PCR) in experimentally infected calves



Hoffmann et al., 2012

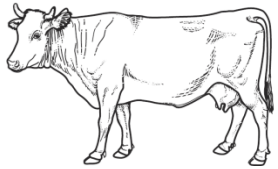
Pathogenesis of infection with Schmallenberg virus

Viremia



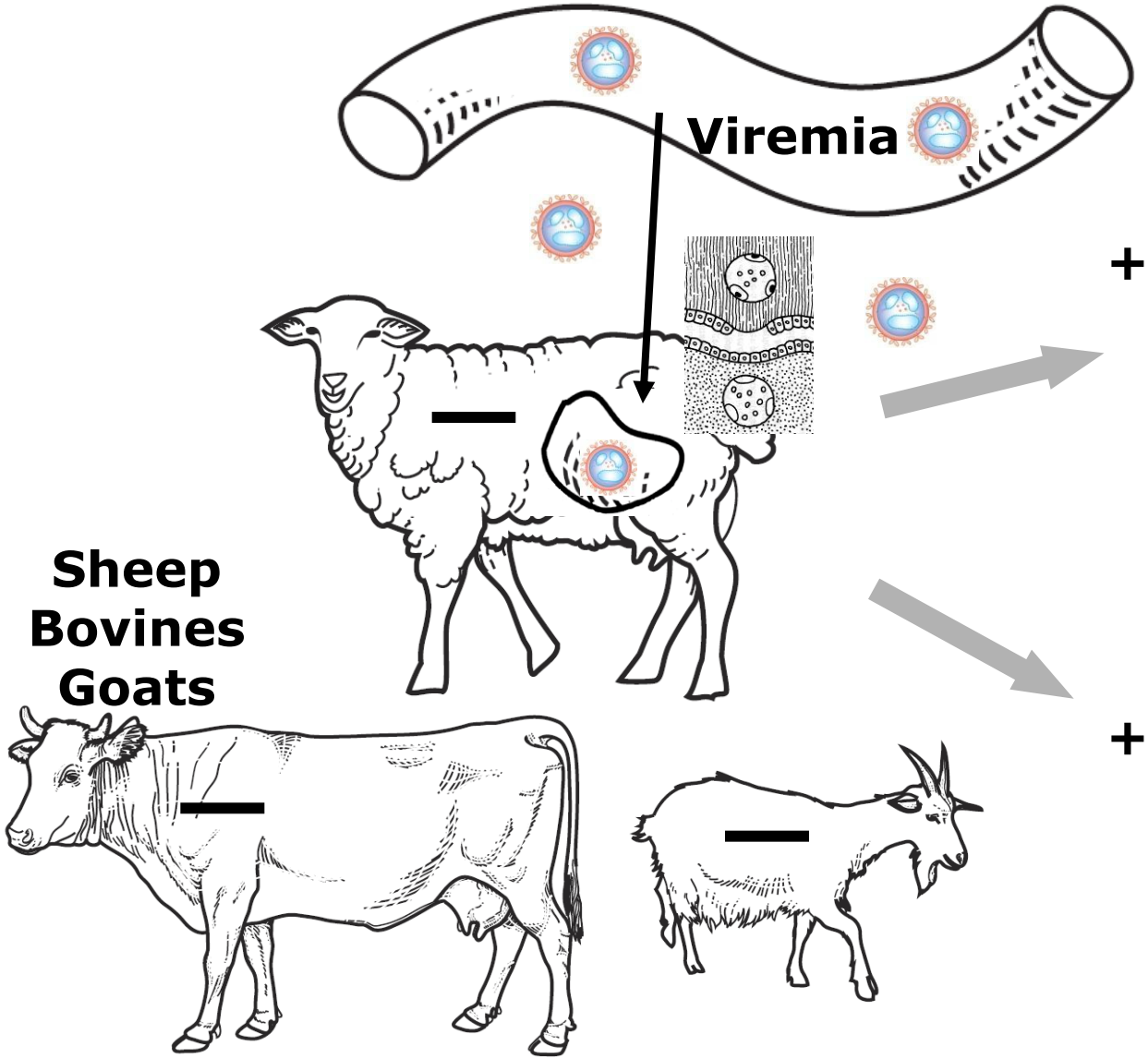
Sites of Virus replication?

Neutralising antibodies



General clinical signs:
Fever, anorexia, diarrhea
Drop of milk production

Pathogenesis of infection with Schmallenberg virus



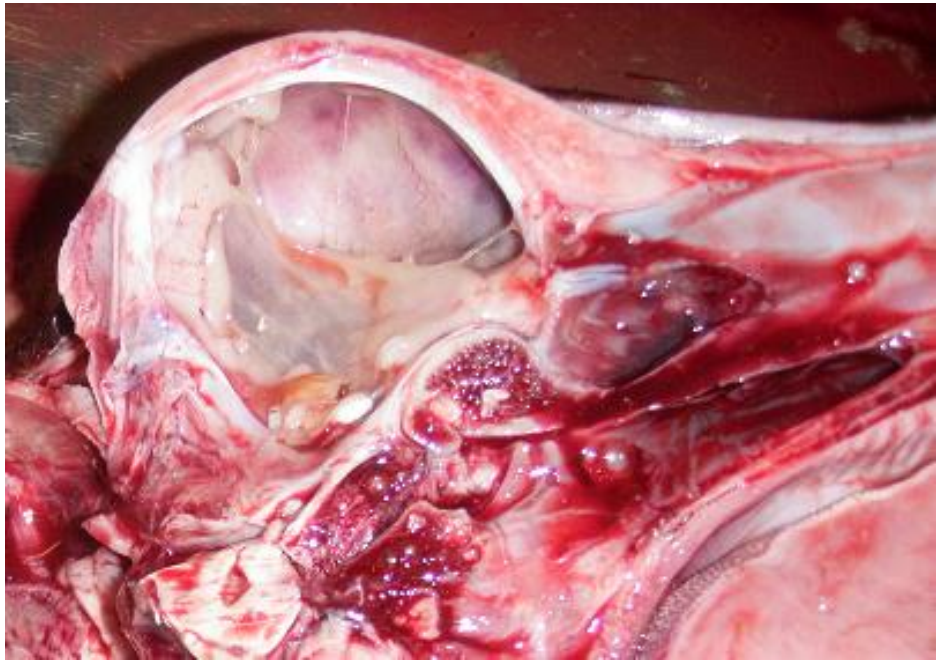
Schmallenberg in adult animals

- *Subclinical infection*
  - **In sheep**
- *Non specific clinical signs in dairy cattle*
  - **Fever**
  - **Diarrhea**
  - **Reduction in milk production**
- *Subclinical infection of pregnant females is of upmost importance*

Arthrogryposis

Arsia asbl

Hydranencephaly – porencephaly - anencephaly



Arsia asbl

Clinical suspicion

- *Suspicion : ovine > bovine > caprine*
  - **Adult animal (not pathognomonic)**
    Decrease of the general condition
    Drop in milk production
  - **Abortion or stillborn**
    Congenital abnormalities
- *Sampling*
  - **Living animal**
    Whole blood and serum
    Nasal swab and diarrheic sample
  - **Abortion or stillborn:**
    Whole fetus
    Meconium

http://www.favv.be/santeanimale/schmallenberg/

Diagnosis of Schmallenberg virus

- *Virology*
  - **Isolation in cell culture**
    Only experimental
  - **PCR : quickly set up**
- *Serology*
  - **Seroneutralisation**
  - **ELISA**
    As for other orthobunyavirus
    Current setting up

Thank you for your attention