Bienvenue !

3ème colloque scientifique du réseau Arbo-France

24-25 octobre 2023, Institut Pasteur - Paris

Day 1: Preparedness and response to emerging arboviruses.

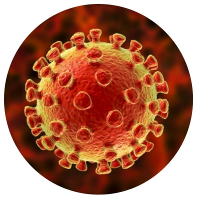
Welcome

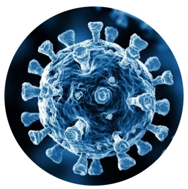
By Yazdan Yazdanpanah

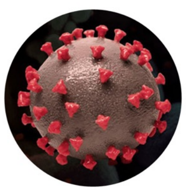
Day 1: Preparedness and response to emerging arboviruses.

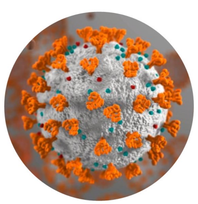
Update of Arbo-France

By Xavier de Lamballerie









Arbo-France
Réseau Français d'étude des arboviroses

Arbo-France

3ème colloque scientifique

24-25 octobre 2024

https://arbo-france.fr

Objectifs

Les objectifs de Arbo-France sont :

- de créer un système de veille et d'alerte auprès de l'ANRS | Maladies infectieuses émergentes
- d'améliorer la visibilité de la recherche sur les arbovirus en France et à l'international
- d'aider aux montages de projets de recherche
- d'apporter une expertise scientifique

Début 2023, Arbo-France publiait sa stratégie de la recherche sur les arboviroses humaines et animales qui est disponible ci-dessous :

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Mise à jour 2024 : complément de la stratégie scientifique du réseau Arbo-France

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Plus de projets…

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Projets financés, 2022-2024

1. Appel à projets Émergence – pays à revenu faible et intermédiaire (PRFI)

- Surveillance et contrôle des Arbovirus au Burkina Faso selon une approche globale
- Arbovirus (ré)émergents en milieu insulaire en Océanie

2. Appel à Projets PEPR-MIE

- **LSDengue** : Déterminants de la dengue grave dans les territoires français ultramarins.
- **CAZIKANO** : Prévention et Contrôle du Risque Infectieux des Souches Africaines Contemporaines du virus Zika.
- **ACME**: Savoirs, politiques et expériences de la fièvre hémorragique Crimée-Congo aux frontières de l'Europe.

3. Appel à projets PREZODE

- **ARCHE**: Évaluation du risque d'émergence de la fièvre hémorragique de Crimée-Congo dans le sud de la France.
- **AMAZED**: Risque d'émergence arbovirale via les moustiques en Guyane et dans des milieux insulaires,
- **ZOOCAM** : Gestion adaptative intégrée des zoonoses

4. Autres financements ANRS

- Infection à Chikungunya de la mère à l'enfant à Jayavarman VII. 2020, Cambodge
- Circulation des arbovirus WN et Usutu en Nouvelle Aquitaine. 2023

5. Autres financements hors ANRS

- Seroprevalence survey among blood donors.
- Assessment of safety and immunogenicity of dengue vaccination in sickle-cell patients (Sickle-Arbo):
- Seroprevalence of TBE in France: an observational prospective study.

6. Bourses de thèse Arbo-France

Résultats AAP 2022

- Development of the sterile and the incompatible insect techniques (SIT-IIT) as part of integrated *Aedes albopictus* control in Mexico
- How insecticide resistance can affect Wolbachia-induced resistance to arbovirus transmission

Résultats AAP 2023

- Understanding behavioral plasticity across Aedes aegypti populations to enhance surveillance and vector control strategies
- *Spatial Risk assessment of tick-borne zoonoses in the "One Health" framework : joint modelling of tick-borne encephalitis and Lyme Borreliosis in France.* ***Ce doctorant ayant également bénéficié d'une bourse de l'université Paris 7, la bourse Anrs a été attribuée au candidat suivant.***
- Development of a new sero-diagnostic test for the specific detection of Dengue and Zika Flavivirus infections.
- Functional characterization of the Alphaviruses Macro domain: Application as a new target for the development of anti-viral agents.

Résultats AAP 2024

- Multitrophic interactions in Wolbachia-based strategy against dengue virus: a focus on insect-specific viruses (MintS).
- Avian and equine surveillance for two flaviviruses in Burkina Faso: Usutu virus and West Nile virus

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Plus de projets
Mieux financés
Plus interdisciplinaires
Impliquant davantage les TUMs

Plus de bourses de thèses

Plus de visibilité

Qui sommes-nous ? Que faisons-nous ? Act

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Plus de visibilité

Accompagnement réussi de la mise en place de l'ANRS MIE

Objectifs principaux atteints

Nécessité d'un bilan et d'une remise en cause pour préparer l'avenir

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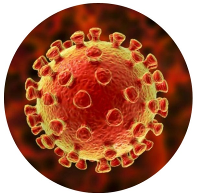
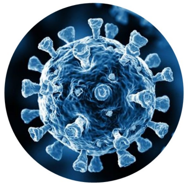
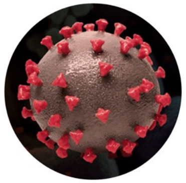
La stratégie d'Arbo-France se structure autour de trois compartiments :



- Principes Généraux,

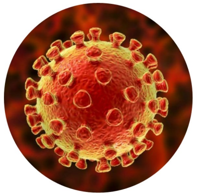


- Acquisition de Connaissances,



- Préparation & Réponse aux émergences

A - Principes généraux



Arbo-France est un réseau

- Inclusif : continuum de partenariats allant de la surveillance à la recherche et qui se situe au-delà des prérogatives institutionnelles.

- Intégrant la dimension One Health, la santé humaine, animale et environnementale, l'étude des écosystèmes et les sciences sociales.

- Intégrant et structurant la recherche dans, avec et entre les Territoires ultramarins.

- Développant des activités de mise en réseau, d’animation scientifique, de contribution à l’expertise pour les pouvoirs publics et de communication.

Organisation

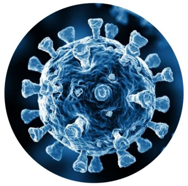
ANRS-MIE

Département Stratégie et Partenariats

Arbo-France

8 membres	**Comité d'Orientation Stratégique**	Stratégie scientifique Lien avec les principaux partenaires
17 membres	**Comité de Pilotage**	Lien avec les experts Mise en place et suivi des groupes de travail Organisation réunions scientifiques
200 membres	**Comité d'experts** *Surveillance épidémiologique* *Veille scientifique*	Réunions d'informations Participation aux groupes de travail Expertise

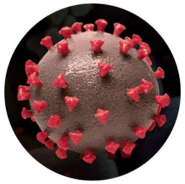
B - Acquisition de Connaissances



Une attention particulière est apportée au soutien à la recherche fondamentale et aux domaines de recherche plus négligés :

- Mécanismes d’émergence et de diffusion des épidémies/épizooties
- Franchissement de la barrière d’espèces, déterminants de la capacité vectorielle, bases et conséquences de l'immunité croisée, impact du changement climatique, étude des écosystèmes et impact de leur anthropisation sur la dynamique des arboviroses.

C - Préparation et Réponse aux émergences arbovirales humaines et animales



- SCÉNARIOS D’ÉMERGENCE
    - OUTILS DE RECHERCHE ET DE SURVEILLANCE
        - NOUVELLES STRATÉGIES DE CONTRÔLE VECTORIEL
            - APPUI AUX STRATÉGIES D’INTERVENTIONS

Scénarios d'émergence

- Simulation d'une situation d'émergence concrète
- État des lieux
- Identification des manques et des besoins
- Recommandations: priorités d'action et de recherche

*Dans le cadre du groupe de travail « Préparation aux émergences arbovirales », **le premier scénario développé a été celui d'une émergence de la Fièvre Jaune aux Antilles**. Un document a été rédigé proposant des priorités d'actions et de recherche à développer en anticipation de l'émergence mais aussi pendant et après l'émergence.*

Outils de recherche et de surveillance

- *Cohortes*
  - *Études de séroprévalence*
    - *Systèmes de surveillance innovants*
    - *Diagnostic & Génomique virale*

Outils de recherche et de surveillance

Préparation et Réponse aux émergences arbovirales humaines et animales

- **Cohortes**: L'objectif est de bâtir un réseau multicentrique de centres adhérents dans les différents territoires ultramarins (TUM) et la métropole, à partir du modèle de la cohorte CARBO.

Projet LSDengue (PEPR-MIE 2023) *: déterminants de la dengue sévère dans les TUM. Emblématique de la structuration multi-territoires recherchée par Arbo-France.*

Outils de recherche et de surveillance

Préparation et Réponse aux émergences arbovirales humaines et animales

- **Études de séroprévalence**: L'objectif est de remédier à l'absence d'études de séroprévalence permettant de documenter la circulation des arbovirus en France métropolitaine et dans les TUM. La première étape se fera à travers une mobilisation des infrastructures de don de sang.

Un premier projet de recherche a été mis en place dans une population de ***50 000 donneurs de sang français avec un financement de la fondation Pfizer****. Il a pour objet l'analyse de la circulation du virus* ***TBE en France métropolitaine****, avec une* ***extension en cours au virus WNV et USUV****. Il a également servi de base pour répondre à la CTV (vaccin dengue). Autres études en préparation: WNV en Aquitaine, DENV chez les enfants en Martinique etc..*

Outils de recherche et de surveillance

Préparation et Réponse aux émergences arbovirales humaines et animales

- **Systèmes de surveillance innovants**: L'objectif est de favoriser les actions de recherche permettant d'améliorer la surveillance des arbovirus zoonotiques et non zoonotiques.

- Journée scientifique West Nile Nov 2023.

*- GT multidisciplinaire intitulé « **recherche et innovation pour l'amélioration de la surveillance des arboviroses zoonotiques** » mis en place début 2024. Projet de recherche multidisciplinaire One Health basé sur la surveillance du virus WN et intégrant les volets oiseau, cheval et moustique, soumis au PEPR Prezode 2024.*

*- GT « **détection des arbovirus dans les eaux usées en collaboration avec Obépine** » : dengue et WN, approche technologique et expérimentale.*

- Fusion des 2 GT et restructuration.

Outils de recherche et de surveillance

Préparation et Réponse aux émergences arbovirales humaines et animales

- **Diagnostic et génomique virale**: Les objectifs sont : (i) Accélérer la mise à disposition de tests moléculaires ; (ii) Accélérer la mise au point de tests antigéniques et/ou sérologiques rapides et de tests multi-cibles ; (iii) Améliorer la détection d'arbovirus dans des échantillons biologiques d'animaux ; (iv) Accélérer les études génomique et métagénomique.

*- **Diagnostic** : une **bourse de thèse ANRS MIE Arbo-France** 2023 porte sur le développement d'un nouveau test de sérodiagnostic de la dengue, du virus Zika et des infections par les flavivirus.*

*- **Génomique** : financement obtenu pour le projet **ARBOGEN** et coordination avec le programme EMERGEN.2 et la mise en place d'une UMS dédiée, par l'Inserm.*

Nouvelles stratégies de contrôle vectoriel

Préparation et Réponse aux émergences arbovirales humaines et animales

- Les objectifs sont :
  - de **disposer d'une expertise forte** portant sur les **nouvelles méthodes de contrôle vectoriel**, au-delà des méthodes de lutte chimique en fin de cycle de développement.
  - d'accompagner par la recherche la **mise en place** et l'**évaluation** de ces méthodes
  - de prendre en compte aspects réglementaires et éthique

- *Colloque scientifique Arbo-France 2022 : nouvelles stratégies de lutte antivectorielle.*
- *2 bourses de thèse Arbo-France 2022 concernent les nouvelles méthodes de lutte antivectorielle:*

  - How insecticide resistance can affect Wolbachia-induced resistance to arbovirus transmission (Nelle Calédonie)

  - Development of the sterile and incompatible insect techniques (SIT-IIT) as part of integrated Aedes albopictus control in Mexico

- Journée scientifique sur les nouvelles méthodes de LAV en 2025 : Rationnel et stratégie d'utilisation, méthodologie d'évaluation, place de la modélisation et des SHS

Stratégies d’intervention

Préparation et Réponse aux émergences arbovirales humaines et animales

- L'objectif est d’accompagner le déploiement des nouvelles interventions, pharmaceutiques ou non-pharmaceutiques

- *Colloque scientifique Arbo-France 2022 : nouvelles stratégies de vaccination.*
- *Séroprévalence de la dengue chez les enfants aux Antilles*

- Groupe de travail en collaboration avec I-Reivac: acceptabilité d’un vaccin contre la dengue dans les TUMs et immunogénicité dans des populations particulières

Les chantiers en cours:

- Priorité maintenue pour la structuration intégrative du réseau avec les TUM
- Thématiques « en chantier » :
  - Arboviroses transmises par les tiques (TBEV, CCHF)
  - Bunyavirus (disease X)
  - Développement d’une stratégie internationale (Brésil, Cambodge..)
  - Positionnement et mise en place de projets thérapeutiques (vaccins, antiviraux)

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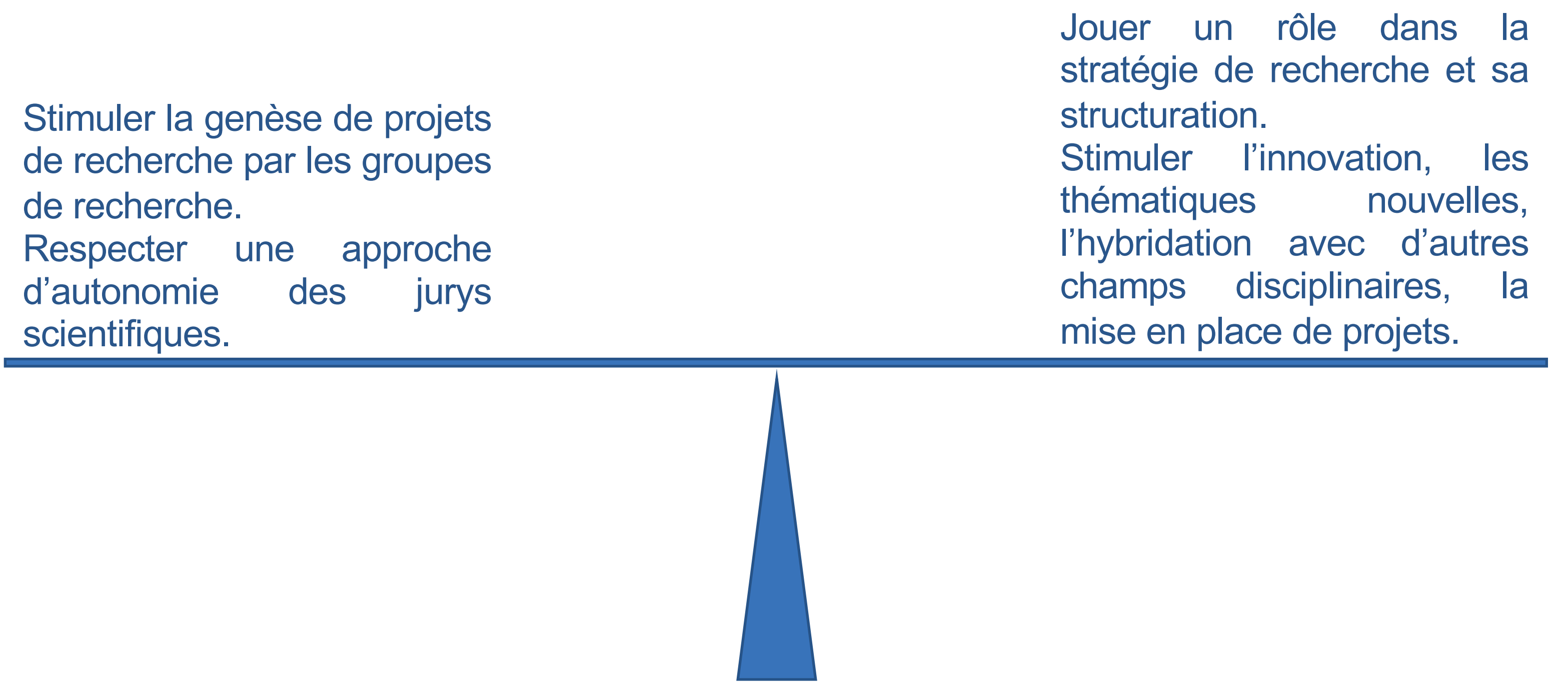
Perfectible, point d'attention spécifique

Nécessité de mettre en place un format concret de remontée des informations


Stimuler la genèse de projets de recherche par les groupes de recherche.
Respecter une approche d'autonomie des jurys scientifiques.
Jouer un rôle dans la stratégie de recherche et sa structuration.
Stimuler l'innovation, les thématiques nouvelles, l'hybridation avec d'autres champs disciplinaires, la mise en place de projets.

Discussions avec l'ANRS MIE pour:

- améliorer la remontée d'information & mieux contribuer à l'alerte
- définir comment AF peut contribuer à un pilotage stratégique
- structurer une stratégie internationale

Créer un point d'inflexion dans la trajectoire d'Arbo-France

Consulter les membres AF sous la forme d'un questionnaire pour:

- recueillir leurs éléments de satisfaction et insatisfaction
- examiner leurs attentes et propositions d'évolution

Projets financés

PEPR-MIE 2023: 11 projets financés au total

- Cazikano (PIMIT): Facteurs favorisant la transmission de Zika par les moustiques et persistance virale.
- LSDengue (CHU Martinique): Déterminants de la dengue sévère.
- ACME (IP Paris): Savoirs, politiques et expériences de la fièvre hémorragique Crimée-Congo aux frontières de l'Europe.

Projets financés

PREZODE 2023: 3 projets financés

- ARCHE: Évaluation du risque d'émergence de la fièvre hémorragique de Crimée-Congo dans le sud de la France. Université Corse/AMU.
- AMAZED: Risque d'émergence arbovirale via les moustiques en Guyane et dans des milieux insulaires, risque de diffusion dans les milieux insulaires et en France. IP Guyane
- ZOOCAM : Gestion adaptative intégrée des zoonoses. CNRS

Bourses de thèse Arbo-France

Création d'un appel à candidatures en 2022, financé par l'ANRS-MIE

- Jury international
- Ouvert à toutes les disciplines et toutes les thématiques de l'arbovirologie
- Incitation sur des thématiques à renforcer: volet animal des infections arbovirales, stratégies innovantes de vaccination et de LAV, recherche interventionnelle

Bourses 2022

- How insecticide resistance can affect Wolbachia-induced resistance to arbovirus transmission. IP Paris et IP Nelle Calédonie.

- Development of the sterile and the incompatible insect techniques (SIT-IIT) as part of integrated Aedes albopictus control in Mexico. IRD

Bourses 2023

- Understanding behavioral plasticity across Aedes aegypti populations to enhance surveillance and vectorielle control strategies. IP Guadeloupe & IP Guyane.

- Functional characterization of the Alphaviruses Macro domain: Application as a new target for the development of anti-viral agents. CNRS

- Development of a new sero-diagnostic test for the specific detection of Dengue and Zika Flavivirus infections. CNR/IRBA.

- Spatial Risk assessment of tick-borne zoonoses in the ”One Health” framework : joint modelling of tick-borne encephalitis and Lyme Borreliosis in France. Institut Pierre Louis *(bourse financée par Paris 7)*

Bourses 2024

- Multitrophic interactions in Wolbachia-based strategy against dengue virus: a focus on insect-specific viruses (MintS): IP Nelle Calédonie & IP Paris

- Avian and equine surveillance for two flaviviruses in Burkina Faso: Usutu virus and West Nile virus: PCCEI, Montpellier

- Structural snapshots of Chikungunya Replication Complexes: AFMB ***(désistement)***

Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2022 laureates

By Benjamin Dupuis

Impact of insecticide on *Wolbachia*-induced pathogen-blocking in *Aedes aegypti*

Arbo-France Symposium

October 24, 2024

DUPUIS Benjamin
benjamin.dupuis@pasteur.fr
(2023 – 2026)

PhD supervisor: FAILLOUX Anna-Bella

Co-supervisor: POCQUET Nicolas

Institut Pasteur

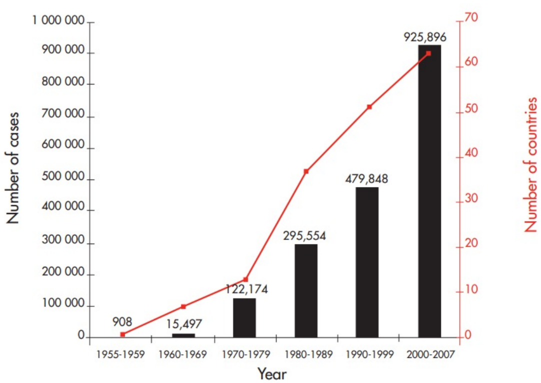
Virology Department

Arboviruses and Insect Vectors (AIV)

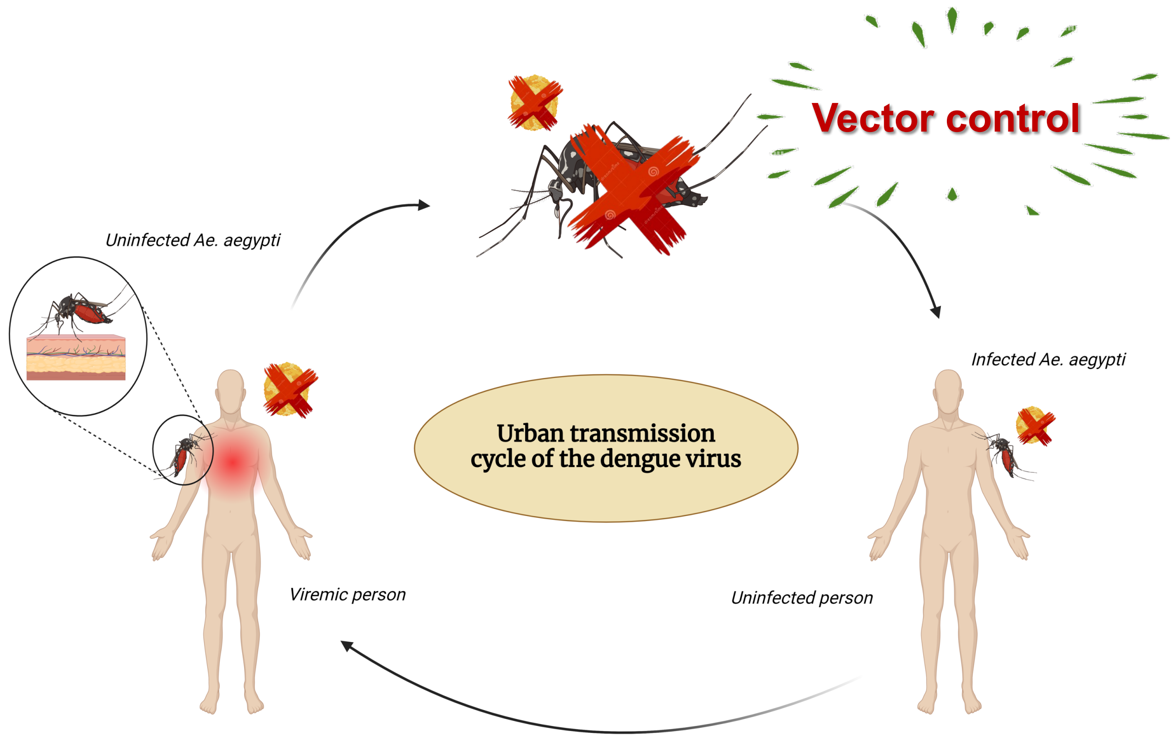
General context

WHO, 2009

Evolution of the number of dengue cases

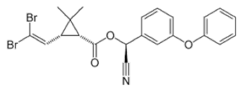


No specific treatments and promising vaccines developed



- **Asymptomatic dengue**
- **Classic dengue**
- **Dengue hemorrhagic fever**
- **Dengue with shock syndrome**

Vector control strategies

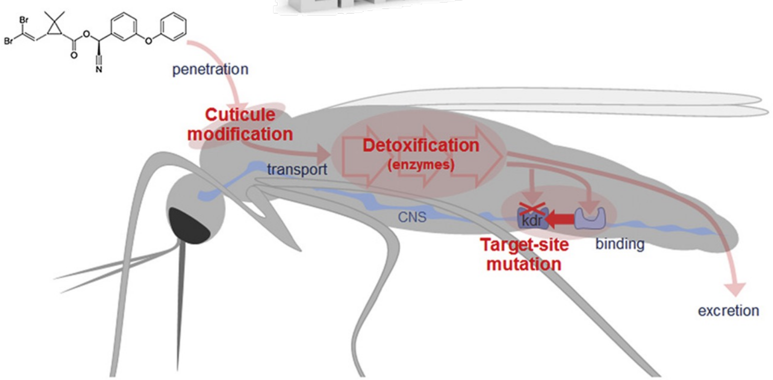


Deltamethrin

Insecticides

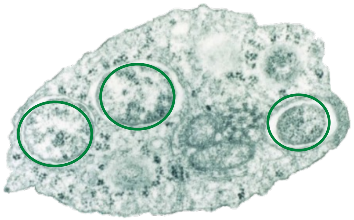
Mechanical vector control

Wolbachia



David et al., 2013

« Pathogen-blocking » effect



Credit : Scott O'Neill

World Mosquito Program™

Field mission and objectives

Implementation of *Wolbachia* in New Caledonia from 2018

- Using **pathogen-blocking effect** : reduction in arbovirus transmission by *Wolbachia*-carrying ***Ae. aegypti***
- **No arbovirus epidemics** but **insecticide use** (comfort treatments) and **presence of resistance**

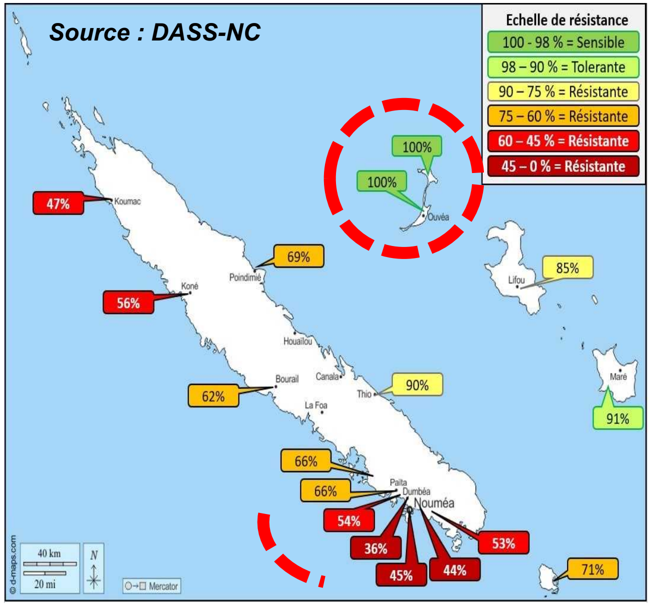
Objectives: **Does insecticide resistance or exposure affect *Wolbachia*-induced pathogen-blocking efficiency?**

***Ae. aegypti* Nouméa NS**

Ae. aegypti Ouvéa

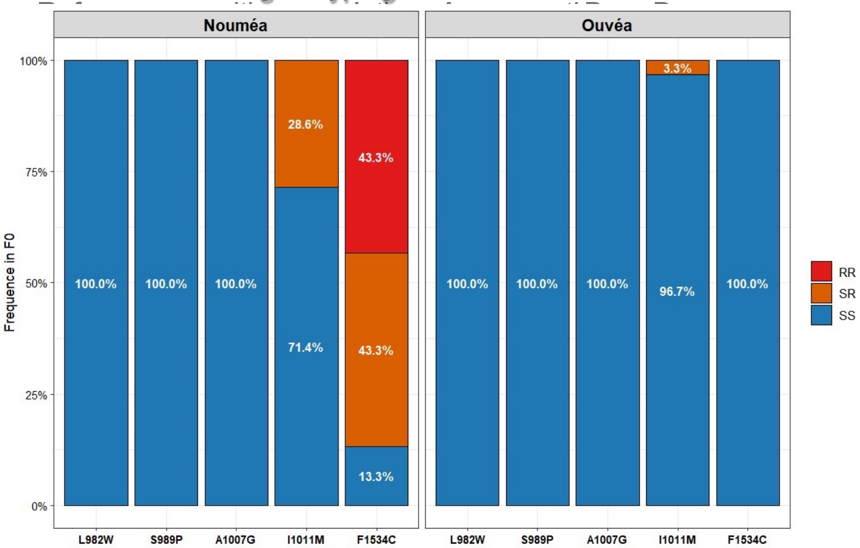
- **Presence** of *Wolbachia* (World Mosquito Program)
- **Resistant** to deltamethrin (*Cattel et al., 2021*)

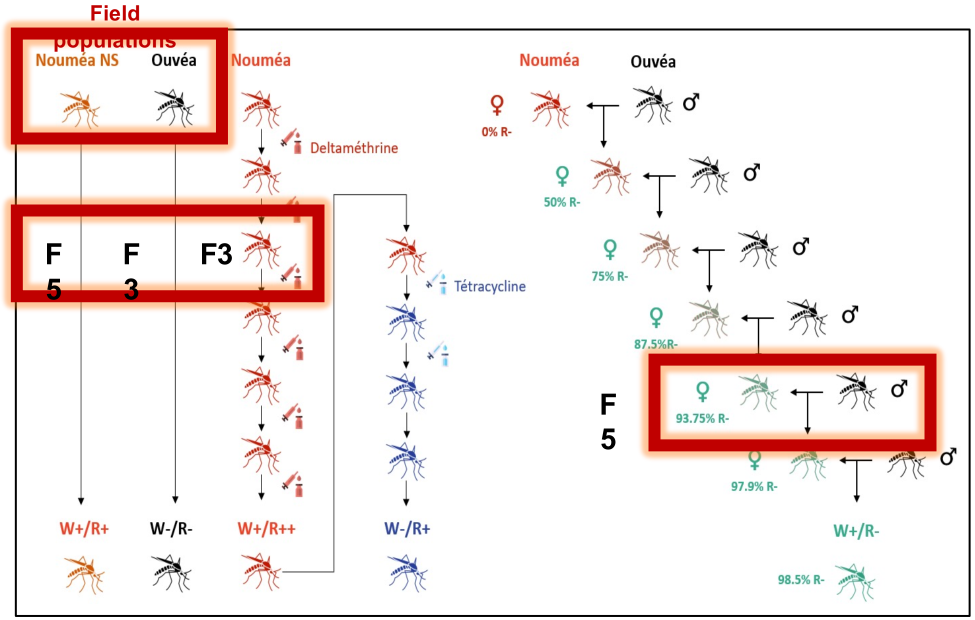
- **Absence** of *Wolbachia*
- **Sensitive** to deltamethrin (*DASS*)



Characterization of resistance

- WHO insecticide tube
- kdr mutations genotyping





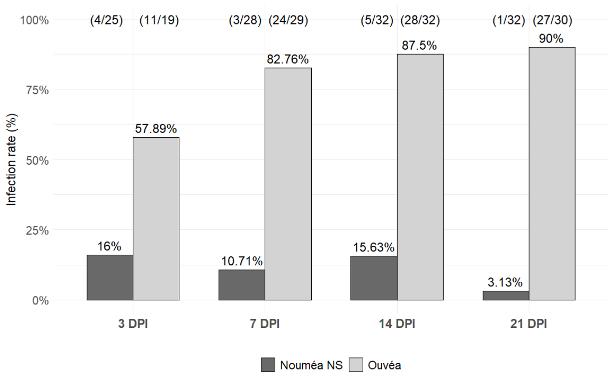
Population	Sexe	Generation	LD50	IC95	RR50	IC95.1
Ouvéa	♀	F2	0.0042%	[0.00222% - 0.00618%]	1.18	[0.60 - 1.76]
Nouméa NS	♀	F2	0.0518%	[0.0419% - 0.0670%]	14.79	[8.57 - 21.01]

- **W+/R+ NS** : Nouméa : field
- **W+/R+ sel** : Δ selected
- **W+/R-** : Backcross
- **W-/R+** : Tetracycline treatment
- **W-/R-** : Ouvéa : field

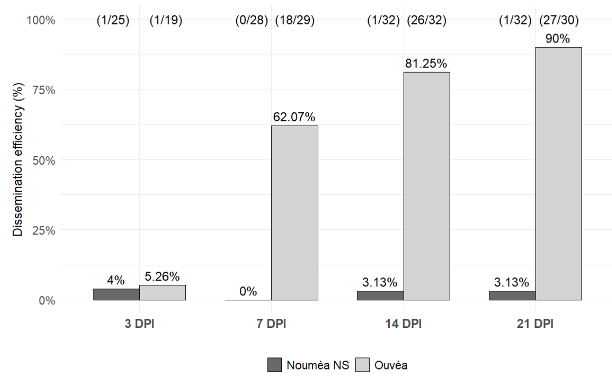
Vector competence for DENV

Oral infection
Virus : DENV-2 Bangkok (10^7 FFU/mL)

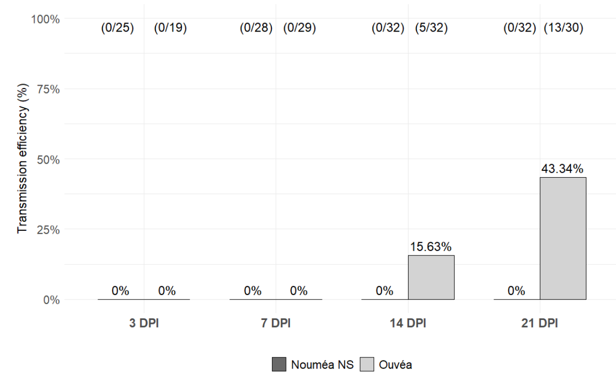
Infection



Dissemination



Transmission



***Ae. aegypti* Ouvéa (W-):** Increased proportion of mosquitoes infected with DENV up to D21

***Ae. aegypti* Nouméa (W+):** Low level of DENV infection

***Ae. aegypti* Ouvéa (W-):** Increased proportion of mosquitoes where DENV has disseminated

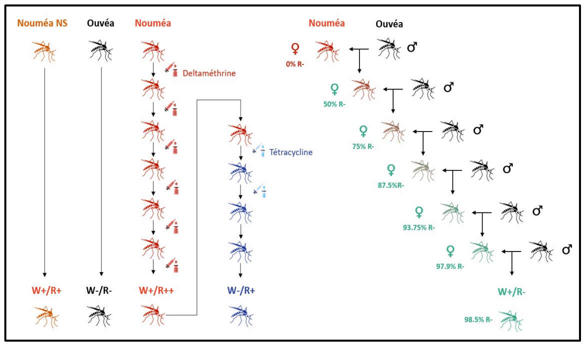
***Ae. aegypti* Nouméa (W+):** Very low level of DENV infection

***Ae. aegypti* Ouvéa (W-):** Increased proportion of mosquitoes transmitting DENV from D14

***Ae. aegypti* Nouméa (W+):** No DENV transmission

In progress …

Complete W±/R± strains selection

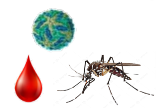


- **Vector competence study** (impact of insecticide resistance on *Wolbachia* and *Ae. aegypti*)
- **RNA-seq**

Impact of insecticide exposure on DENV vector competence

Time

***Infectious** blood meal*

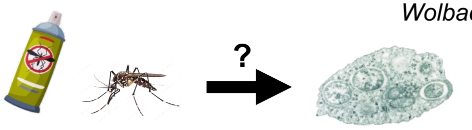


Exposure** to a **sub-lethal** dose of **insecticide

***Vector competence** and **viral replication** study*

Determining the **impact** of **insecticide exposure** <u>after infection</u> on DENV **vector competence** of *Ae. aegypti*

Impact of insecticide exposure on *Wolbachia and "pathogen-blocking" effect*



- *Wolbachia* **density** ?
- *Wolbachia* **frequency** ?
- « **Pathogen-blocking** » efficiency ?

Does insecticide have any effect on *Wolbachia*?

Mechanisms
(oxidative stress ? Immunity ?)

Thanks

Institut Pasteur, Paris
Arbovirus and Insect Vectors Unit

Anna-Bella FAILLOUX
Marie VAZEILLE
Laurence MOUSSON
Chloé BOHERS
Renée ZAKHIA
Marine VIGLIETTA
Adrien BLISNICK
Christian MITRI
Emma BRITO-FRAVALLO
Malika HOCINE
Amandine BRETON
Lazare BREZILLON-DUBUS

Institut Pasteur of New Caledonia
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Nicolas POCQUET
Morgane POL
Kenny TERAIHAROA
Sosiasi KILAMA

Alpine Ecology Laboratory (LECA) of Grenoble

Jean-Philippe DAVID
Louis NADALIN
Thierry GAUDE

University of Strasbourg

Stéphanie BLANDIN

Thank you for your attention

Arbo-France Symposium

October 24, 2024

DUPUIS Benjamin
benjamin.dupuis@pasteur.fr
(2023 – 2026)

PhD supervisor: FAILLOUX Anna-Bella

Co-supervisor: POCQUET Nicolas

Institut Pasteur

Virology Department

Arboviruses and Insect Vectors (AIV)

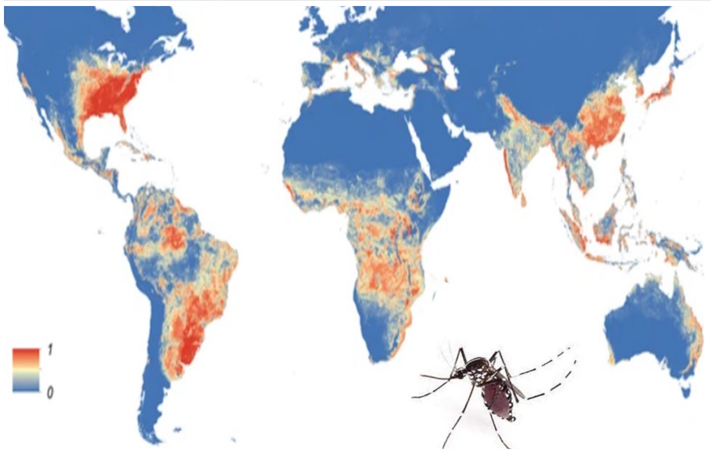
Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2022 laureates

By Silvia Margarita Perez Carrillo

Development of the Sterile Insect technique and the Incompatible Insect technique for the control of *Aedes albopictus* (Diptera: Culicidae) in Yucatán, Mexico

Global distribution of *Ae. albopictus*



- Intrinsic factors: High ecological plasticity and strong competitive aptitude.
- Extrinsic factors: Globalization, lack of vigilance and lack of efficient specific control.1

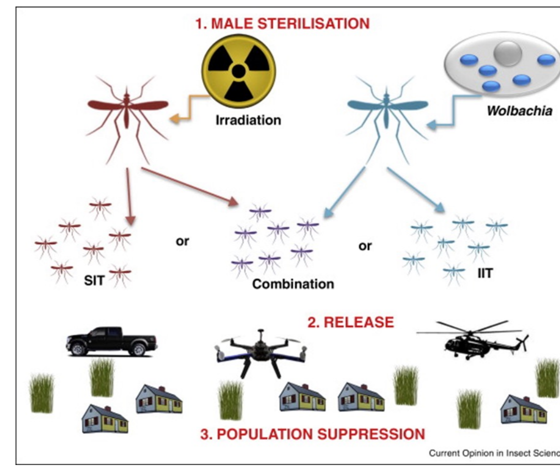
PhD student: Silvia Pérez Carrillo

❖ Novel approaches and new control methods

Two basic modes of *Wolbachia*-based biocontrol with rear-and-release of *Aedes*

Reduce Mosquito Vector Population Densities (Population Suppression).

Reduces the capacity of vectors to transmit pathogens (Population Replacement)



OBJETIVES

GENERAL:

- To evaluate the effectiveness of the implementation of a pilot study using the Sterile insect and Incompatible Insect technique with controlled releases of male *Aedes albopictus* with triple *Wolbachia* infection (*w*AlbA, *w*AlbB and *w*Pip) to suppress wild populations in a suburban area of Mexico.

SPECIFIC:

1. To describe the abundance and seasonal variation of wild-populations of *Aedes albopictus* in a suburban area of Mérida prior to releasing *Wolbachia*-carrying males for population suppression.

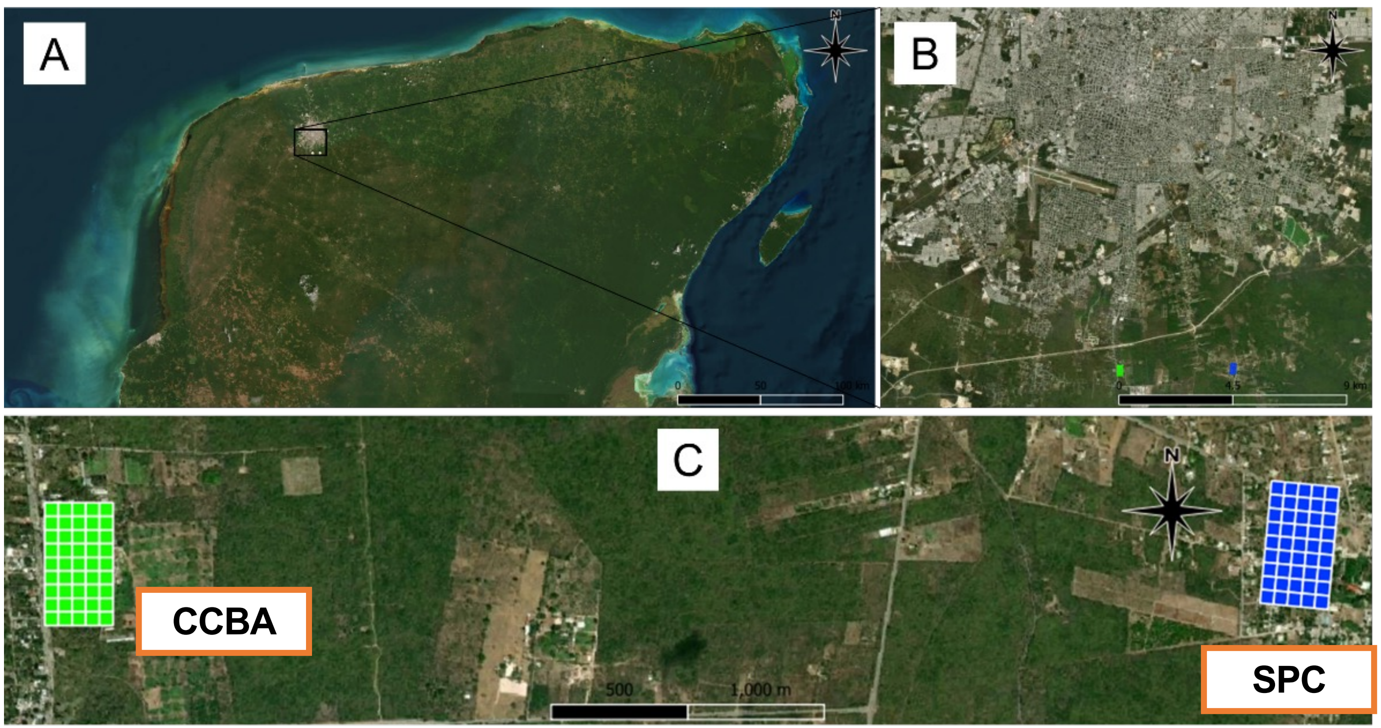
2. Develop a standardized mass-rearing system to produce Wolbachia triple-infected *Ae. albopictus* males and evaluate key biological parameters for a population suppression approach with combined IIT-SIT.

3. To implement a pilot field study to evaluate the entomological impact of the release of male *Ae. albopictus* produced with the IIT-SIT for the control of wild populations in a suburban area of Merida.

Describe the abundance and seasonal variation of wild-populations of *Aedes albopictus* in a suburban area of Mérida prior to releasing *Wolbachia*-carrying males for population suppression.

STUDY SITES

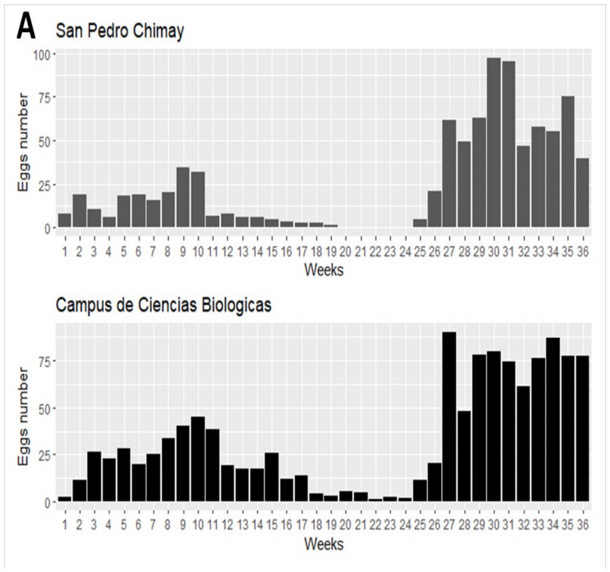
January-Decembre 2024



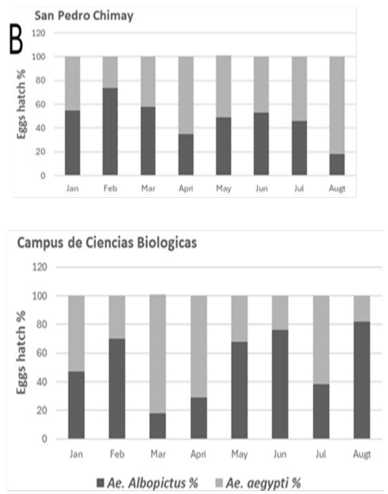
The sites are in located in the periphery of the city of Merida, Yucatan, Mexico (A-B).

Baseline monitoring 2024

❖ Eggs per ovitraps

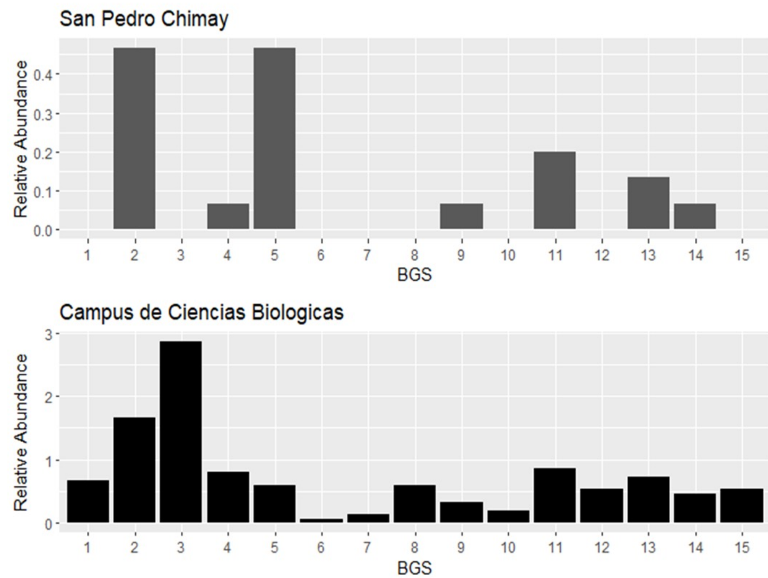


Eggs hatch



- Results showed 51% *Ae. albopictus* and 49% *Ae. aegypti*.
- Both species coexisted at the two study sites, and there was a tendency for one species to decrease when the other increased.

Bg traps baseline



- *Ae. aegypti* with 94 individuals (4%) y with 455 individuals (7%) SPC y CCBA.
- *Ae. albopictus* with 23 individual (1%), y with 168 individual (3%).

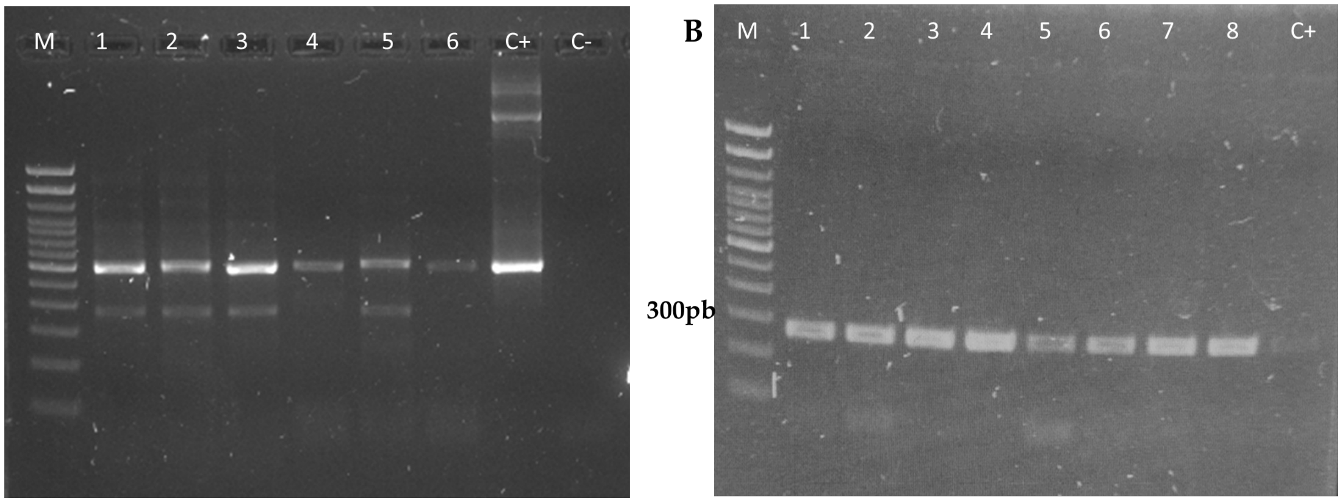
Wolbachia detection in the HC and SPN lines

A

600pb

B

300pb



A) Detection of Wolbachia (wAlbA, wAlbB) genome female (lane 1-3) and male (lane 4-6) mosquito line SPN (F=14, n=20) reared under laboratory conditions. PCR positive amplicon ~600 bp. B) Detection of *Wolbachia* (wPip) genome female (lane 1-4) and male (lane 5-8) mosquito line HC, total genomic DNA was extracted from generation (F19, n=20,) of laboratory-reared. PCR positive amplicon ~300 bp (wPip). Were used as positive (C+) and negative (C-) controls of the assay, respectively. DNA marker (100 bp). Agarose gel (1%) stained with SYBR safe.

Day 1: Preparedness and response to emerging arboviruses.

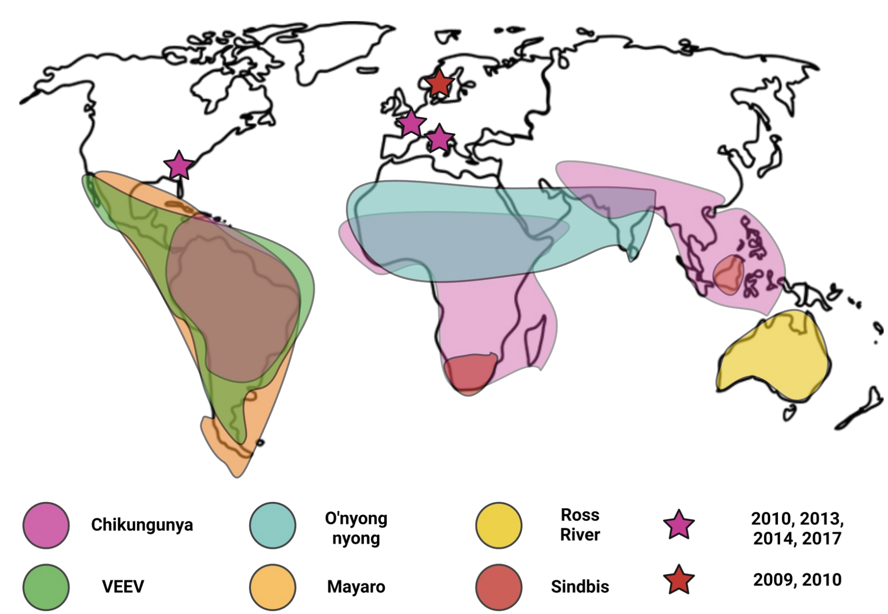
Arbo-France PhD: the 2023 laureates

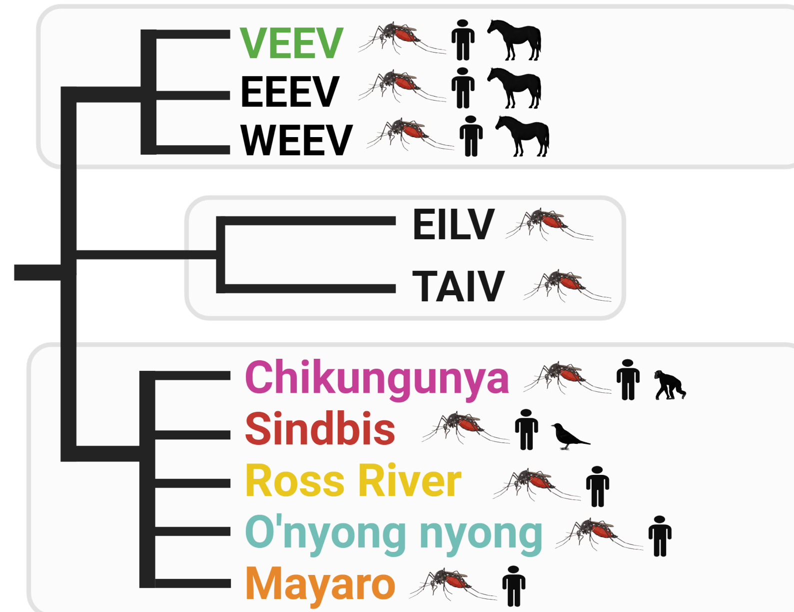
By Jérémie Jamain

Alphavirus *Macrodomains as promising anti-viral target*

Thesis director : Dr. Nadia RABAH
Team director : Dr. Bruno CANARD

ANRS Maladies infectieuses émergentes, Inserm
Arbo-France — Réseau Français d'étude des arboviroses
AFMB — Architecture et Fonction des Macromolécules Biologiques
Aix-Marseille université — Socialement engagée

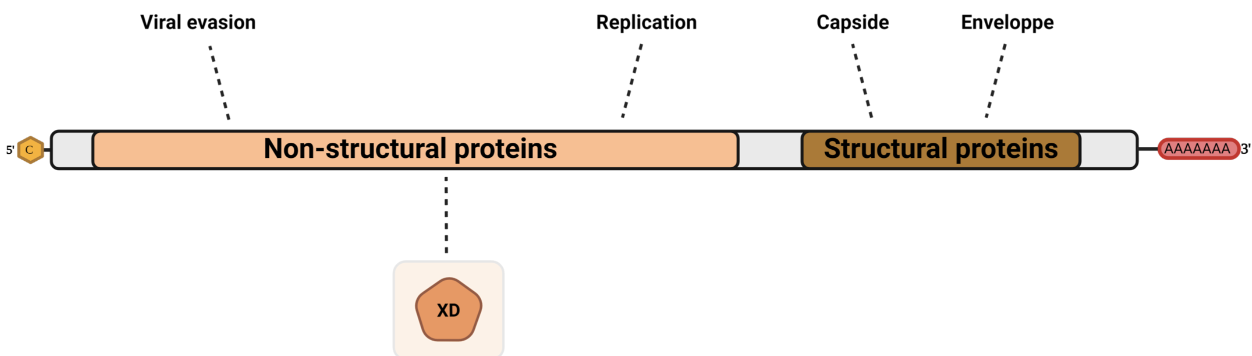


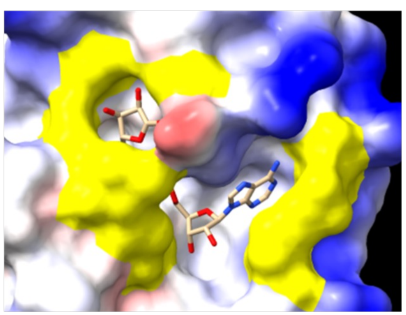


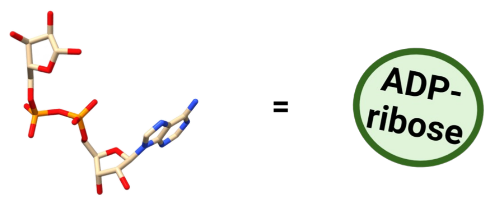
- Majority of cases from **Chikungunya** (1 million per year)

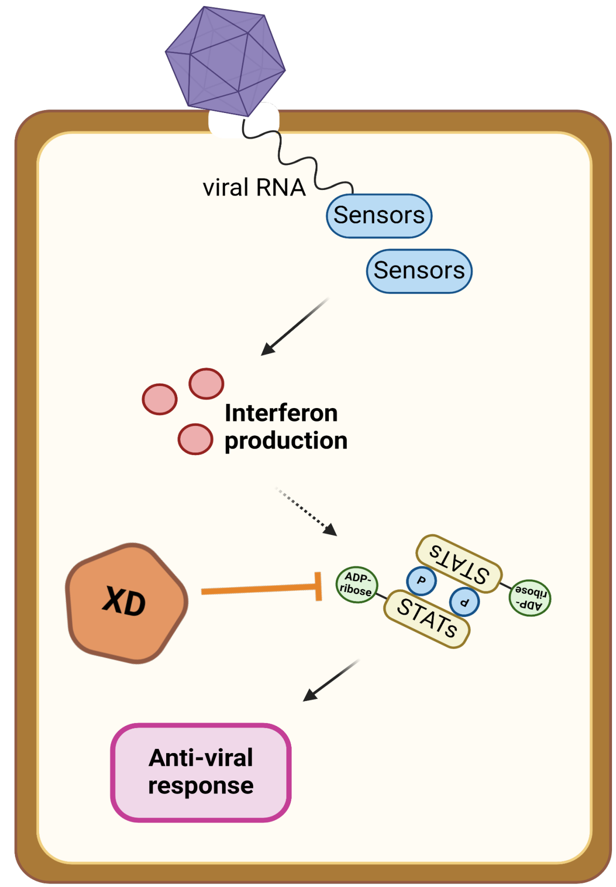
- Mortality rate :
  - **Chikungunya 0,5% to 1%**
  - **VEEV up to 20% in severe cases**
  - **VEEV up to 80%**

Macrodomains function (XDs) : Viral evasion

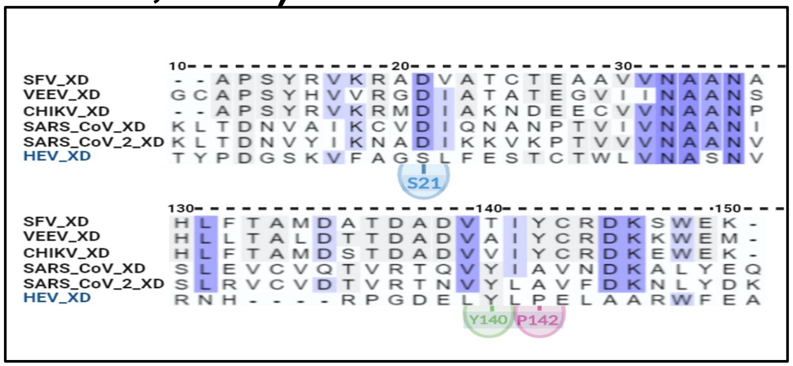




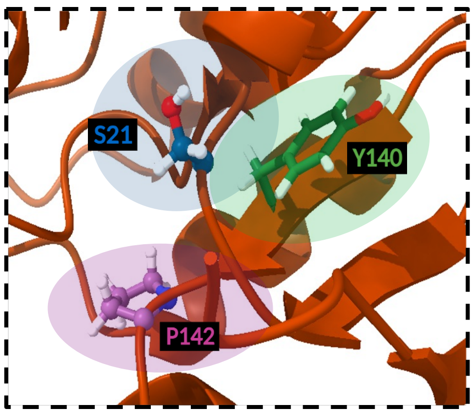


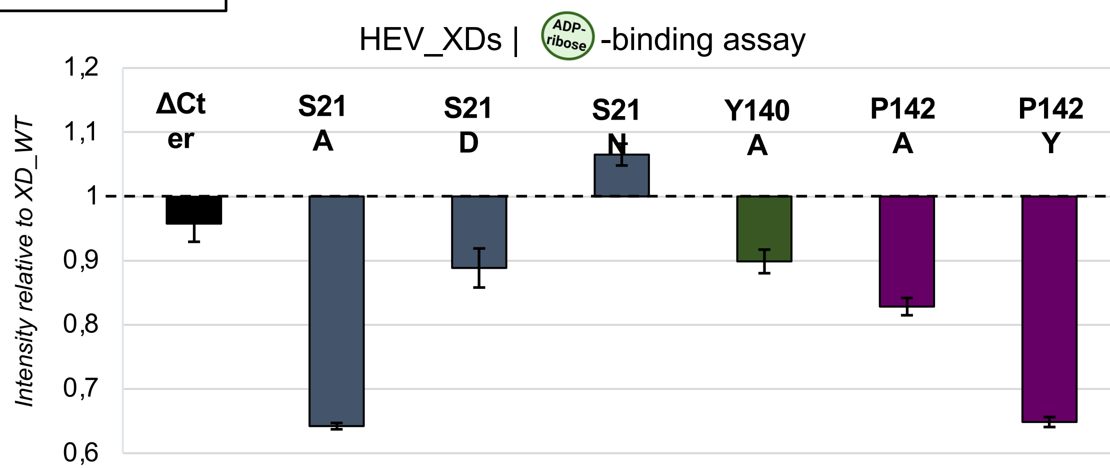


M2 internship : Functional characterization of an Alpha-like *Macrodomain* (Hepatitis E virus , HEV)

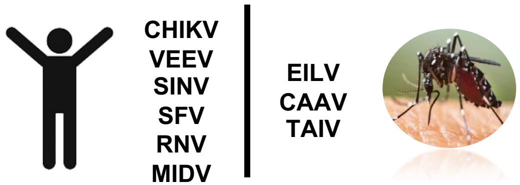


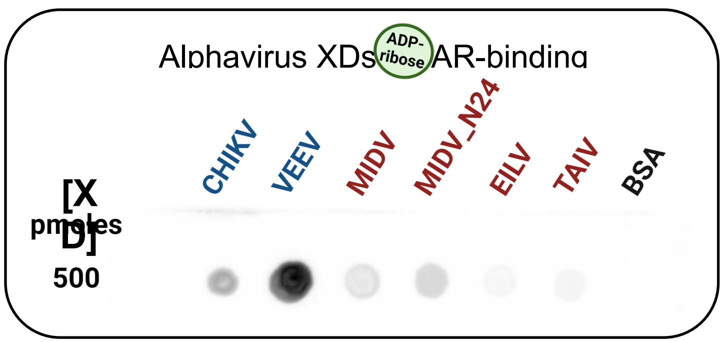
- Identification of core active site residues
- Characterization of HEV_XD hydrolysis activity
- Transposition of results to Alphaviruses *Macrodomains*



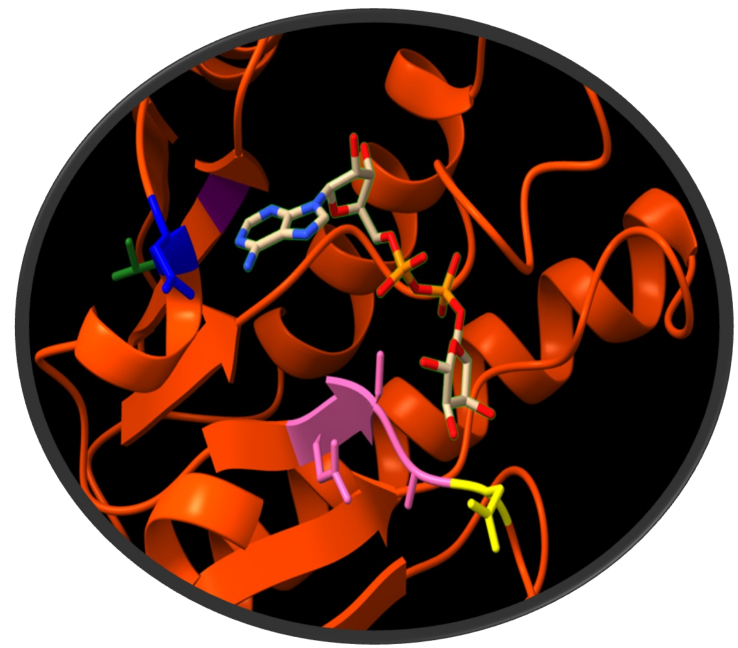


Thesis objective : role of XD in resilience of viral infection in arthropods





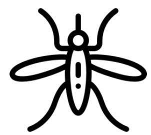
- Insect-specific XDs predicted not to be active
- Lesser or absence of XD activity may allow to keep viral infection contained on low level



Conclusion & Perspectives

***Macrodomains* as potential anti-viral target**

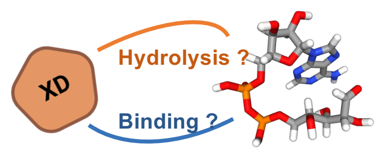
➢ XD's role in resilience of viral infection in vectors



❖ Mutagenesis study of key residues

❖ Study of XD's interaction with innate immunity actors

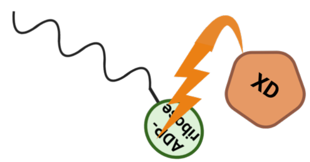
➢ Characterization of XD's interaction with ADP-ribose & derivatives



➢ In vitro binding/hydrolysis studies

➢ Structural studies with ligands

➢ Impact of *Macrodomains* on processes involving other substrates



❖ Interaction with other potential substrates (ADP-ribosylated **RNA**)

Big thanks to all

Big thanks to:

Dr. Nadia RABAH

Dr. Oney ORTEGA

Dr. Bruno CANARD

Dr. François FERRON

The Viral replicases
AFMB team

Aix Marseille université Socialement engagée

AFMB

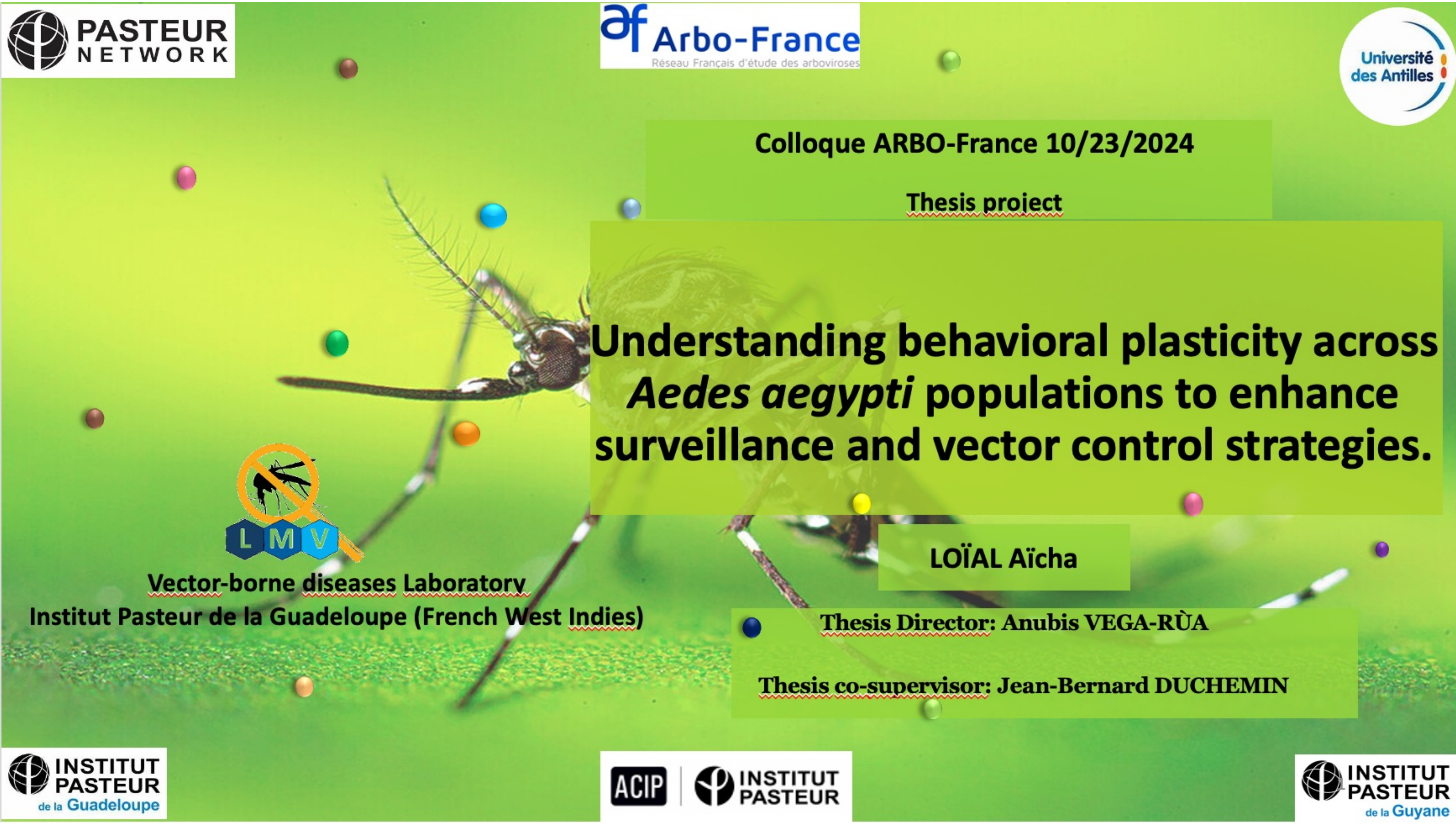
Arbo-France Réseau Français d'étude des arboviroses

anrs MALADIES INFECTIEUSES ÉMERGENTES Inserm

Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2023 laureates

By Aïcha Loïal



Colloque ARBO-France 10/23/2024

Thesis project

Understanding behavioral plasticity across *Aedes aegypti* populations to enhance surveillance and vector control strategies.

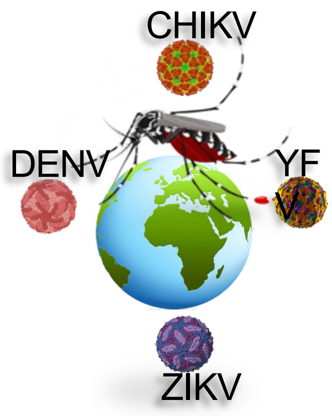
LOÏAL Aïcha

Thesis Director: Anubis VEGA-RÙA

Thesis co-supervisor: Jean-Bernard DUCHEMIN

Vector-borne diseases Laboratory

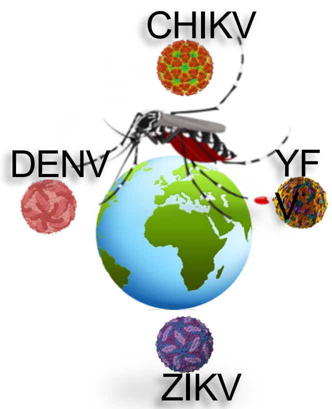
Institut Pasteur de la Guadeloupe (French West Indies)



Mosquito life cycle influenced by odor perception

- ❑**Main vector of several arboviruses**
- ❑Increase of global distribution and abundance

Source: WHO, 2024



Mosquito life cycle influenced by odor perception

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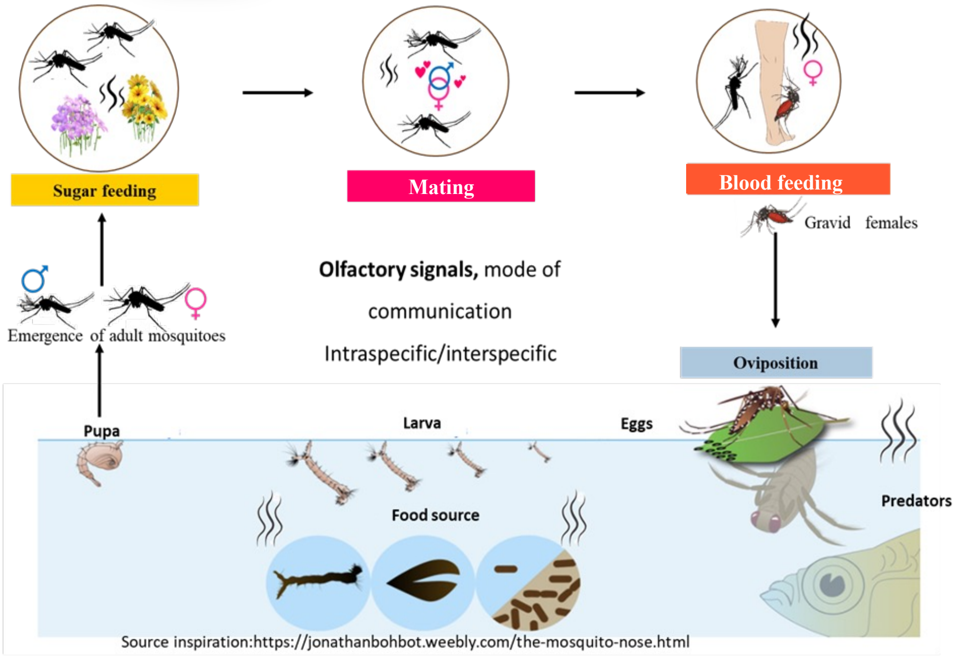
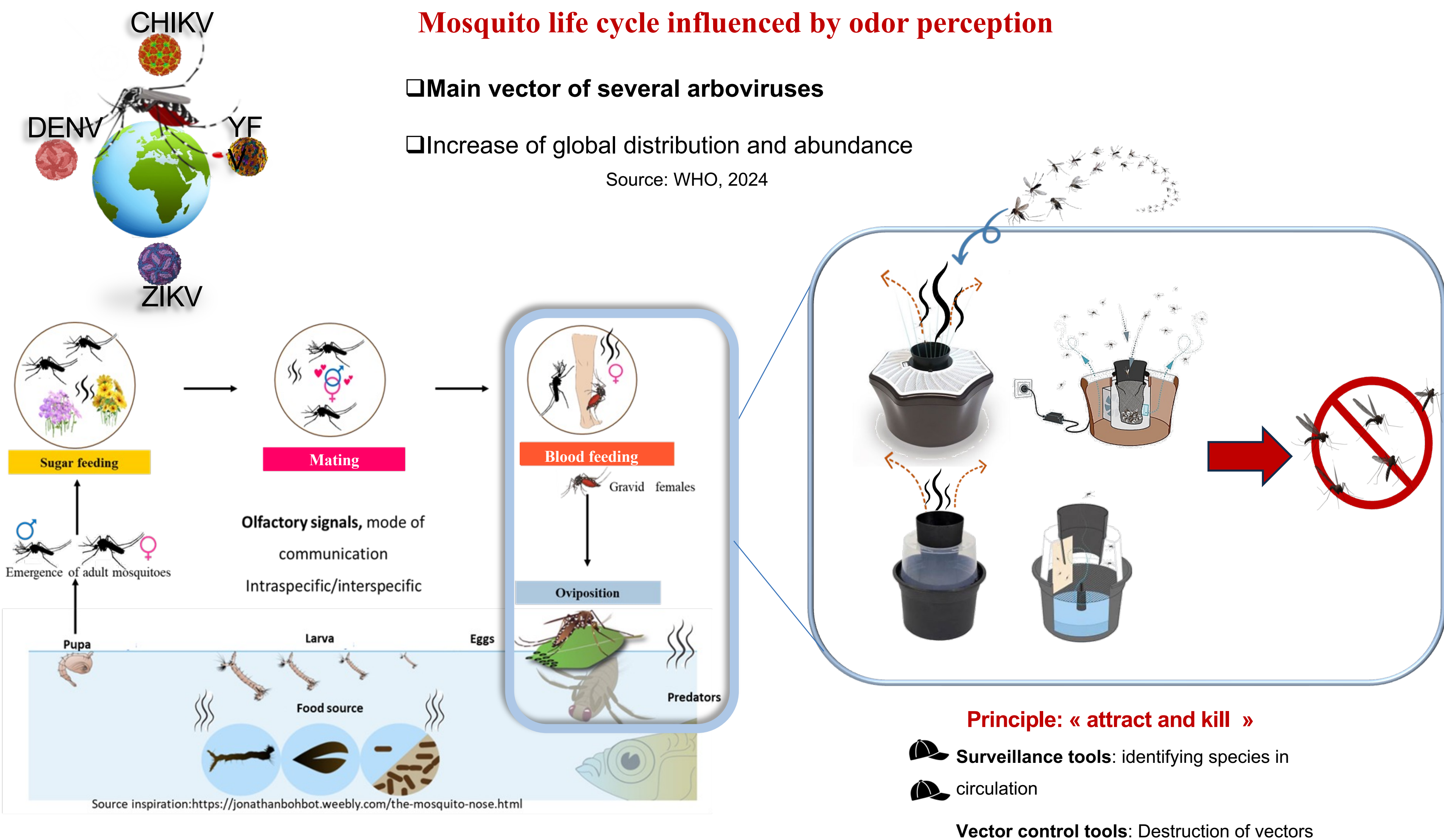
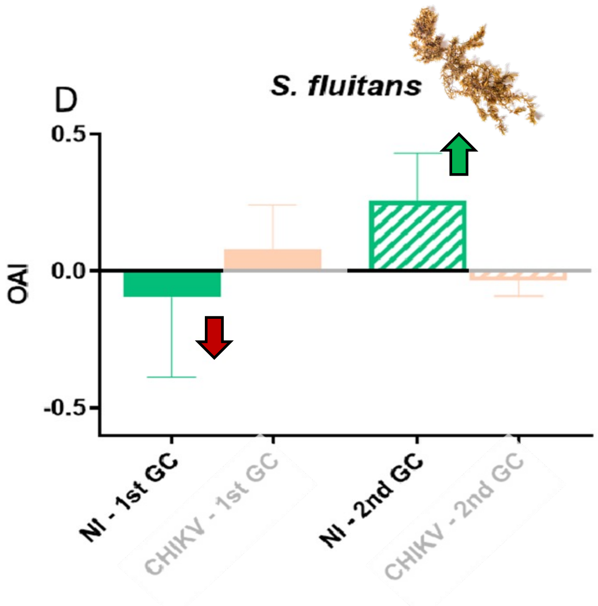



CHIKV
DENV
YF
ZIKV
Mosquito life cycle influenced by odor perception
❑Main vector of several arboviruses
❑Increase of global distribution and abundance
Source: WHO, 2024
Sugar feeding
Mating
Blood feeding
Gravid females
Oviposition
Emergence of adult mosquitoes
Olfactory signals, mode of communication
Intraspecific/interspecific
Pupa
Larva
Eggs
Food source
Predators
Source inspiration:https://jonathanbohbot.weebly.com/the-mosquito-nose.html
Principle: « attract and kill »
Surveillance tools: identifying species in circulation
Vector control tools: Destruction of vectors

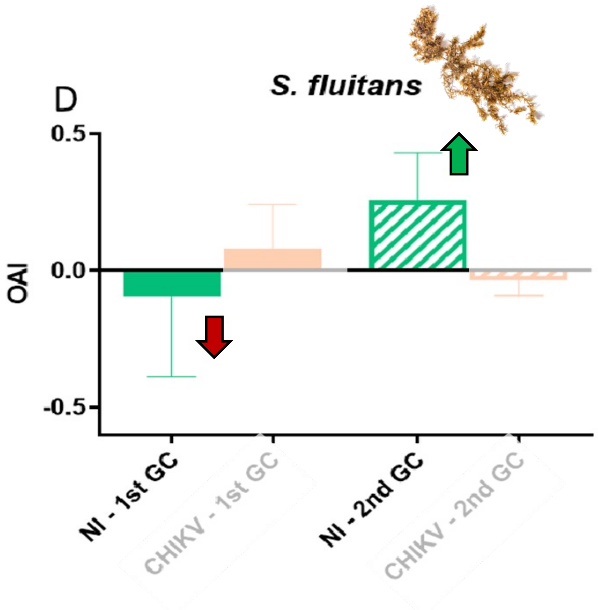
Variability in attractant efficacy



Mulatier et al.2023

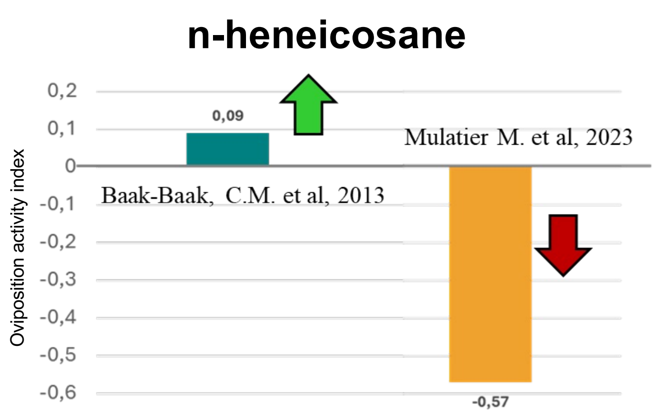
Does the gonotrophic cycle influence behavioral responses?

Variability in attractant efficacy



Mulatier et al.2023

Does the gonotrophic cycle influence behavioral responses?

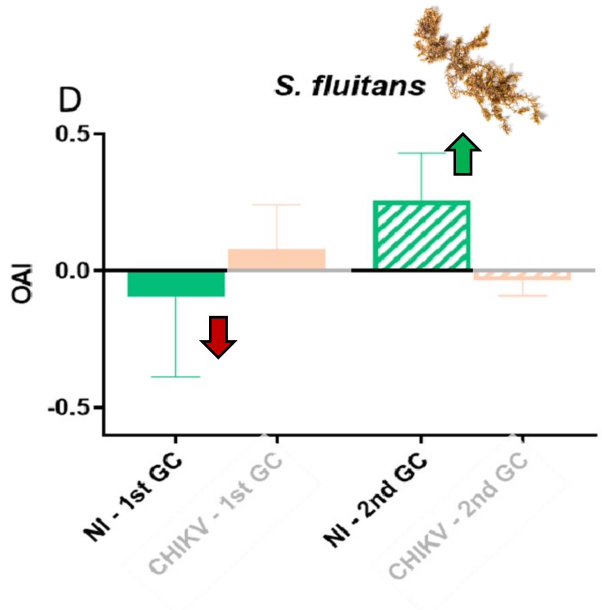


1:Population: **Tapachula, Chiapas**

2: Population: **Guadeloupe**

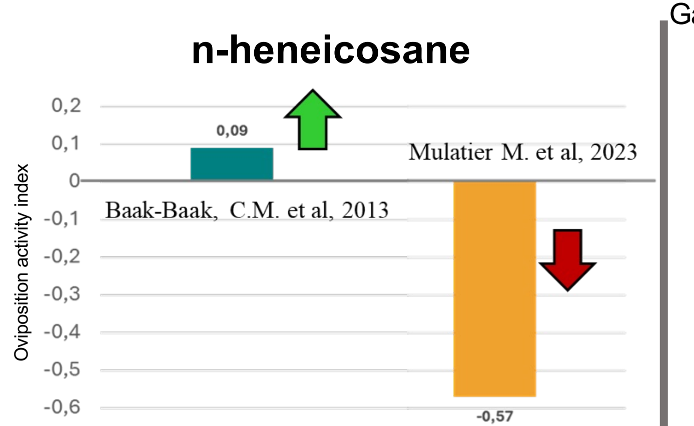
Does population origin influence behavioral responses?

Variability in attractant efficacy



Mulatier et al.2023

Does the gonotrophic cycle influence behavioral responses?



1:Population: **Tapachula, Chiapas**

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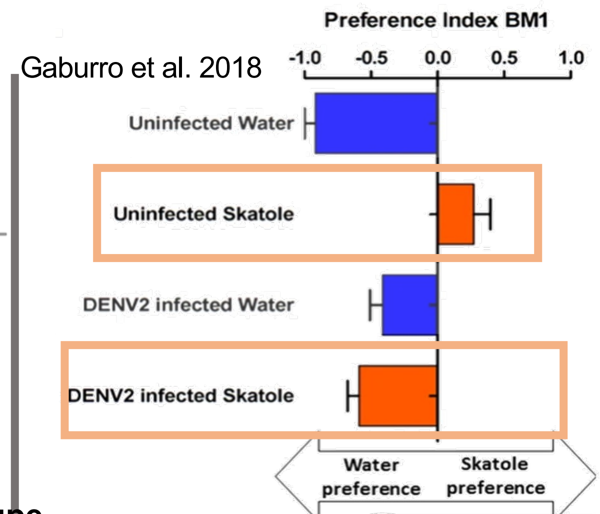
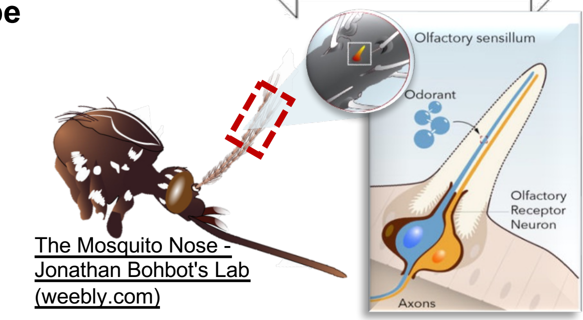
Does population origin influence behavioral responses?





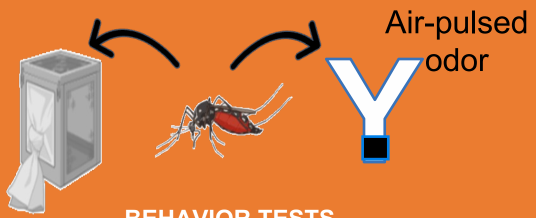
How does arbovirus infection affect antennal perception?

Research objectives

1

OBJECTIVE 1:

Determine the influence of the gonotrophic cycle and mosquito origin on *Ae. aegypti* behavior responses



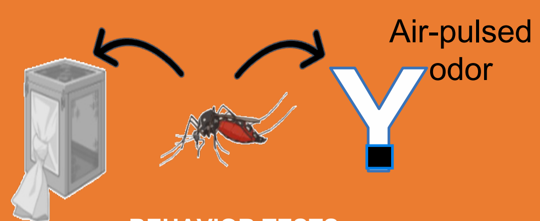
BEHAVIOR TESTS

Research objectives

1

OBJECTIVE 1:

Determine the influence of the gonotrophic cycle and mosquito origin on *Ae. aegypti* behavior responses

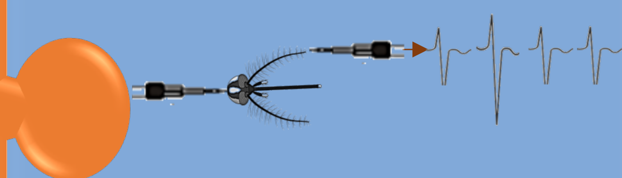


BEHAVIOR TESTS

2

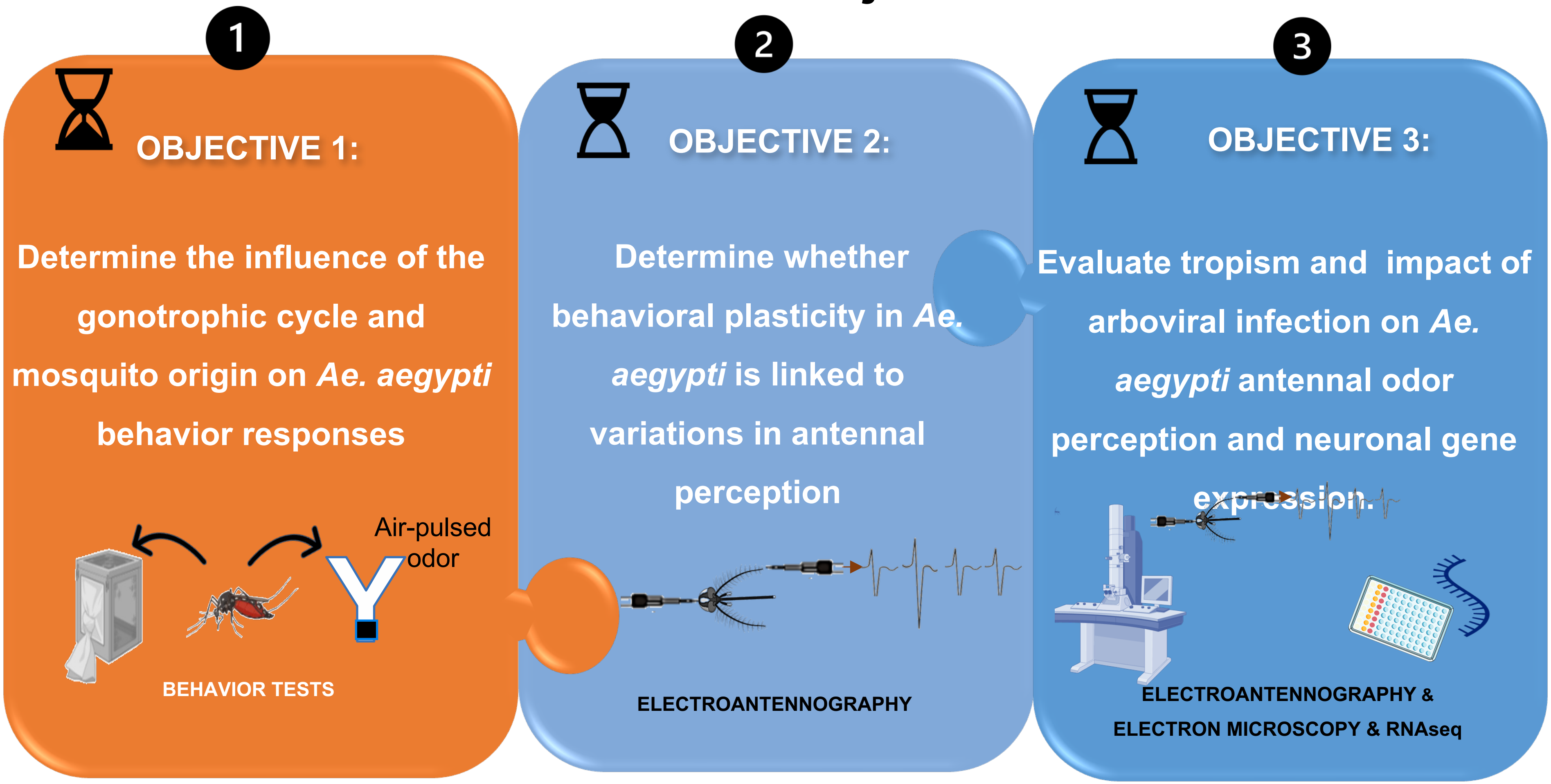
OBJECTIVE 2:

Determine whether behavioral plasticity in *Ae. aegypti* is linked to variations in antennal perception



ELECTROANTENNOGRAPHY

Research objectives



Unpublished data

PASTEUR NETWORK

ACIP | INSTITUT PASTEUR

LMV

Université des Antilles

Arbo-France
Réseau Français d'étude des arboviroses

Thank you for your attention !

INSTITUT PASTEUR de la Guadeloupe

INSTITUT PASTEUR de la Guyane

Oviposition behavior

Z 5 dodecanoic acid

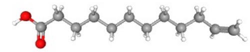
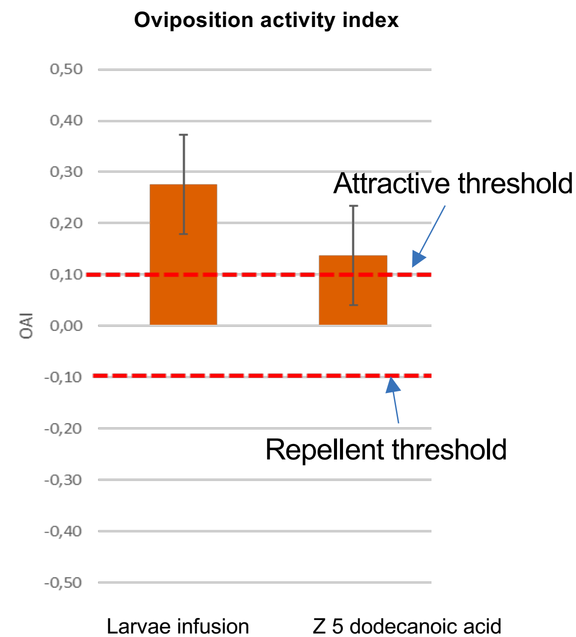
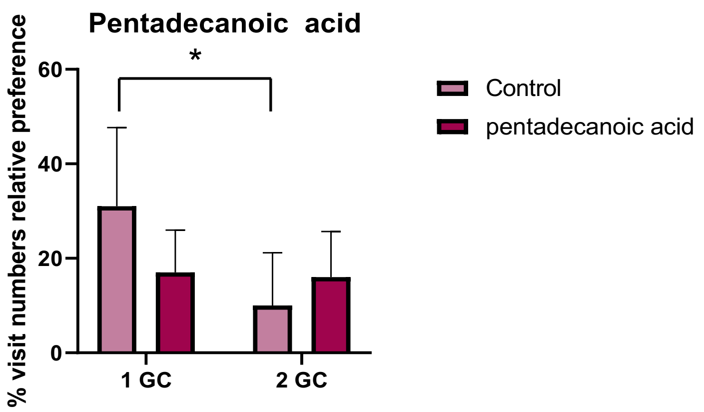


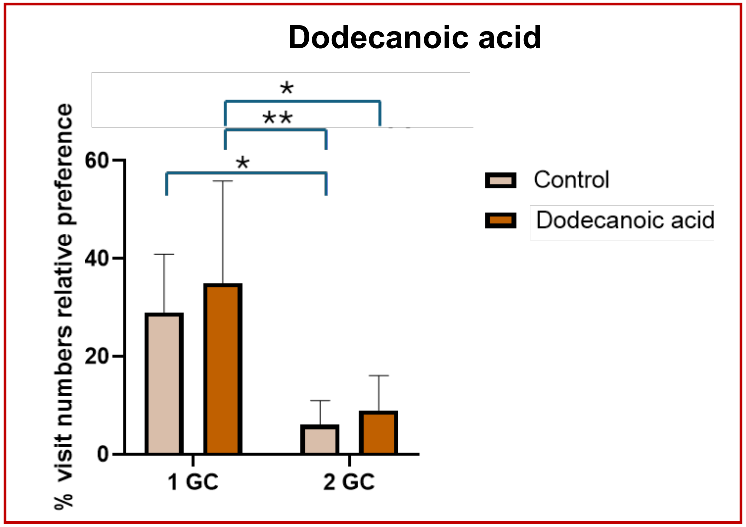
Photo greenhouse INRAE Guadeloupe

H. Smitch, et al, 2021



Blood feeding





Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2023 laureates

By Emma Sicherre

Development of a new serodiagnostic tool for the specific detection of flavivirus infections

Emma Sicherre – 24/10/2024
Arbo-France seminar

Thesis directors : Cyril Badaut & Ombeline Rossier

Flavivirus diagnostic issues

Quick decrease of viremia
PCR diagnosis quickly no longer possible

Cross-reactivity of antibodies
Non-specific IgM serodiagnostics

Co-circulation of viruses
Difficult to determine the infecting virus

MAC-ELISA and seroneutralisation

- ✓ Good sensitivity
- ✗ Low specificity
  Use of BSL3 laboratory
  Costly and time-consumming

Commercial tests

- ✗ Low sensitivity
- ✓ Rapid and easy
  Good specificity

New test principle

IgM detection

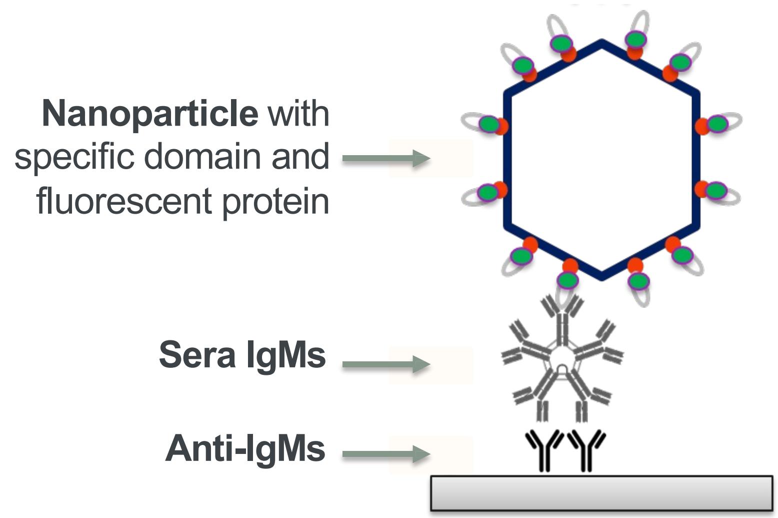
To have a serological early diagnosis

Specific antigen domain

To avoid cross-reactivity and false positives

New nanoparticle

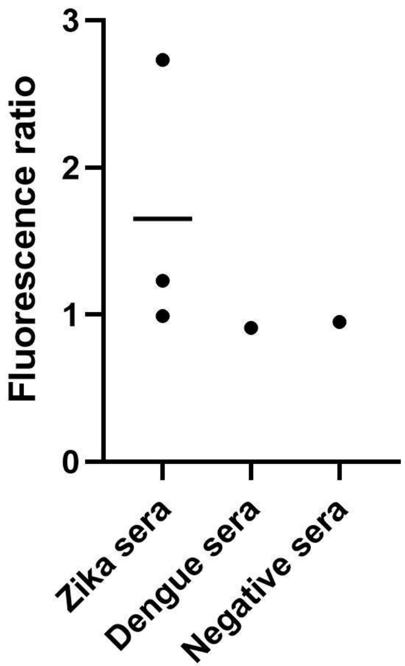
To increase the antigen presentation and avoid false negatives



- **Good sensitivity**
- **Good specificity**
- **No need of BSL3**

First results

Serum IgM (CNR)	Ratio
ZIKV positive	2,73
ZIKV positive	1,23
ZIKV, CHIKV and YFV positive	0,99
DENV positive	0,91
Negative	0,95



Zika positive sera are detected as positive

Dengue positive and negative sera are detected as negative

The questionable sera is detected as negative

Perspectives

STEP 01

Optimise the ELISA test

STEP 02

Develop a **rapid diagnostic test**

STEP 03

Realise a **retrospective study** of infections

STEP 04

Spread the technology to **other viruses**

Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2023 laureates

By Ilona Eveline Suhanda

Spatial Risk Assessment of Lyme Borreliosis and Tick-Borne Encephalitis

Ilona Eveline Suhanda

PhD candidate (2023-2026)

Supervisor : Dr Raphaëlle Métras

Annual Scientific Symposium of Arbo-France

24/10/2024

PhD overview

	Lyme Borreliosis (LB)	Tick-borne encephalitis (TBE)
Pathogen	*Borrelia burgdorferi* sensu lato	Flavivirus : TBE virus
Symptoms	• Early : erythema migrans, fever, headache • Disseminated : neurologic, cardiac, musculoskeletal manifestations	Often biphasic : • Influenza-like illness • neurological symptoms
Epidemiology (France)	Endemic Incidence (2023) : 59 per 100,000 inh. [CI95% 50-68]	Sporadic outbreaks Reported cases since 2021 : ~ 35 cases/year
Vector	*Ixodes ricinus* ticks	

Objective :
To better understand the distribution of Lyme borreliosis and tick-borne encephalitis in France, and their spatial drivers, accounting for epidemiological similarities.

Fu et al., *Pathogens* (2021); Steere et al., *Nature Reviews Disease Primers* (2016); Septfons et al., *Eurosurveillance* (2019, 2023); Réseau Sentinelles, Annual reports, https://www.sentiweb.fr/ (2023); Velay et al., *Ticks and Tick-borne Diseases* (2018)

Methods

Mapping LB

Case reports (Réseau Sentinelles & Antibioclic)

Serology data (blood donors)

Mapping TBE

Case reports

Serology data (blood donors)

Tick bites & outdoor activities (national online surveys)

Incidence estimation + spatial interpolation

Bayesian joint spatial model

Multinomial logistic regression + INLA

LB+/TBE+

LB+/TBE-

LB-/TBE+

LB-/TBE-

INLA

Expected results

Maps of LB and TBE occurrence

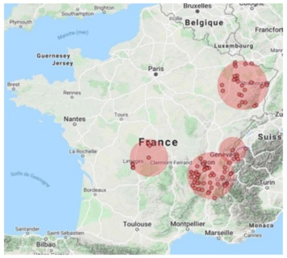
Gómez-Rubio et al., *Stat. Oper. Res. Trans.* (2019); Rue et al., *J. R. Statist. Soc. B.* (2009)

Paper 1 : Evaluating the Potential of a Computerized Decision Support System (CDSS) to Improve Knowledge of Lyme Borreliosis Occurrence in France

ANTIBIOCLIC
Antibiothérapie rationnelle en soins primaires

In France
- Endemic with clusters in eastern France
- Incidence (2023) : 59 per 100,000 inhabitants [CI95% 50-68]
- Réseau Sentinelles → represent 2% of French general practitioners (GPs)

CDSS (Antibioclic)
- 40 health indicators, including Lyme borreliosis (tick bite, EM, disseminated)
- Over 29 million requests made since November 2017
- Used by 28,963 GPs in 2023 → represents 45.8% of French GPs
- Nationwide coverage



Spatial clusters of LB cases in 2018
(Fu et al., *Pathogens* (2021))

Objectives
Evaluate how Antibioclic can improve our current knowledge on Lyme borreliosis (LB) occurrence in France.
1. Estimate the incidence of LB requests from Antibioclic data over time and over space
2. Compare the incidence estimation of Antibioclic requests with LB cases incidence

Fu et al., *Pathogens* (2021); Steere et al., *Nature Reviews Disease Primers* (2016); Septfons et al., *Eurosurveillance* (2019); Réseau Sentinelles, Annual reports, https://www.sentiweb.fr/ (2023); Delory et al., *The Journal of antimicrobial chemotherapy* (2020)

Unpublished data

Acknowledgements

ANTIBIOCLIC
Antibiothérapie rationnelle en soins primaires

grippe covid net.fr

Sentinelles
Réseau Sentinelles

CNR Borrelia

UVE
UNITÉ DES VIRUS ÉMERGENTS
INSERM1207 – IRD190 – AMU – EFS – IRBA

anr

MOZART
Modelling zoonotic & arthropod-borne diseases

SORBONNE UNIVERSITÉ

af Arbo-France
Réseau Français d'étude des arboviroses

Thank You For Your Attention

Day 1: Preparedness and response to emerging arboviruses.

Arbo-France PhD: the 2024 laureates

By Djara Konate

Avian and equine surveillance for two flaviviruses in Burkina Faso: Usutu virus and West Nile virus

Picture framer :

Pr Yannick SIMONIN
Professor of Virology at the University of Montpellier

PhD student :

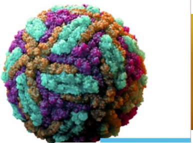
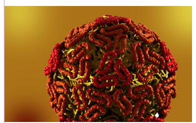
Djara KONATE

Co-Framer:

Dr Bachirou TINTO
Virology Research Associate at IRSS;
Associate Researcher at LNR/FHV
Centre MURAZ in BF

Research protocol presentation_Colloque Scientifique d'Arbo france

Background and Rationale

Usutu (USUV) **West Nile (WNV)**

Arbovirus; *Flaviviridae* family;Genus *Orthoflavivirus*

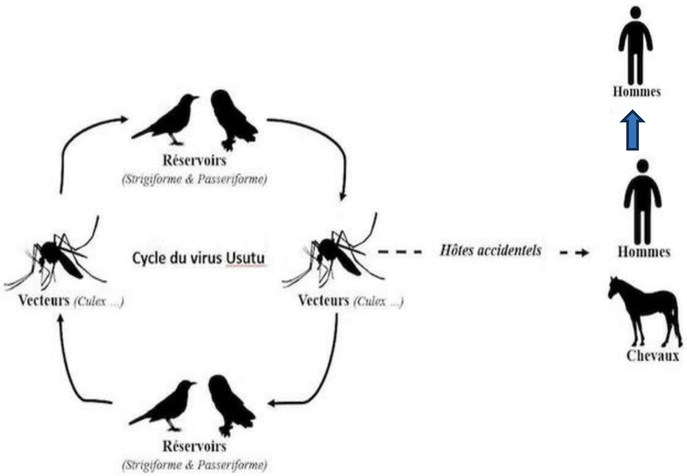
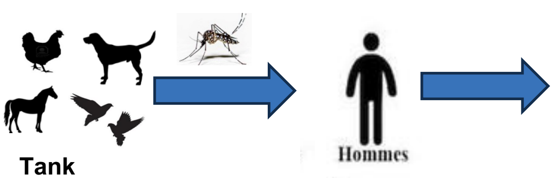


Figure:Transmission cycle of USUV and WNV

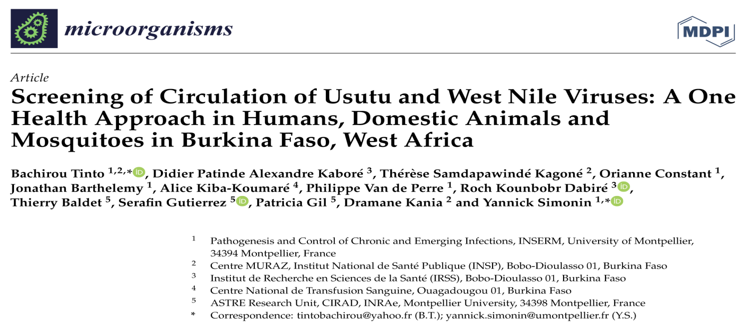


Tanks

Monitoring animal reservoirs involved in the enzootic cycle of these viruses

BURKINA FASO

- For several years now, the region has been faced with the emergence and re-emergence of arboviruses, causing epidemics and deaths;
- Surveillance system in place for these arboviruses; USUV and WNV not covered by surveillance.
- Serological evidence of circulation of both viruses has recently been reported in Burkina Faso in humans, birds, horses and dogs.



microorganisms MDPI

Article

Screening of Circulation of Usutu and West Nile Viruses: A One Health Approach in Humans, Domestic Animals and Mosquitoes in Burkina Faso, West Africa

Bachirou Tinto [1,2,*], Didier Patinde Alexandre Kaboré [3], Thérèse Samdapawindé Kagoné [2], Orianne Constant [1], Jonathan Barthelemy [1], Alice Kiba-Koumaré [4], Philippe Van de Perre [1], Roch Kounbobr Dabiré [3], Thierry Baldet [5], Serafin Gutierrez [5], Patricia Gil [5], Dramane Kania [2] and Yannick Simonin [1,*]

1 Pathogenesis and Control of Chronic and Emerging Infections, INSERM, University of Montpellier, 34394 Montpellier, France
2 Centre MURAZ, Institut National de Santé Publique (INSP), Bobo-Dioulasso 01, Burkina Faso
3 Institut de Recherche en Sciences de la Santé (IRSS), Bobo-Dioulasso 01, Burkina Faso
4 Centre National de Transfusion Sanguine, Ouagadougou 01, Burkina Faso
5 ASTRE Research Unit, CIRAD, INRAe, Montpellier University, 34398 Montpellier, France
* Correspondence: tintobachirou@yahoo.fr (B.T.); yannick.simonin@umontpellier.fr (Y.S.)

USUV: 14,17% WNV : 19,16%	USUV :4,76% WNV : 4,76%	USUV :6,17% WNV : 17,28%	USUV : 0% WNV : 1,92%

Methods

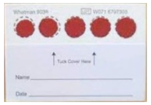
Objective

Carry out molecular and serological surveillance for USUV and WNV in domestic and wild birds and horses in urban and semi-urban areas of Burkina Faso, taking seasonal variations into account..

➢ **Cross-sectional descriptive study with prospective data collection over 36 months; Bobo Dioulasso and Banfora; seasonal variations**

➢ **Study population and sampling:**

Blood sampling



Samples blood drop on blotting paper; oral or rectal swabs

Organ harvesting will also be carried out from dead birds

Conveyed

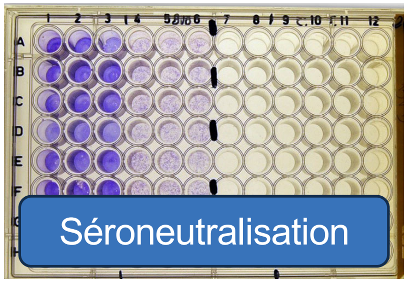
Host laboratory in Montpellier for analysis

Sampling

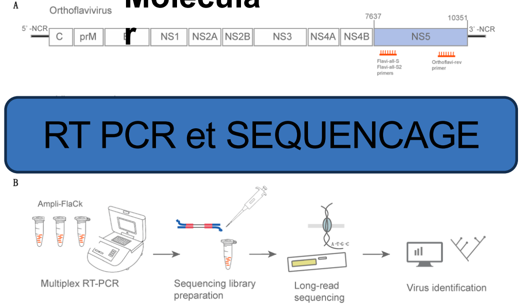
➢ We will collect samples from 385 wild birds, 385 domestic birds and 385 horses.

➢ **Laboratory analysis**

Serological



Molecula



THANK YOU FOR YOUR KIND ATTENTION

Arbo-France PhD: the 2024 laureates

By Dominique Valtain

My scientific background

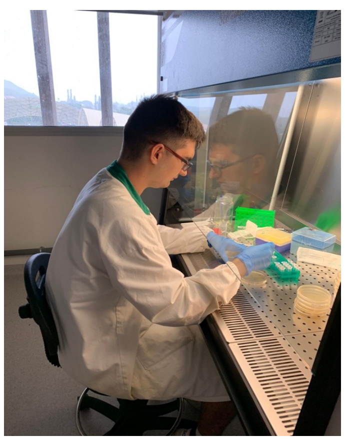
2015
Lycée Nevers, Montpellier, France **Scientific Baccalaureate**

2018
University of Sciences of Montpellier, France
Degree in Microbiology

2022
Montpellier University of Sciences, France
Master Ecology-Epidemiology of parasitic and infectious diseases, Integrative studies of infectious diseases pathway

2024

2025
Start of thesis at Institut Pasteur Paris and Institut Pasteur of New-Caledonia
Multitrophic interactions in *Wolbachia*-based strategy against dengue virus: a focus on insect-specific viruses



Institut Pierre-Richet, Bouaké, Ivory Coast - 3-month internship
Development of a recombinant protein-based ELISA test for TAA (entomology, fieldwork, vector capture, ELISA tests, PCR, data collection and processing, morphometry)

Institut Pasteur of New-Caledonia - 6-month internship
Study of the impact of *Wolbachia* in the constitution of the microbiome (cultivable bacteria) within laboratory strains of *Aedes aegypti* (bacteriology, Maldi-Tof, *Wolbachia* , vector)

Arbo-France Réseau Français d'étude des arboviroses | INSTITUT PASTEUR de Nouvelle-Calédonie | INSTITUT PASTEUR | UREDA Unité de Recherche et d'Expertise Dengue et Arboviroses | UNC Université de la Nouvelle-Calédonie | EDP École Doctorale du Pacifique | anrs Maladies infectieuses émergentes Inserm

Multitrophic interactions in *Wolbachia*-based strategy against dengue virus: a focus on insect-specific viruses

Context

Wolbachia

Aedes aegypti

Microbiome

World Mosquito Program™

The main objective of my PhD project is:

To describe the viriome of *Ae. aegypti* in the presence and absence of *Wolbachia* and to measure its impact on the vectorial competence of *Ae. aegypti* towards DENV.

anr®

The project is organized into three Work Packages:

WP 1: Characterization of viral communities.
WP 2 : Isolation of ISVs.
WP 3: Study of their effects on vector competence.

Perspectives

Identify risks affecting *Wolbachia* efficacy.
Reduce the impact of vector-borne diseases.

Day 1: Preparedness and response to emerging arboviruses.

Lunch break, back in 1h30

With the next session:

Scenario of a yellow fever virus outbreak in Martinique

Day 1: Preparedness and response to emerging arboviruses.

Analysis and propositions of the working group

By Jean-Claude Desenclos

Scénario d'une épidémie de Fièvre Jaune en Martinique: *Analyse et proposition d'un groupe de travail d'Arbo-France*

Scenario of a Yellow Fever outbreak in Martinique: Analysis & proposals of a Arbo-France working group

Membres par ordre alphabétique: *André Cabié – CHU Martinique, Fabrice Chandre – Institut de Recherche pour le Développement, Simon Cauchemez – Institut Pasteur Paris, Xavier de Lamballerie – Université Aix-Marseille, Jean Claude Desenclos – Santé Publique France, Anna Bella Failloux - Institut Pasteur Paris, Harold Noël - Santé Publique France, Bernadette Murgue – Inserm, Jacques Rosine – Santé Publique France*

Relecture du document: *André Yébakima – ex- Directeur CEDRE-LAV, Martinique, consultant , Alain Blateau – ex-Directeur de la Santé publique de l'ARS Martinique, consultant.*

Annual Scientific Symposium of Arbo-France, 24-25 October 2024, Institut Pasteur, Paris

Plan

- Evaluation du risque en Martinique
- Méthode
- Thèmes clés
  - Capacité diagnostique
  - Prise en charge médicale
  - Vaccination
  - Lutte anti-vectorielle (LAV)
  - Surveillance, suivi de l'épidémie
  - Recherche
  - Retex
- Conclusion

Arbo-France
Réseau Français d'étude des arboviroses

anrs MALADIES INFECTIEUSES ÉMERGENTES Inserm

Risque d'émergence de la Fièvre jaune en Martinique

- **Epidémies entre 1682 et 1908 en Martinique, aucun cas depuis**
- **Epidémies récentes (Angola, RDC, 2016; Brésil 2016-17)**
- **Risque réel d'introduction par des voyageurs virémiques**
- **Risque de transmission efficace élevé des virus « Ouganda » ou « Bolivie » par *Ae. aegypti* et d'épidémie en cas d'introduction***
  - **évaluation de 9 populations d'*Ae. aegypti* de Martinique**
  - **5 génotypes viraux: 4 africains et 1 d'Amérique du Sud**
  - **très bonne transmission du virus "Ouganda"**
  - **beaucoup moindre pour le virus "Ghana".**
  - **virus "Bolivie", transmis par toutes les populations d' *Ae. aegypti***

**Gabiane G et al. Nature Communications (2024)15:1236*

Arbo-France
Réseau Français d'étude des arboviroses

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Groupe de travail multidisciplinaire

- Virologie, infectiologie, épidémiologie, entomologie, SHS, santé publique…
- Représentants des agences de santé publique locale et nationale
- Une douzaine de réunions en visioconférence et/ou présentiel 2020-2023
- Méthodologie
    - Identification de thèmes clés: Diagnostic - Prise en charge médicale – Vaccination – Lutte anti-vectorielle (LAV) – Répulsifs - Suivi de l'épidémie.
    - Etat des lieux de l'existant: connaissances, avis/reco, plans, moyens…
    - Pour chaque thème questions qui se posent
    - Proposer des priorités d'action et de recherche à court et moyen terme
    - Proposition d'un phasage des actions (avant, pendant et après épidémie)

Capacité diagnostique

- Laboratoires de 1ère ligne (hôpitaux) identifiés,
- Laboratoires de ville: capacité variable et difficile à anticiper
- CNR des arbovirus en soutien, expertise, développement…
- Etat des lieux des laboratoires faisant le diagnostic de dengue (ARS)
    - suivi des tests utilisés et capacité des laboratoires à s’adapter à une émergence.
    - assurer/évaluer la continuité de la capacité diagnostique en cas d’épidémie
- Indication et algorithme diagnostic basé sur critères cliniques/biologiques
- Evaluer la proportion des formes de FJ asymptomatiques
- Vaccination: test avant la vaccination; test après la vaccination si fièvre
- Capacité à déployer le DGV chez les donneurs de sang
- Séroprévalence (enquête avec séro-neutralisation en fin de l’épidémie)

Prise en charge médicale

- Acquis/expérience lors des épidémies d'arboviroses (Dengue, Chik, Zika)
- Filière d'hospitalisation dédiée au sein du CHU
- En début d'épidémie cas suspects et confirmés tous adressés au CHU
- Epidémie en cours:
  - orientation pré-hospitalière selon des critères cliniques et biologiques
  - prise en charge/suivi ambulatoire (Communauté Professionnelle Territoriale de Santé)
- Evaluation et suivi de la capacité de prise en charge
  - évaluation des besoins de lits hospitaliers/soins critiques selon la dynamique de l'épidémie.
  - suivi de la capacité/modalités de prise en charge hospitalière et ambulatoire par l'ARS
- Prévention et contrôle de la transmission nosocomiale (Avis HCSP, 2017*)
- En l'absence de traitement évalué, revue des molécules (antiviraux, anticorps monoclonaux) au minimum en stade préclinique et en développement

* Avis du HCSP 2017. https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=599

Vaccination

- Préparation en temps de paix
  - campagnes d'information et de communication à préparer pour une situation épidémique
  - évaluation de la perception et de l'acceptabilité de la vaccination contre la Fièvre Jaune
- Stratégie (avis HCSP, 2017*)
  - personnes autour des cas de FJ confirmés, population à vacciner évaluée régulièrement
  - évaluation de l'efficacité/impact de la stratégie déployée sur le terrain
- Capacité et disponibilité vaccinale au regard des données épidémiologiques
  - si risque de tension, envisager le fractionnement des doses (avis ANSM et HAS)
  - procédures d'approvisionnement: ARS, rôle de l'ANSM auprès des producteurs…
- Vaccination du personnel soignant et du personnel des laboratoires
  - recensement du personnel de 1ère ligne par la Santé au travail (statut vaccinal)
  - évaluation de la perception et de l'intention de se faire vacciner contre la FJ
- Suivi des vaccinations (modèle Vaccin-Covid de l'Assurance Maladie)
- Effets indésirables: information, déclaration, CRPV, BNPV, ANSM

* Avis du HCSP 2017. https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=599

Lutte anti-vectorielle

- **Rôle stratégique structurant du PSAGE Dengue**
- **Pas d'adulticides efficaces (résistance) autorisés vs danger pour la santé publique**
- **Revue des substances actives hors cadre règlementaire Européen (Anses 2023)***
  - **produits parmi ceux pré-qualifiés par l'OMS* pour traitements spatiaux et larvicides**
  - **dérogation (180 jours prolongeable 18 mois) en cas de menace pour la santé publique**
  - **processus long (semaines/mois) pas compatible avec LAV efficace précoce**
  - **expertises réglementaires, obtention, approvisionnement, stocks, protocoles d'utilisation…**
- **Dimension sociale: acceptabilité, usage dérogatoire, participation…**
- **Nouvelles méthodes préventives : Wolbachia, TIS…**
- **En phase épidémique**
  - **commencer avec la deltaméthrine et relai dès que possible avec produits dérogatoires**
  - **messages de protection personnelle et mobilisation communautaire (à préparer en amont)**
  - **produits répulsifs à base des 4 molécules recommandées**; prise en charge financière?**

*https://www.anses.fr/fr/system/files/BIOCIDES2020SA0029-1.pdf
**DEET, IR3535, KBR3023, huile d'Eucalyptus citriodora, hydratée, cyclisée ou son équivalent de synthèse le para-menthane-3,8 diol

Surveillance et suivi de l'épidémie

- Adapter le PSAGE Dengue comme lors des émergences Chik et Zika
- Surveillance: indicateurs de suivi (cf. PSAGE dengue)
  - définitions de cas (DO)
  - nouveaux cas totaux, cas en ambulatoire, cas hospitalisés, sévérité (soins critiques…)
  - mortalité : décès hospitaliers, taux de létalité, certificats de décès, excès de mortalité
- Rétro-information hebdomadaire par Santé publique
- Estimation, suivi de la prévalence de la population infectée : enquête de séro prévalence (donneurs de sang?)
- Sévérité : suivi (18 mois) des patients inclus dans la cohorte CARBO
- « Efficacité » des, et résistance aux insecticides employés
  - densités d'*Ae. aegypti*: pièges adultes et pondoirs pièges avant et après traitement LAV
  - suivi de la résistance aux molécules utilisées par la LAV

Recherche

- Plan défini en amont:
  - travaux à anticiper
  - travaux à mettre en œuvre dés la détection et à préparer
- Volet clinique
- Volet virologique
- Evaluation de la réponse vaccinale
- Volet thérapeutique
- Volet entomologique
  - Cf. questions sur la LAV
  - produits identifiées dans la saisine de Anses (résistance des populations locales; efficacité)
- Volet épidémiologie et modélisation
- Recherche multidisciplinaire en système de soins et Sciences humaines et sociales
  - capacité de prise en charge ambulatoire/hospitalière/calibrage de la filière dédiée
  - perception, représentation de la population et personnel soignant
  - dimension participative

Retex

A distance de l'épidémie, un groupe de travail multidisciplinaire incluant des professionnels de la santé, des chercheurs, des patients et des représentants des opérateurs et des agences de santé sera mis en place sous la coordination d'un expert en retour d'expérience indépendant: tire les enseignements, les forces de la réponse, ses faiblesses et les améliorations à apporter.

Conclusion

- Risque réel d'introduction et de transmission
- Sévérité et gravité de la maladie (létalité 20-60%)
- Expérience et ressources présentes ou pouvant être activées rapidement
- Stratégie de réponse vaccinale définie
- Des points critiques identifiés
- Une réponse rapide et efficace nécessite une préparation en amont et un plan opérationnel dès la détection (réponse et recherche)
- Intérêt pour d'autres émergences dans les DFA et en métropole

Annexes

Arbo-France
Réseau Français d'étude des arboviroses

anrs MALADIES INFECTIEUSES ÉMERGENTES Inserm

Timing: diagnostic

	Avant	**Pendant**	**Après**
Diagnostic	État de lieux annuel des laboratoires de villes capables de faire le diagnostic moléculaire de la FJ et des tests utilisés : ARS	Tests in-house: CNR	Étude de séroprévalence
	Développement d'un algorithme de diagnostic : CNR-CHU	Recommandations des kits commerciaux à utiliser et du protocole d'isolement des souches : CNR	
	Différenciation par PCR vaccination *vs* infection : CNR		
	État des lieux et évaluation des tests antigéniques rapides : CNR		
	Protocole générique d'investigation des personnes vivant à proximité des patients pour évaluer le pourcentage d'infections asymptomatiques (avenant à Carbo) : CHU/SPF/ARS		
	Évaluation de la capacité de détection du virus de la FJ chez les donneurs de sang		

Timing: LAV

Lutte antivectorielle	Avant	pendant	Après
	Préparation d'un cahier des charges : quelles molécules et comment les utiliser, procédures, Anses, ARS	Caractérisation et suivi des souches virales circulantes : acteurs locaux, CNR	
	Recherche opérationnelle pour évaluer l'efficacité et la résistance des traitements actuels et de ceux identifiés par l'anses : CEDRE, ARS, IRD	Renforcement des messages sur la protection personnelle : ARS	
	Évaluation des aspects réglementaires et des risques environnementaux des produits identifiés par l'Anses: Anses, HCSP		
	Étude d'acceptabilité par la population et les soignants des insecticides recommandés		
	Renforcer la prévention primaire : ARS, CTM, Mairies	Mobilisation sociale et Participation communautaire maximales : Préfecture (dispositif ORSEC), ARS, CTM, Mairies,…	
	Evaluation Compétence Vectorielle *Aedes albopictus* (si introduit)		

Day 1: Preparedness and response to emerging arboviruses.

Round table: Viewpoint of local actors

With Raymond Césaire
Mehdaoui Hossein
André Yebakima
Anubis Vega-Rúa
Lionel Gresh

Round table: Interest in such scenario and possible adaptation to others - Institutional viewpoint

With Eric D'Ortenzio
Gilles Salvat
Brigitte Autran
Alexis Pernin
Marie-Eve Raguenaud
Bruno Coignard

Day 1: Preparedness and response to emerging arboviruses.

Coffee break, back in 20 minutes

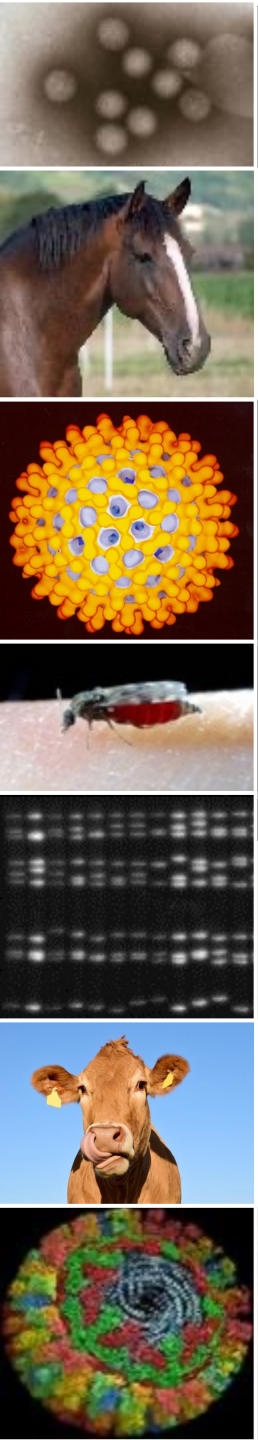
With the next session:

Emergence of animal arboviruses

Day 1: Preparedness and response to emerging arboviruses.

Emergence of culicoides transmited arboviruses in Europe over the last 20 years in animal health

By Stephan Zientara



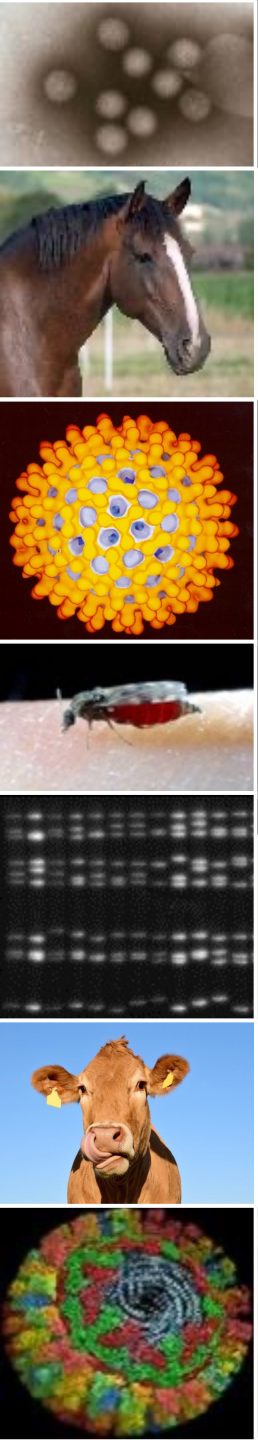
24 of October 2024, Arbo-France, IP

Stéphan Zientara

Emergence of culicoïdes transmitted arboviruses in Europe over the last 20 years in animal

Anses – Laboratory for Animal Health

Maisons-Alfort



24 of October 2024, Arbo-France, IP

Stéphan Zientara

Emergence of culicoïdes transmitted arboviruses in Europe over the last ~~20~~ 37 years in animal

Anses – Laboratory for Animal Health

Maisons-Alfort

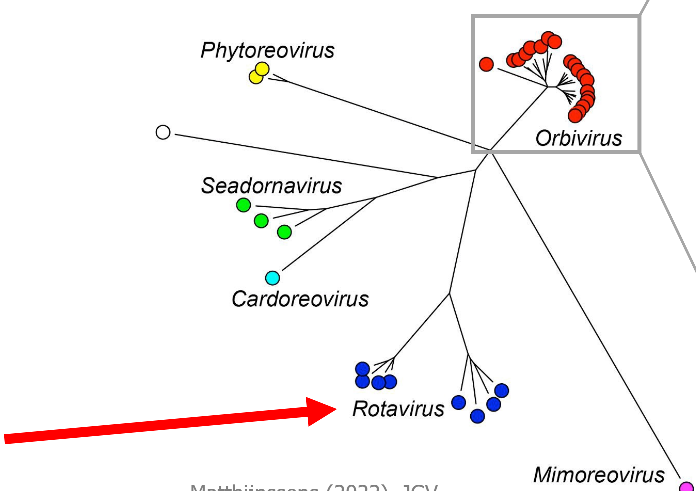
Emergence of culicoïdes transmitted arboviruses in Europe over the last 20 years in animal

- **Orbiviruses:**
- **- Bluetongue**
- **- EHD**
- **- AHS**
- **Bunyavirus:**
- **- Schmallenberg**

-

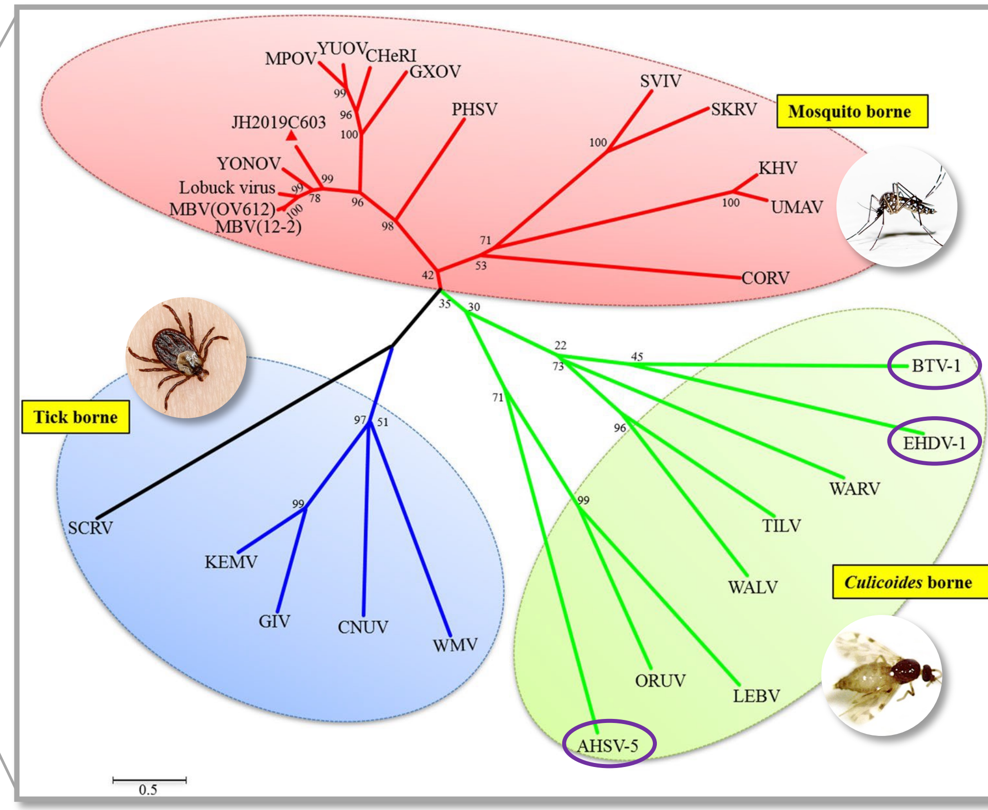
Orbiviruses

Family *Sedoreoviridae*



Matthijnssens (2022), JGV

Genus *Orbivirus*: 22 species

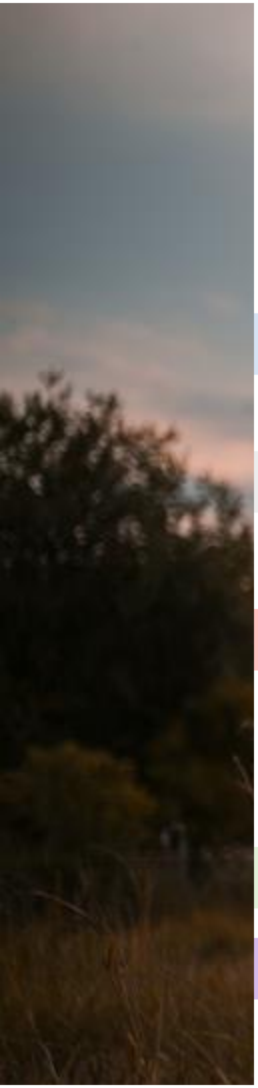


Yang (2021), Virus genes

World Organisation for Animal Health
Founded as OIE

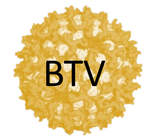
3 important diseases

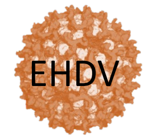
- **BTV:** Bluetongue virus (FCO)
- **EHDV:** Epizootic hemorragic disease virus (MHE)
- **AHSV:** African horse sickness virus (Peq)



Bluetongue (BTV) & Epizootic Hemorrhagic Disease (EHD)

WOAH & European notifiable animal diseases



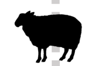


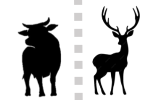
Virus — *Sedoreoviridae, Orbivirus*

	BTV	EHDV
Virus	36 serotypes	7 serotypes

Host(s)

- Susceptible
- "Reservoir"





Disease — Bleeding + Inflammation

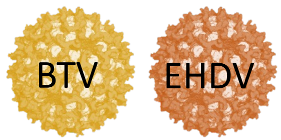
Fever, oedemas, loss of appetite, weakness, excessive salivation, haemorrhages, respiratory distress, ulceration (buccal mucosa, tongue…)

Transmission — Vector *Culicoides*

Distribution

BTV	EHDV
Enzootic	**Emerging**

Sedoreoviridae, Orbivirus



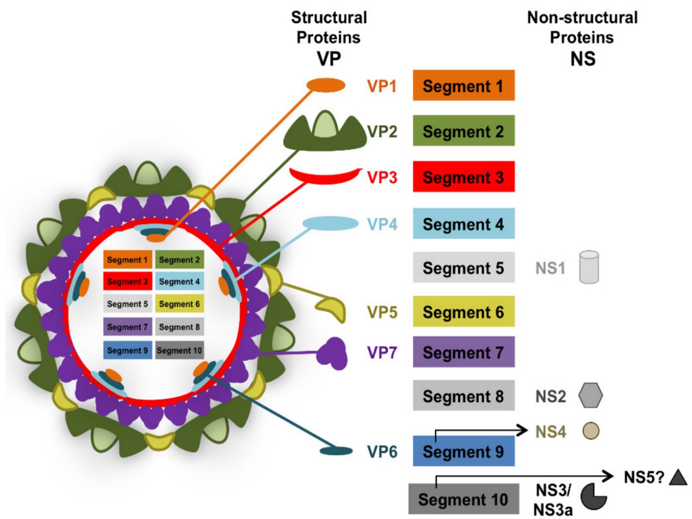


Figure from Rodríguez-Martín *et al*., 2021

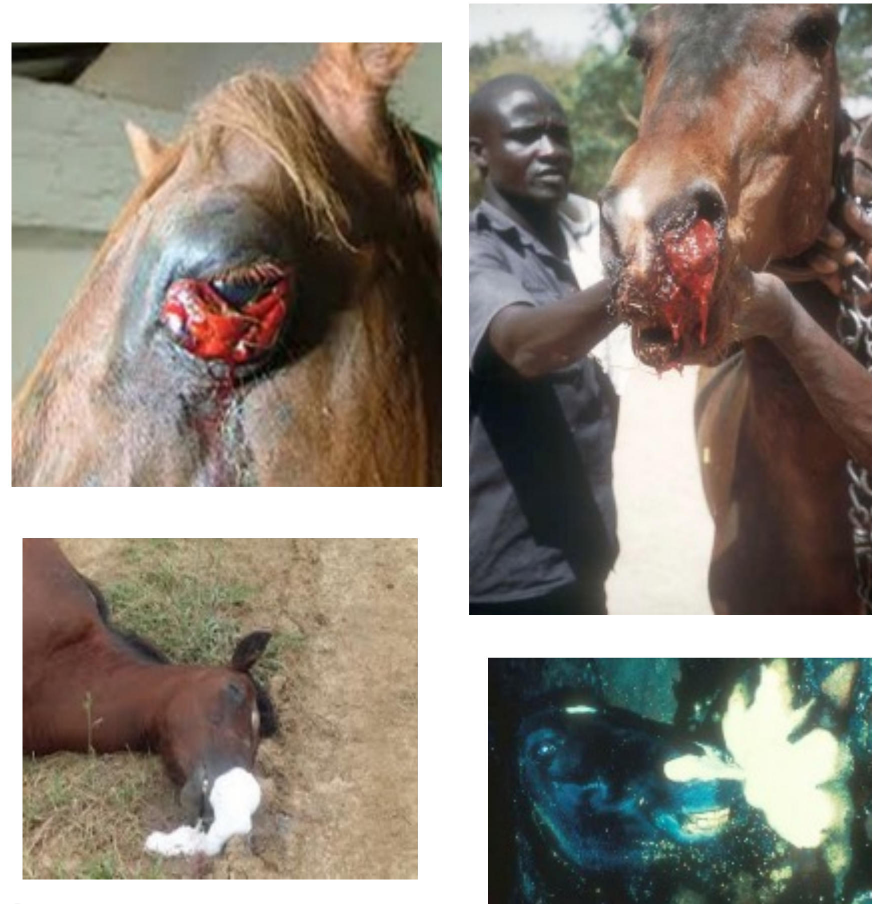
- **Non-enveloped segmented dsRNA+ genome**
- **10 segments ≈ 19,2 kb**
- Conserved sequence at the extremities:

  5' [GUU(A/U)A(A/U) ... AC(A/U)UAC] 3'
- S1 to S8: Monocistronic segment
- S9 & S10: Bicistronic segments
- **Serotyping: Segment 2**

reassortment

Viral Hemorrhagic Fevers

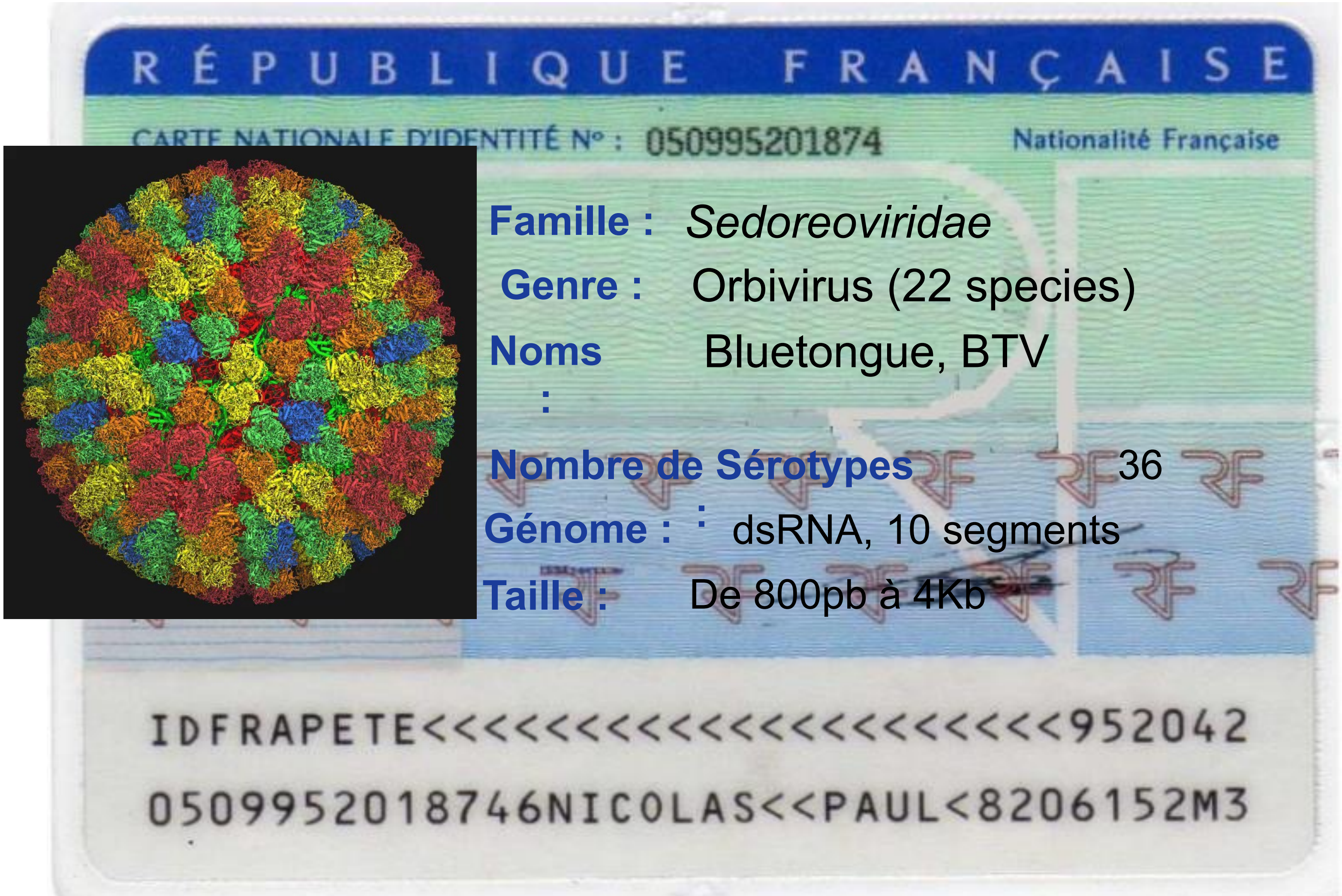
BTV



AHSV

Bluetongue/Fièvre catarrhale ovine

Identity card BTV



Famille : *Sedoreoviridae*

Genre : Orbivirus (22 species)

Noms : Bluetongue, BTV

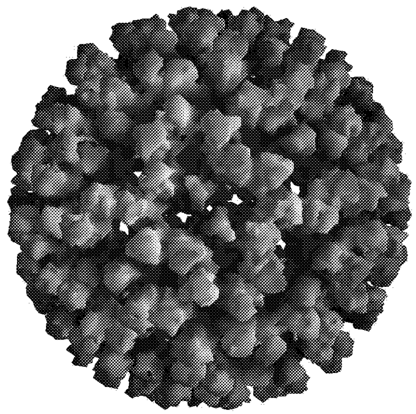
Nombre de Sérotypes : 36

Génome : dsRNA, 10 segments

Taille : De 800pb à 4Kb

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

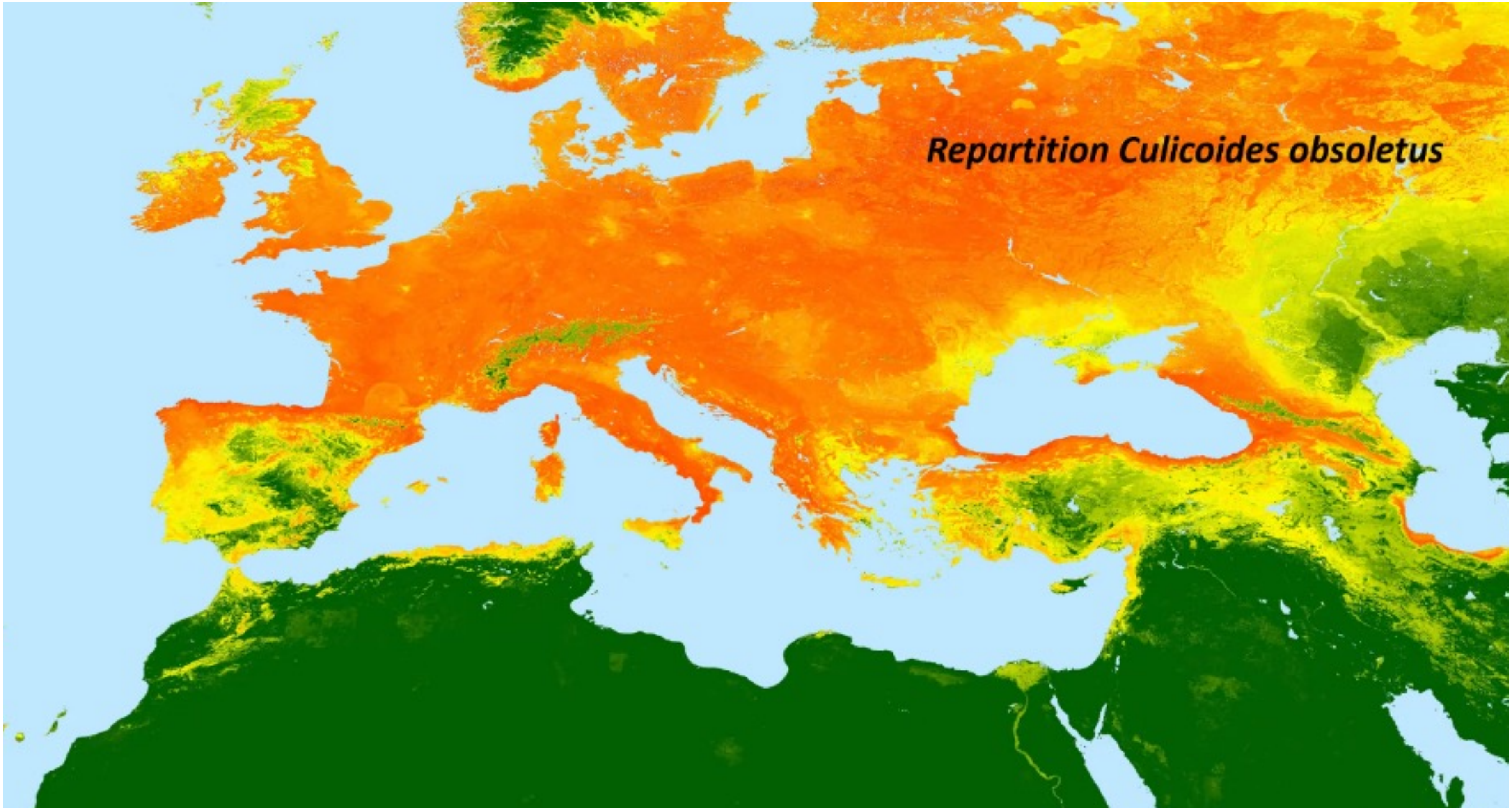


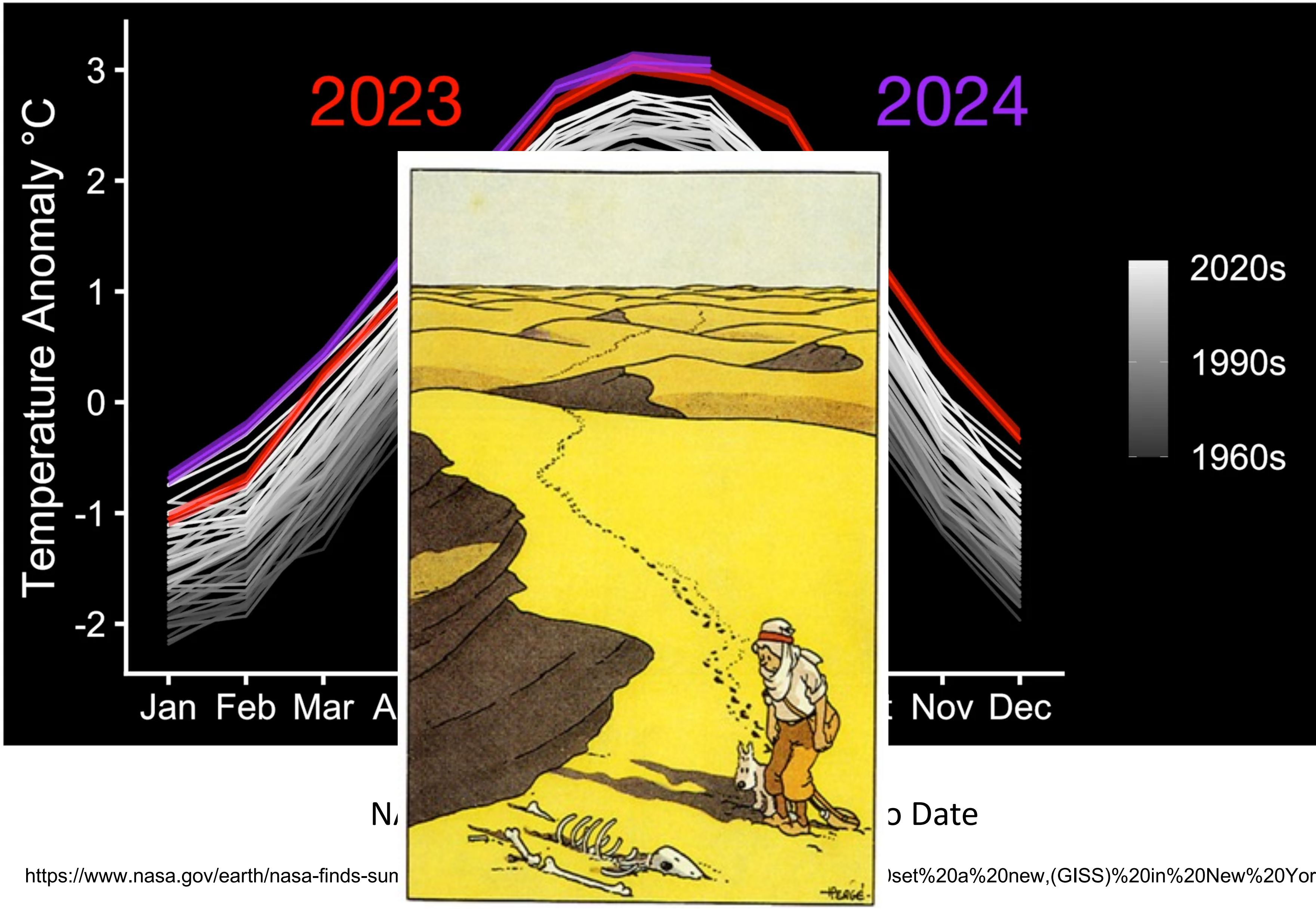
- **36 serotypes BTV**
  - **1-24 biting midges**
  - **25 - 36: non-vector transmission**

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




Culicoides imicola


Repartition Culicoides obsoletus



N/ ɔ Date

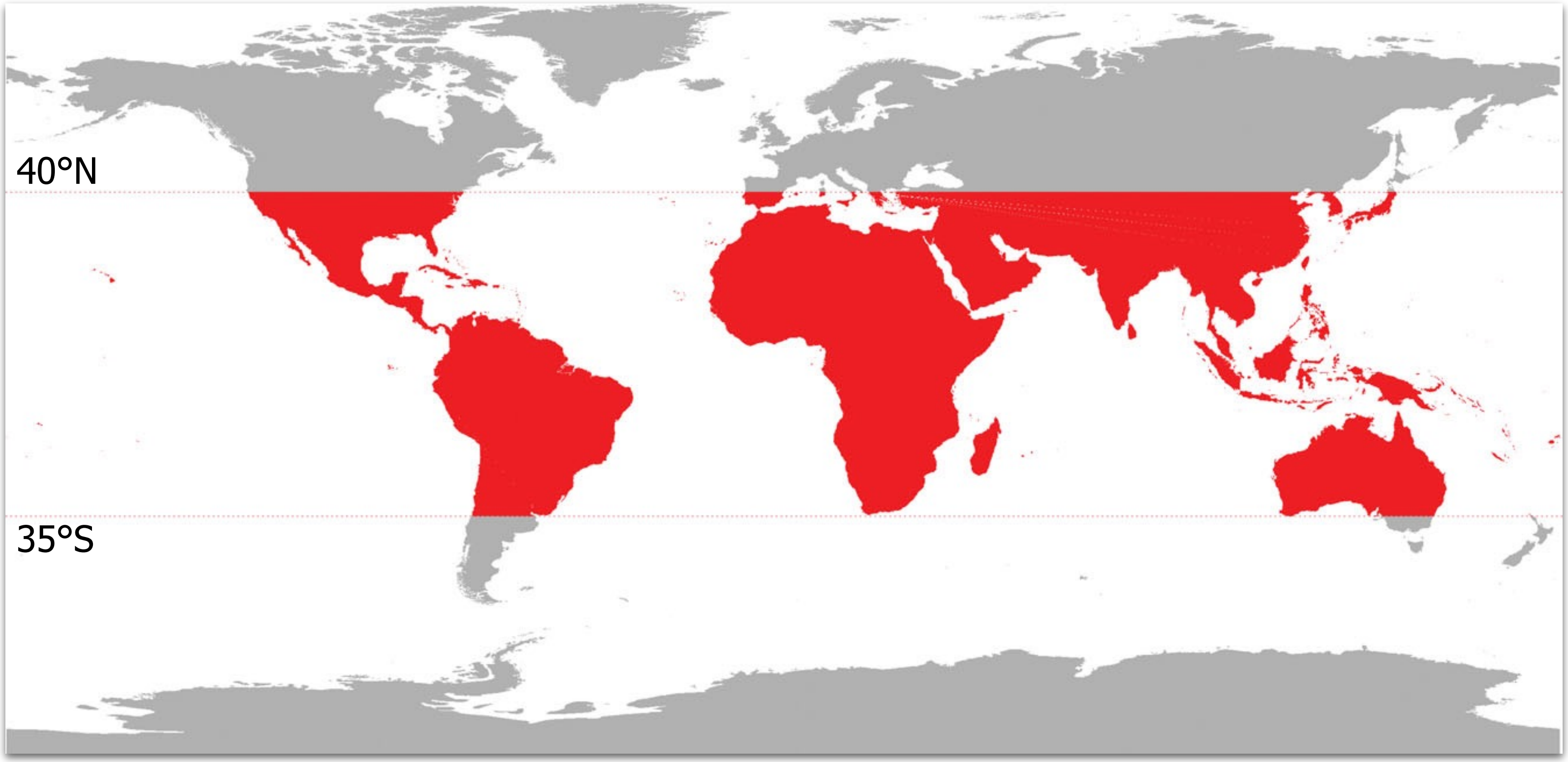
https://www.nasa.gov/earth/nasa-finds-sun)set%20a%20new,(GISS)%20in%20New%20York.

Epidemiology - 1998

FRANCE 98
WORLD CUP

Zinedine Zidane

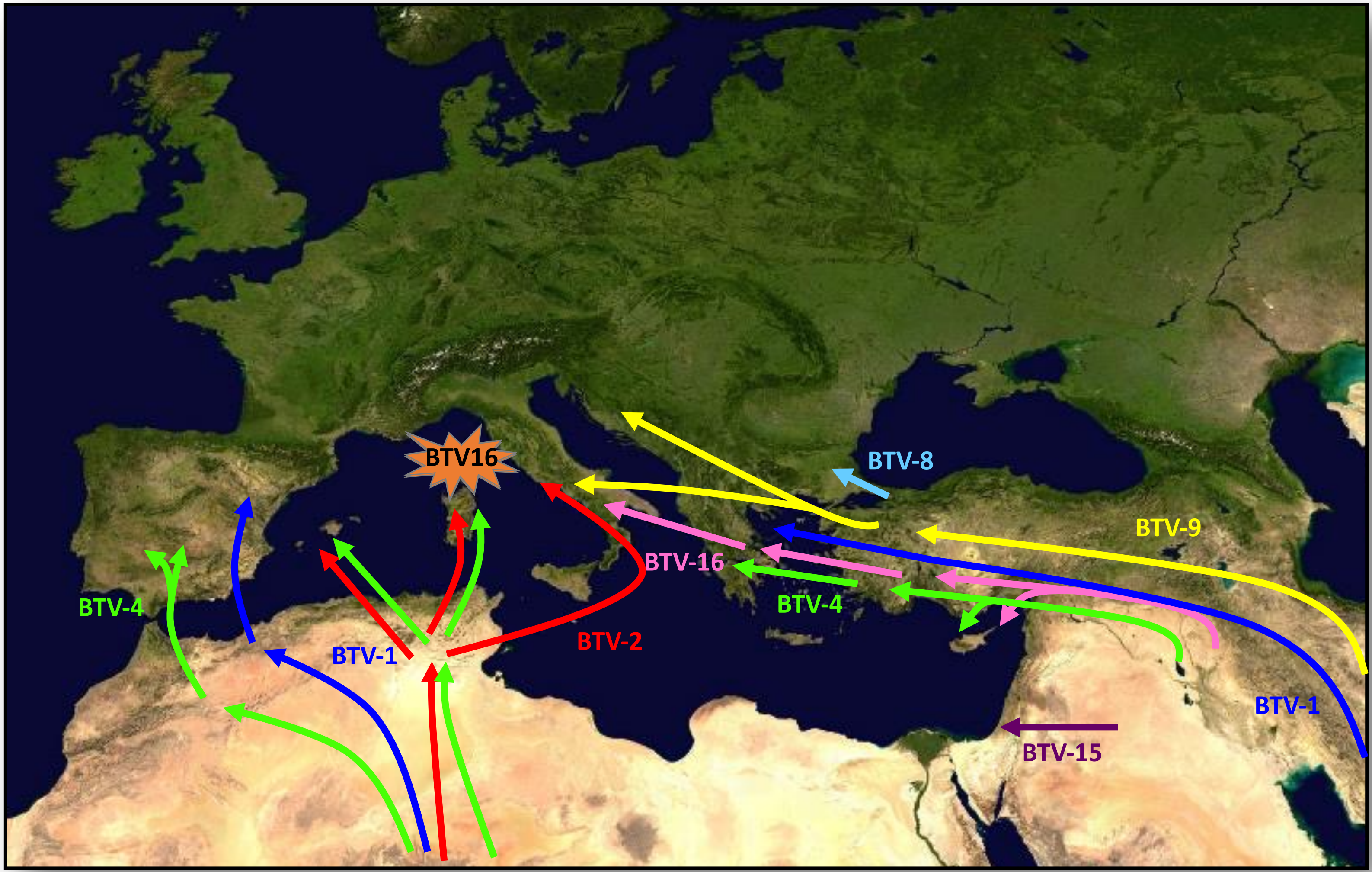
World distribution of BT before 1998



Wilson (PTRSLBBS, 2009)

BT in Europe before 1998...

1998-2006: circulation in the South of Europe

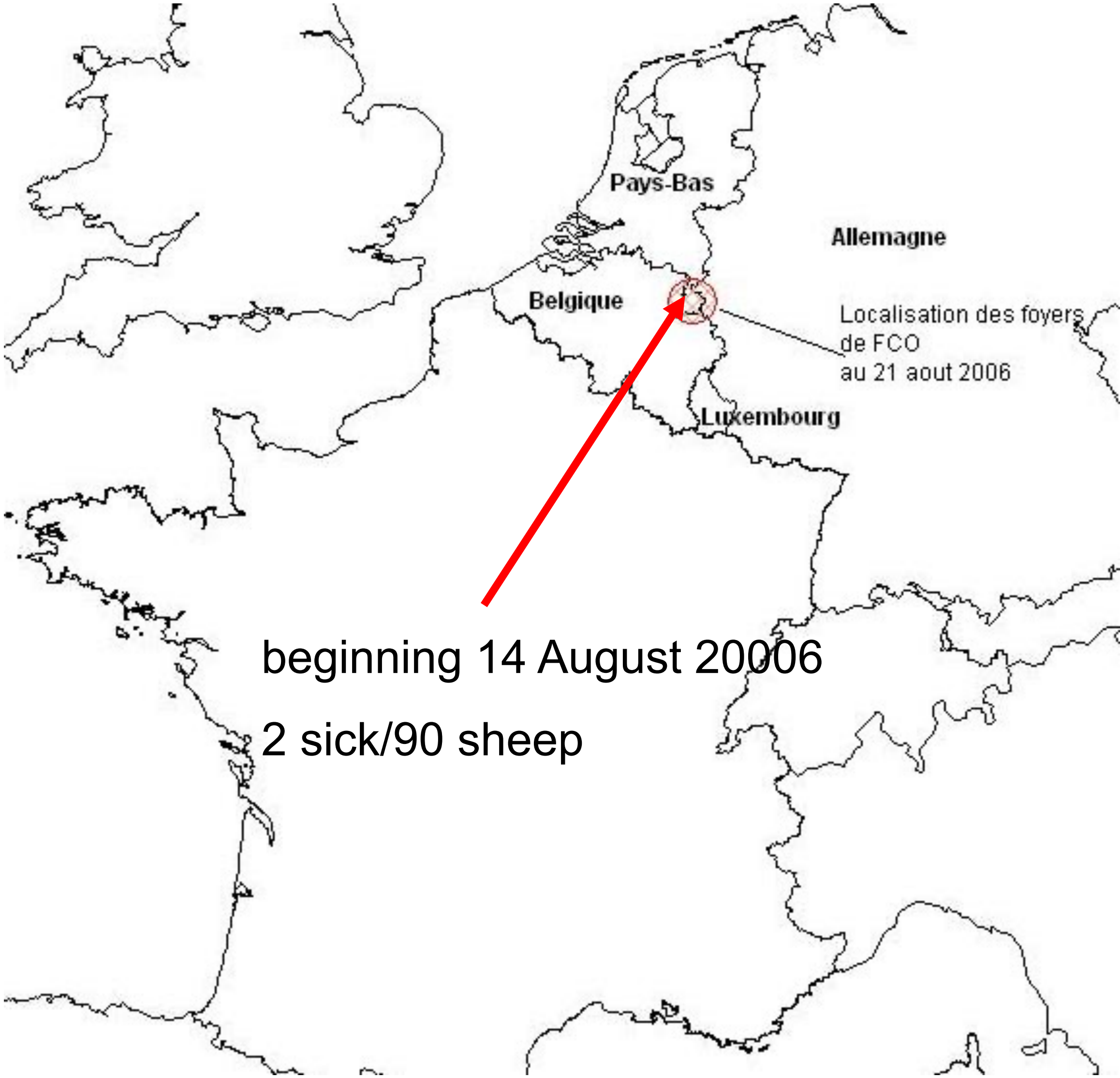


2006 (9th of July)

Summer 2006

Emergence in 2006
New serotype
New area
New clinical pattern

Clinical signs
BT
cattle



beginning 14 August 20006

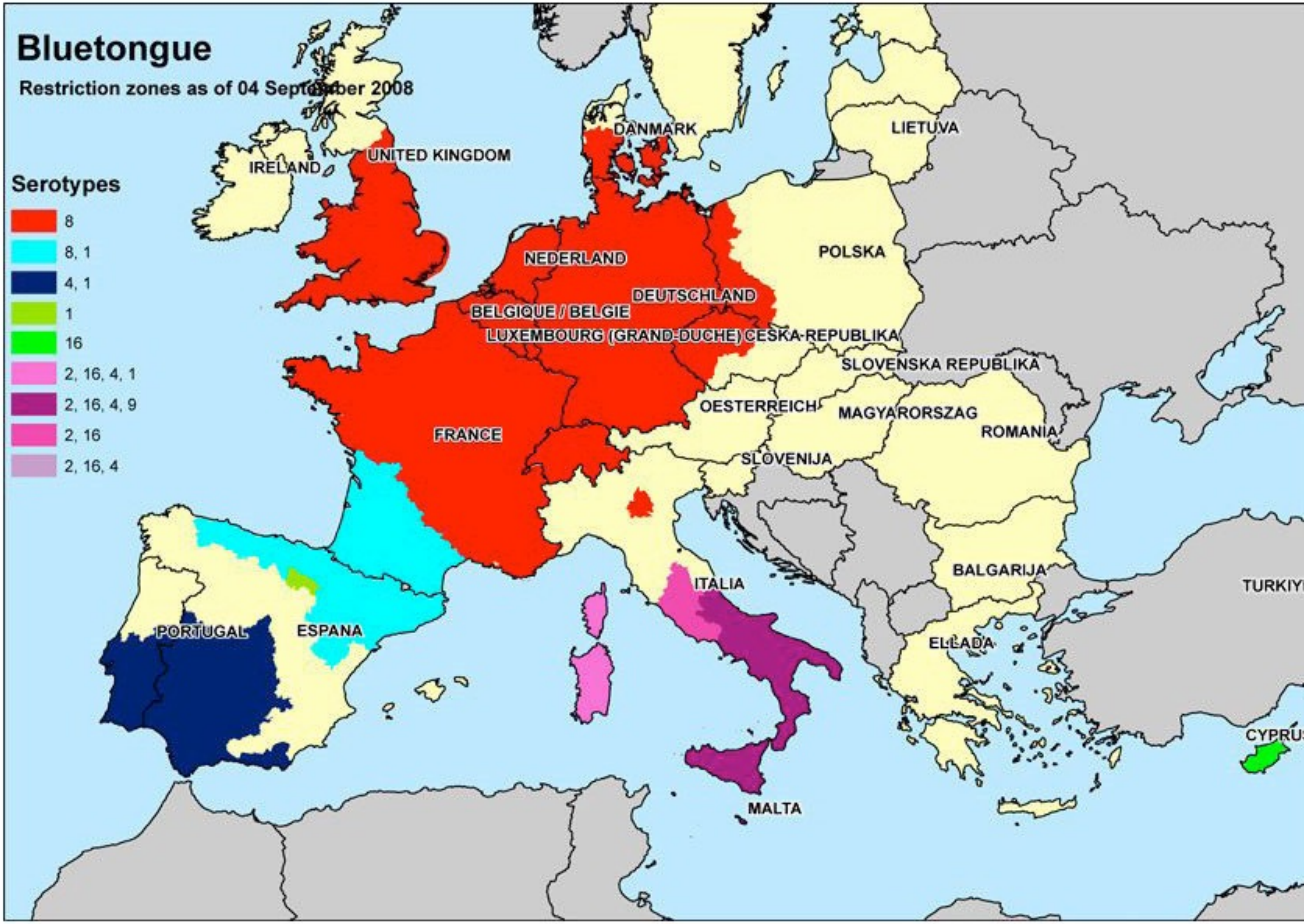
2 sick/90 sheep

Etienne Thiry, ULG

2007

Bluetongue virus distribution in Europe in 2007.

2008



Bluetongue
Restriction zones as of 04 September 2008
Serotypes
8
8, 1
4, 1
1
16
2, 16, 4, 1
2, 16, 4, 9
2, 16
2, 16, 4
UNITED KINGDOM
IRELAND
DANMARK
LIETUVA
NEDERLAND
POLSKA
DEUTSCHLAND
BELGIQUE / BELGIE
LUXEMBOURG (GRAND-DUCHE)
CESKA REPUBLIKA
SLOVENSKA REPUBLIKA
OESTERREICH
MAGYARORSZAG
ROMANIA
FRANCE
SLOVENIJA
BALGARIJA
ITALIA
TURKIYE
PORTUGAL
ESPANA
ELLADA
CYPRUS
MALTA

2009

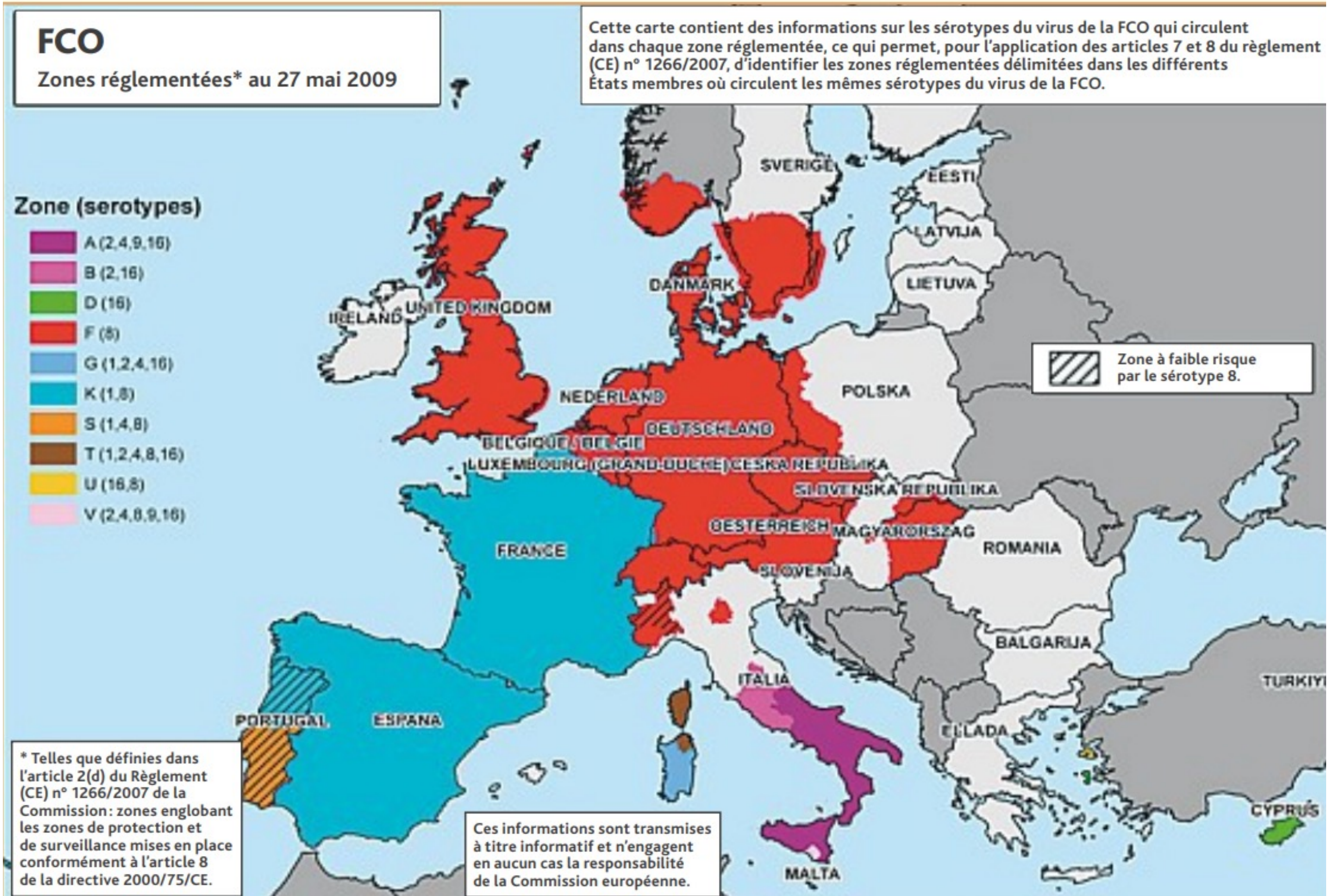


Figure 2. Zones réglementées pour la FCO en vigueur en Europe en mai 2009

2006 : 7 cases

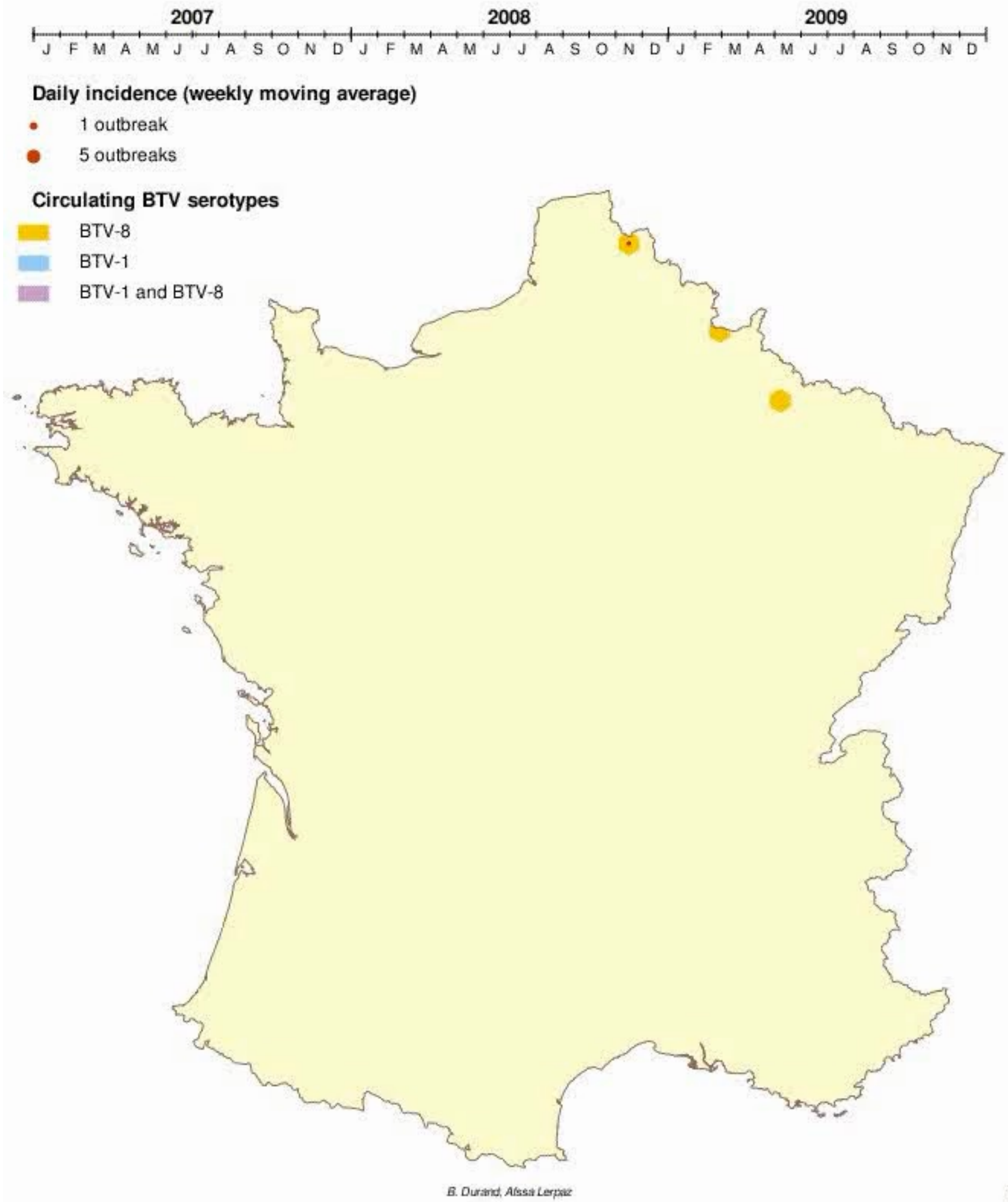
2007: 14 000

2008 : 38 000

2009 : 83

2010 : 1

2011: 0



Benoit Durand
unité EPI, Anses

2010

2006 : 7 cases

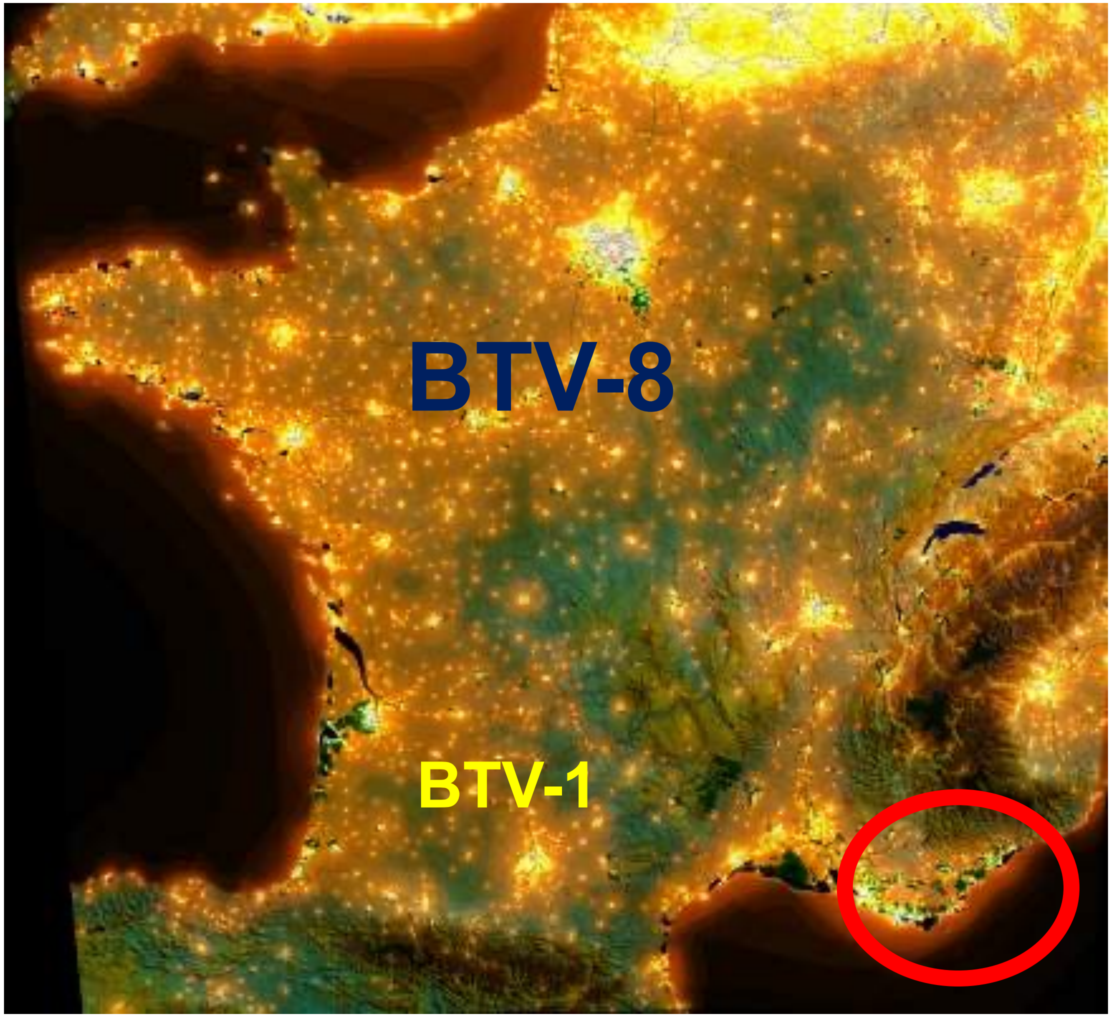
2007: 14 000

2008 : 38 000

2009 : 83

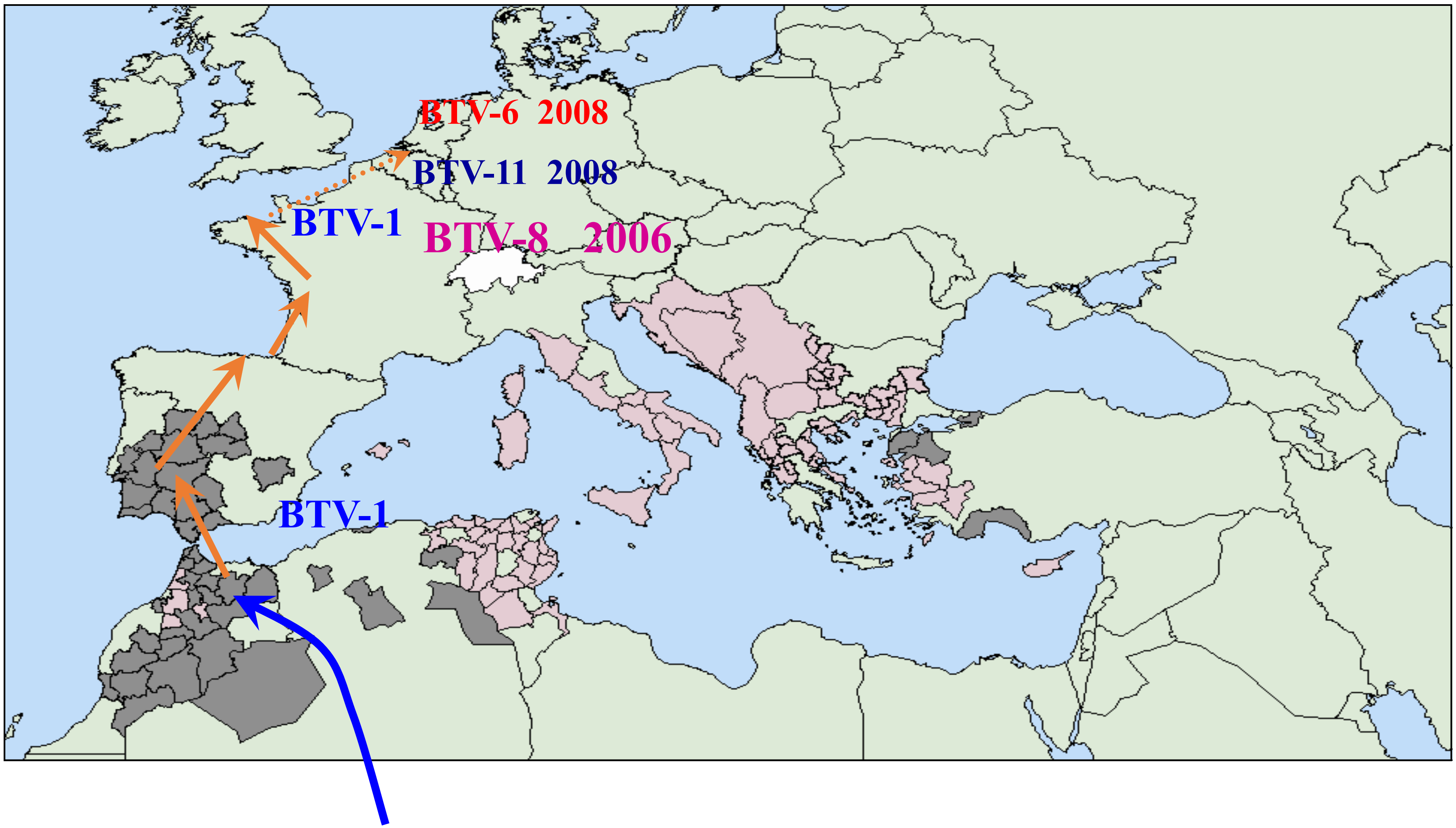
2010 : 1

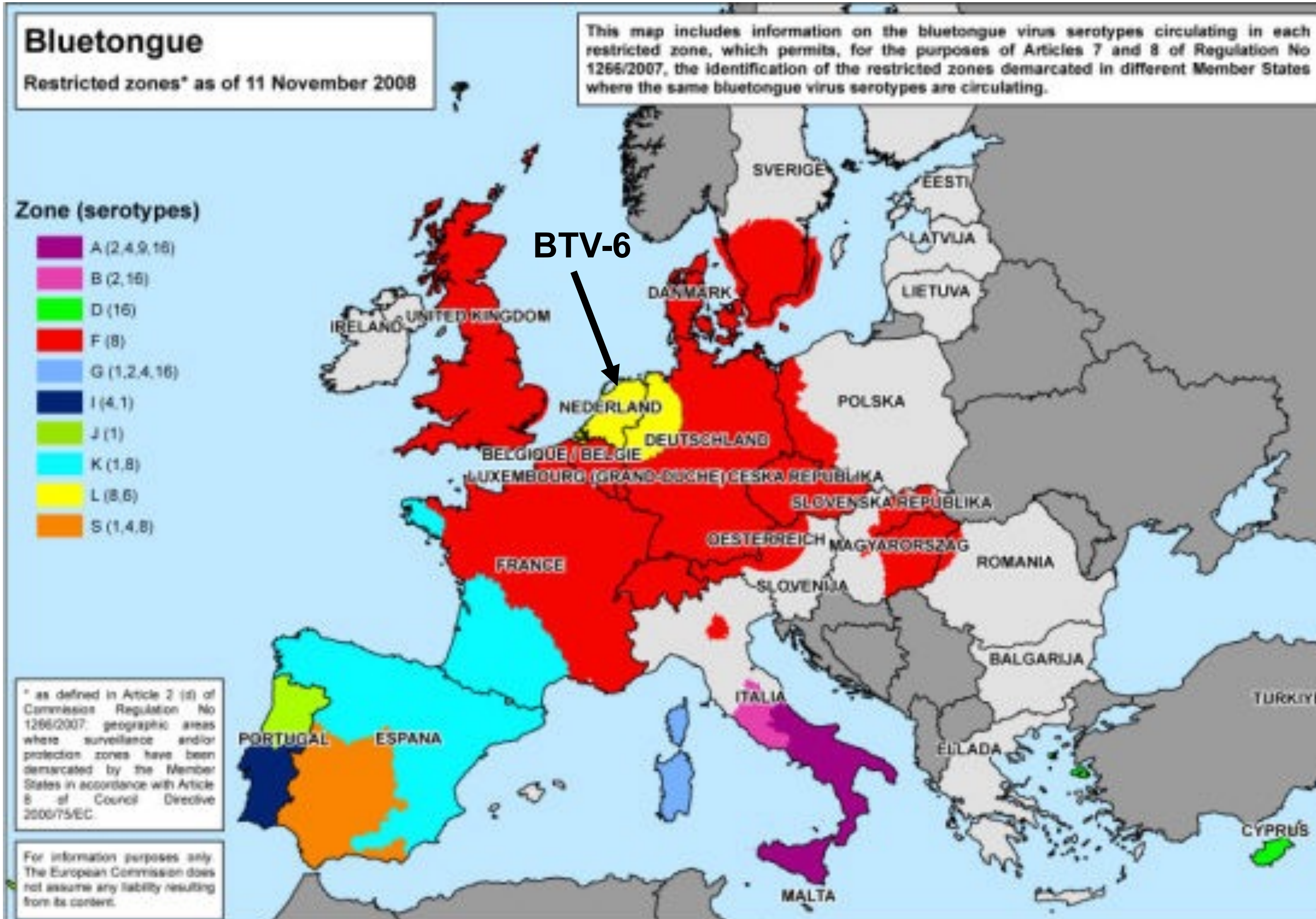
2011: 0



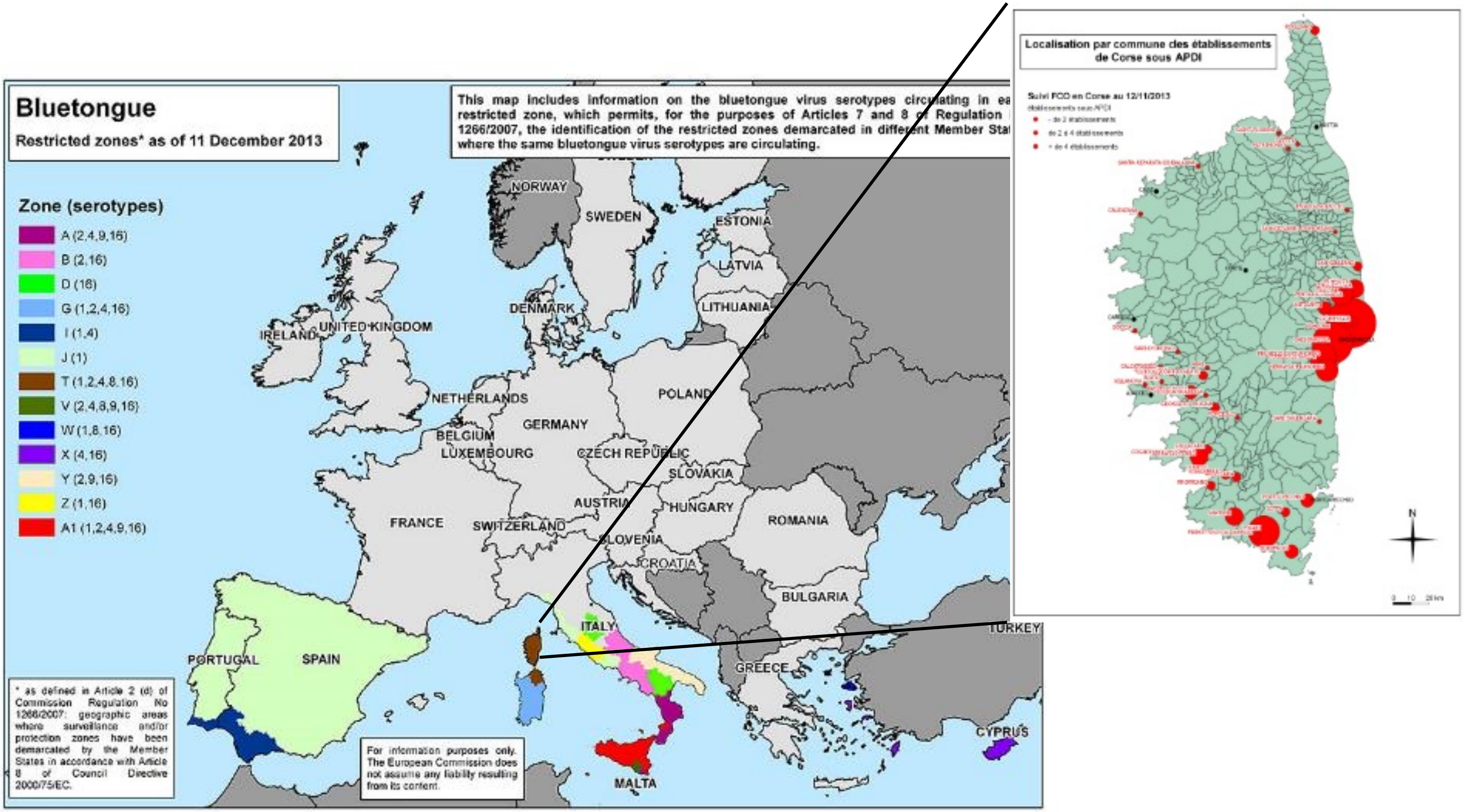
2012 : 14 of December: free status

BTV-8/1/6/11




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
POLSKA
DEUTSCHLAND
BELGIQUE / BELGIE
LUXEMBOURG (GRAND-DUCHE)
CESKA REPUBLIKA
SLOVENSKA REPUBLIKA
OESTERREICH
MAGYARORSZAG
ROMANIA
FRANCE
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 8 of Council Directive 2000/75/EC.
For information purposes only. The European Commission does not assume any liability resulting from its content.

BTV circulation in Europe in 2013



Compulsory vaccination, BTV-1, 2014-2015

Other serotypes

2008

Genetic Characterization of Toggenburg Orbivirus, a New Bluetongue Virus, from Goats, Switzerland

Martin A. Hofmann, Sandra Renzullo, Markus Mader, Valérie Chaignat, Gabriella Worwa, and Barbara Thuer

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

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 20, No. 12, December 2014

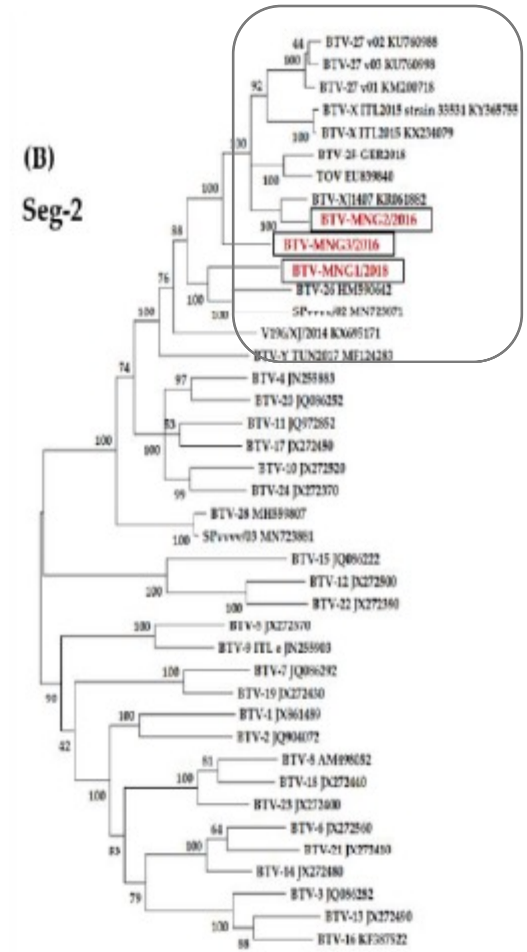
Serotypes adapted to small ruminants (direct transmission)

New serotypes	Origin	Host
BTV-25 (Toggenburg)	Switzerland	goats
BTV-26	Koweit	sheep
BTV-27	Corsica	Goats
BTV-28 (vaccine)	Israel	Sheep
BTV-29 (vaccine)	Israel	Sheep
BTV-30	China	Goat/sheep
BTV-30	Mongolia	Goat/sheep
BTV-31	China	Goat/sheep
BTV-32	Italy	Goat
BTV-33	Mongolia	Goat/sheep
BTV-34	Tunisia	sheep
BTV-35	Mongolia	Goat/sheep
BTV-36	Switzerland	goat

2007

2014

2021




viruses
MDPI
Viruses. 2021 Jan; 13(1): 42.
Published online 2020 Dec 29. doi: 10.3390/v13010042

Putative Novel Serotypes '33' and '35' in Clinically Healthy Small Ruminants in Mongolia Expand the Group of Atypical BTV

LONDON
2012

Bluetongue serotype 14

In November 2012, Estonia, Latvia, Lithuania and Poland.
Russian government reported the detection BTV-14 in Belarus
and Russia to animals imported from Europe

Close to live South African vaccine

2015

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

Share this: 2.6K

The Nobel Prize in Physiology or Medicine 2015

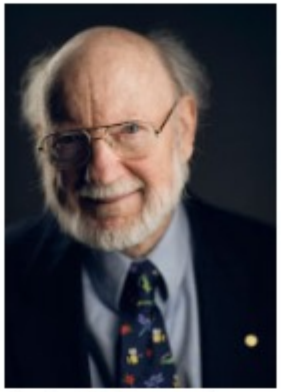
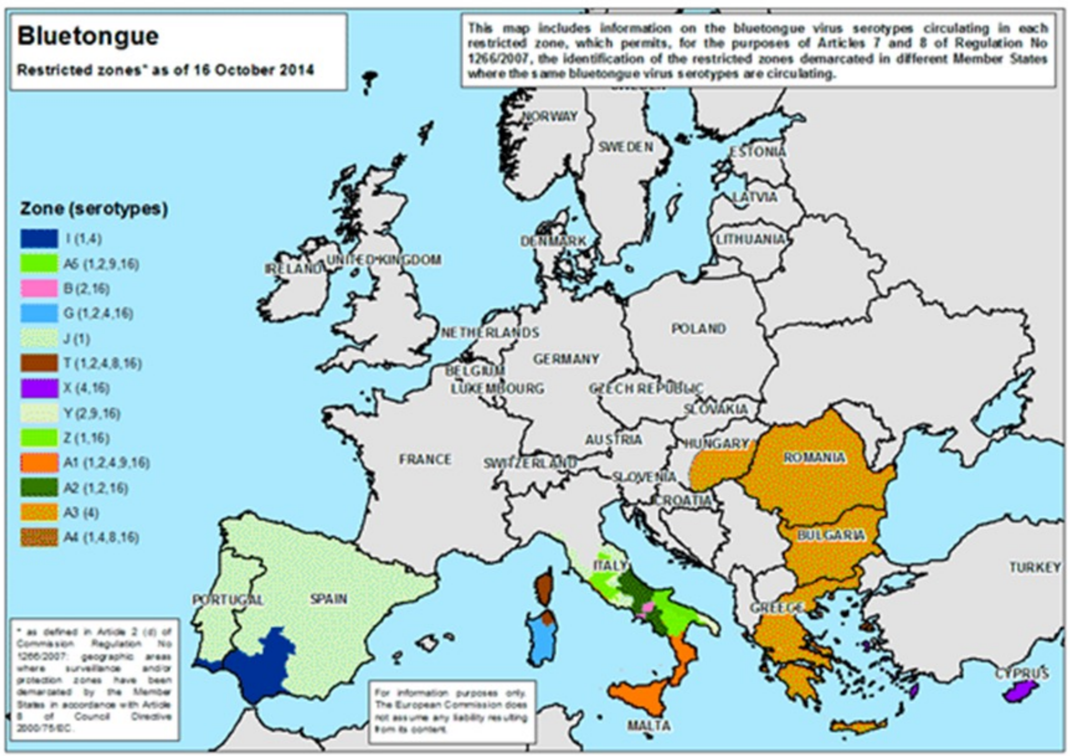


Photo: A. Mahmoud
William C. Campbell
Prize share: 1/4

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"

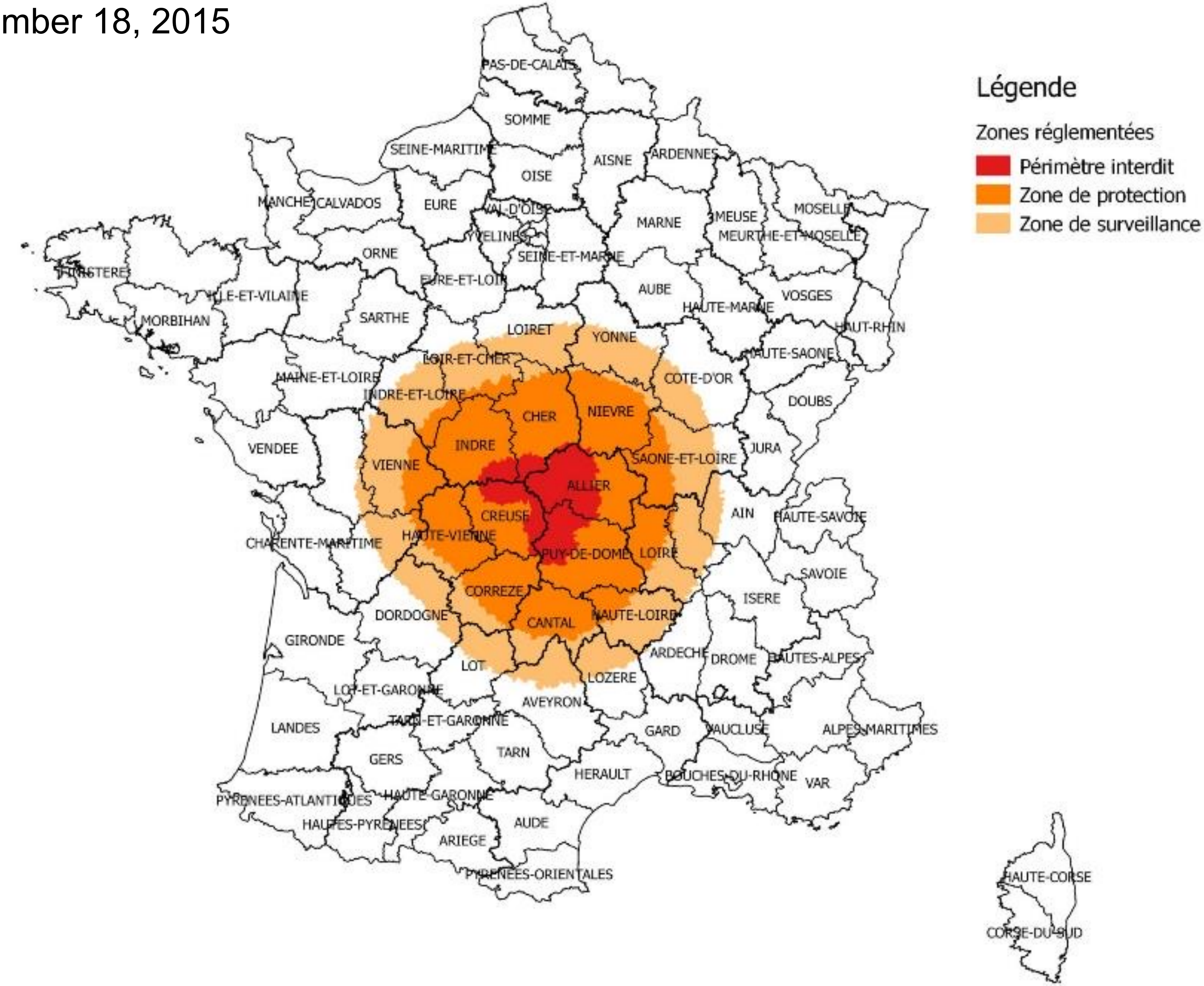

Bluetongue
Restricted zones* as of 16 October 2014
This map includes information on the bluetongue virus serotypes circulating in each restricted zone, which permits, for the purposes of Articles 7 and 8 of Regulation No 1266/2007, the identification of the restricted zones demarcated in different Member States where the same bluetongue virus serotypes are circulating.
Zone (serotypes)
I (1,4)
A5 (1,2,9,16)
B (2,16)
G (1,2,4,16)
J (1)
T (1,2,4,8,16)
X (4,16)
Y (2,9,16)
Z (1,16)
A1 (1,2,4,9,16)
A2 (1,2,16)
A3 (4)
A4 (1,4,8,16)
* 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.
NORWAY
SWEDEN
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

Allier « département »

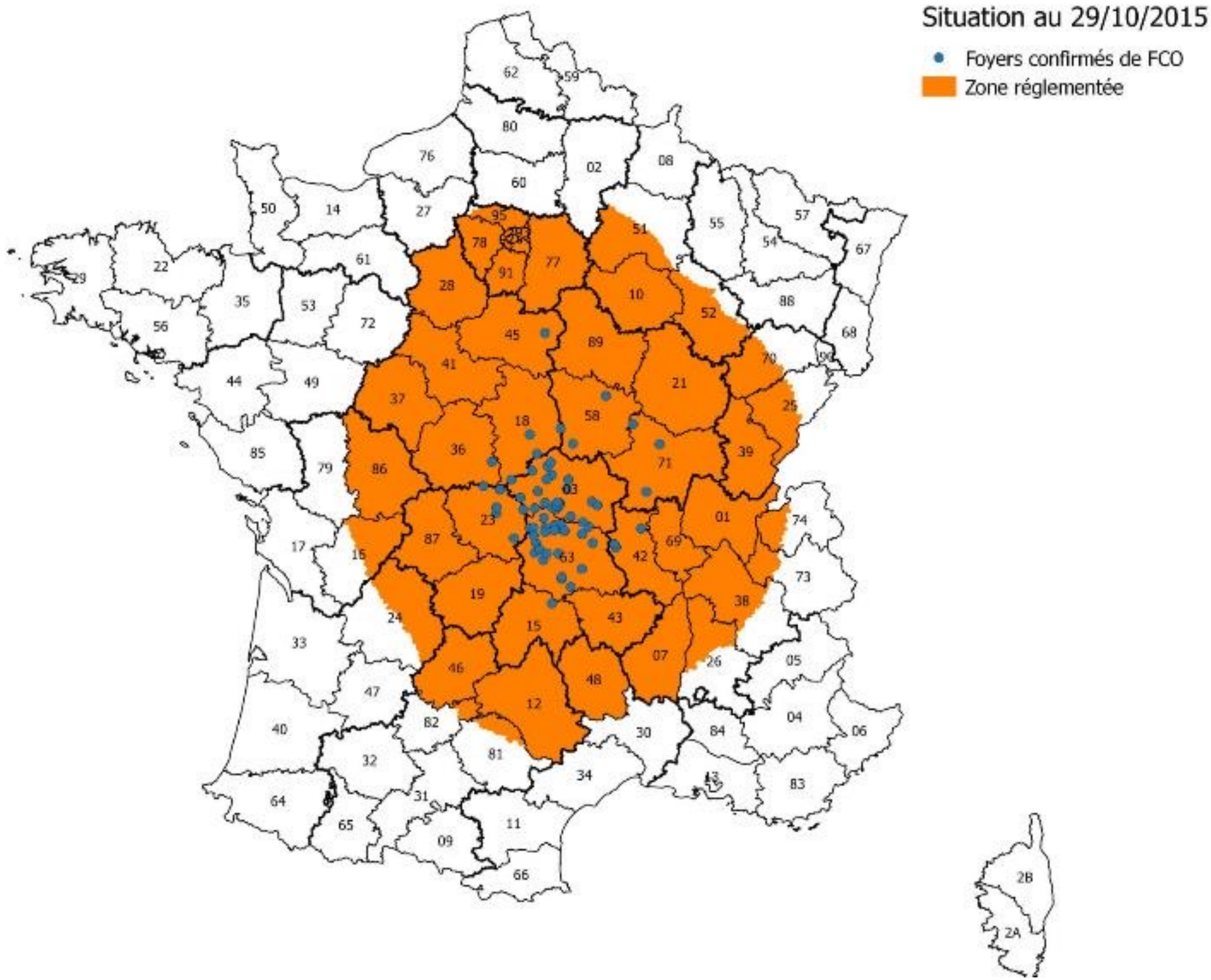
2015

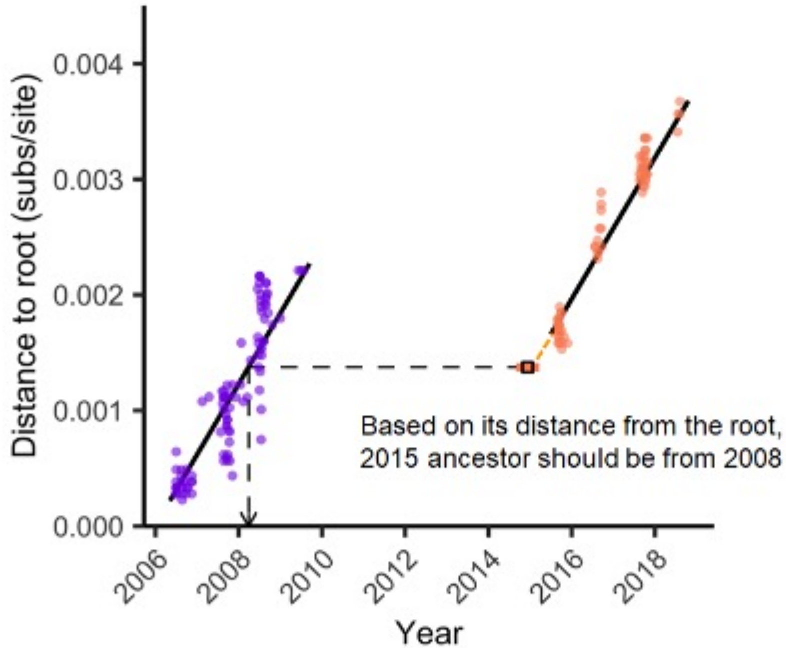
Julien Buttet, DDCSPP03

September 18, 2015



October 30, 2015





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

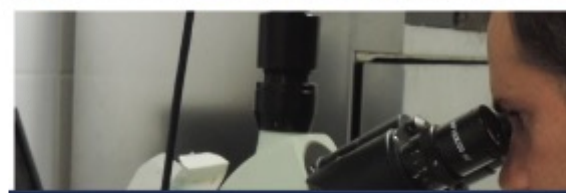
Analyse du sperme au microscope :

- Motilité
- % de vivant

Analyse au spectro-photomètre :

- Concentration (nb spz/mm3)

› **Contrôle qualité de semence en frais**



private seed production

viruses

MDPI

Article

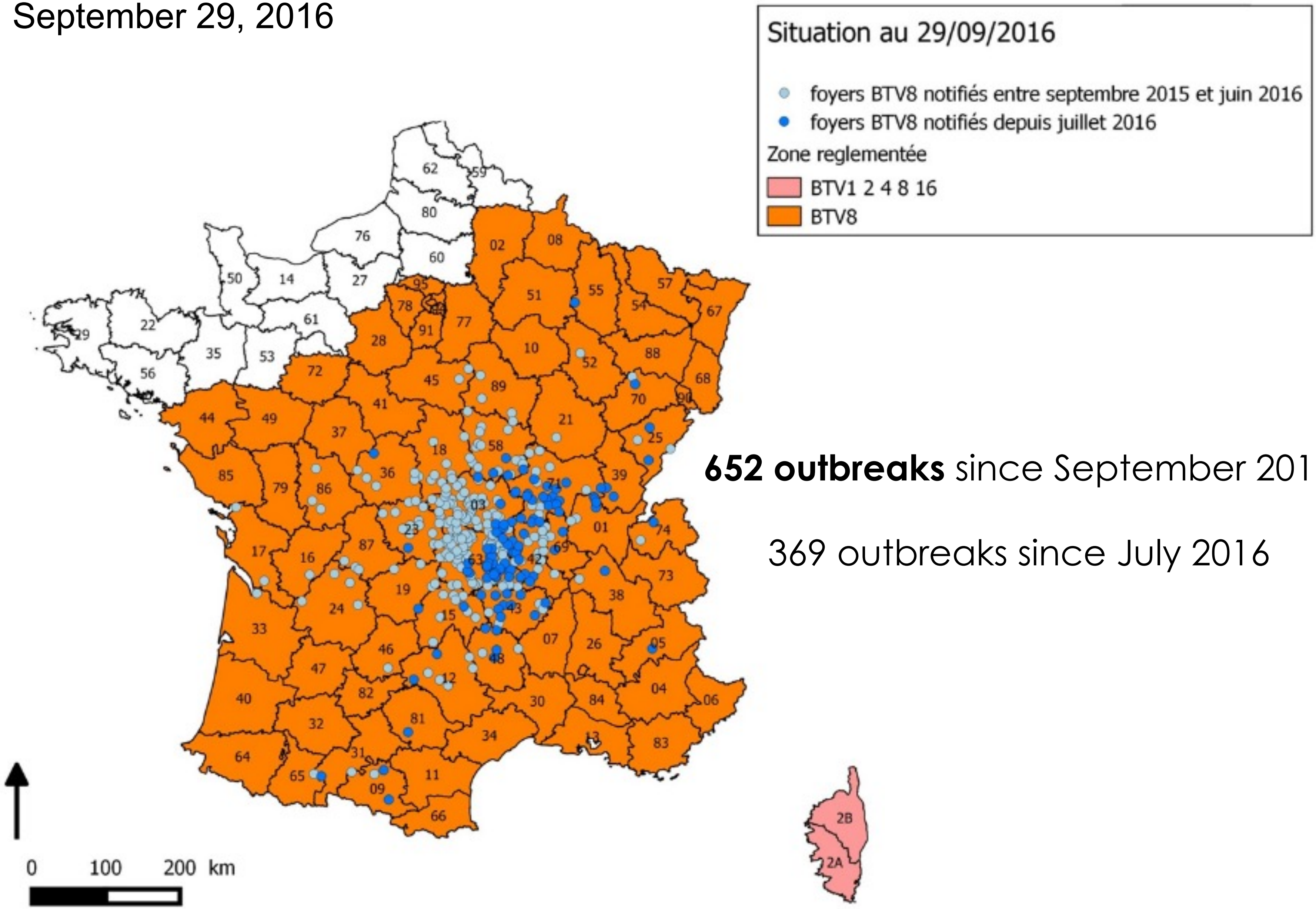
Transmission of Bluetongue Virus Serotype 8 by Artificial Insemination with Frozen–Thawed Semen from Naturally Infected Bulls

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

2016

September 29, 2016

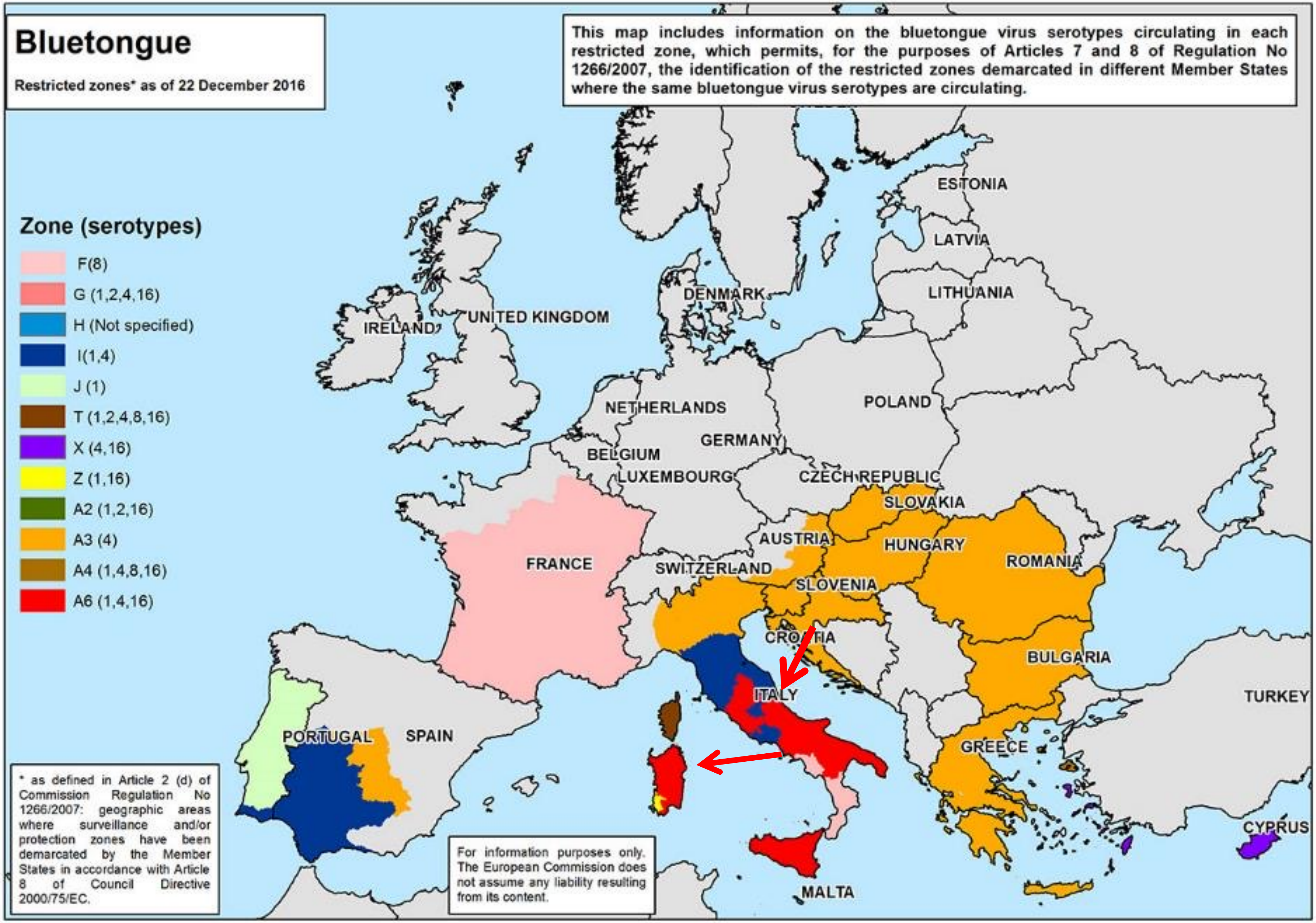


652 outbreaks since September 2015

369 outbreaks since July 2016

Welcome in Corsica

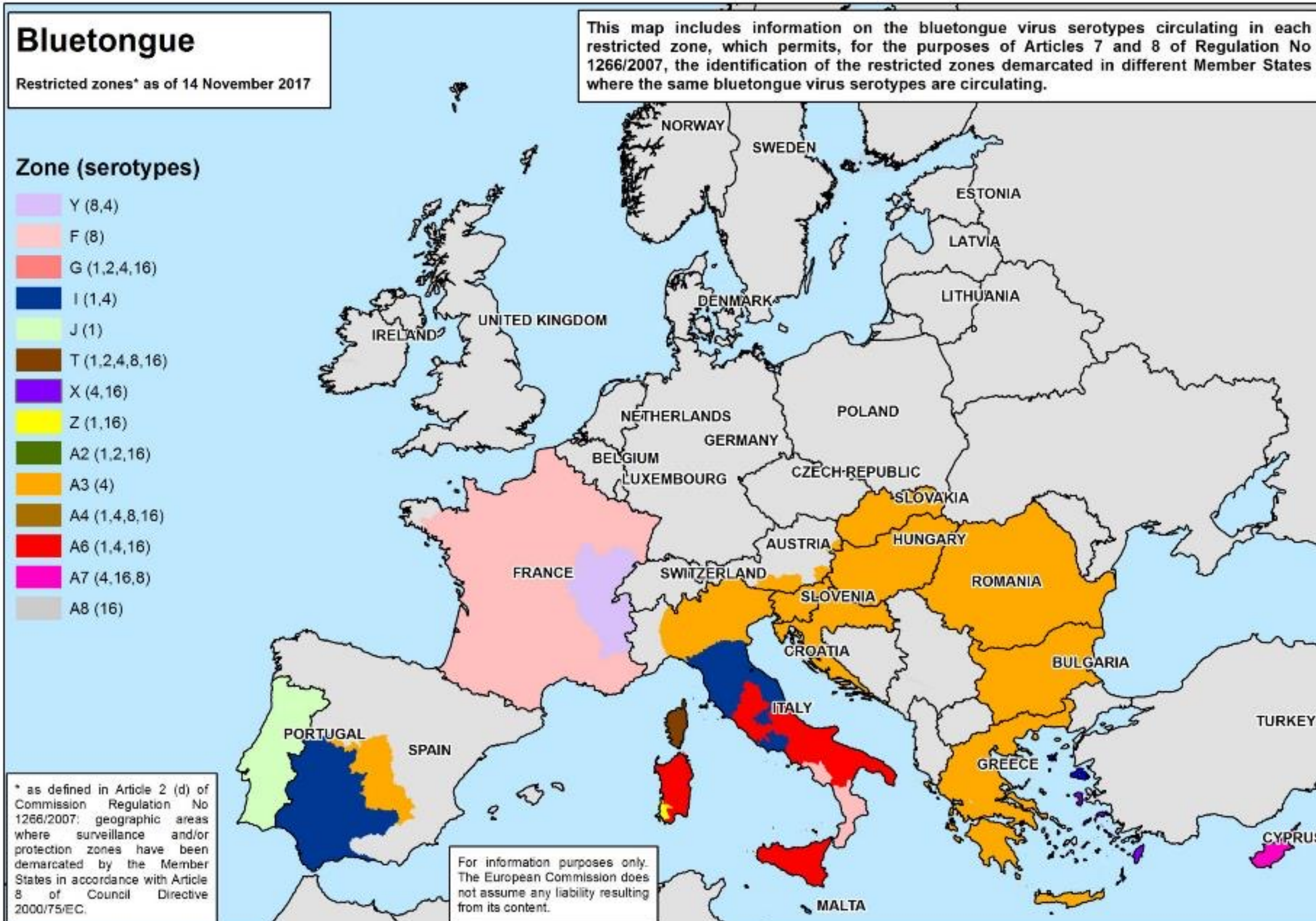
Genève
Limoges
Clermont-Ferrand
Lyon
Côme
Milan
Slovénie
Zagreb
Trieste
Vérone
Venise
Padoue
Grenoble
Turin
Croatie
Bologne
Gênes
Rimini
Saint-Marin
Zadar
Nîmes
Toulouse
Montpellier
Monaco
Cannes
Marseille
Pise
Florence
170 km
Italie
Mer Adriatique
Andorre
Corse
Gérone
Rome
Barcelone
Tarragone
12 km
Naples
Pompei
Sardegna
Mer Tyrrhénienne
Mer des Baléares
Castellón de la Plana
Mallorca
Palma de Majorque
Cagliari
Earth
Google



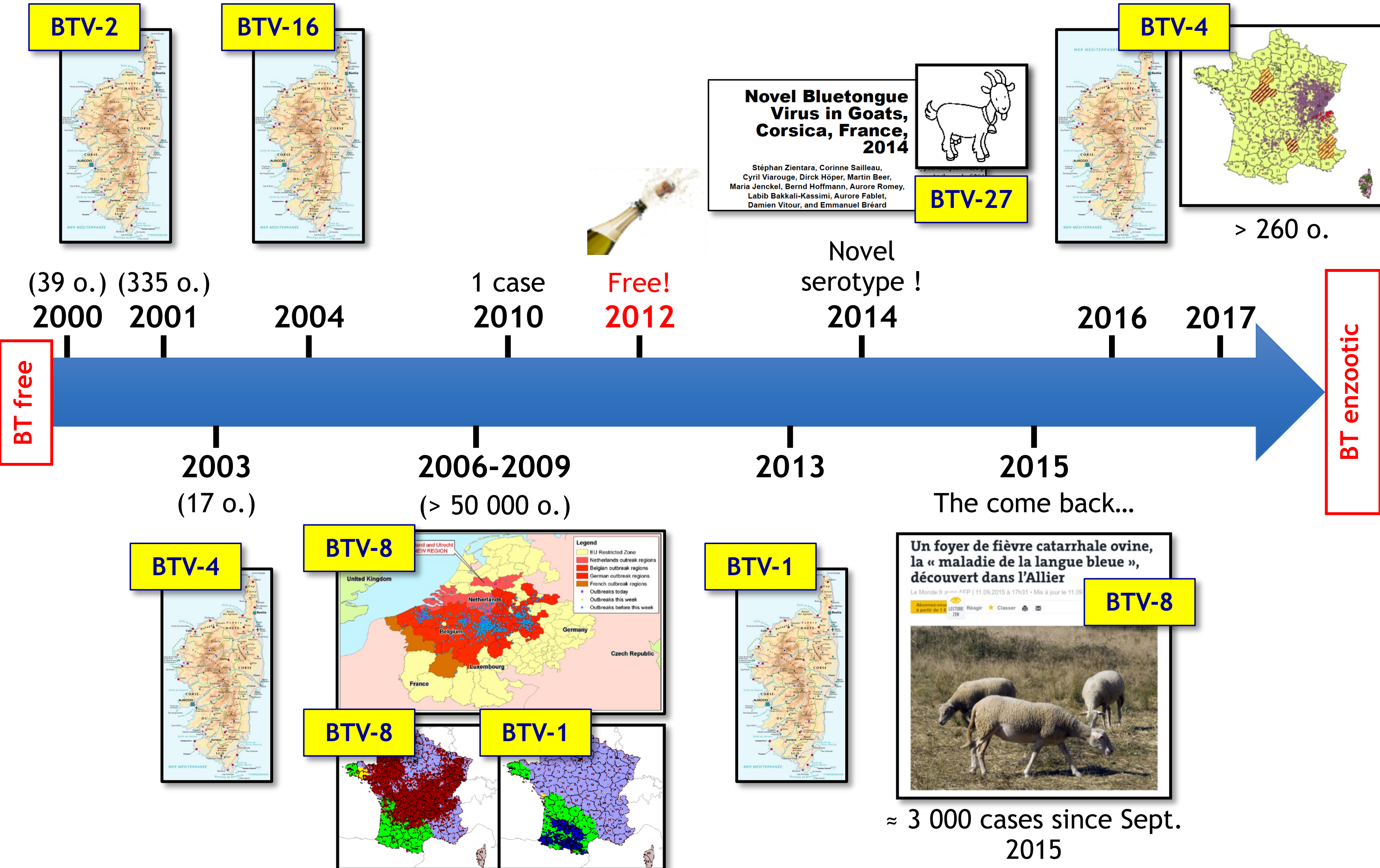
Bluetongue
Restricted zones* as of 22 December 2016
This map includes information on the bluetongue virus serotypes circulating in each restricted zone, which permits, for the purposes of Articles 7 and 8 of Regulation No 1266/2007, the identification of the restricted zones demarcated in different Member 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
FRANCE
SWITZERLAND
ROMANIA
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


Brighton
Plymouth
Manche (mer)
Bruxelles
Lille
Belgique
Francfort
Luxembourg
Mannheim
Nuremberg
Karlsruhe
Stuttgart
Guernesey
Jersey
Mer Celtique
Paris
Strasbourg
Augsbourg
Munich
Brest
Rennes
Zurich
Tours
Nantes
Liechtenstein
Suisse
France
La Rochelle
Genève
Limoges
Clermont-Ferrand
Lyon
Côme
Milan
Vérone
Venise
Padoue
Grenoble
Turin
Golfe de Gascogne
Bordeaux
Gênes
Bologne
Nîmes
Toulouse
Monaco
Pise
Florence
Gijón
Santander
Saint-Sébastien
Montpellier
Marseille
Cannes
Oviedo
Bilbao
León
Vitoria-Gasteiz
Satellite
Andorre
Google
Données cartographiques ©2017 GeoBasis-DE/BKG (©2009), Google, Inst. Geogr. Nacional


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.
Zone (serotypes)
Y (8,4)
F (8)
G (1,2,4,16)
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)
A7 (4,16,8)
A8 (16)
NORWAY
SWEDEN
ESTONIA
LATVIA
LITHUANIA
DENMARK
UNITED KINGDOM
IRELAND
NETHERLANDS
POLAND
GERMANY
BELGIUM
LUXEMBOURG
CZECH REPUBLIC
SLOVAKIA
AUSTRIA
HUNGARY
FRANCE
SWITZERLAND
ROMANIA
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.

BT epidemiology - situation in France



2023

September 2023

← Aller à la page régionale

Epidémie de "langue bleue" : des foyers détectés dans l'Aveyron et le Tarn font trembler les éleveurs

Publié le 14/09/2023 à 15h12

Écrit par Sylvain Duchampt

LADEPECHE.fr 17° / 24° Toulouse Rechercher

mardi 17 octobre 2023, Saint Baudouin

Aveyron : une recrudescence de cas de fièvre catarrhale ovine

Le virus de la FCO provoque l'inflammation des muqueuses, ce qui entraîne de l'hyperthermie, des difficultés de locomotion, des ulcérations dans la bouche, de l'hypersalivation, voire une langue bleue.

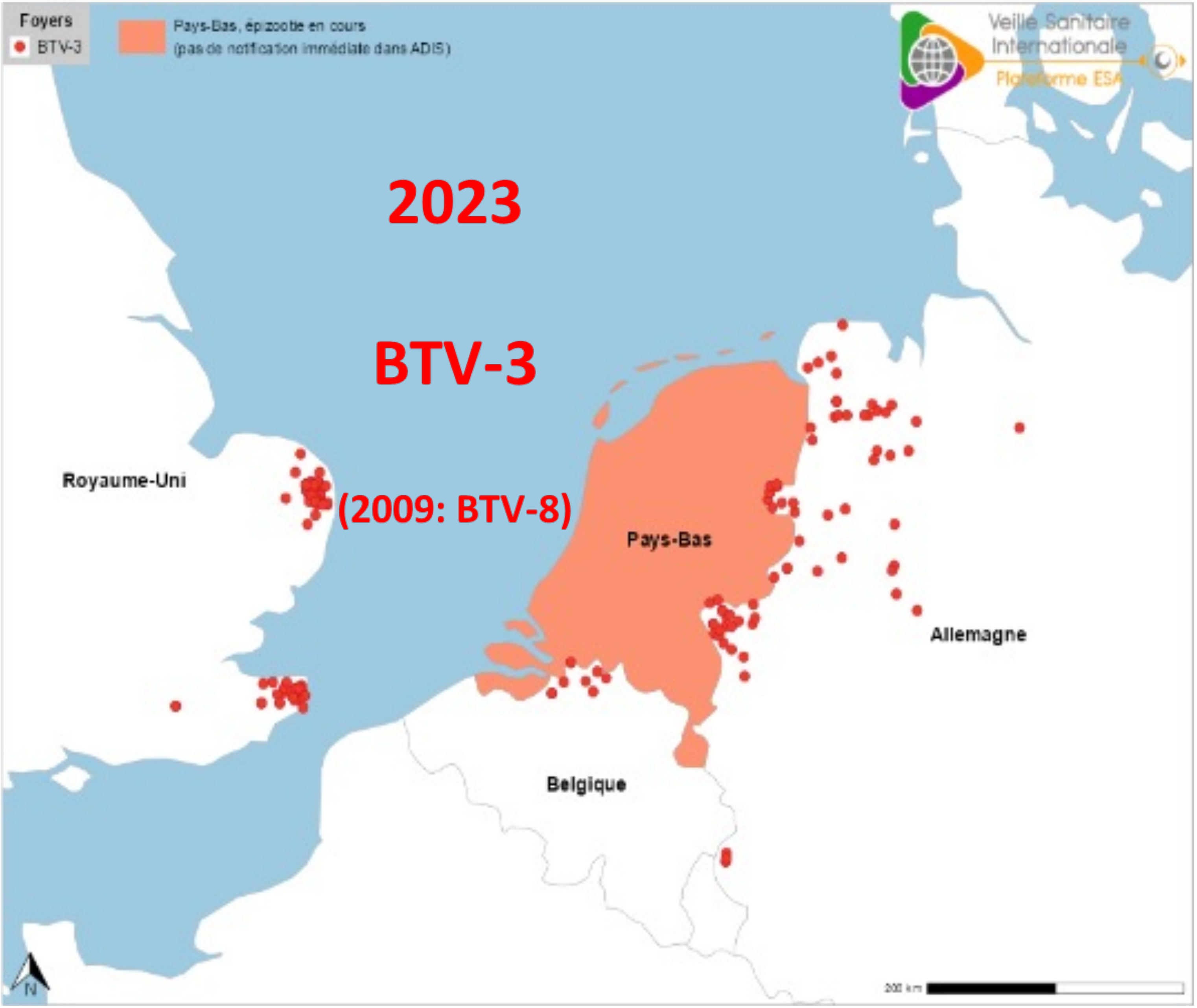
Depuis août 2023, une recrudescence inquiétante de la fièvre catarrhale ovine (FCO), communément appelée "langue bleue", sévit dans le sud du Massif Central, en particulier en Aveyron. Les rapports font état de treize foyers détectés dans le département voisin du Tarn.

29 September 2023, 450 outbreaks: Aveyron, Cantal, Lot, Lozère, Tarn et Tarn-et-Garonne

BTV-8

January 2024:

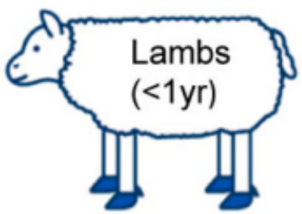
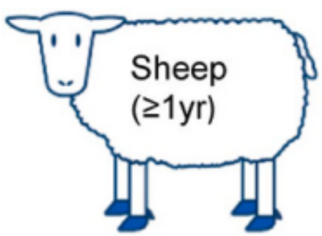
2,068 outbreaks
-1,537 cattle
-531 sheep



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

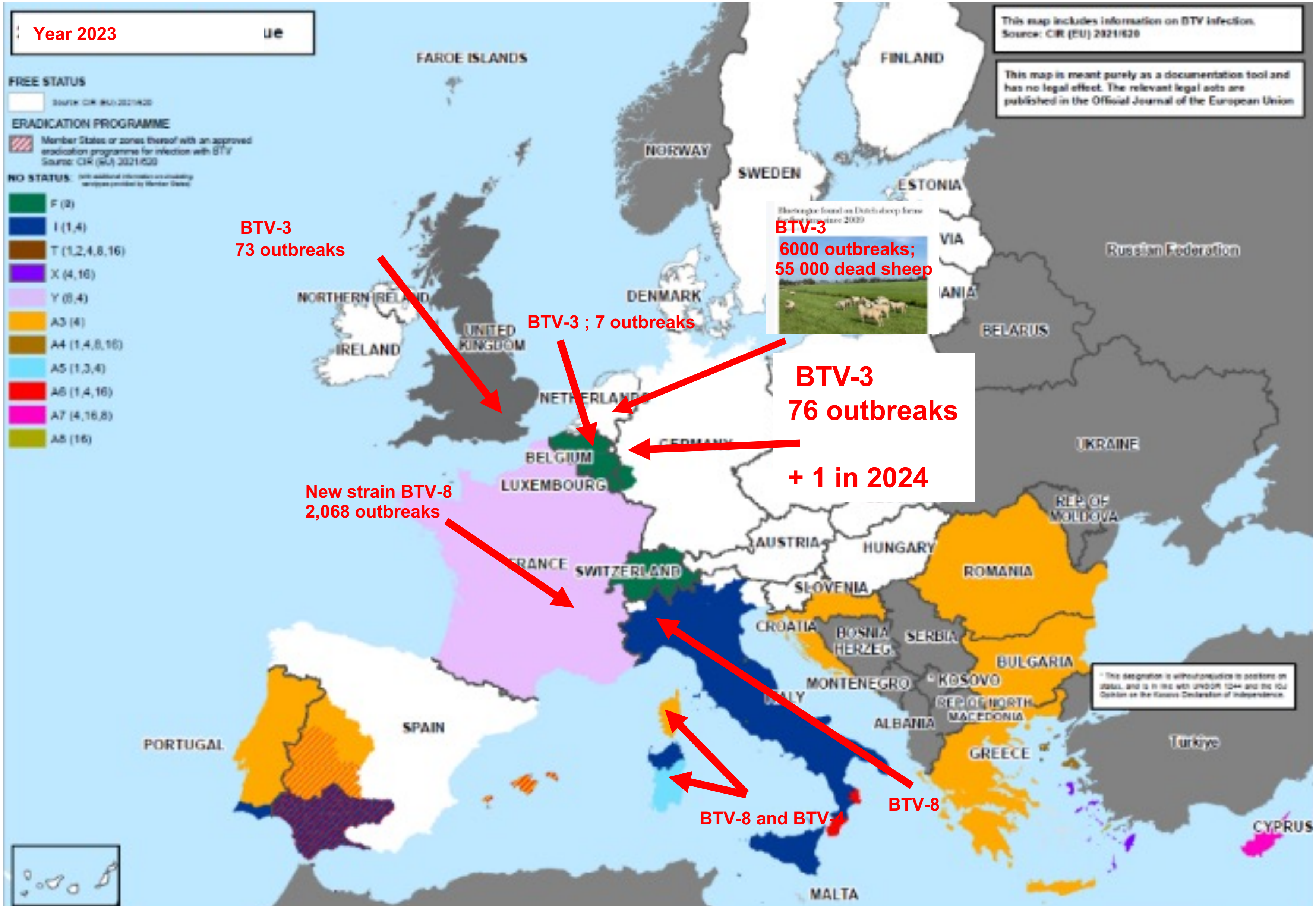
21/05/24

Table 2
Descriptive results of the number of dead sheep per age category in the period of the year before BTV-3 and during the BTV-3 outbreak in 2020–2022 (BTV-3 free during the whole year) and 2023.

Age category	Period	Total number of dead sheep		Difference
		2020–2022	2023	
	Week 1–35: BTV–3 free	31,551	29,350	–2201
	Week 36–52: BTV–3 outbreak period in 2023	14,904	**35,451** *	**20,547***
	Week 1–35: BTV–3 free	38,657	39,480	823
	Week 36–52: BTV–3 outbreak period in 2023	11,573	**46,183** *	**34,610***

* Assumed to be influenced by the BTV-3 outbreak

2,994 sheep farmers and 89 goat farmers notified clinical signs of BTV-3
55,000 sheep died compared to the same period 2020-2022
4,2-15,5 times increase in sheep mortality
Goat: 4,000 additional deaths (goat mortality 1,8 times higher)



Year 2023
FREE STATUS
ERADICATION PROGRAMME
Member States or zones thereof with an approved eradication programme for infection with BTV
Source: CIR (EU) 2021/620
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.
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
FAROE ISLANDS
FINLAND
NORWAY
SWEDEN
ESTONIA
Russian Federation
DENMARK
BELARUS
NORTHERN IRELAND
IRELAND
UNITED KINGDOM
UKRAINE
BELGIUM
LUXEMBOURG
REP. OF MOLDOVA
FRANCE
SWITZERLAND
AUSTRIA
HUNGARY
ROMANIA
SLOVENIA
CROATIA
BOSNIA HERZEG.
SERBIA
BULGARIA
MONTENEGRO
KOSOVO
REP. OF NORTH MACEDONIA
ALBANIA
GREECE
Türkiye
SPAIN
PORTUGAL
MALTA
CYPRUS
BTV-3
73 outbreaks
BTV-3 ; 7 outbreaks
BTV-3
6000 outbreaks;
55 000 dead sheep
BTV-3
76 outbreaks
+ 1 in 2024
New strain BTV-8
2,068 outbreaks
BTV-8 and BTV-4
BTV-8


Before 1998

After 1998

Serotypes in Europe

1, 2, 3, 4, 6, 8, 9, 11, 14, 25, 27

PARIS 2024

Situation sanitaire FCO BTV 3 aux Pays-Bas

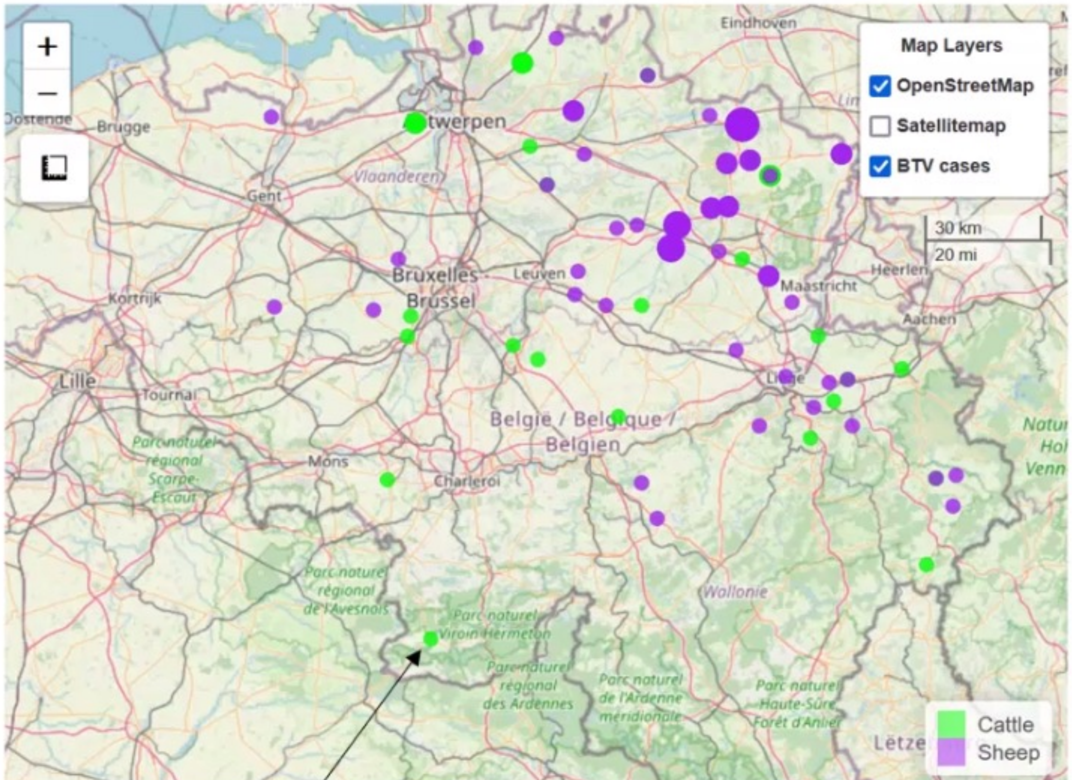
15 JUILLET 2024
21 foyers confirmés en PCR
73 foyers cliniques

25 JUILLET 2024
593 foyers confirmés en PCR
198 foyers cliniques

1 AOUT 2024
1044 foyers confirmés en PCR
364 foyers cliniques

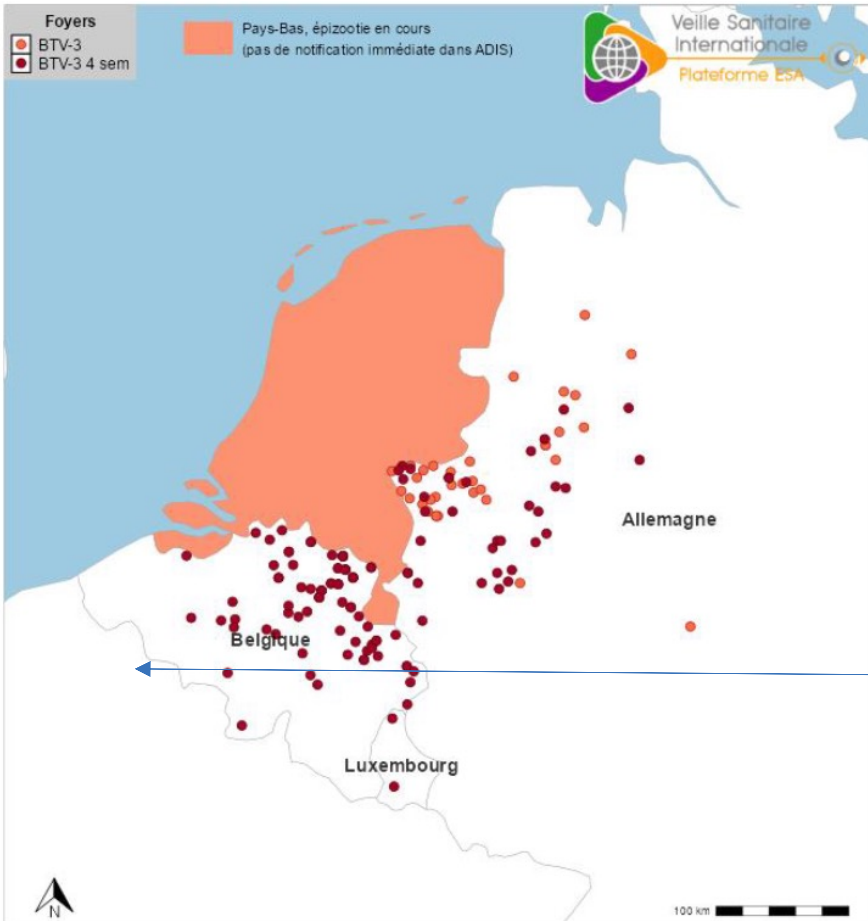
MINISTÈRE
DE L'AGRICULTURE
ET DE LA SOUVERAINETÉ
ALIMENTAIRE

Situation sanitaire FCO BTV 3 en Belgique au 31/07/2024



1 foyer clinique bovin

1 foyer clinique à Chimay, commune frontalière



e. Localisation des foyers de FCO uniquement de sérotype 3 confirmés en Europe détectés depuis le /2024 et sur les quatre dernières semaines (incidence mensuelle) (source : Sciensano pour la Belgique et S OMSA pour le Royaume-Uni et l'Allemagne consultés le 05/08/2024).

5 August 2024

Netherlands: 1,205 outbreaks

Germany: 1,383 outbreaks

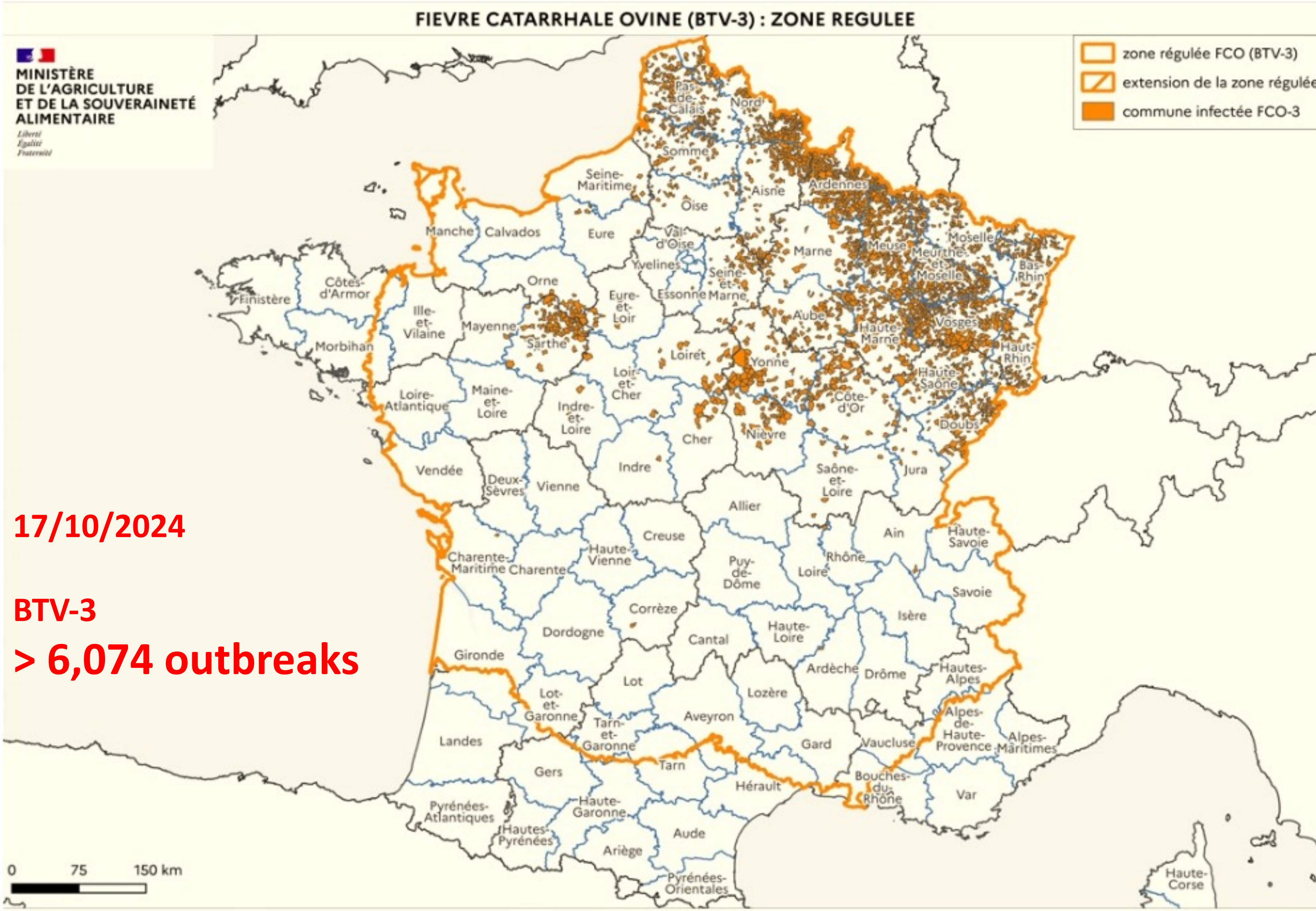
Belgium: 69 outbreaks

Luxembourg : 2 outbreaks

France : 1

10/10/2024

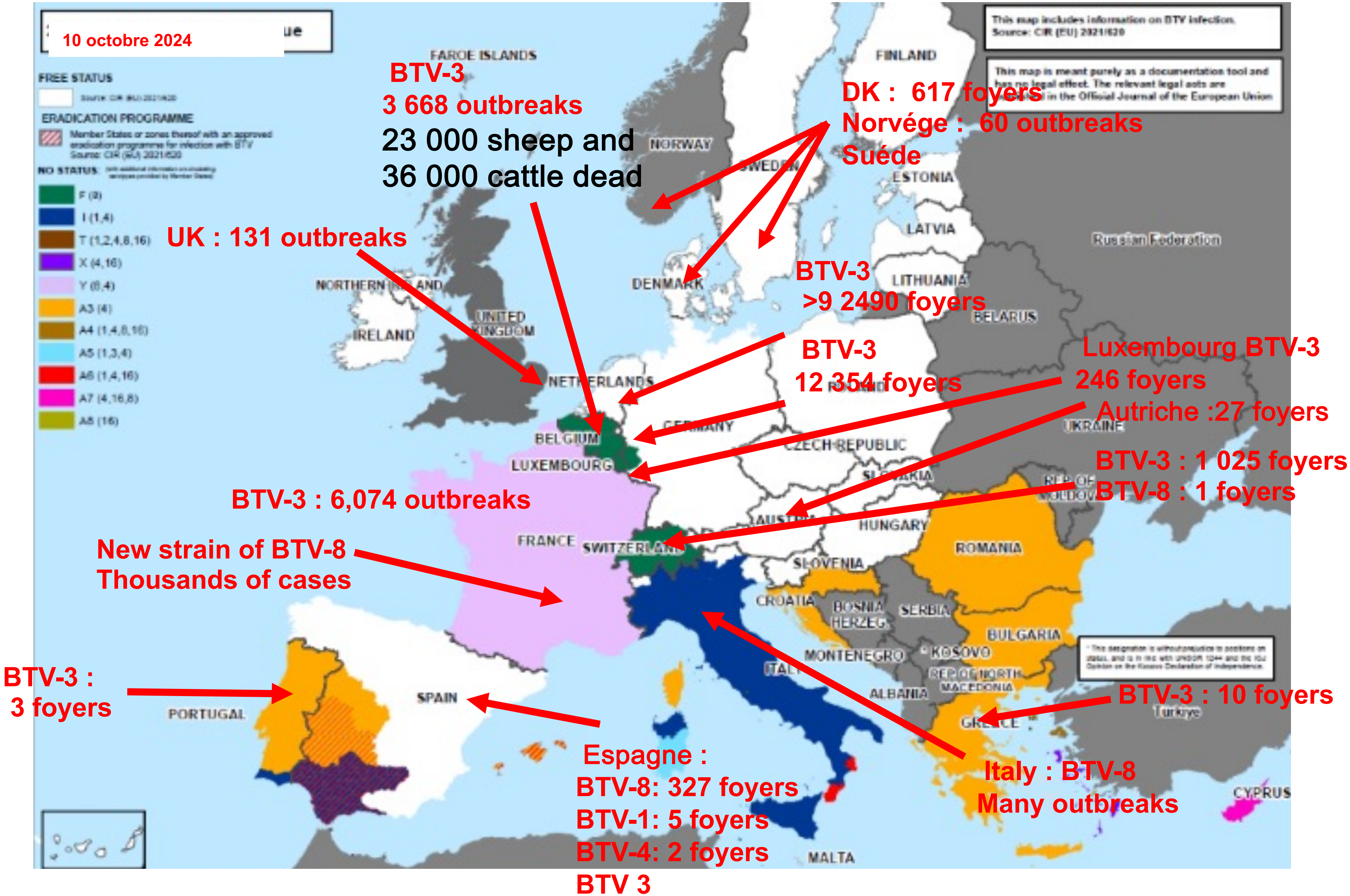
Foyers
BTV-3 > 4 sem
BTV-3 < 4 sem
Epizootie en cours
(pas de notification immédiate dans ADIS)
Veille Sanitaire
Internationale
Plateforme ESA
Norvège
Suède
Danemark
Royaume-Uni
Pays-Bas
Allemagne
Belgique
Luxembourg
Tchéquie
Autriche
Suisse
France
Espagne
Portugal
N
500 km



17/10/2024

BTV-3

> 6,074 outbreaks



10 octobre 2024
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.
FAROE ISLANDS
FINLAND
NORWAY
SWEDEN
ESTONIA
LATVIA
LITHUANIA
DENMARK
BELARUS
Russian Federation
NORTHERN IRELAND
IRELAND
UNITED KINGDOM
NETHERLANDS
BELGIUM
LUXEMBOURG
GERMANY
POLAND
CZECH REPUBLIC
SLOVAKIA
UKRAINE
REP. OF MOLDOVA
AUSTRIA
HUNGARY
ROMANIA
FRANCE
SWITZERLAND
SLOVENIA
CROATIA
BOSNIA HERZEG.
SERBIA
BULGARIA
MONTENEGRO
KOSOVO
REP. OF NORTH MACEDONIA
ALBANIA
ITALY
GREECE
Türkiye
CYPRUS
MALTA
SPAIN
PORTUGAL
BTV-3
3 668 outbreaks
23 000 sheep and
36 000 cattle dead
DK : 617 foyers
Norvége : 60 outbreaks
Suéde
UK : 131 outbreaks
BTV-3
>9 2490 foyers
BTV-3
12 354 foyers
Luxembourg BTV-3
246 foyers
Autriche :27 foyers
BTV-3 : 1 025 foyers
BTV-8 : 1 foyers
BTV-3 : 6,074 outbreaks
New strain of BTV-8
Thousands of cases
BTV-3 :
3 foyers
Espagne :
BTV-8: 327 foyers
BTV-1: 5 foyers
BTV-4: 2 foyers
BTV 3
Italy : BTV-8
Many outbreaks
BTV-3 : 10 foyers

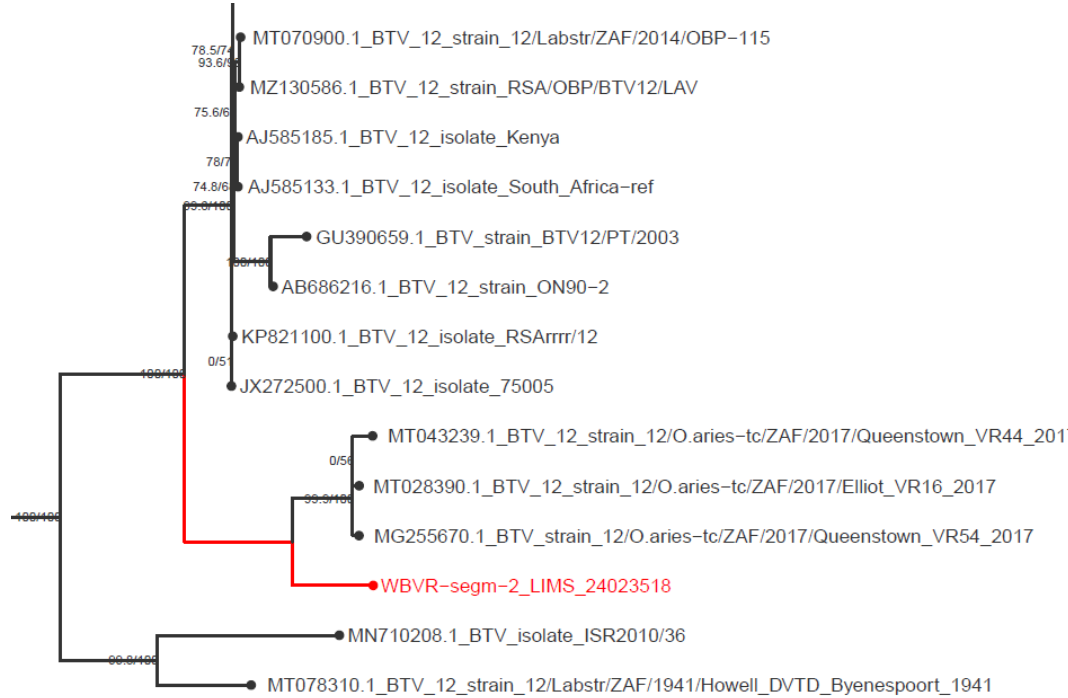
News

New bluetongue virus serotype, BTV-12, identified in the Netherlands

October 11, 2024

A new variant of the bluetongue virus has been identified in a sheep in Kockengen. It was identified as bluetongue serotype BTV-12, according to research by Wageningen Bioveterinary Research (WBVR, part of Wageningen University & Research). The European Bluetongue Reference Laboratory in Madrid confirmed that the animal in question was infected

3 octobre 2024



One sheep Ct = 22

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

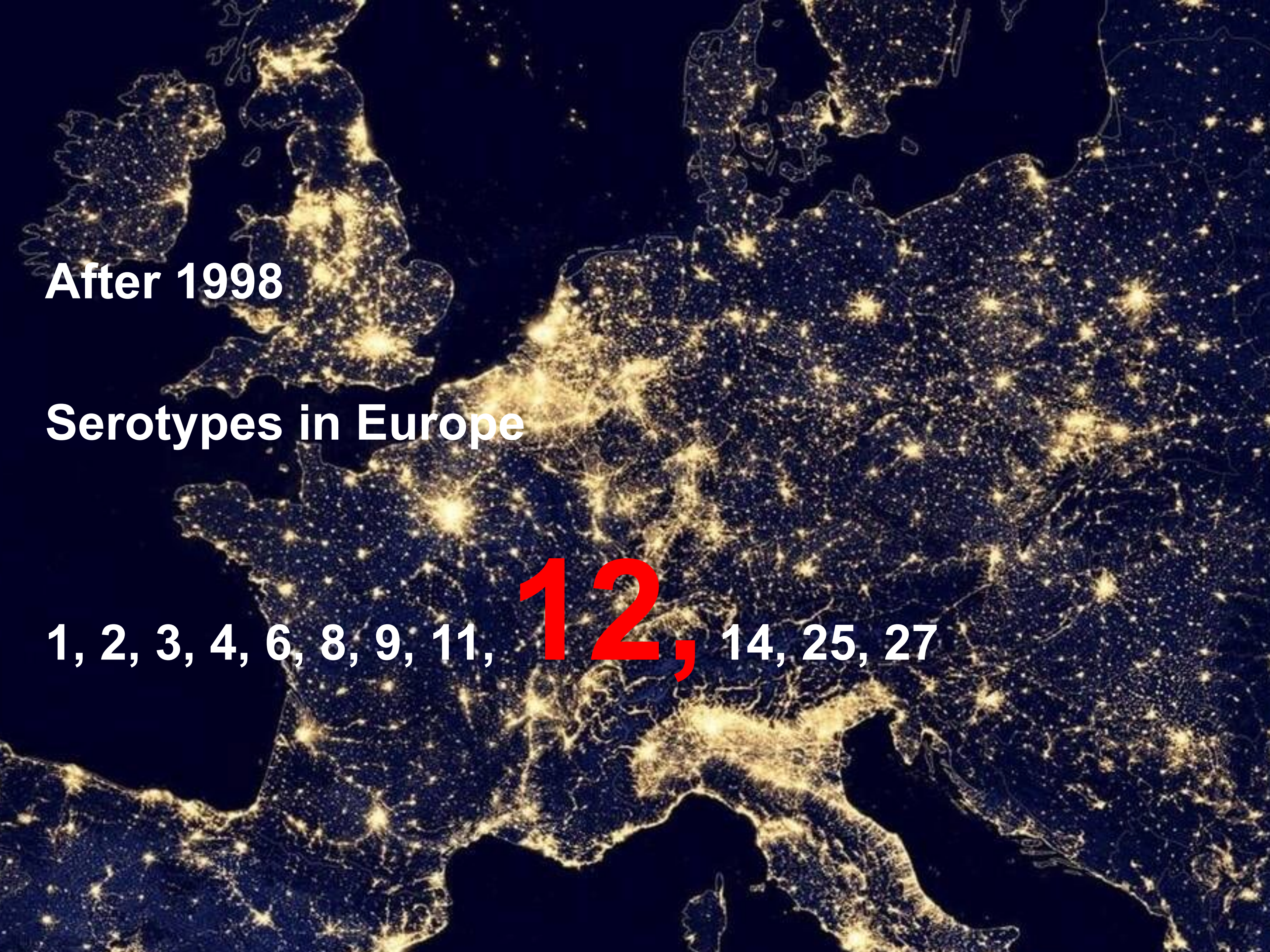
Segment	Virus protein	% identity with LIMS 24023518	Isolate name	GenBank accession
Segm-1	VP1	98.08	BTV-24/ISR2009/02_2009	MN710085.1
Segm-2	VP2	96.56	BTV-12/O.aries-tc/ZAF/2017/Queenstown VR54 2017	MG255670.1
Segm-3	VP3	97.11	BTV-3/ISR-2019/13 2013	MG344982.1
Segm-4	VP4	97.87	BTV-3/ISR-2153/16 2016	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.		

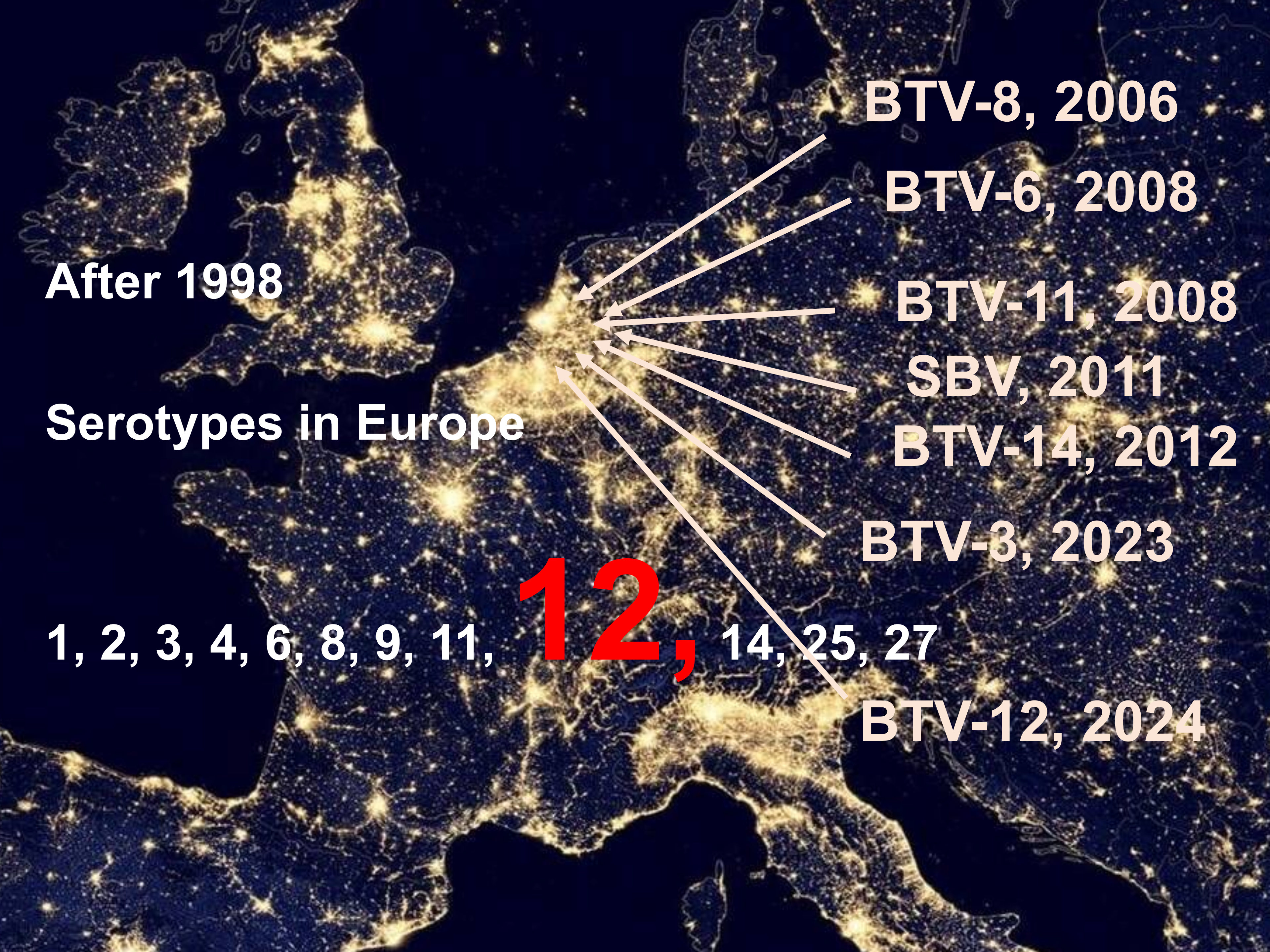
BTV-12 !!!!!!!!!!!

Melle Holwerda, WUR

But where do they stop?????????


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

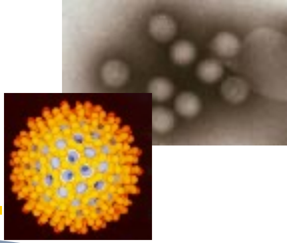

After 1998
Serotypes in Europe
1, 2, 3, 4, 6, 8, 9, 11, 12, 14, 25, 27


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

Contribution of research to orbivirus management

Diagnosis BTV

B*luetongue virus* (BTV)

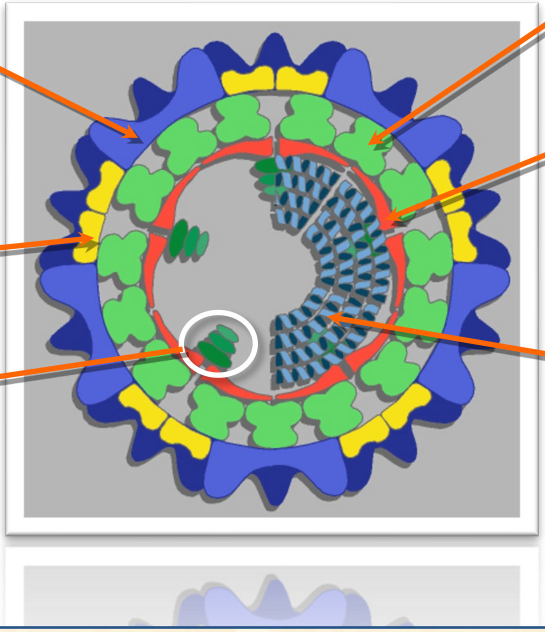


VP2 :
- binding to the receptor, virus entry
- neutralisation, type specificity

VP7 :
- conserved among serotypes

VP3 :

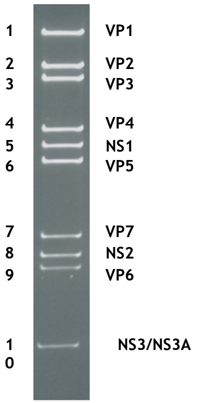
VP5 : ▪ pénétration



transcription complex :
- **VP1** : RNA polymerase
- **VP4** : capping enzyme
- **VP6** : RNA helicase

virus genome:

10 segments
dsARN



4 non structural proteins (NSP):
- NS1 : pathogenesis and morphogenesis of BTV (tubules)
- NS2 : RNA encapsidation
- NS3/3A : virion release
- NS4 : discovery 2011
- NS5 : discovery 2015

Institut Pourquier

IdVet

Transboundary and Emerging Diseases

ORIGINAL ARTICLE | Full Access

Evaluation of an IGM-specific ELISA for early detection of bluetongue virus infections in domestic ruminants sera

Emmanuel Bréard, Axel Gorlier, Cyril Viarouge, Fabien Donnet, Corinne Sailleau, Claudia Schulz, Bernd Hoffmann, Loic Comtet, Martin Beer, Stéphan Zientara, Damien Vitour

First published: 05 November 2018 | https://doi.org/10.1111/tbed.13060

Services SFX pour l'INRA

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anses
Laboratoire de santé animale
De Maisons Alfort
LNR Fièvre catarrhale ovine

24/05/2024

Liste des kits officiels et méthodes validés par le LNR pour la détection du génome du virus de la FCO par méthode PCR

	KITS /Méthode	FOURNISSEURs
Dépistage de groupe « tout génotype » (RT-PCR duplex)	Méthode Hofmann modifiée	
	LSI VetMax Bluetongue Virus NS3	Life Technologies SAS
	BTV ADIAVET™ BTV REAL TIME	BioX
	ID Gene® BlueTongue duplex	ID
	Bio-T kit® BTV all genotypes	BioSellal
Dépistage de génotype (RT-PCR duplex)	LSIVetMax BTV 8 typing-IAH	Life Technologies SAS
	LSIVetMAX™ BTV4 IAH Typing Kit	Life Technologies SAS
	ADIAVET™ BTV TYPE 8 REAL TIME	BioX
	ADIAVET™ BTV TYPE 4 REAL TIME	BioX
	ADIAVET™ BTV TYPE 3 REAL TIME	BioX
	Bio-T kit ® BTV-8 v2	BioSellal
	Bio-T kit® BTV Genotype 4	BioSellal
	Bio-T kit® BTV Genotype 3	BioSellal
	ID Gene™ Bluetongue genotypes 3	
Dépistage de type 4 +8 (RT-PCR triplex)	ID Gene Bluetongue genotypes 8 et 4 Triplex2.0	ID
Dépistage de groupe BTV/EHDV (RT-PCR triplex)	ID Gene™ BTV & EHDV Advantage Triplex	ID

Epizootic Haemorrhagic disease

Although recognised earlier in the south-eastern United States,
EHD was first described after a severe outbreak of the disease in **white-tailed deer** (*Odocoileus virgininianus)* in New Jersey in 1955

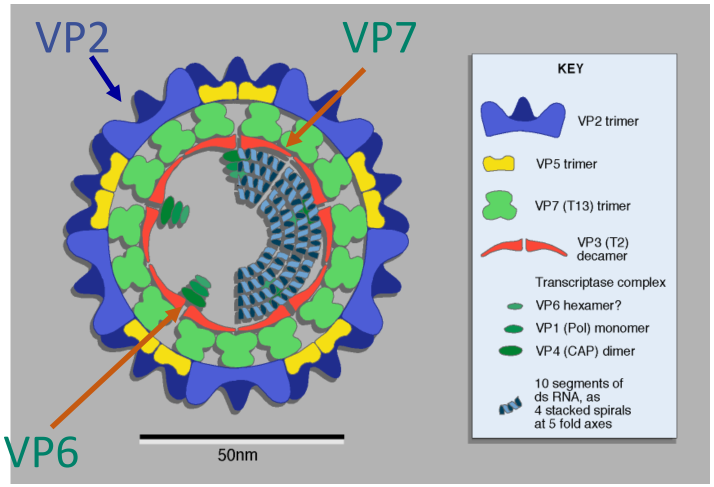
Shope R.E., Macnamara L.G. & Mangold R. (1960). – A virus-induced epizootic hemorrhagic disease of the Virginia white-tailed deer (Odocoileus virginianus). J. Experim. Med., 111, 155–170

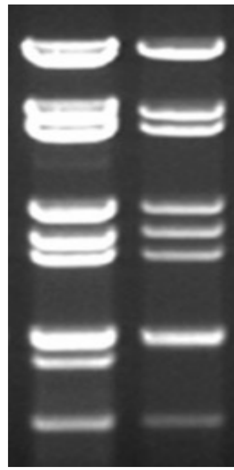
Review

Epizootic haemorrhagic disease N.J. Maclachlan, S. Zientara, G. Savini & P.W. Daniels

Rev. Sci. Tech. Off. Int. Epiz., 2015, 34 (2), 341-351

EHDV caused by an Orbivirus
Family: *Sedoreoviridae*





7 serotypes

Reference strains							
EHDV-1 USA1955/01	EHDV-2 CAN1962/01 EHDV-2 (Ibaraki virus) JAP1959/01	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?

Infection, Genetics and Evolution 53 (2017) 38–46

Contents lists available at ScienceDirect

Infection, Genetics and Evolution

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

Research paper

Characterization of genome segments 2, 3 and 6 of epizootic hemorrhagic disease virus strains isolated in Japan in 1985–2013: Identification of their serotypes and geographical genetic types

Hiroaki Shirafuji, Tomoko Kato, Makoto Yamakawa, Toru Tanaka, Yutaka Minemori, Tohru Yanase

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 PMCID: PMC7706924 DOI: 10.3201/eid2612.191301

EHDV Identity card

Family *Sedoreoviridae*

Genus Orbivirus (22 species)

Species *Epizootic hemorrhagic disease virus* (EHDV)

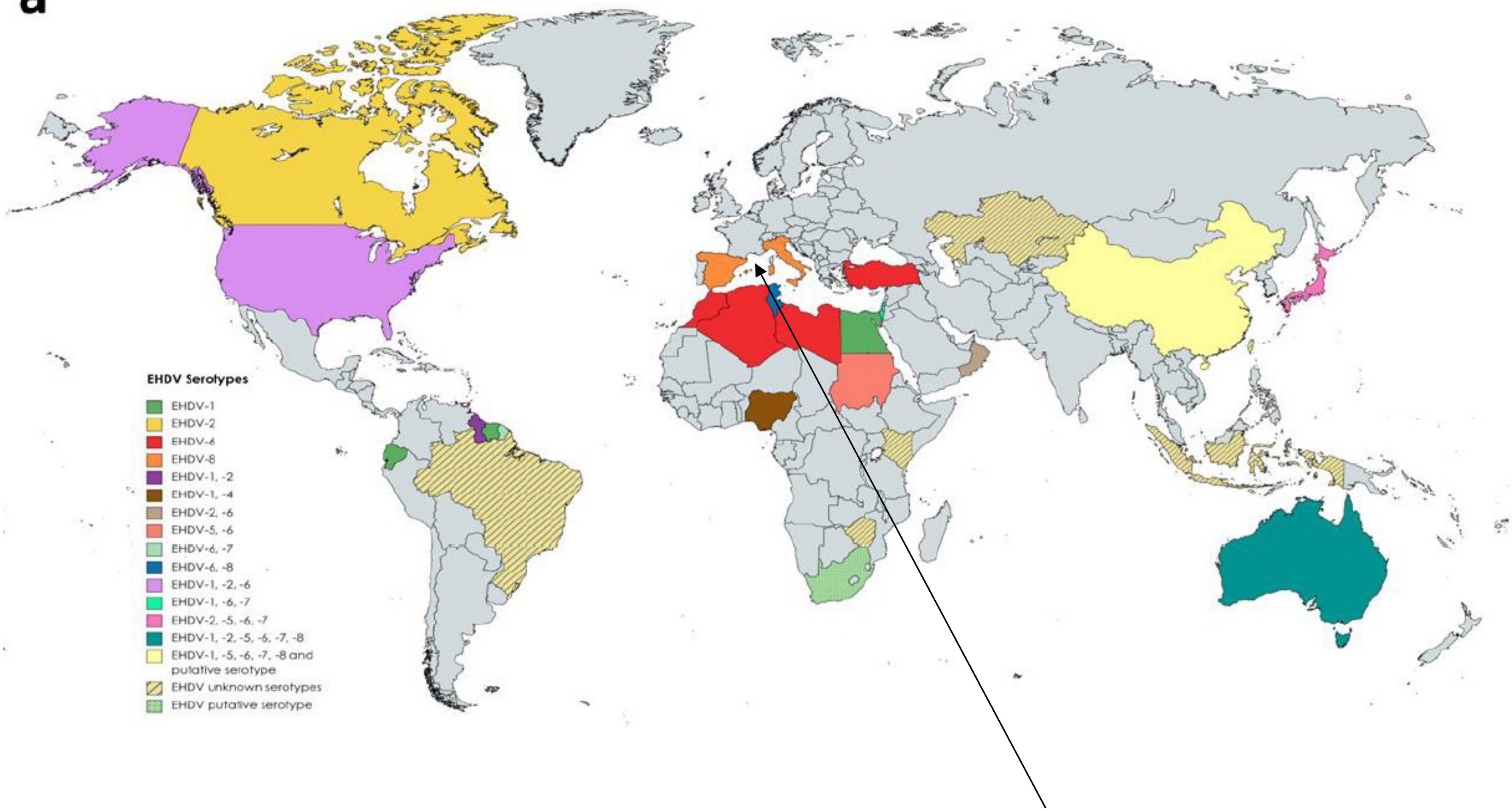
Number of serotypes 7

Genome dsRNA, 10 segments

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.


90% fatal in deer

a



microorganisms

MDPI

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 ; 2023 ; 2024

2022

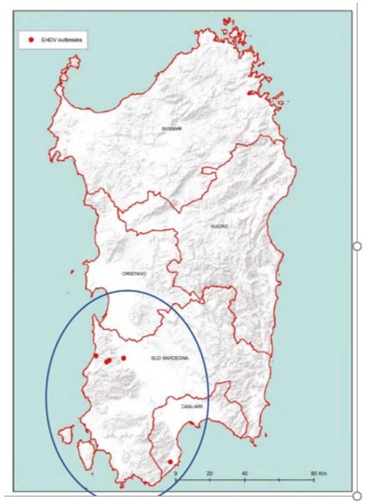
A deer jumps really high!!

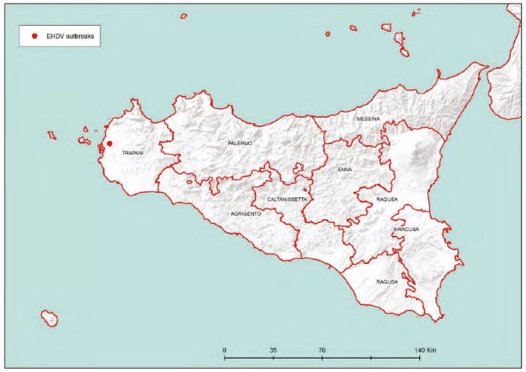
From 28 Octobre 2022

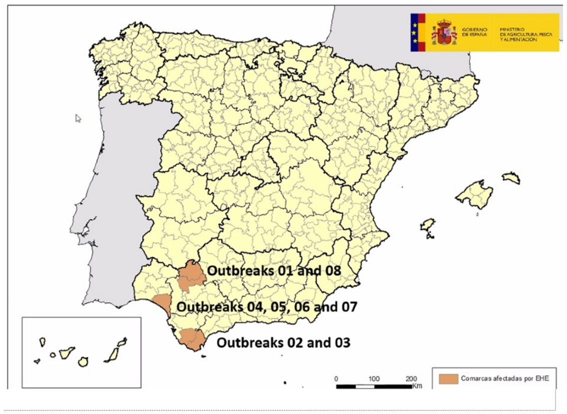
Clinical signs

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

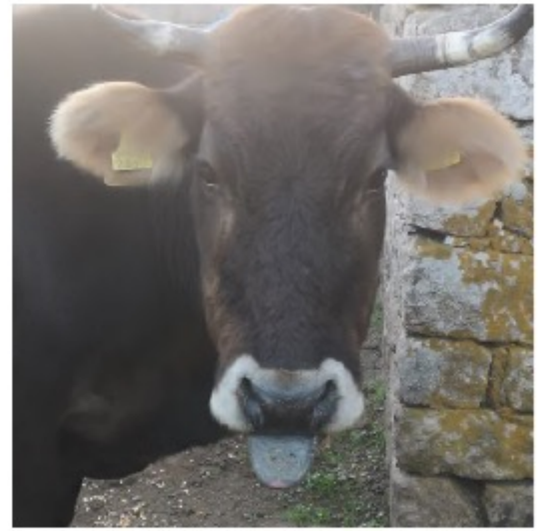
→ Confirmation EHDV-8







The first infected animal



Alessio Lorusso, IZST

EMERGING INFECTIOUS DISEASES®

EID Journal > Volume 29 > Number 5—May 2023 > Main Article

Volume 29, Number 5—May 2023

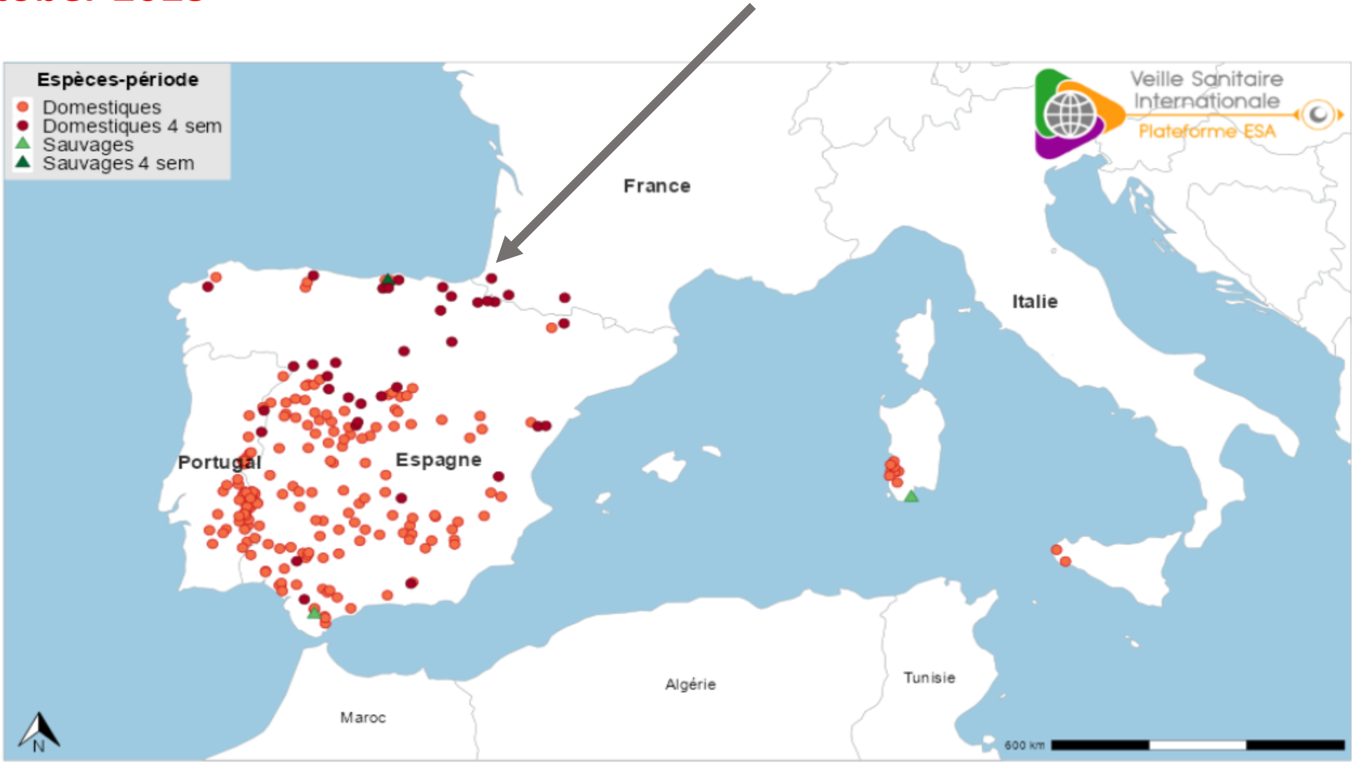
Research Letter

Epizootic Hemorrhagic Disease Virus Serotype 8, Italy, 2022

Alessio Lorusso✉ , Stefano Cappai, Federica Loi, Luigia Pinna, Angelo Ruiu, Giantonella Puggioni, Annalisa Guercio, Giuseppa Purpari, Domenico Vicari, Soufien Sghaier, Stephan Zientara, Massimo Spedicato, Salah Hammami, Thameur Ben Hassine, Ottavio Portanti, Emmanuel Breard, Corinne Sailleu, Massimo Ancora, Daria Di Sabatino, Daniela Morelli, Paolo Calistri, and Giovanni Savini

2023

02 October 2023



LA NOUVELLE RÉPUBLIQUE des Pyrénées

Rechercher sur le site...

JE COMMANDE

Accueil > Economie > Agriculture

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

ABONNÉS

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

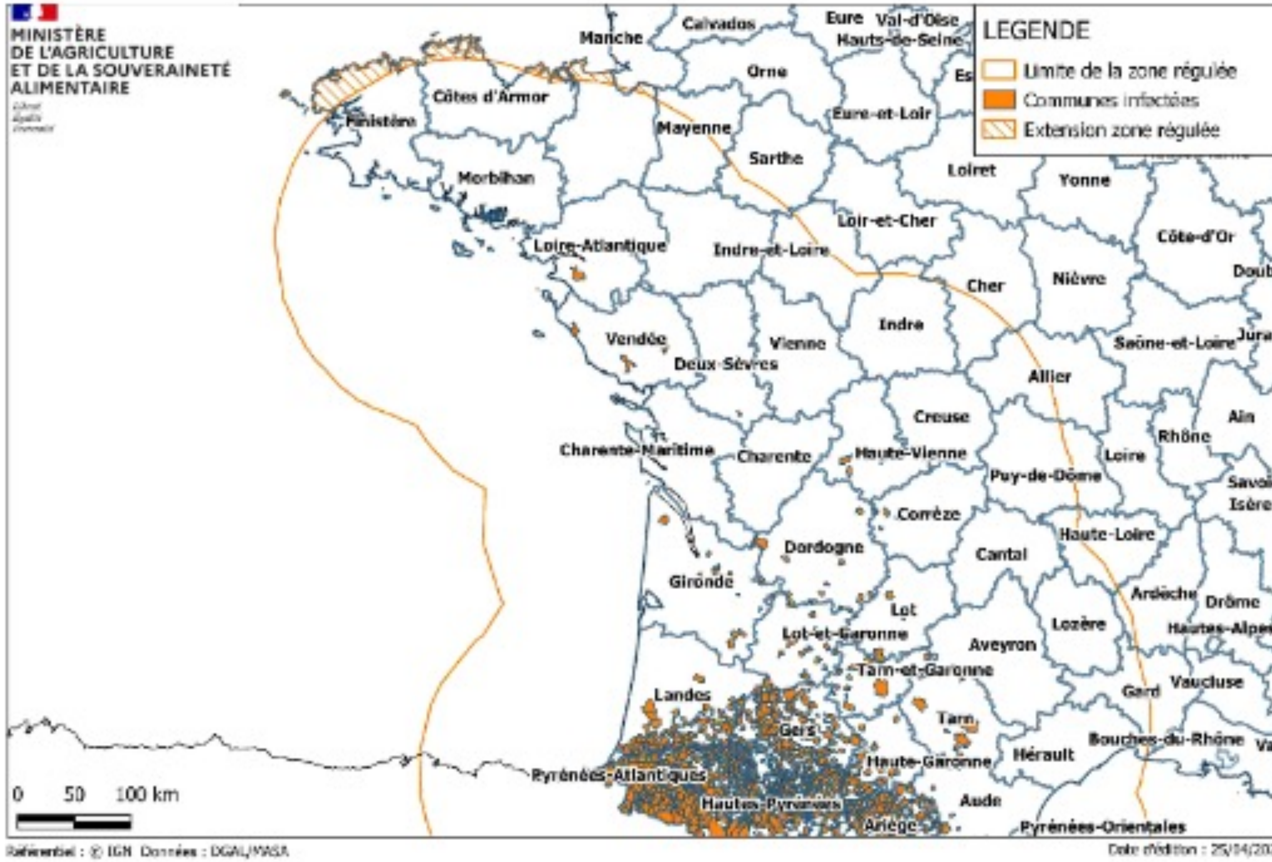
Pyrénées Atlantiques (2), Hautes Pyrénées (1)

18/09/2023

> 4,330 outbreaks

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

1 izard
2 deers
1 roe deer



National Library of Medicine
National Center for Biotechnology Information

PubMed®

epizootic hemorrhagic disease france
Advanced

Search results

Save

> 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

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

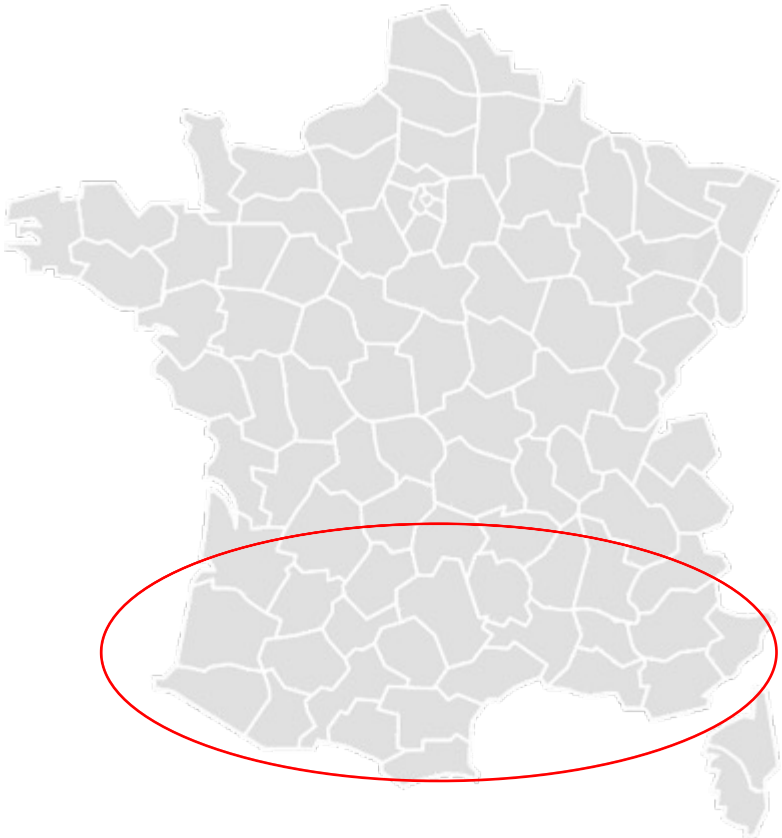
Dr Vivien Philis, Lannemezan
Dr Mylène Lemaire-Meyer (LVD09)

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

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

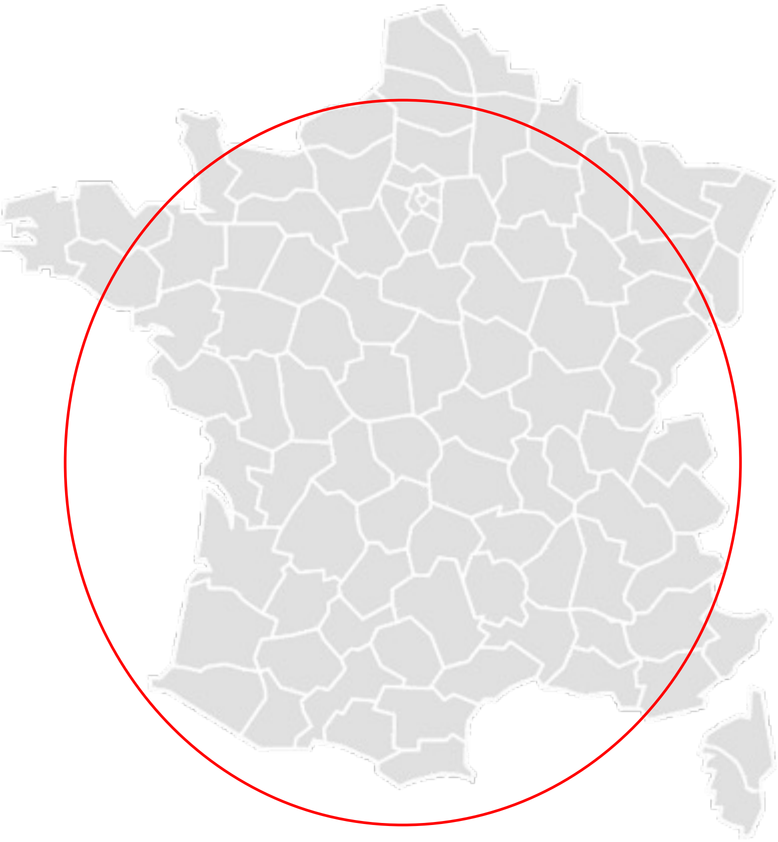
Network of laboratories for rt-RT-PCR EHDV

French network for EHD diagnosis



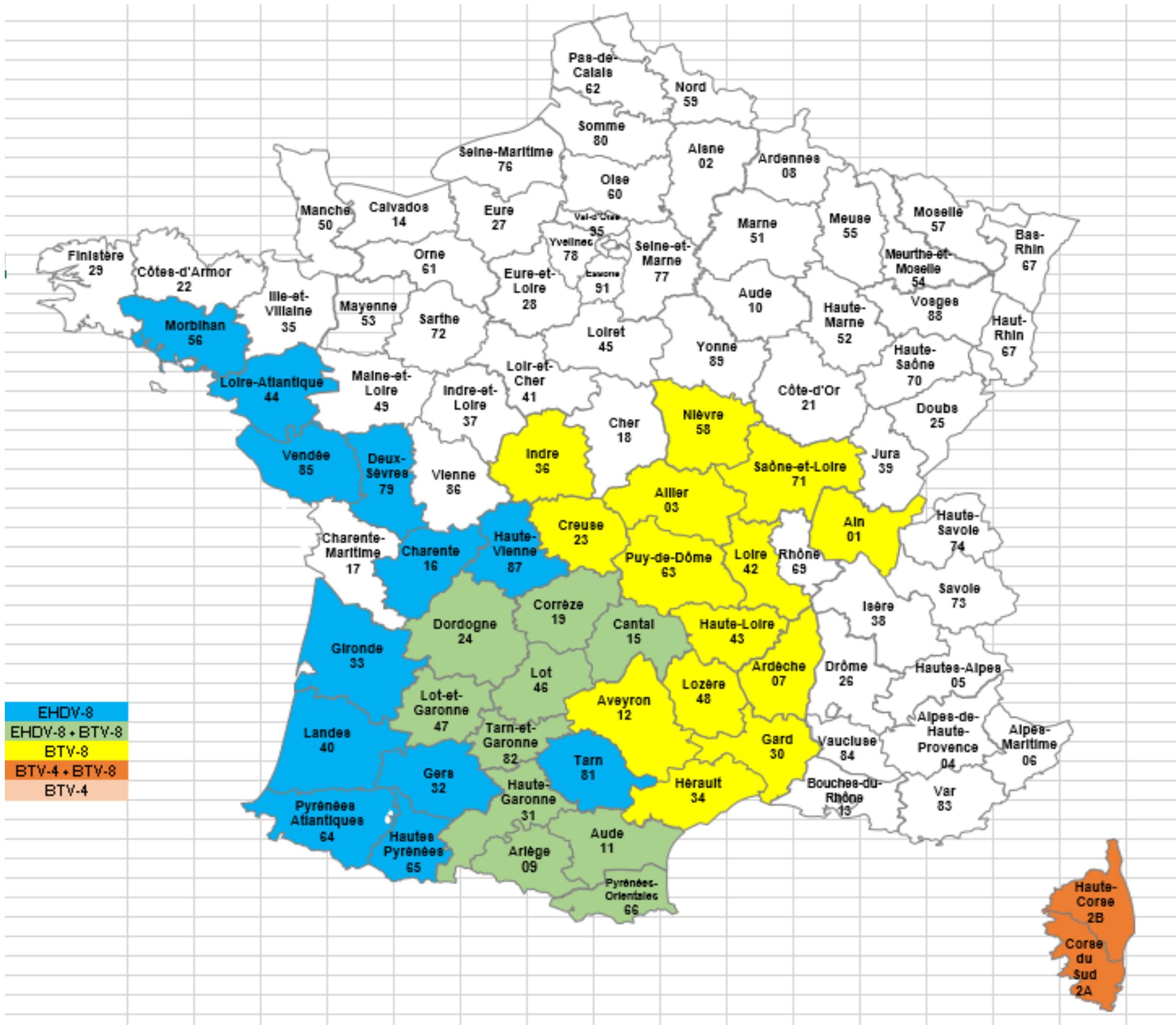
14 labs

French network for EHD diagnosis

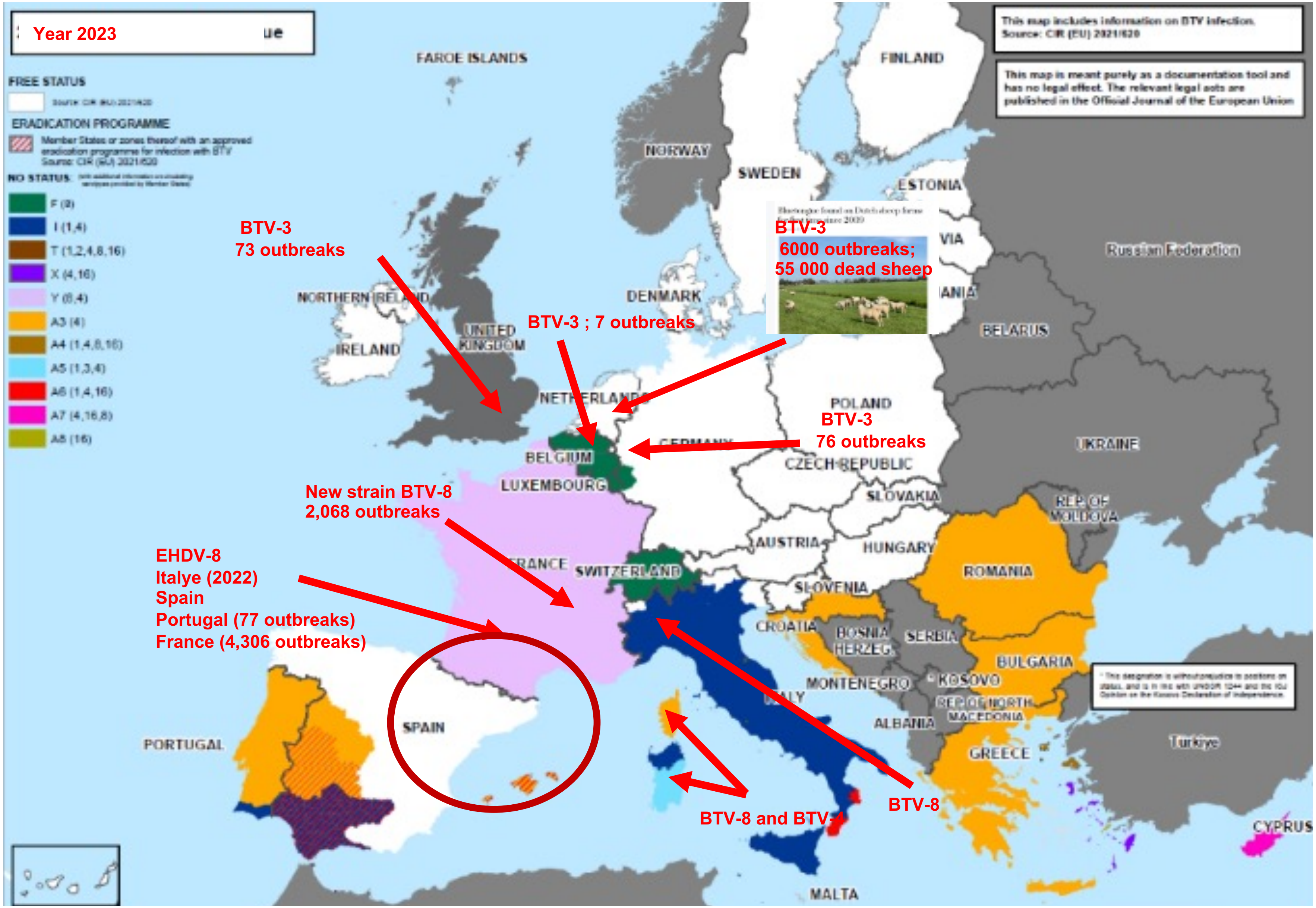


55 labs

Year 2023



EHDV-8
EHDV-8 + BTV-8
BTV-8
BTV-4 + BTV-8
BTV-4
Pas-de-Calais 62
Nord 59
Somme 80
Seine-Maritime 76
Aisne 02
Ardennes 08
Oise 60
Manche 50
Calvados 14
Eure 27
95
Marne 51
Meuse 55
Moselle 57
Bas-Rhin 67
Finistère 29
Côtes-d'Armor 22
Orne 61
Yvelines 78
Seine-et-Marne 77
Meurthe-et-Moselle 54
Eure-et-Loire 28
91
Ille-et-Vilaine 35
Mayenne 53
Aube 10
Haute-Marne 52
Vosges 88
Morbihan 56
Sarthe 72
Loiret 45
Yonne 89
Haut-Rhin 67
Haute-Saône 70
Loire-Atlantique 44
Maine-et-Loire 49
Loir-et-Cher 41
Indre-et-Loire 37
Côte-d'Or 21
Nièvre 58
Cher 18
Doubs 25
Vendée 85
Deux-Sèvres 79
Vienne 86
Indre 36
Saône-et-Loire 71
Jura 39
Allier 03
Ain 01
Haute-Savoie 74
Creuse 23
Charente-Maritime 17
Charente 16
Haute-Vienne 87
Puy-de-Dôme 63
Loire 42
Rhône 69
Savoie 73
Isère 38
Corrèze 19
Dordogne 24
Cantal 15
Haute-Loire 43
Gironde 33
Ardèche 07
Drôme 26
Hautes-Alpes 05
Lot 46
Lot-et-Garonne 47
Aveyron 12
Lozère 48
Alpes-de-Haute-Provence 04
Alpes-Maritime 06
Landes 40
Tarn-et-Garonne 82
Gard 30
Vaucluse 84
Tarn 81
Gers 32
Haute-Garonne 31
Hérault 34
Bouches-du-Rhône 13
Var 83
Pyrénées Atlantiques 64
Hautes Pyrénées 65
Ariège 09
Aude 11
Pyrénées-Orientales 66
Haute-Corse 2B
Corse du Sud 2A



Year 2023
FREE STATUS
ERADICATION PROGRAMME
Member States or zones thereof with an approved eradication programme for infection with BTV
Source: CIR (EU) 2021/620
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. 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
FAROE ISLANDS
NORWAY
SWEDEN
FINLAND
ESTONIA
Russian Federation
BELARUS
UKRAINE
REP. OF MOLDOVA
ROMANIA
HUNGARY
SLOVAKIA
POLAND
CZECH REPUBLIC
AUSTRIA
SLOVENIA
CROATIA
BOSNIA HERZEG.
SERBIA
BULGARIA
KOSOVO
MONTENEGRO
REP. OF NORTH MACEDONIA
ALBANIA
GREECE
Türkiye
CYPRUS
MALTA
ITALY
SWITZERLAND
FRANCE
LUXEMBOURG
BELGIUM
NETHERLANDS
GERMANY
DENMARK
UNITED KINGDOM
NORTHERN IRELAND
IRELAND
SPAIN
PORTUGAL
BTV-3
73 outbreaks
BTV-3 ; 7 outbreaks
BTV-3
6000 outbreaks;
55 000 dead sheep
BTV-3
76 outbreaks
New strain BTV-8
2,068 outbreaks
EHDV-8
Italye (2022)
Spain
Portugal (77 outbreaks)
France (4,306 outbreaks)
BTV-8 and BTV-4
BTV-8

PARIS 2024

Juin 2024

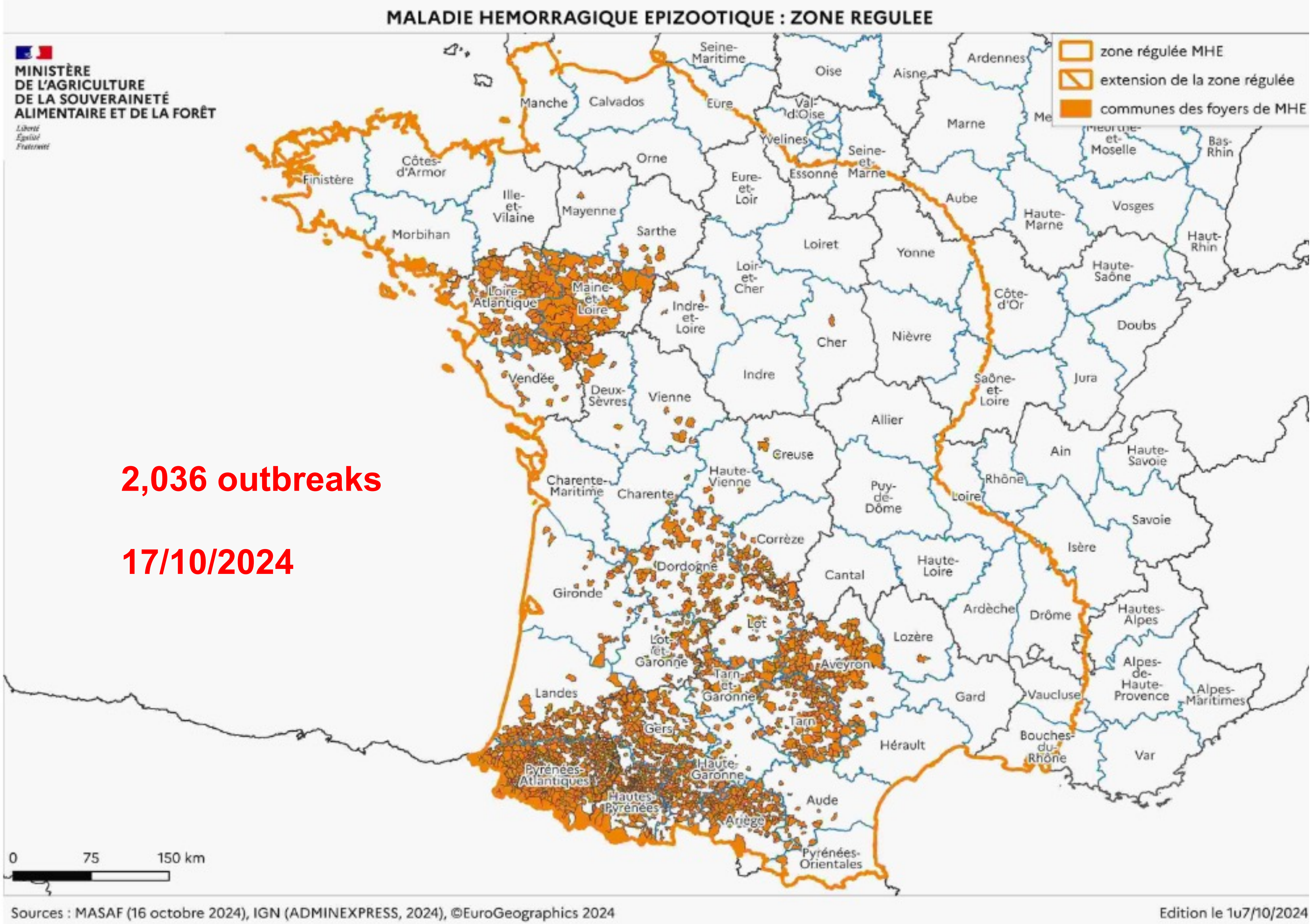
Confirmado el primer caso de enfermedad hemorrágica epizoótica de la actual temporada vectorial

El Ministerio de Agricultura, Pesca y Alimentación ha confirmado el primer caso de enfermedad hemorrágica epizoótica en una explotación de bovino de Guadalajara

Vacas libres de enfermedad hemorrágica epizoótica según la última actualización del Gobierno. (Foto: Freepik)

Archivado en:

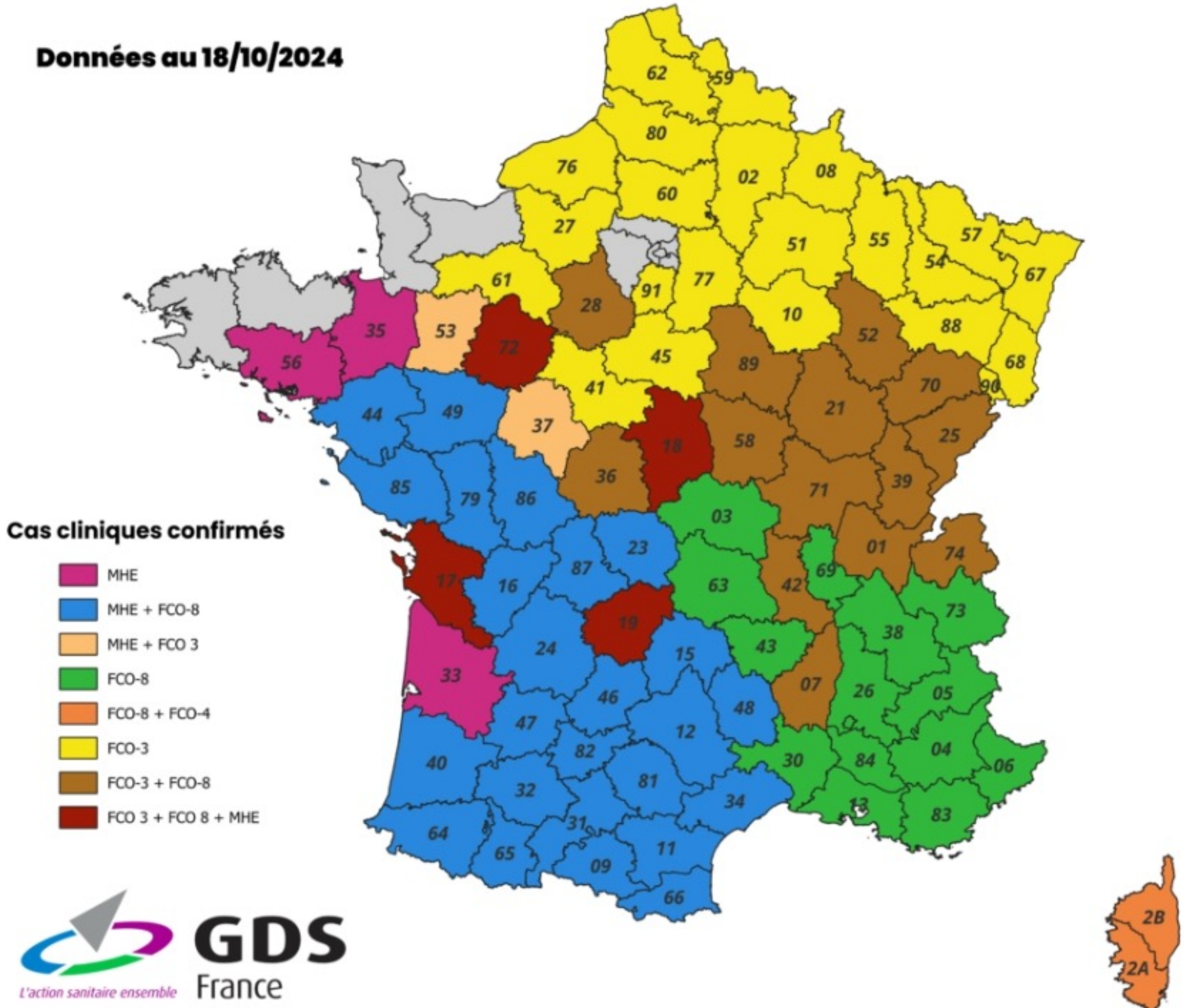

EHDV-8
Juin 2024
Auch
Toulouse
Montauban
Agen
Mont-de-Marsan
Pau
Lourdes
Bayonne
Bordeaux
Bergerac
Albi
Carcassonne
Narbonne
Perpignan
Béziers
Montpellier
Alès
Avignon
Aix-en-Provence
Marseille
Toulon
Valence
Grenoble
Saint-Étienne
Lyon
Chambéry
Annecy
Genève
Lausanne
Mâcon
Roanne
Vichy
Clermont-Ferrand
Montluçon
Limoges
Brive-la-Gaillarde
Châteauroux
Bourges
Nevers
Dijon
Besançon
Chalon-sur-Saône
Tours
Blois
Angers
Nantes
Saint-Nazaire
Challans
La Roche-sur-Yon
Les Sables-d'Olonne
Châtellerault
Poitiers
Niort
La Rochelle
Rochefort
Saintes
Royan
France
Parc naturel régional Loire-Anjou-Touraine
Parc naturel régional de la Brenne
Parc naturel régional du Morvan
Parc naturel régional Périgord-Limousin
Parc naturel régional de Millevaches en Limousin
Parc naturel régional de l'Aubrac
Parc naturel régional des Monts d'Ardèche
Parc naturel régional des Grands Causses
Parc national des Écrins
Parc naturel régional des Landes de Gascogne
Parc naturel régional des Pyrénées Ariégeoises
Parc national des Pyrénées
Andorre
Bilbao
Saint-Sébastien
Vitoria-Gasteiz
Pampelune
Logroño



2,036 outbreaks

17/10/2024

Données au 18/10/2024



Source : GDS France

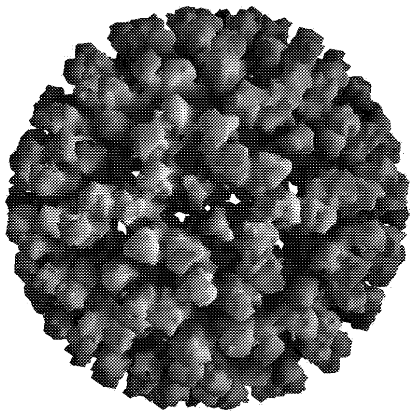
Emergence of culicoïdes transmitted arboviruses in Europe over the last 20 years in animal

- **Orbiviruses:**
- **- Bluetongue**
- **- EHD**
- **- African Horse Sickness**
- **Bunyavirus:**
- **- Schmallenberg**

-

Orbivirus

reassortment



9 serotypes AHSV

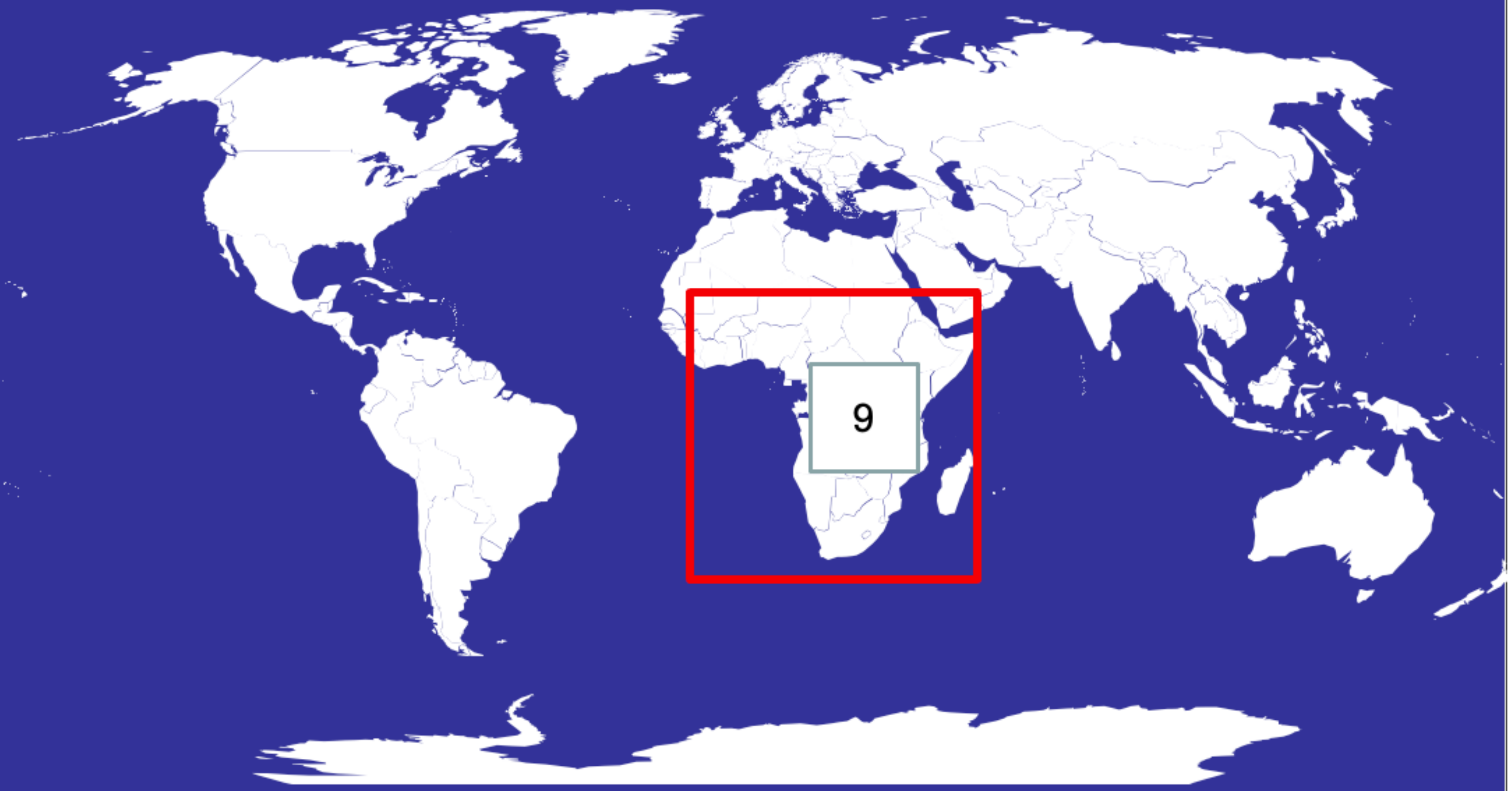
Vectors: *Culicoides*

imicola, bolitinos

AHS

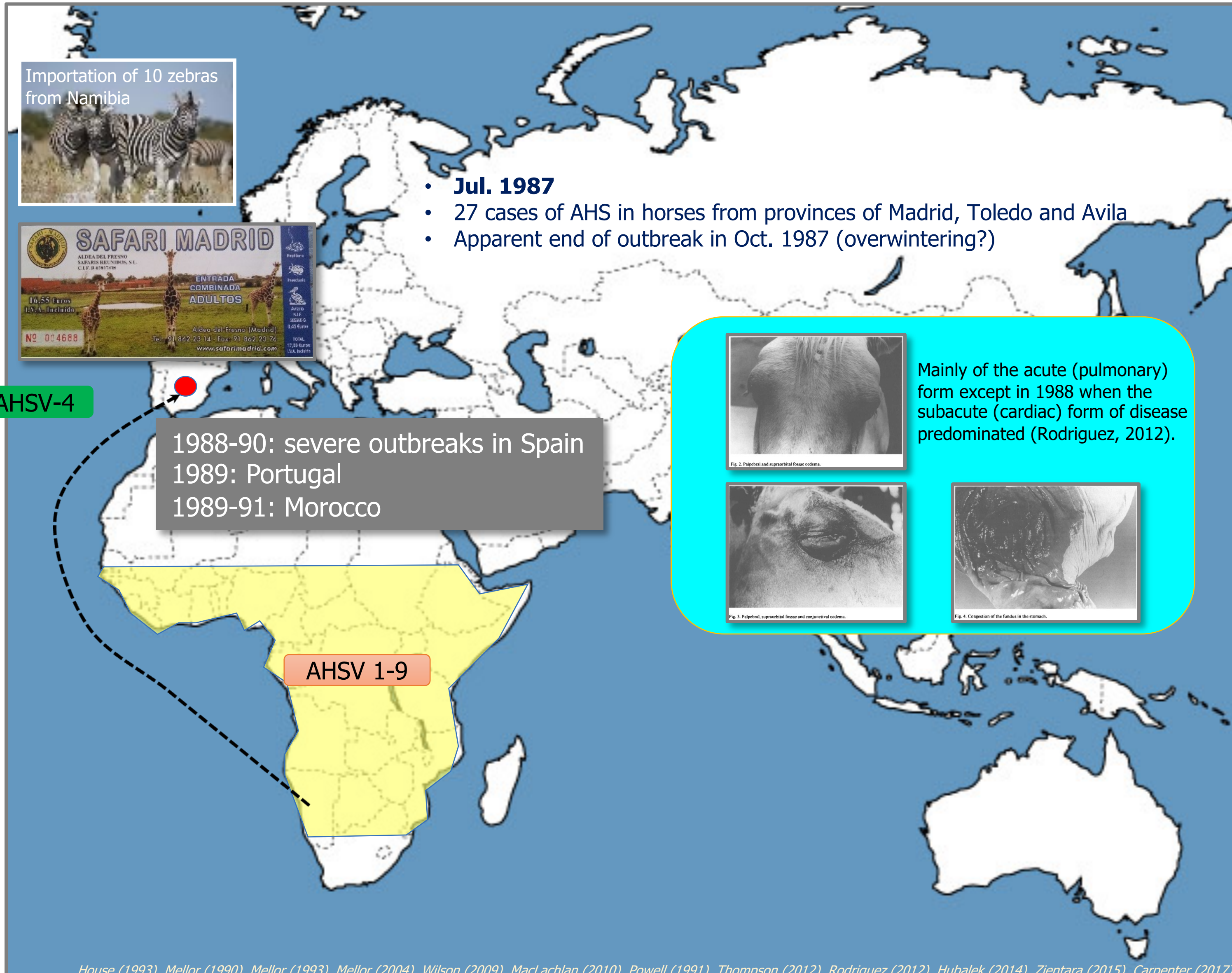
Courtesy Alan Guthrie, SA

Distribution of AHS



AHS distribution: mid to end 20th

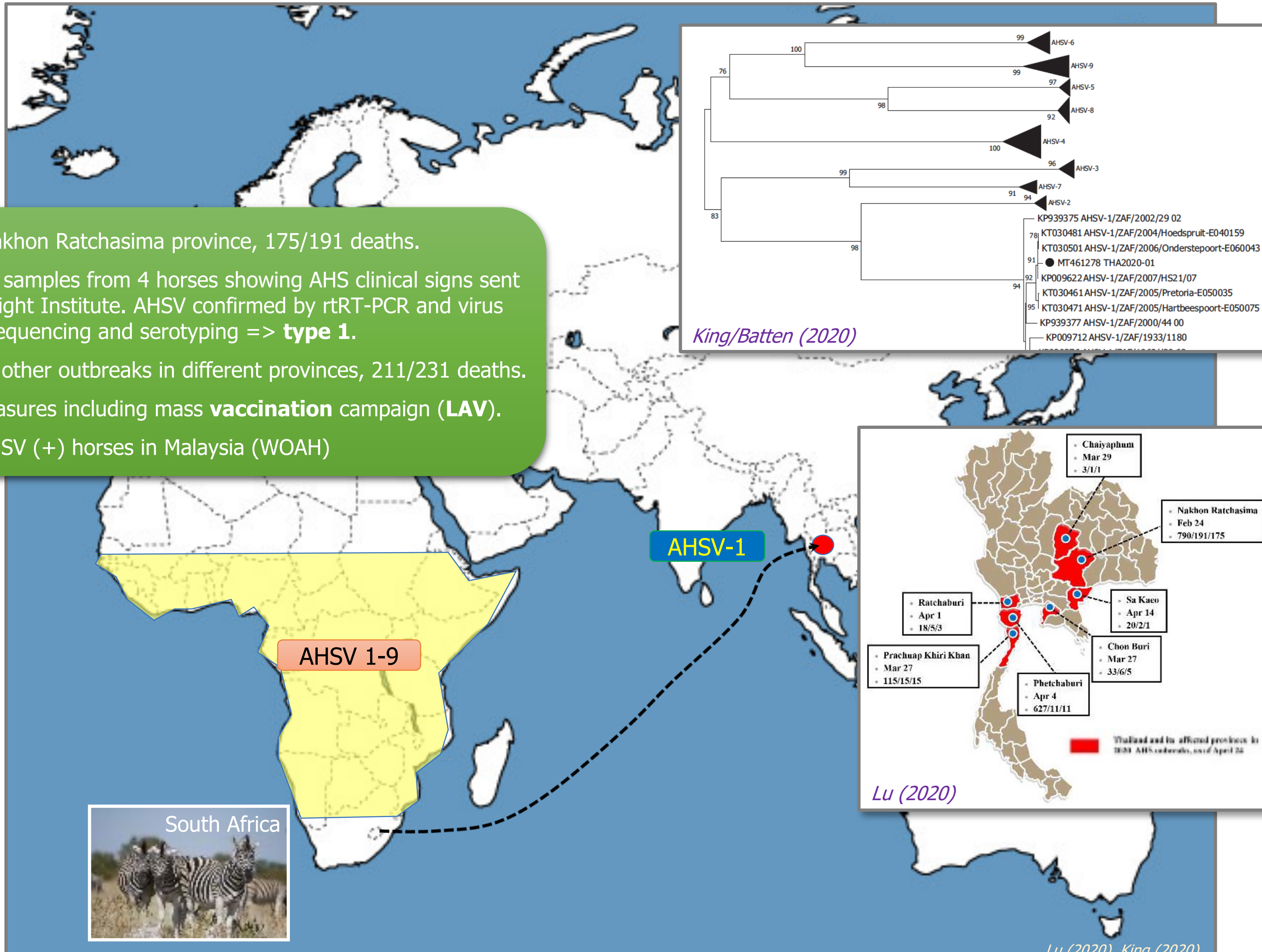
1987-91

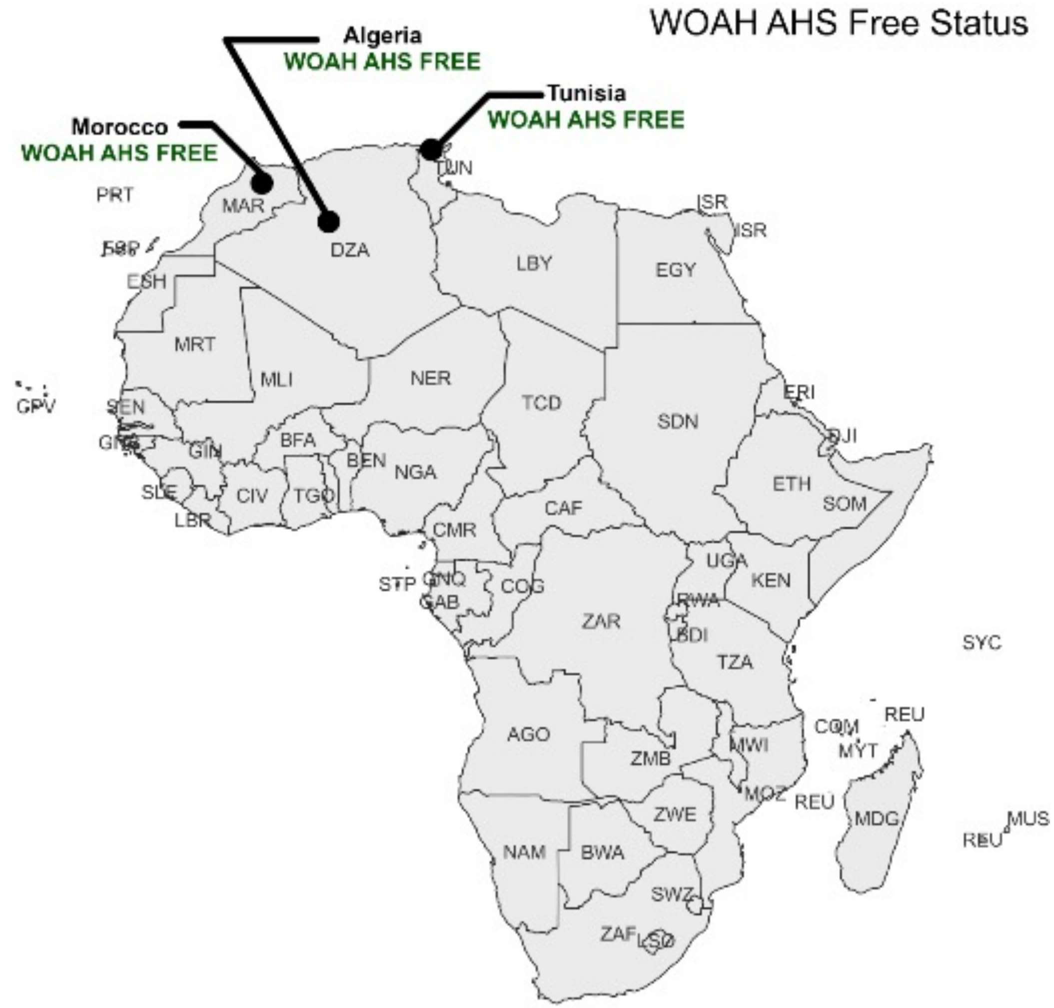


AHS distribution: end 20th - 21st century

2020

- **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 rtRT-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)





Data source: WOAH
accessed 4 Sep 2023

John Grewar, SA

Emergence of culicoïdes transmitted arboviruses in Europe over the last 20 years in animal

- **Orbiviruses:**
- - Bluetongue
- - EHD
- - African Horse Sickness
- **Bunyavirus:**
- - Schmallenberg

-

- **August-October 2011**
- Fever,
- Loss of apetite
- Dop of milk production
- Diarrheas
- abortions

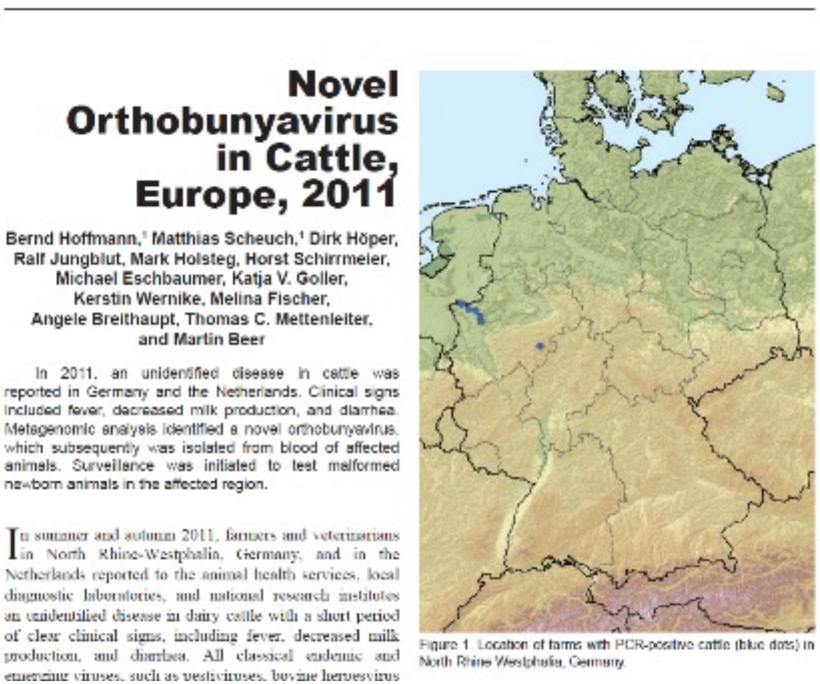
- Exclusion: BTV, IBR, BVDV, EHDV, …


Schmallenberg
A
Deutschland
(Germany)
Nederland
(Netherlands)
Belgique
België
(Belgium)
Lëtzebuerg
(Luxembourg)
English
Channel
Kiel
Rostock
Lübeck
Hamburg
Schwerin
Bergedorf
Neustrelitz
Norden
Groningen
Leeuwarden
Bremen
Hannover
Berlin
Magdeburg
Potsdam
Halle
(Saale)
Leipzig
Borna
Dresden
Den Haag
Dortmund
Essen
Köln
Chorweiler
Bonn
Frankfurt
am Main
Antwerpen
Mechelen
Gent
Lille
York
Leeds
Hull
Sheffield
Nottingham
Coventry
London
Southampton
Portsmouth
Brighton
Le Havre
Caen
Reims
Paris
Saint-Dizier
Nancy
Troyes
Alençon
Rennes
Le Mans
Mitte
Karlsruhe
Strasbourg
Freiburg im
Breisgau
Stuttgart
Ulm
Nürnberg
Ingolstadt
Augsburg
München
Landau
Passau
Wels
Plzeň

Metagenomic approach

Mix of 3 blood samples (sick animals + 1 healthy)

Sequencing with no priori



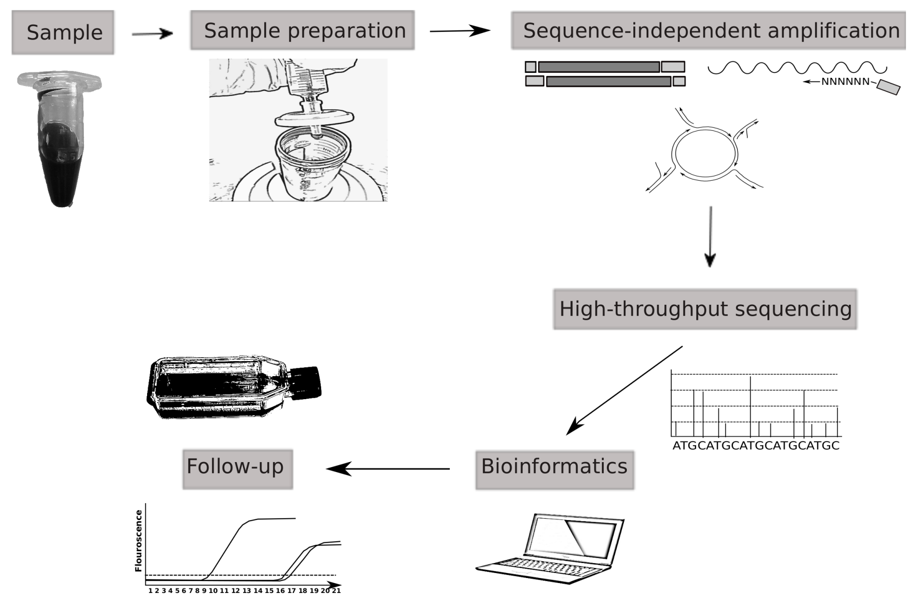
Novel Orthobunyavirus in Cattle, Europe, 2011

Bernd Hoffmann,[1] Matthias Scheuch,[1] Dirk Höper, Ralf Jungblut, Mark Holsteg, Horst Schirrmeier, Michael Eschbaumer, Katja V. Goller, Kerstin Wernike, Melina Fischer, 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

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



Blomström A-L Veterinary Quartely 2011 Vol. 31 No. 3

Hoffmann et al, Emerging Infectious Diseases, Vol. 18, No. 3, March 2012

Metagenomic

Table. Output of raw sequence data for the sequencing libraries in the analysis of a novel orthobunyavirus in cattle, Europe, 2011

Sample	Total no. reads	No. reads classified into superkingdom					No. unclassified reads
		Eukaryota	Archaea	Bacteria	Viruses	Root	
BH 80/11 RNA (3 pooled samples)	27,413	12,296	4	13,363	55 (Myoviridae, Siphoviridae, Podoviridae, Bunyaviridae, Retroviridae, Papillomaviridae)	377	1,318
BH 81/11 RNA	16,125	10,220	2	4,821	57 (Myoviridae, Siphoviridae, Podoviridae, Retroviridae)	19	1,006
BH 80/11 DNA (3 pooled samples)	77,929	59,308	3	95	3 (Herpesviridae, Mimiviridae, unclassified virus)	9,181	9,339
BH 81/11 DNA	89,728	79,742	9	44	1 (Retroviridae)	3	9,929

Hoffmann et al, Emerging Infectious Diseases, Vol. 18, No. 3, March 2012

Orthobunyavirus

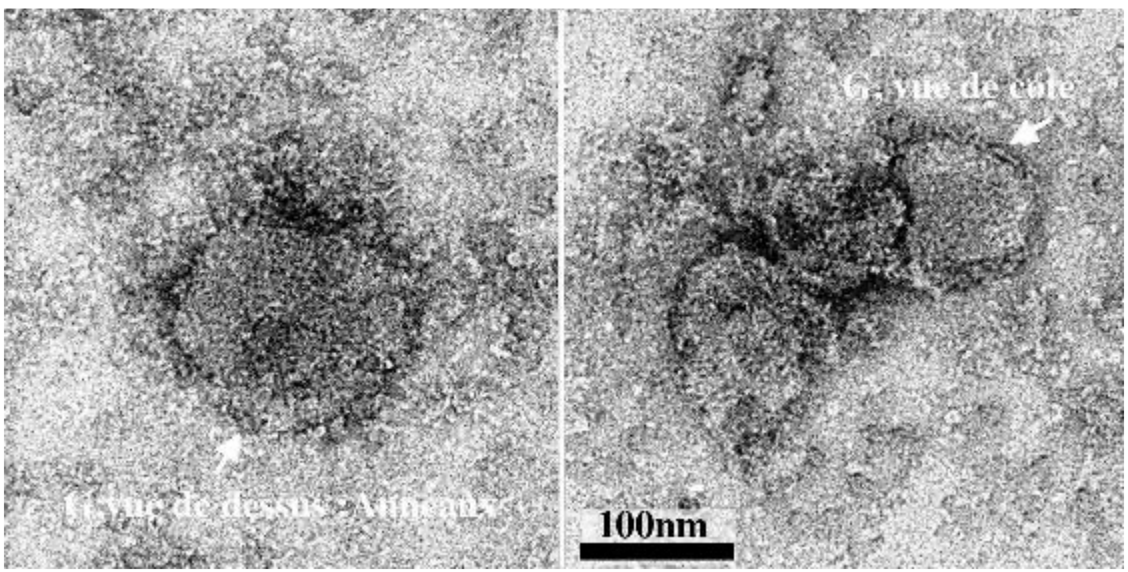
Phylogeny (source FLI)

- Segment S : 97 % similarity

Shamonda, Sathuperi, Douglas

- Segment L : 69% similarity
- Akabane
- Segment M : 71 % similarity
- Aino

Neonatal abnormalities



Electronic microscopy, Jean Lepault, UMR VMS CNRS-INRA

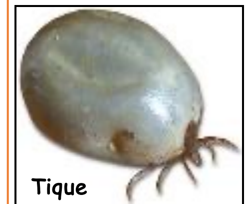
Vectors of the family *Peribunyaviridae*

Orthobunyavirus

Californie / Bunyamwera

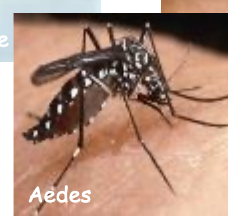
Simbu

Nairovirus

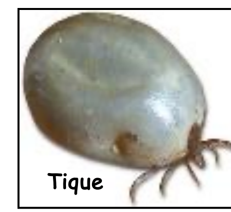


Phlebovirus

Sandfly

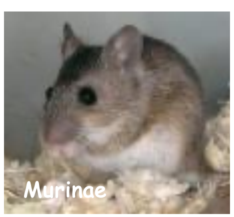


Tick (UUK)



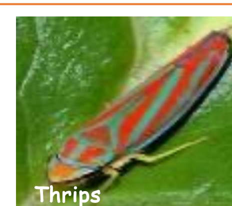
Hantavirus

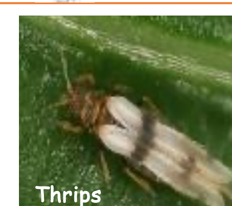
HFSR



HPS

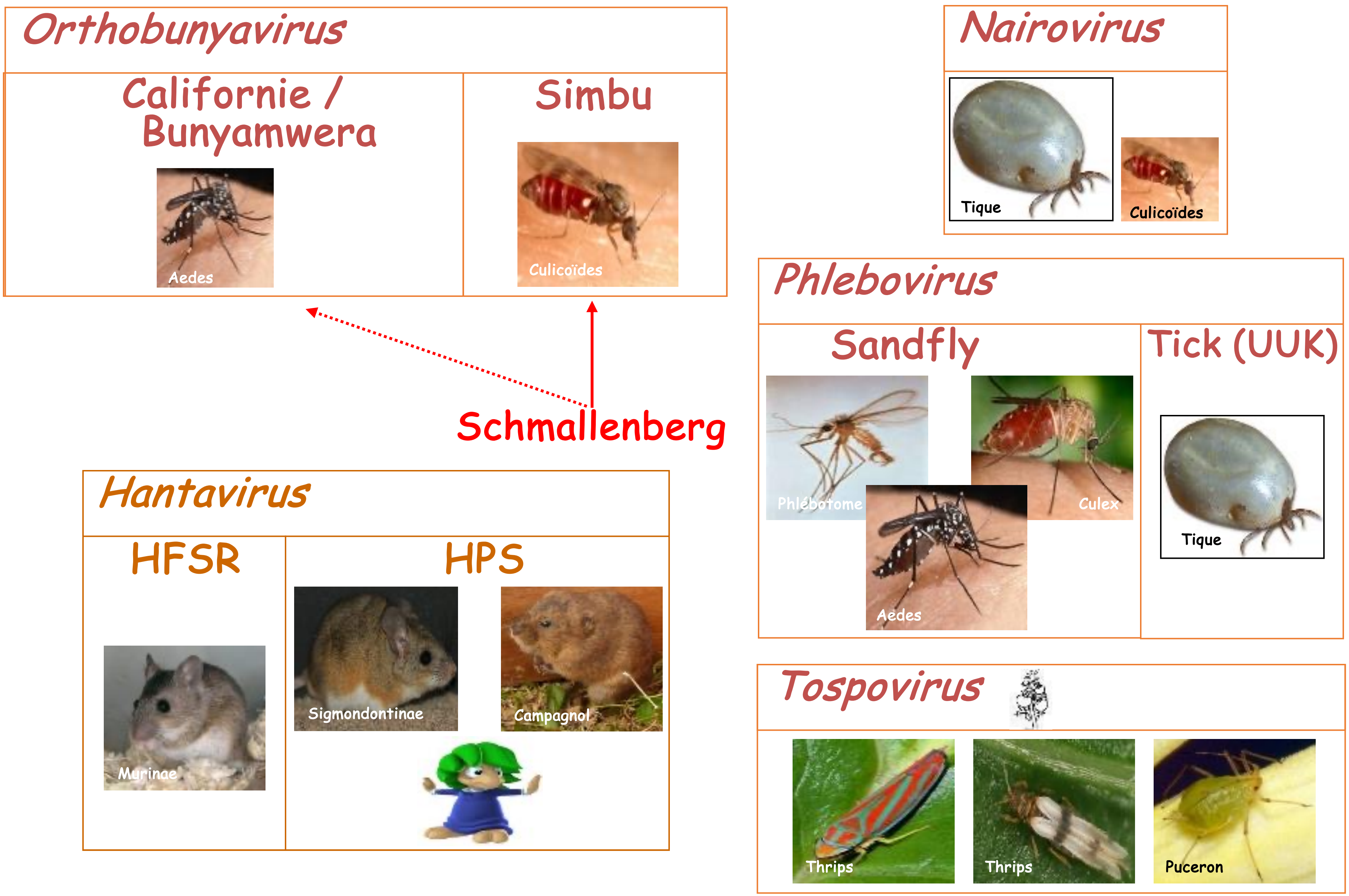
Tospovirus



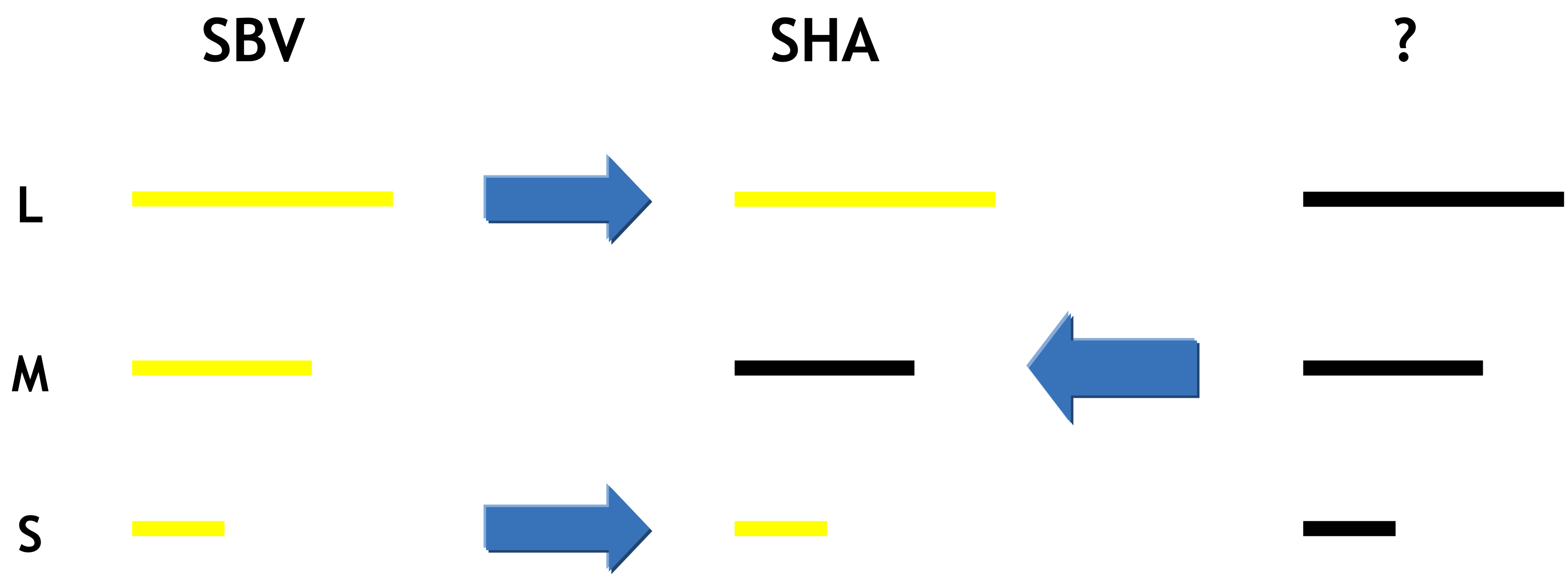


Estelle Lara

Vectors of the family *Peribunyaviridae*



Shamonda : reassortant SBV + ?



Weekly incidence

52

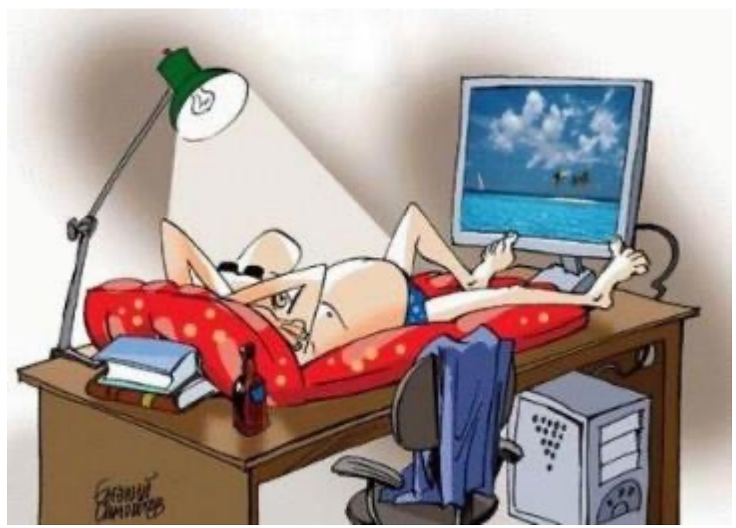
○ Ovins
□ Caprins
△ Bovins
◆ Foyer confirmé
● Suspicion non confirmée

[End Decembre 2011 – beginning April 2012]

(per week)

Morgane Dominguez, ANSES

« Overwintering ? »



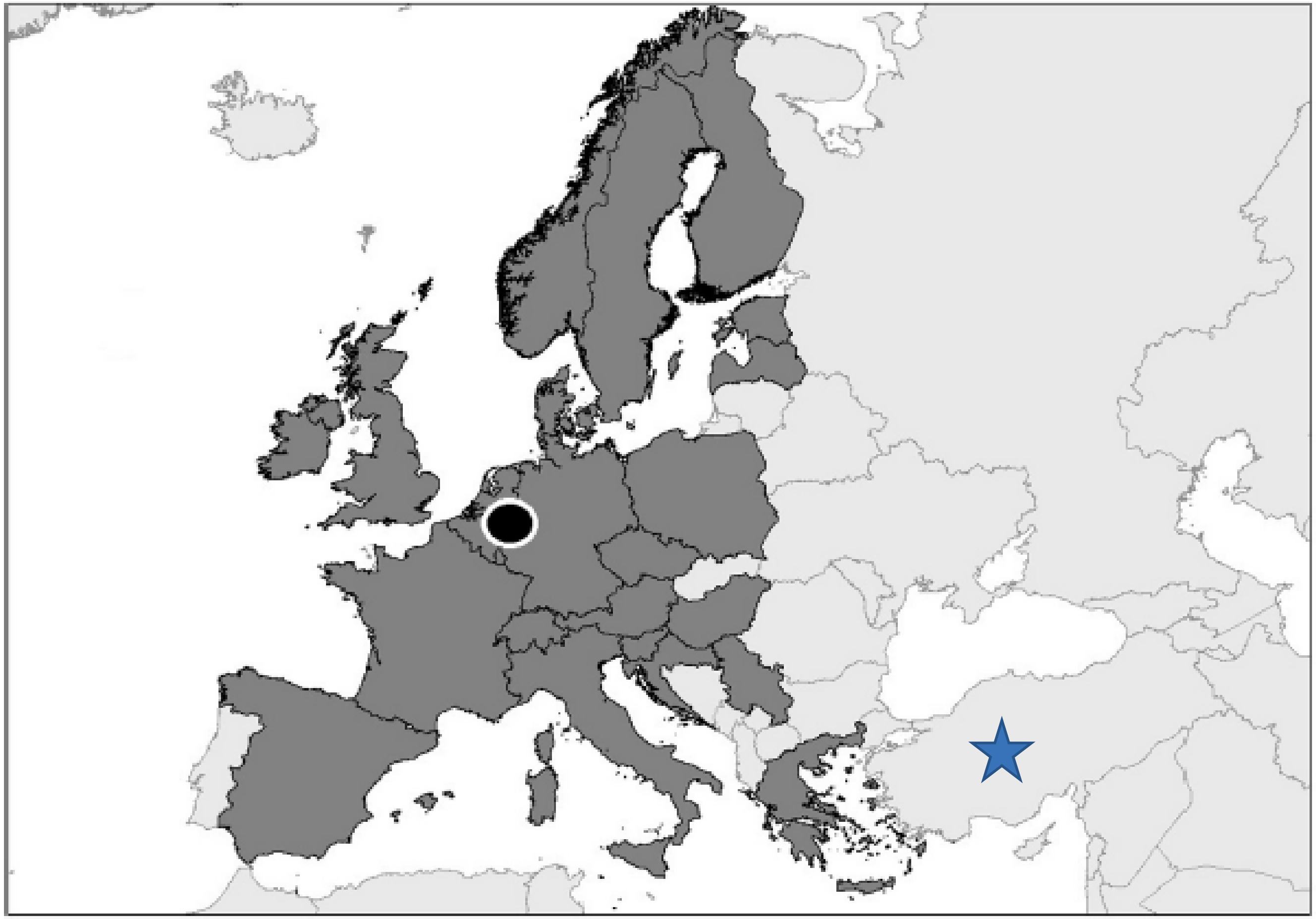


Fig. 5. European countries affected by Schmallenberg virus by September 2013. The area, where the epidemic started in 2011 is marked by a dot.

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 Schirrmeier[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,*]

Neonatal abnormalities

Pierre AUTEF
Eric COLLIN

a

b

arthrogryposis hydranencephaly syndrom

c

d

Fig. 2. Schmallenberg virus-associated torticollis and arthrogryposis in a lamb.

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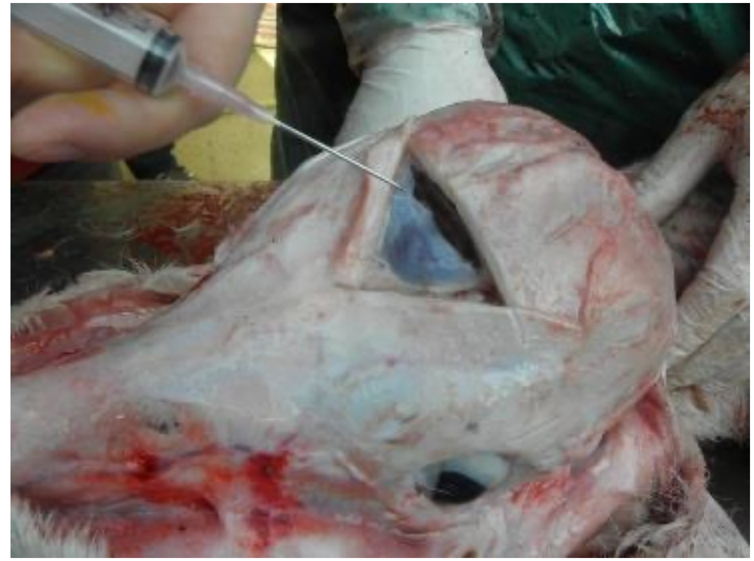
Schmallenberg virus—Two years of experiences

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




Kristel GACHE
Vétérinaire Epidémiologiste
GDS France



Guillaume Belbis, ENVA

Virus isolation on Vero (KC, BHK).

rt-RT-PCR

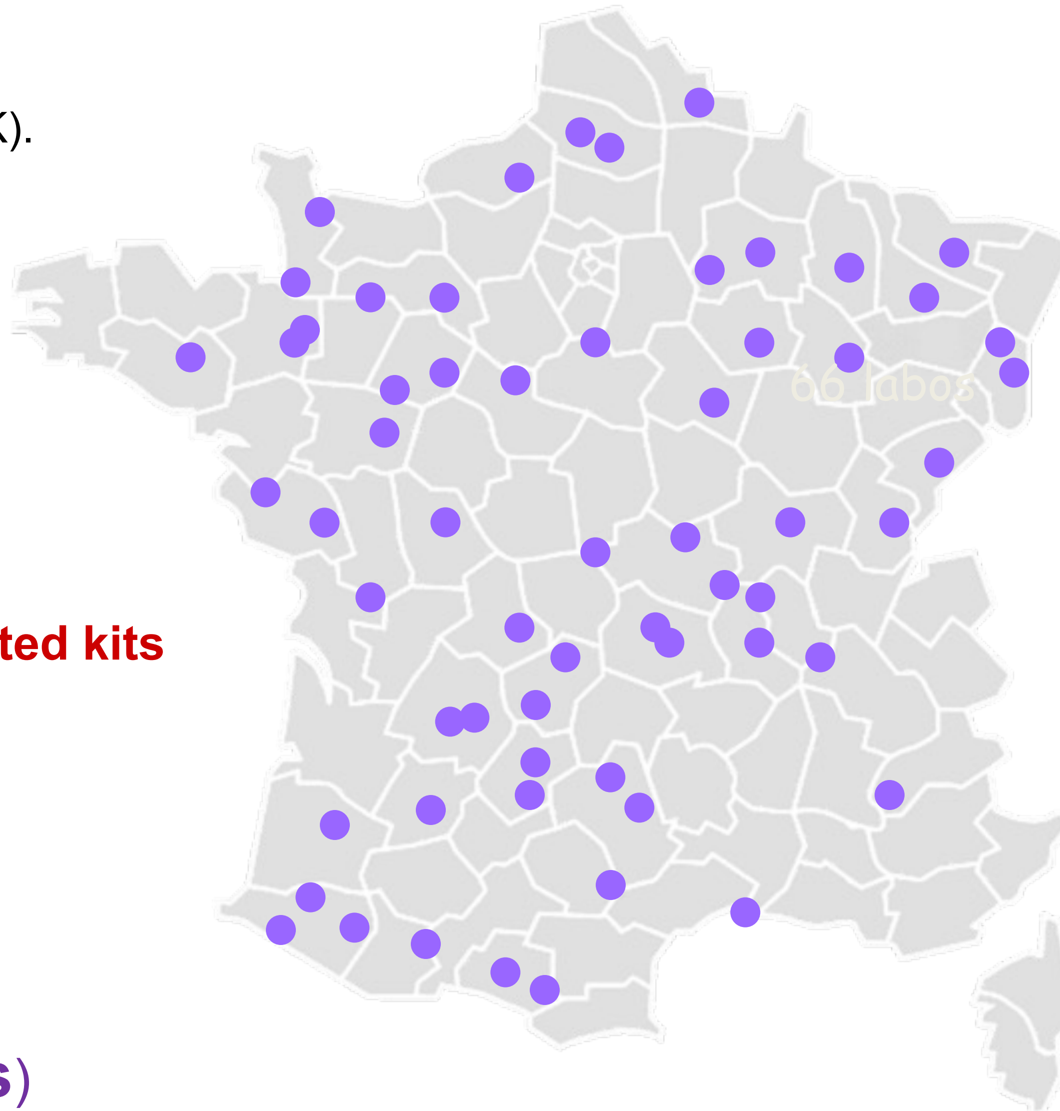
FLI RT-PCR number 1 :
- segment L

FLI RT-PCR number 2 :
segment S

2 commercial validated kits

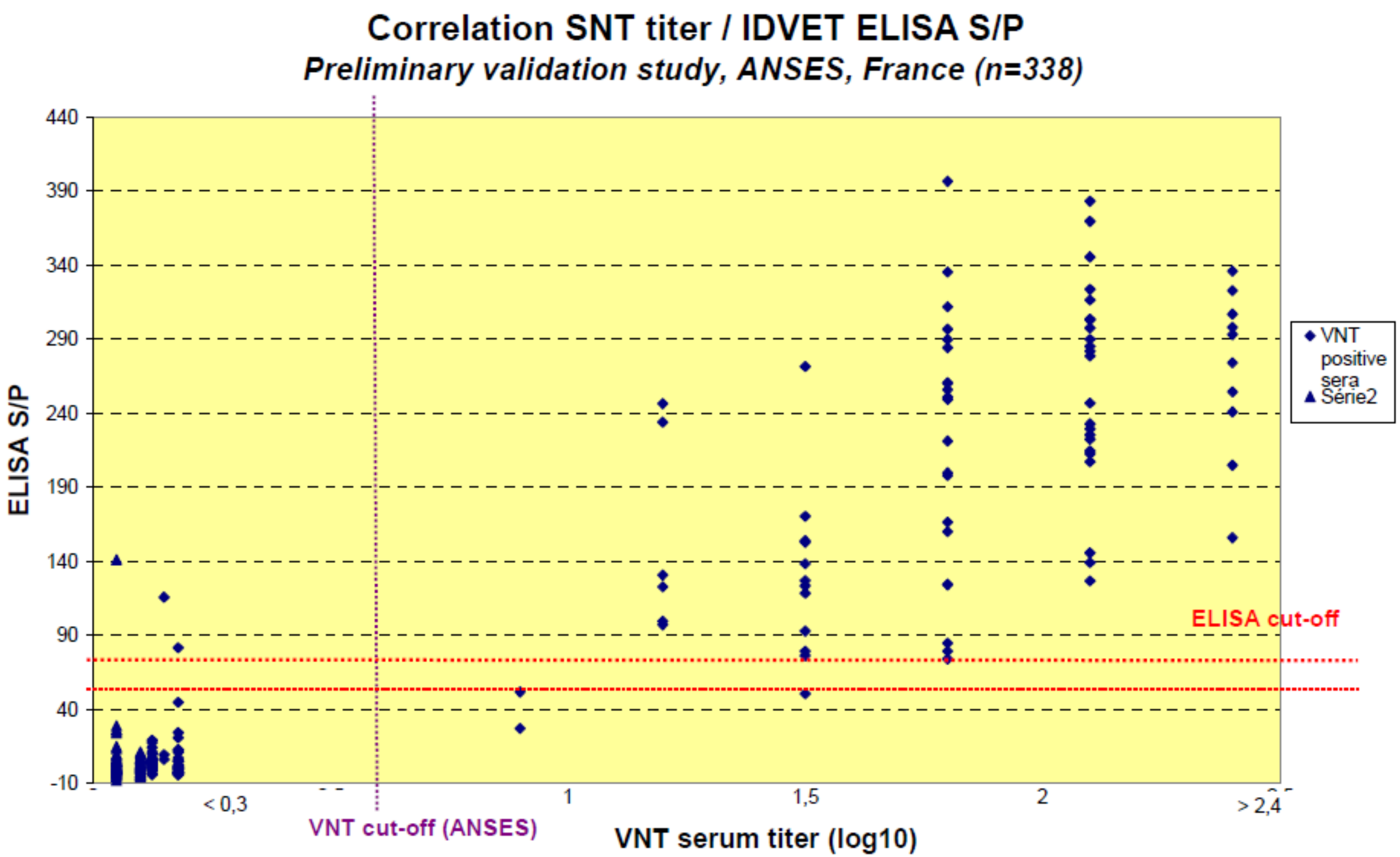
-Duplex : SBV and GAPDH
(or beta Actine)
RNA amplification

AES - ADIAGENE
LSI (Life technologies)



256

Serological diagnosis

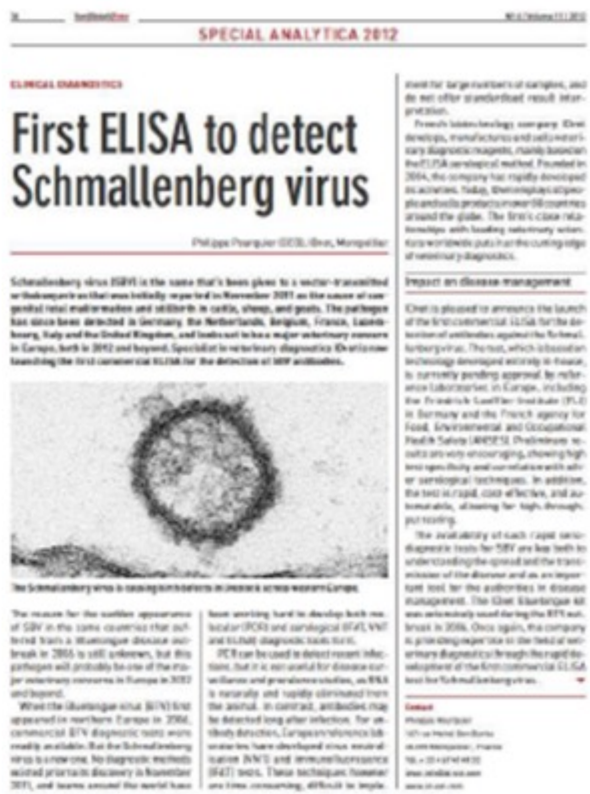


+ kit IDEXX

PLoS One. 2013;8(1):e53446. doi: 10.1371/journal.pone.0053446. Epub 2013 Jan 15.

Validation of a commercially available indirect ELISA using a nucleocapside recombinant protein for detection of Schmallenberg virus antibodies.

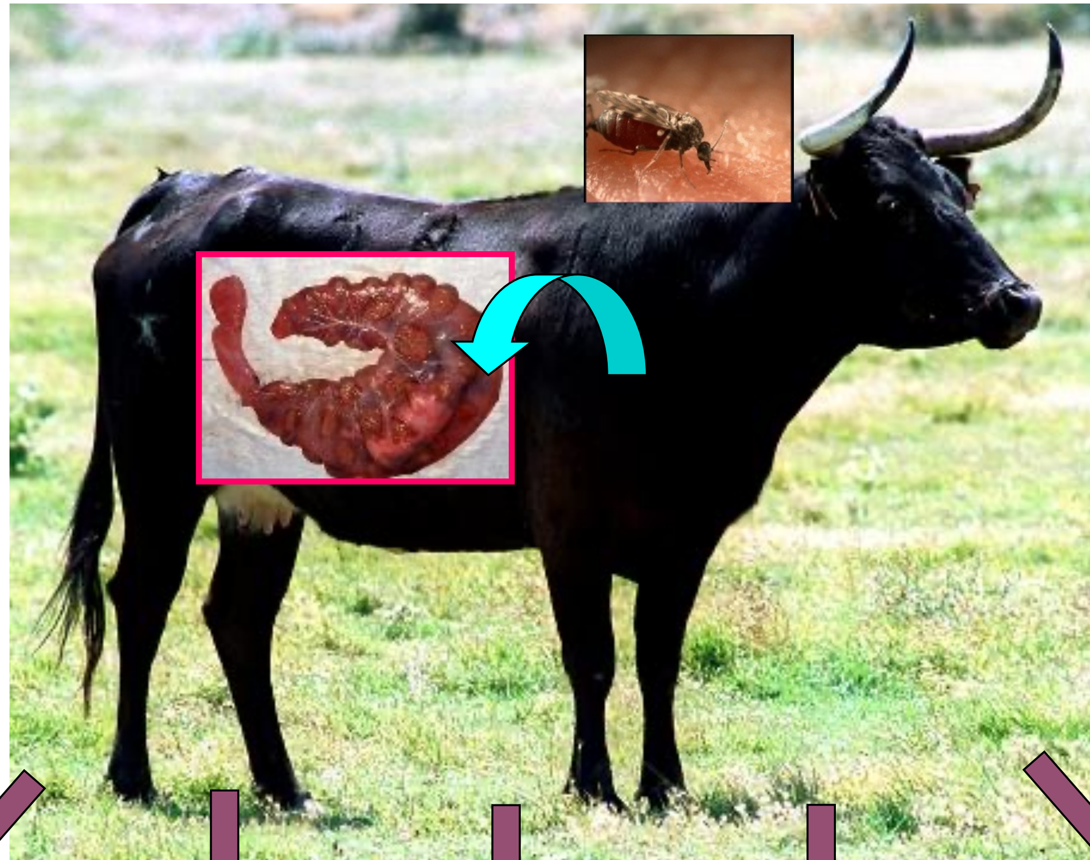
Bréard E[1], Lara E, Comtet L, Viarouge C, Doceul V, Desprat A, Vitour D, Pozzi N, Cay AB, De Regge N, Pourquier P, Schirrmeier H, Hoffmann B, Beer M, Sailleau C, Zientara S.



SPECIAL ANALYTICA 2012

CLINICAL DIAGNOSTICS

First ELISA to detect Schmallenberg virus



Mortalité embryonnaire

Avortements

IPI
?

Malformations néonatales

Veau normal
Séropositif
Immunocompétence
150-180j

MERCK ANIMAL HEALTH PRESENTS
RESULTS OF A VACCINE AGAINST

Merck Animal Health Presents Results of a Vaccine Against Schmallenberg Virus to protect Sheep and Cattle

Le 10 octobre, le laboratoire Merial a annoncé le lancement d'un vaccin inactivé contre le virus de Schmallenberg.

Mis au point par le laboratoire Merial, le vaccin contre la maladie d
disponible depuis le 21 octobre. Dès le mois d'août, le vaccin a obt
mise sur le marché (AMM) pour circonstances exceptionnelles. Dès 20
procuré une souche virale et en 18 mois, son équipe de chercheurs a
solution efficace prévenant la virémie. Pour les bovins, l'immunité i
injections d'un millilitre de vaccin en sous-cutané à trois semai
vaccination peut intervenir dès 2,5 mois d'âge. Le laboratoire rappel
prévention contre ce virus dont les conséquences semblent souven
éleveurs. La maladie provoque non seulement la naissance de veau
viables, mais elle induit également des avortements, retours en ch
production.
D'autre part, la maladie risque de continuer à être présente, du fa
nombreux vecteurs et de réservoirs à virus. Les principaux transm
culicoïdes ; de même, un grand nombre de chevreuils ont été diagno
virus, facilitant du même coup son maintien pendant l'hiver. Le
également que des études ont montré qu'une transmission transova
possible. De même, la semence de taureaux pouvait également infect

Le laboratoire américain MSD a également lancé son propre vaccin d
Grande Bretagne depuis le mois d'août.

Envoyer à un ami | Imprimer | g+1 0 | Share

anses

anses

Organisation mondiale de la santé animale
Fondée en tant qu'OIE

Corinne Sailleau

IZS TERAMO

Giovanni Savini

Alessio Lorusso

Lydie Postic

Mathilde Turpaud

Mathilde Gondard

INSTITUT DE LA RECHERCHE VETERINAIRE DE TUNISIE

Soufien Sghaier

Damien Vitour

Emmanuel Bréard

Veille Sanitaire Internationale

Plateforme ESA

Thank you for your attention

Day 1: Preparedness and response to emerging arboviruses.

The national animal health surveillance Plateforme and arbovirus emergence - added values and challenges

By Céline Dupuy

THE NATIONAL ANIMAL HEALTH SURVEILLANCE PLATFORM AND ARBOVIRUS EMERGENCE
ADDED VALUE AND CHALLENGES

CÉLINE DUPUY

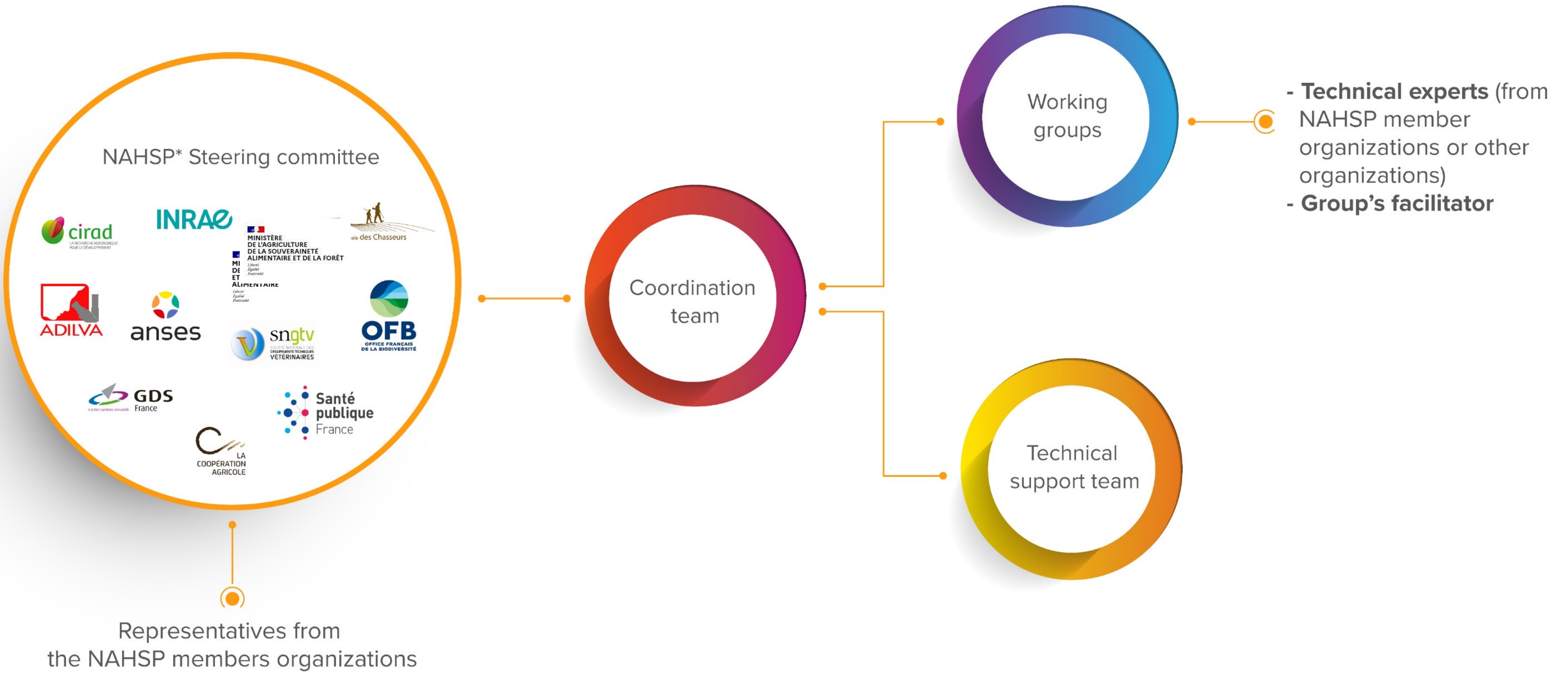
SERVANE BAREILLE, JULIEN CAUCHARD, ROMANE DI BIAGGIO, KRISTEL GACHE, EMMANUEL GARIN, GUILLAUME GERBIER, VIVIANE HENAUX, CARLENE TREVENNEC, SYLVAIN VILLAUDY

ANNUAL SCIENTIFIC SYMPOSIUM OF THE ARBO-FRANCE NETWORK - OCTOBER 24, 2024

PLAN

- The national animal health surveillance platform
- International epidemic intelligence
- Syndromic bovine mortality surveillance system: Omar bovins
- Schmallenberg virus

THE NATIONAL ANIMAL HEALTH SURVEILLANCE PLATFORM



NAHSP = National Animal Health Surveillance Platform

OBJECTIVE

Develop, adapt and promote surveillance systems

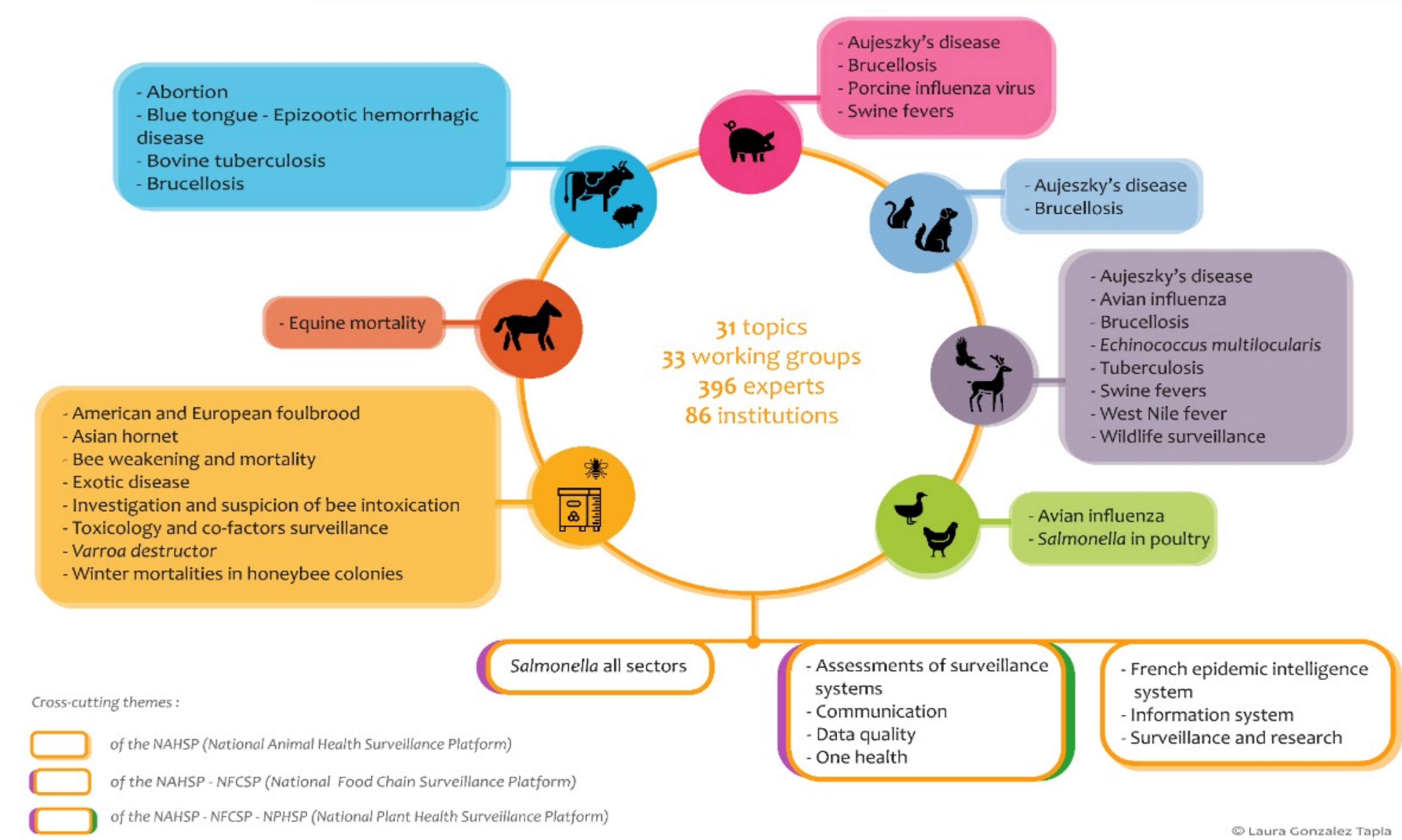
Implement national and international epidemic intelligence

Perform synthesis on epidemiological status of health hazards

Improve the efficiency of the epidemiological surveillance

Technical support for surveillance systems

Not decision maker for surveillance systems


- Abortion
- Blue tongue - Epizootic hemorrhagic disease
- Bovine tuberculosis
- Brucellosis
- Aujeszky's disease
- Brucellosis
- Porcine influenza virus
- Swine fevers
- Aujeszky's disease
- Brucellosis
- Equine mortality
31 topics
33 working groups
396 experts
86 institutions
- Aujeszky's disease
- Avian influenza
- Brucellosis
- *Echinococcus multilocularis*
- Tuberculosis
- Swine fevers
- West Nile fever
- Wildlife surveillance
- American and European foulbrood
- Asian hornet
- Bee weakening and mortality
- Exotic disease
- Investigation and suspicion of bee intoxication
- Toxicology and co-factors surveillance
- *Varroa destructor*
- Winter mortalities in honeybee colonies
- Avian influenza
- *Salmonella* in poultry
Salmonella all sectors
- Assessments of surveillance systems
- Communication
- Data quality
- One health
- French epidemic intelligence system
- Information system
- Surveillance and research
Cross-cutting themes :
of the NAHSP (National Animal Health Surveillance Platform)
of the NAHSP - NFCSP (National Food Chain Surveillance Platform)
of the NAHSP - NFCSP - NPHSP (National Plant Health Surveillance Platform)
© Laura Gonzalez Tapia

ADDED VALUE

- Shared governance between the public and private sector
- Co-construction method

Veille Sanitaire Internationale

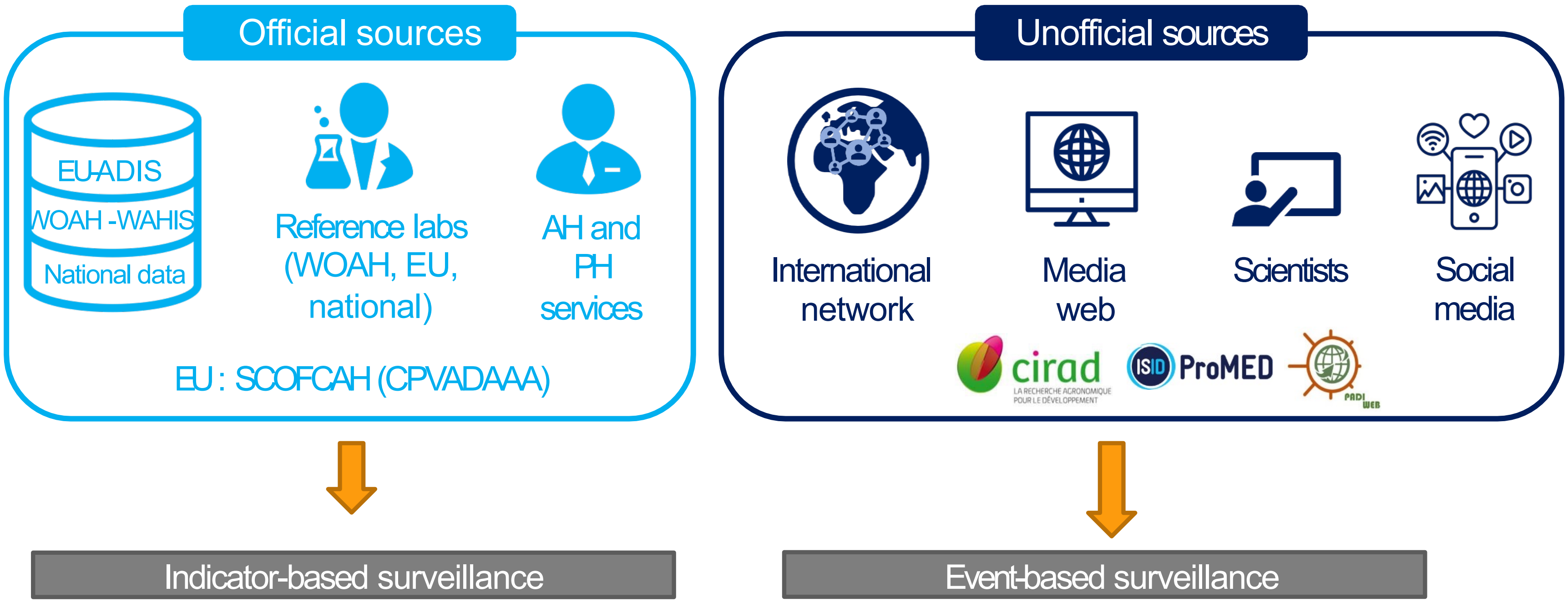
Plateforme ESA

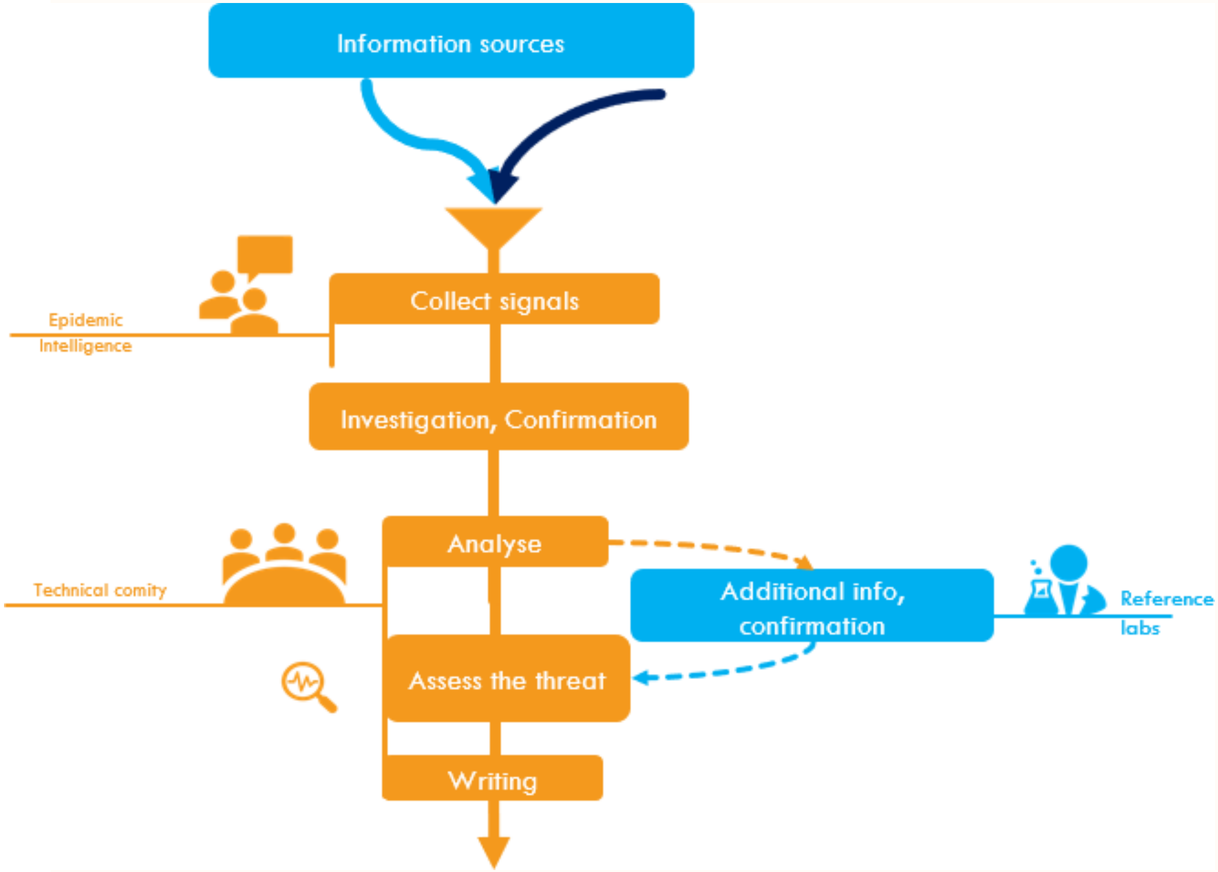
INTERNATIONAL EPIDEMIC INTELLIGENCE

Useful tool to anticipate emergences

- Increase awareness of stakeholders
- Anticipate surveillance protocols evolution
- Communication tool

SOURCES


Official sources
EU-ADIS
WOAH -WAHIS
National data
Reference labs (WOAH, EU, national)
AH and PH services
EU : SCOFCAH (CPVADAAA)
Unofficial sources
International network
Media web
Scientists
Social media
cirad
LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT
ISID ProMED
PADI WEB
Indicator-based surveillance
Event-based surveillance



Information sources
Collect signals
Epidemic Intelligence
Investigation, Confirmation
Analyse
Technical comity
Additional info, confirmation
Reference labs
Assess the threat
Writing

- Weekly report (BHVSI-SA)
- Publication every Tuesday at the end of the day
- Processes data from week S-1
- Categorization according to the epidemiological situation
- Easy reading (logos, essentials, highlighting the news)
- Several arbovirus: West Nile, Blue tongue, Epizootic heamorrhagic disease

Veille Sanitaire Internationale

BHVSI-SA

Bulletin **H**ebdomadaire de **V**eille **S**anitaire **I**nternationale - **S**anté **A**nimale

SOMMAIRE

Du 15/10/2024, semaine du 07 au 13/10/2024

Le BHVSI-SA rapporte et met en perspective des signaux et des alertes en santé animale au niveau national et international. Pour accéder à la thématique souhaitée, cliquez directement sur le titre.

Clavelée : poursuite des détections en Grèce et en Bulgarie.
Fièvre catarrhale ovine en Europe : premiers foyers de BTV12 aux Pays-Bas.
Fièvre West Nile en Europe : baisse de l'incidence en Europe.
Influenza aviaire hautement pathogène en Europe : foyers de volailles sur la partie Est de l'Europe.
Influenza aviaire hautement pathogène sur le continent américain : poursuite des détections chez les ruminants aux États-Unis.
Maladie hémorragique épizootique en Europe : poursuite des détections en France et en Espagne.
Peste des petits ruminants : Pas de nouvelle déclaration.
Peste porcine africaine en Europe : tendance à la baisse des détections en Europe.
Dangers sanitaires à actualité réduite : rage classique en Europe.
Instructions de lecture : voir en fin de document.
Abonnez-vous
Accédez à la carte interactive

Information notes / Reports

- Annual reports for seasonal diseases (ex: WN)
- Short reports when necessary

Veille Sanitaire Internationale
Plateforme ESA

Thématique veille sanitaire internationale	
Bilan	04/09/2023

Bilan de la saison 2022 de fièvre West Nile en Europe

Pour le laboratoire national de référence : Gaëlle Gonzalez, Camille Migné, Stephan Zientara
Pour l'OFB : Anouk Decors, Stephanie Desvaux
Pour Santé publique France : Harold Noël, Marie-Claire Paty
Pour le Cirad : Sérafin Gutierrez
Pour le comité de rédaction VSI de la Plateforme ESA : Jean
Eric Cardinale, Julien Cauchard, Céline Dupuy, Guillaume Gerbi
Lancelot, Célia Locquet, Carlène Trévennec, Sylv
Auteurs correspondants : plateforme-esa@a

Essentiels

- La saison 2022 s'entend de début juin à mi-décembre (détections sp
- Au total, 267 cas dans l'avifaune (principalement en Allemagne (principalement en Italie et Espagne) et 1 335 cas humains (principalem détectés dans douze pays européens.
- La première détection de la saison a été réalisée sur un pool de m 07/06/2022 dans le nord de l'Italie, suivie de deux cas dans l'avifau toujours dans le nord de l'Italie.
- La dynamique temporelle est similaire aux saisons précédentes (pic plus forte chez les oiseaux et les humains par rapport aux années précé début du mois de juin et les cas sporadiques tardifs sont à mettre en climatiques favorables aux vecteurs (printemps chaud et hiver dou observées en 2018.
- Une extension géographique a été observée dans le nord de l'Allem rapport aux deux années précédentes et des foyers ont été détectés pou de la France (Gironde).

Sources

Sources de données :
- pour les foyers et cas animaux : Commission européenne ADIS et 04/09/2023.
- pour les cas humains : données issues de The European Surveillance S [Allemagne, Autriche, Croatie, Espagne, France, Grèce, Hongrie, Italie et Slovaquie][1] et mises à disposition par l'ECDC pour les pays de l'UE-E

Les sources de données et le traitement des informations issues des sou sont décrites ici. Les modalités de traitement des données par l'ECDC son

Pour la surveillance faune sauvage en France, source OFB réseau Sagir au

[1] pays ayant notifié des cas humains à TESSY en 2022

Veille Sanitaire Internationale
Plateforme ESA

West Nile en Gironde – point au 04/08/2023

Veille sanitaire internationale	
Note information	04/08/2023

Circulation active du virus West-Nile en Gironde, région Nouvelle-Aquitaine – point au 04/08/2023

Gaëlle Gonzalez, Clément Bigeard, Camille Migné, Thierry Touzet, Albin Fontaine, Grégory L'Ambert, Xavier de Lamballerie, Stéphan Zientara, Alexandre Duvignaud et Denis Malvy.

Auteur correspondant : plateforme-esa@anses.fr

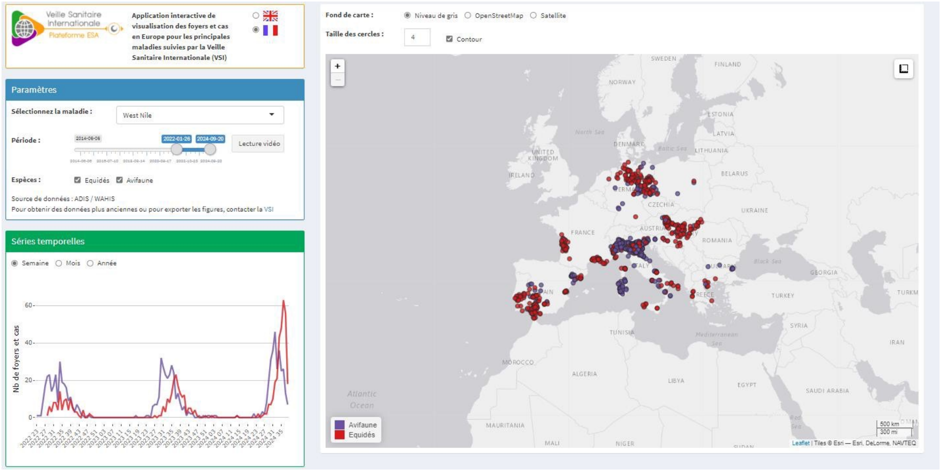
Le virus West Nile (WNV, ou virus du Nil Occidental) est un arbovirus transmis par les moustiques communs du genre *Culex* spp. La plupart des infections à WNV chez l'humain sont asymptomatiques ou d'expression bénigne (fièvre, courbatures, douleurs articulaires, éruption). Des formes neurologiques surviennent dans environ 1 % des cas et entraînent parfois des séquelles ou le décès. Les personnes immunodéprimées sont plus à risque de développer une forme grave.
La circulation du WNV est connue depuis les années 1960 en France (Camargue), époque à laquelle ont été détectés les premiers cas d'infection symptomatique chez l'humain et le cheval. Depuis, des épizooties sont régulièrement rapportées sur la façade méditerranéenne, plus particulièrement dans les départements du Gard, des Bouches-du-Rhône et du Var (région PACA).

En 2022 :
- De façon inattendue, trois cas équins d'infections symptomatiques à WNV ont été diagnostiqués en Gironde (région Nouvelle-Aquitaine).
- Dans un programme de recherche « One Health », un consortium scientifique interdisciplinaire et inter-institutionnel mobilisant un réseau d'acteurs régionaux et nationaux en santé vétérinaire, humaine et environnementale, a étudié la circulation du WNV et ses déterminants en Nouvelle-Aquitaine.
- Ce consortium a mené chez les chevaux une étude de séroprévalence qui a objectivé la circulation du WNV dans les territoires du Blayais et de la confluence Garonne-Dordogne.

En 2023 :
- Des cas humains d'infection à WNV ont été diagnostiqués au sein de la métropole bordelaise, incluant la ville de Bordeaux, à partir de la deuxième quinzaine de juillet.
- Un cas équin d'infection à WNV a été diagnostiqué au Nord de Bordeaux, sur la rive gauche de l'estuaire de la Gironde, début août.

Diseases treated:

- *Aethina tumida*
- African swine fever (ASF)
- Bovine tuberculosis (bTB)
- Capripox
- Highly Pathogenic Avian Influenza (HPAI)
- Lumpy Skin Disease(LSD)
- **West Nile Fever (WNF)**



List of diseases is evolving

Data available since 2014

Time series monitoring

Video monitoring of the spread

[Interactive Map]

Updated every two weeks or more (depending on current events)

Available in French and English versions

- Collaborative approach : active expert networks
- One Health approach when necessary: WN weekly reports produced in collaboration with animal health, wildlife, human health and vector sector
- Consolidated and interprated data publicly available
- More and more used in France (surveillance stakeholders, competent authority, journalists) and for other european countries

FIEVRE WEST NILE EN EUROPE

BAISSE DE L'INCIDENCE EN EUROPE

Les essentiels
• **Compartiment animal** : seize nouvelles déclarations en France dont une au sein de l'avifaune captive en Charente-Maritime. Nombreuses nouvelles déclarations en Europe dans les compartiments équins et avifaune sauvage, dont de nombreuses *a posteriori*. • **Compartiment humain** : Dix-neuf pays ont déclaré des cas depuis le début de cette saison (nouveau pays cette semaine : Chypre).

Section rédigée en collaboration avec le Cirad Guadeloupe, LNR West Nile, SpF, OFB, CNR arboviroses et le Respe.

Le Monde

Selon la plateforme ESA d'épidémiologie santé animale en Europe, 13 pays européens, dont la France, sont touchés par le virus H5N8 véhiculé par les oiseaux migrateurs. Le nombre total de foyers et de

Les MARCHÉS
Le média de l'alimentaire

Une situation alarmante selon la plateforme ESA

La plateforme Épidémiosurveillance en santé animale (ESA) interpelle sur une situation alarmante, « Un niveau record de détections d'IAHP H5N1 et de mortalités associées a été observé sur les oiseaux sauvages ». Les scientifiques évoquent une probable « endémisation de la maladie dans le compartiment sauvage sur le territoire national », ainsi

ADDED VALUE OF NAHSP : SPECIFIC TOOLS IMPLEMENTED FOR NAHSP EI

PADI - WEB

Platform for
Automated Extraction of
Animal Disease Information
from the Web

- Google news (> 400,000 articles collected since 2016)
- Search platform (by title, keyword, period, etc.)
- Retrieving articles in txt file
- Subscription to RSS feeds (disease and language keywords) email notifications +++

padi-web@cirad.fr

ADDED VALUE OF NAHSP : SPECIFIC TOOLS IMPLEMENTED FOR NAHSP EI

UTOPIA: User Tool for Outbreak Prevention and Introduction Assessment

When a foreign country declares the (re-)emergency of an animal disease, need to **assess if animals or products of animal origin potentially carrying this pathogen have been imported into France** to know if its an important signal to observe

Objective: Investigate trade movements declared in the regulatory European database **TRACES-NT**
Challenge: Complex data with laborious query procedures that make analysis time-consuming and possibly inaccurate

Two steps:

1) **characterization** of live animals and animal products imported from the diseased country over the period considered at risk
2) **filtering** of movements so that only those involving goods likely to contain the disease are retained

↓

Can be used for all diseases
Epidemiological characteristics saved for a dozen

SYNDROMIC BOVINE MORTALITY SURVEILLANCE SYSTEM: OMAR BOVINS

Omar
Observatoire de la mortalite des animaux de rente

- From a research project

Preventive Veterinary Medicine 105 (2012) 244–252

Contents lists available at SciVerse ScienceDirect

Preventive Veterinary Medicine

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

ELSEVIER

Assessment of the utility of routinely collected cattle census and disposal data for syndromic surveillance

Jean-Baptiste Perrin[a,b,*], Christian Ducrot[b], Jean-Luc Vinard[a], Eric Morignat[a], Didier Calavas[a], Pascal Hendrikx[c]

[a] *Unité Epidémiologie, Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Anses), 31, avenue Tony Garnier, F69364 Lyon Cedex 07, France*
[b] *Unité d'épidémiologie animale, UR346, INRA, 63122 St Genès Champanelle, France*
[c] *Direction scientifique des laboratoires, Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Anses) 27-31 avenue du général Leclerc F-94701 Maisons-Alfort Cedex, France*

Omar
Observatoire de la mortalite des animaux de rente

Plateforme ESA

- To a concrete syndromic surveillance system for animal health emerging detection with the support of NAHSP

frontiers in Veterinary Science

ORIGINAL RESEARCH
published: 09 January 2020
doi: 10.3389/fvets.2019.00453

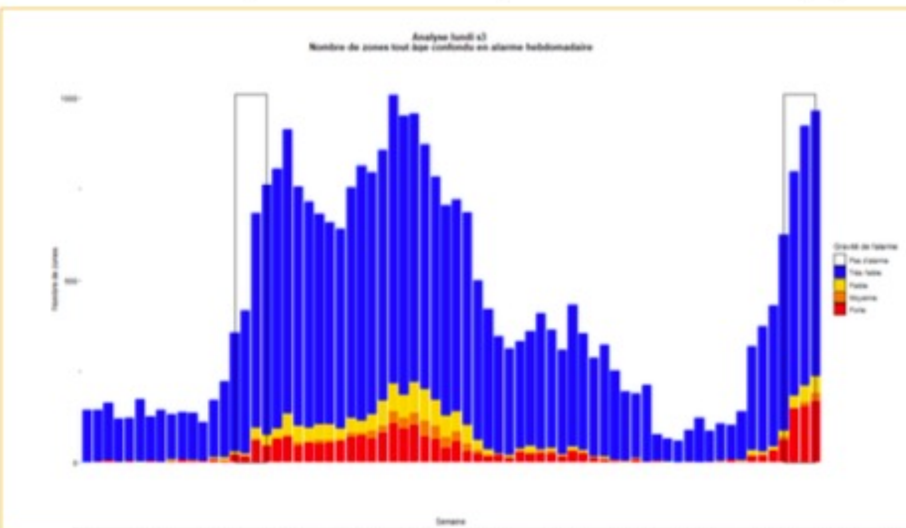
Designing a Syndromic Bovine Mortality Surveillance System: Lessons Learned From the 1-Year Test of the French OMAR Alert Tool

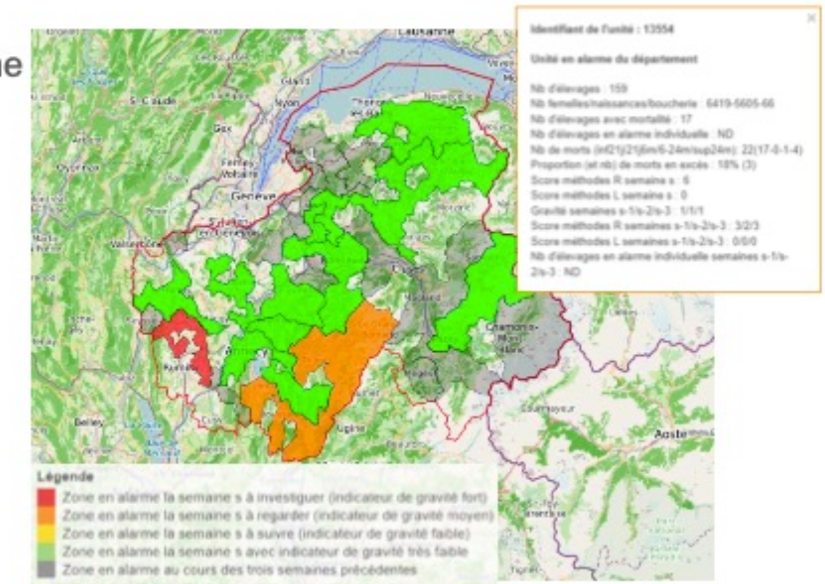
Carole Sala[1*†], Jean-Luc Vinard[1], Fanny Pandolfi[2†], Yves Lambert[3†], Didier Calavas[1†], Céline Dupuy[1†], Emmanuel Garin[4†] and Anne Touratier[4†]

[1] Epidemiology and Support to Surveillance Unit, University of Lyon-ANSES Lyon, French Agency for Food, Environmental and Occupational Health & Safety (ANSES), Lyon, France, [2] National Technical Grouping of Vets Association (SNGTV), Paris, France, [3] Ministry of Agriculture, Directorate General for Food (DGAL), Paris, France, [4] National Federation of Farmers' Animal Health Services (GDS France), Paris, France

SYNDROMIC SURVEILLANCE

- Automated weekly analysis of the number of cattle deaths within spatial units (>11,000 for France)
- Based on fallen stock data
- 5 detection algorithms with seven detection limits for each one → four categories of severity of excess mortality (alarm)





RETROSPECTIVE ANALYSIS

- Use Omar tools to describe bovine mortality in departements where BTV and EHD occurred

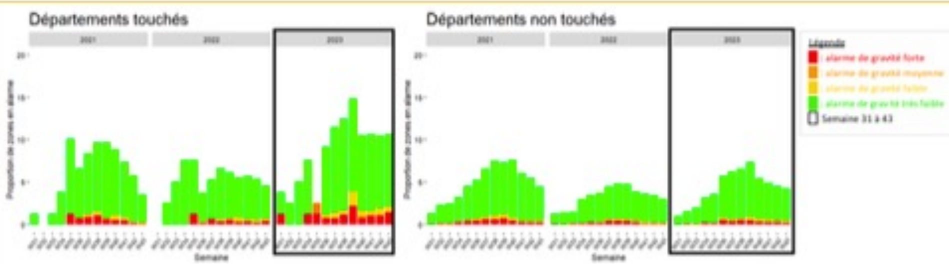


Figure 2 : Proportion de zones en alarme dans les départements touchés et non touchés par la FCO et la MHE (inclusion au fur et à mesure que le département est considéré comme touché) sur la période d'août-septembre-octobre sur les trois dernières années

4. Conclusion

D'après les éléments du présent rapport, nous observons une différence au niveau des alarmes statistiques entre les départements atteints par la FCO et/ou la MHE et ceux non touchés notamment pour les bovins de 6-24 mois et de plus de 24 mois avec plus de zones en alarme et des niveaux de mortalité plus élevées dans les départements touchés. **Ainsi, la mortalité globale observée sur les mois de septembre-octobre 2023 dans les départements touchés par la FCO et/ou la MHE est plus importante que celle observée dans les départements non touchés.** Cette mortalité est également plus importante que celle observé dans les départements touchés et les départements non touchés lors des deux années précédentes. Les résultats pour les bovins de 6-24 mois et de plus de 2 ans présentent une surmortalité sur les mois de septembre-octobre 2023 dans les départements touchés.

20240209_SYNTHESE_EXPERTISE_MORTALITE_0.PDF

ADDED VALUE OF NAHSP APPROACH FOR THIS SURVEILLANCE SYSTEM

- From research to operational system
- Innovative approach when implemented
- Detection of abnormal mortality, investigation and conclusion based on the tryptique : local competent authority, GDS, GTV
- Used for other purposes: several tools implemented

CHALLENGES

- Human ressources for development and maintenance
- Human ressources for investigation at local level: used in 9 départements
- Human ressources for investigation at national level: pilot during summer 2024
- Data quality and timeliness of data collection/transmission
- Convince to obtain sustainable financial support

From Omar V1 to Omar V2

SUPPORT FOR SURVEILLANCE PROTOCOL

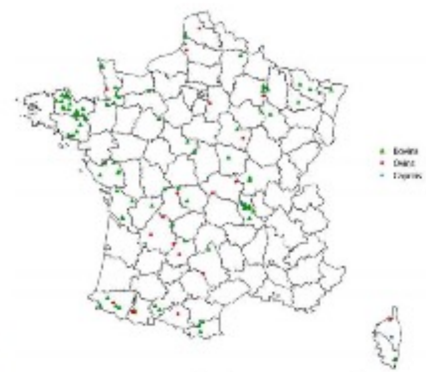
SCHMALLENBERG VIRUS

FROM AN EMERGENCE IN FOREIGN COUNTRY TO DEDICATED SURVEILLANCE

- Emergence of new virus in northern Europe in late 2011: Schmallenberg virus (SBV)
- Anticipation with creation of a NAHSP working group
  - Proposition of a surveillance protocol to detect the potential introduction of SBV into France
  - Implementation of the protocol
  - Analysis of surveillance data: detection of the first case in France and follow up reports

Saison I (du 04/01/2012 au 31/08/2012)
n=2 976 élevages

Saison II (du 01/09/2012 au 31/08/2013)
n= 1 824 élevages



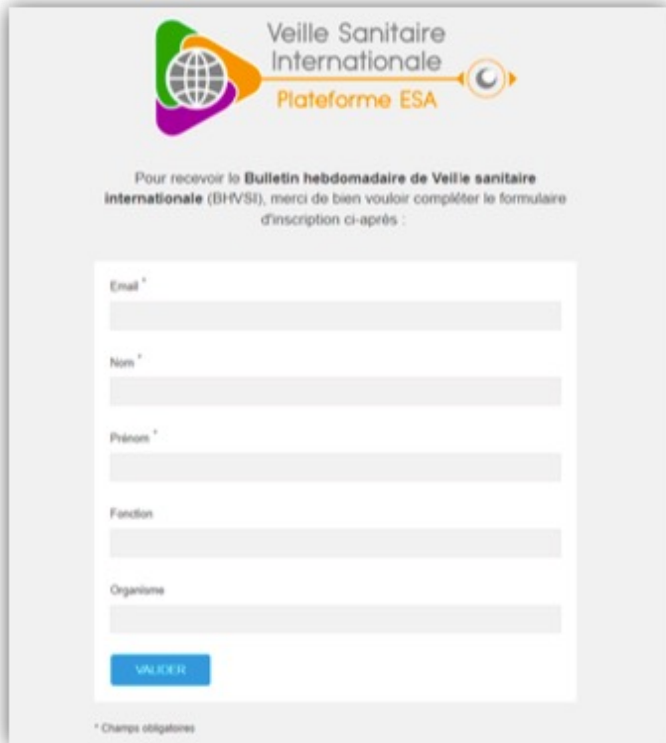
Saison III (du 1/09/2013 au 31/08/2014)
n= 110 élevages

Saison IV (du 1/09/2014 au 31/08/2015)
n= 10 élevages

NAHSP ADDED VALUE

- Capacity to anticipate
- Reactivity
- From co-construction of surveillance protocol to implementation, data analysis and interpretation

SUBSCRIBE TO THE NEWSLETTER OF NAHSP EPIDEMIC INTELLIGENCE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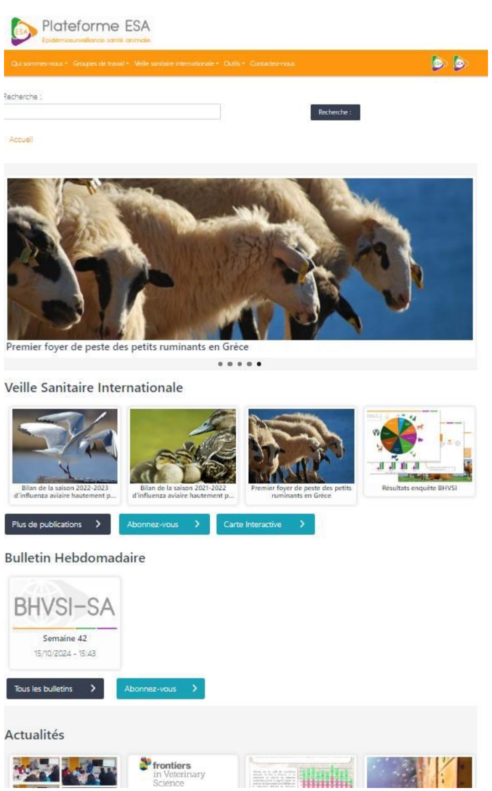

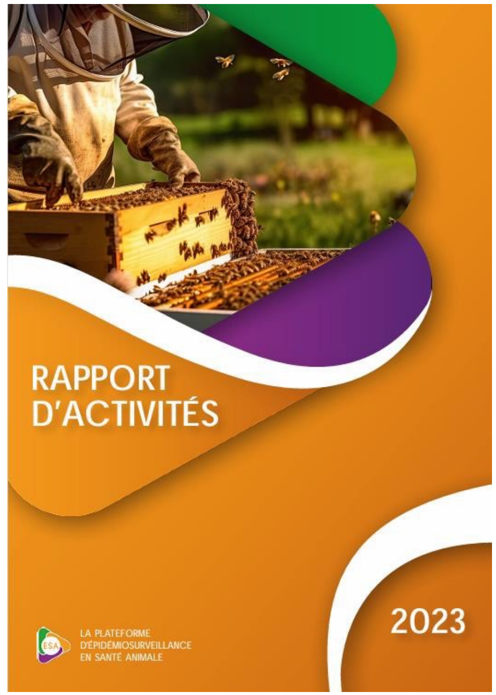

Annual report

frontiers | Frontiers in Veterinary Science

TYPE Community Case Study
PUBLISHED 21 August 2024
DOI 10.3389/fvets.2024.1249925

Check for updates

OPEN ACCESS

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The French National Animal Health Surveillance Platform: an innovative, cross-sector collaboration to improve surveillance system efficiency in France and a tangible example of the One Health approach

Céline Dupuy[1*], Célia Locquet[2], Christophe Brard[3], Laure Dommergues[4], Eva Faure[5], Kristel Gache[6], Renaud Lancelot[7,8], Alexandra Mailles[9], Justine Marchand[4], Ariane Payne[10], Anne Touratier[6], Aurèle Valognes[11] and Sophie Carles[12]

[1]University of Lyon – French Agency for Food, Environmental and Occupational Health and Safety (ANSES), Laboratory of Lyon, Epidemiology and Support to Surveillance Unit, Lyon, France, [2]French Ministry of Agriculture, Paris, France, [3]Société Nationale des Groupements Techniques Vétérinaires (SNGTV), Paris, France, [4]La Coopération Agricole, Paris, France, [5]French Hunters' Federation (FNC), Issy-les-Moulineaux, France, [6]GDS France, Paris, France, [7]The French Agricultural Research and International Cooperation Organization (CIRAD), UMR Animal, Sante, Territoires, Risques, et Ecosystemes, Sainte-Clothilde, France, [8]Animal, Sante, Territoires, Risques, et Ecosystemes, University of Montpellier, CIRAD, INRAE, Montpellier, France, [9]Santé Publique France, Saint-Maurice, France, [10]French Biodiversity Office, Paris, France, [11]Association of French Managers of Public Veterinary Analysis Laboratories (ADILVA), Paris, France, [12]French National Research Institute for Agriculture, Food and Environment (INRAE), Marcy-l'Étoile, France

The French National Animal Health Surveillance Platform (NAHSP) was created in 2011. This network of animal health stakeholders was set up to improve surveillance efficiency for all health risks that threaten animal health, as well as zoonoses affecting human health. The NAHSP steering committee decides on the strategies and program of activities. It is composed of 11 institutions from both public and private sectors (policy-makers, scientific institutions, and representatives of farmers, veterinarians, hunters, and laboratories). A

https://www.frontiersin.org/journals/veterinary-science/articles/10.3389/fvets.2024.1249925/full

MERCI POUR VOTRE ATTENTION

Day 1: Preparedness and response to emerging arboviruses.

Round table: Global Health - how animal health experience can shed light on the public health situation?

With Gilles Salvat
Kristel Gache
Sylvie Lecollinet
Claire Garros

Merci d'avoir suivi cette première journée !

3ème colloque scientifique du réseau Arbo-France

24-25 octobre 2023, Institut Pasteur - Paris

Arbo-France
Réseau Français d'étude des arboviroses

Bienvenue !

3ème colloque scientifique du réseau Arbo-France

24-25 octobre 2023, Institut Pasteur - Paris

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Arbo-France
Réseau Français d'étude des arboviroses

INSTITUT PASTEUR

Day 2: Application to Tick-Borne Virus infections

Circulation of Tick-Borne Viruses

By Patricia Nuttall

Circulation of Tick-borne Viruses

Pat Nuttall

Emeritus Professor of Arbovirology

Arbo-France
Institut Pasteur
24-25th October 2024

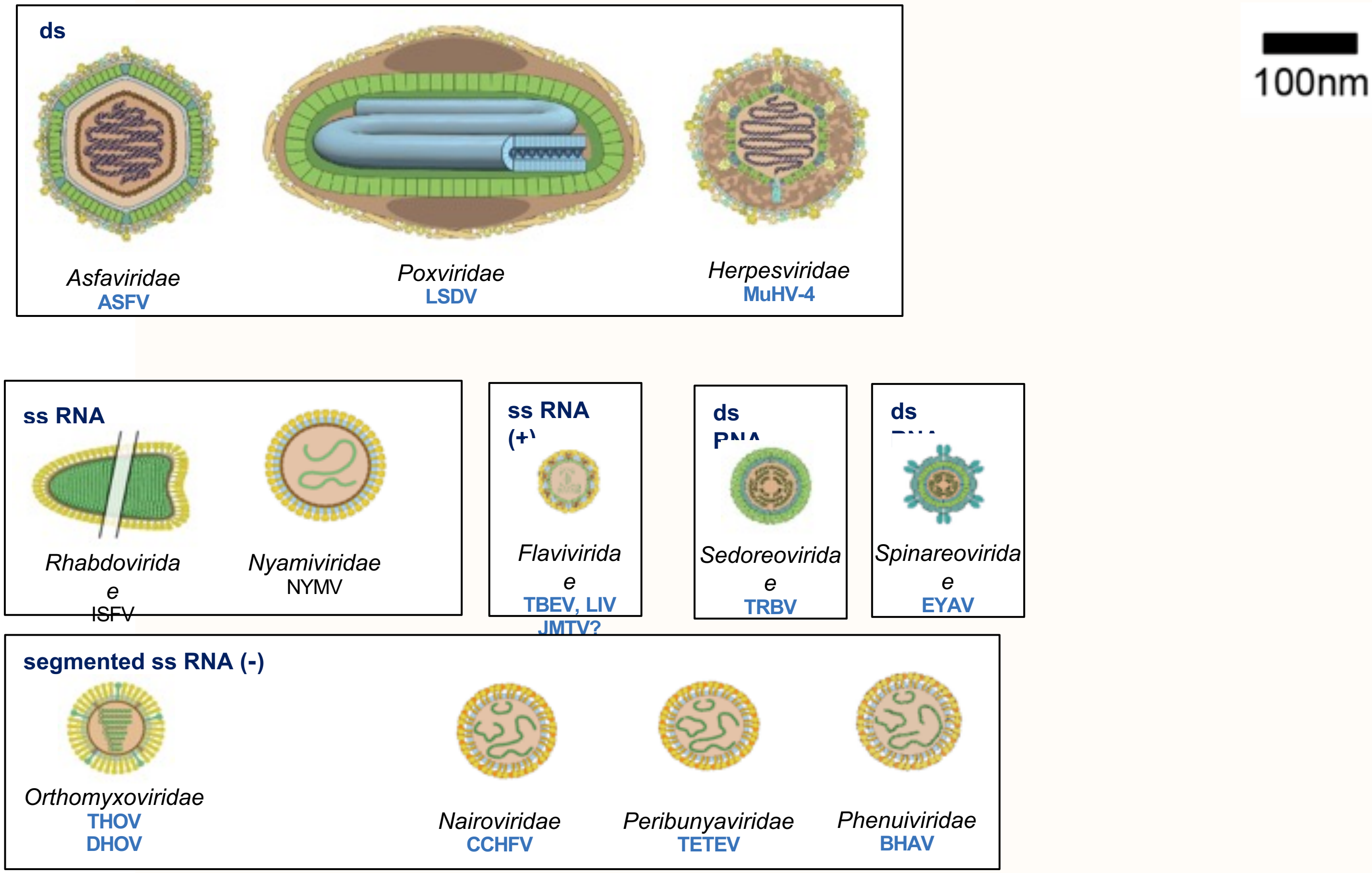
Department of
BIOLOGY

UNIVERSITY OF
OXFORD

Aspects to cover

- Diversity of tick-borne viruses
- Tick-borne transmission cycle and infection of the tick vector
- Vector competence
- Non-viraemic transmission

- Lessons for surveillance



Virus families containing tick-borne viruses

- incubation period 2-9 days: fever, aches
- haemorrhagic state (in >75% of patients) after 3-5 days
- ...massive bleeding, multi-organ failure, cardiac arrest
- death ~day 7-9 or recovery
- treatment by supportive care, ribavirin
- prior exposure may offer protection
- fatal disease usually lacks detectable antibody; antibody not predictive of recovery

courtesy of Roger Hewson, 2014

UK Health Security Agency

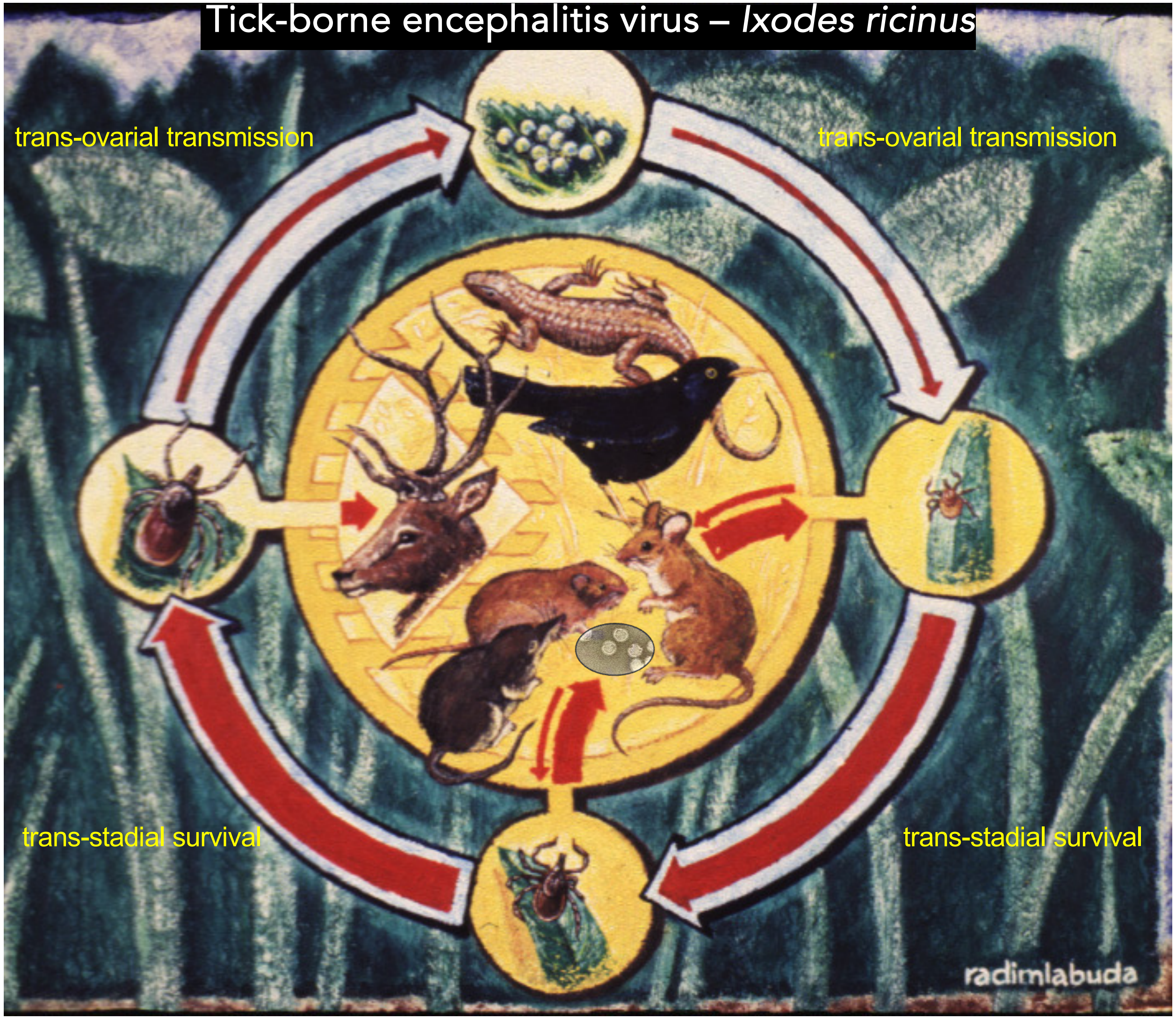
Crimean-Congo haemorrhagic fever

Tick vector species:

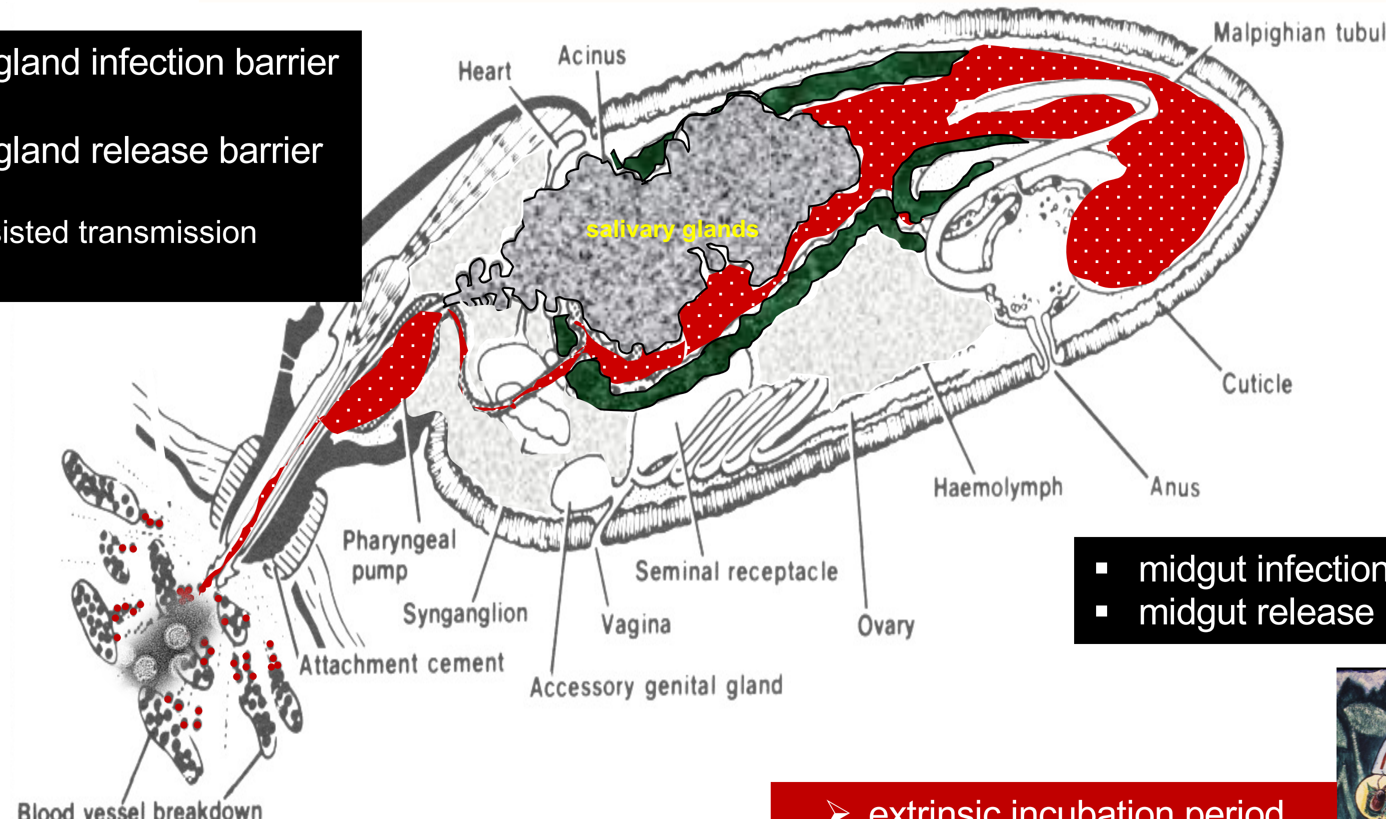
Ixodes ricinus
Ixodes persulcatus

Dermacentor reticulatus

Tick-borne encephalitis virus


Tick-borne encephalitis virus – *Ixodes ricinus*
trans-ovarial transmission
trans-ovarial transmission
trans-stadial survival
trans-stadial survival
radimlabuda

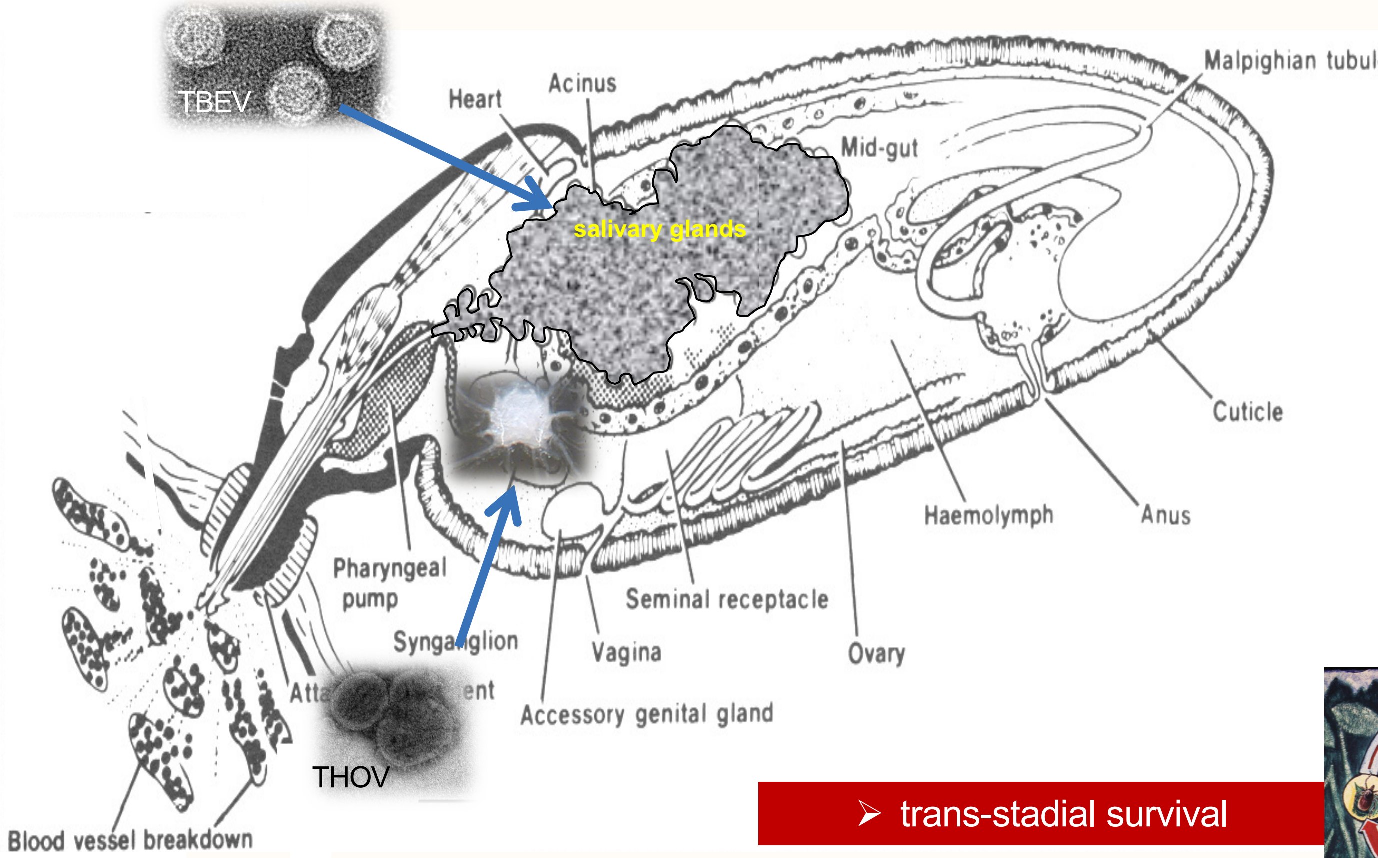
- salivary gland infection barrier ?
- salivary gland release barrier ?
- saliva-assisted transmission factors



- midgut infection barrier
- midgut release barrier

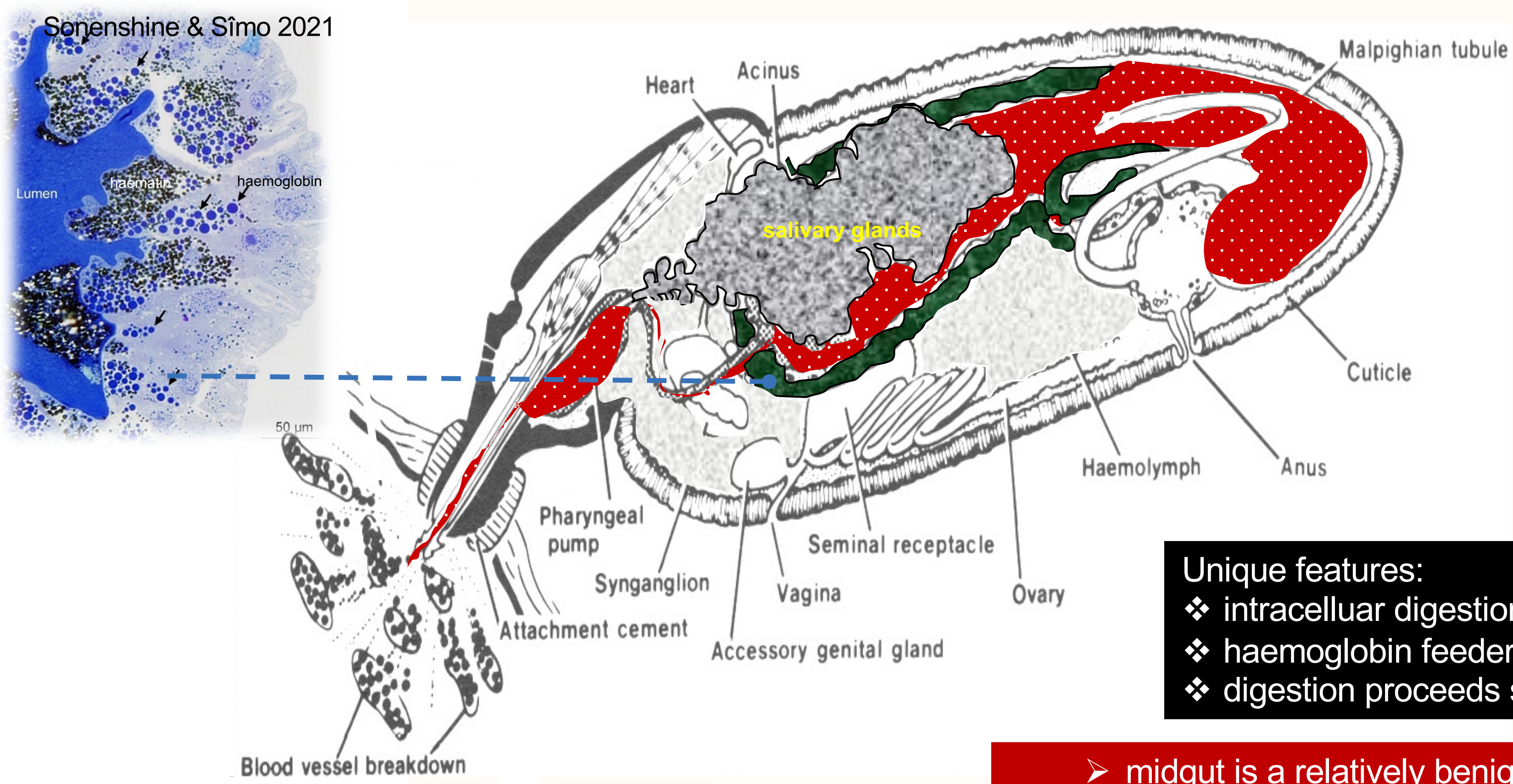
➢ extrinsic incubation period

Tick vector competence for arboviruses



➢ trans-stadial survival

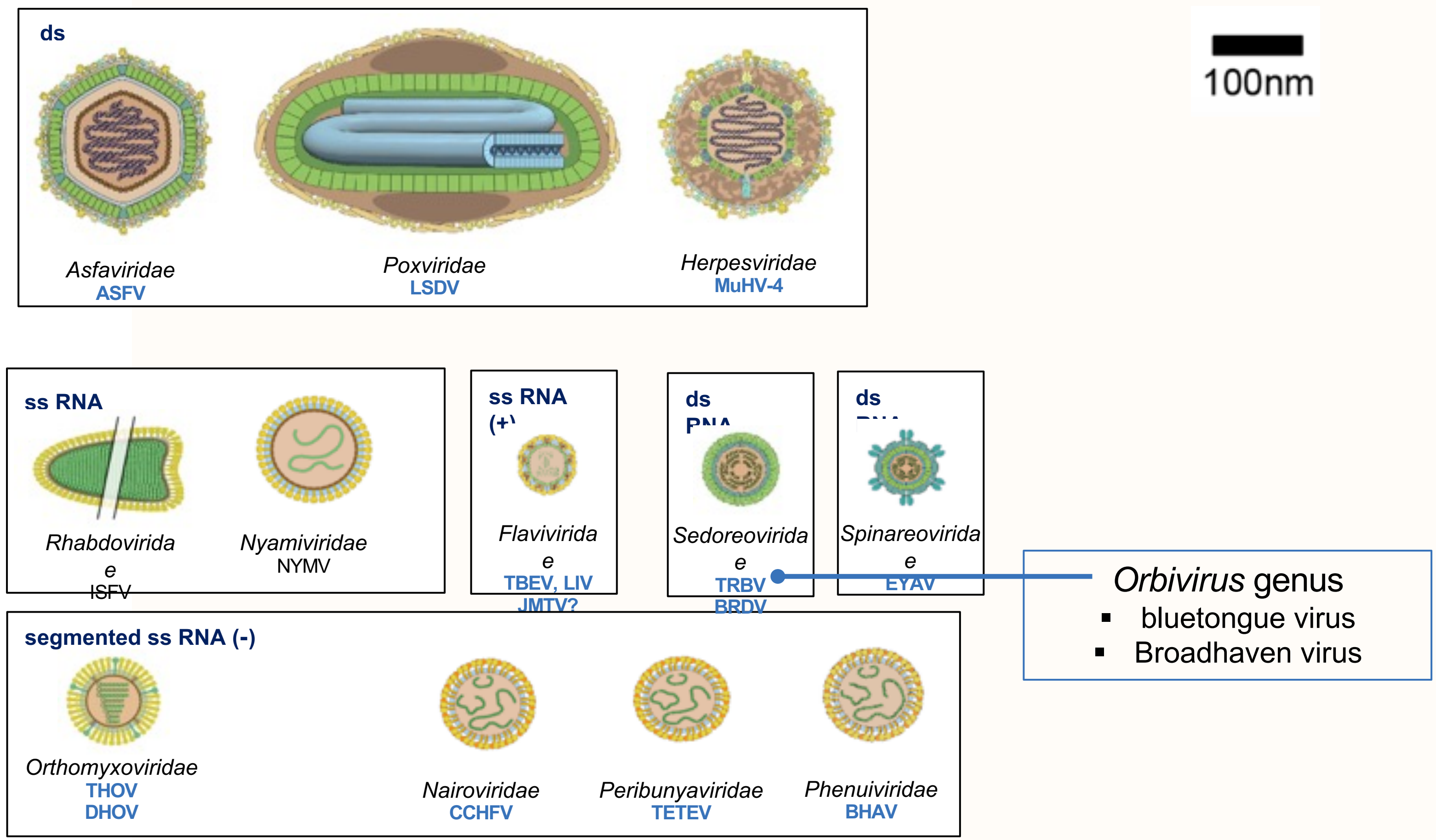
Tick vector competence for arboviruses



Unique features:
- intracelluar digestion
- haemoglobin feeders
- digestion proceeds slowly

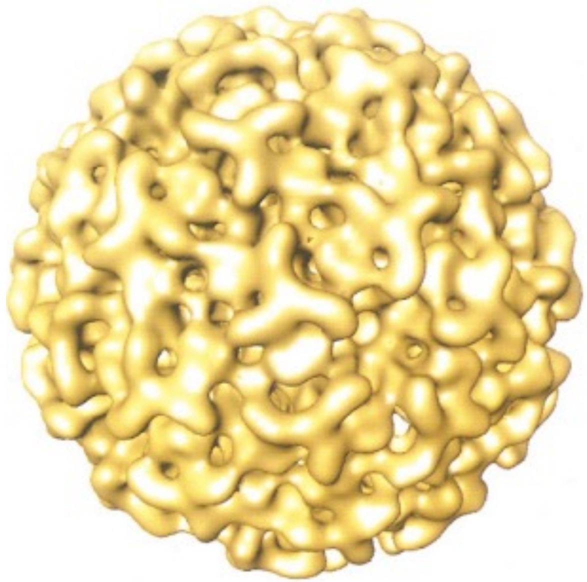
➢ midgut is a relatively benign environment

Ticks as arbovirus vectors

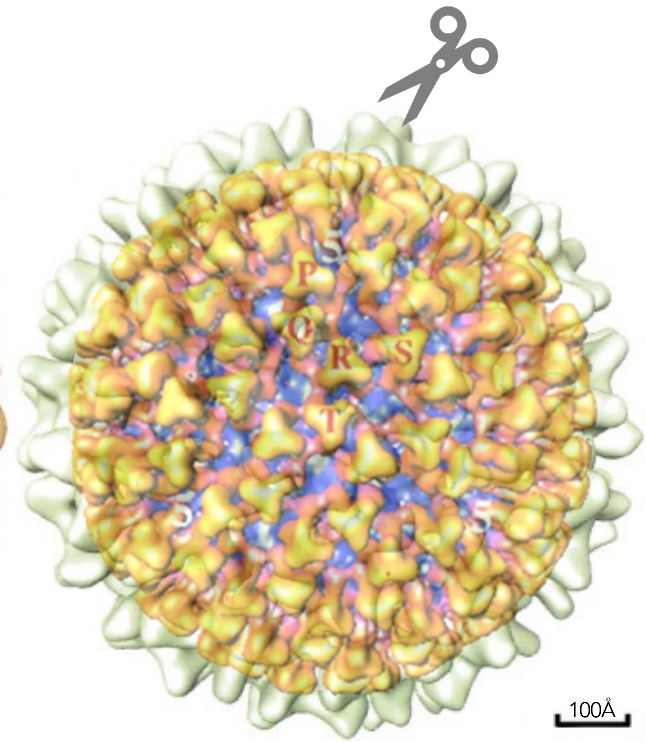


Comparison of tick-borne and insect-borne viruses

Ixodes uriae



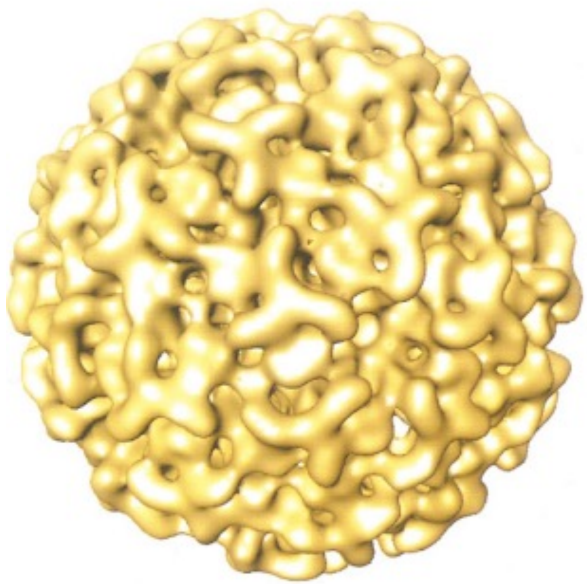
Tick-borne orbivirus
(Broadhaven virus)



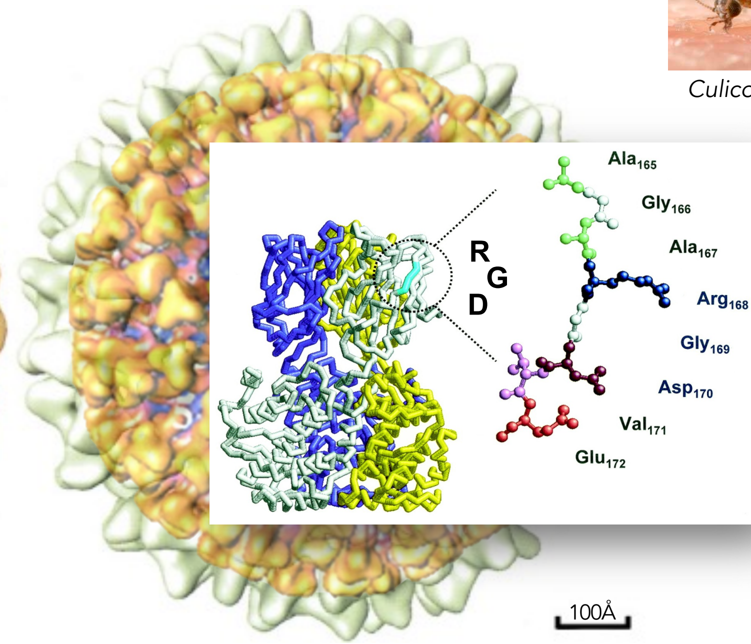
Insect-borne orbivirus
(bluetongue virus)

Culicoides midges (gnats)

Ixodes uriae



Tick-borne orbivirus
(Broadhaven virus)



Insect-borne orbivirus
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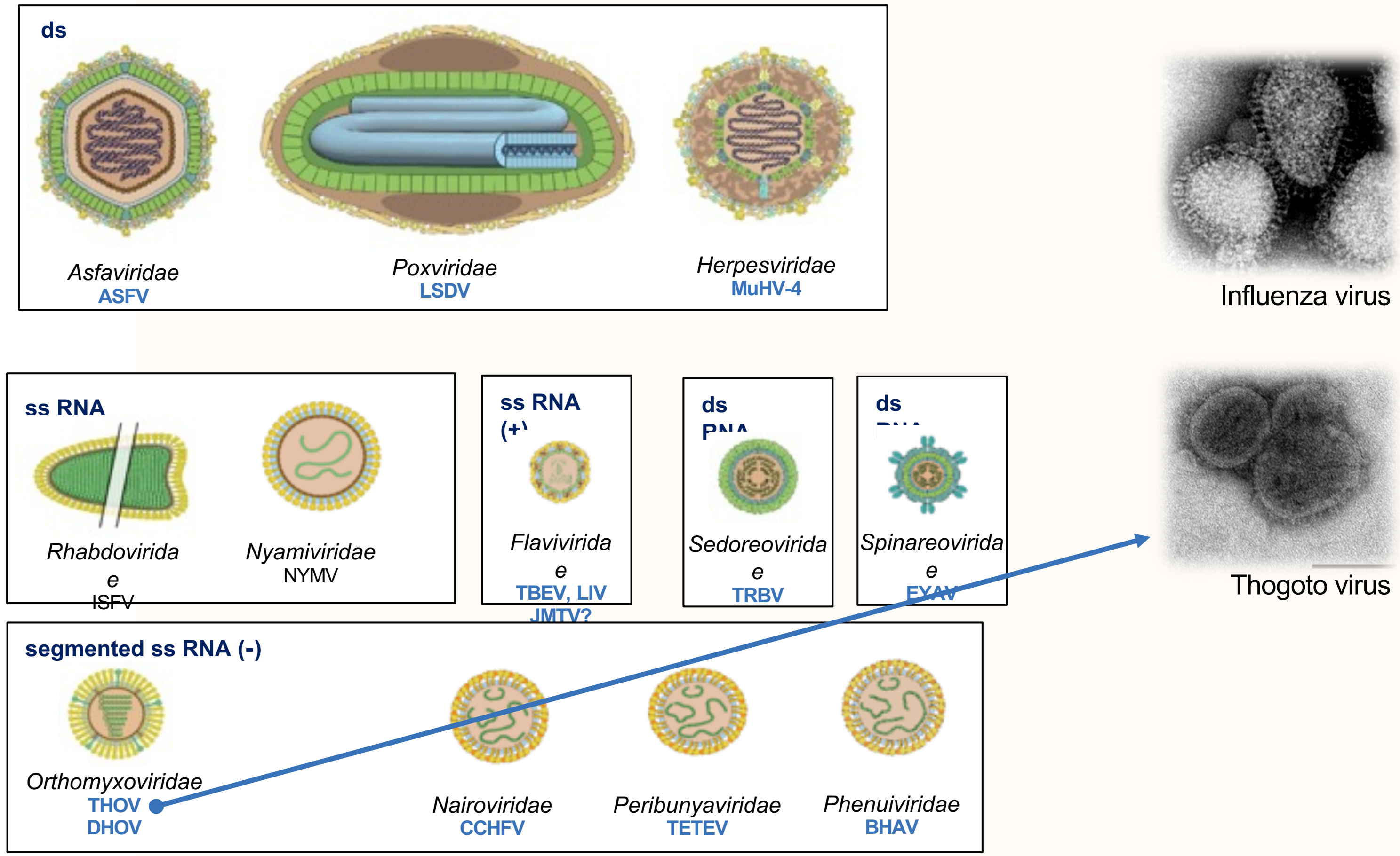
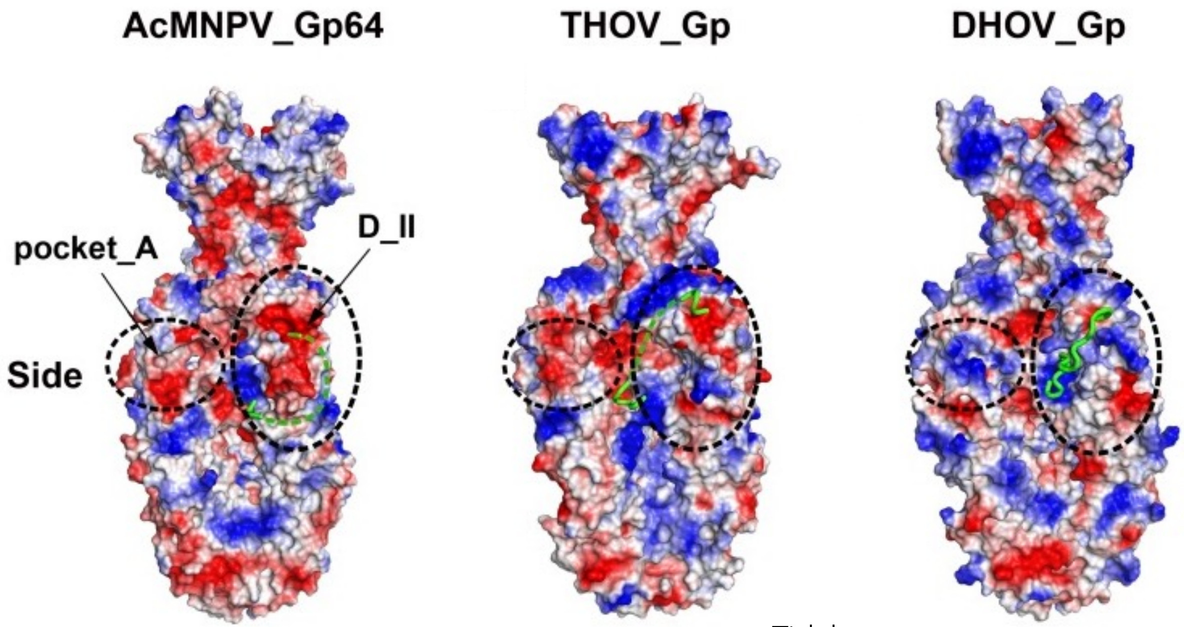


Virus families containing tick-borne viruses

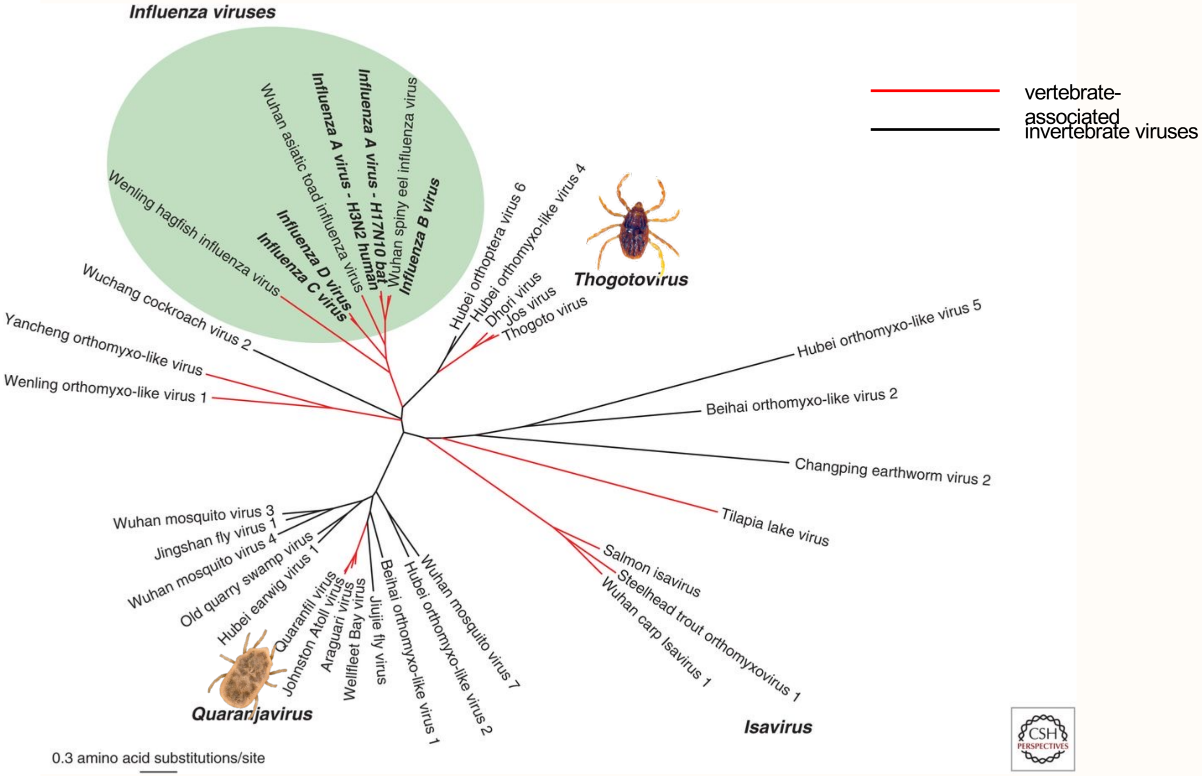
Gp – surface glycoprotein



Baculovirus

Tick-borne
orthomyxoviruses

Evolutionary relationships among the orthomyxo-like viruses revealing the position of the vertebrate-associated influenza viruses (shaded green).



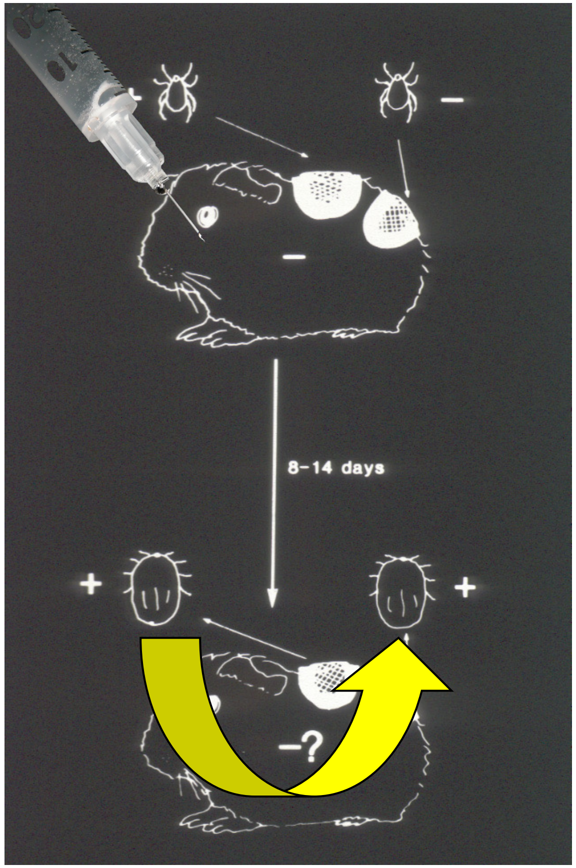
Michelle Wille, and Edward C. Holmes Cold Spring Harb Perspect Med 2020;10:a038489

Arboviruses are viruses that are maintained in nature principally, or to an important extent, through biological transmission between susceptible vertebrate hosts by haematophagous arthropods or through transovarian and possibly venereal transmission in arthropods:

- the viruses multiply and produce viraemia in the vertebrates,
- multiply in the tissues of arthropods,
- and are passed on to new vertebrates by the bites of arthropods after a period of extrinsic incubation.

Original definition of arboviruses

World Health Organization Technical Report Series 719; WHO, Geneva, 1985




SCIENCE

Reprint Series
14 August 1987, Volume 237, pp. 775–777

A Novel Mode of Arbovirus Transmission Involving a Nonviremic Host

LINDA D. JONES, CLIVE R. DAVIES, GORDON M. STEELE, AND PATRICIA A. NUTTALL

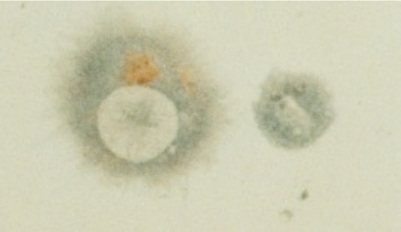
➢ saliva-assisted transmission

VIROLOGY 219, 357–366 (1996)
ARTICLE NO. 0261

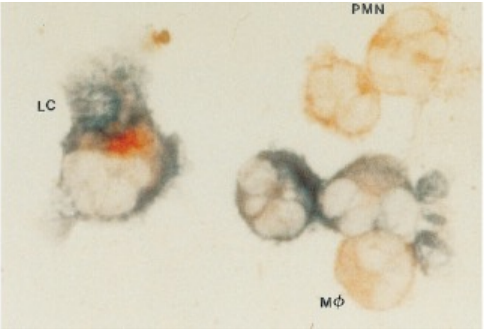
Importance of Localized Skin Infection in Tick-Borne Encephalitis Virus Transmission

MILAN LABUDA,* JONATHAN M. AUSTYN,† EVA ZUFFOVA,* OTO KOZUCH,‡ NORBERT FUCHSBERGER,‡ JAN LYSY,* and PATRICIA A. NUTTALL§,[1]

*Institute of Zoology and ‡Institute of Virology, Slovak Academy of Sciences, 842 46 Bratislava, Slovakia; †Nuffield Department of Surgery, University of Oxford, John Radcliffe Hospital, Oxford OX3 9DU, United Kingdom; and §NERC Institute of Virology and Environmental Microbiology, Oxford OX1 3SR, United Kingdom

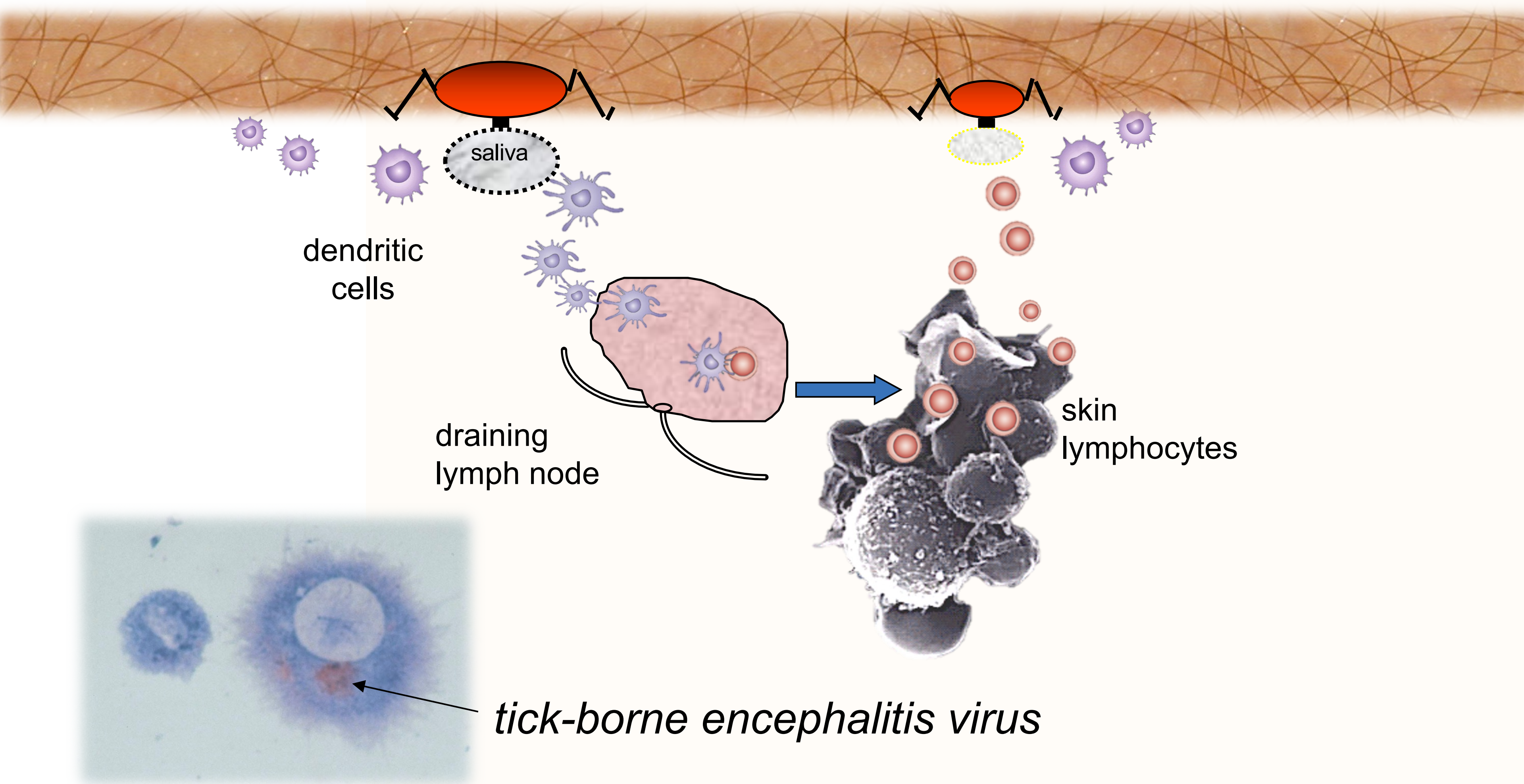


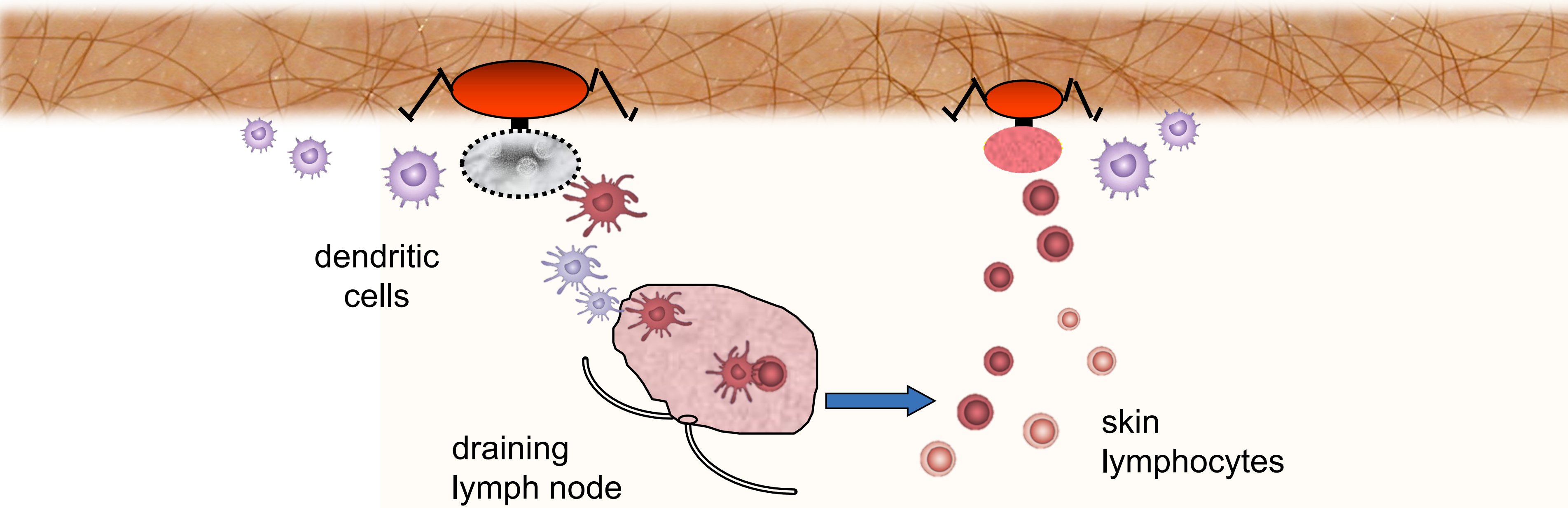
In vitro



In vivo

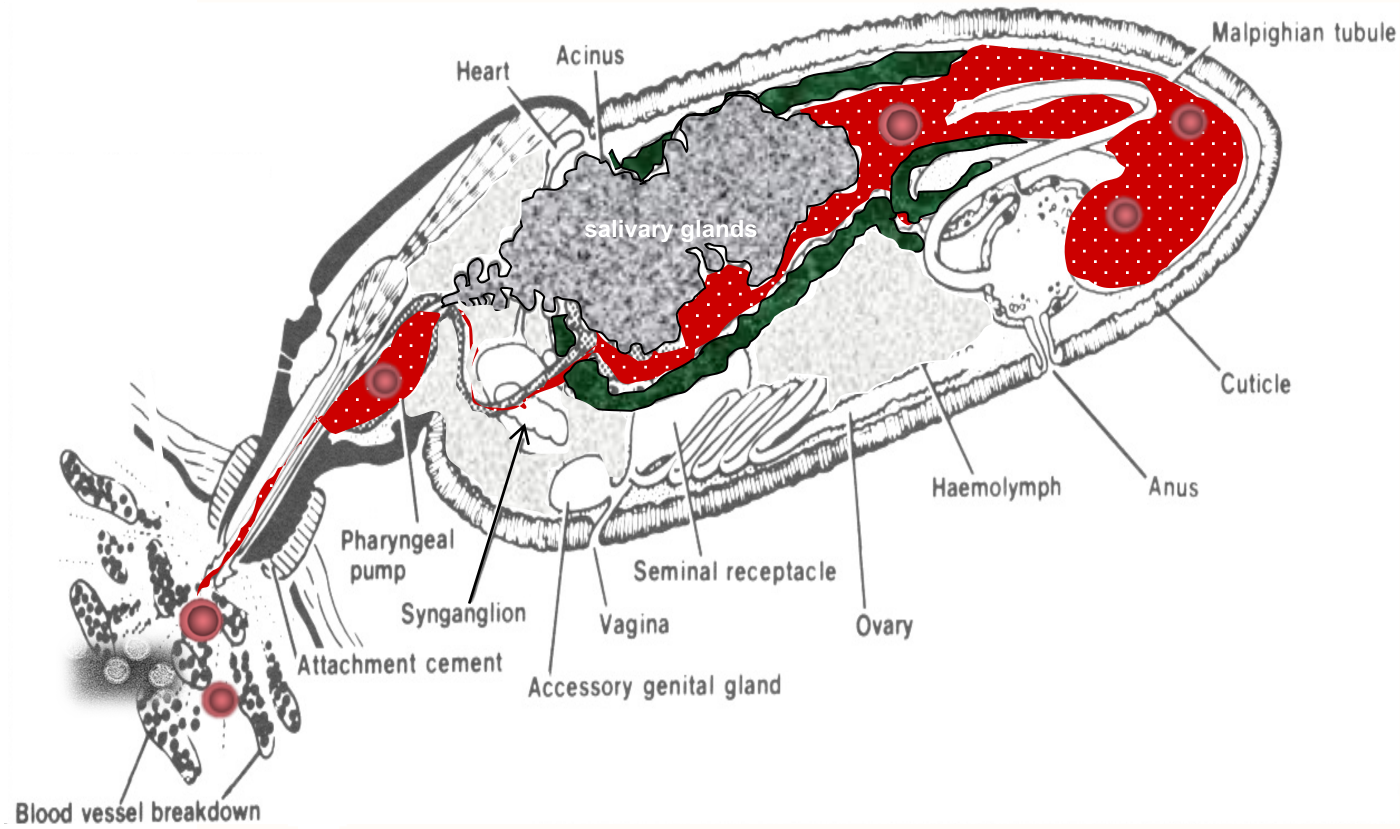
➢ tick-borne encephalitis virus infects Langerhans cells


saliva
dendritic cells
draining lymph node
skin lymphocytes
tick-borne encephalitis virus



➢ Model of ‘non-viraemic’ transmission: Red Herring hypothesis

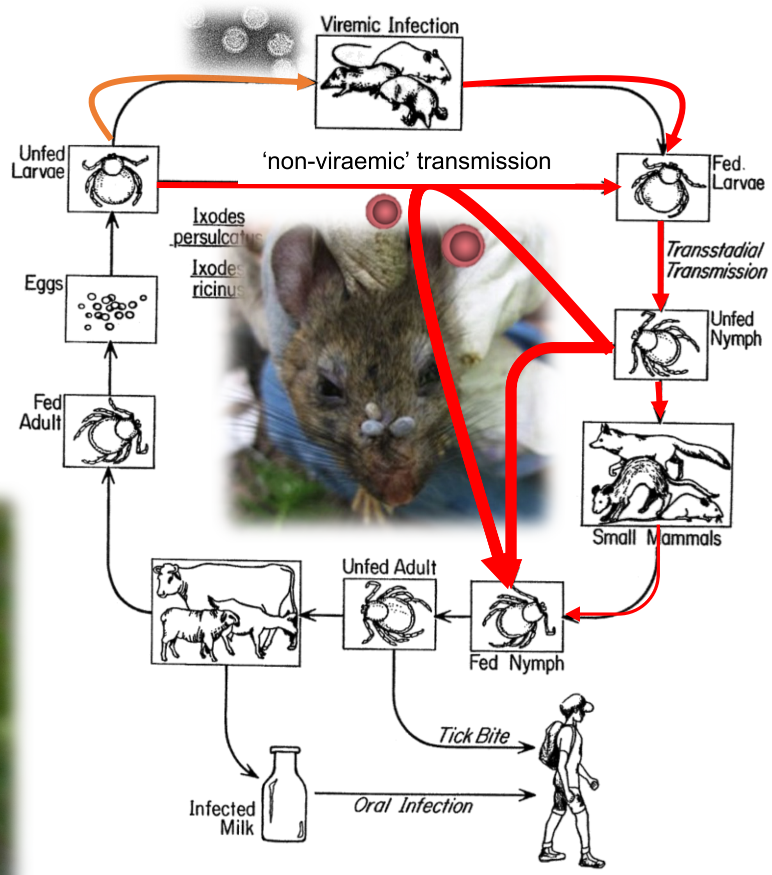
c’est un faux-fuyant



➢ ticks feed on infected cells

What does ‘non-viraemic’ transmission mean for the circulation of tick-borne viruses?

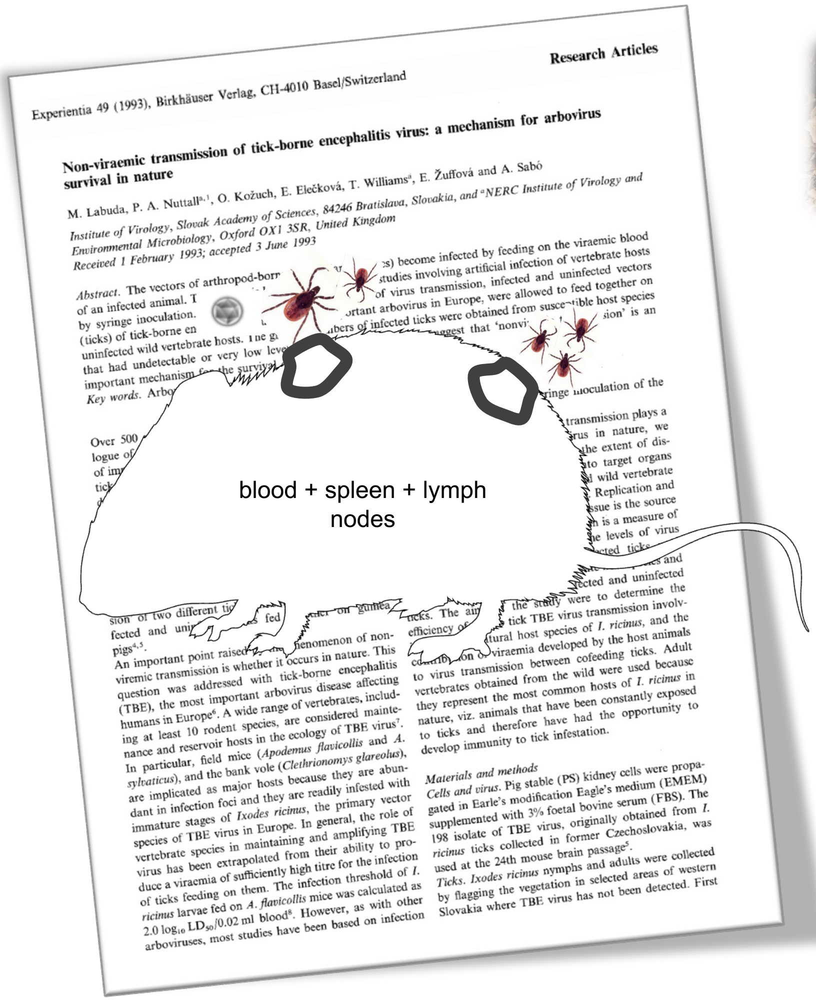
hosts of
‘non-viraemic transmission?



Circulation of tick-borne encephalitis virus

Phasianus colchicus

Erinaceus europaeus



Experientia 49 (1993), Birkhäuser Verlag, CH-4010 Basel/Switzerland
Research Articles

Non-viraemic transmission of tick-borne encephalitis virus: a mechanism for arbovirus survival in nature

M. Labuda, P. A. Nuttall[a,1], O. Kožuch, E. Elečková, T. Williams[a], E. Žuffová and A. Sabó

Institute of Virology, Slovak Academy of Sciences, 84246 Bratislava, Slovakia, and [a]NERC Institute of Virology and Environmental Microbiology, Oxford OX1 3SR, United Kingdom

Received 1 February 1993; accepted 3 June 1993

Abstract. The vectors of arthropod-born … s) become infected by feeding on the viraemic blood
of an infected animal. T … studies involving artificial infection of vertebrate hosts
by syringe inoculation. … of virus transmission, infected and uninfected vectors
(ticks) of tick-borne en … ortant arbovirus in Europe, were allowed to feed together on
uninfected wild vertebrate hosts. The g … bers of infected ticks were obtained from susceptible host species
that had undetectable or very low leve … ggest that 'nonvi … sion' is an
important mechanism for the surviva …
Key words. Arbo … ringe inoculation of the

Over 500 … transmission plays a
logue of … rus in nature, we
of im … the extent of dis-
tick … to target organs
… l wild vertebrate
… Replication and
… ssue is the source
… h is a measure of
… he levels of virus
… cted ticks
… es and
… ected and uninfected
… the study were to determine the
sion of two different tic … fed … on guinea … ticks. The aim … tick TBE virus transmission involv-
fected and uni … efficiency of … tural host species of *I. ricinus*, and the
pigs[4,5]. … viraemia developed by the host animals

An important point raised … phenomenon of non-viremic transmission is whether it occurs in nature. This question was addressed with tick-borne encephalitis (TBE), the most important arbovirus disease affecting humans in Europe[6]. A wide range of vertebrates, including at least 10 rodent species, are considered maintenance and reservoir hosts in the ecology of TBE virus[7]. In particular, field mice (*Apodemus flavicollis* and *A. sylvaticus*), and the bank vole (*Clethrionomys glareolus*), are implicated as major hosts because they are abundant in infection foci and they are readily infested with immature stages of *Ixodes ricinus*, the primary vector species of TBE virus in Europe. In general, the role of vertebrate species in maintaining and amplifying TBE virus has been extrapolated from their ability to produce a viraemia of sufficiently high titre for the infection of ticks feeding on them. The infection threshold of *I. ricinus* larvae fed on *A. flavicollis* mice was calculated as 2.0 $\log_{10}$ LD_{50}/0.02 ml blood[8]. However, as with other arboviruses, most studies have been based on infection

co … on of viraemia developed by the host animals … cofeeding ticks. Adult
to virus transmission between cofeeding ticks. Adult vertebrates obtained from the wild were used because they represent the most common hosts of *I. ricinus* in nature, viz. animals that have been constantly exposed to ticks and therefore have had the opportunity to develop immunity to tick infestation.

Materials and methods

Cells and virus. Pig stable (PS) kidney cells were propagated in Earle's modification Eagle's medium (EMEM) supplemented with 3% foetal bovine serum (FBS). The 198 isolate of TBE virus, originally obtained from *I. ricinus* ticks collected in former Czechoslovakia, was used at the 24th mouse brain passage[5].

Ticks. *Ixodes ricinus* nymphs and adults were collected by flagging the vegetation in selected areas of western Slovakia where TBE virus has not been detected. First

Apodemus
flavicollis
Apodemus agarius

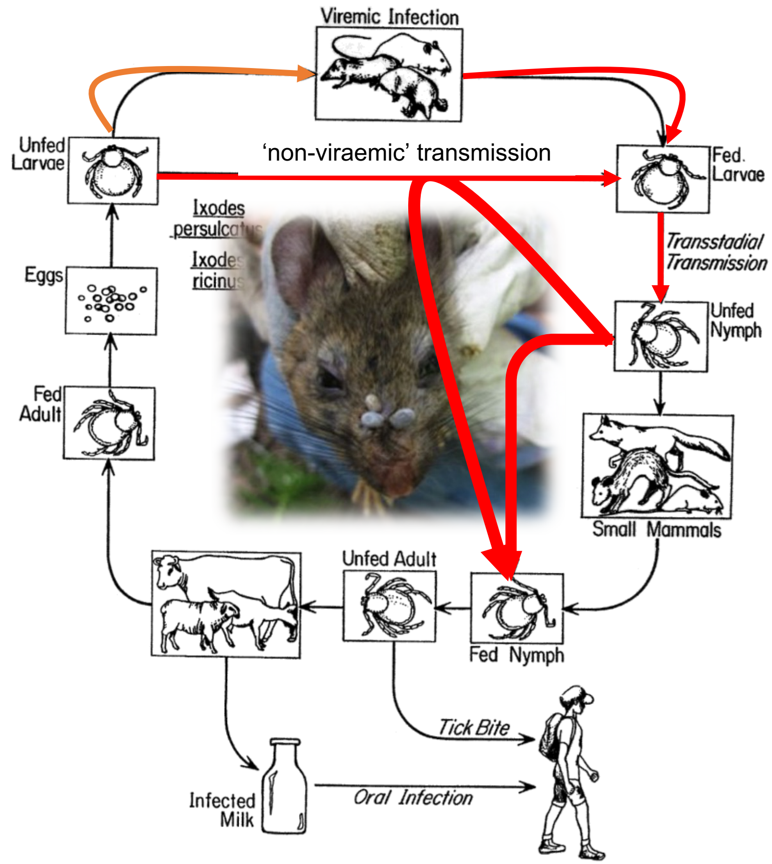
Myodes glareolus

Microtus subterraneus

Circulation of tick-borne encephalitis virus

Phasianus colchicus

Erinaceus europaeus



Apodemus flavicollis
Apodemus agarius

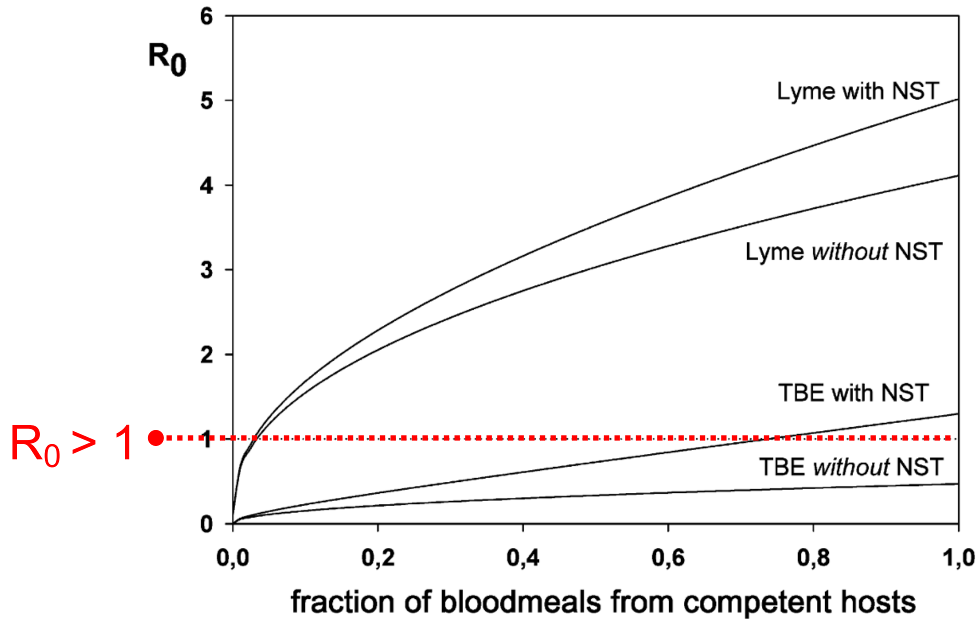
Myodes glareolus

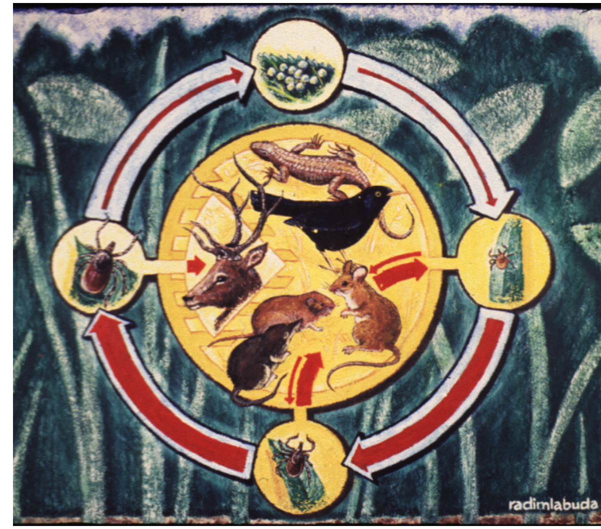
Microtus subterraneus

Circulation of tick-borne encephalitis virus

R_0 basic reproduction number

Hartemink *et al* 2008

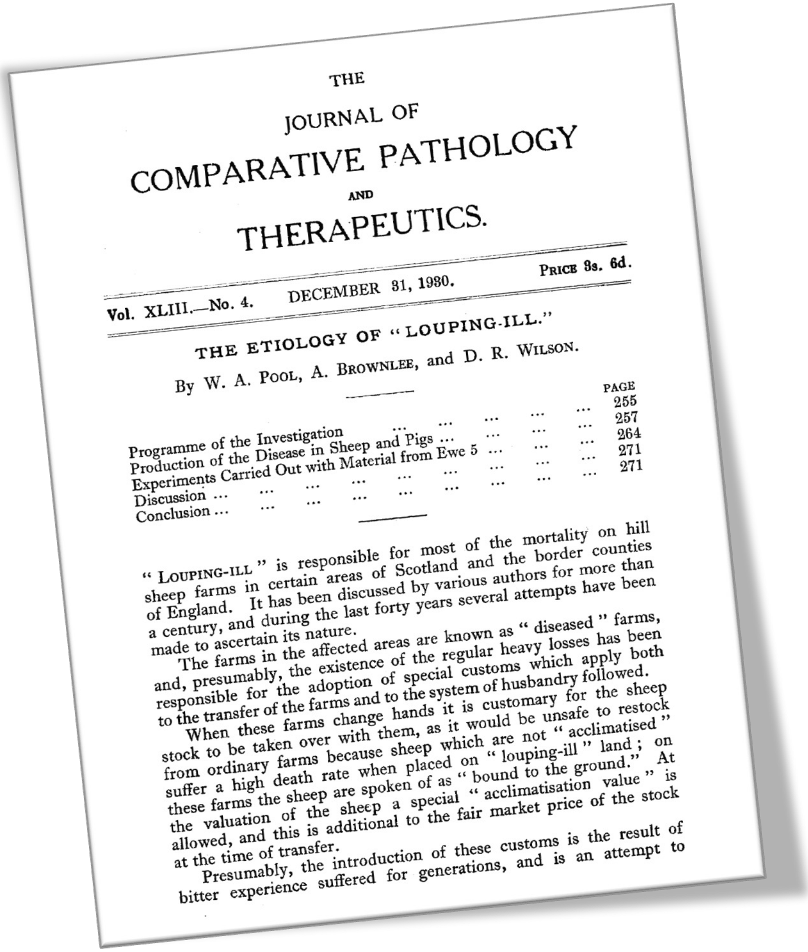




larvae & nymphs: synchronous seasonal feeding activity

Circulation of tick-borne encephalitis virus and *Borrelia burgdorferi*

(next generation matrix model)



THE
JOURNAL OF
COMPARATIVE PATHOLOGY
AND
THERAPEUTICS.

Vol. XLIII.—No. 4. DECEMBER 31, 1930. PRICE 8s. 6d.

THE ETIOLOGY OF "LOUPING-ILL."

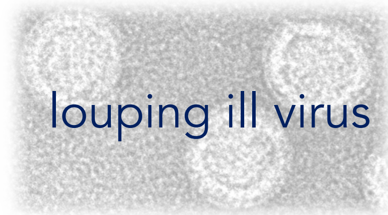
By W. A. POOL, A. BROWNLEE, and D. R. WILSON.

"LOUPING-ILL" is responsible for most of the mortality on hill sheep farms in certain areas of Scotland and the border counties of England. It has been discussed by various authors for more than a century, and during the last forty years several attempts have been made to ascertain its nature.

The farms in the affected areas are known as "diseased" farms, and, presumably, the existence of the regular heavy losses has been responsible for the adoption of special customs which apply both to the transfer of the farms and to the system of husbandry followed.

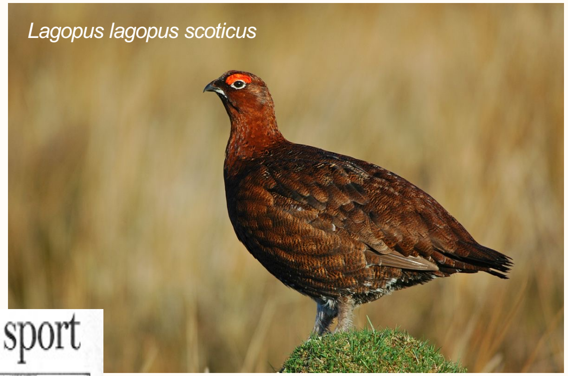
When these farms change hands it is customary for the sheep stock to be taken over with them, as it would be unsafe to restock from ordinary farms because sheep which are not "acclimatised" suffer a high death rate when placed on "louping-ill" land; on these farms the sheep are spoken of as "bound to the ground." At the valuation of the sheep a special "acclimatisation value" is allowed, and this is additional to the fair market price of the stock at the time of transfer.

Presumably, the introduction of these customs is the result of bitter experience suffered for generations, and is an attempt to



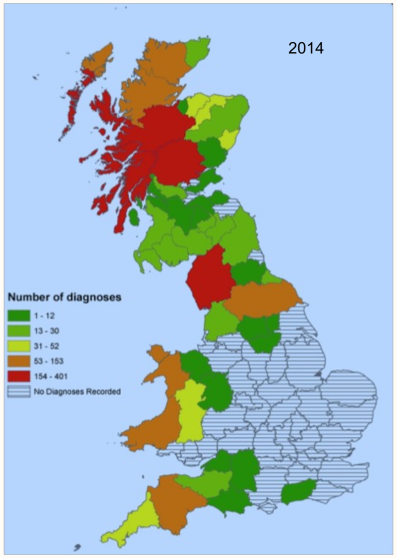
➤ First arthropod-borne virus isolated in Europe

Louping ill

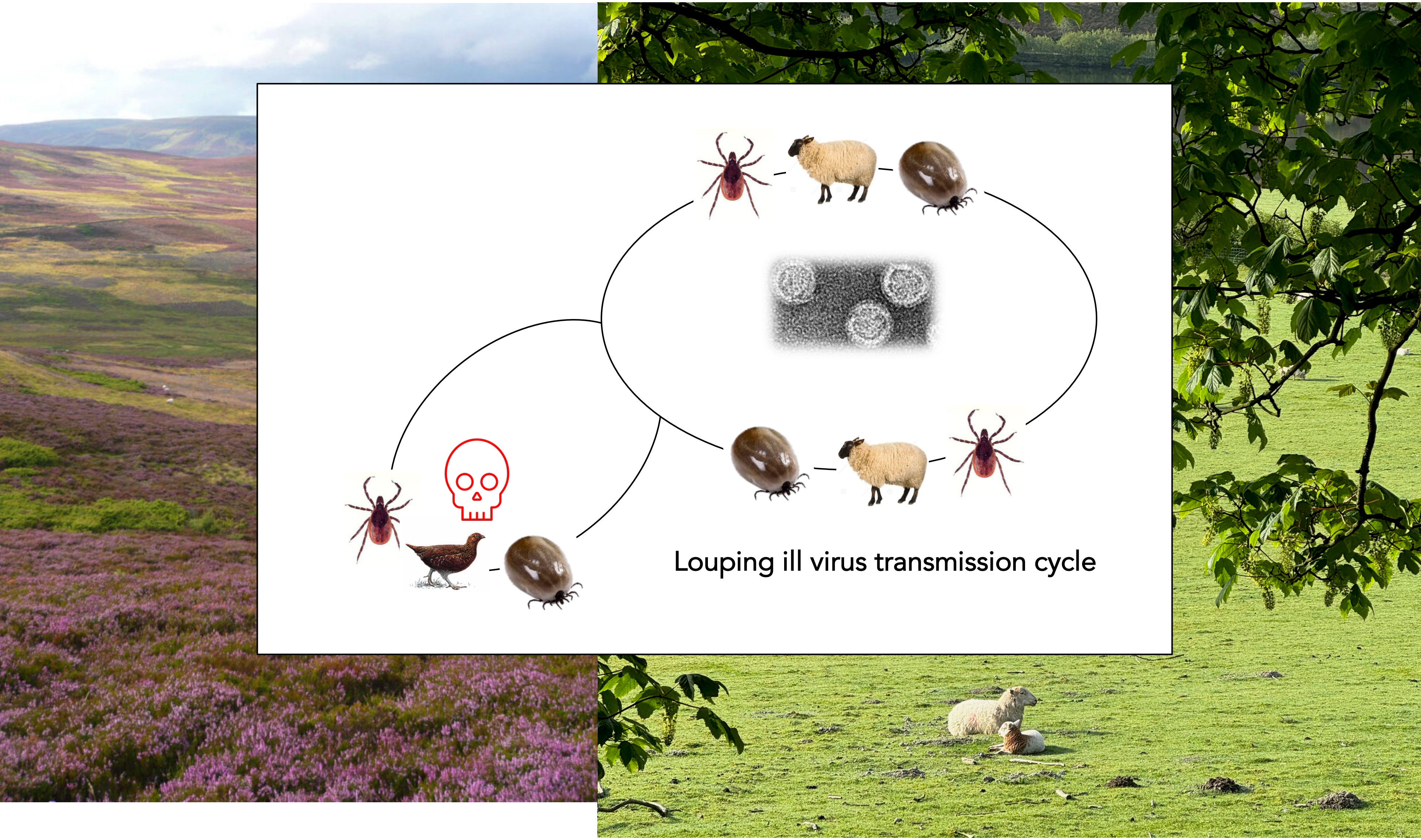


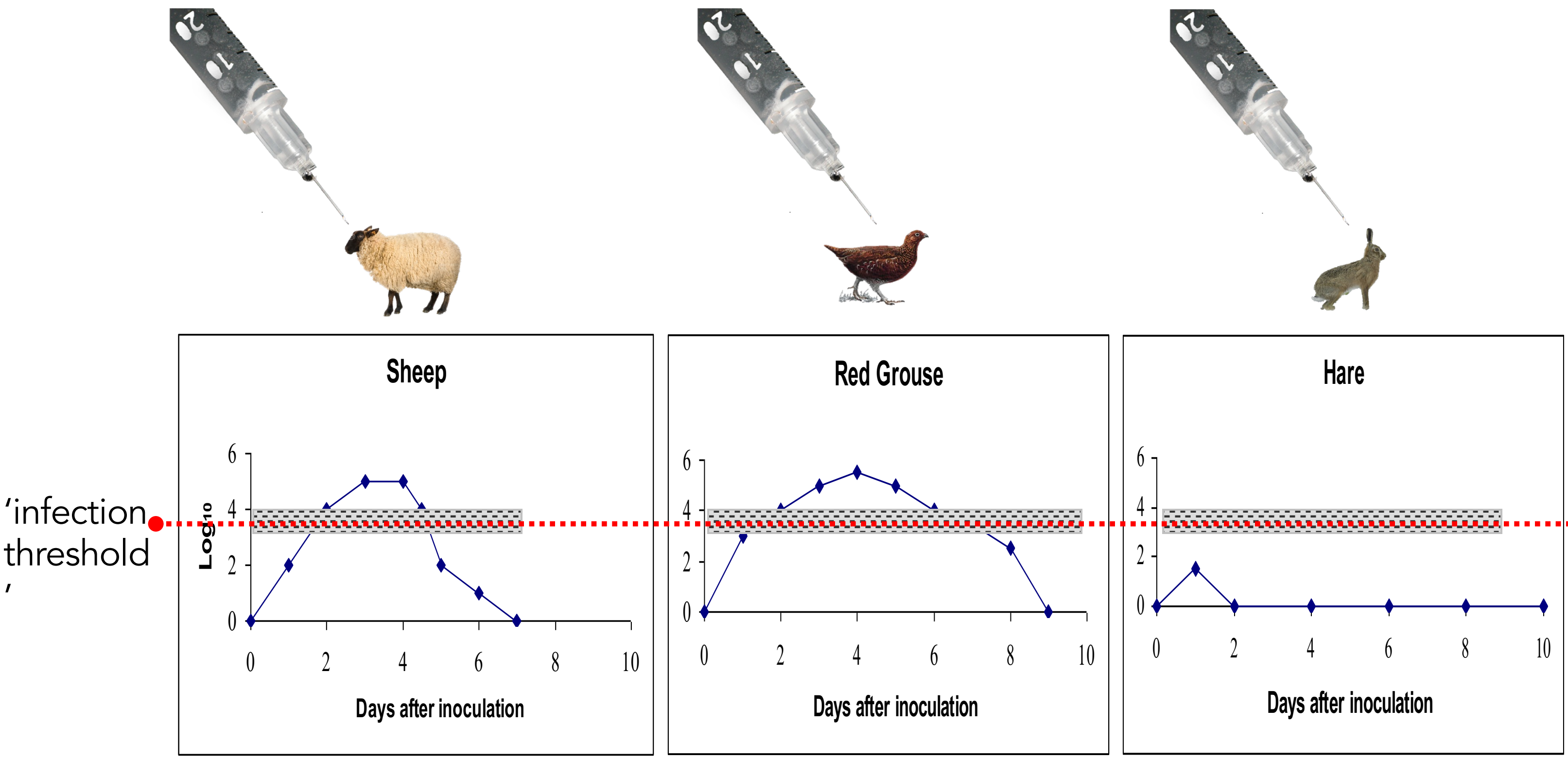
Grousers to blame for curse on their sport

The killer tick that devastates the moors was brought in by the gentry who drove crofters from their land



Jeffries *et al* 2014


Louping ill virus transmission cycle

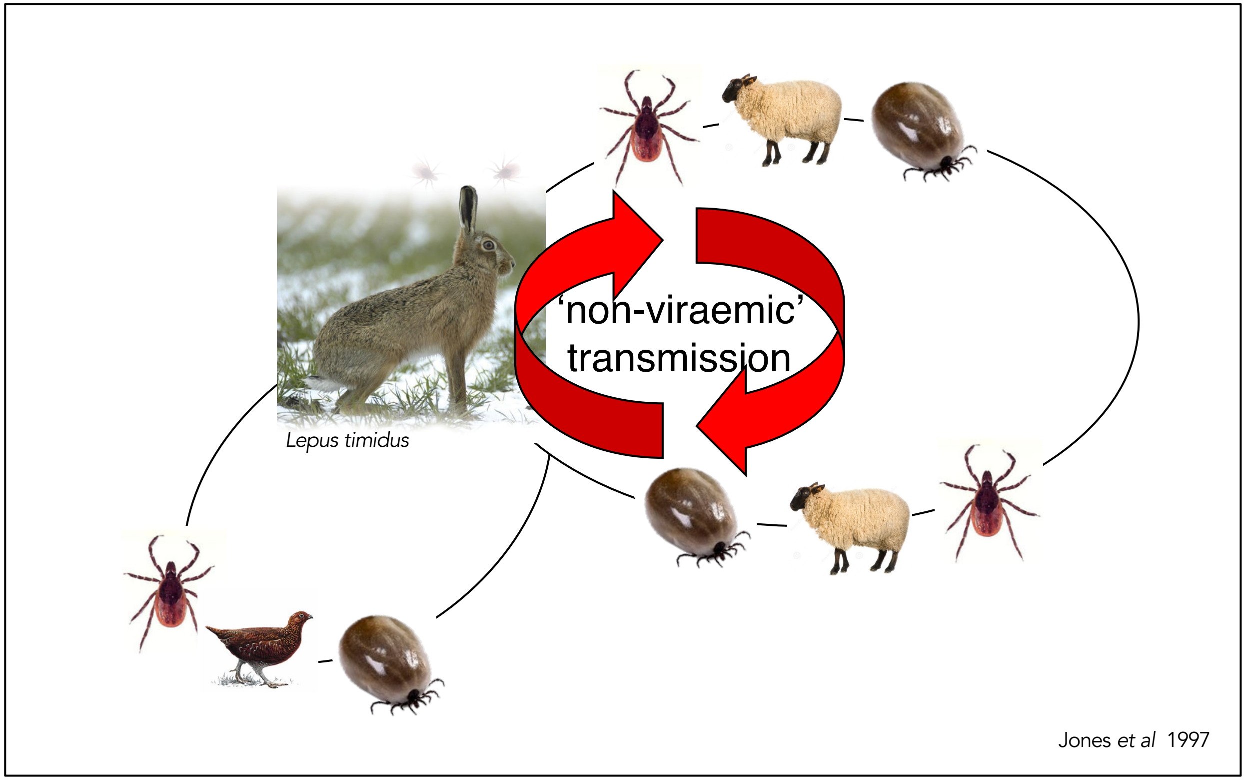


It is therefore apparent that the intensity and duration of the host's viremia will determine its epizootiological relevance. While all vertebrates may be infected, only those species that develop viremias in excess of threshold titers are involved in the maintenance of louping-ill virus. To assess the potential

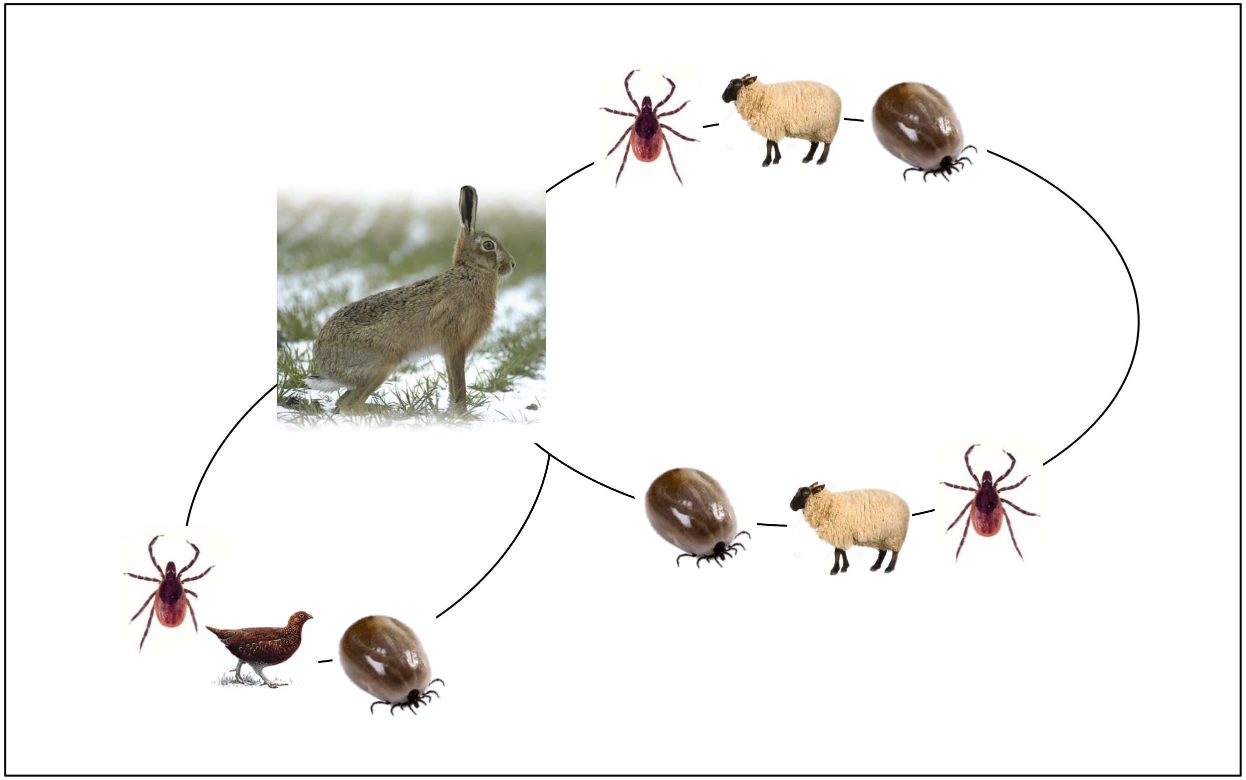
Reid, 1984

'Infection threshold' of louping ill virus

Cervus elaphus



Louping ill virus transmission cycle



Louping ill virus transmission cycle - management

Lessons for surveillance

- Screen for diversity (DNA viruses, JMTV-like viruses)
- Tick species → Virus species
- Use ticks for xenodiagnosis
- Identify maintenance hosts

Day 2: Application to Tick-Borne Virus infections

Risk of Crimean-Congo hemorrhagic fever (CCHF) in Europe

By Ali Mirazimi

Crimean – Congo Haemorrhagic fever virus

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Public Health Agency of Sweden
National veterinary Institute, Sweden
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CCHF – Historical Perspective (i)

1st Descriptions of Central Asian / Crimean Haemorrhagic fever

- 1136 Tajikistan / Kyrgyzstan (Zayn al-Din Sayyed)

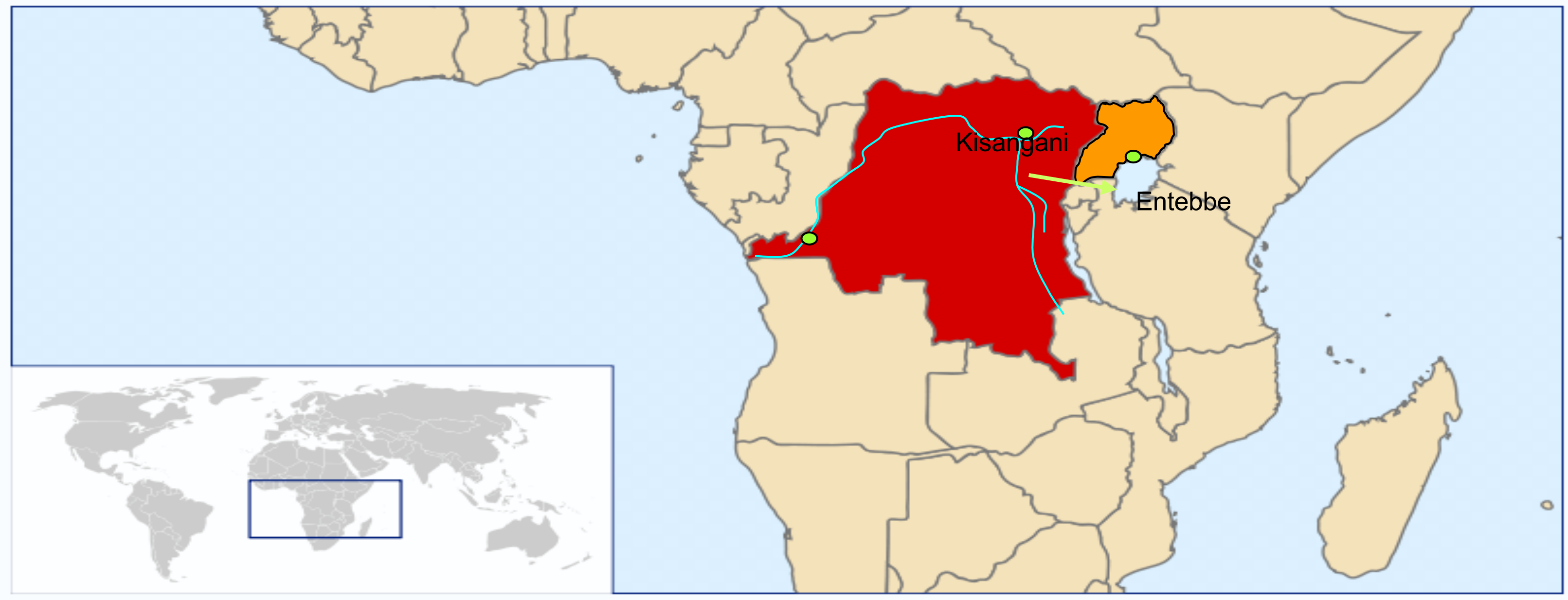
•1944 Viral origin - passage through human volunteers (they could not Isolate the virus by using the mice model, most probably due to that they used Adult Mice)

⇨ Isolation / registration - Yale 1968 (Crimean HF)

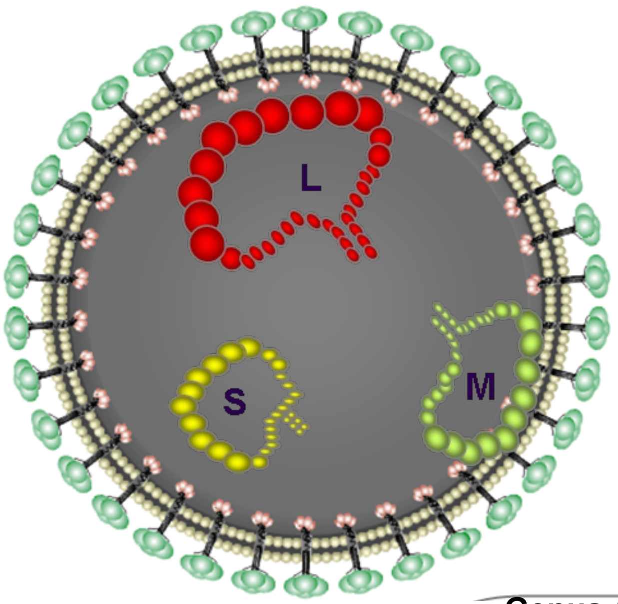
M.P Chumakove et al.,

CCHF – Historical Perspective (ii)

1st Descriptions of Congo fever



- Stanleyville March 1956: 13 year old presented with fever / bruising.
- Dr. Courtios Isolated / adapted to mice ("2-3 days old, Intraperneatal/ maintained by passage.
- He get also the disease but survived.
- Sent to EAVRI / Entebbe 1957



Bunyavirale

- Segmented Genome [Small Medium Large]
- Single Stranded -ve sense RNA
- Lipid enveloped viruses
- Arthropod borne [*x Hanta*]
- Some viruses cause disease in humans

Nairoviridae

Genus *Norwavirus.* Běijí nairovirus (BJNV) and Grotenhout virus (GRHV)infect ixodid ticks. BJNV also may infect humans. Norwavirus genomes are bisegmented.

Genus *Ocetevirus.* Red goblin roach virus 1 (RGRV1) infects ectobiid cockroaches. Ocetevirus genomes are trisegmented.

Genus *Orthonairovirus.* Almost all members of the genus have been found argasid and/or ixodid ticks.

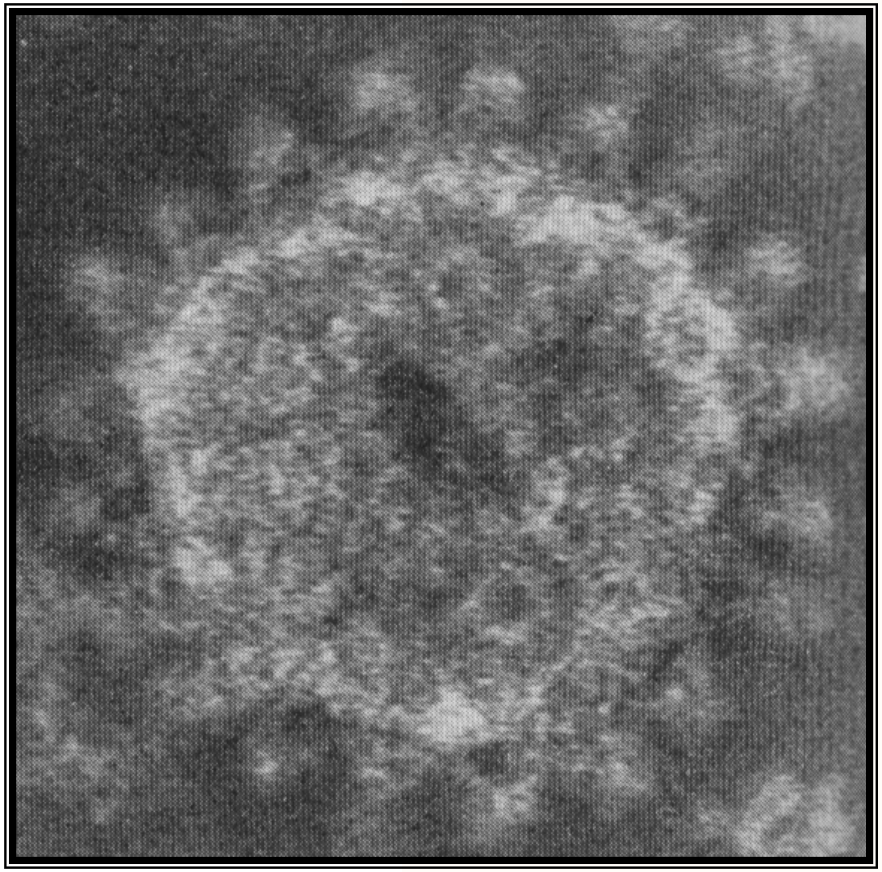
Genus *Sabavirus.* South Bay virus (SBV) infects ixodid ticks. Sabavirus genomes are bisegmented.

Genus *Shaspivirus.* Shāyáng spider virus 1 (SySV1) infects araneid spiders. Shaspivirus genomes are trisegmented.

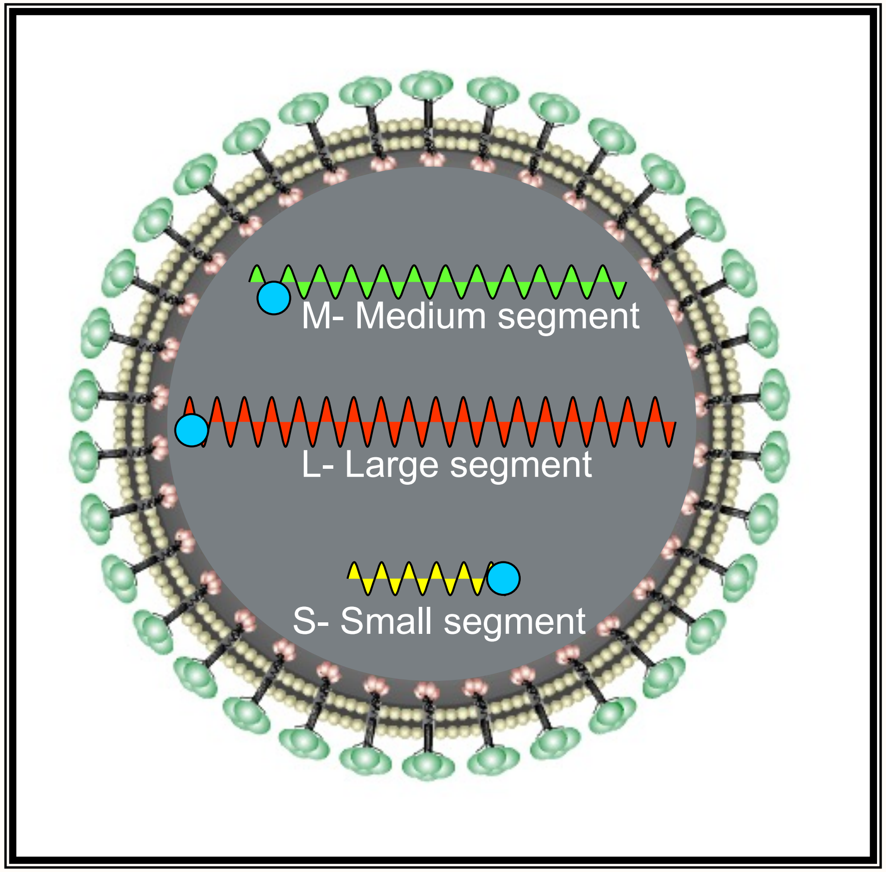
Genus *Striwavirus.*Sānxiá water strider virus 1 (SxWSV1) infects water striders. Striwavirus genomes are trisegmented.

Genus *Xinspivirus.*Xīnzhōu spider virus (XSV) infects araneid spiders. Xinspivirus genomes are trisegmented.

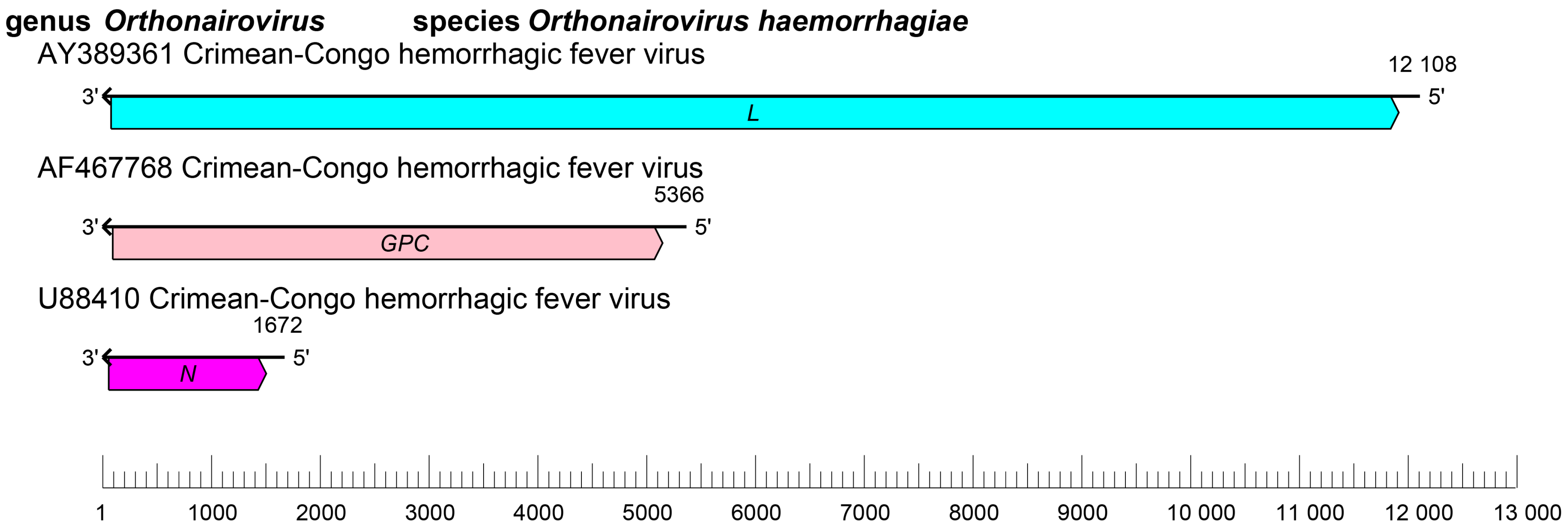
Crimean-Congo hemorrhagic fever virus



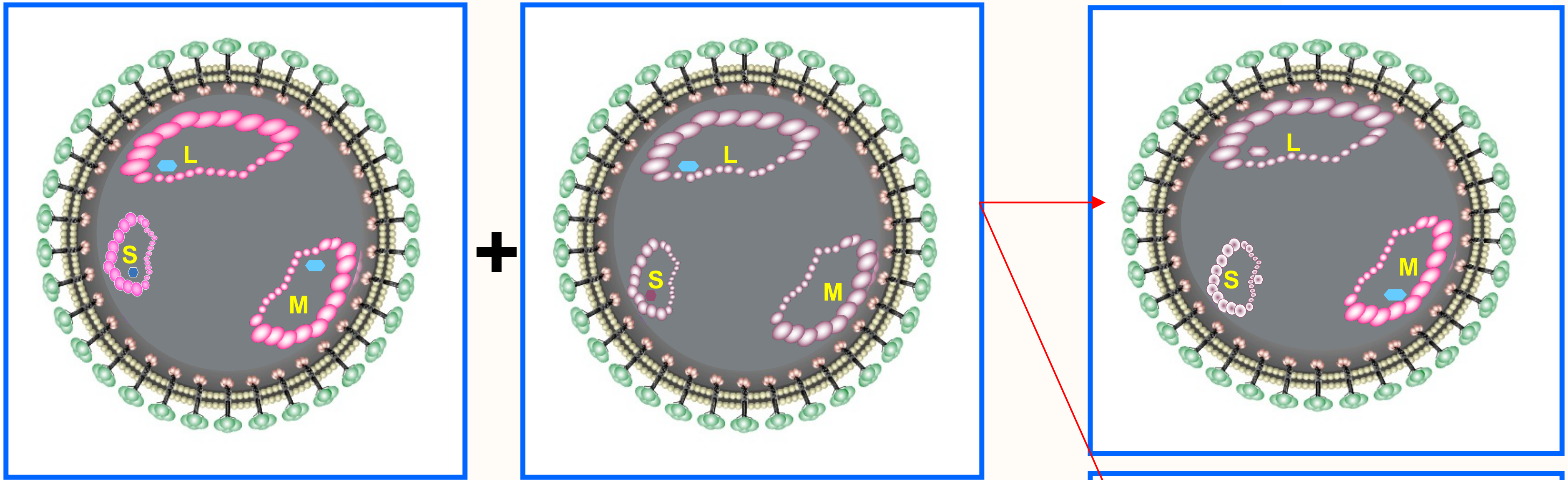
Transmission EM X20,000
–ve staining

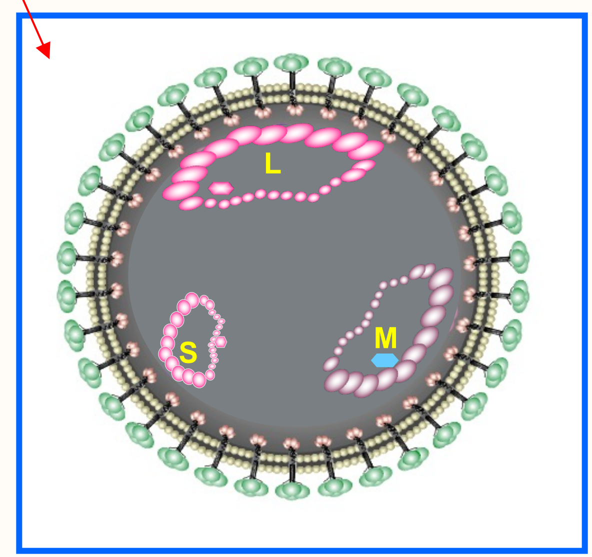


Nairovirade



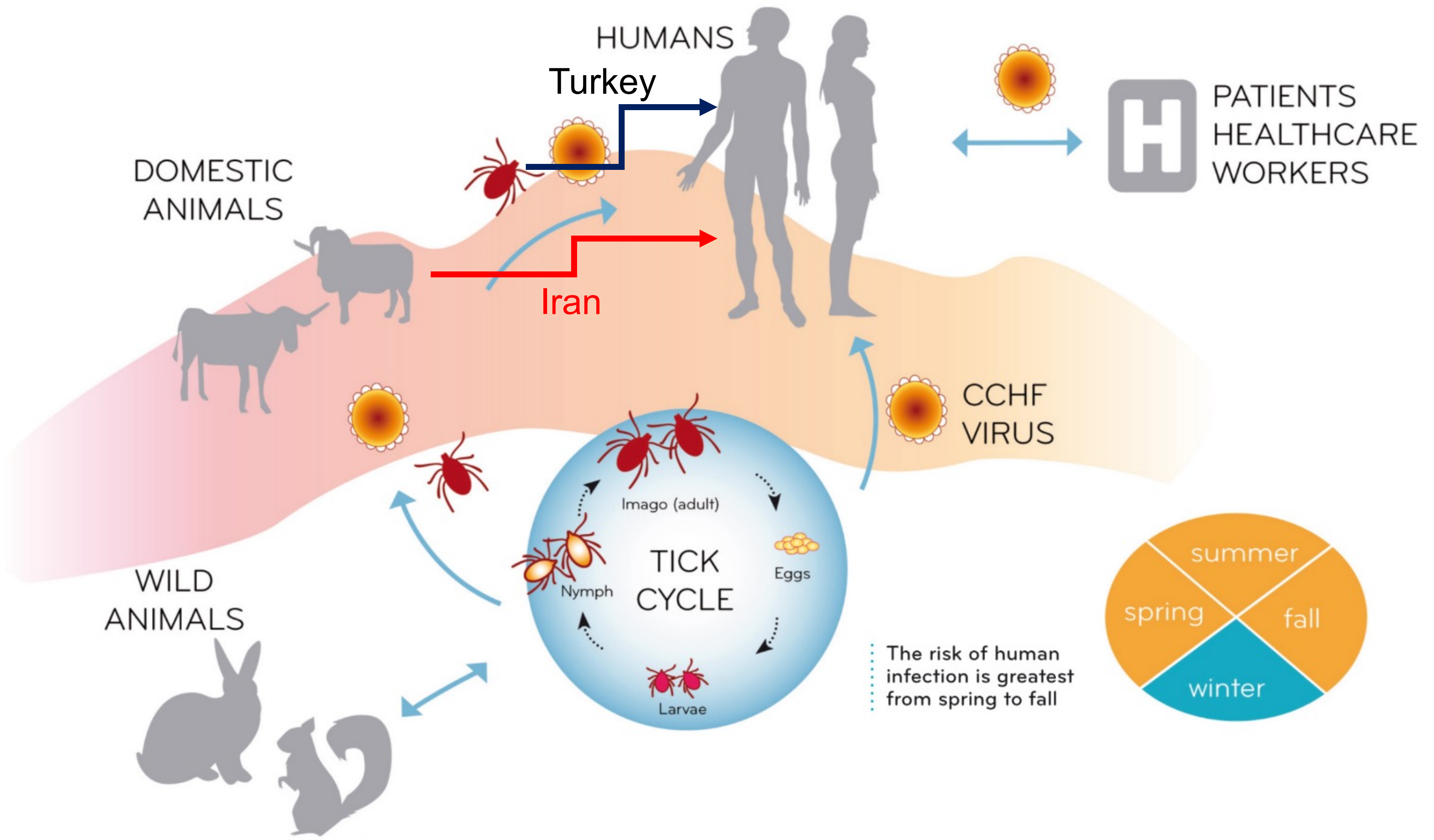
CCHF Segment reassortment between strains





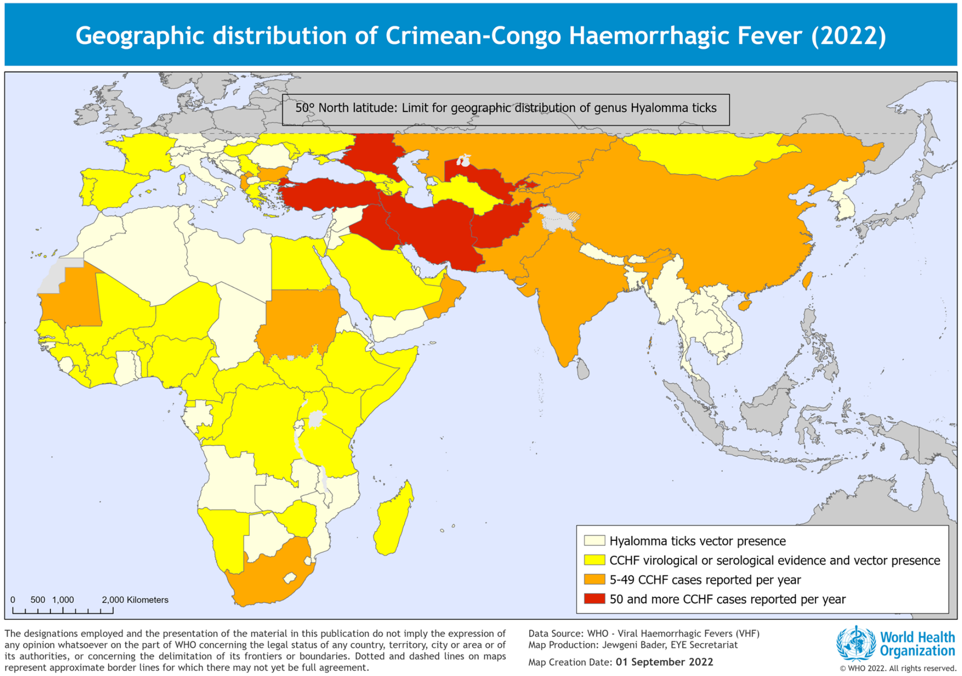
- Co-replication of two strains in the same cell / organism
- Ticks are suitable hosts to support reassortment

➢ Global & dynamic reservoir of CCHF virus



HUMANS
Turkey
PATIENTS
HEALTHCARE
WORKERS
DOMESTIC
ANIMALS
Iran
CCHF
VIRUS
Imago (adult)
TICK
CYCLE
Eggs
Nymph
Larvae
WILD
ANIMALS
summer
spring
fall
winter
The risk of human
infection is greatest
from spring to fall

Crimean – Congo Haemorrhagic fever



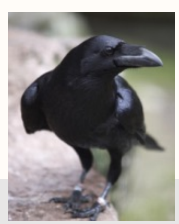
CCHF virus (Nairovirus genus of the family Bunyaviridae)

30% mortality rate (but can approach 80% in some circumstances) [WHO]

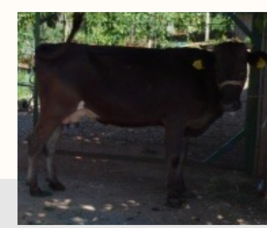
CCHF virus is the most widely distributed agent of severe haemorrhagic fever known - its distribution stretches over much of Asia, Africa and parts of south-eastern Europe.

Transmission by tick bite or contact with infected blood/body fluids. Zoonosis



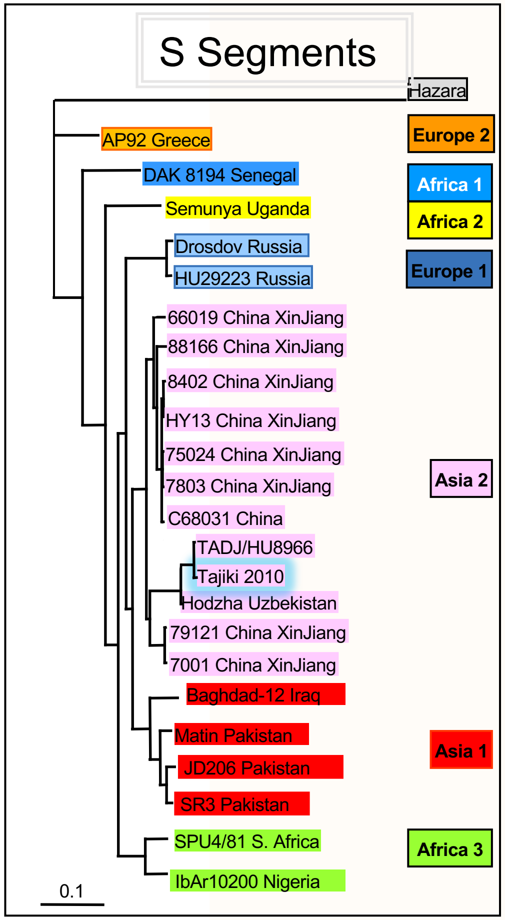


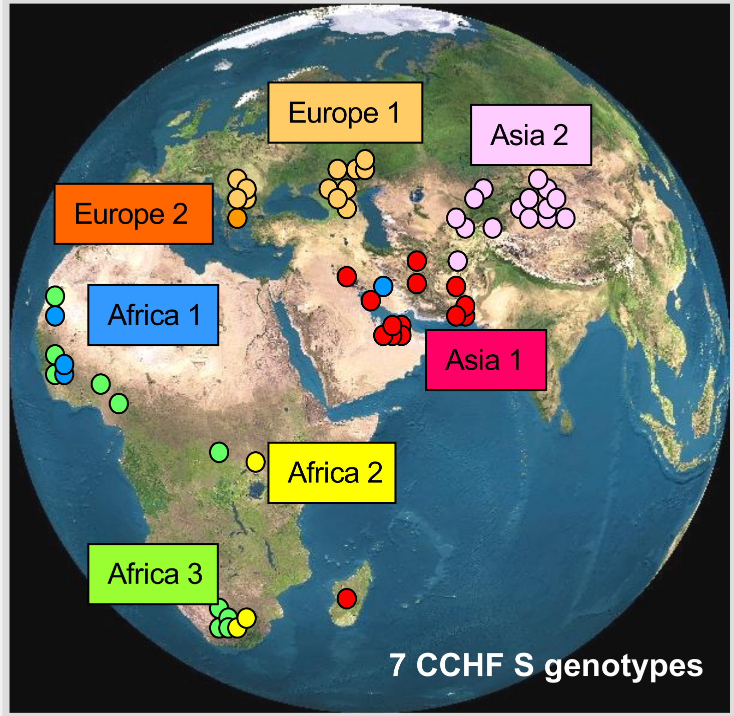




Tick Vectors and Disease Transmission

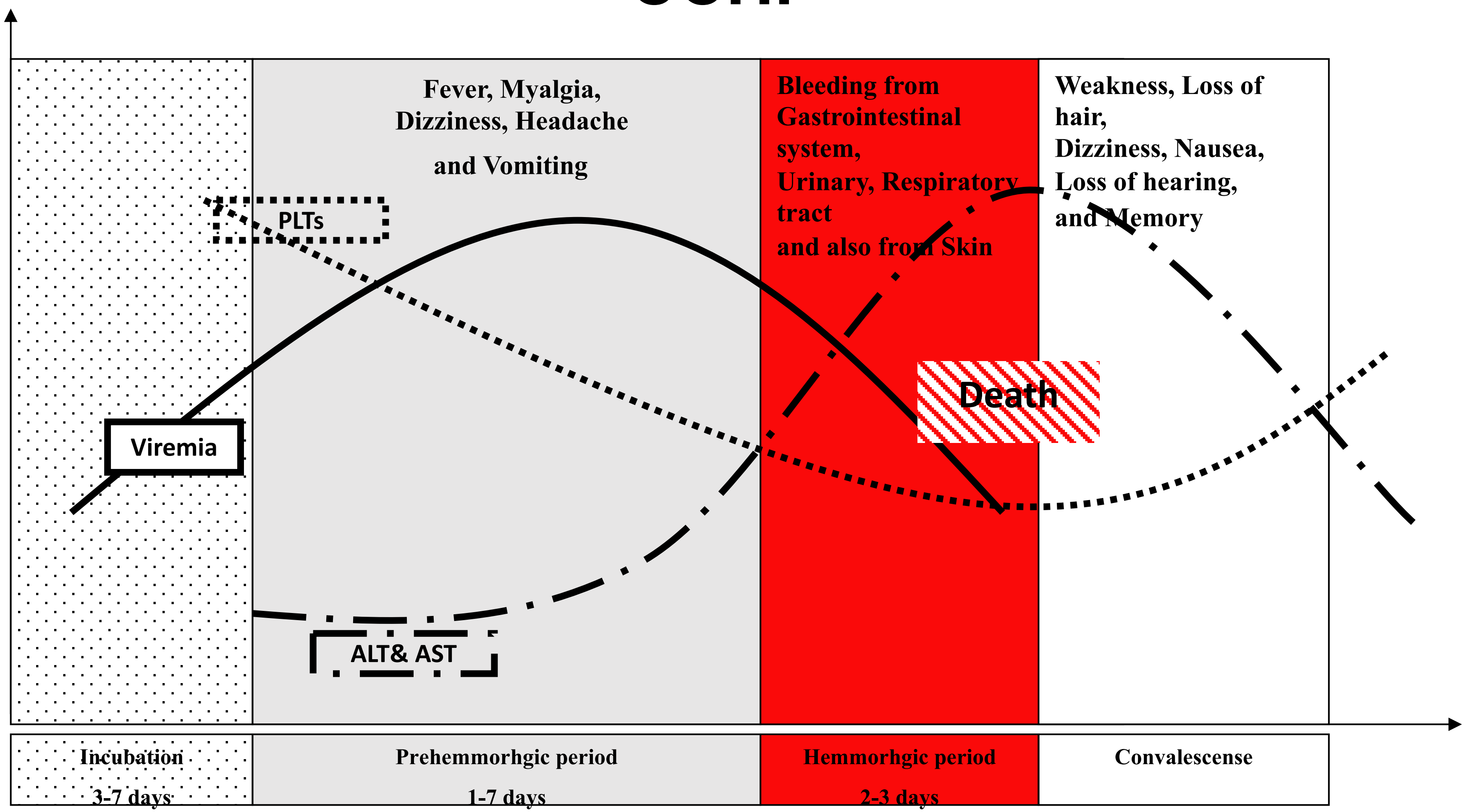
Hyalomma marginatum, are "two-host" ticks
Hyalomma are "hunting" ticks, which can quest up to 400 m to find their hosts (including humans).





hylogeny of CCHF

CCHF

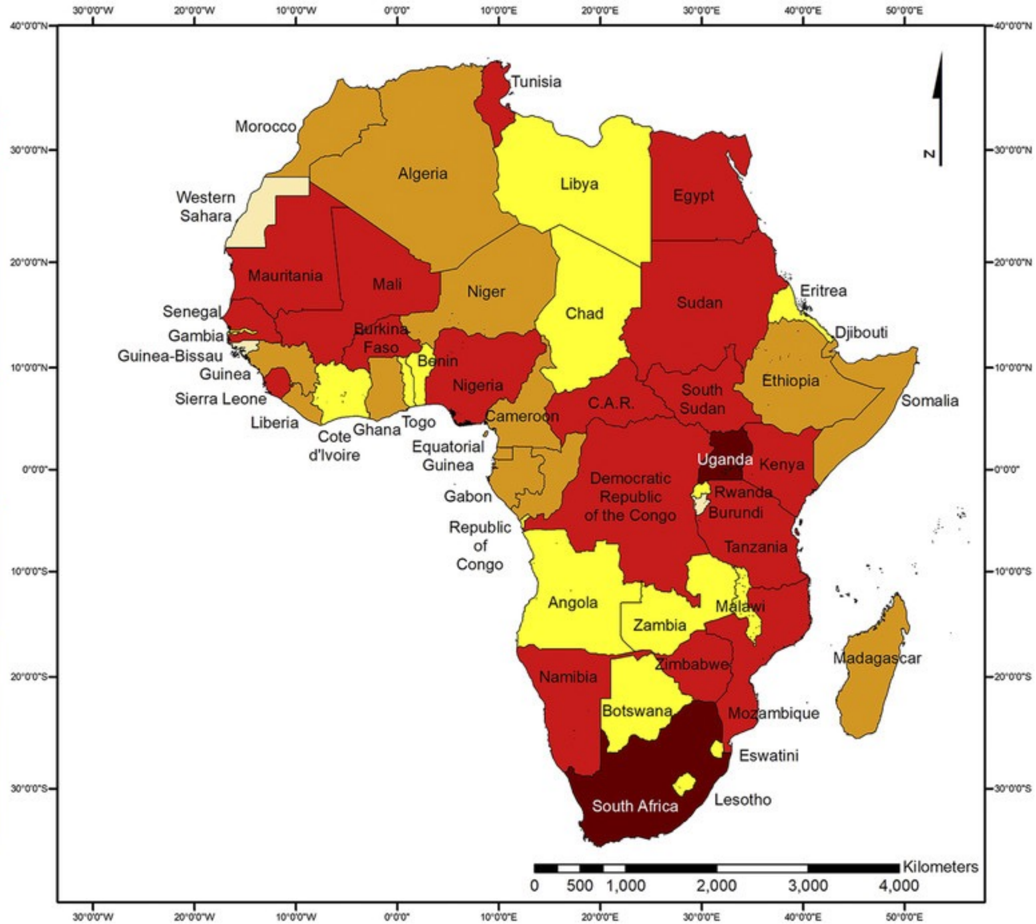


Fever, Myalgia, Dizziness, Headache and Vomiting
Bleeding from Gastrointestinal system, Urinary, Respiratory tract and also from Skin
Weakness, Loss of hair, Dizziness, Nausea, Loss of hearing, and Memory
PLTs
Viremia
Death
ALT& AST
Incubation 3-7 days
Prehemmorhgic period 1-7 days
Hemmorhgic period 2-3 days
Convalescense

Central and south Eastern-Asia

Country	Total confirmed cases	Total deaths	Year (s)
Kazakhstan	801	101	1948–2021
Kyrgyzstan	19	NA	1948, 1951, 1953, 2018–21
Tajikistan	527	81[a]	1944–2020
Turkmenistan	14	10	1944, 1946
Uzbekistan	665	66	1944–83, 1998–2007, 2001–4, 2013–15, 2017–18
China	287	59	1964-2003
Total	2313	317	1944–2021

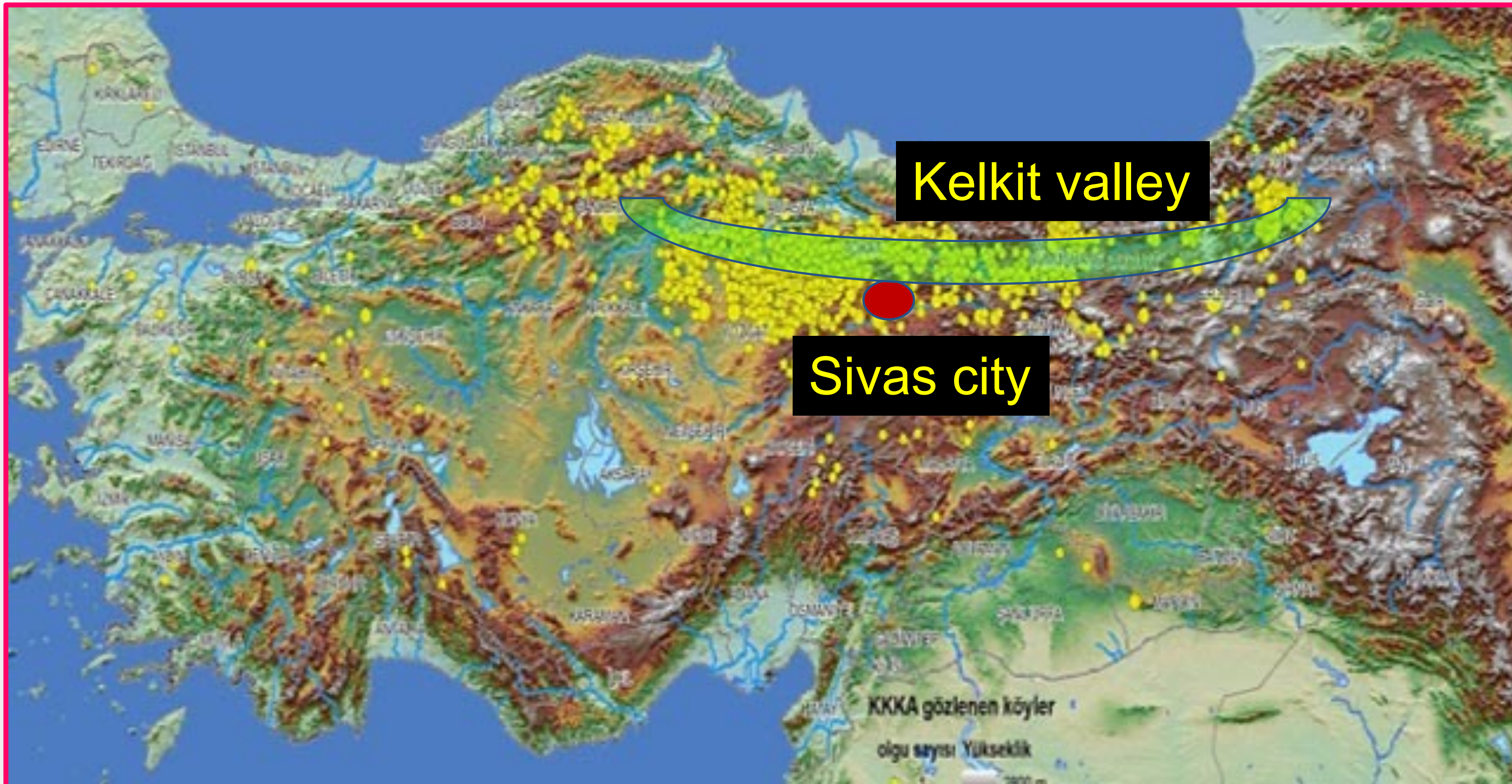
CCHF Burden Level	Countries
Level 1 (2 countries)	South Africa, Uganda
Level 2 (16 countries)	Burkina Faso, Central African Republic (CAR), Democratic Republic of the Congo (DRC), Egypt, Kenya, Mali, Mozambique, Namibia, Nigeria, Sierra Leone, South Sudan, Sudan, Senegal, United Republic of Tanzania, Tunisia, Zimbabwe
Level 3 (14 countries)	Algeria, Cameroon, Djibouti, Equatorial Guinea, Ethiopia, Gabon, Ghana, Guinea, Liberia, Madagascar, Morocco, Niger, Republic of the Congo, Somalia
Level 4 (15 countries)	Angola, Benin, Botswana, Cabo Verde, Chad, Côte d'Ivoire, Eritrea, Eswatini, Gambia, Lesotho, Libya, Malawi, Rwanda, Togo, Zambia
Level 5 (13 countries)	British Indian Ocean Territory, Burundi, Comoros, French Southern Territories, Guinea Bissau, Mauritius, Mayotte, Réunion, São Tomé and Príncipe, Saint Helena, Ascension and Tristan da Cunha, Seychelles, Western Sahara



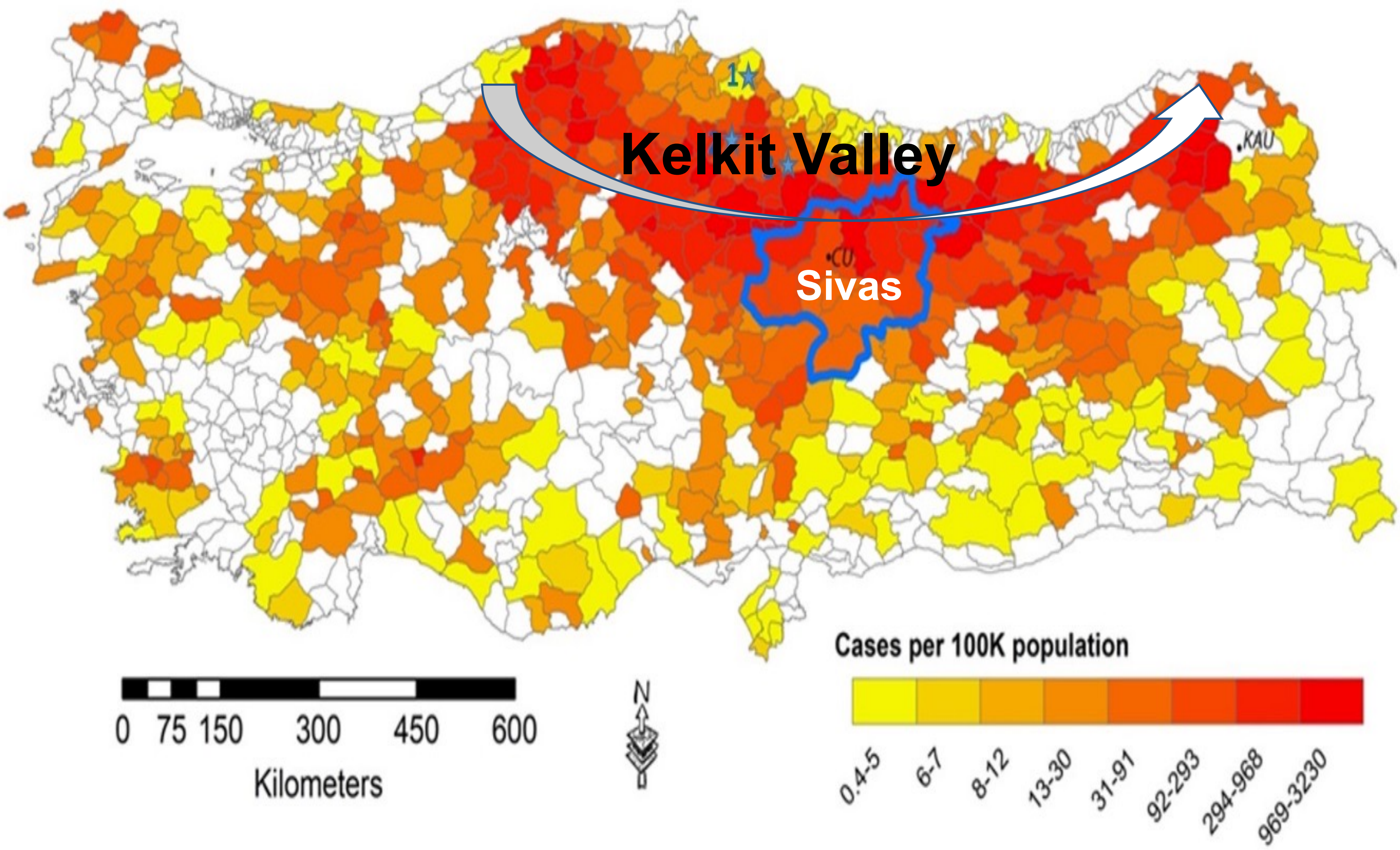
1956 to 2020, 494 CCHF cases (115 lethal) were reported in Africa.
Since 2000, nine countries (Kenya, Mali, Mozambique, Nigeria, Senegal, Sierra Leone, South Sudan, Sudan, and Tunisia) have reported their first CCHF cases.

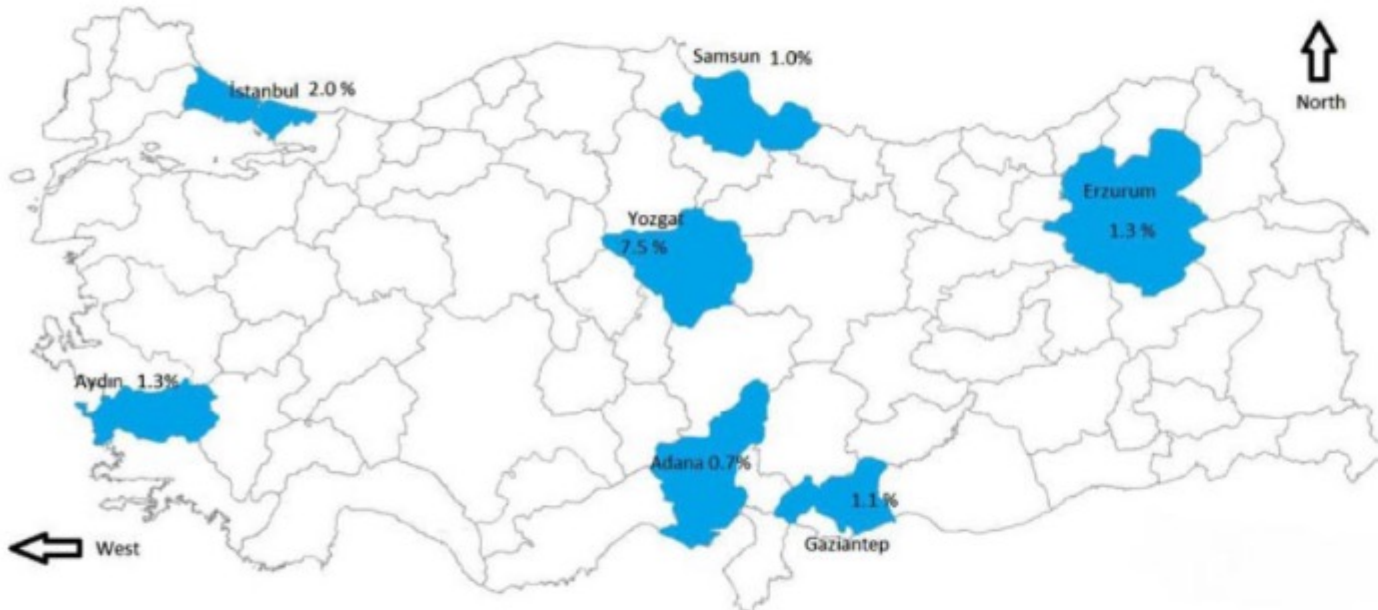
level 1, CCHF cases reported annually through established surveillance;
level 2, CCHF cases reported intermittently in absence of robust surveillance;
level 3, no CCHF cases reported and no robust surveillance established,;
level 4, no CCHF cases reported and no robust surveillance or epidemiologic/epizootiologic studies, but *Hyalomma* ticks present;
level 5, no available data. Classification at the country level was performed for policy implications.

Geographic Distributions of CCHF in Turkey



CCHF Cumulative Incidence per 100 000 rural population (2003-2017)





Seroprevalence and Risk Factors of Crimean–Congo Hemorrhagic Fever in Selected Seven Provinces in Turkey

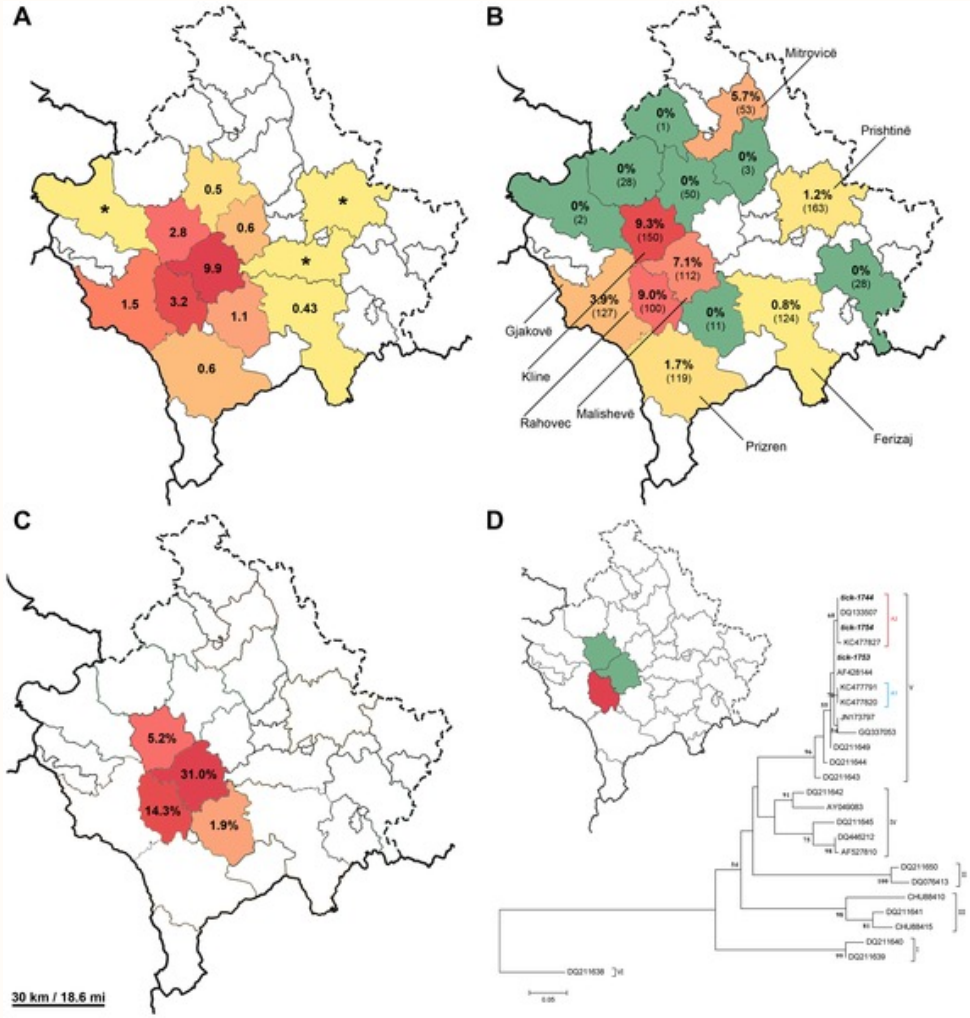
Dilek Yagci-Caglayik,* Gülay Korukluoglu, and Yavuz Uyar
Virology Reference and Research Laboratory, Department of Microbiology Reference Laboratories, Public Health Institute of Turkey, Ankara, Turkey

CCHFV IgG antibodies were detected in 2.3% of the population. The most important risk factors for CCHF seropositivity, were older age, male gender, illiterate, farmer, animal husbandry, living in rural residence in adobe houses, and a previous tick bite history. ***J. Med. Virol.***

CCHFV seroprevalence in Bulgaria

CCHFV seroprevalence in Greece

•Figure 1. Prevalence of CCHF in Kosovo A. Cumulative incidence (per 100,000) of CCHF (from 1995 to 2013) in each municipality of Kosovo.

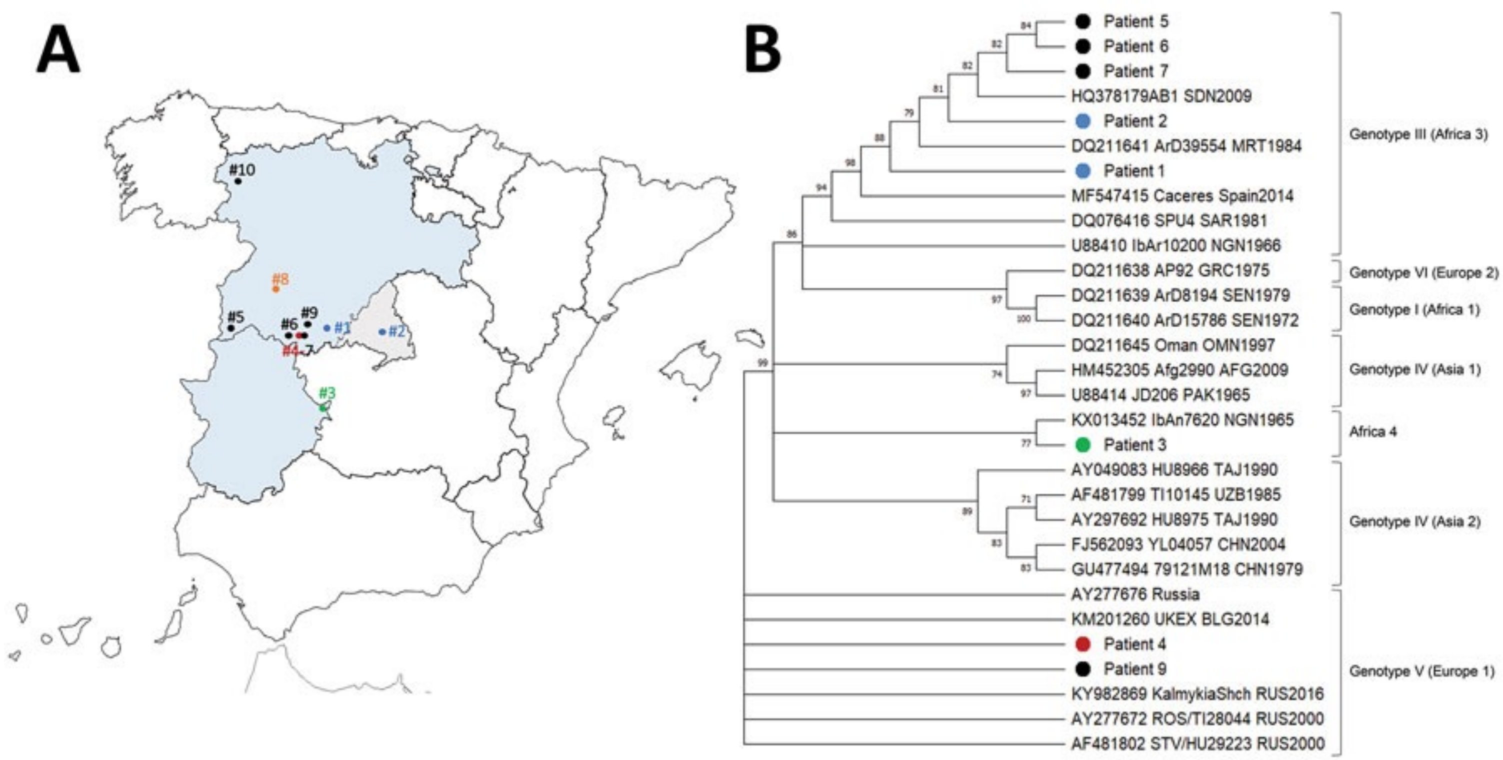


Fajs L, Humolli I, Saksida A, Knap N, Jelovšek M, et al. (2014) Prevalence of Crimean-Congo Hemorrhagic Fever Virus in Healthy Population, Livestock and Ticks in Kosovo. PLoS ONE 9(11): e110982. doi:10.1371/journal.pone.0110982
http://127.0.0.1:8081/plosone/article?id=info:doi/10.1371/journal.pone.0110982

PLOS ONE

CCHFV seroprevalence in Albania

10 cases of CCHF diagnosed in Spain during 2013–2021; genotypes III and V. (30% mortality)
Six case-patients acquired the infection in urban areas.
The epidemiologic pattern of CCHF in Spain is based on occasional cases Genotype III and, to a less extent also genotype V, CCHF circulates in humans in a common geographic area in Spain.



Monitoring

- **1. Surveillance of Tick Vectors**
- **Tick Collection & Mapping:** Regular collection of *Hyalomma* ticks in high-risk areas and neighboring area and creating a geographic distribution map can help understand where the virus-carrying ticks are prevalent.
- **Genomic Screening of Ticks:** Using molecular diagnostics to test the collected ticks for the presence of CCHFV can provide real-time data on the potential for outbreaks.
- **Environmental Surveillance:** Monitoring climate factors like temperature, rainfall, and humidity, which influence tick distribution and survival, would help predict high-risk periods.

- **2. Animal Surveillance**
- **Livestock Monitoring:** As livestock (such as cattle, sheep, and goats) are key reservoirs for CCHFV, periodic blood sampling in livestock for antibodies against CCHFV would provide insights into virus circulation in a region.
- **Wildlife Surveillance: Monitoring wildlife populations, especially migratory birds, that can carry infected ticks over long distances is also important for understanding the spread of the virus across borders.**

- **3. Human Disease Surveillance**
- **Human Case Reporting:** Establish a standardized protocol for health professionals to report suspected and confirmed cases of CCHFV.
- **Serological Surveys:** Conduct serosurveys in regions with tick activity to detect past exposure in human populations, especially in farmers, veterinarians, and others with frequent contact with livestock.
- **Hospital-Based Sentinel Surveillance**

- **4. Geospatial & Predictive Modeling**
- **Risk Mapping:** Use geospatial tools to map areas at risk based on tick distribution, livestock density, human population movement, and environmental conditions.
- **Predictive Models:** Develop mathematical models to predict potential outbreaks based on climatic changes, tick distribution data, and livestock movements.

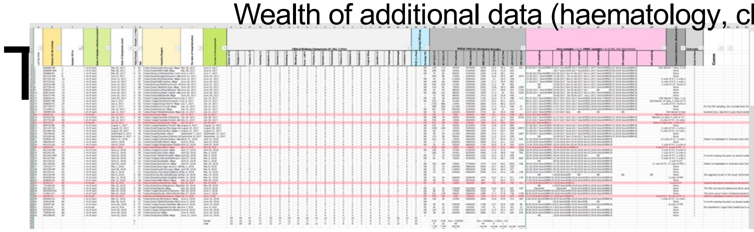
- **5. International Collaboration & Data Sharing**
- **Cross-Border Surveillance:** Since CHFV can spread across borders, cross-border collaborations between countries are essential. Sharing real-time data on tick populations, livestock movements, and human cases with agencies like the World Health Organization (WHO) and ECDC is critical.
- **Early Warning Systems:** Use mobile health (mHealth) platforms or web-based systems to alert authorities and the public in case of detected outbreaks or when environmental conditions suggest a high-risk period for tick activity.
- **Rapid Diagnostics:** Invest in the development and dissemination of point-of-care diagnostic tools to enable quick detection in remote areas.
- **8**
- **6. Public Health Communication & Education**
- **Awareness Campaigns:** Educate populations at risk (e.g., farmers, hikers, and health workers) on tick-bite prevention and recognizing early symptoms of CCHFV.
- **Community Engagement:** Engage local communities in reporting tick encounters or suspicious livestock deaths to improve real-time monitoring.
- **7. Laboratory & Diagnostic Capacity**
- **Laboratory Networks:** Strengthen the capacity of national reference labs to rapidly identify CCHFV in human and animal samples.

CCHFVaccine

Dr Nazif Eladi

- 55 patients
  - 6 timepoints over 2 year period
    - Upon hospitalisation: 1-3 days post symptom onset
    - At 4-6 days post symptom onset or 2-3 days after the first sample
    - At 10-15 days post symptom prior to hospital discharge
    - 6 months post infection
    - 12 months post infection
    - 24 month post infection
- Analysed by PCR, IgM, IgG (against N, Gn and Gc), Gp 38 under discussion.
- Neutalization assay by VLP and Turkish Isolated virus
- PBMC analysed for T
  Proteomics

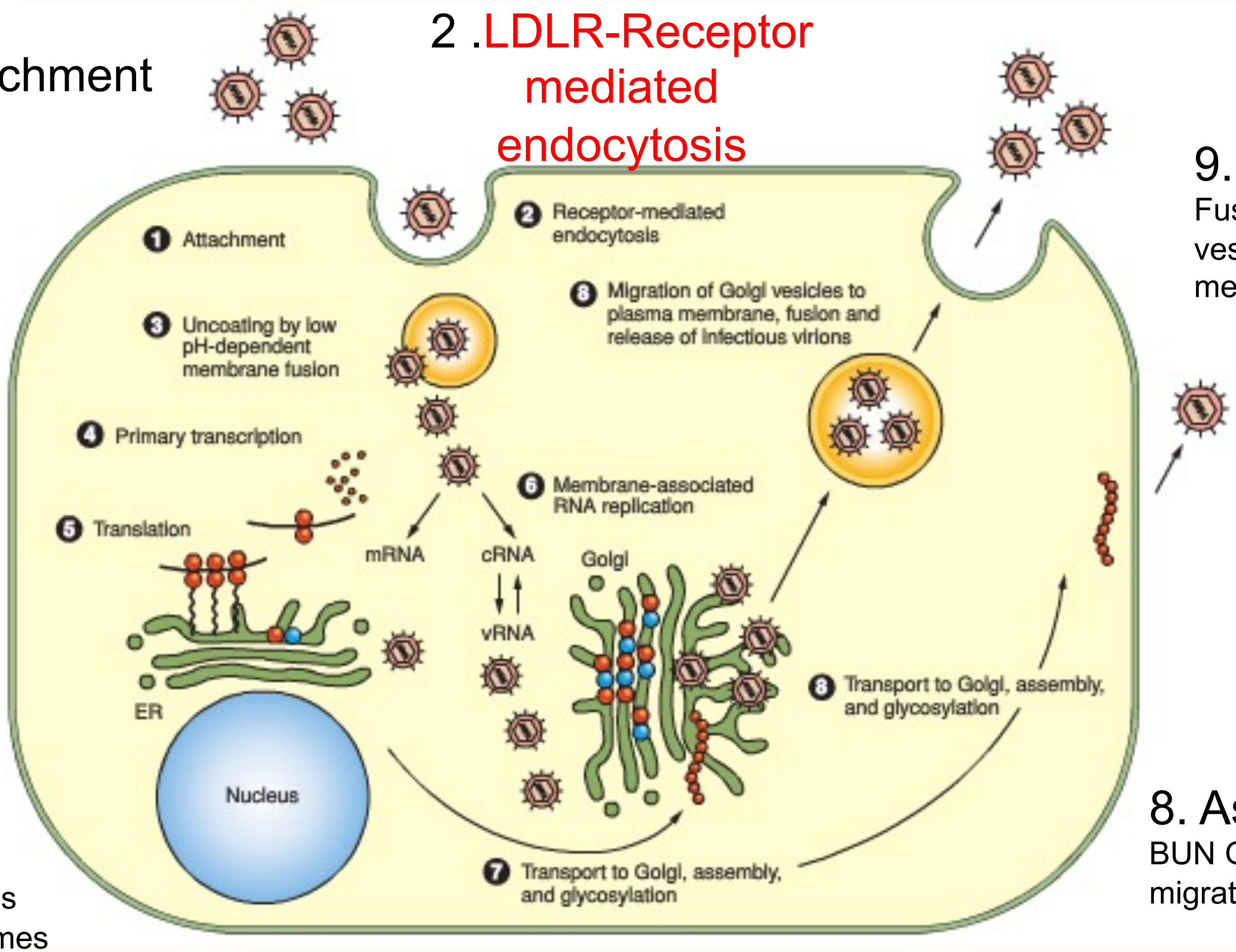
Wealth of additional data (haematology, clinical chemistry, etc)



CCHFV Replication

1. Attachment

2 .LDLR-Receptor mediated endocytosis



3. Uncoating:
Acidification of endosomes fusion of membranes

4. Transcription:
Host delivered primers & BUN Pol & BUN N

5. Translation:
S & L mRNA – Free ribosomes
M on membrane bound ribsomes

6. RNA replication
cRNA - vRNA - encapsidation

7. Golgi processing
Maturation within Goli

8. Assembly
BUN Goli vesicles migrate to cell surface

9. Release:
Fusion of Golig vesicles with pl membrane

nature microbiology

Article

https://doi.org/10.1038/s41564-024-01672-3

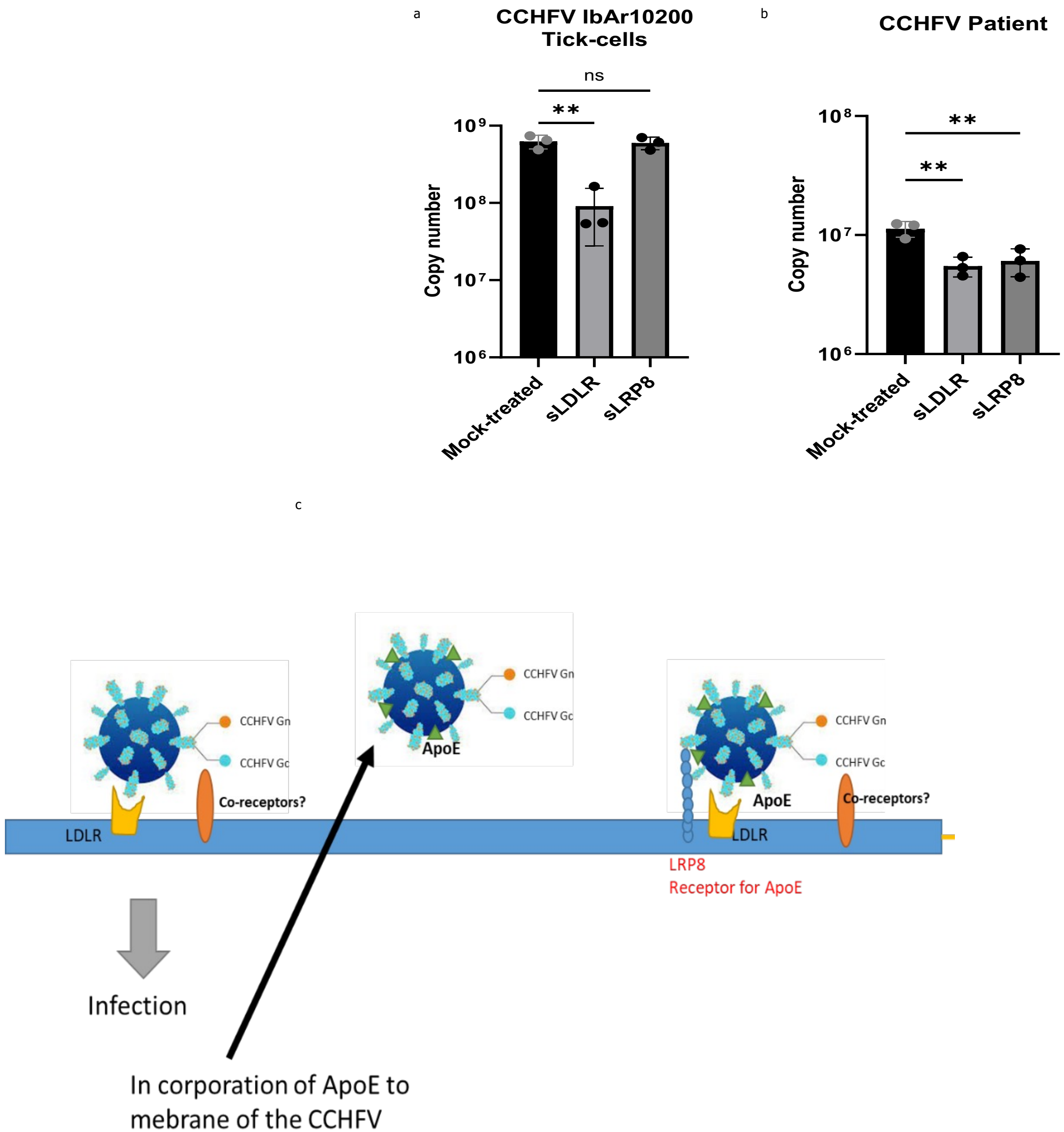
Crimean–Congo haemorrhagic fever virus uses LDLR to bind and enter host cells

Received: 10 July 2023

Accepted: 11 March 2024

Check for updates

Vanessa M. Monteil[1,2], Shane C. Wright[3,23], Matheus Dyczynski[4,5,23], Max J. Kellner[6,7], Sofia Appelberg[2], Sebastian W. Platzer[6,7], Ahmed Ibrahim[8], Hyesoo Kwon[9], Ioannis Pittarokoilis[3], Mattia Mirandola[10], Georg Michlits[5], Stephanie Devignot[1,2], Elizabeth Elder[9], Samir Abdurahman[2], Sándor Bereczky[2], Binnur Bagci[11], Sonia Youhanna[3], Teodor Aastrup[8], Volker M. Lauschke[3,12,13], Cristiano Salata[10], Nazif Elaldi[14], Friedemann Weber[15], Nuria Monserrat[16,17,18], David W. Hawman[19], Heinz Feldmann[19], Moritz Horn[4,5], Josef M. Penninger[6,20,21,22] & Ali Mirazimi[1,2,9]


a
CCHFV IbAr10200
Tick-cells
ns
**
Copy number
10⁹
10⁸
10⁷
10⁶
Mock-treated
sLDLR
sLRP8
b
CCHFV Patient
**
**
Copy number
10⁸
10⁷
10⁶
Mock-treated
sLDLR
sLRP8
c
CCHFV Gn
CCHFV Gc
Co-receptors?
LDLR
ApoE
LRP8
Receptor for ApoE
Infection
In corporation of ApoE to
mebrane of the CCHFV

Diagnostic

- **PCR (available Kits)**
- Antigen detection
- Virus Isolation (Require BSL-4)
- Electron Microscopy
- **IgM/IgG detection (Avalilable Kits)**
- Neutralization Assay (Require BSL-4)

Treatment

- Supportive treatment
- Ribavirin (very early administration- shows to have a benefit)

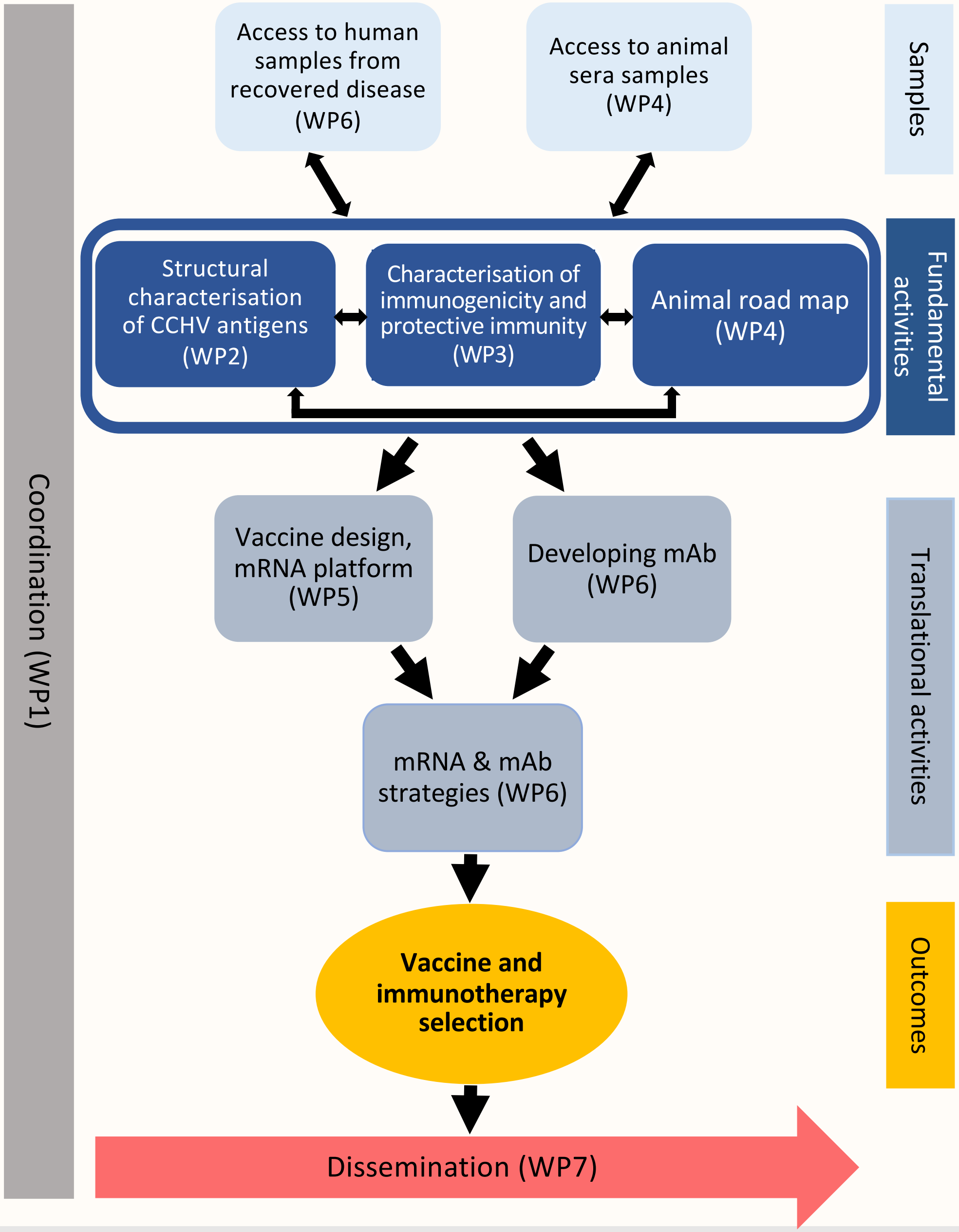
Vaccine

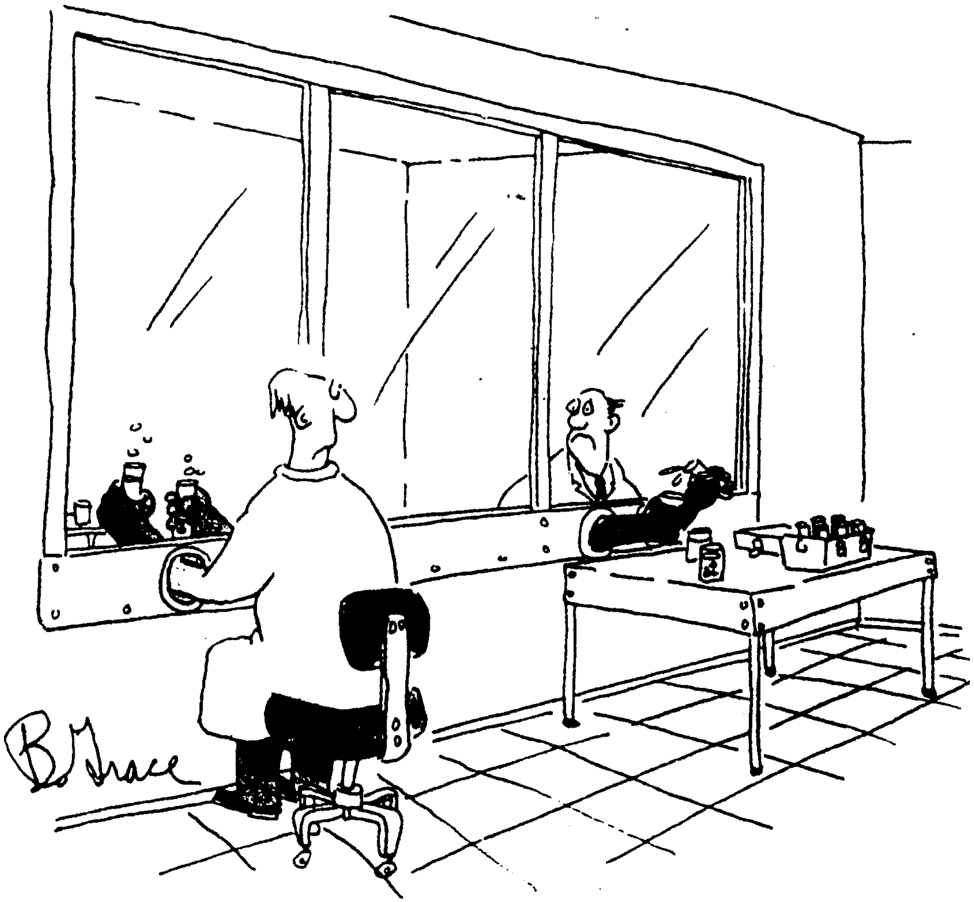
- **Inactivated Vaccine (Unsafe)**
- **Vector-based Vaccine (Under clinical trials- MVA and ChaAd)**
- **Genetic Vaccine (Under Clinical trials)**

CCHFVACCIM, Horizon EUROPE 2024-2028
8 Meuro

Partners:

- ERINHA (Audrey Richard)
- Karolinska (Matti Sällberg)
- Pasteur Inst (Felix Rey)
- Upenn (Drew Weisman)
- INSERM P4 Lyon (Vincent Lotteau)
- FLI (Martin Groschup)
- Giessen (Fridemann Weber)
- UKHS (Roger Hewson)
- Turkey (Nazif Elaldi)
- Bulgaria (Iva Christova)
- Cambodia (Tineke Cantaert)





Day 2: Application to Tick-Borne Virus infections

CCHF in France

By Laurence Vial

ANNUAL SCIENTIFIC SYMPOSIUM OF THE ARBO-FRANCE NETWORK, 24-25 octobre 2024

Crimean Congo Hemorrhagic Fever in France

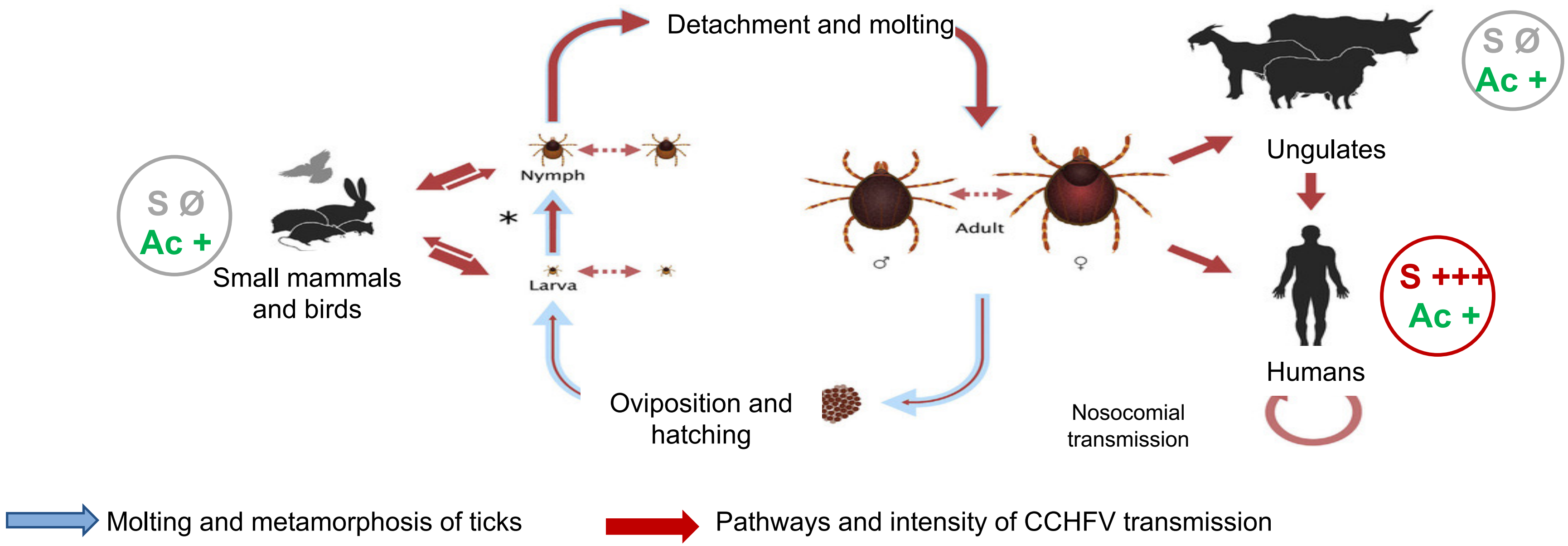
Laurence VIAL

A new tick species detected in South of France in 2015 (but already present in Corsica Island since the 1950ies): ***Hyalomma marginatum***.

Grech-Angelini S et al. 2016. Parasites & Vectors

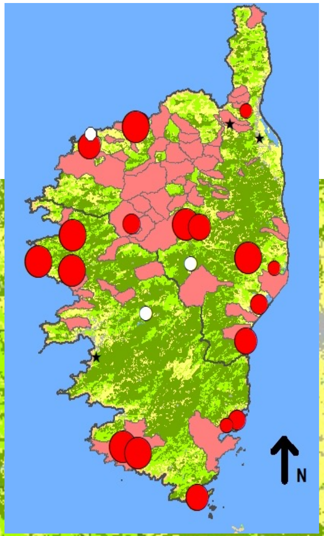
Vial L et al. 2016. TTBDs

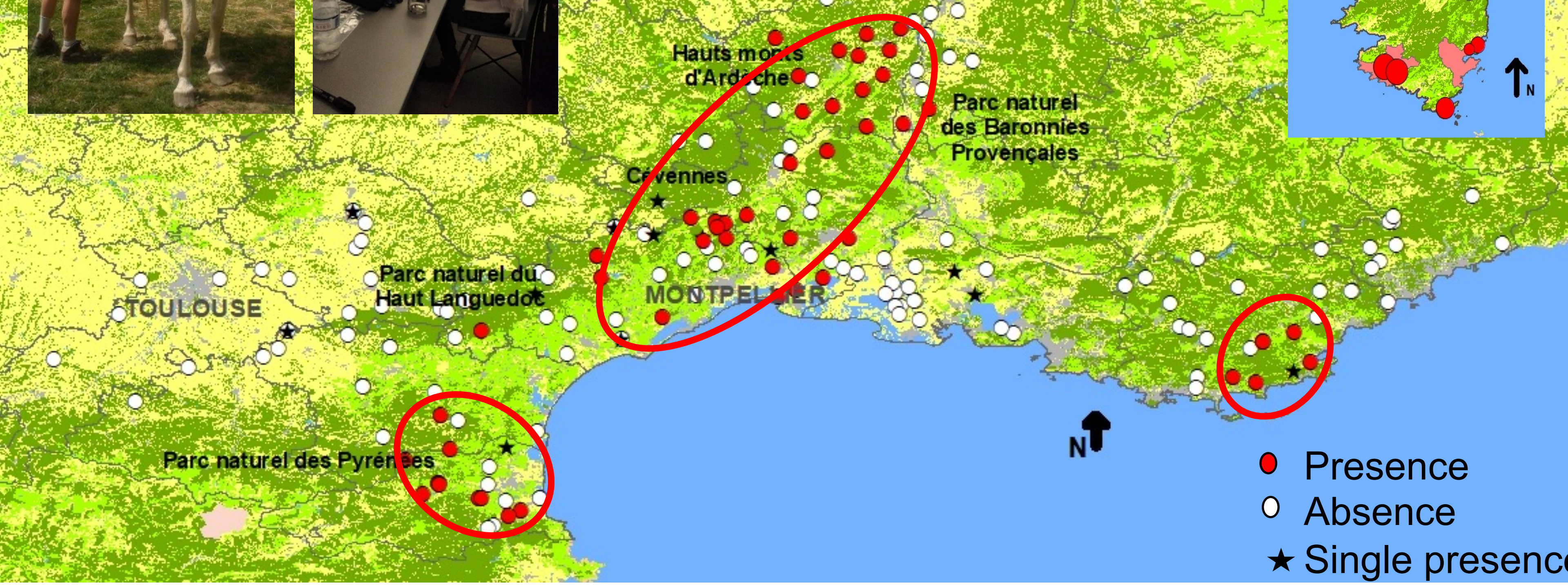
One of the main vectors of Crimean-Congo Hemorrhagic Fever virus (CCHFV) in the Mediterranean Basin.



H. marginatum is present **in coastal areas from Spain to Italy on the mainland** (spatial clusters).

It is **abundant in Corsica Island** on horses and cattle .

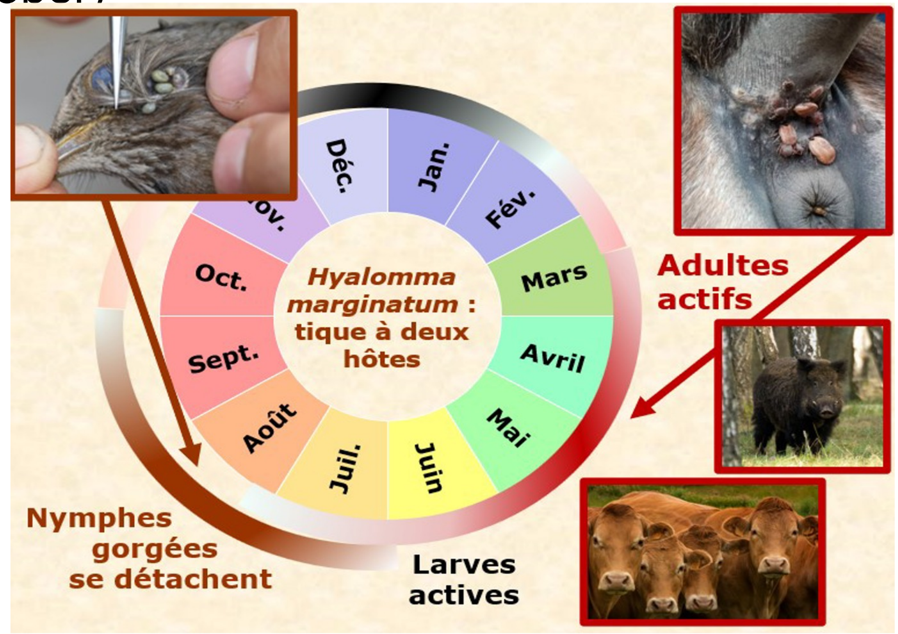




Stachurski et Vial. 2018. Bulletin épidémiologique, santé animale et alimentation n°84 (8) – Mai 2018
Bah. 2022. Transboundary and Emerging Diseases. doi: 10.1111/tbed.14578

LONGITUDINAL MONITORING: Seasonal dynamics of *H. marginatum*

H. marginatum is active at **spring for the adult stage** (April to July) and in **autumn for the immature stages** (July to October)

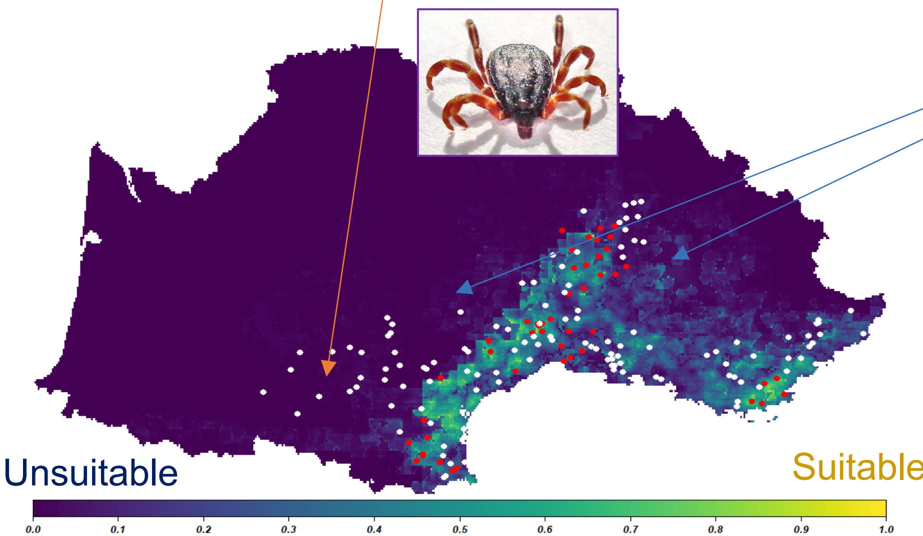


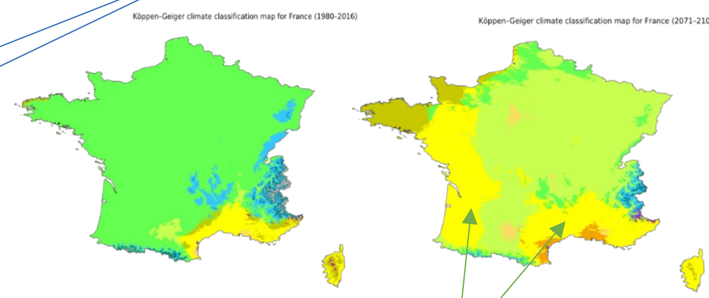
Stachurski et Giupponi, in prep

Experiments conducted on ticks reared in insectary and placed in field cages showed that **unengorged adults can overwinter** (behavioral diapause) and occasionally engorged females (development diapause).

The main factor of establishment is **the cumulative temperatures between the hatching of females and the next adult generation.**

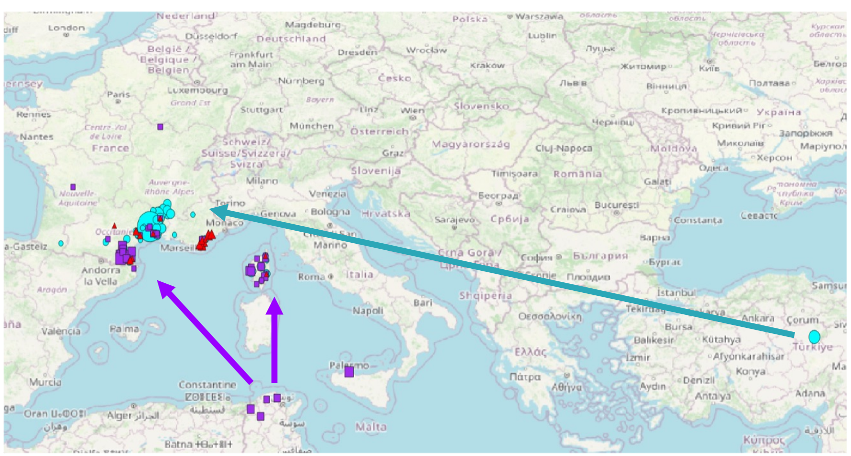
H. marginatum is predicted to remain Mediterranean and seems to be limited by humid oceanic climates (west) and cold continental/mountainous climates (north).





Mediterranean climate is predicted to expand in the next 50 years.

Bah et al. 2022. Transboundary and Emerging Diseases. doi: 10.1111/tbed.14578.



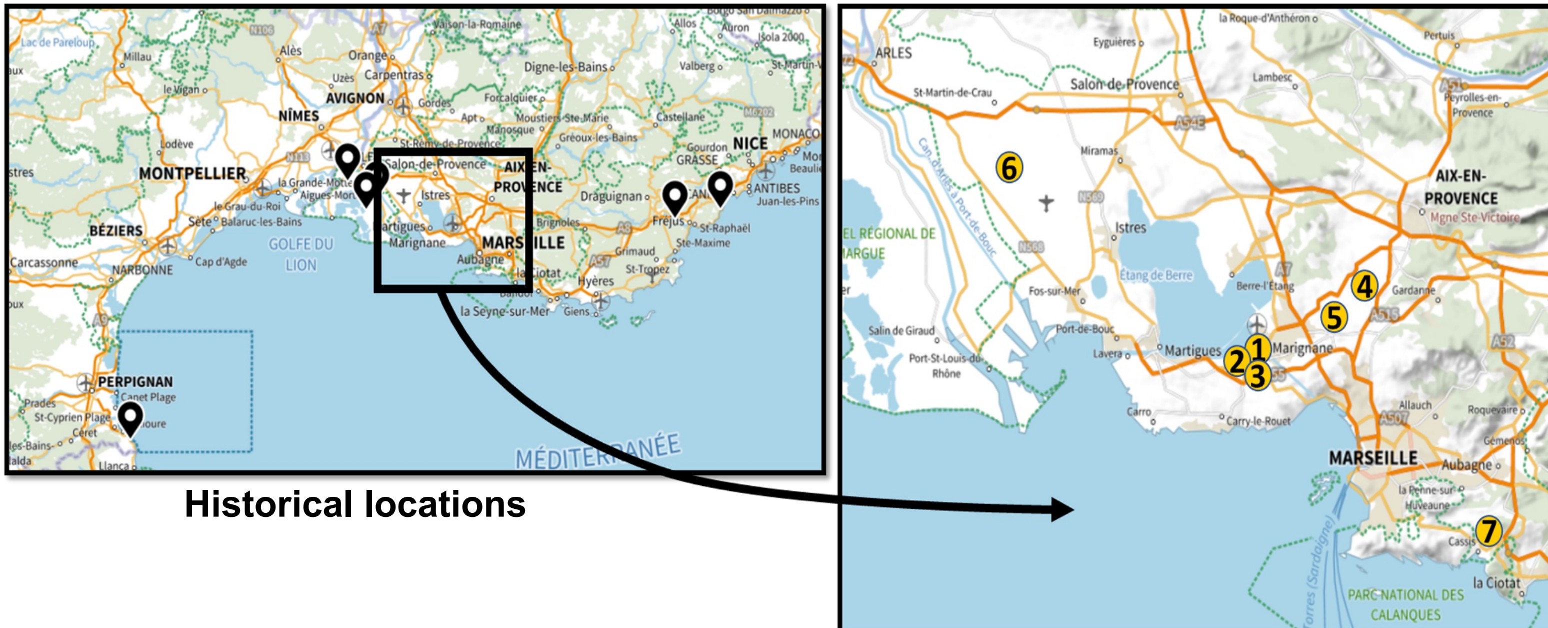
Giupponi et al., in prep

Different genetic groups signing **several events of introduction and establishment,** and then spread around introduction foci.

In **Bouches-du-Rhône**, near Marseille, ***H. lusitanicum* has been detected since 2020 around wild rabbits' warrens.**

Although we assumed it has disappeared from France due to myxomatosis and Hemorrhagic disease in rabbits since the 1970ies.

Stachurski et al. In prep.



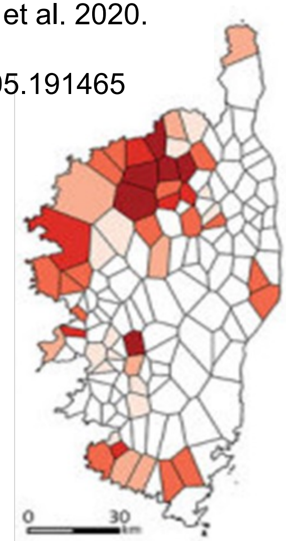
Historical locations

Recent locations

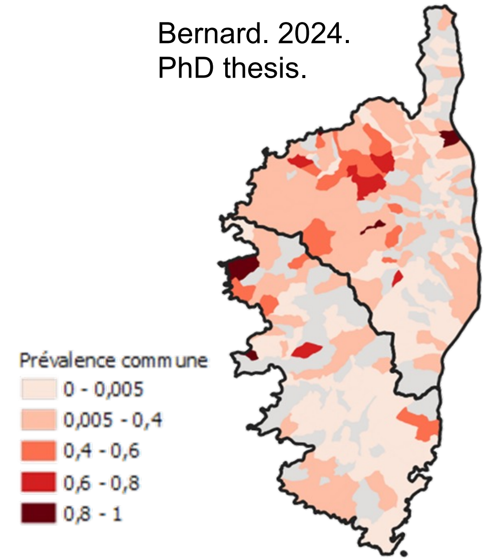
In Spain, H. lusitanicum is considered the main vector for CCHFV prior to *H. marginatum* that is also present.

In Corsica,

Grech-Angelini et al. 2020. EID. doi: 10.3201/eid2605.191465



Bernard. 2024. PhD thesis.



2014-2016: Around 4,000 sera

Global seroprévalence = 9%

Cattle = 13% / Small ruminants =2-3%

2019-2020: Only cattle (around 6,000 sera)

Global seroprevalence = 15.8%

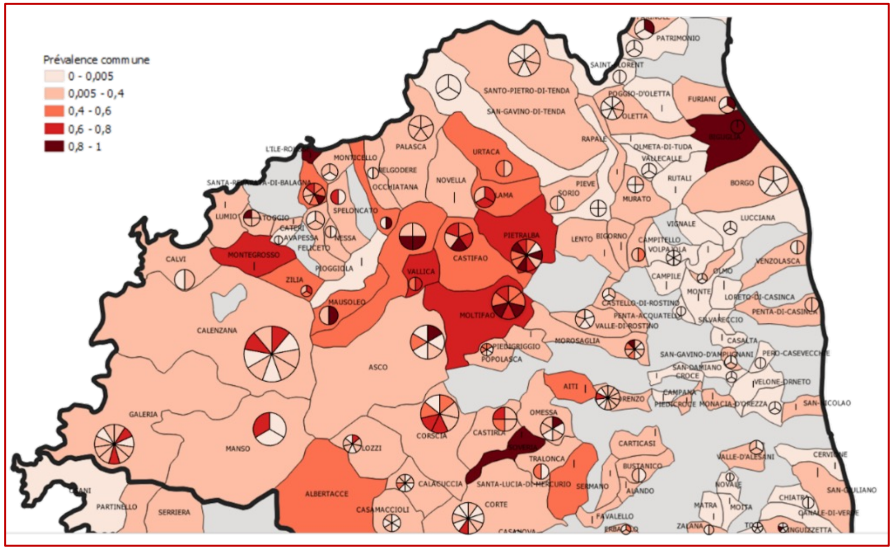
→ **CCHF antibodies were detected in both studies**, with **persistant virus transmission** (similar seroprevalence and same hotspots of transmission)

Spatial heterogeneity at farm level

(2 farms can be close but with opposite status)

→ Importance of **breeding practices**

Free-ranging in spring/summer pastures (++)



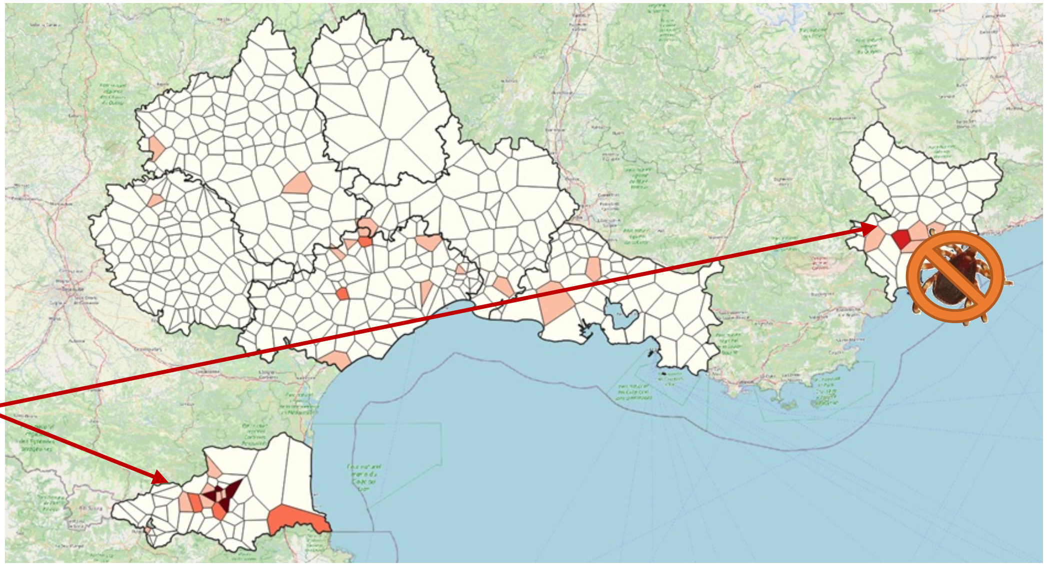
FIRST SEROLOGICAL INVESTIGATIONS: Suggested circulation of CCHFV (2)

On mainland,

2018-2020: Around 8,500 cattle sera

Global seroprevalence = 2%

→ **High transmission areas, similar to Corsica** (global seroprevalence = 7-9%, intra-herd up to 80-100%)



Bernard. PhD, 2023.

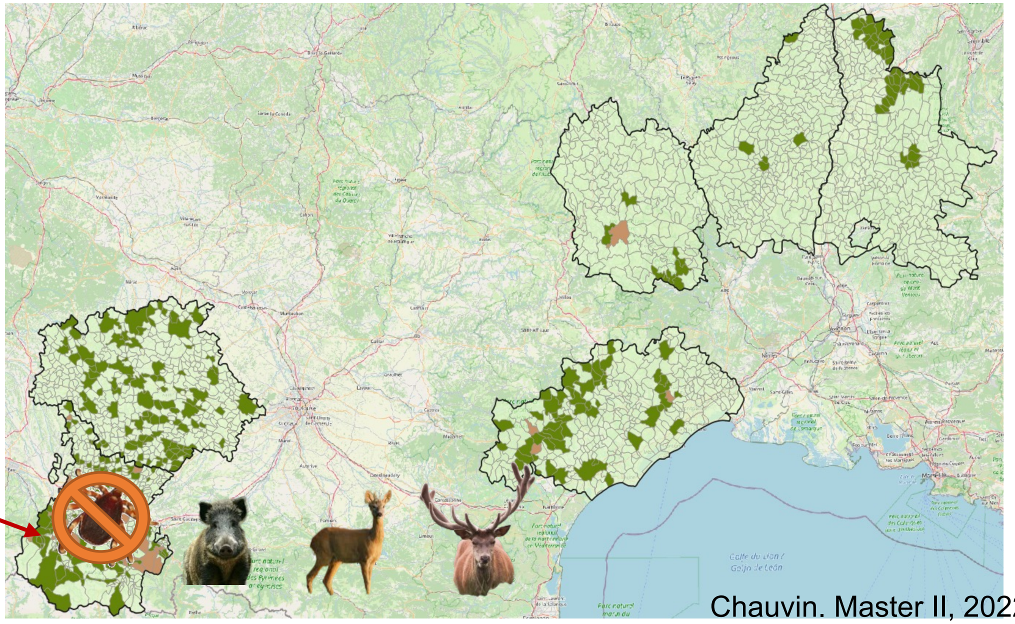
2008-2022: 2,000 sera from wilboar, roe and red deers, mouflons

A few seropositives in wilboar, where *H. marginatum* is abudant

→ **Many seropositives in Hautes-Pyrénées**

where *H. marginatum* is predicted to be absent

Secondary vectors?

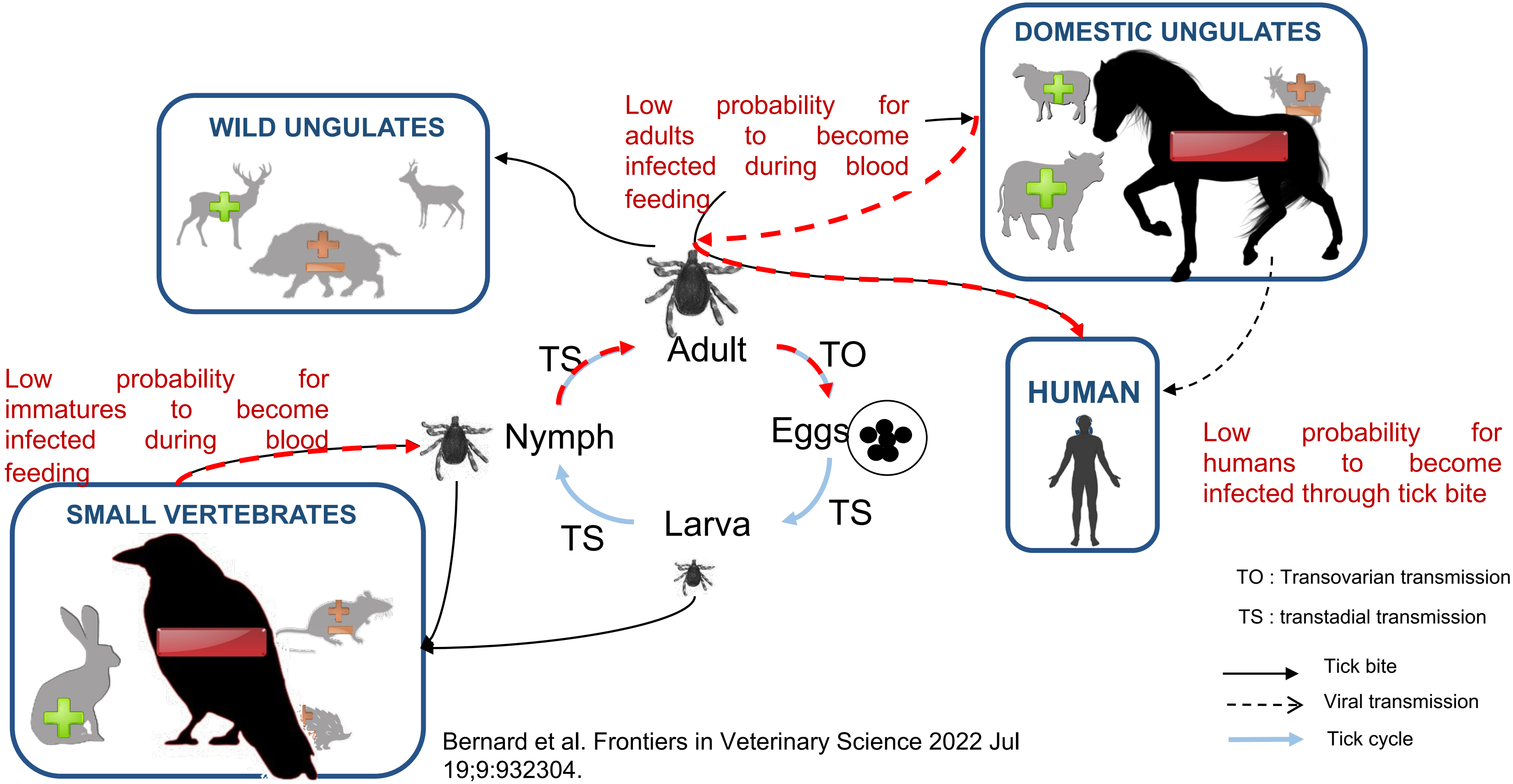


Chauvin. Master II, 2022

Tick vectors present in France, local densities of animal hosts and their respective abilities to replicate efficiently CCHFV

→ Between ticks and animals, **rate of CCHFV transmission is assumed to be low** (dilution hosts)

→ Necessary to **optimisize our sampling design for tick collection to detect CCHFV**



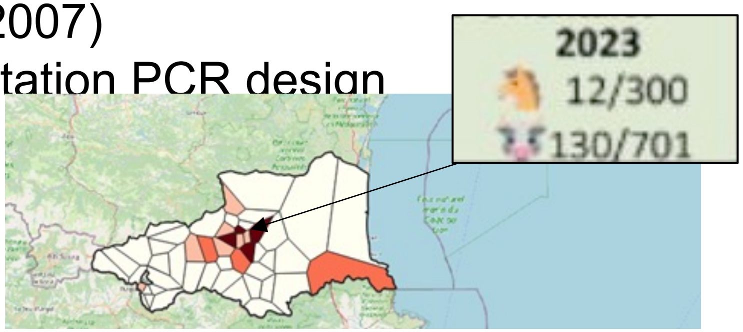
Bernard et al. Frontiers in Veterinary Science 2022 Jul 19;9:932304.

On the mainland (2023),

Targeted sampling in Pyrénées-Orientales **(High seroprevalence)**

- **In or around farms highly seropositives**, on pastures suitable for *H. marginatum*
- **In April** (suspected period of virus recirculation because of tick activity)
- **Mainly on cattle** (« good » amplifiers for CCHFV, allowing tick reinfection)

Optimization of virus detection method (collaboration with Innovative Diagnostics)
- 2qRT-PCR CCHF (Sas, 2018; Wölfel, 2007)
- Production of positive control and adaptation PCR design



14 cattle farms and 4 equestrian structures
1001 *H. marginatum* → **142 positive ticks**

→ Confirmed by validated PCRs in the National Reference Center (BSL-4 Lyon)
→ Proportion of infected ticks in positive farms: 3-55%

Bernard et al. Eurosurveillance 2024. 29(6):2400023

NEW TICK COLLECTIONS : Different genotype in Corsica

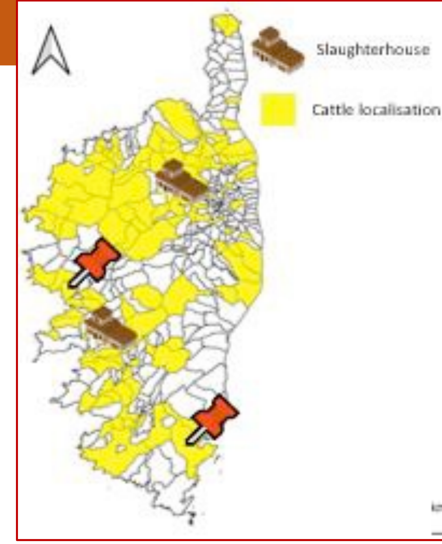
In Corsica,

Thanks to **tick surveillance in slaughterhouses**, a total of 24 pools of ticks collected from five cattle from two sites of southern Corsica were detected positive in 2023.

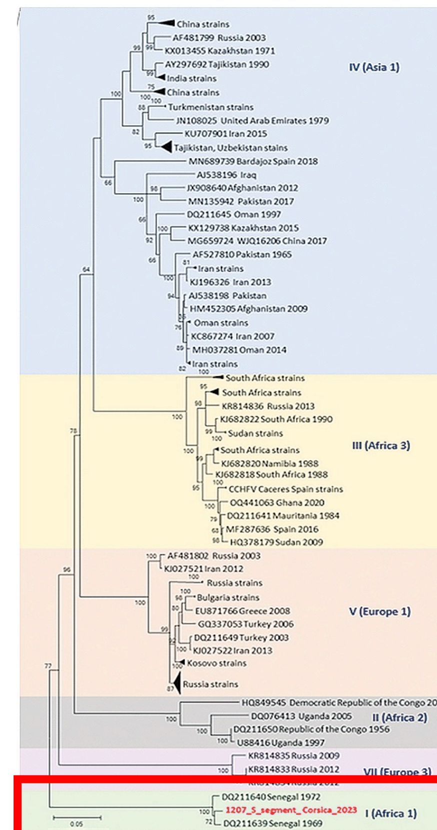
Continental virus belonged to genotype III (AfrW, AfS, Esp)

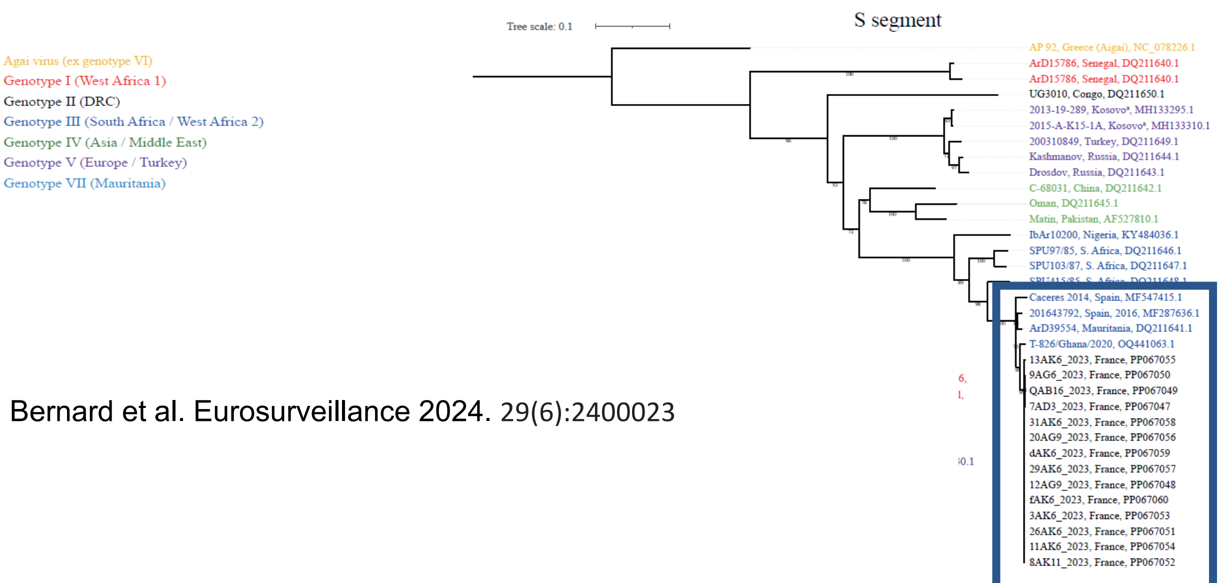
Whereas Corsican virus belonged to genotype I (AfW)

→ Different events of CCHFV introduction



Kiwan et al. EID 2024. 30 (5): 1036-9





Bernard et al. Eurosurveillance 2024. 29(6):2400023

No impact on animal health

- **No clinical signs** in domestic and wild ungulates
- **Animals are not reservoirs** (transient viremia); ticks are the only reservoirs!

Impact on human health

- **Risk of tick bites** : Only by adult stages, unengorged ones, free in the environment
  Between April and July
  Only in CCHFV transmission zones

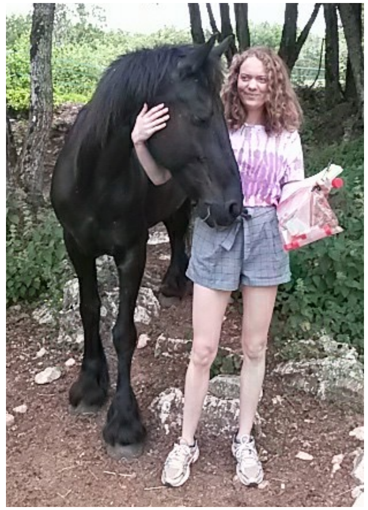
  → Prevalence of infection in ticks? Exposure for humans? Other vectors?

- **Risk of contact with contamined animal fluids** :
  During their short transient viremia (5-10j) – only « good » amplifiers
  At spring for domestic and wild ungulates (activity of adult ticks)
  In autumn for lagomorphs (activity of immature ticks)

  → Infectious dose? Respective ability of species to infect? Virus and Ab dynamics?

- **Risk of nosocomial transmission** when human cases will occur

Two national expert groups (ANSES and HCSP) – Vial. 2024. Semaine Vétérinaire n°2038, 14 juin 2024




Thank you for your attention





Day 2: Application to Tick-Borne Virus infections

ARCHE - A French research project on CCHF

By Alessandra Falchi

ARCHE: Assessing the Risk of Crimean-Congo Haemorrhagic fever Emergence in Southern France

Alessandra Falchi, MCU-HDR, UCPP
Unité de Virus Emergents
Aix-Marseille Univ, Università di Corsica, IRD 190, Inserm 1207, IRBA, France
ARCHE Consortium

Arbo-France
Réseau Français d'étude des arboviroses
24-25 October 2024

ARCHE: Assessing the Risk of Crimean-Congo Haemorrhagic fever Emergence in Southern France.

October 2024 –2029

Six Work Packages

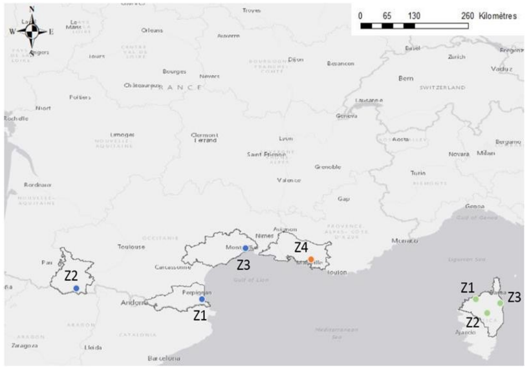
11 internationally teams

Lead by: Emerging Viruses Unit

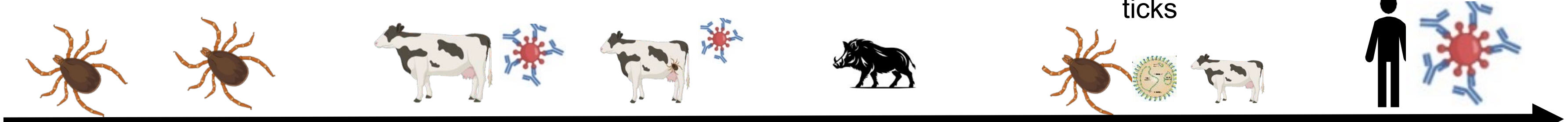
UVE
UNITÉ DES VIRUS ÉMERGENTS
INSERM1207 – IRD190 – AMU – EFS – IRBA

ARCHE: information gathered by ARCHE partners at the outset of the project

Aims: To elucidate the determinants of CCHFV emergence in two regions of Southern France: Occitania and Corsica



Evidence of establishment *Hyalomma marginatum* → Increasing evidence of exposure of domestic animals to CCHFV → Evidence of exposure in wilboar → Evidence of CCHFV circulation in ticks → First data on human exposure to CCHFV



1950 Corsica

2016 Occitania

2014-2016 Corsica

2018-2020 Corsica Occitania

2008-2022 Occitania

2023 Africa 1 Africa 3

CCHFV IgG in human population in Corsica

Serological evaluation of Crimean-Congo Hemorrhagic fever in residual sera and in humans with High-Risk professional exposure collected in 2022-2023 across Corsica (France).

Populations

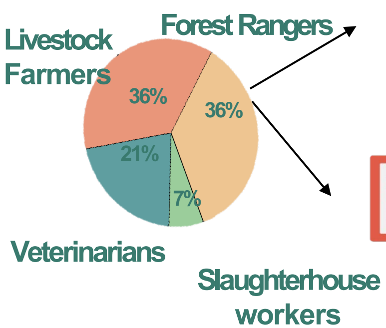
Medical labs

N=2,500 serums **11 medical labs**

Age, sex and lab location

At risk population

N= 201 individuals high-risk professional exposure



% Tick-bites and risk factors related to

ELISA

Anti-CCHFV IgG seropositivity

Anti-CCHFV IgG = 0.08% [95% CI: 0.06; 0.09]

Two individuals, aged 72 and 77 years, (northern region of Corsica)

Anti-CCHFV IgG = 0.5 % [95% CI: 0.43; 0.56]

A 53-year-old slaughterhouse worker

Abattoir worker

VNT confirmation

Evidence of neutralizing antibodies has been assessed for the 53-year-old slaughterhouse worker with a neutralization titer of 1:40

Slaughterhouse worker

(1:40)

- **Cell line: Vero E6;**
- **Virus: clinical isolate CCHFV Kosova-Hoti (Europe I) (EVA Global reference number Ref-SKU: 007v-EVA70)**

University of Ljubljana

The University of Ljubljana, Faculty of Medicine, Institute of Microbiology and Immunology

Results: Self-reported tick-bite exposure and risk factors for tick bites among high-risk groups

Self-reported tick-bite history in their lifetime

66% (n=118 of 179)

30% french general population

Septfons A *et al.*, 2022 (Barometre santé 2019)

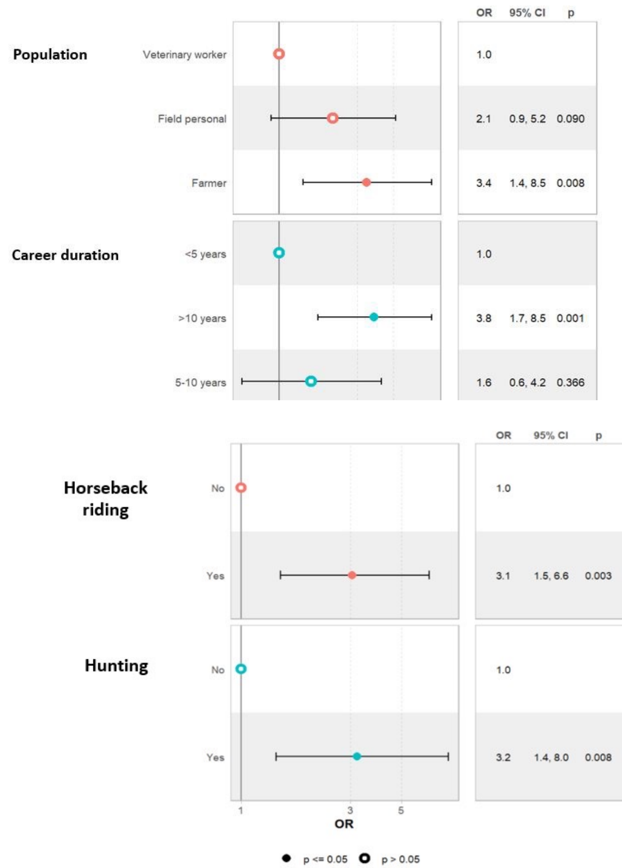
Self-reported tick-bite history during the last 12 months

30.0% (n=35)

6% french general population

Septfons A *et al.*, 2022 (Barometre santé 2019)

Multivariate analyses on risk factors for tick-bite rates



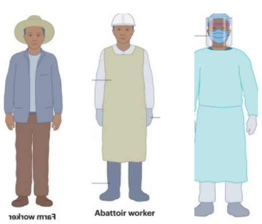
Livestock Farmers (OR = 3.4 [1.4-8.5])

Horseback riding (OR = 3.1 [1.5-6.7])
Hunting (OR = 3.4 [1.4-9.1])

Serological evaluation of Crimean-Congo Hemorrhagic fever in humans with High-Risk professional exposure and in residual sera collected in 2022-2023 across Corsica (France).

- This study provides:
  - first evidence of human exposure to CCHFV in Corsica, with rates consistent with those observed in other Western European regions;
  - a risk of CCHF in the Corsican population, particularly in farmers and slaughterhouse workers.

It also provides an important BASELINE database for further research on the virus

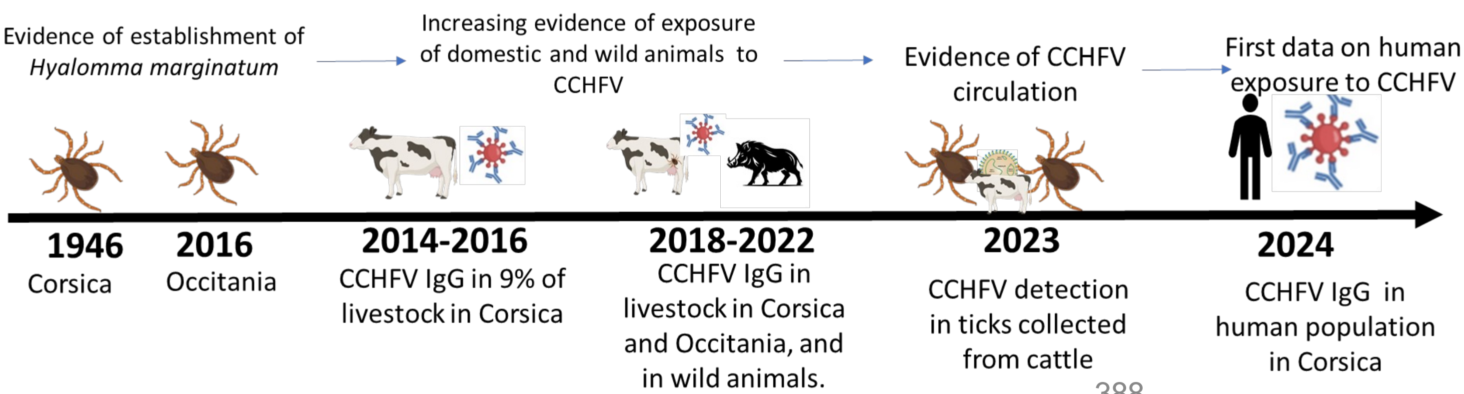


The need to consider studies with more high-risk human populations

ARCHE: information gathered by ARCHE partners at the outset of the project

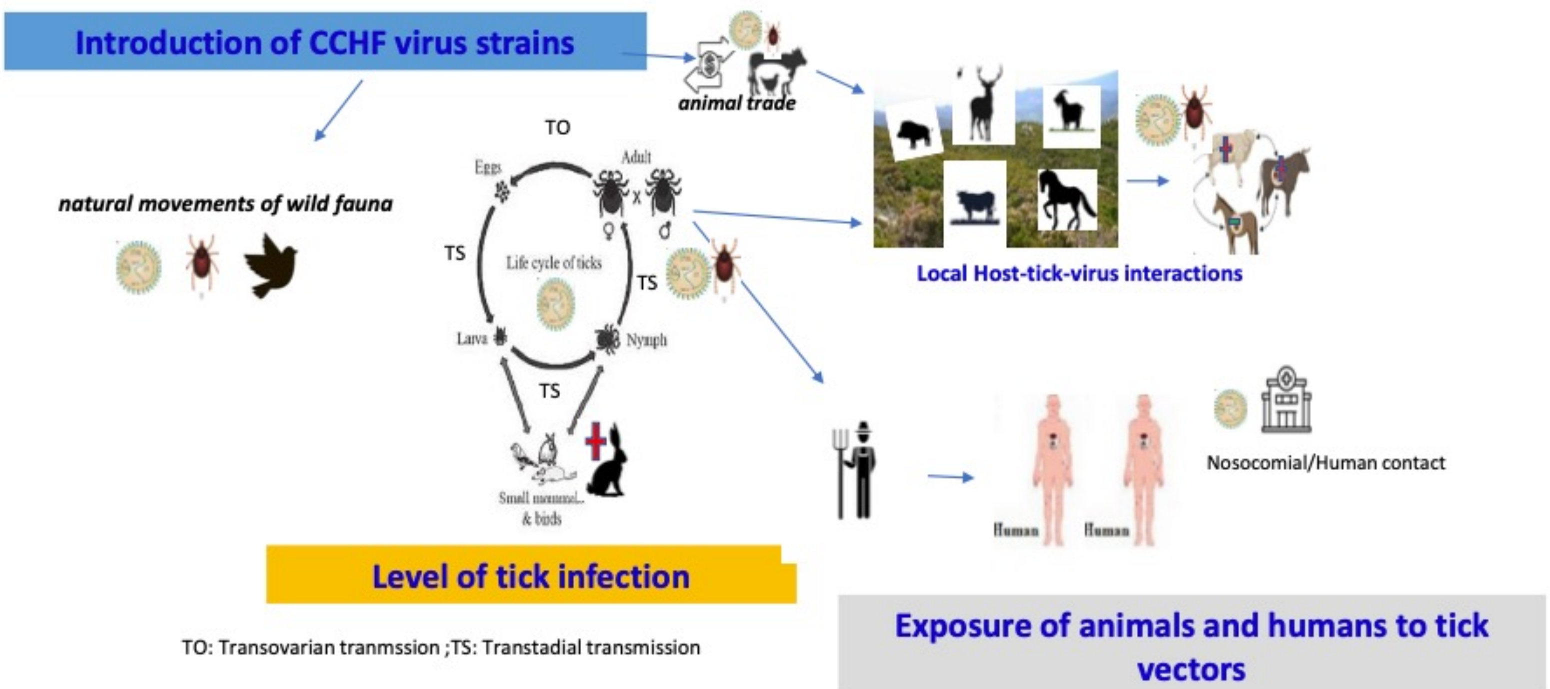
The seroprevalence rates reported in the Corsican population and all the various epidemiological elements described here :

- Are not sufficient to assess the risk of the emergence of autochthonous cases (none have yet been reported in France),
- But they do provide evidence of the risk of exposure.



Main Hypothesis of ARCHE

- CCHFV is silently circulating in ticks and vertebrates in southern France;
- The CCHFV transmission determinants and pathways may vary spatially, according to local conditions.

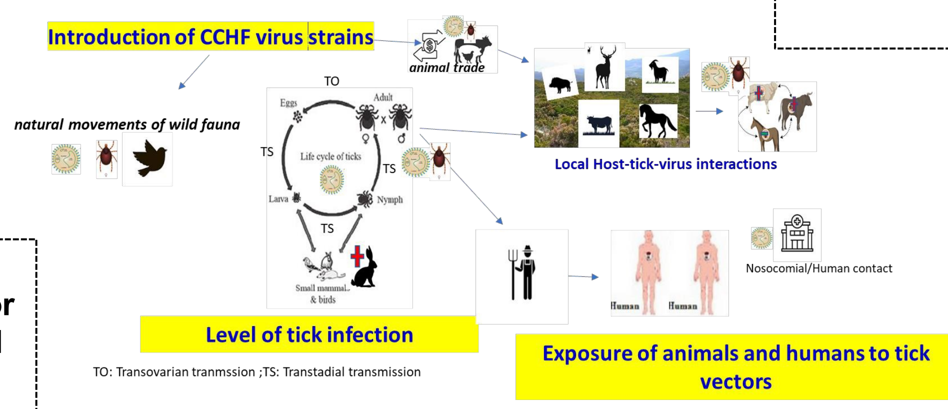


TO: Transovarian tranmssion ;TS: Transtadial transmission

ARCHE: Description and main Work Packages (WPs)

WP1. To evaluate exposure of animal and humans to tick bites and CCHFV

WP2. To document perceptions and practices regarding Health/Nature/Agriculture, among scientists, local communities and stakeholders.



WP3. To characterize Tick - animal - environment interactions

WP4. To improve laboratory methods for detecting CCHFV and estimate the viral circulation

WP5. To elucidate and estimate the spatio-temporal determinants and mechanisms of CCHFV transmission at the animal- tick-human interface using modelling approaches.

WP6. Project Management

Main criteria used for study areas pre-selected for ARCHE

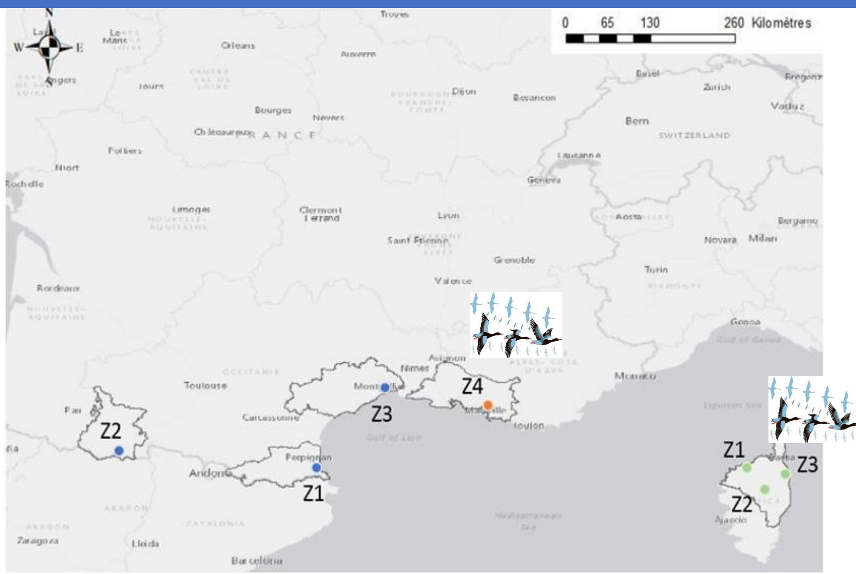


Figure 1 : Study areas selected

Two regions: Corsica and Occitania

Three areas by regions: To test hypothetical factors influencing the endemic circulation of CCHFV at the interface animals-ticks and the exposure of the human population.

Two criteria:

- A significant CCHFV seroprevalence rates in domestic or wild animals;
- A significant spatial heterogeneity of seroprevalence rates between investigated farms

- **To test the hypothesis of the potential introduction of the virus through infected ticks transported by migratory birds**, two points of introduction (**POI**) have been selected (Z3 in Corsica & Z4 in PACA in Fig. 1)

Pre-selected areas in Corsica

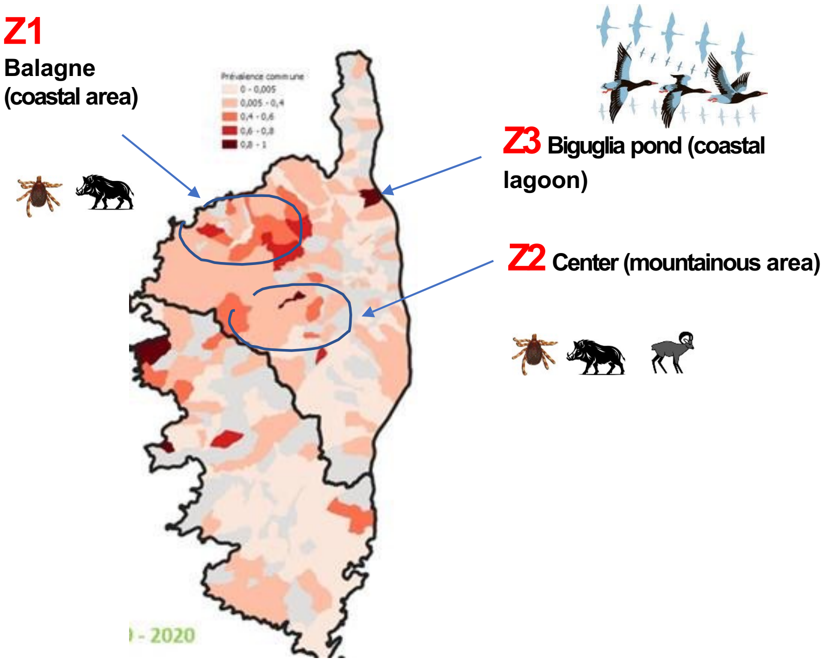


Figure 2 : Study areas pre-selected in Corsica

Study areas	Zone 1	Zone 2
Area localization	Northwestern/Balagne area (coastal).	The center area (mountainous area)
Km² and inhabitants	273 Km2 area of and 9,750 inhabitants	220 Km2 area and 1,320 inhabitants
CCHFV positive rate of farms	91% (20 of 22).	83% (20 of 24).
Median value CCHFV positive rate	30% [15-57%].	50% [0-100%].
Hyalomma marginatum	Presence	Presence
Wild animals/Livestocks	Wild boars	Wild boars and mouflons

Corsica: Zone 3 POI (Biguglia pond). A shallow coastal lagoon in the northeastern.

Pre-selected areas Occitania and PACA

Figure 3 : Study areas pre-selected in Occitania and PACA

Zone 1: The Conflent area in Pyrénées-orientales.

- *H. marginatum* is abundant;
- Seroprevalence rates in cattle are high;
- Wildlife are common and outdoor activities.

Zone 2: Hautes-Pyrénées:

- Status of *H. marginatum* is unknown;
- Cattle prevalence rates unknown;
- Wild animals presented CCHFV antibodies.

Zone 3: The countryside of Montpellier:

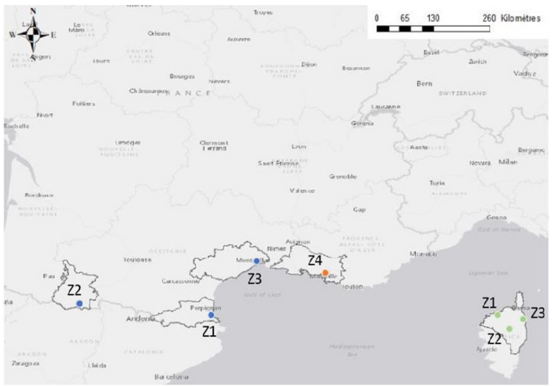
- *H. marginatum* is very abundant;
- Several cattle farms present seropositive animals.

PACA: Zone 4 POI 2 (Wetland environment (Camargue)).

- *H. lusitanicum* is invasive since 2022;
- *H. marginatum* has never been described

First year of ARCHE

Two main tasks (WP1 and WP2):



- **To update the epidemiological situation of pre-selected study areas and better characterize the "hot spots" identified**
  - **Serological study**
    - In blood donors;
    - In high-risk groups (abattoir workers; livestock farmers; veterinarians and rangers);
    - Cattle farms (GDS) and wild animals (wild boar/hunters)
  - To engage with local stakeholders to identify associated groups of actors willing engage in the project (WP2)
    - *to provide a better knowledge of social and ecological determinants of local epidemiological dynamics*

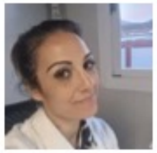
In parallel : A specific Hyalomma module in the "Signalement tiques" application will be developed to report Hyalomma ticks (and automatically identify tick species from images, based on artificial intelligence techniques (deep learning)).

Main expected outcomes of the project

- Spatial-temporal exposure of human and animal populations to tick bites and CCHFV explained by epidemiological factors and community science data;
- To provide a better understanding of the social and environmental determinants of local epidemiological dynamics through improved participation of citizens and local stakeholders in surveillance/control of emerging vector-borne diseases;
- To elucidate the role of specific tick-vertebrate combinations in the natural enzootic transmission of CCHFV;
- To establish a specimen repository in ISO20387 biobanks of ticks and human/animal sera for future studies of pathogen dynamics;
- To provide an ARCHE website with open source updated data for citizens and stakeholders.

ARCHE CONSORTIUM

WP1



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Dr P. Verger
ORS PACA

Dr A. Lurette
INRAE, SELMET

Dr J. DURAND
CITIQUE

Dr P. Frey-Klett
CITIQUE

WP2

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ASTRE, CIRAD

Dr E. de Garine
LESC,
U. Nanterre

WP3

Dr L. Vial
ASTRE, CIRAD

Dr M. Vittecoq
Tour du Valat

Dr F. JORI
ASTRE, CIRAD

Dr T. Pellet
ASTRE, CIRAD

WP4

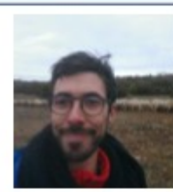
Dr R. Charrel
UVE, AIX-Marseille

Dr S. Moutailler
BIPAR, Anses

WP5

Dr R. Metras
SUMO, IPLESP

Dr A. Apolloni
ASTRE, CIRAD



Dr. J.B. Menassol
INRAE, SELMET

ARCHE

One Health

Thank you for your attention

Day 2: Application to Tick-Borne Virus infections

Coffee break, back in 20 minutes

With the next presentation:

New TBV monitoring tools

By Sara Moutailler

anses

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

ÉCOLE NATIONALE VÉTÉRINAIRE ALFORT
Paris - 1765

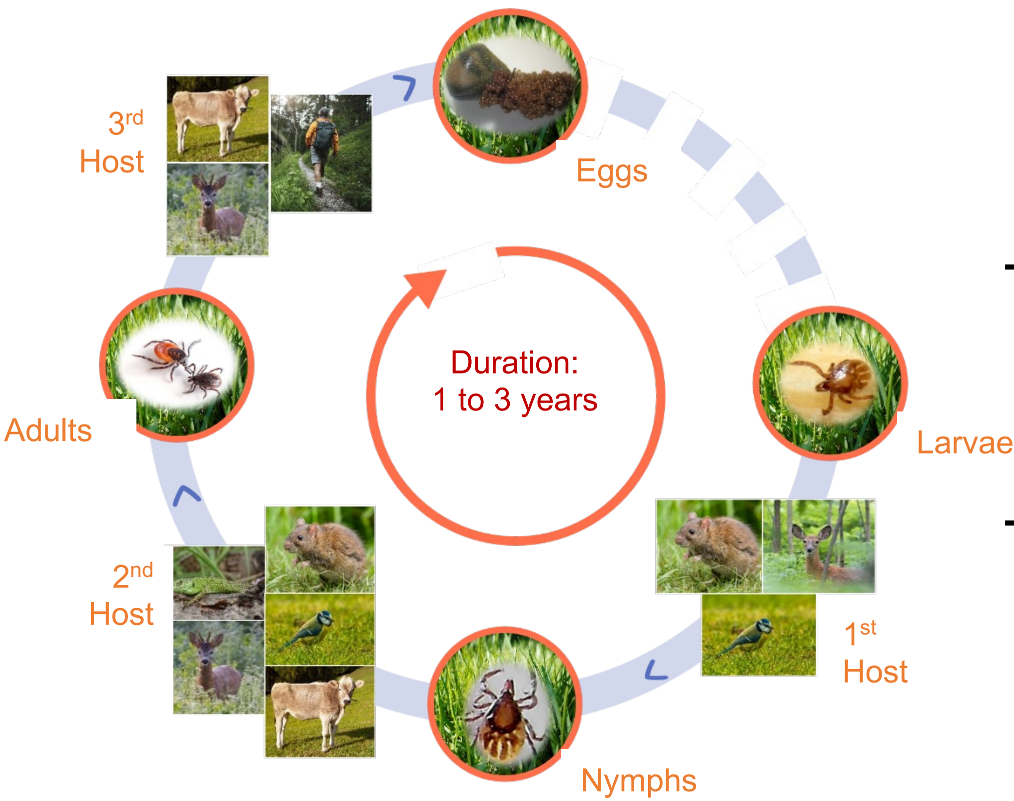
High-throughput nanotechnologies for tick-borne pathogens detection

Sara Moutailler
ANSES - Animal Health Laboratory
UMR BIPAR - MiTick Team – Ticks&Co Group

Arbofrance _ Institut Pasteur_ 24-25 october 2024

Context: Ticks and tick-borne pathogens (TBPs)

Life cycle of ticks



Epidemiological impact

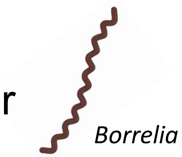
→ Acquisition and transmission of pathogens

→ Ticks are « hubs » in pathogen's circulation cycle

Context: Ticks and TBPs: “One health” concern

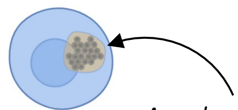
Most TBPs cause zoonotic diseases → « One Health » perspective

Borreliosis:
~ 40 000 human cases/year
(USA, CDC report 2021)



Borrelia sp.

Anaplasmosis:
~ 4000 human cases/year
(USA, CDC report 2021)

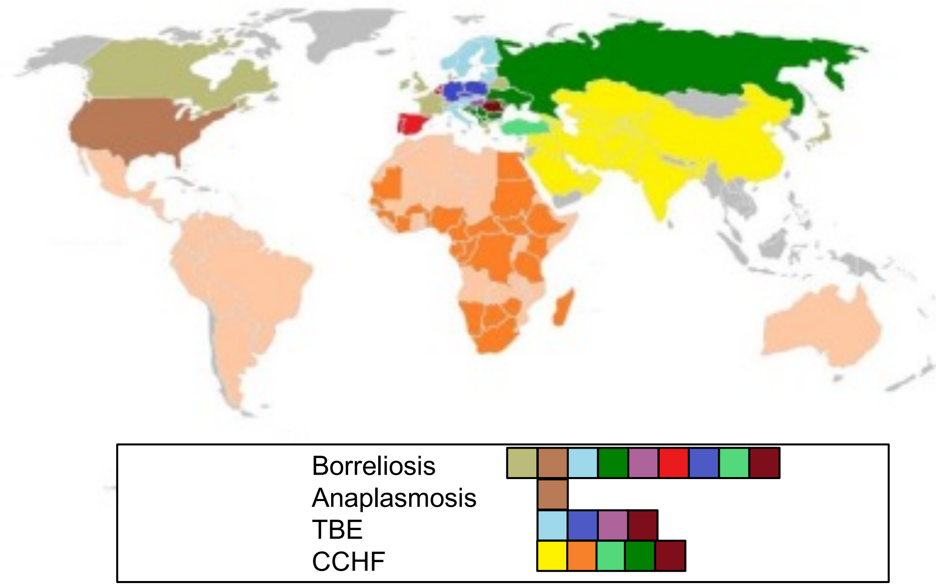


Anaplasma sp.

Tick-borne encephalitis:
~ 3000 human cases/year
(USA, CDC report 2021)

TBE virus

Distribution of main TBPs



Some TBPs affect only animals, but with a high economical impact

New TBPs are discovered each year

de la Fuente *et al*. 2017. Frontiers

Objectives: High-throughput detection of TBPs

Be able to detect in ticks (*I. ricinus* and others) : expected, non expected and new TBPs

- Detection and characterization without *a priori* of TBPs by RNA sequencing

- Development of a high-throughput tool using real-time microfluidic PCRs (Standard Biotools_BioMark™ dynamic arrays) to detect bacteria, parasites and viruses present in ticks

Material and Methods

Individual lysis in
300µL DMEM
+ 10% FCS

1 aliquot (virus isolation) -80°C

DNA from individual tick

RNA from individual tick

Random RT

Preamplification

Microfluidic PCRs
(BioMark Dynamic Arrays, Standard Biotools)

RNAs pooled by areas

Random RT (phi 29 polymérase)

RNA seq
(NGS)
(Illumina)

Institut Pasteur

Collaboration
Prof. Marc Eloit

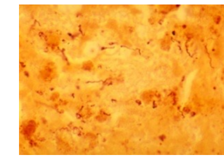
Microfluidic PCRs – Targets

Lorraine Michelet, Post-doc 2013

Mathilde Gondard, PhD, 2017

- Bacteria = 67 species (*Borrelia* spp., *Anaplasma* spp., *Bartonella* spp., *Ehrlichia* spp., *Coxiella burnetii*, *Francisella tularensis*, *Rickettsia* spp.)

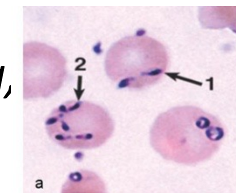
Borrelia burgdorferi spirochètes (Source: CDC)



- Parasites = 28 species (*Babesia* spp., *Theileria* spp., *Hepatozoon* spp.,…)

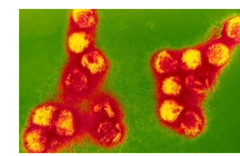
- 11 Genus of Bacteria, Parasites (*Borrelia*, *Anaplasma*, *Ehrlichia*, *Rickettsia*, *Bartonella*, *Theileria*…)

Babesia divergens (Source: EUCALB)

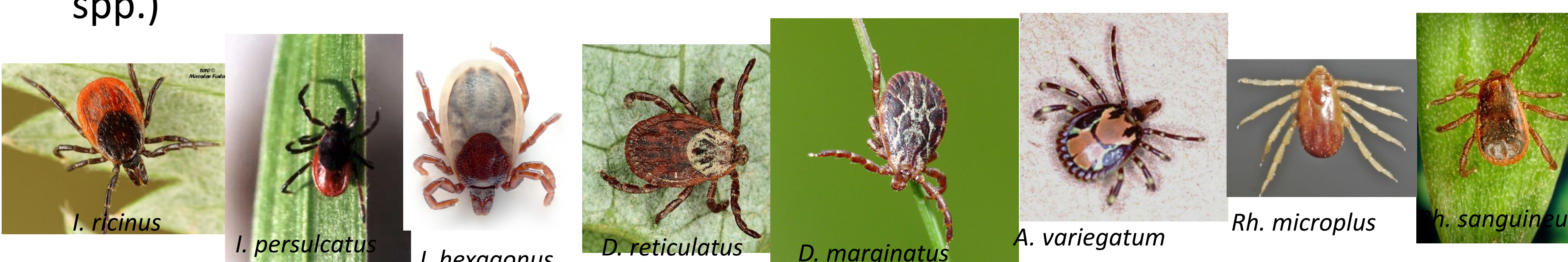


- Viruses = 53 viruses from 5 families and 8 genus

TBEV (Source: ECDC)



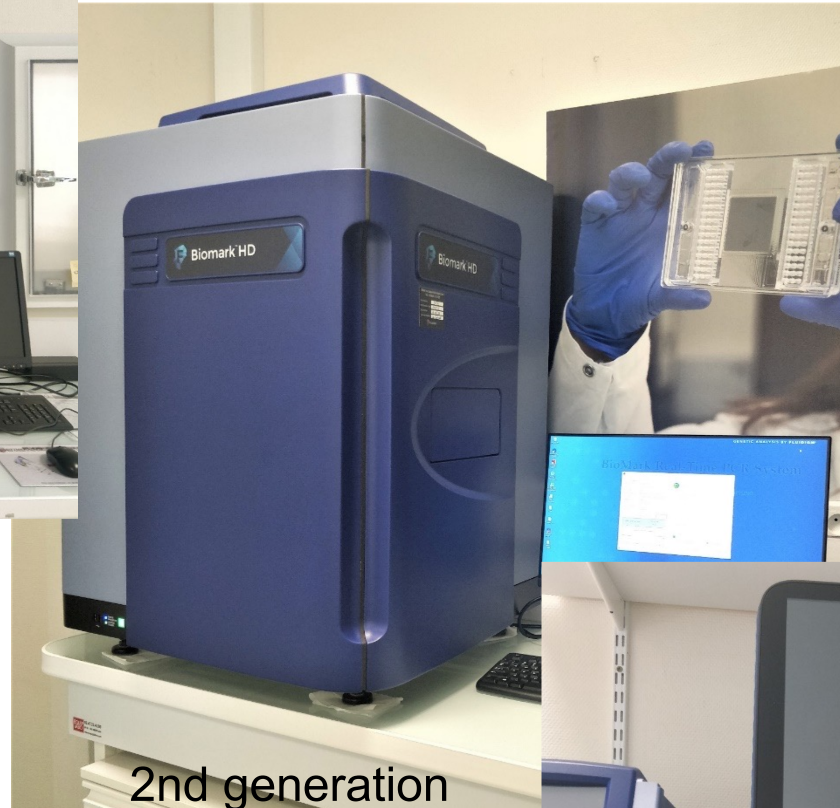
- Ticks = 8 species (*Ixodes* spp., *Dermacentor* spp., *Amblyomma* spp., *Rhipicephalus* spp.)



(Michelet et al., 2014 ; Gondard et al., 2018 ; Gondard et al., 2020)

Material _ BioMark HD System_ Standard Biotools

1st generation
~250k€



2nd generation
~200k€

3rd generation
~100k€

Patrick
FACH

Sabine
DELANNOY

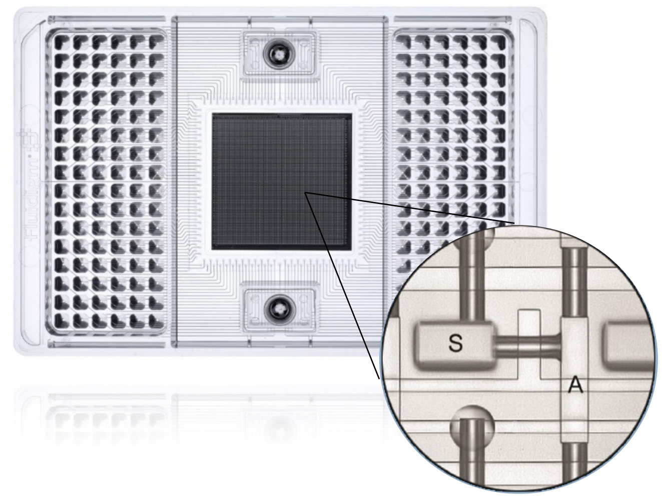
IdentyPath Plateform
ANSES

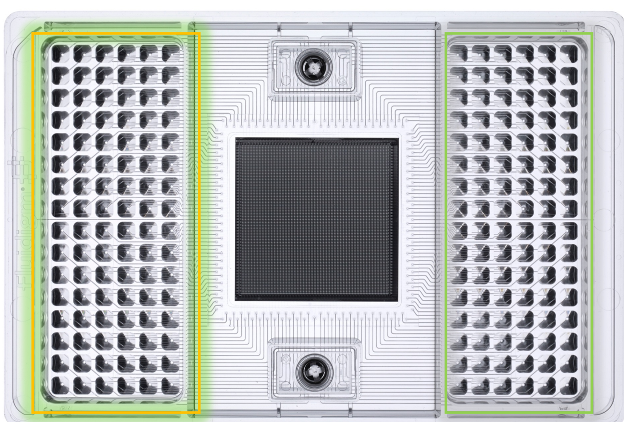
(previously Fluidigm company)

Material

BioMark™ HD System

Integrated Fluidic Circuit (IFC)
nanolitre reaction volumes





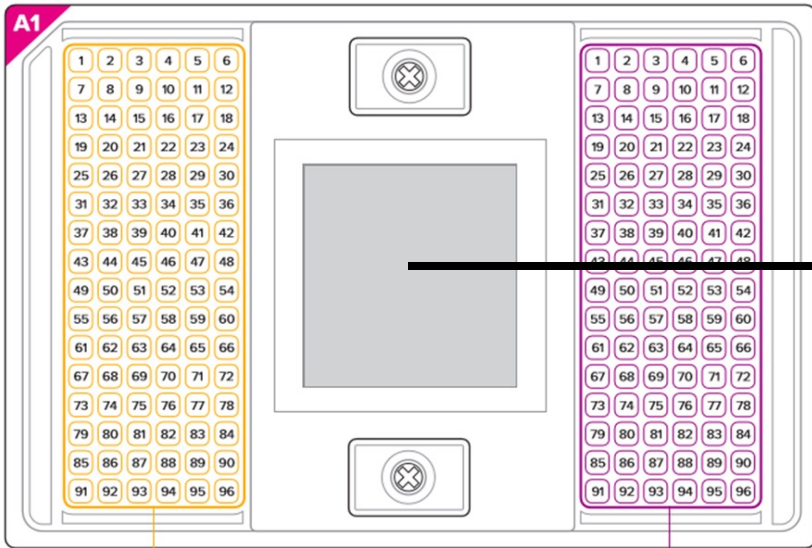
Targets

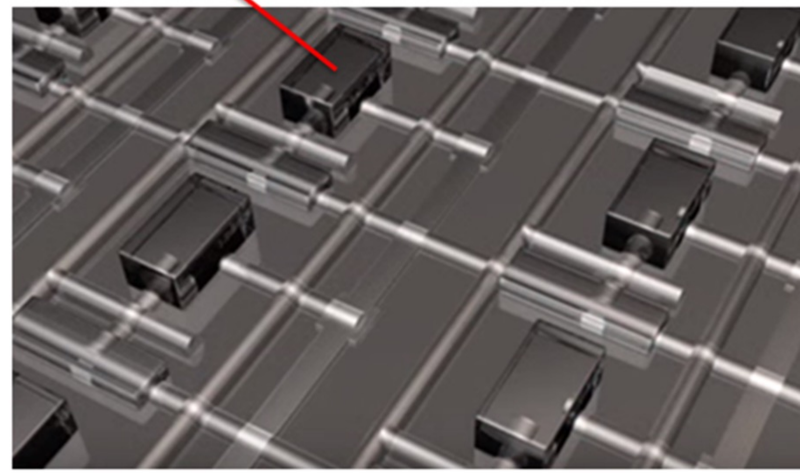
Samples

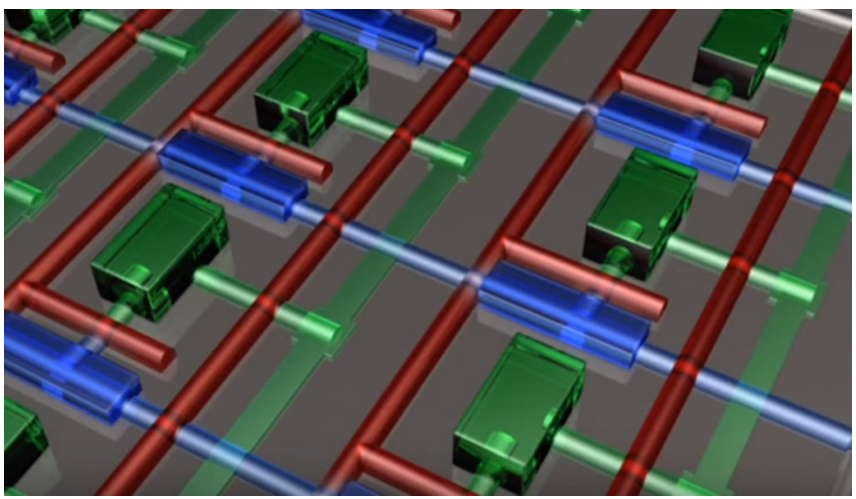
- Taqman probe (FAM – BHQ1): Ta 70°C
- Primers: Ta 60°C
- qPCR program:

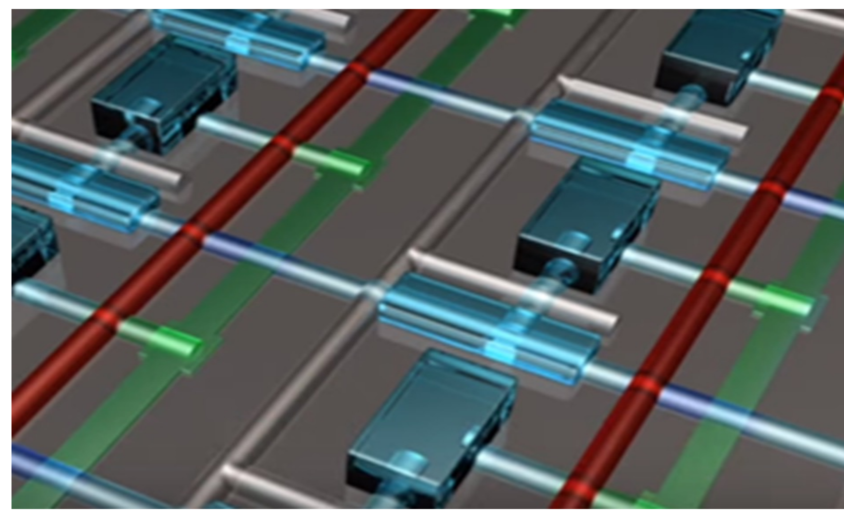
Pre-incubation	95°C	5 min
Amplification	95°C	10 s
(45 cycles)	60°C	15 s

Material



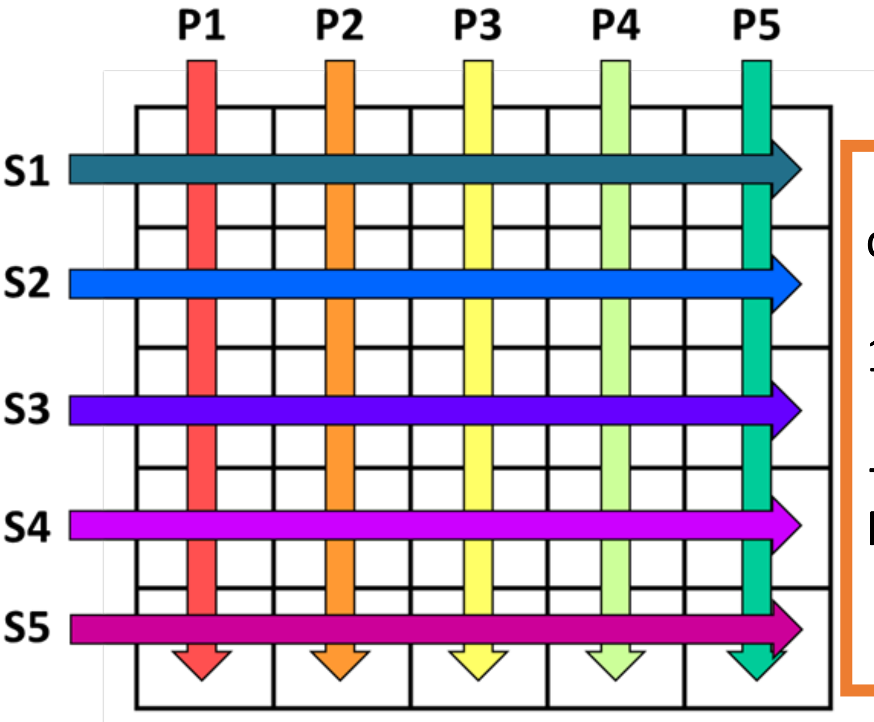






Material

Public Health England

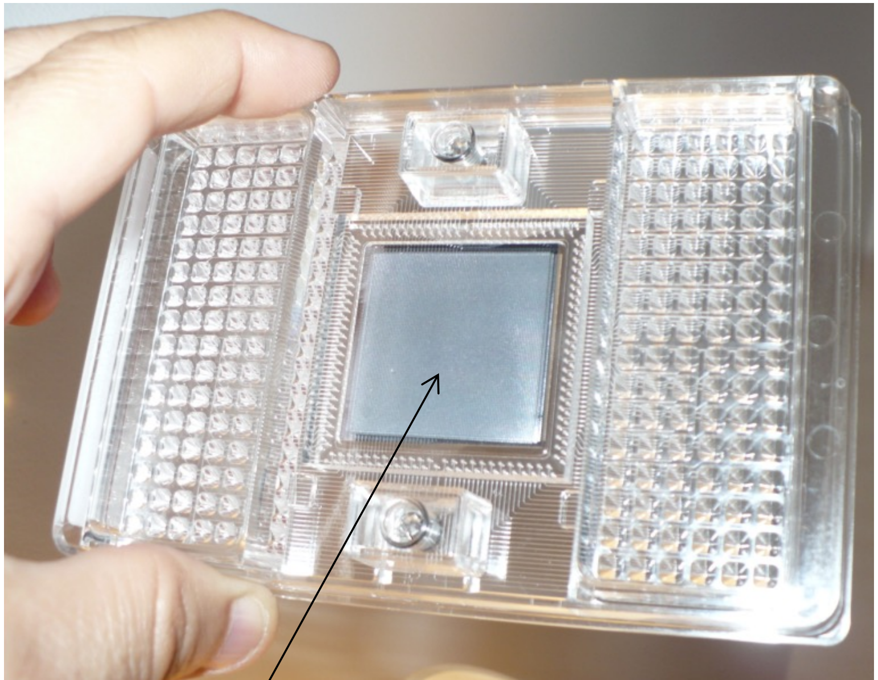


1 set of primers/probe (P) will meet all the cDNA

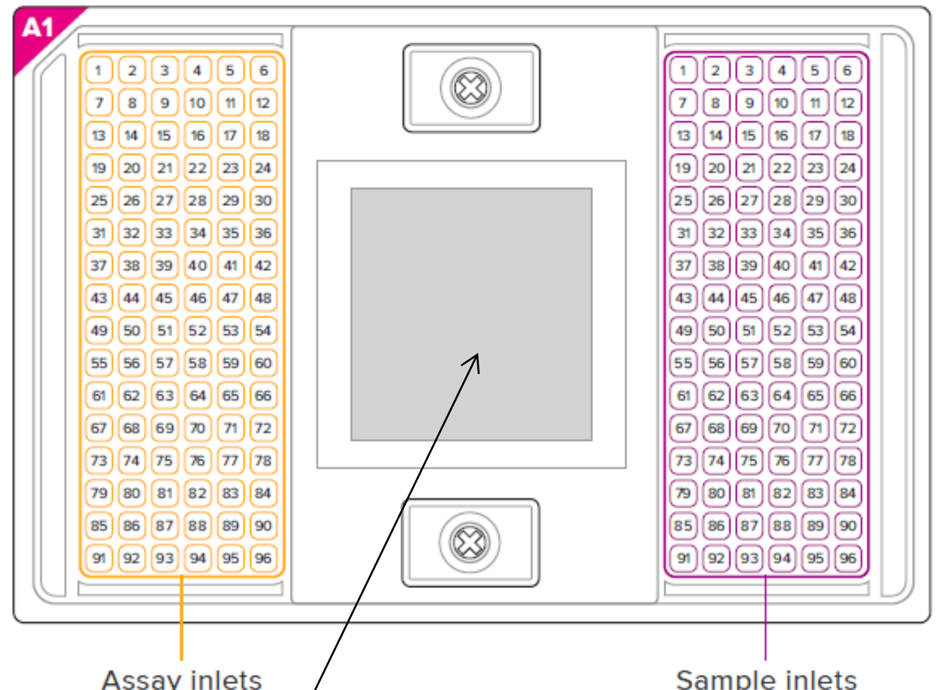
1 cDNA will meet all the sets of primers/probe

→ Individual real-time PCRs, not multiplex PCRs

Material



96.96 IFC Pipetting Map

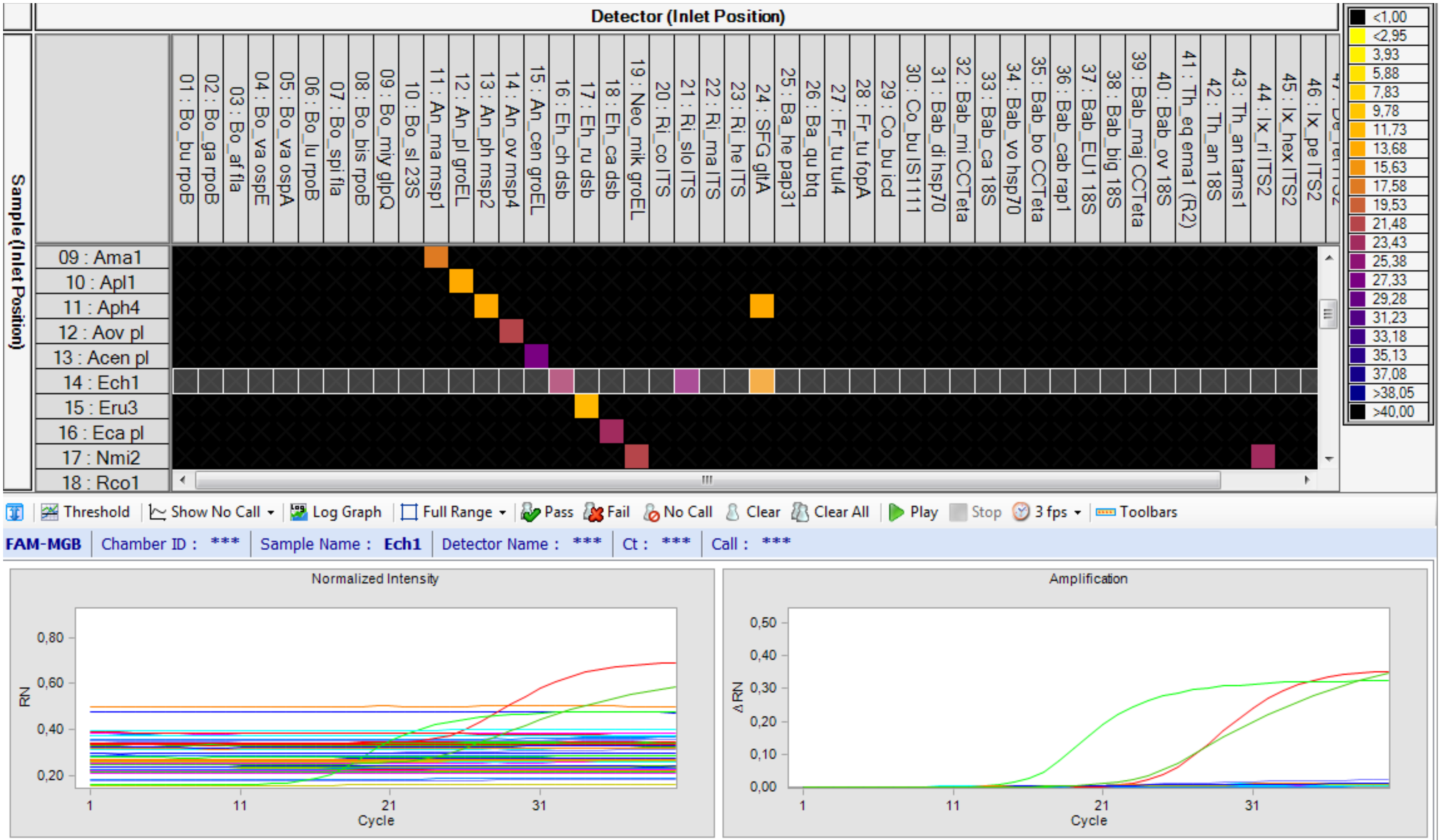


96x96 IFC: 9216 qPCR reactions

Or 48x48 IFC: 2304 qPCR reactions

Fluidigm GENETIC ANALYSIS

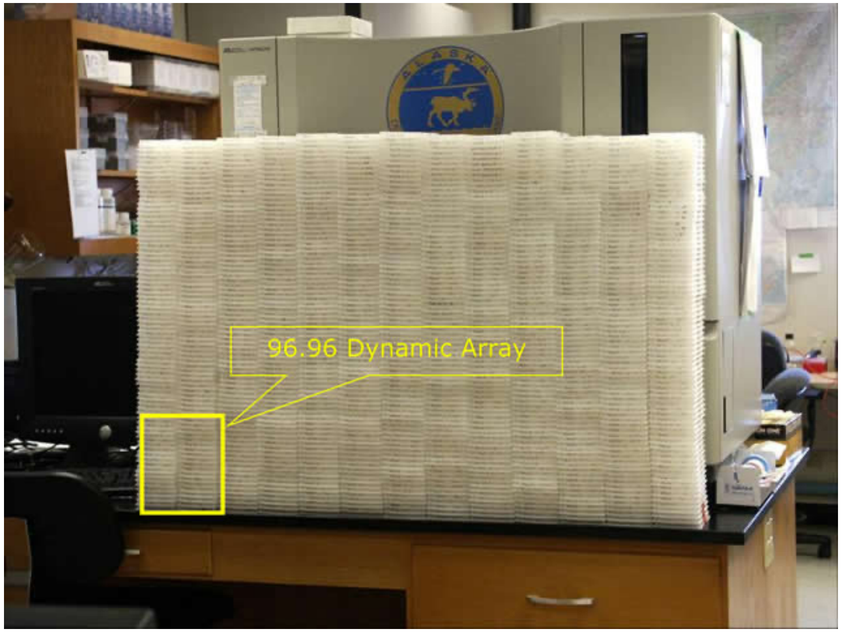
Material


Detector (Inlet Position)
Sample (Inlet Position)
01 : Bo_bu rpoB
02 : Bo_ga rpoB
03 : Bo_af fla
04 : Bo_va ospE
05 : Bo_va ospA
06 : Bo_lu rpoB
07 : Bo_spi fla
08 : Bo_bis rpoB
09 : Bo_miy glpQ
10 : Bo_sl 23S
11 : An_ma msp1
12 : An_pl groEL
13 : An_ph msp2
14 : An_ov msp4
15 : An_cen groEL
16 : Eh_ch dsb
17 : Eh_ru dsb
18 : Eh_ca dsb
19 : Neo_mik groEL
20 : Ri_co ITS
21 : Ri_slo ITS
22 : Ri_ma ITS
23 : Ri_he ITS
24 : SFG gltA
25 : Ba_he pap31
26 : Ba_qu btq
27 : Fr_tu tul4
28 : Fr_tu fopA
29 : Co_bu icd
30 : Co_bu IS1111
31 : Bab_di hsp70
32 : Bab_mi CCTeta
33 : Bab_ca 18S
34 : Bab_vo hsp70
35 : Bab_bo CCTeta
36 : Bab_cab rap1
37 : Bab_EU1 18S
38 : Bab_big 18S
39 : Bab_maj CCTeta
40 : Bab_ov 18S
41 : Th_eq ema1 (R2)
42 : Th_an 18S
43 : Th_an tams1
44 : Ix_ri ITS2
45 : Ix_hex ITS2
46 : Ix_pe ITS2
09 : Ama1
10 : Apl1
11 : Aph4
12 : Aov pl
13 : Acen pl
14 : Ech1
15 : Eru3
16 : Eca pl
17 : Nmi2
18 : Rco1
<1,00
<2,95
3,93
5,88
7,83
9,78
11,73
13,68
15,63
17,58
19,53
21,48
23,43
25,38
27,33
29,28
31,23
33,18
35,13
37,08
>38,05
>40,00
Threshold
Show No Call
Log Graph
Full Range
Pass
Fail
No Call
Clear
Clear All
Play
Stop
3 fps
Toolbars
FAM-MGB
Chamber ID : ***
Sample Name : Ech1
Detector Name : ***
Ct : ***
Call : ***
Normalized Intensity
RN
0,80
0,60
0,40
0,20
1
11
21
31
Cycle
Amplification
ΔRN
0,50
0,40
0,30
0,20
0,10
0,00
1
11
21
31
Cycle

Material

Advantage of BioMark™ Dynamic Array

	Dynamic array		qPCR	
	96.96	48.48	384 wells	96 wells
Mastermix	240 µl	120 µl	46 ml	184 ml
Primer/probe	240 µl	120 µl	4.6 ml	18.4 ml
Plates	1	4	24	96
Time	3 h	8 h	8 days	32 days
Pipetting	192	384	18432	73728



Yield

96.96 chip → 9216 reactions

48.48 chip → 2304 reactions

Speed : time cost 30 min

Cost : 4.5 à 9.11 centimes/reactions

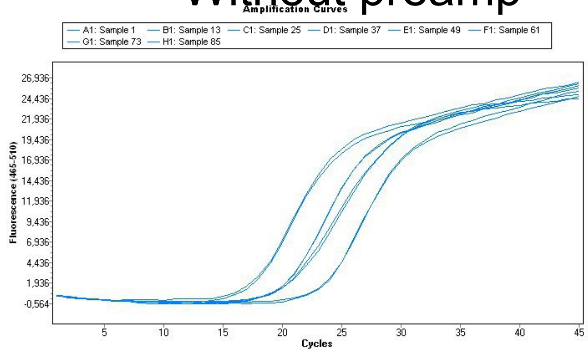
Methods – Preamplification for better sensitivity

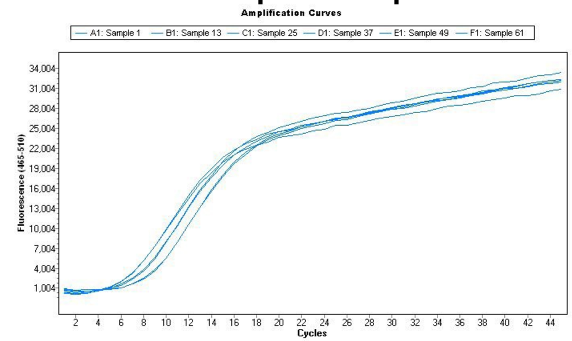
Preamplification step allows better detection of pathogens

	Without preamp	With preamp

Group 1

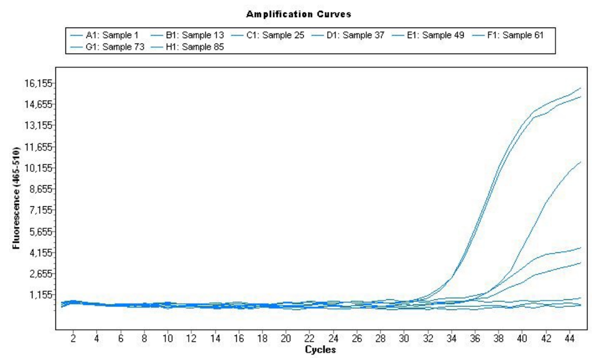
Bartonella henselae, culture of B1 strain, pap31 gene

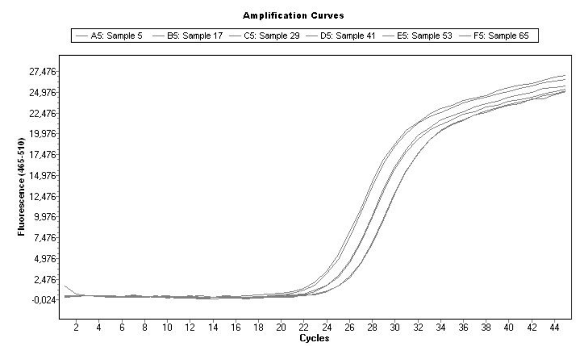




Group 2

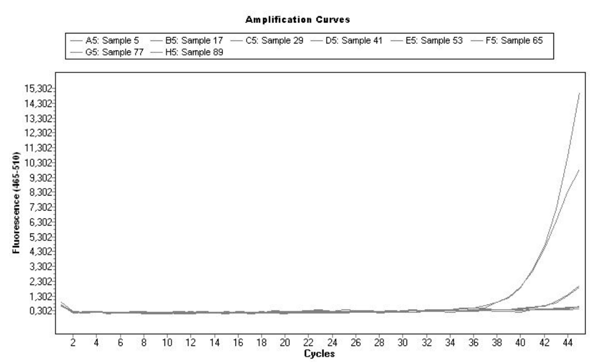
Borrelia burgdorferi s.s., culture of B31 strain, rpoB gene

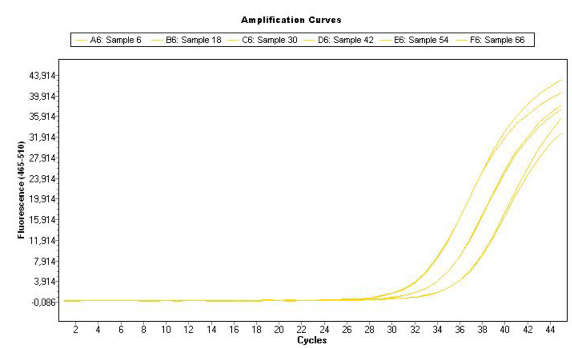




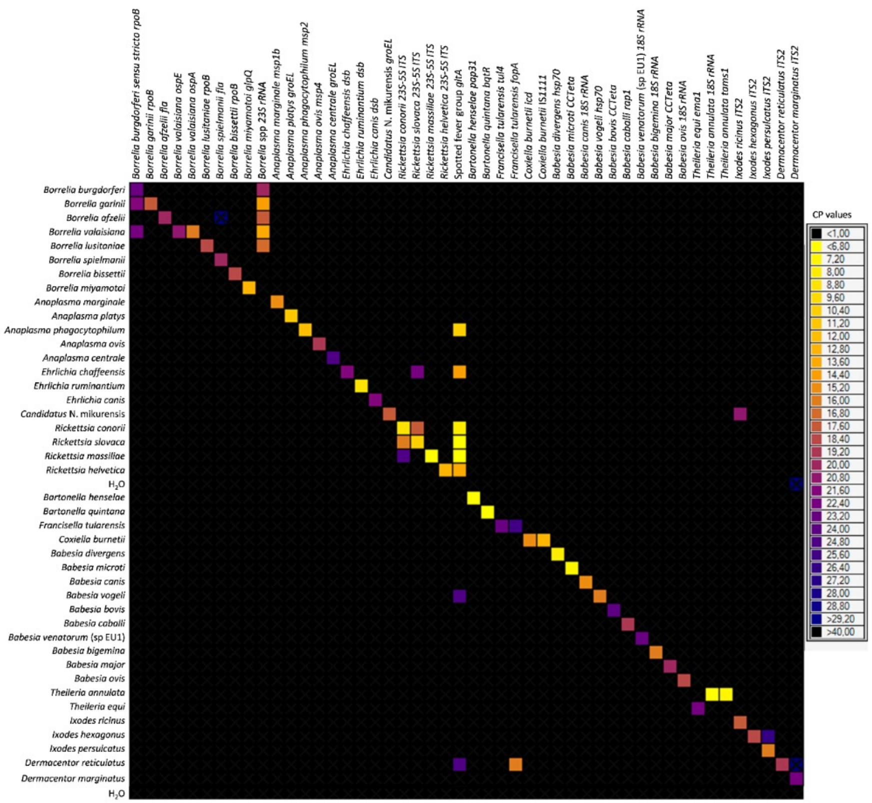
Group 3

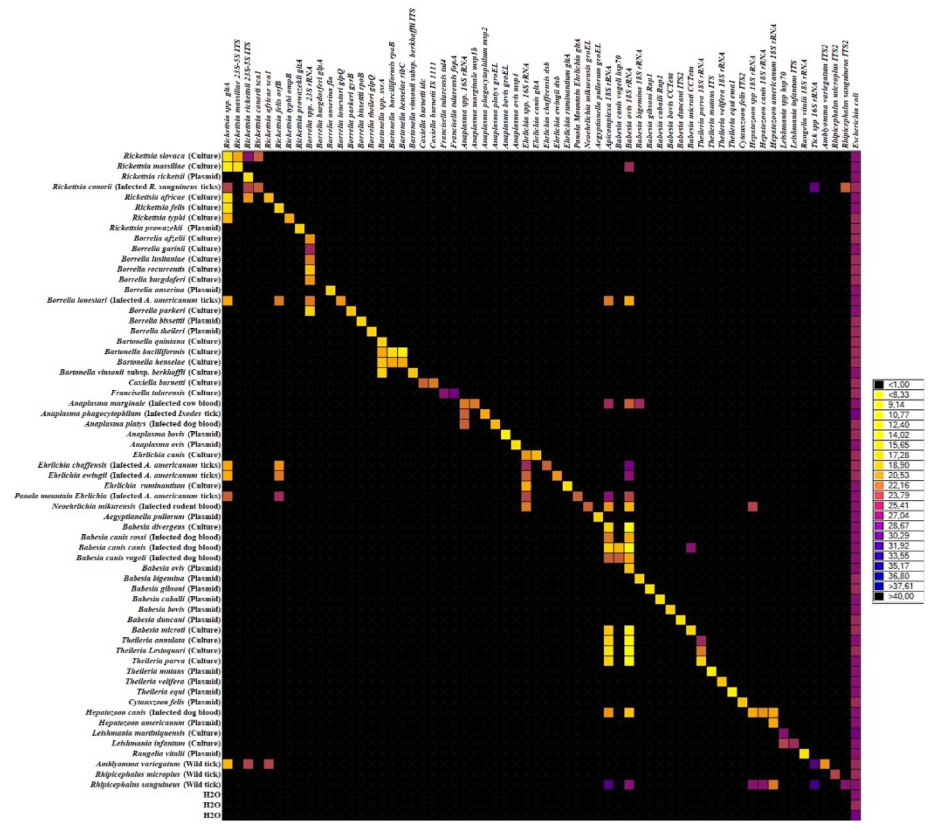
Borrelia afzelii, culture of NE632 strain, fla gene





Methods – Specificity





(Michelet et al., 2014 ; Gondard et al., 2018 ; Gondard et al., 2020)

Large scale epidemiological studies

25N

49 pools

Broyage dans
300µL DMEM
+ 10% SVF

100µL → Virus isolation

100µL → DNA Extractions

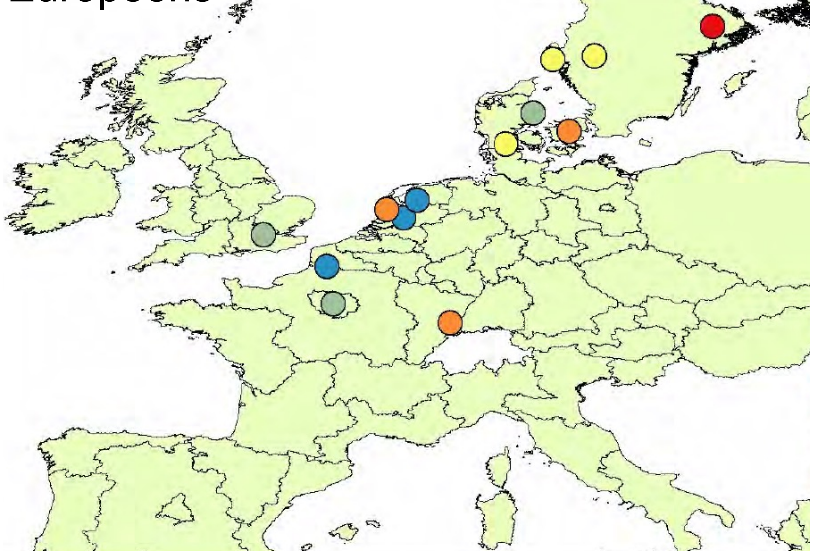
100µL → RNA Extractions

DNA Extractions → Preamplification (pool 0.2X with primers targeting bacteria and parasites) → Bacteria & Parasites Chip

DNA Extractions + Random primer RT → DNA + cDNA → Preamplification (pool 0.2X with primers targeting bacteria, parasites and viruses) → TBPs Chip

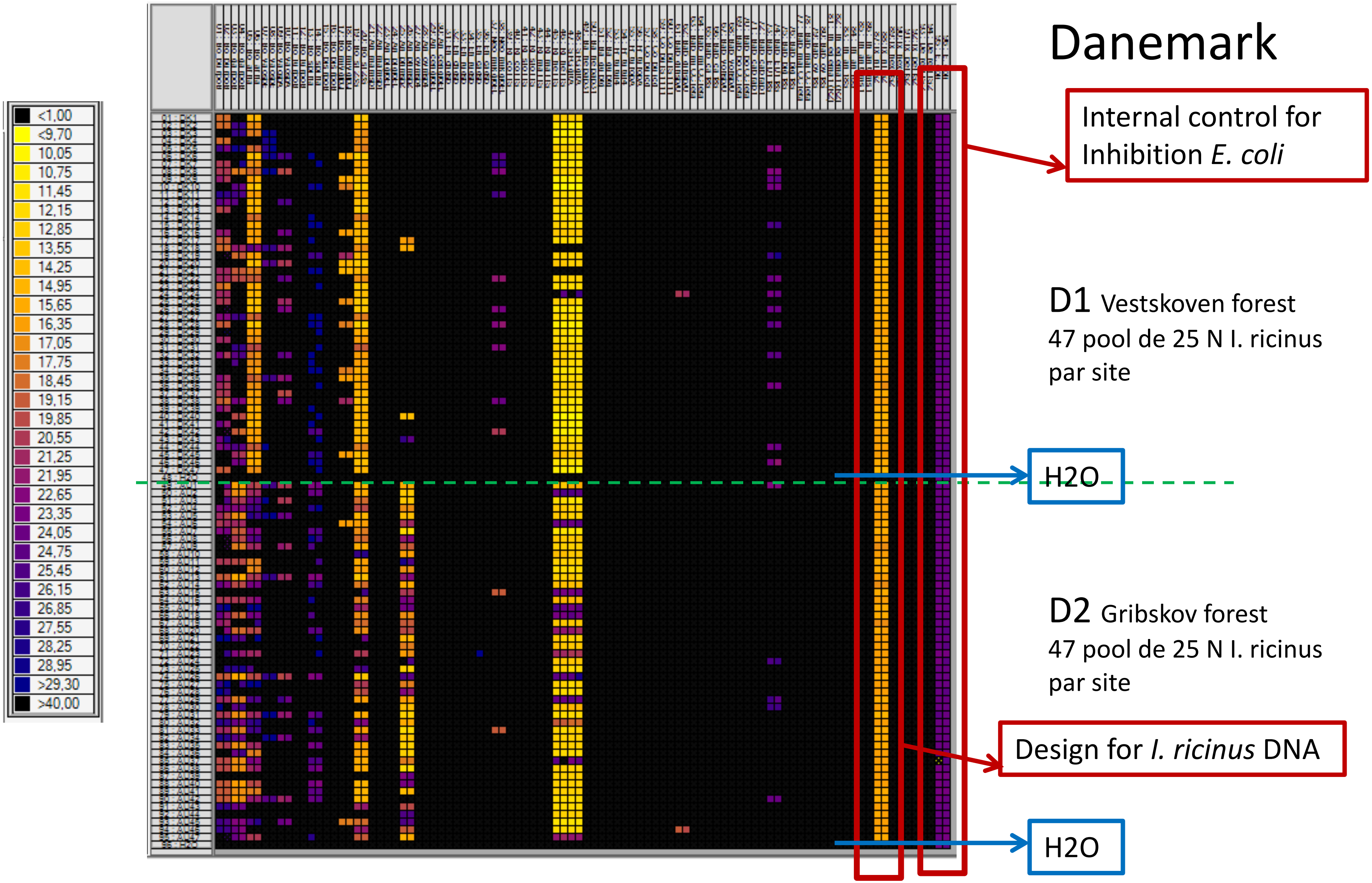
RNA Extractions → Random primer RT → Preamplification (pool 0.2X with primers targeting viruses) → Viruses Chip

Collecte de tiques = 13 sites dans 5 Pays Européens



(Michelet et al., 2014 ; Gondard et al., 2018 ; Gondard et al., 2020)

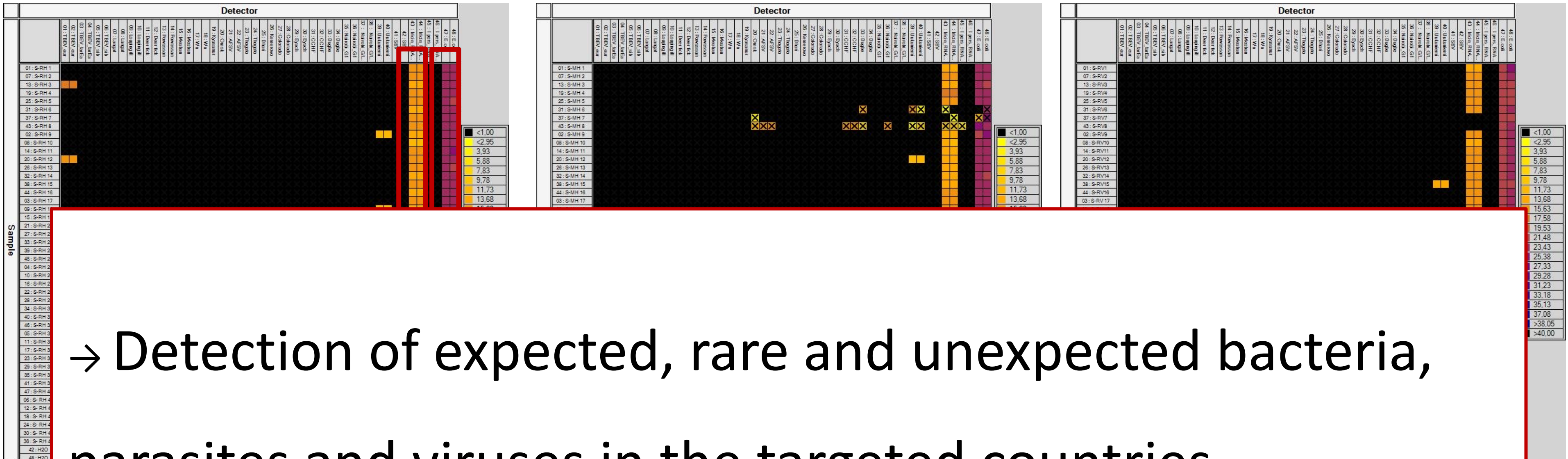
Example of Results Prevalence of 39 bacteria and parasites



(Michelet et al., *Frontiers in Cellular and Infection Microbiology* 2014)

Example of Results   Prevalence of 22 viruses

Sweden



→ Detection of expected, rare and unexpected bacteria, parasites and viruses in the targeted countries

(Gondard et al., *FEMS Pathogens and Disease* 2018)

Large scale epidemiological studies: collaborative projects on hard and soft ticks

Elodie DEVILLERS Technician

Clemence GALON Engineer

Ticks and Tick-borne Diseases 15 (2024) 102285

ELSEVIER

Contents lists available at ScienceDirect

Ticks and Tick-borne Diseases

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

Original article

High-throughput screening of pathogens in *Ixodes ricinus* removed from hosts in Lombardy, northern Italy

Sophie Melis [a], Gherard Batisti Biffignandi [a], Emanuela Olivieri [b], Clémence Galon [c], Nadia Vicari [b], Paola Prati [b], Sara Moutailler [c], Davide Sassera [a,d], Michele Castelli [a,*]

[a] *Department of Biology and Biotechnology, University of Pavia, Pavia, Italy*
[b] *Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna, Pavia, Italy*
[c] *ANSES, INRAE, Ecole Nationale Vétérinaire d'Alfort, UMR BIPAR, Laboratoire de Santé Animale, Maisons-Alfort, F-94700, France*
[d] *Fondazione IRCCS Policlinico San Matteo Pavia Italy*

Large scale epidemiological studies: collaborative projects on mammals and humans

Received: 13 April 2022 | Revised: 7 June 2022 | Accepted: 25 June 2022

DOI: 10.1111/tbed.14645

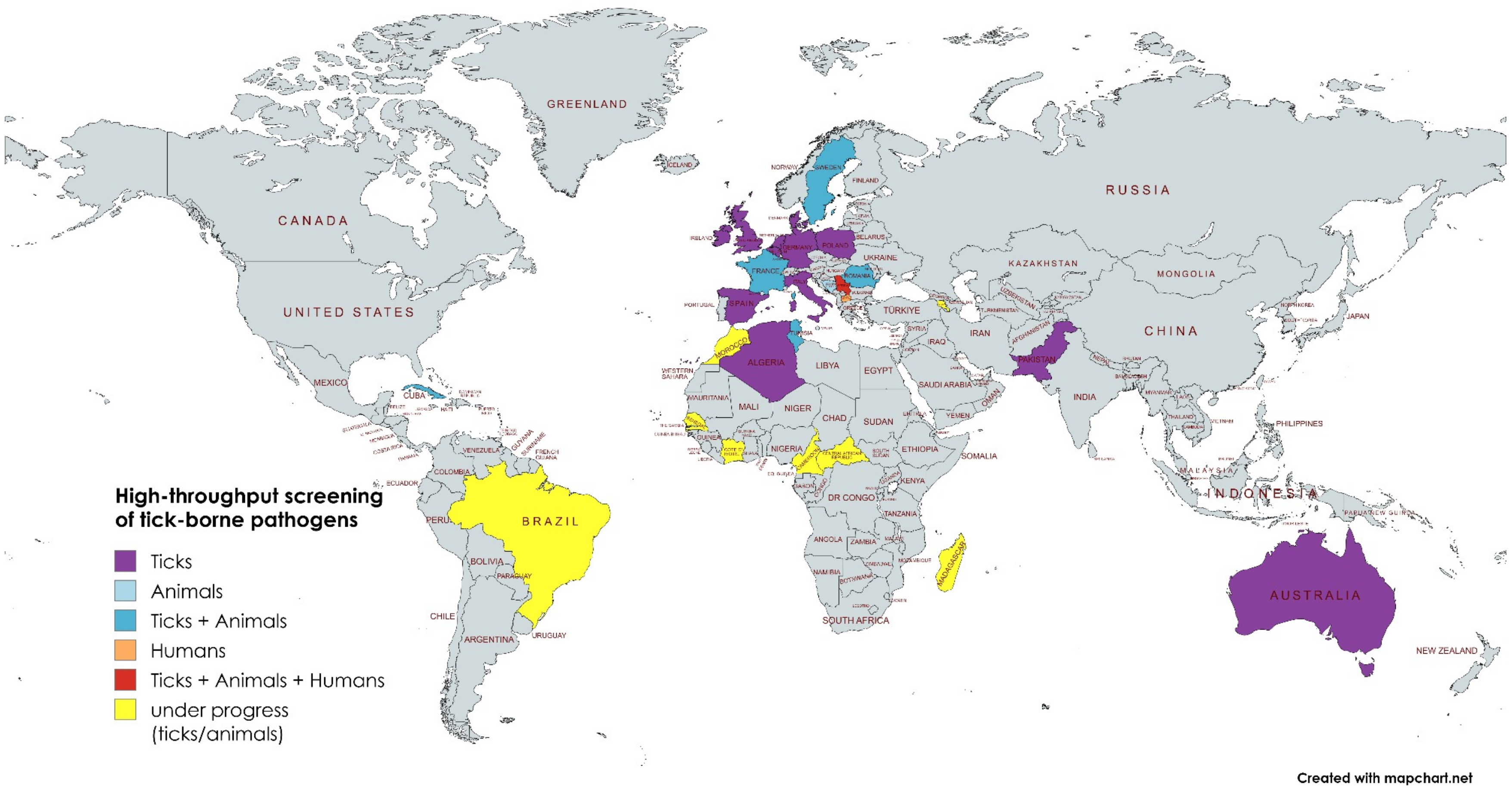
Transboundary and Emerging Diseases WILEY

ORIGINAL ARTICLE

High-throughput microfluidic real-time PCR for the simultaneous detection of selected vector-borne pathogens in dogs in Bosnia and Herzegovina

Vito Colella[1,2] | Lucas Huggins[2] | Adnan Hodžić[3] | Clemence Galon[4] | Rebecca Traub[2] | Amer Alić[5] | Roberta Iatta[1] | Lénaïg Halos[6] | Domenico Otranto[1,7] | Muriel Vayssier-Taussat[4] | Sara Moutailler[4]

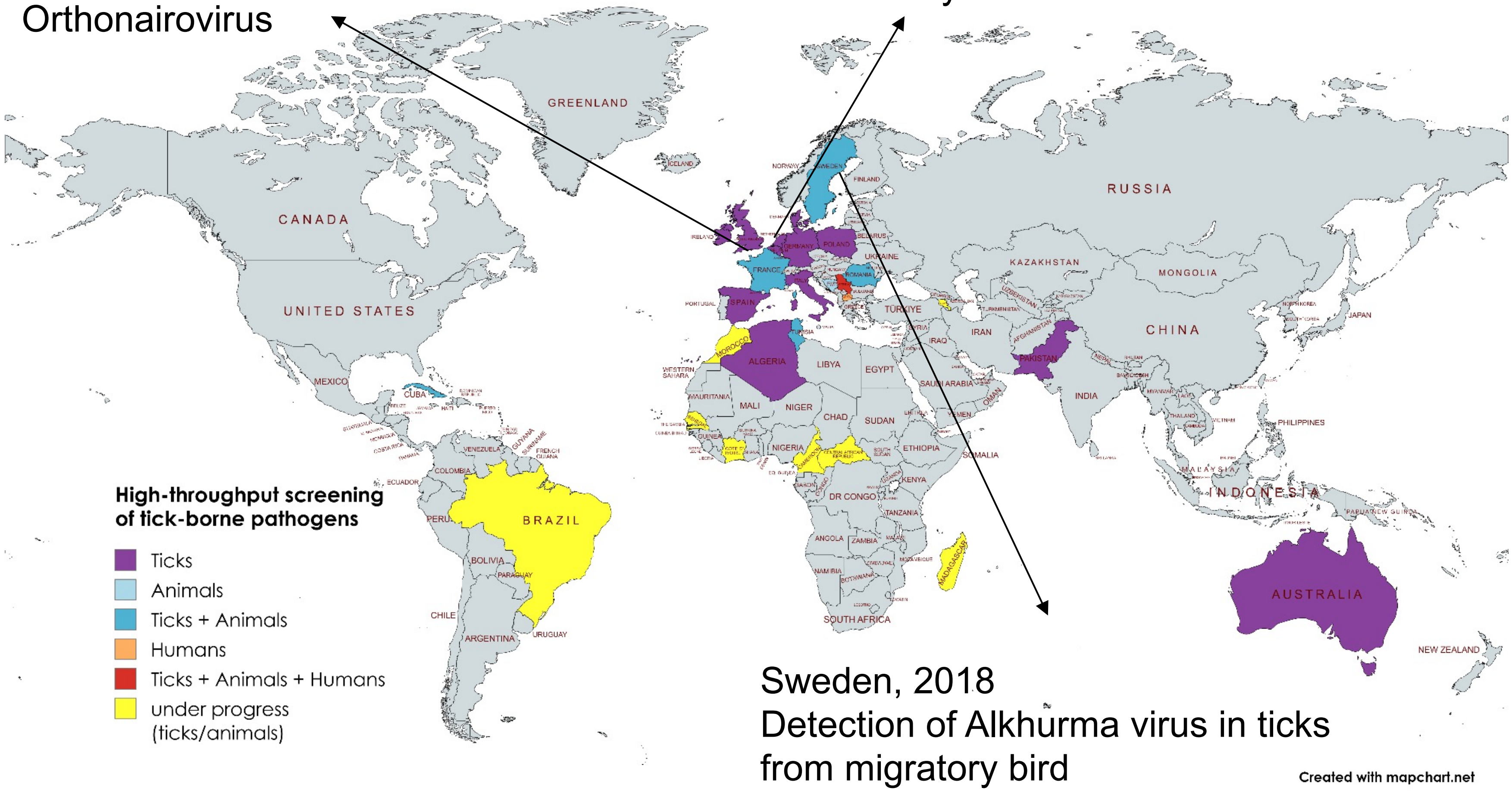
Collaborative studies since 2014 using this technic



Collaborative studies since 2014 using this technic

France, 2018
First detection in ticks of a new Orthonairovirus

The Netherlands, 2018
First detection in ticks of a new Orthonairovirus and of Eyach virus



Sweden, 2018
Detection of Alkhurma virus in ticks from migratory bird

(Gondard et al., 2018, Pathog Dis ; Hofmann et al., 2018, Emerg Infect Dis)

And now… for mosquito borne viruses…

viruses

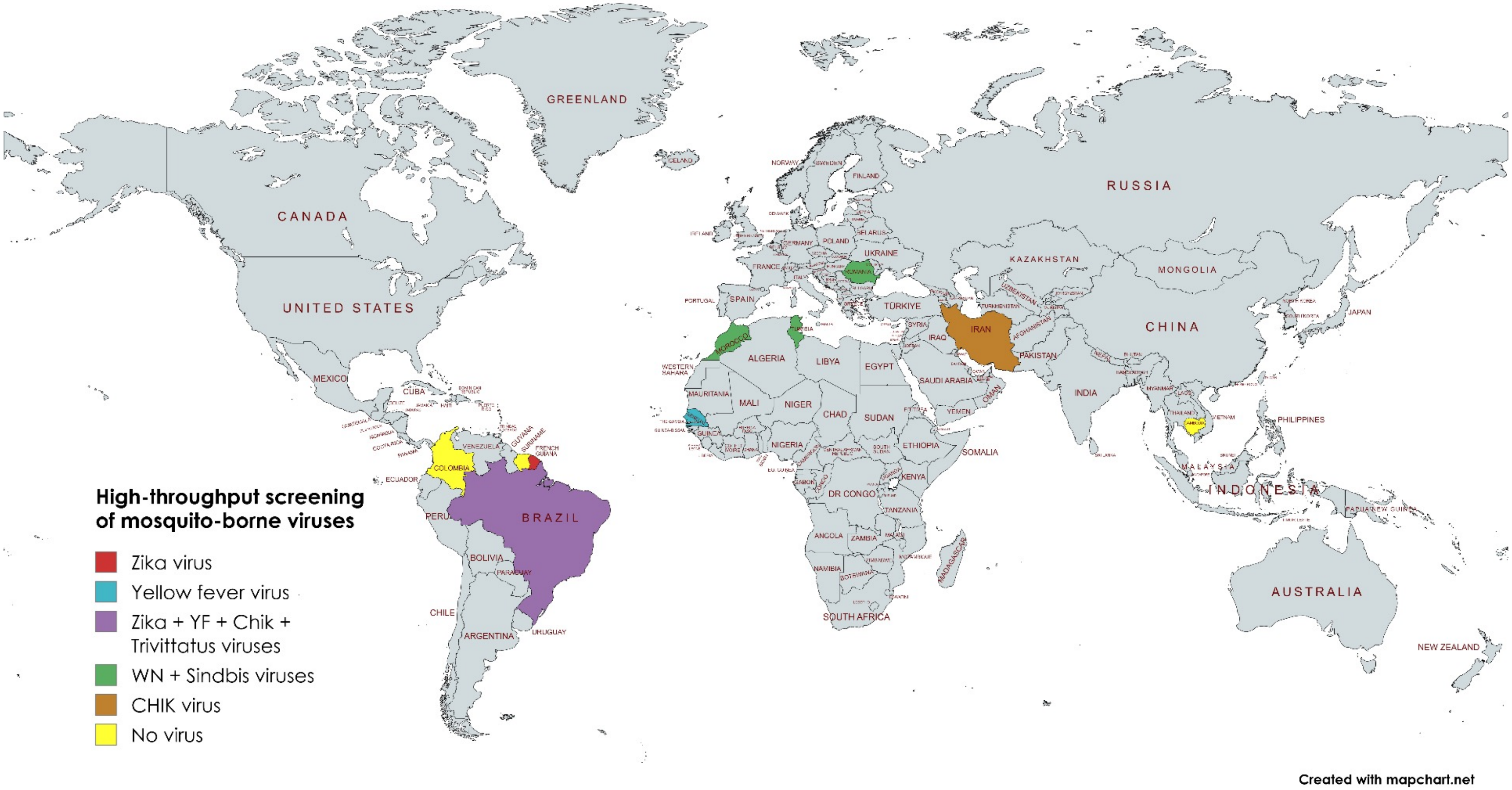
MDPI

Article

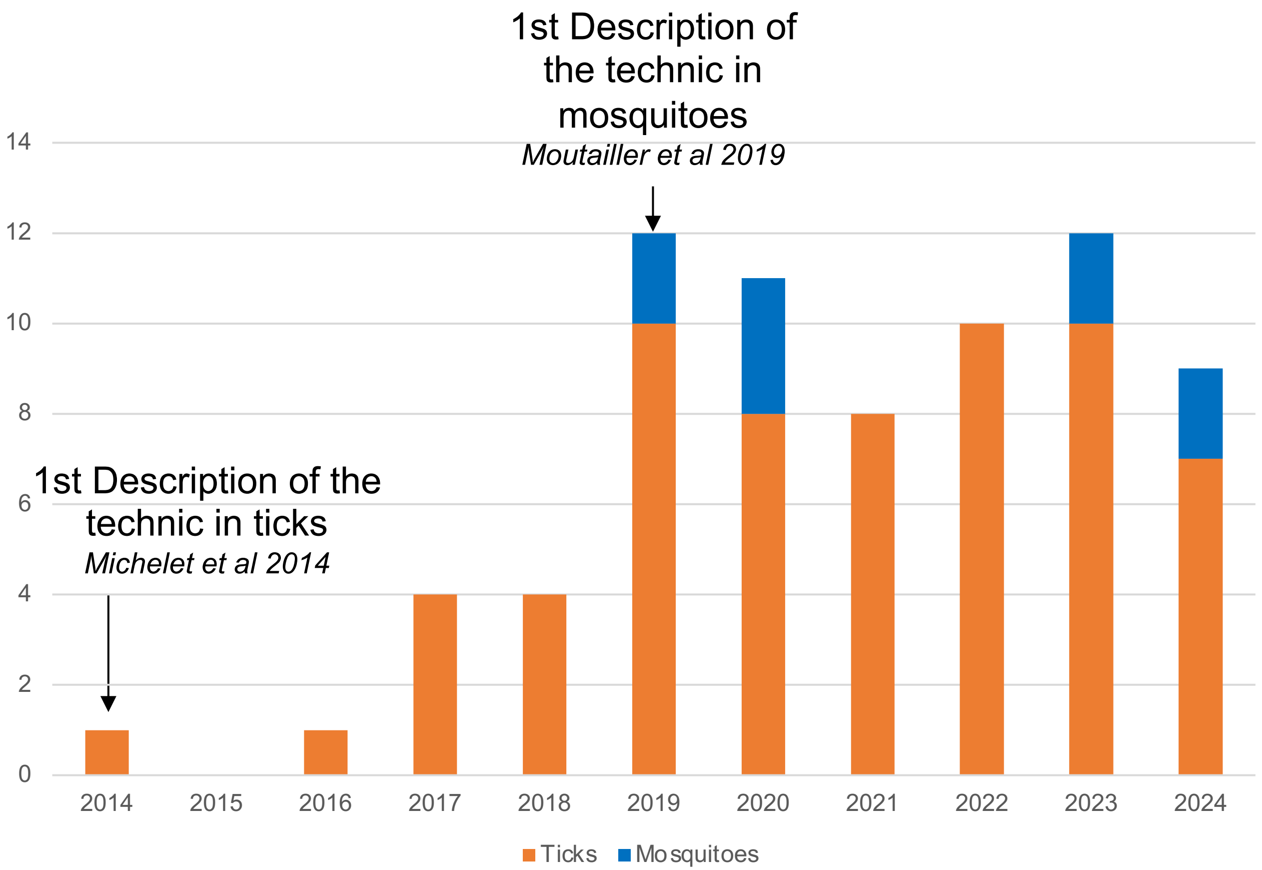
A New High-Throughput Tool to Screen Mosquito-Borne Viruses in Zika Virus Endemic/Epidemic Areas

Sara Moutailler [1,*], Lena Yousfi [1], Laurence Mousson [2], Elodie Devillers [1], Marie Vazeille [2], Anubis Vega-Rúa [3], Yvon Perrin [4], Frédéric Jourdain [4,5], Fabrice Chandre [4,5], Arnaud Cannet [4], Sandrine Chantilly [6], Johana Restrepo [6], Amandine Guidez [7], Isabelle Dusfour [7], Filipe Vieira Santos de Abreu [8], Taissa Pereira dos Santos [5], Davy Jiolle [5], Tessa M. Visser [9], Constantianus J. M. Koenraadt [9], Merril Wongsokarijo [10], Mawlouth Diallo [11], Diawo Diallo [11], Alioune Gaye [11], Sébastien Boyer [12], Veasna Duong [12], Géraldine Piorkowski [13], Christophe Paupy [5], Ricardo Lourenco de Oliveira [8], Xavier de Lamballerie [13] and Anna-Bella Failloux [2,*]

Collaborative studies since 2019 using this technic



Large scale epidemiological studies: number of publications using realtime microfluidic PCR in vector-borne pathogens (mosquitoes and ticks)



Acknowledgment

UMR BIPAR, MiTick Team, Ticks&Co group
Denis Augot
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Lorraine Michelet
Camille Migné
Thomas Pollet
Stefania Porcelli
Léna Yousfi

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Angélique Foucault-Simonin

All the collaborators from the different collaborative projects mentioned

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SVA, Sweden : Jan Chirico, Anna Aspan, Karin Ullman, G
Grandi
DTU, Denmark : Rene Bodker, Kirstine Klitgaard
CVI, The Netherlands : Fimme van der Wal, Aline de Koeijer
APHA, UK : Karen Mansfield, Anthony Fooks

CoVetLab partner institutes

ZikAlliance Partners
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International Network of Pasteur Institute

Plateforme Identypath, ANSES
Patrick Fach
Sabine Delannoy

Fundings:

LabEx IBEID

ZIKAlliance
A Global Alliance for Zika Virus Control and Prevention

sara.moutailler@anses.fr

MiTick Team

UMR BIPAR (ANSES, INRAE, ENVA)

ANSES Animal Health Laboratory

Day 2: Application to Tick-Borne Virus infections

Blood donors and seroprevalence

By Pierre Gallian

TICK BORNE ENCEPHALITIS VIRUS (TBEV) : SEROPREVALENCE SURVEY IN THE FRENCH BLOOD DONOR POPULATION

Direction Médicale EFS siège - Saint Denis,
Unité des Virus Emergents (AMU, INSERM, IRD) - Marseille, Dr Pierre GALLIAN

Annual Scientific Symposium of the Arbo-France Network – 2024 oct 24-25th

UVE Unité des Virus Émergents IRD 190 – Inserm 1207

EFS Établissement Français du Sang Du donneur aux patients

Donnons au sang le pouvoir de soigner

Declaration of potential conflict of interest :

This seroprevalence study was granted by Pfizer SAS

The funder was not involved in the design of the study, the interpretation of the results or the formulation of the conclusions

Introduction - Background

TBEV is a member of the *Flaviviridae* family

Five main sub-types :

- **European sub-type (TBEV-Eu)**
- **Siberian sub-type (TBEV-Sib)**
- **Far-eastern sub-type (TBEV-FE)**
- **Baikalian sub-type (TBEV-Bkl)**
- **Himalayan sub-type (TBEV-Him)**

Vector : ticks of *Ixodes sp*

Hosts : Humans = accidental host, epidemiological impasse

The main reservoirs of the virus are small wild vertebrate hosts (e.g. rodents), although larger mammals, such as wild deer, ruminants (goats, sheep, cows) are also important reservoir hosts

Routes of transmission of TBEV to humans:

- **Infected tick bites +++**
- **Consumption of unpasteurised dairy products from infected livestock**
- **Human-to-human transmission is extremely rare: blood transfusion or organ transplantation**

Clinical picture: **Asymptomatic (70- >90%)**

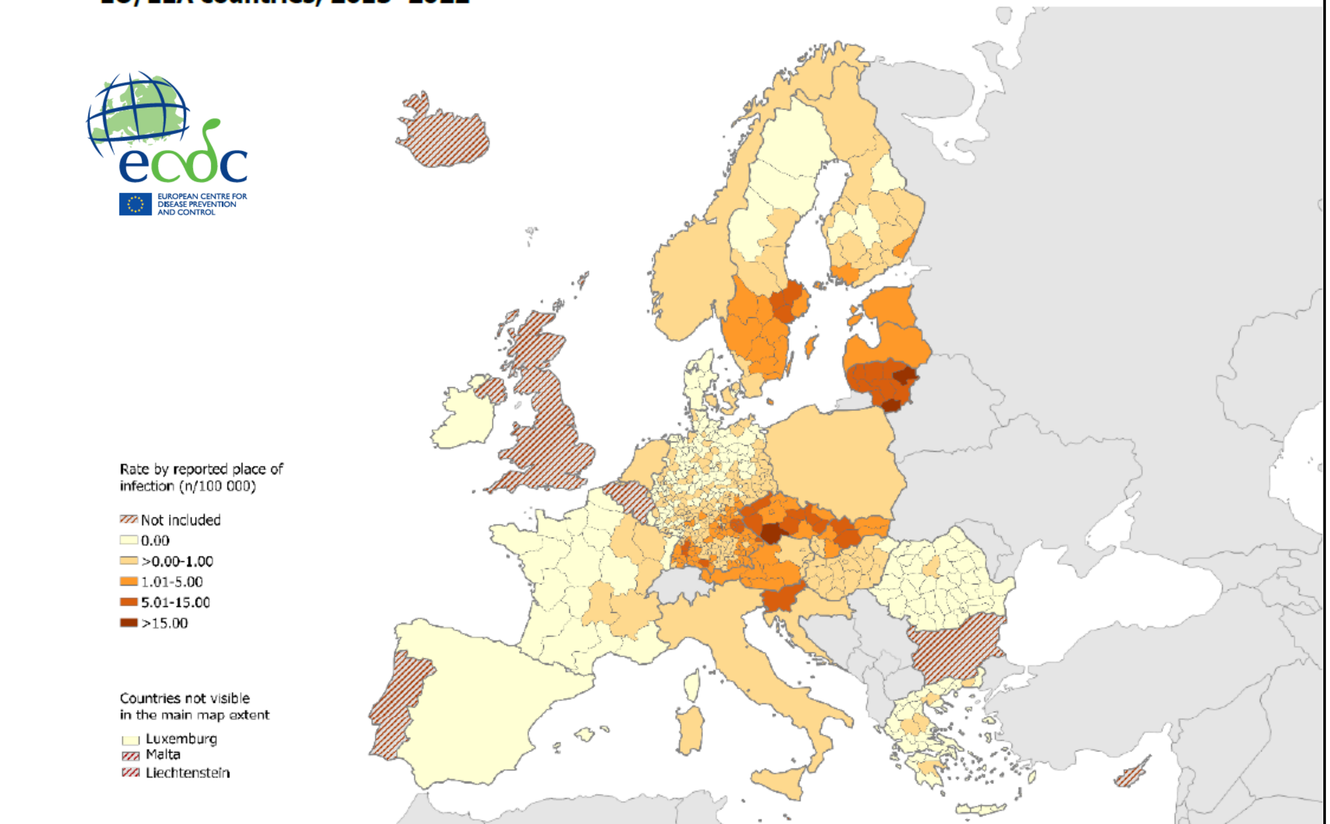
Symptomatic infection : monophasic or biphasic disease = an initial flu-like illness (first phase) followed (in 30% ?) by a second phase including an afebrile phase (8 days) followed by inflammation of the central nervous system.

Case fatality rate : <2%

Long term sequelea in 10-40% of patients with neurological symptoms

Epidemiology in Europe :

Figure 1. Mean notification rates of confirmed locally-acquired TBE cases per 100 000 population, EU/EEA countries, 2013–2022



©ECDC. Administrative boundaries: © EuroGeographics. The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. ECDC. Map produced on: 16 April 2024

ECDC Evidence Assessment. **The risk of tick-borne encephalitis virus transmission via substances of human origin. Sept 2024.**

Unpublished data

Thank you for your attention

UNKNOWLEDGMENTS

French blood donors

Etablissement Français du Sang

- Regional blood collection teams
- Biobanks teams
- Dr Nadège Brisbarre
- Ms Christine Isnard
- Dr Syria Laperche
- Dr Pascale Richard
- Dr Pascal Morel

UVE and National Reference Center for arboviruses

- Pr Xavier de Lamballerie
- Dr Gilda Grard
- Dr Guillaume Durand

ÉTABLISSEMENT FRANÇAIS DU SANG
Du donneur aux patients

efs.sante.fr

Day 2: Application to Tick-Borne Virus infections

Vector control and vaccine

By Jose de la Fuente

Vector control and vaccine
The evolution of tick vaccinology

José de la Fuente

SaBio. Instituto de Investigación en Recursos Cinegéticos IREC (CSIC-UCLM-JCCM), Ronda de Toledo s/n, 13005 Ciudad Real, Spain.
Department of Veterinary Pathobiology, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK 74078, USA.

IREC (CSIC-UCLM-JCCM), Ciudad Real, Spain

SaBio
Sanidad y Biotecnología
Health and Biotechnology

Healthy wildlife, healthy livestock, healthy humans

A multidisciplinary One Health approach is necessary for the control of infectious diseases

Freely available online

PLOS | PATHOGENS

Pearls

Crossing the Interspecies Barrier: Opening the Door to Zoonotic Pathogens

Christian Gortazar[1]*, Leslie A. Reperant[2], Thijs Kuiken[2], José de la Fuente[1,3], Mariana Boadella[1], Beatriz Martínez-Lopez[4], Francisco Ruiz-Fons[1], Agustin Estrada-Peña[5], Christian Drosten[6], Graham Medley[7], Richard Ostfeld[8], Townsend Peterson[9], Kurt C. VerCauteren[10], Christian Menge[11], Marc Artois[12], Constance Schultsz[13], Richard Delahay[14], Jordi Serra-Cobo[15], Robert Poulin[16], Frederic Keck[17], Alonso A. Aguirre[18], Heikki Henttonen[19], Andrew P. Dobson[20], Susan Kutz[21], Juan Lubroth[22], Atle Mysterud[23]

June 2014 | Volume 10 | Issue 6 | e1004129

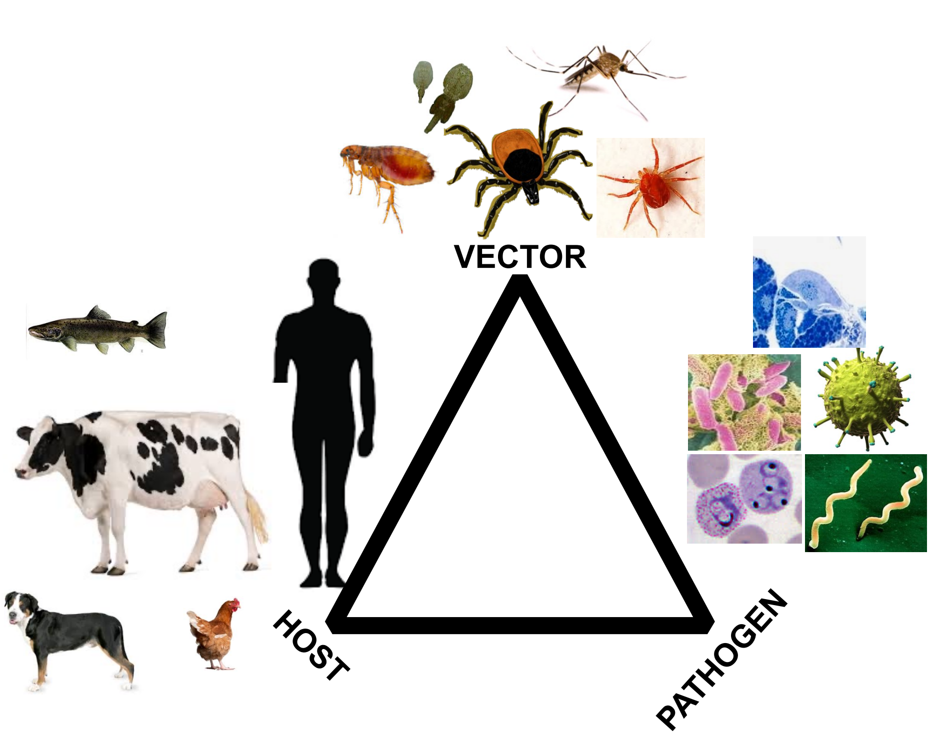
SaBio
Health and Biotechnology

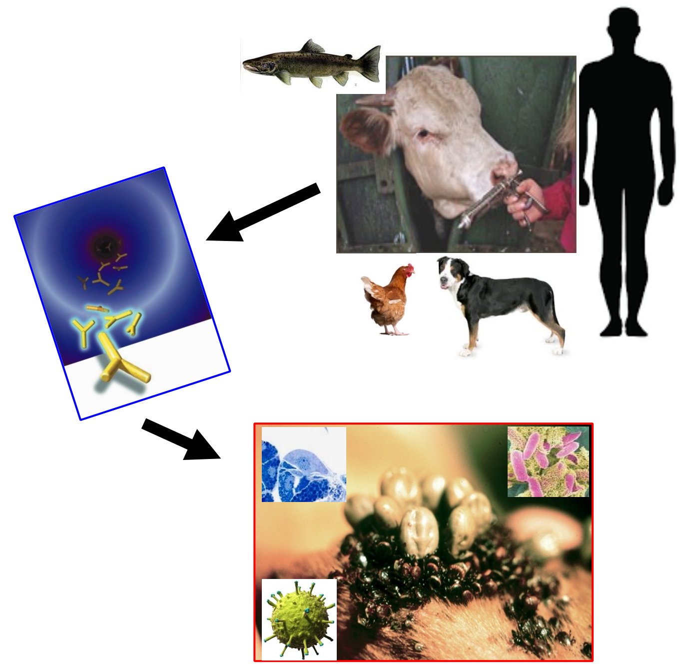
GENOMICS, PROTEOMICS & BIOTECHNOLOGY

Our mission: Control of infectious diseases (https://youtu.be/DhbBjQSuLYk)

Molecular biology of host-vector-pathogen interactions

Control of vector infestations and pathogen infection/transmission





Basic biological information

Translational research

Algorithms

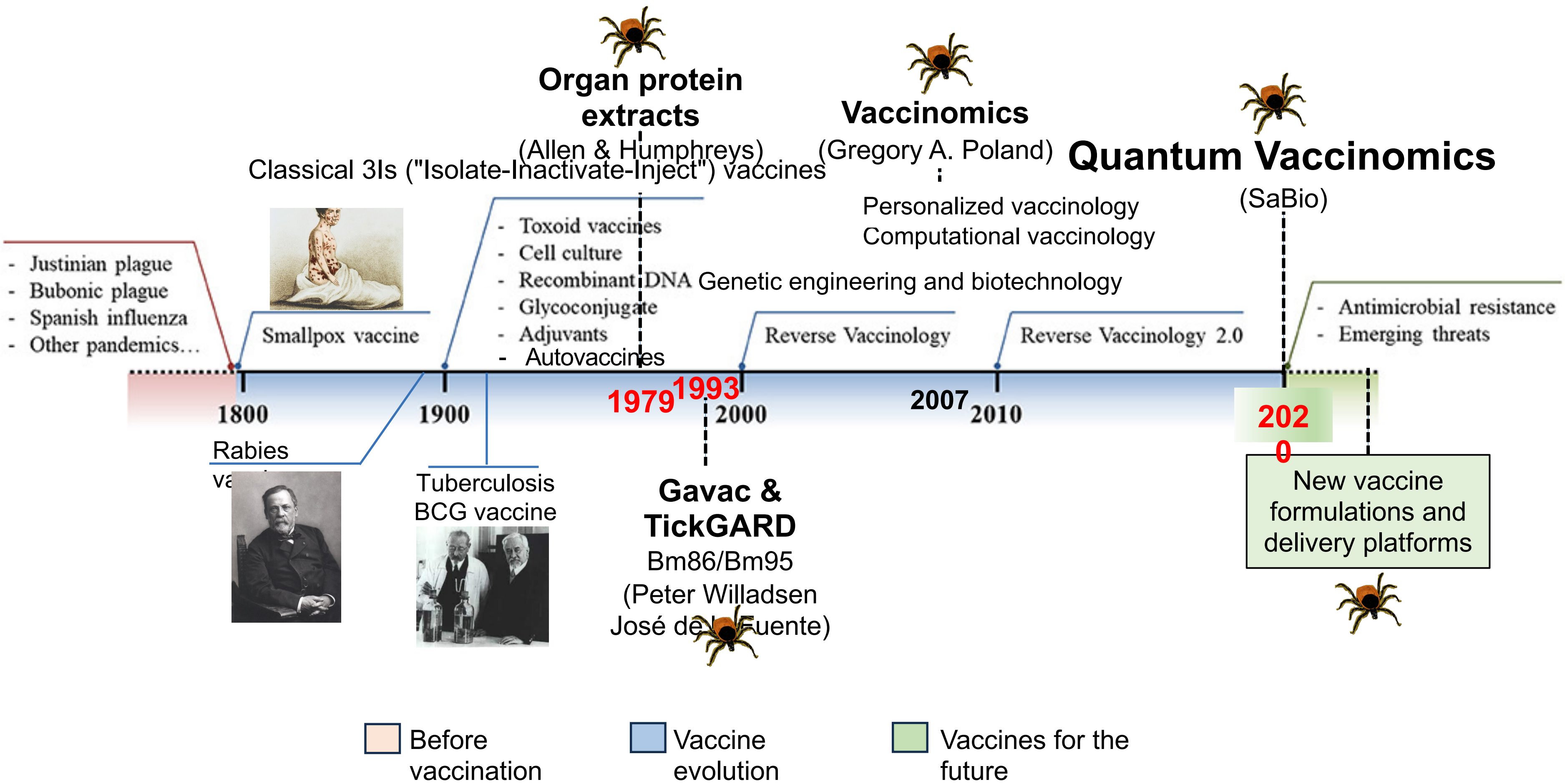
Disease control & prevention

TICKS

- A model organism for the the study of vector-host-pathogen interactions.
- Considered to be second in the world to mosquitoes as vectors of human diseases.
- A major ectoparasite of domesticated and wild animals.

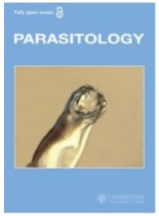
SaBio
Health and Biotechnology

Evolution of vaccinology



Andreano E, D'Oro U, Rappuoli R and Finco O (2019) Vaccine Evolution and Its Application to Fight Modern Threats. *Front. Immunol.* 10:1722.
de la Fuente J & Contreras M (2021) Vaccinomics: a future avenue for vaccine development against emerging pathogens. *Expert Review Vaccines* 20:12:1561-1569

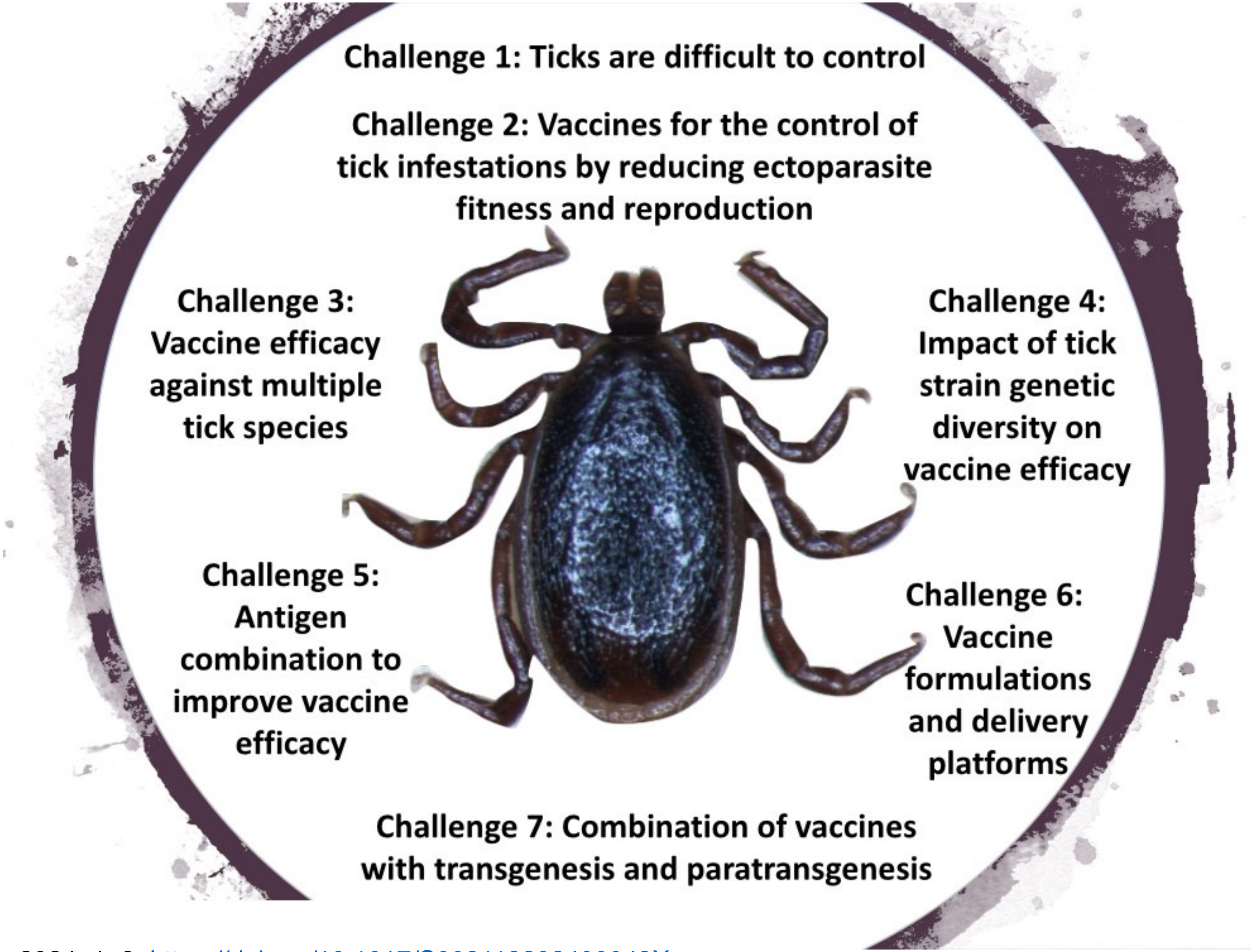
SaBio Health and Biotechnology



Challenges driven tick vaccinology

Evolution of tick vaccinology

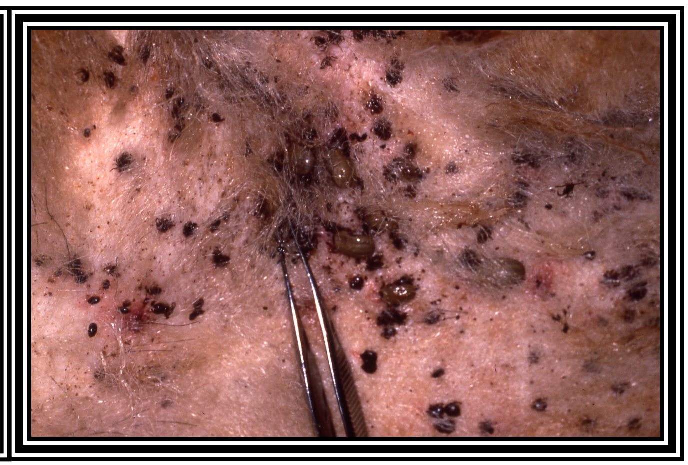
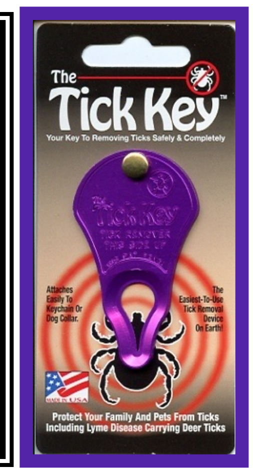
José de la Fuente[1,2] and Srikant Ghosh[3,4]



Parasitology 2024, 1–8. https://doi.org/10.1017/S003118202400043X

First challenge: Ticks are difficult to control



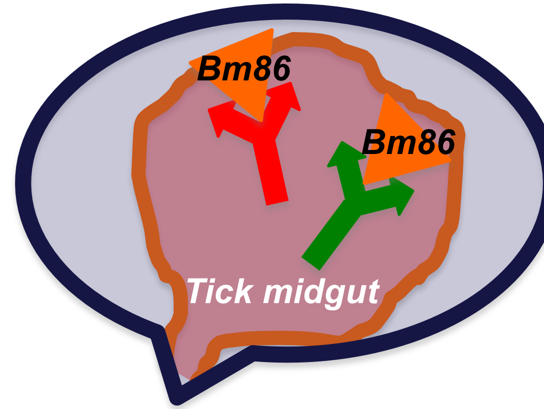
Traditional control methods have been only partially successful and primarily based on the use of chemical acaricides with implicit drawbacks such as the selection of drug-resistant ticks and the impact of environmental contamination.

SaBio
Health and Biotechnology

Bm86/Bm95 tick vaccines

Immunization of cattle with Bm86/Bm95

Antibody response



Antibody-antigen interactions in the midgut lumen of feeding ticks

Vaccinated cattle

Control cattle

Reduction in the number of ticks completing the life cycle and their weight, oviposition and fertility

CHAPTER 12

DEVELOPMENT OF VACCINES FOR CONTROL OF TICK INFESTATIONS AND INTERRUPTION OF PATHOGEN TRANSMISSION

JOSÉ DE LA FUENTE AND KATHERINE M. KOCAN

Bm86/Bm95 tick vaccines

ELSEVIER

Vaccine 18 (2000) 2275–2287

Vaccine

www.elsevier.com/locate/vaccine

Control of ticks resistant to immunization with Bm86 in cattle vaccinated with the recombinant antigen Bm95 isolated from the cattle tick, *Boophilus microplus*☆

José C. García-García[a, 1], Carlos Montero[a], Miguel Redondo[a], Milagros Vargas[a], Mario Canales[b], Oscar Boue[b], Manuel Rodríguez[a], Marisdania Joglar[a], Héctor Machado[a], Iliana L. González[a], Mario Valdés[c], Luis Méndez[c], José de la Fuente[a,*]

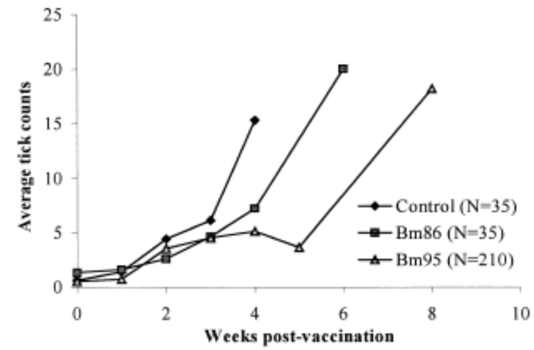
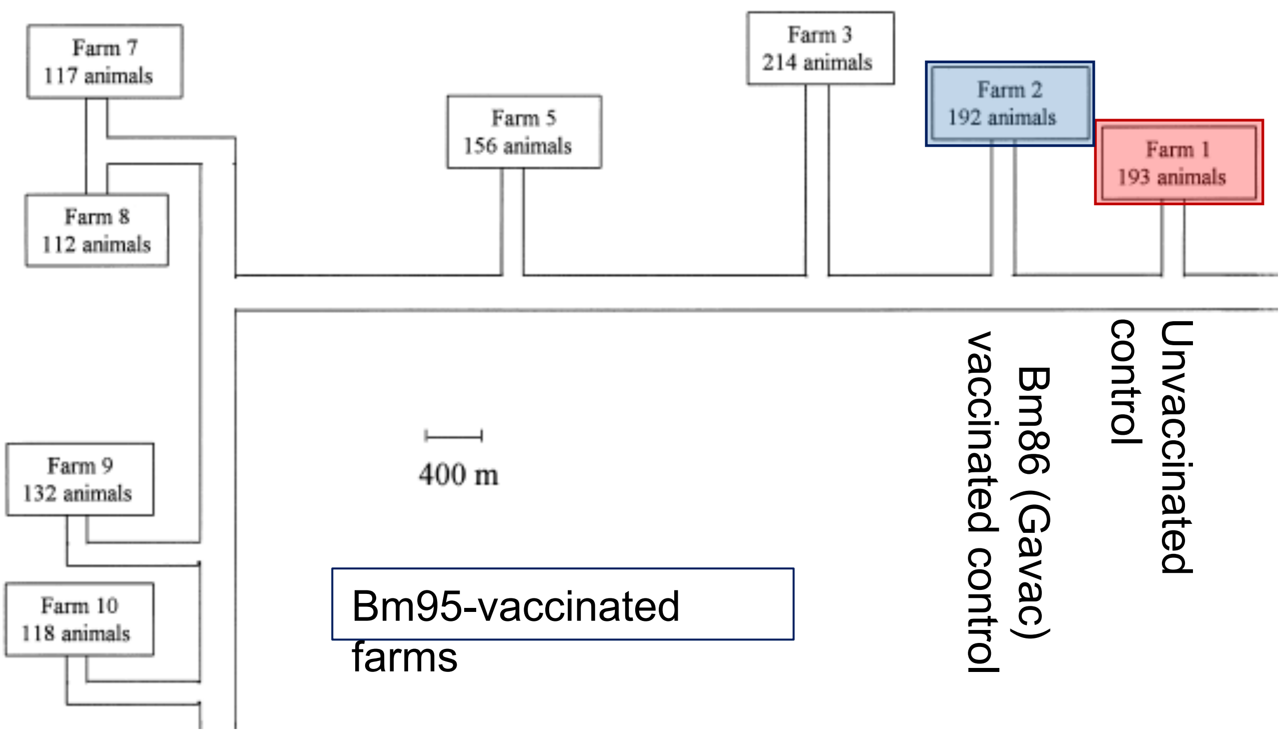


Fig. 6. Average tick counts in vaccinated and control farms. Female ticks engorging on 35 animals from each farm were counted weekly after the second immunization was given until tick numbers reached a value higher than 15 ticks/animal, when organophosphate vats were used.



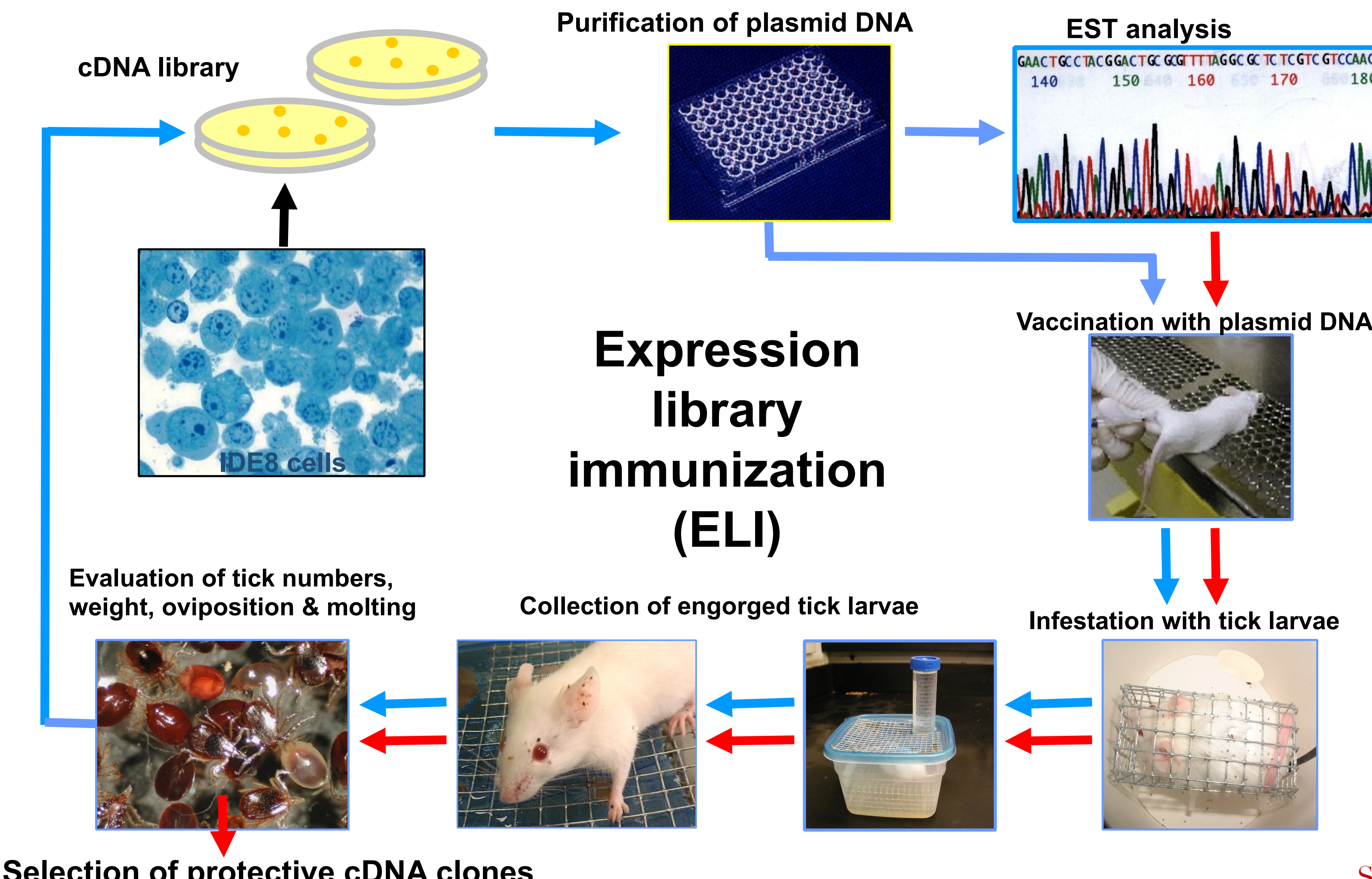
Vaccine efficacy
Bm86 (Gavac): 84%
Bm95: 89%

Interval between acaricide treatment
Bm86: 46 days
Bm95: 60 days
Control: 27 days

SABIO
Health and Biotechnology

Second challenge: Vaccine efficacy against multiple tick species

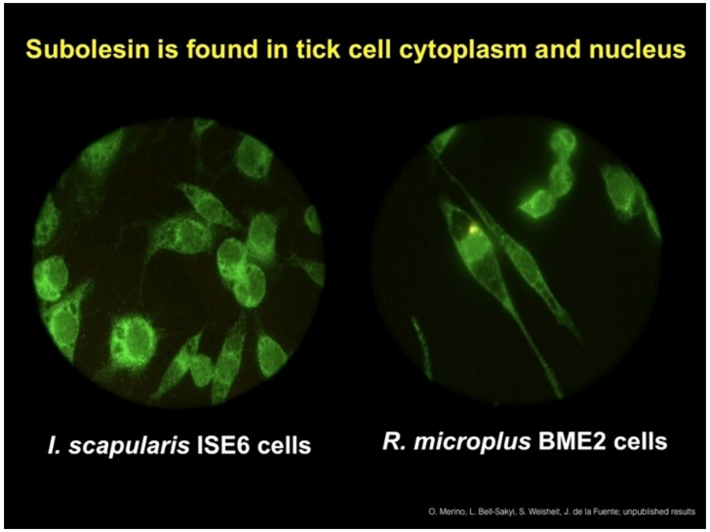
Discovery of *Ixodes scapularis* Subolesin (4D8, Akirin) protective antigen



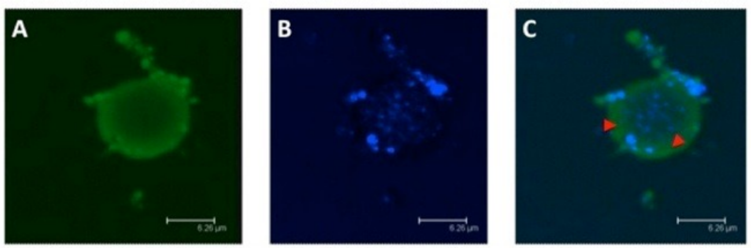
Almazán et al. 2003. Vaccine 21: 1492-1501.

SaBio
Health and Biotechnology

Model for Subolesin vaccine protection



Antibodies can enter into tick cells



Antibodies (in green) | Nucleic acids (in blue) | Superimposed image

Veterinary Parasitology 181 (2011) 17–22

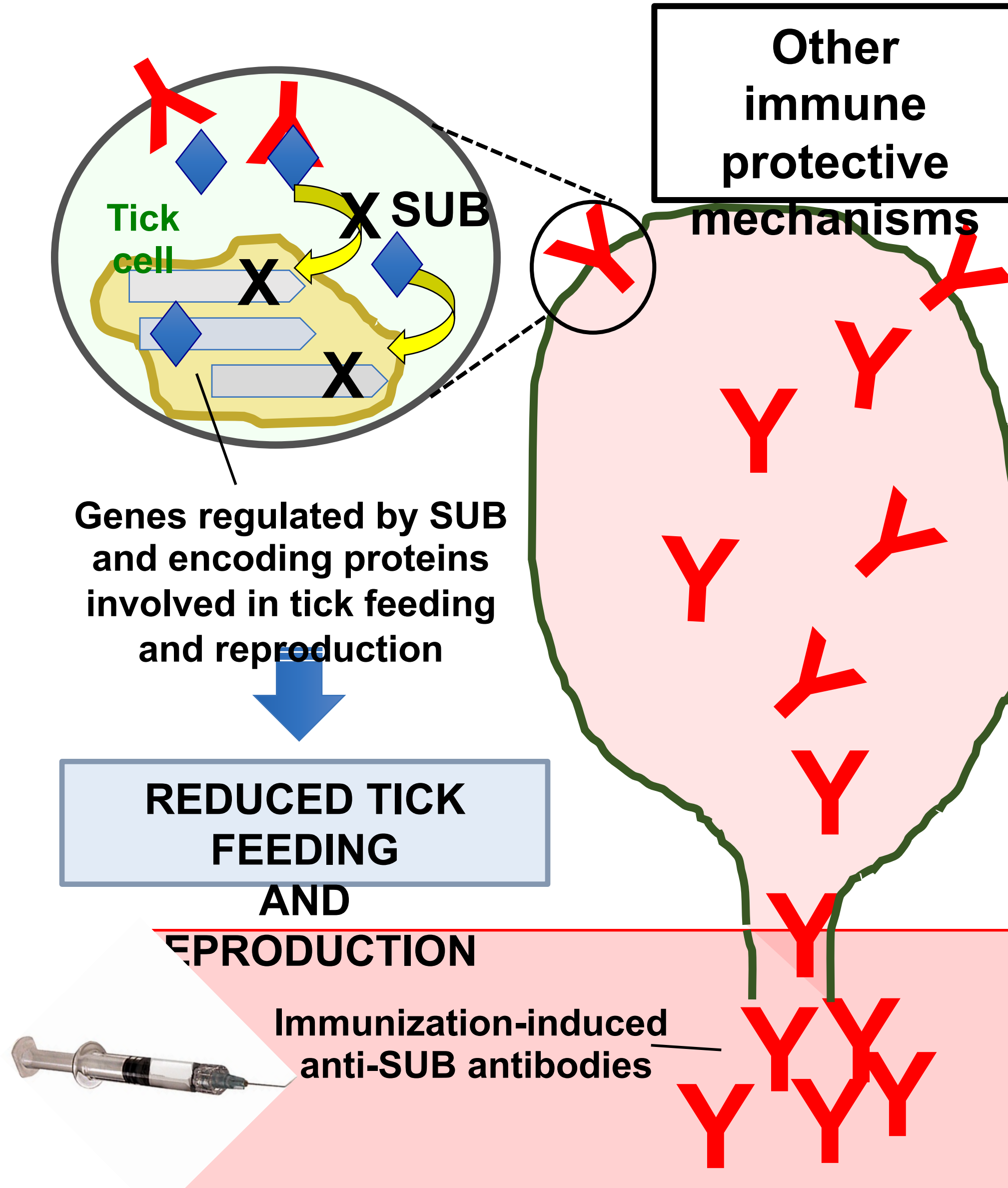
Contents lists available at ScienceDirect

Veterinary Parasitology

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

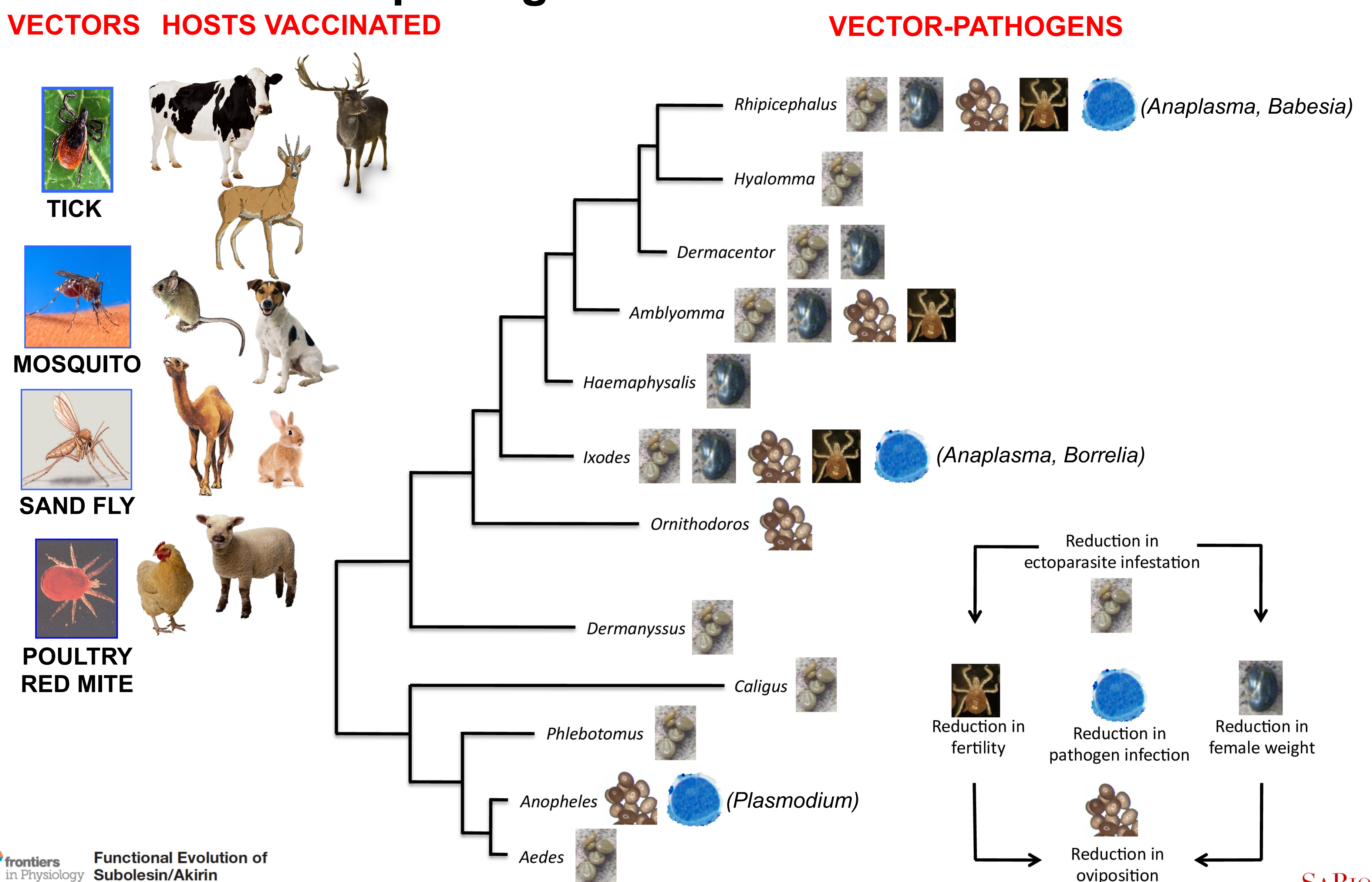
Targeting arthropod subolesin/akirin for the development of a universal vaccine for control of vector infestations and pathogen transmission

José de la Fuente[a,b,*], Juan A. Moreno-Cid[a], Mario Canales[a], Margarita Villar[a], José M. Pérez de la Lastra[a], Katherine M. Kocan[b], Ruth C. Galindo[a], Consuelo Almazán[c], Edmour F. Blouin[b]



SABIO
Health and Biotechnology

Effect of Subolesin immunization on ectoparasite infestations and pathogen infection/transmission



frontiers in Physiology
9: 1612
(2018)

Functional Evolution of Subolesin/Akirin

Sara Artigas-Jerónimo[1†], Margarita Villar[1†], Alejandro Cabezas-Cruz[2], James J. Valdés[3,4,5], Agustín Estrada-Peña[6], Pilar Alberdi[1] and José de la Fuente[1,7*]

SaBio

Effect of Subolesin (SUB-MSP1a) vaccine efficacy in the field

Torina *et al. Parasites & Vectors* 2014, 7:10
http://www.parasitesandvectors.com/content/7/1/10

Parasites & Vectors

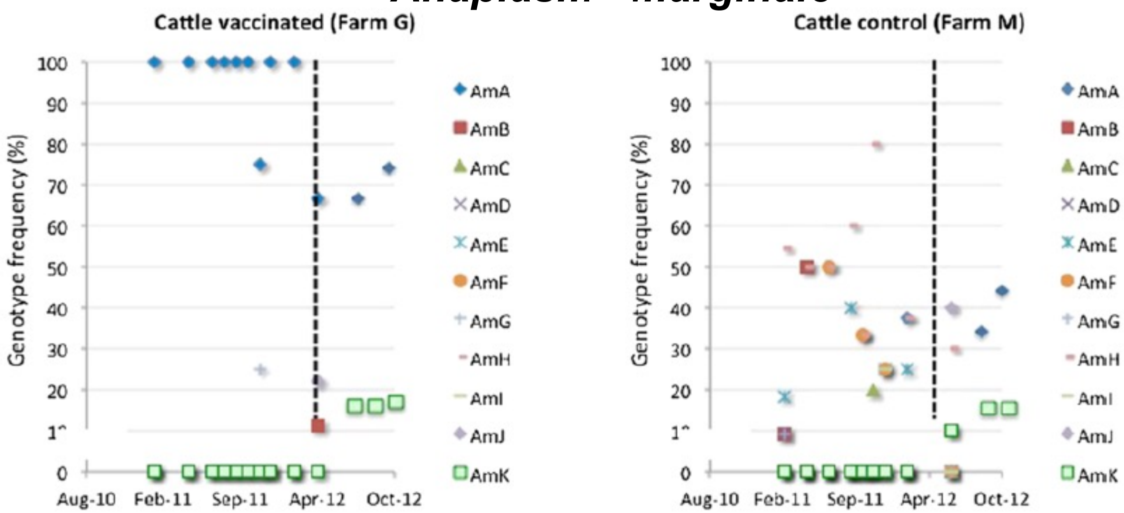
RESEARCH Open Access

Control of tick infestations and pathogen prevalence in cattle and sheep farms vaccinated with the recombinant Subolesin-Major Surface Protein 1a chimeric antigen

Alessandra Torina[1,2], Juan A Moreno-Cid[3], Valeria Blanda[1], Isabel G Fernández de Mera[3], José M Pérez de la Lastra[3], Salvatore Scimeca[1], Marcellocalogero Blanda[1], Maria Elena Scariano[1], Salvatore Briganò[1], Rosaria Disclafani[1], Antonio Piazza[1], Joaquín Vicente[3], Christian Gortázar[3], Santo Caracappa[1], Rossella Colomba Lelli[1] and José de la Fuente[3,4*]

- **63% reduction of tick infestations in sheep**
- **8-fold reduction in the percent of infested cattle**
- **32-55% reduction in tick weigh**
- **Reduction in acaricide treatments**

Anaplasma marginale



SABIO
Health and Biotechnology

New antigens for vaccine efficacy against multiple tick species

2000 - 2023

Table 1. Examples of recombinant tick protective antigens.

Tick protein	Tick species	Characterization
Bm86/Bm95	*B. microplus*	Gut proteins of unknown function
Bm91	*B. microplus*	Peptidase
BmTI	*B. microplus*	Trypsin inhibitor
64P	*R. appendiculatus*	Cement protein
Immuno-globulin-binding proteins	*R. appendiculatus*	Immunomodulator
p29	*H. longicornis*	Salivary gland putative extracellular matrix protein
4F8	*I. scapularis*	Nucleotidase
3E1	*I. scapularis*	β-adaptin
4G11	*I. scapularis*	Chloride channel

Recombinant tick antigen
Metalloprotease
Ribosomal protein P0
Ferritin 2
Aquaporin
Subolesin
Q38[§] Silk Subolesin
BM95-MSP1a Subolesin-MSP1a
BM86 BM86 + Subolesin

15th International Symposium on Ticks and Tick-borne Diseases
29–31 March 2023
Weimar, Germany

Potassium ion channels

Canonical metabolic pathways

Proteasome inhibitors

Metalloproteases

De la Fuente J & Kocan KM. Expert Rev. Vaccines 2(4), 583–593 (2003)
De la Fuente J & Contreras M. Expert Rev. Vaccines 14(10), 1367–1376 (2015)
De la Fuente J. Ticks and Tick-borne Diseases 14 (2023) 102227

SaBio
Health and Biotechnology

Third challenge: Impact of tick genetic diversity on vaccine efficacy

Personalized vaccinology: Regional, tick spp./strains and host driven approaches

vaccines

NARO

irec

MDPI

Conference Report

Towards a multidisciplinary approach to improve cattle health and production in Uganda

José de la Fuente[1,2,*], Marinela Contreras[1], Paul D. Kasaija[1,3], Christian Gortazar[1], Jose F. Ruiz-Fons[1], Rafael Mateo[1], Fredrick Kabi[3]

Vaccines 2020,8,319

Article

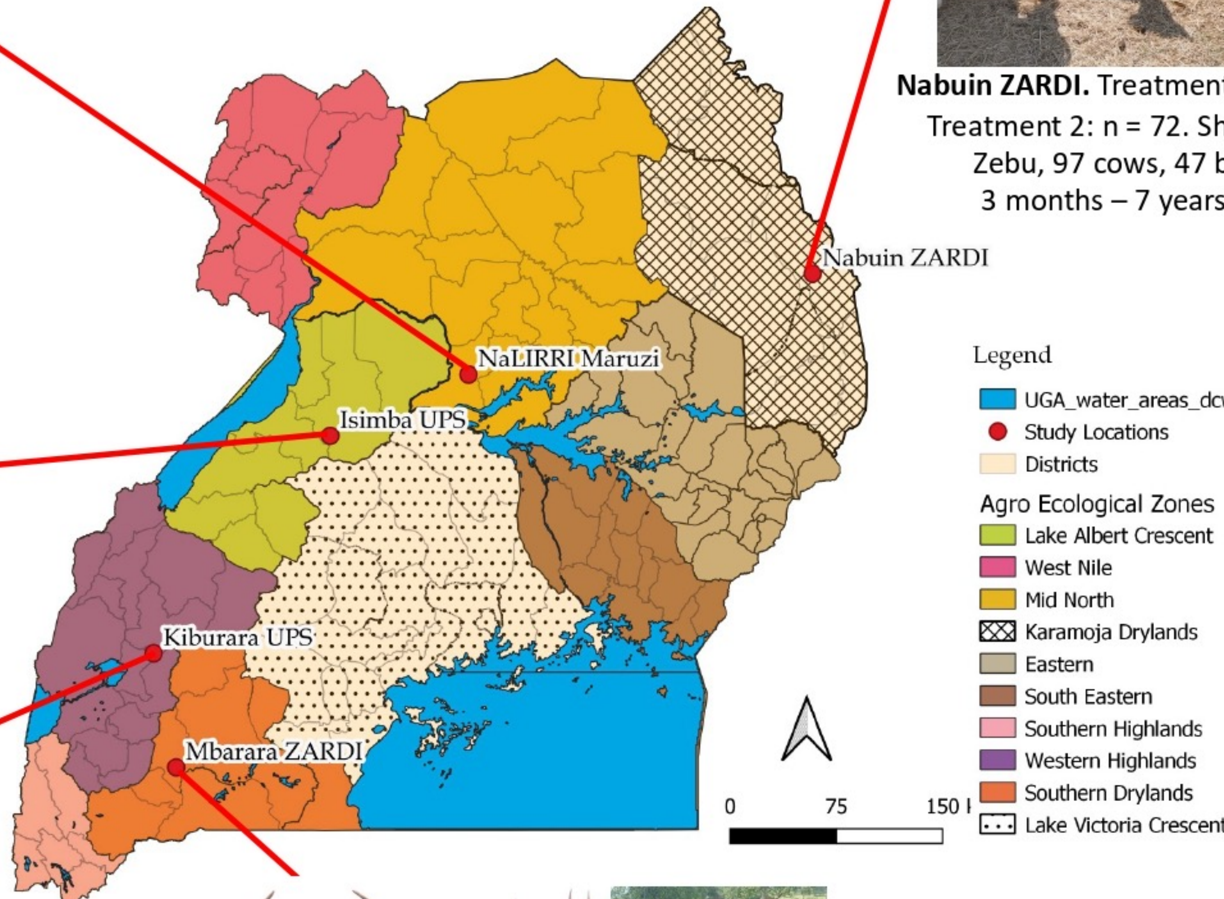
Vaccination with Recombinant Subolesin Antigens Provides Cross-Tick Species Protection in *Bos indicus* and Crossbred Cattle in Uganda

Paul D. Kasaija [1,2,†], Marinela Contreras [1,3,†], Fredrick Kabi [2], Swidiq Mugerwa [2] and José de la Fuente [1,4,*]

Field trial with personalized SUB anti-tick vaccine in Uganda

Maruzi NaLIRRI. Treatment 1: n = 72. Treatment 2: n = 72. Ankole longhorn and Shorthorn Zebu, 140 cows, 4 bulls, 3 months – 7 years old

Nabuin ZARDI. Treatment 1: n = 72. Treatment 2: n = 72. Shorthorn Zebu, 97 cows, 47 bulls, 3 months – 7 years old



UPS Isimba. Treatment 1: n = 36. Treatment 2: n = 36. Boran, 67 cows, 5 bulls, 3 months – 7 years old

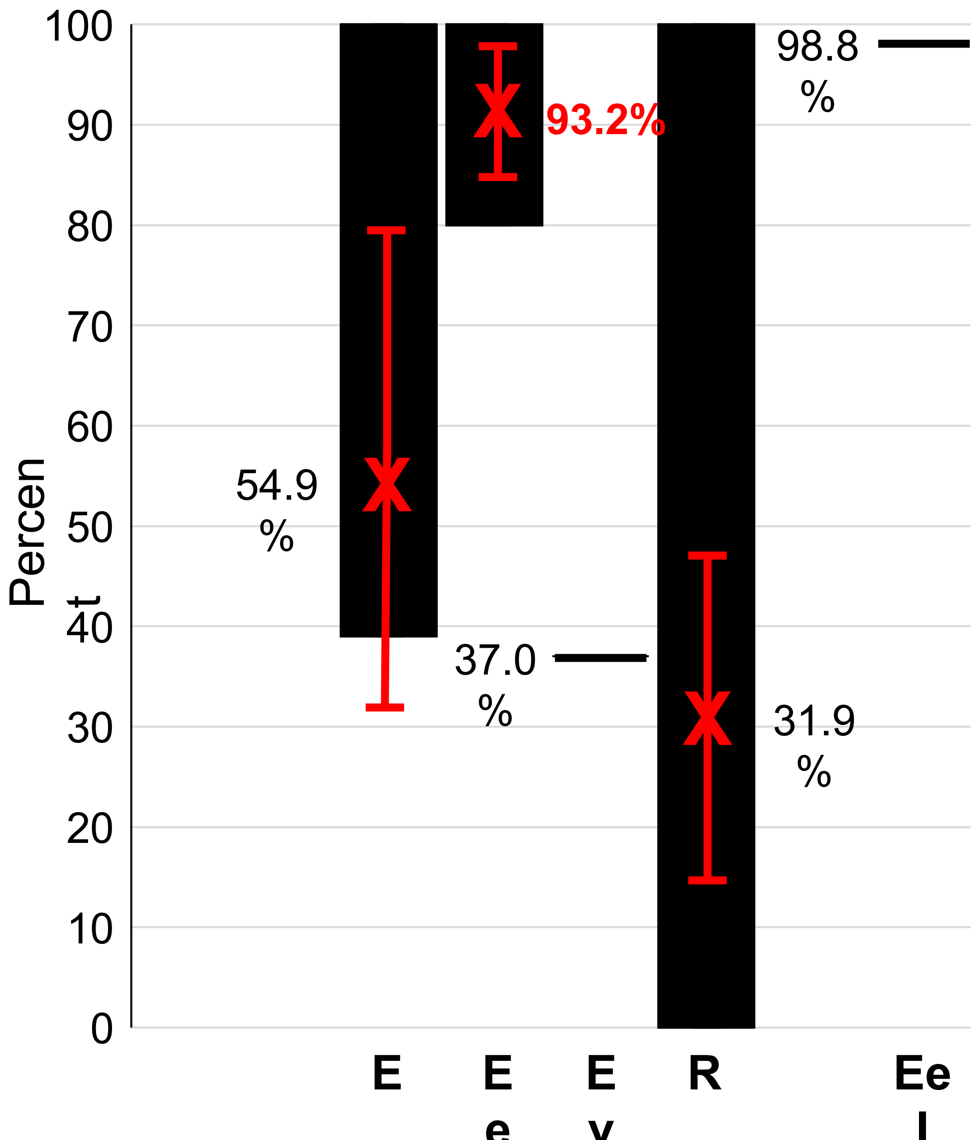
UPS farm - Kiburara. Treatment 1: n = 36. Treatment 2: n = 36. Boran, 68 cows, 4 bulls, 3 months – 7 years old

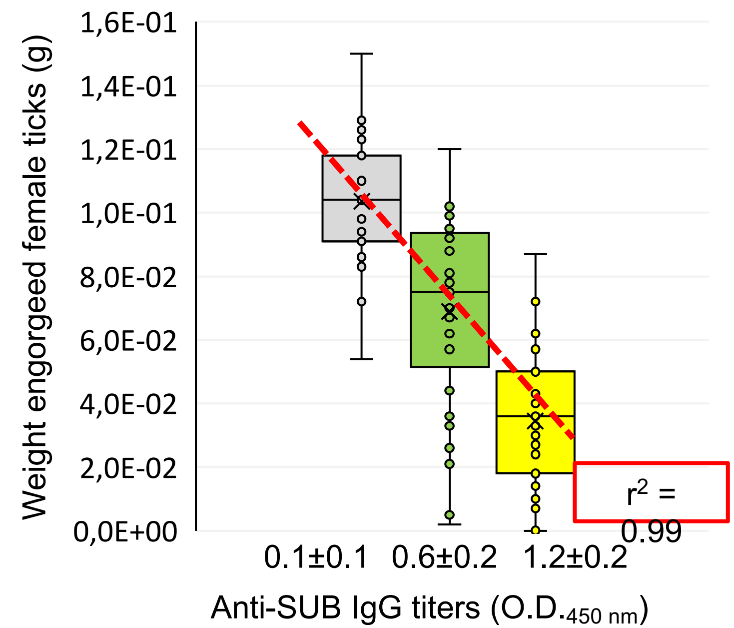
Mbarara ZARDI. Treatment 1: n = 72. Treatment 2: n = 72. Ankole long horn and Fresian crosses, 141 cows and 3 bulls, 3 months – 7 years old

Field trial with personalized SUB anti-tick vaccine in Uganda

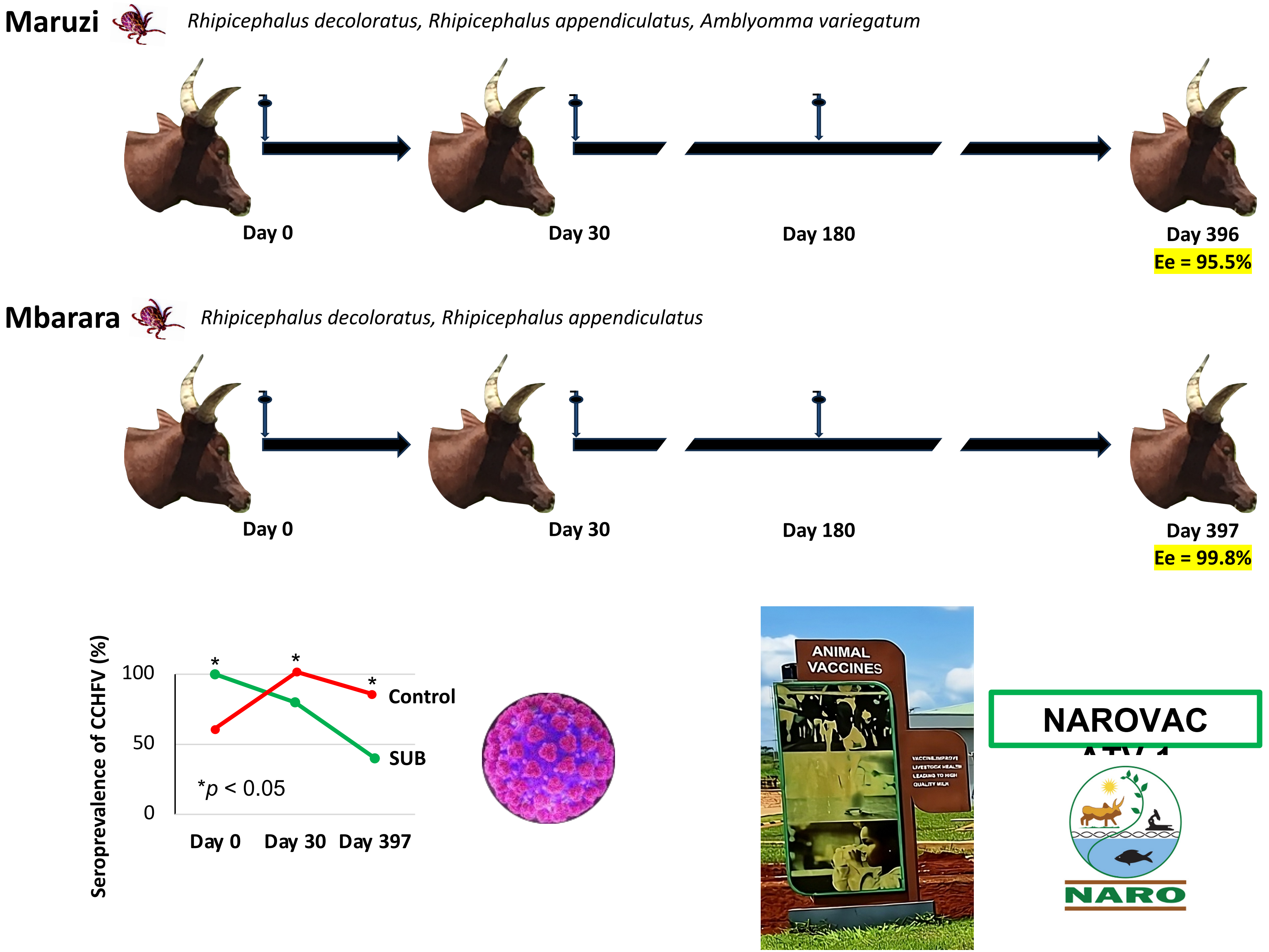
Evaluation of effectiveness and safety of Subolesin anti-tick vaccine in Ugandan multi-site field trial

npj | vaccines
2024. 9:174.
www.nature.com/npjvaccines
https://doi.org/10.1038/s41541-024-00966-1



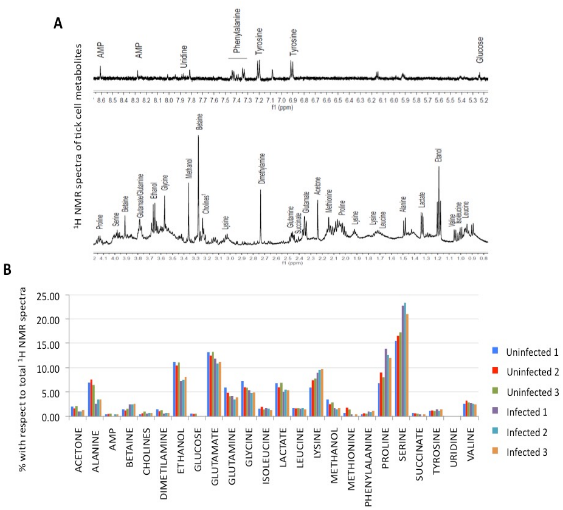


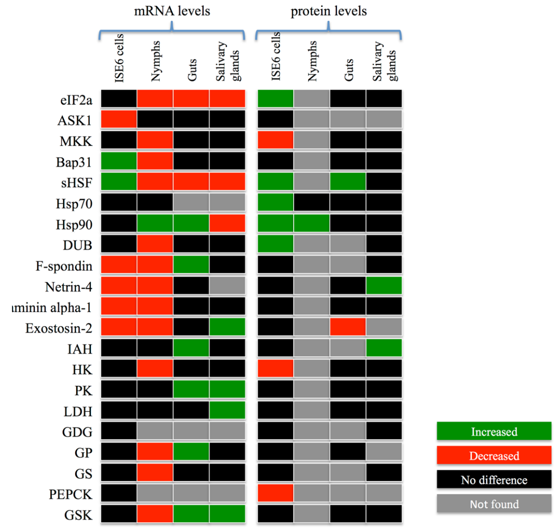
Vaccine efficacy (**E**), vaccine effectiveness (**Ee**), total (larvae, nymphs and adults) tick counts on animals infested with various tick species (**Ev**), reduction in the number of infested cattle (**R**), and total integrated vaccine efficacy/effectiveness (**EeI**) at 167-196 dpv

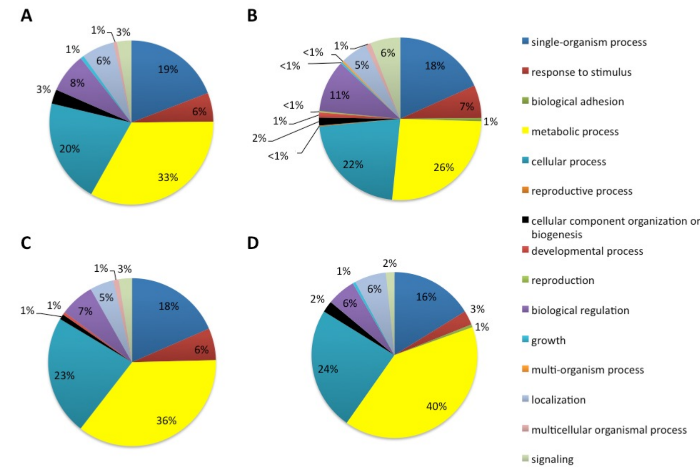

Maruzi
Rhipicephalus decoloratus, Rhipicephalus appendiculatus, Amblyomma variegatum
Day 0
Day 30
Day 180
Day 396
Ee = 95.5%
Mbarara
Rhipicephalus decoloratus, Rhipicephalus appendiculatus
Day 0
Day 30
Day 180
Day 397
Ee = 99.8%
Seroprevalence of CCHFV (%)
100
50
0
*
*
*
Control
SUB
*p < 0.05
Day 0
Day 30
Day 397
ANIMAL VACCINES
NAROVAC
NARO

Fourth challenge: Antigen combination to improve vaccine efficacy

Systems biology integration of omics datasets







METABOLOMICS INTERACTOMICS REGULOMICS

TRANSCRIPTOMICS miRNAOMICS

PROTEOMICS METAGENOMICS

frontiers in Cellular and Infection Microbiology 2018; 8: 265

Use of Graph Theory to Characterize Human and Arthropod Vector Cell Protein Response to Infection With *Anaplasma phagocytophilum*

*Agustín Estrada-Peña[1], Margarita Villar[2], Sara Artigas-Jerónimo[2], Vladimir López[2], Pilar Alberdi[2], Alejandro Cabezas-Cruz[3,4,5] and José de la Fuente[1,6]**

PLOS GENETICS 2015; 11(3): e1005120

RESEARCH ARTICLE

Systems Biology of Tissue-Specific Response to *Anaplasma phagocytophilum* Reveals Differentiated Apoptosis in the Tick Vector *Ixodes scapularis*

Nieves Ayllón[1], Margarita Villar[1], Ruth C. Galindo[1,2], Katherine M. Kocan[2], Radek Šíma[3], Juan A. López[4], Jesús Vázquez[4], Pilar Alberdi[1], Alejandro Cabezas-Cruz[1,5], Petr Kopáček[3], José de la Fuente[1,2]*

PLOS Genetics | DOI:10.1371/journal.pgen.1005120 March 27, 2015

MCP MOLECULAR & CELLULAR PROTEOMICS 2015; 14: 3154-3172
Research

Integrated Metabolomics, Transcriptomics and Proteomics Identifies Metabolic Pathways Affected by *Anaplasma phagocytophilum* Infection in Tick Cells*

Margarita Villar‡§§, Nieves Ayllón‡, Pilar Alberdi‡, Andrés Moreno§, María Moreno§, Raquel Tobes¶, Lourdes Mateos-Hernández‡, Sabine Weisheit‖**, Lesley Bell-Sakyi‖**, and José de la Fuente‡‡‡§§

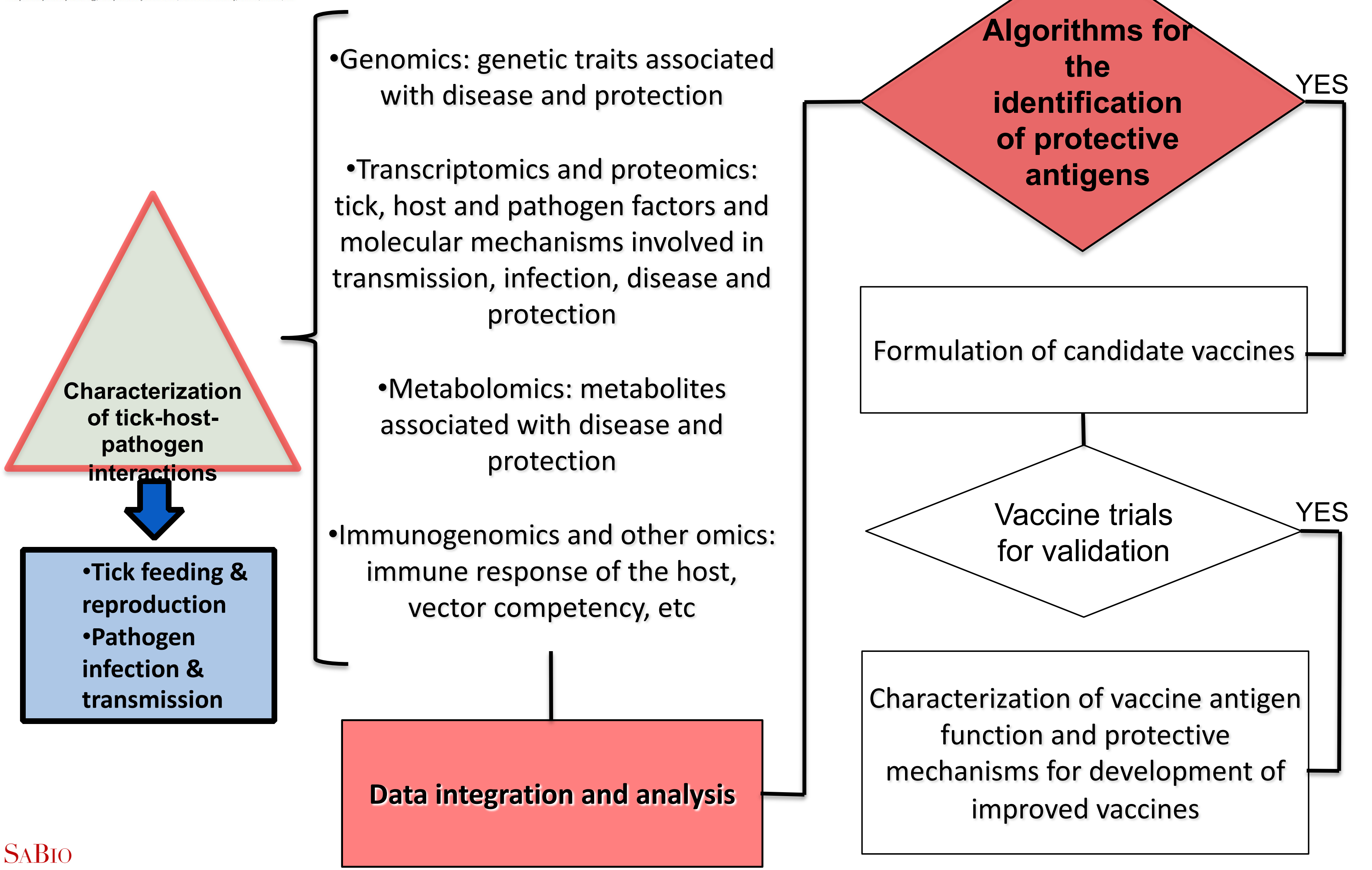
Health and Biotechnology

Vaccine 31 (2013) 5923–5929
Contents lists available at ScienceDirect
Vaccine
journal homepage: www.elsevier.com/locate/vaccine

Vaccinomics, the new road to tick vaccines

José de la Fuente [a,b,*], Octavio Merino [a]
[a] SaBio. Instituto de Investigación en Recursos Cinegéticos IREC (CSIC-UCLM-JCCM), Ronda de Toledo s/n, 13005 Ciudad Real, Spain
[b] Department of Veterinary Pathobiology, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK 74078, USA

Vaccinomics: The new road to tick vaccines



SaBio
Health and Biotechnology

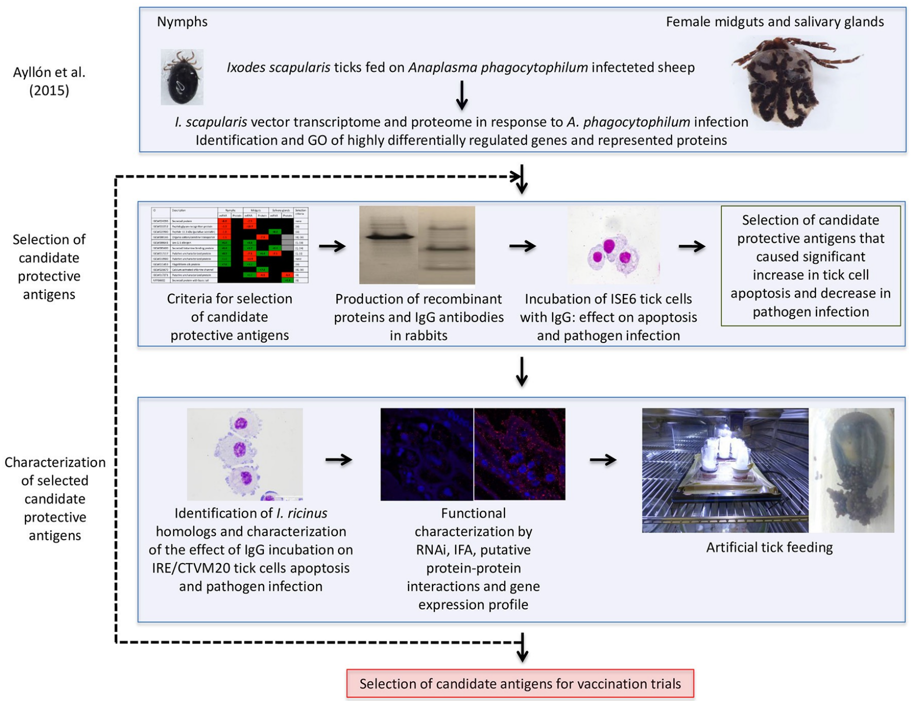
Vaccinomics approach for the identification of protective antigens for the control of ectoparasite infestations, pathogen infection and transmission

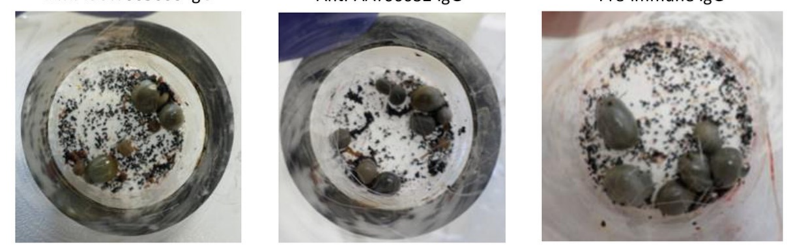
frontiers in Cellular and Infection Microbiology
ORIGINAL RESEARCH
published: 09 August 2017
doi: 10.3389/fcimb.2017.00360

Front. Cell. Infect. Microbiol. 7: 360.

Vaccinomics Approach to the Identification of Candidate Protective Antigens for the Control of Tick Vector Infestations and *Anaplasma phagocytophilum* Infection

Marinela Contreras[1], Pilar Alberdi[1], Isabel G. Fernández De Mera[1], Christoph Krull[2], Ard Nijhof[2], Margarita Villar[1] and José De La Fuente[1,3]*

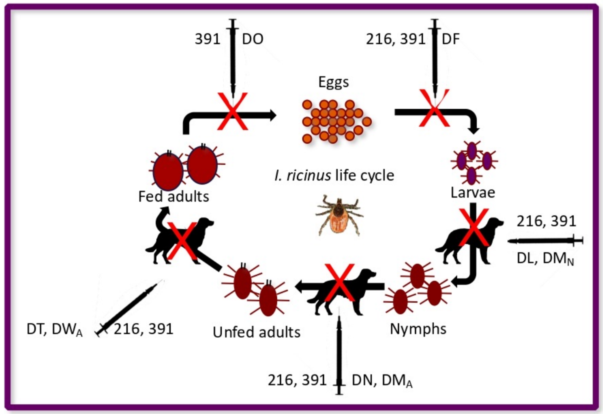


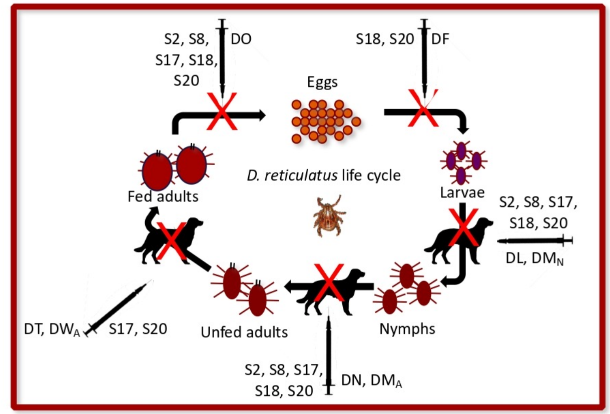


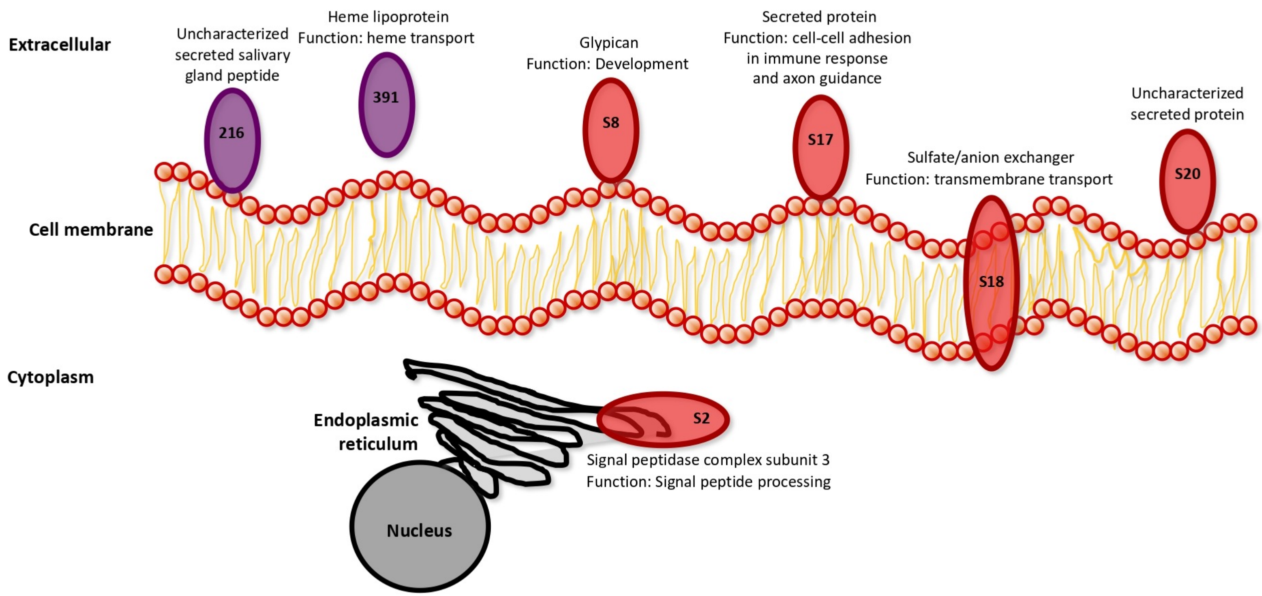
	Anti-ISCW005600 IgG	Anti-AAY66632 IgG	Pre-immune IgG
Number of attached ticks	19	17	17
Number of dead ticks	4	6*	0
Number of fed ticks	15	11	17
Tick weight (mg) (average ± S.D.)	193±39	134±81	177±44
Number of ticks with oviposition	13	5	10
Egg weight (mg) (average ± S.D.)	39±25	48±29	24±18
Reduction in *A. phagocytophilum* infection (%)	34*	53*	0

SABIO
Health and Biotechnology

Vaccinomics approach for the identification of protective antigens for the control of ectoparasite infestations, pathogen infection and transmission







A Vaccinomics Approach for the Identification of Tick Protective Antigens for the Control of *Ixodes ricinus* and *Dermacentor reticulatus* Infestations in Companion Animals

Marinela Contreras[1†], Margarita Villar[1†] and José de la Fuente[1,2*]

frontiers in Physiology 2019; 10: 977

Big Data analytics for protective antigen identification

Vaccine 35 (2017) 5089–5094
Contents lists available at ScienceDirect
Vaccine
journal homepage: www.elsevier.com/locate/vaccine

Review

Targeting a global health problem: Vaccine design and challenges for the control of tick-borne diseases

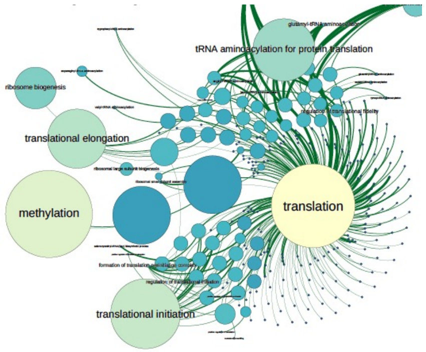
José de la Fuente[a,b,*], Marinela Contreras[a], Agustín Estrada-Peña[c], Alejandro Cabezas-Cruz[d,e,f]

EXPERT REVIEW OF VACCINES
https://doi.org/10.1080/14760584.2018.1493928

PERSPECTIVE

High throughput discovery and characterization of tick and pathogen vaccine protective antigens using vaccinomics with intelligent Big Data analytic techniques

José De La Fuente[a,b], Margarita Villar[a], Agustin Estrada-Peña[c] and José A. Olivas[d]



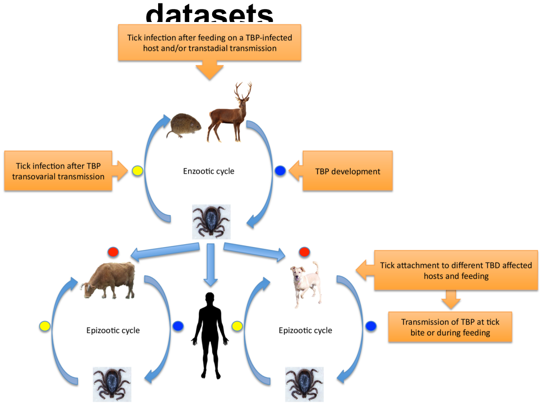
Tick-host-pathogen interactions omics datasets

Table I. An example of the proposed machine learning algorithm. Data are for illustrative purposes only.

Antigens (Ags)	Input variables (observed predictors)											Response variables	
Known Ags	A	B	C	D	E	F	G	H	I	J	K	E_{1-10}	K/R
	Average importance of each score (learned from known Ags)												
	4	3	5	6	6	8	10	7	7	7	7	–	–
Ag1	1	2	1	10	11	13	90	1	0	3	0	20%	R*
Ag2	2	3	0	20	33	8	75	3	2	3	0	100%	K
Ag3	0	4	2	0	3	0	100	0	2	1	0	56%	R**
AgN	2	0	2	0	6	6	50	2	1	0	1	77%	K
New predicted Ags	New observations											Predictions	
New Ag1	2	2	1	10	6	20	90	1	1	1	1	80%	K
New Ag2	1	3	1	35	12	2	20	1	1	1	2	6%	R
New AgN	1	2	1	22	70	9	100	1	1	1	1	92%	K

K, keep; R*, reject for weak protection; R**, reject for poor information of input variables. Input and response variables are described in Tables II and III below.

New Big Data Analytics framework



Risks for tick-borne diseases

Selection of candidate protective antigens

Quantum vaccinomics: Identification of protective epitopes, the immunological quantum

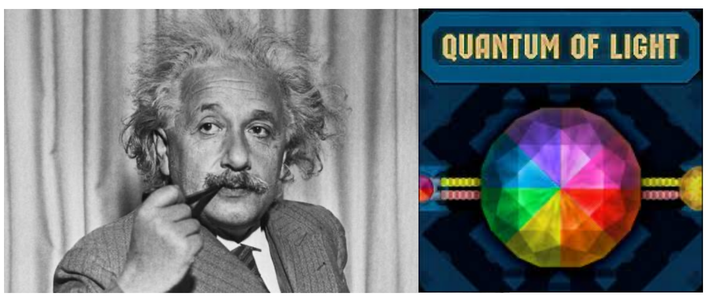
SABIO
Health and Biotechnology

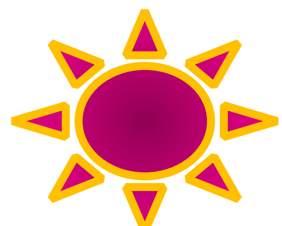
Quantum Vaccinomics

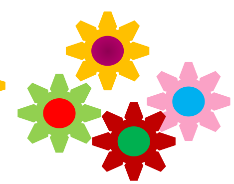
Random processes

- Immunoglobulin recombination events
- Direct correlation between atomic coordination and peptide immunogenicity
- Quantum dynamics within living systems such as the immune response has been subjected to optimizing evolution

Quantum immunology



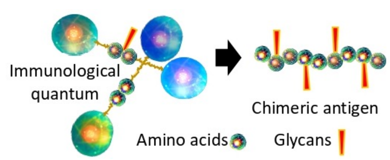




Immunological quantu

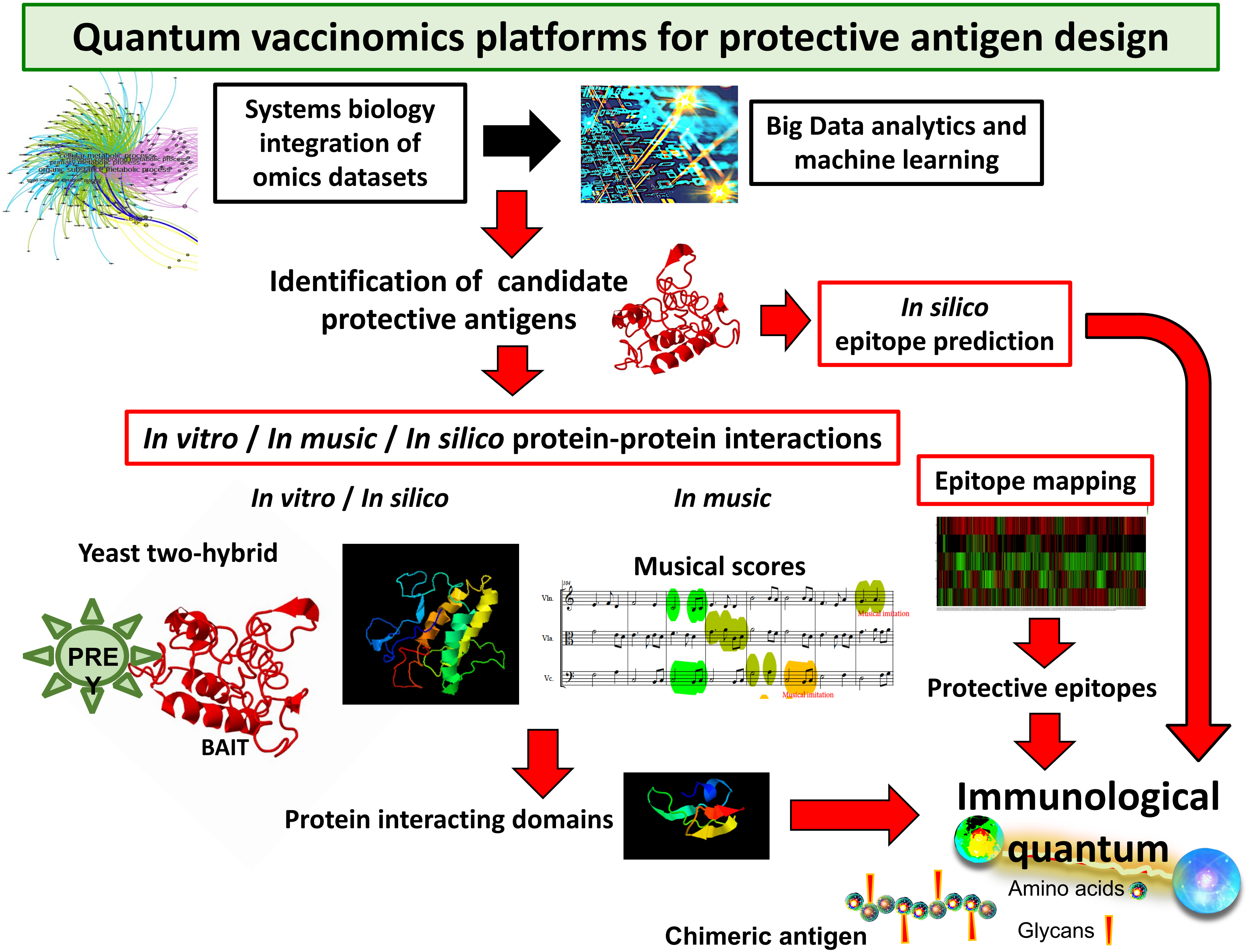
Immune protective epitopes

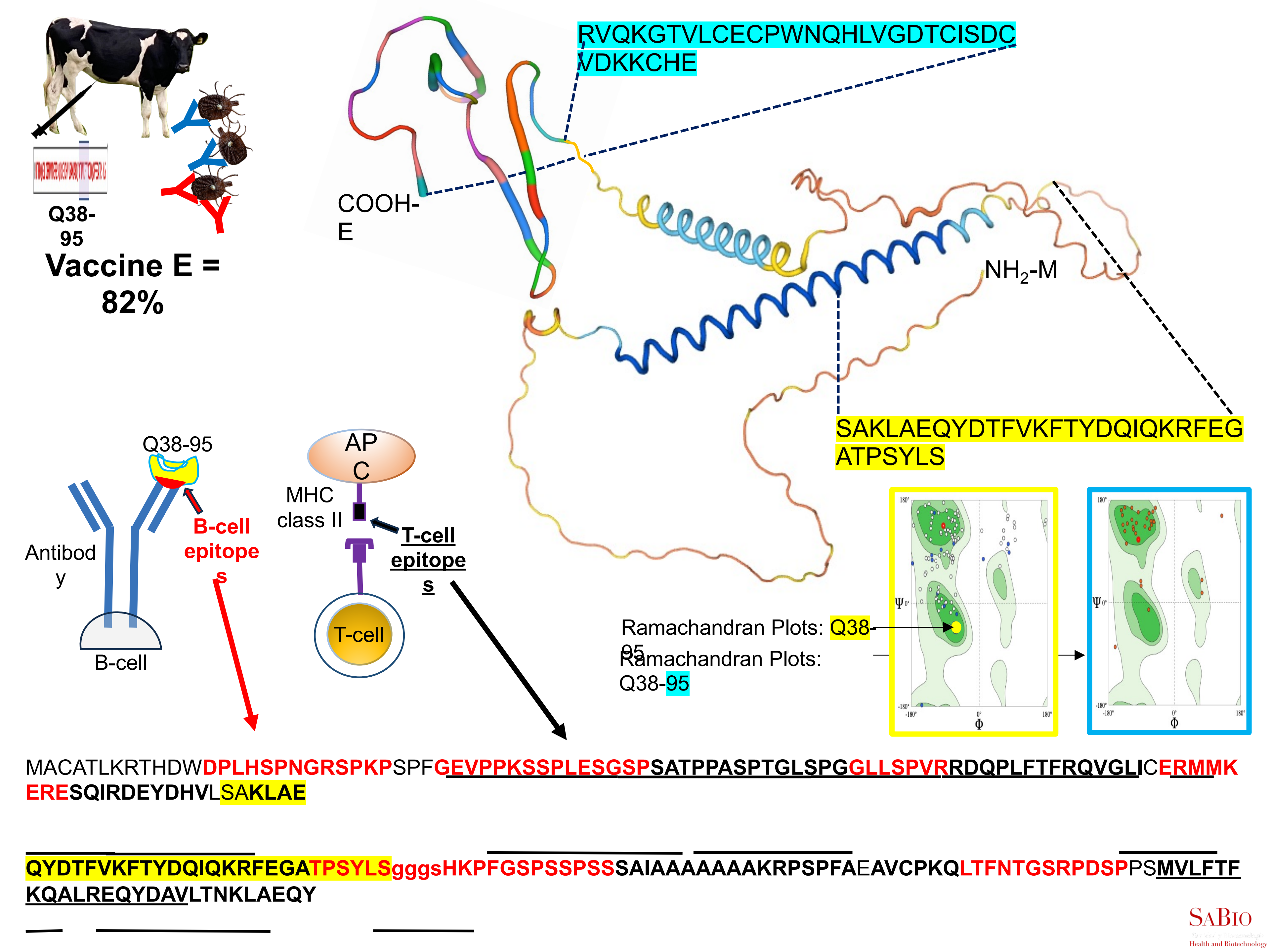
Quantum vaccinomics



Identification and combination of antigen protective epitopes, the immunological quantum, for vaccine development

Artigas-Jeronimo et al. Vaccines 2020, 8, 77; de la Fuente & Contreras Expert Review Vaccines 2021;20:1561-1569


Quantum vaccinomics platforms for protective antigen design
Systems biology integration of omics datasets
Big Data analytics and machine learning
Identification of candidate protective antigens
In silico epitope prediction
In vitro / In music / In silico protein-protein interactions
Epitope mapping
In vitro / In silico
In music
Yeast two-hybrid
PREY
BAIT
Musical scores
Vln.
Vla.
Vc.
Musical imitation
Musical imitation
Protective epitopes
Protein interacting domains
Immunological quantum
Amino acids
Glycans
Chimeric antigen



RVQKGTVLCECPWNQHLVGDTCISDC
VDKKCHE
COOH-
E
Q38-
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Vaccine E =
82%
NH2-M
SAKLAEQYDTFVKFTYDQIQKRFEG
ATPSYLS
Q38-95
AP
C
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class II
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y
B-cell
epitope
s
B-cell
T-cell
Ramachandran Plots: Q38-95
Ramachandran Plots: Q38-95
MACATLKRTHDWDPLHSPNGRSPKPSPFGEVPPKSSPLESGSPSATPPASPTGLSPGGLLSPVRRDQPLFTFRQVGLICERMMK
ERESQIRDEYDHVLSAKLAE
QYDTFVKFTYDQIQKRFEGATPSYLSgggsHKPFGSPSSPSSSAIAAAAAAKRPSPFAEAVCPKQLTFNTGSRPDSPPSMVLFTF
KQALREQYDAVLTNKLAEQY
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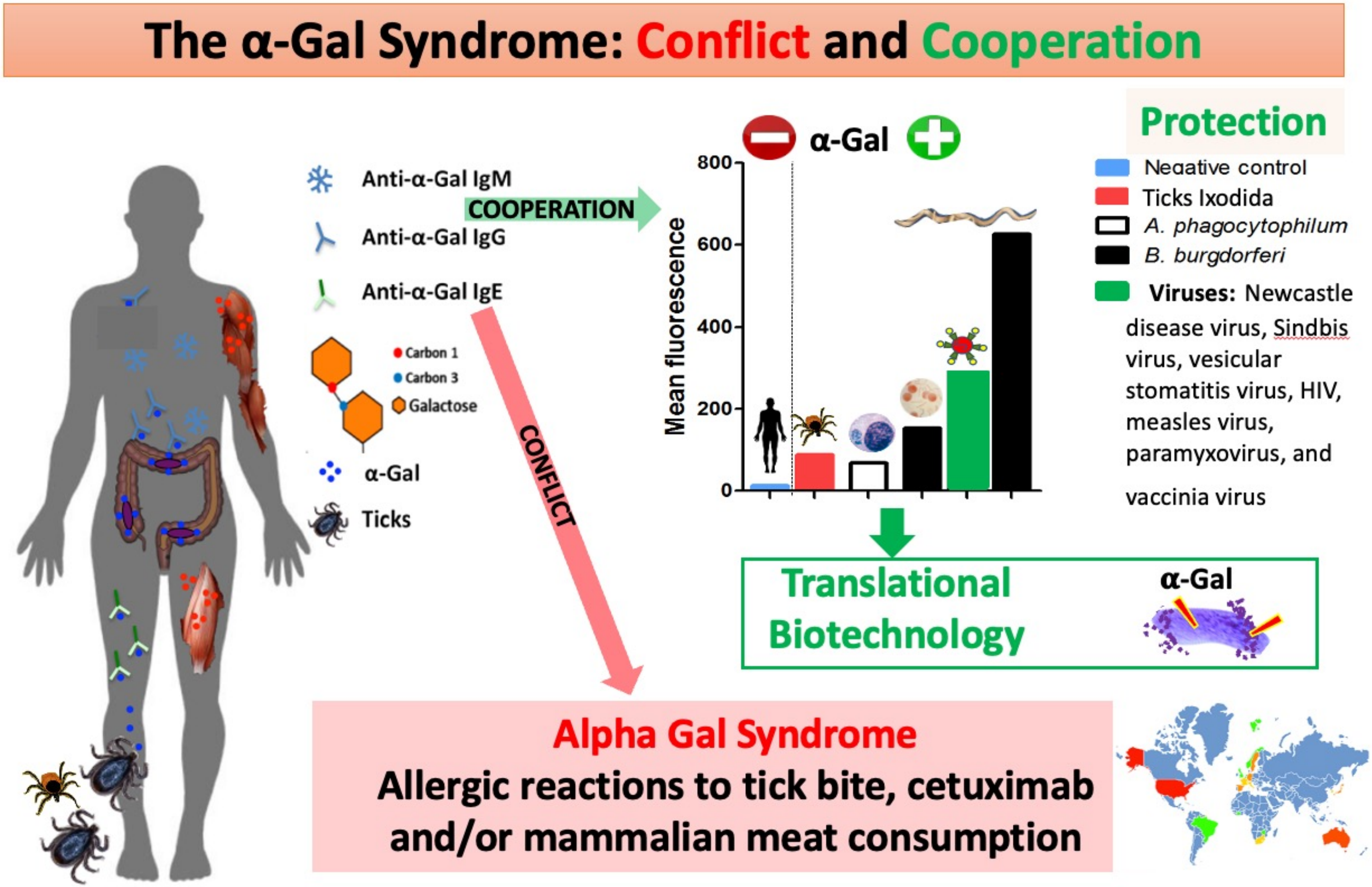
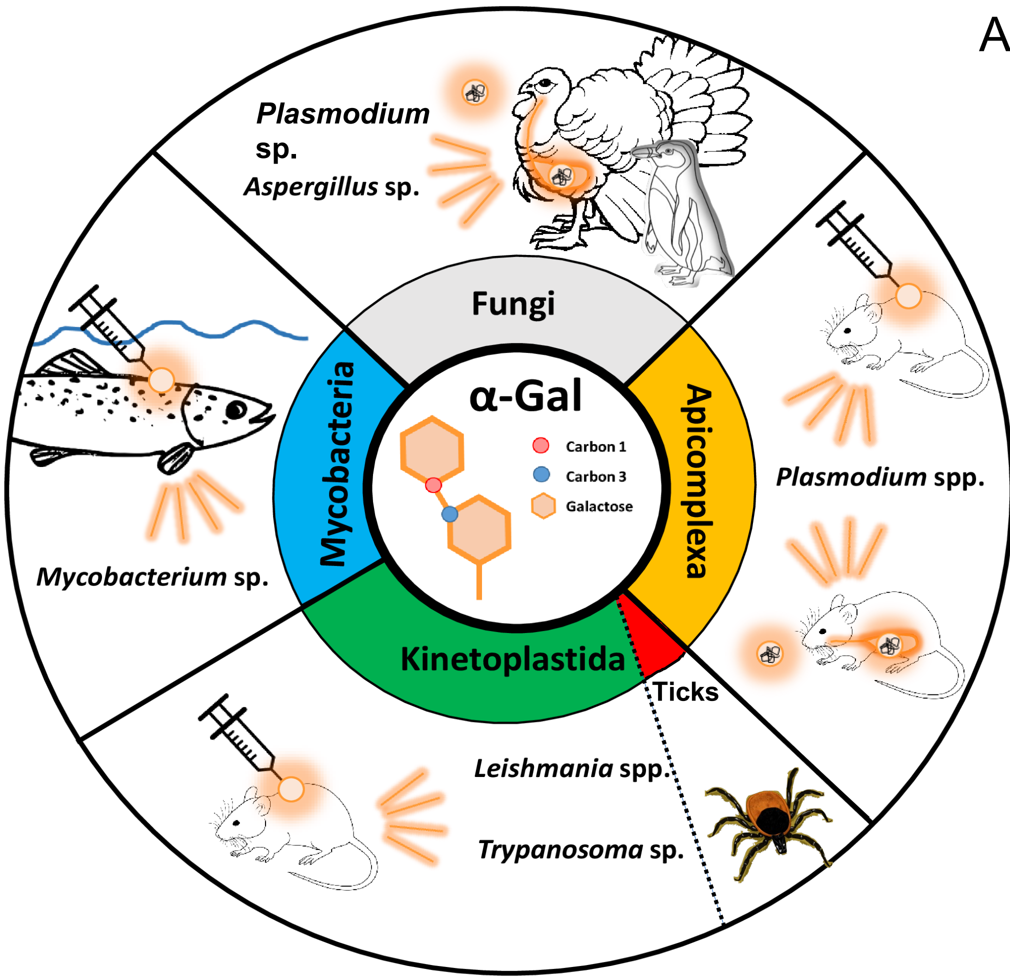
Fifth challenge: Vaccine formulation

Immunity to α-Gal for the control of major infectious diseases

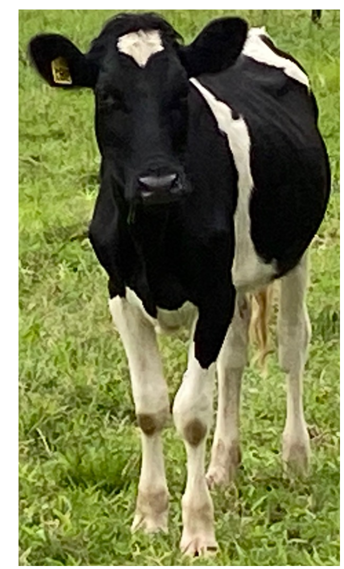


Innovative control interventions for ticks and pathogens

Recent evidence showed that immunization with α-Gal induces a protective immune response against pathogen infection and tick infestations



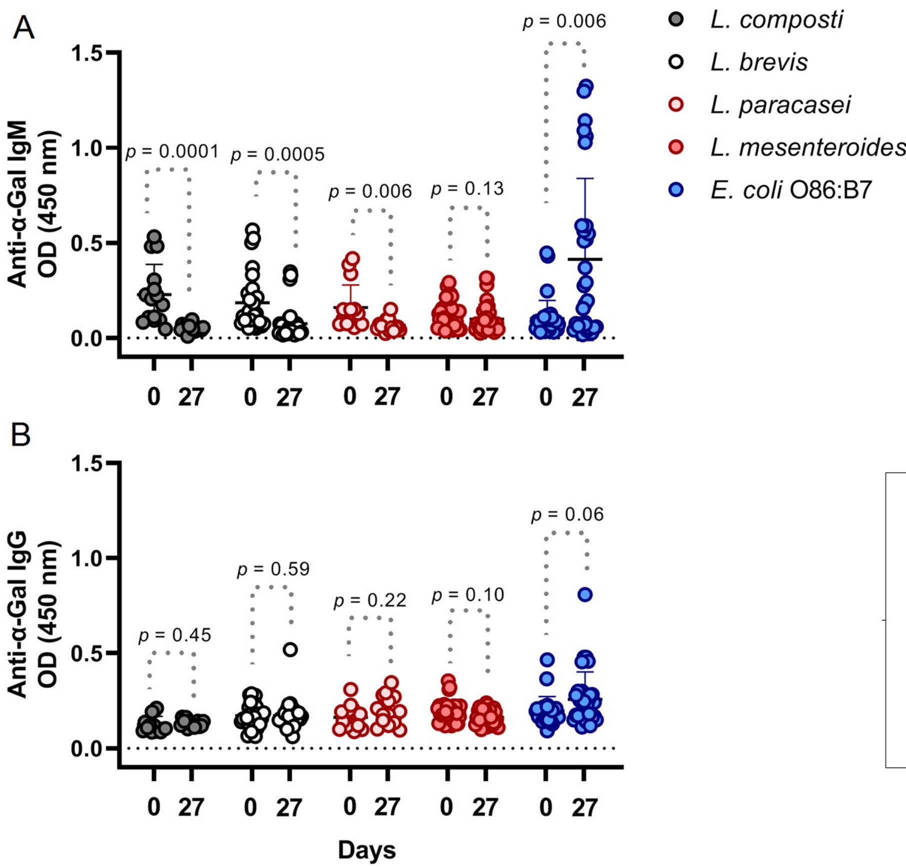
Anti-α-Gal antibodies in dogs and cattle



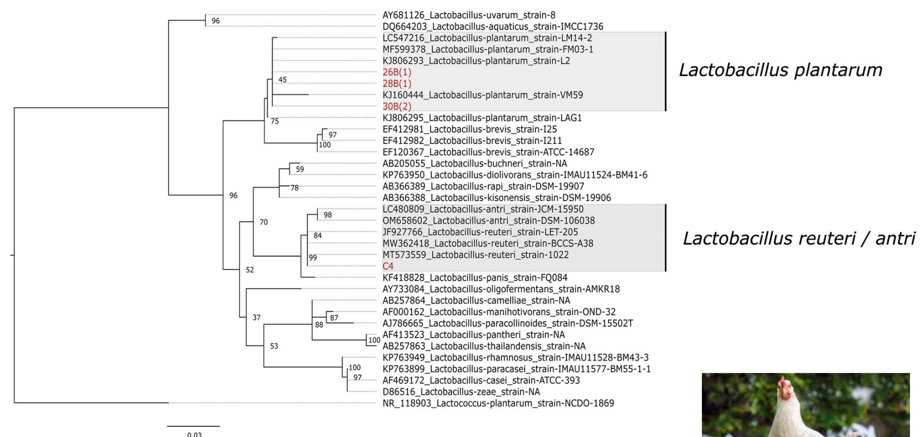
Hodžić, A., Mateos-Hernández, L., de la Fuente, J., Cabezas-Cruz, A. 2020. α-Gal-based vaccines: Advances, opportunities, and perspectives. Trends in Parsitology.

Trends in Parasitology

Targeting host/vector microbiota: Probiotic *Lactobacillus*



Traditionally fermented foods (kununn-zaki, kindirmo and pulque)



scientific reports 12: 7484 (2022)

Functional characterization of α-Gal producing lactic acid bacteria with potential probiotic properties

Timothy Bamgbose[1,3], Pilar Alberdi[2], Isa O. Abdullahi[3], Helen I. Inabo[3], Mohammed Bello[4], Swati Sinha[1], Anupkumar R. Anvikar[1], Lourdes Mateos-Hernandez[5], Edgar Torres-Maravilla[6], Luis G. Bermúdez-Humarán[6], Alejandro Cabezas-Cruz[5] & Jose de la Fuente[2,7]✉

PLOS ONE 18(1): e0280412 (2023)

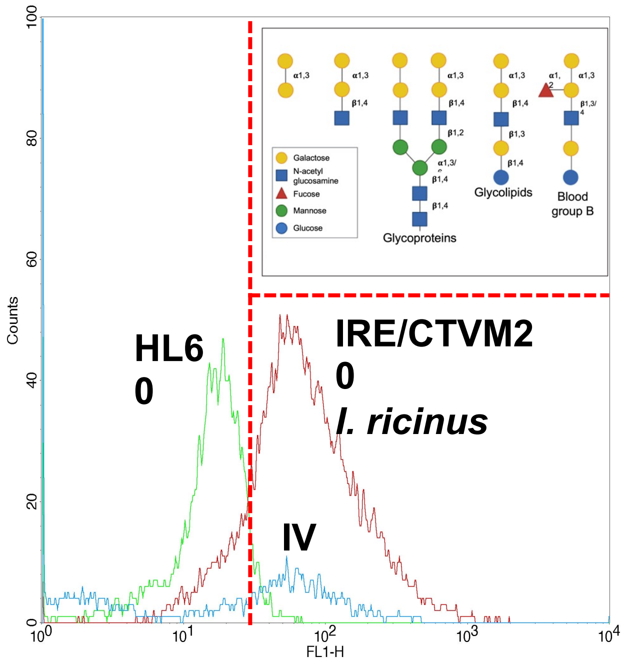
Identification and characterization of probiotics isolated from indigenous chicken (*Gallus domesticus*) of Nepal

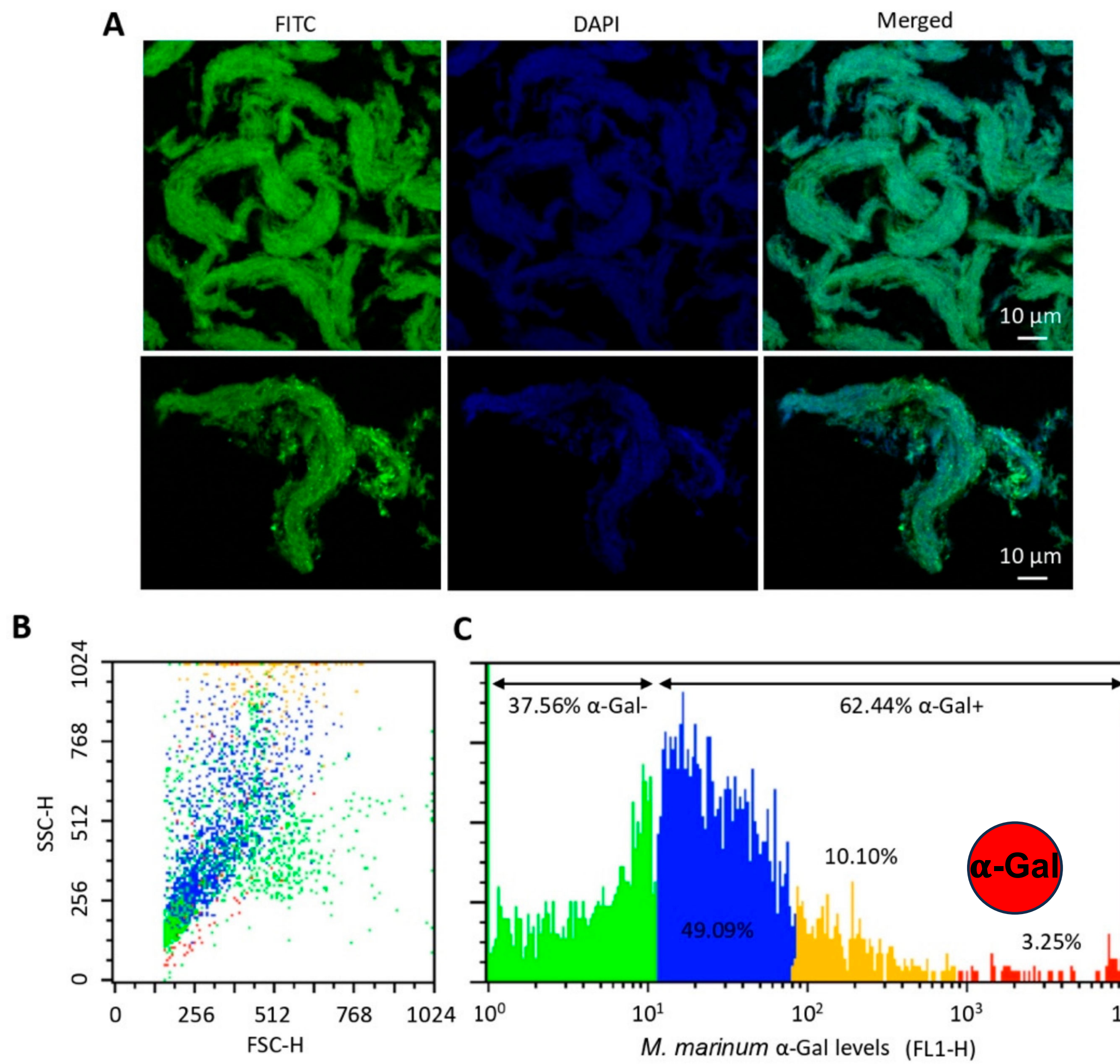
Mohan Gupta[1☯], Roji Raut[2☯], Sulochana Manandhar[2], Ashok Chaudhary[2], Ujwal Shrestha[1], Saubhagya Dangol[1], Sudarshan G. C.[1,3], Keshab Raj Budha[4], Gaurab Karki[5,6], Sandra Díaz-Sánchez[7], Christian Gortazar[7], José de la Fuente[7,8], Pragun Rajbhandari[2], Prajwol Manandhar[2], Rajindra Napit[2,9], Dibesh Karmacharya[2,9,10]*

SABIO

Adjuvants for vaccine formulation

Heat-innactivated mycobacteria





vaccines

MDPI

Article

Vaccination with Alpha-Gal Protects Against Mycobacterial Infection in the Zebrafish Model of Tuberculosis

Iván Pacheco [1,†], Marinela Contreras [1,†], Margarita Villar [1,2], María Angeles Risalde [3], Pilar Alberdi [1], Alejandro Cabezas-Cruz [4], Christian Gortázar [1] and José de la Fuente [1,5,*]

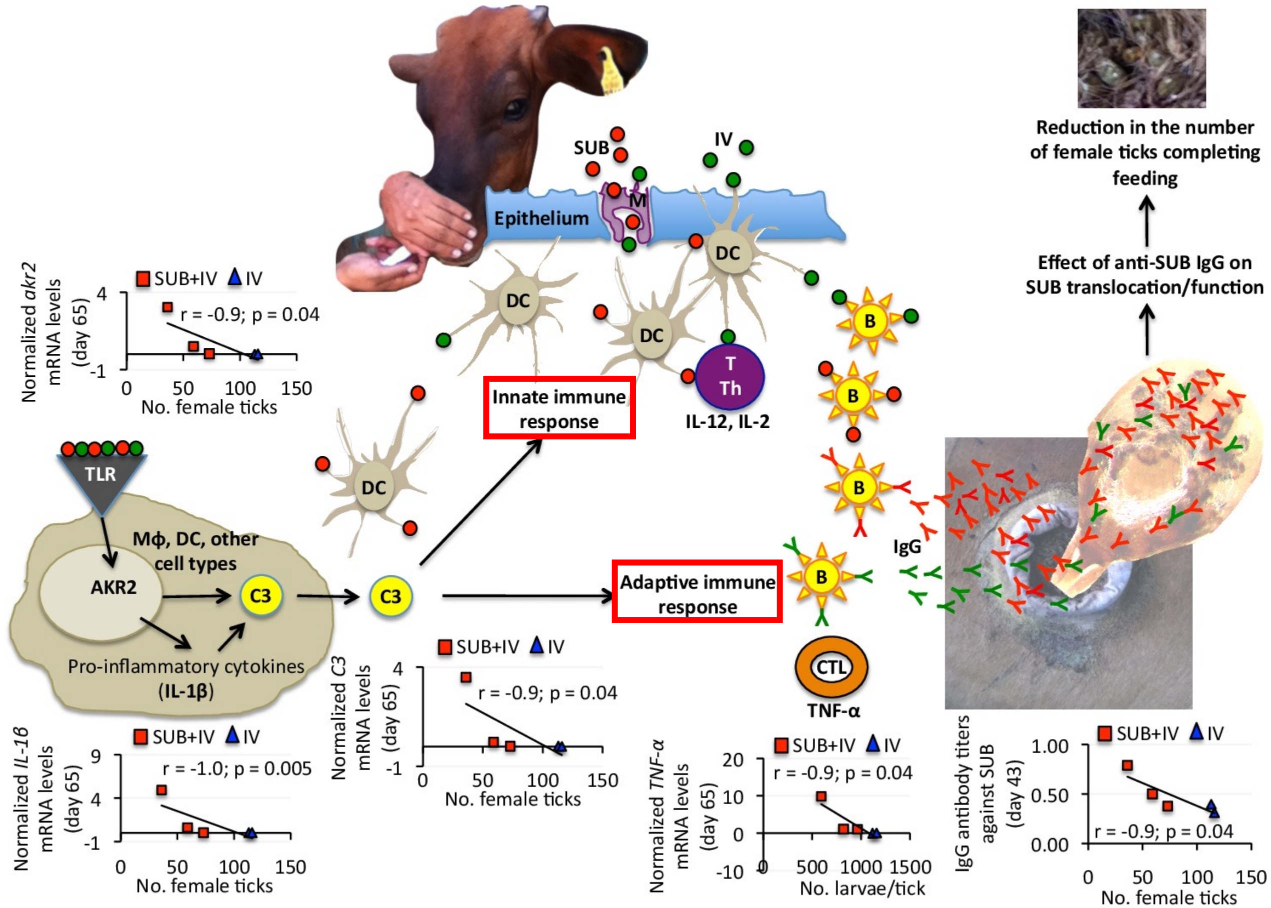
Oral vaccine formulation for the control of cattle tick infestations

Oral vaccine formulation: Recombinant Subolesin + heat-innactivated mycobacteria

Article **Vaccines 2020,8,319**

Vaccination with Recombinant Subolesin Antigens Provides Cross-Tick Species Protection in *Bos indicus* and Crossbred Cattle in Uganda

Paul D. Kasaija [1,2,†], Marinela Contreras [1,3,†], Fredrick Kabi [2], Swidiq Mugerwa [2] and José de la Fuente [1,4,*]



Oral Vaccination With a Formulation Combining *Rhipicephalus microplus* Subolesin With Heat Inactivated *Mycobacterium bovis* Reduces Tick Infestations in Cattle

frontiers in Cellular and Infection Microbiology 9: 45 (2019)

ORIGINAL RESEARCH
published: 01 March 2019
doi: 10.3389/fcimb.2019.00045

Marinela Contreras [1], Paul D. Kasaija [1,2], Octavio Merino [3], Ned I. de la Cruz-Hernandez [3], Christian Gortazar [1] and José de la Fuente [1,4*]

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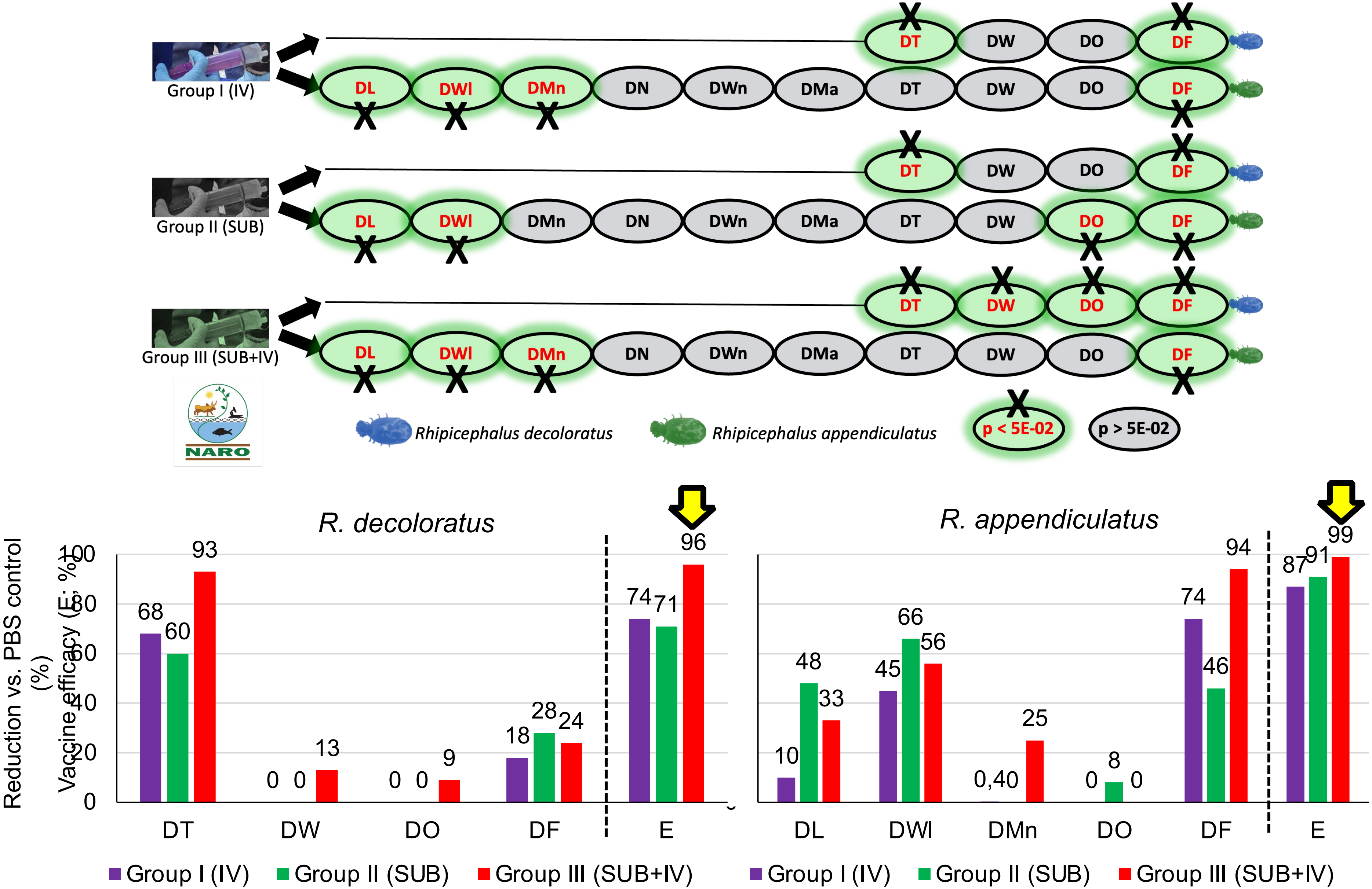
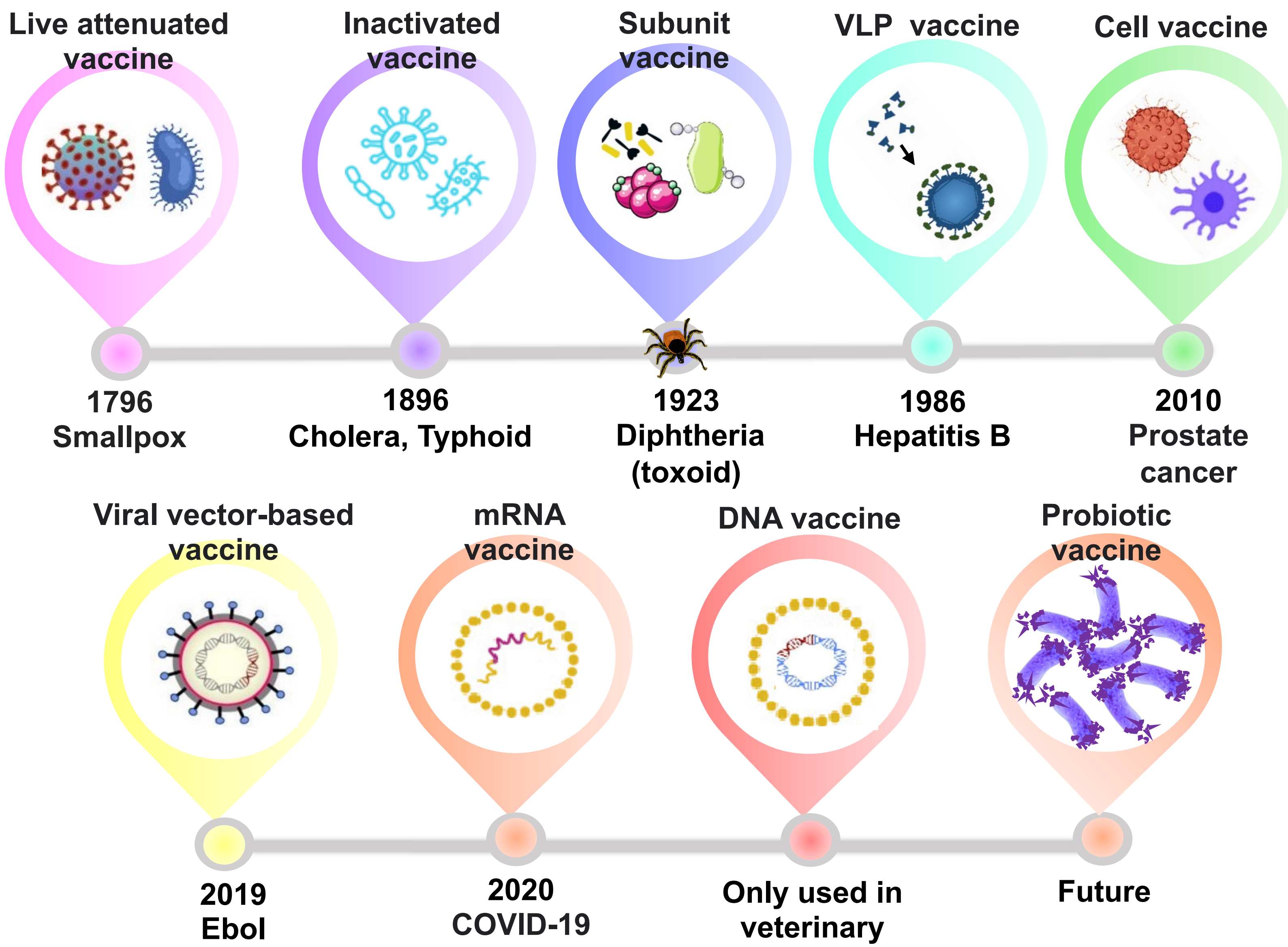
Health and Biotechnology



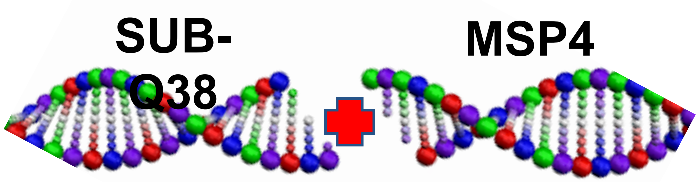
Kasaija PD, Contreras M, Kabi F, Mugerwa S, Garrido JM, Gortazar C, de la Fuente J. Oral vaccine formulation combining tick Subolesin with heat inactivated mycobacteria provides control of cross-species cattle tick infestations. Vaccine. 2022;40(32):4564-4573. doi: 10.1016/j.vaccine.2022.06.036

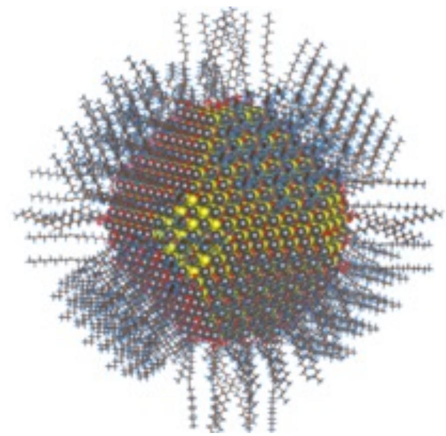
Sixth challenge: Vaccine production & administration

Vaccine production platforms

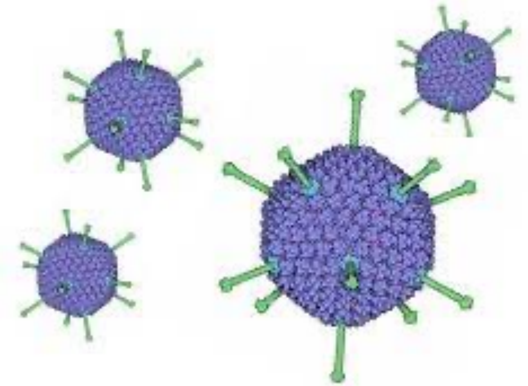


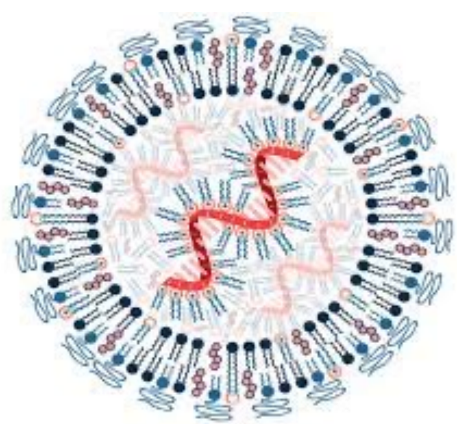
Micro and nanoparticles-based vaccines





Antigen-microparticles



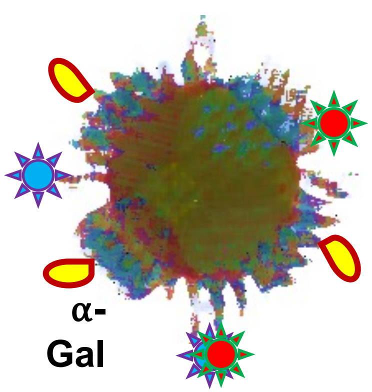


mRNA-lipid nanoparticles

Seventh challenge: Combination of vaccines with innovative and traditional control interventions for ticks and pathogens

Vector **transgenesis** relies on direct genetic manipulation of disease vectors making them incapable of functioning as vectors of a given pathogen.

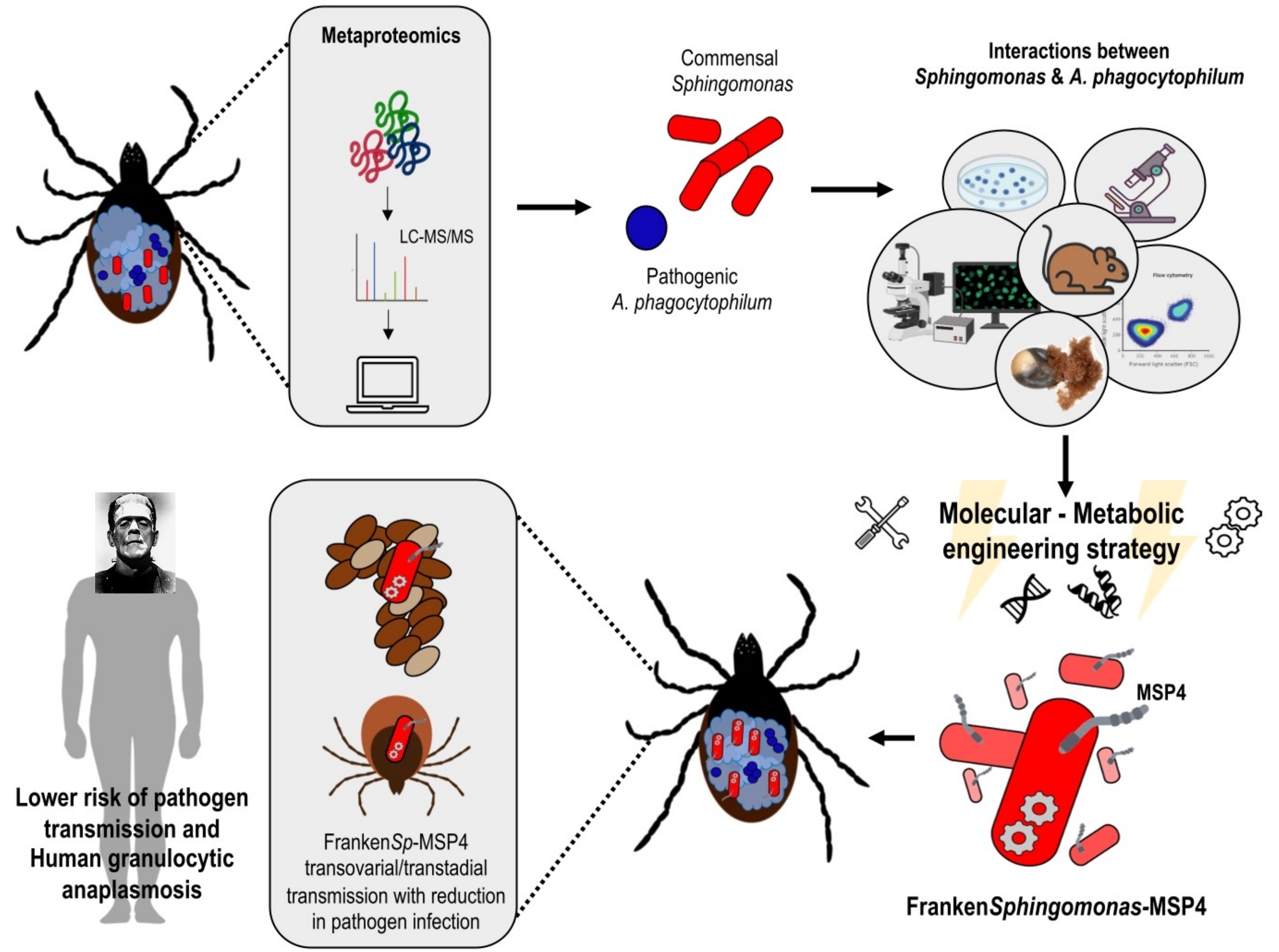
Paratransgenesis focuses on using genetically modified vector symbionts to express molecules within the vector that are deleterious to pathogens they transmit.



Frankenbacteriosis targeting interactions between pathogen and symbiont to control infection in the tick vector

Lorena Mazuecos, Pilar Alberdi, Angélica Hernández-Jarguín, Marinela Contreras, Margarita Villar, Alejandro Cabezas-Cruz, Ladislav Simo, Almudena González-García, Sandra Díaz-Sánchez, Girish Neelakanta, Sarah I. Bonnet, Erol Fikrig, José de la Fuente. **iScience 2023; 26: 106697**.

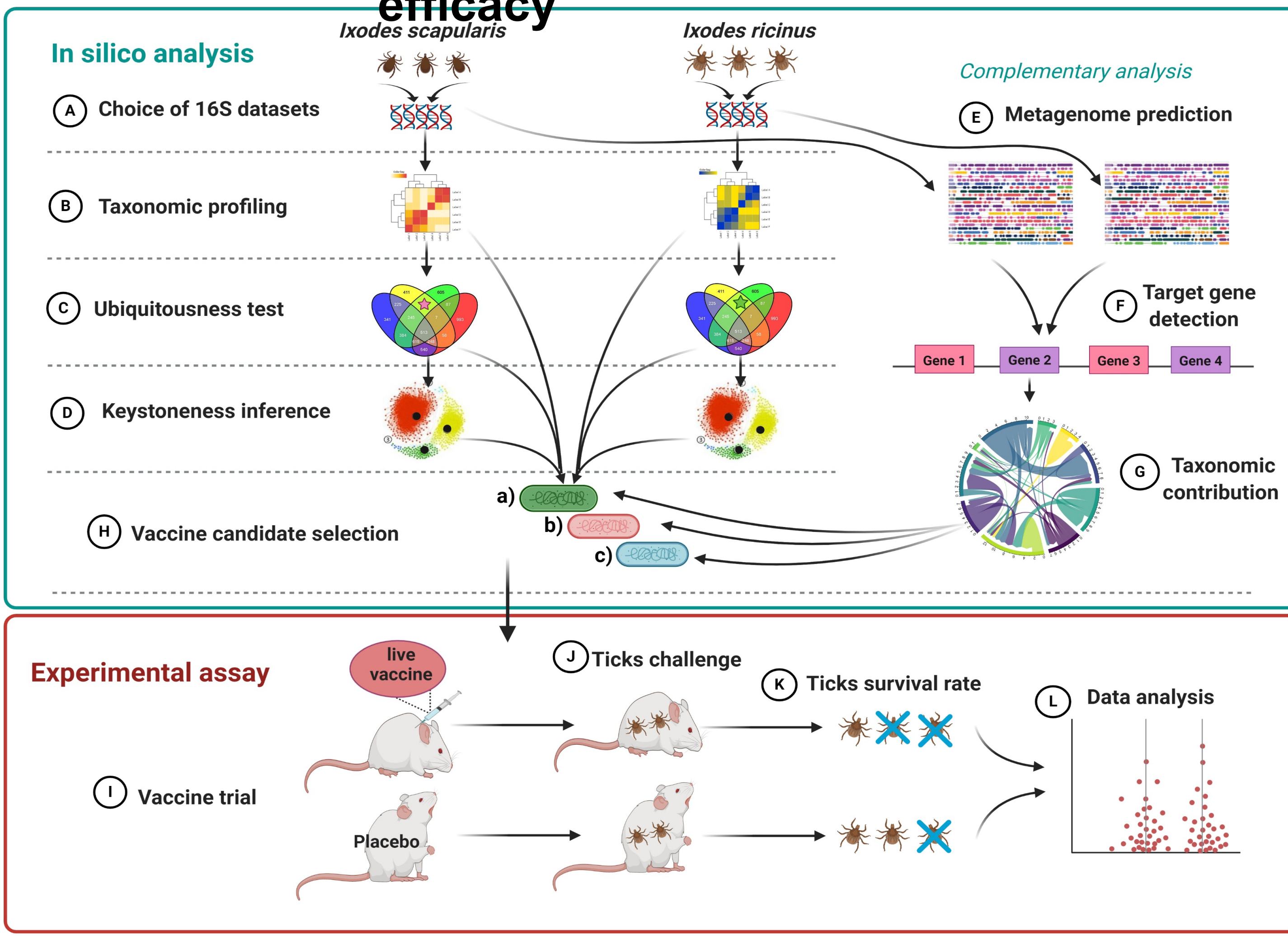
https://doi.org/10.1016/j.isci.2023.106697



Vaccines targeting tick microbiota

Anti-gut microbiota vaccine for the control of tick infestations: anti-*E. coli* and anti-α-Gal IgM and IgG are associated with vaccine efficacy

Holobiont: host organism and its associated microbial community that form an ecological unit.



vaccines MDPI

Article

Anti-Tick Microbiota Vaccine Impacts *Ixodes ricinus* Performance during Feeding

Lourdes Mateos-Hernández, Dasiel Obregón, Jennifer Maye, Jeremie Borneres, Nicolas Versille, José de la Fuente, Agustín Estrada-Peña, Adnan Hodžić, Ladislav Šimo and Alejandro Cabezas-Cruz

Trends in Parasitology CellPress REVIEWS

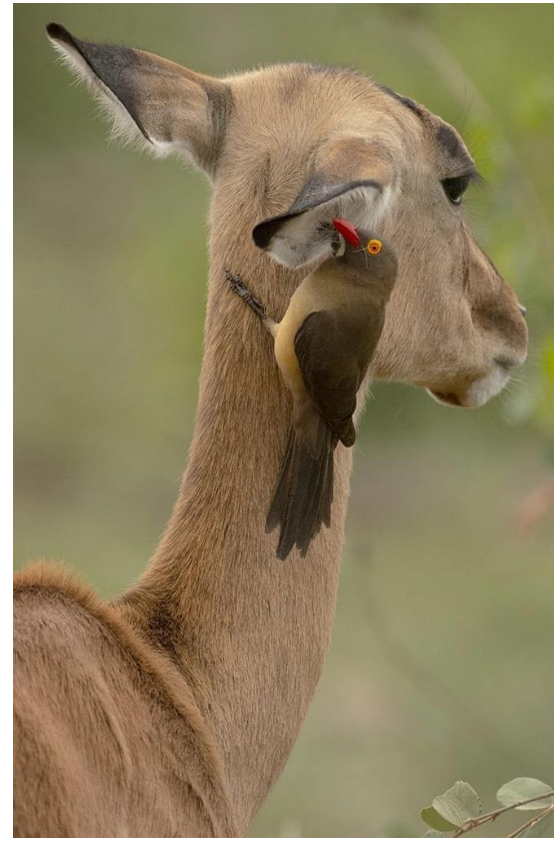
Review

Evolutionary Insights into the Tick Hologenome

Sandra Díaz-Sánchez, Agustín Estrada-Peña, Alejandro Cabezas-Cruz and José de la Fuente

SABIO Health and Biotechnology

SAVE TICKS: Natural predators feed on ticks



Images by Katherine M. Kocan & Andrei Mihalca

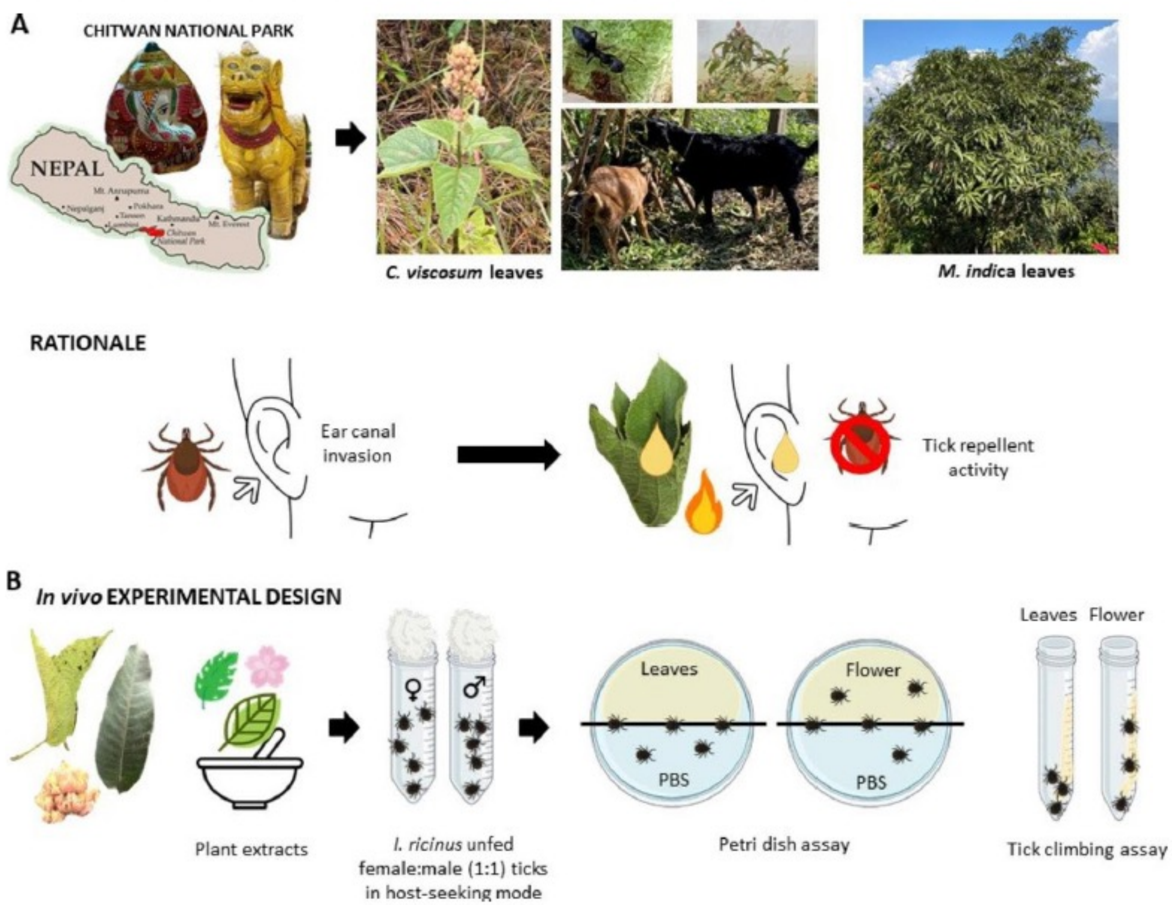
SaBio
Health and Biotechnology

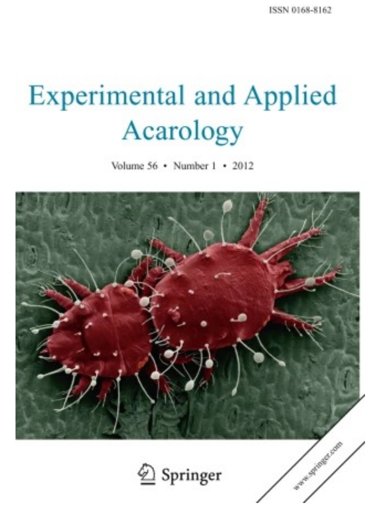
Experimental and Applied Acarology (2023) 90:83–98
https://doi.org/10.1007/s10493-023-00804-4

RESEARCH

Natural *Clerodendrum*-derived tick repellent: learning from Nepali culture

Lorena Mazuecos[1] · Marinela Contreras[1] · Paul D. Kasaija[1,2] · Prajwol Manandhar[3] · Weronika Grąźlewska[1,4] · Eduardo Guisantes-Batan[5] · Sergio Gomez-Alonso[5] · Karelia Deulofeu[6] · Isabel Fernandez-Moratalla[7] · Rajesh Man Rajbhandari[3] · Daniel Sojka[8] · Libor Grubhoffer[8] · Dibesh Karmacharya[3] · Christian Gortazar[1] · José de la Fuente[1,9]





Natural repellents

Main limitations to advance in tick vaccinology includes limited collaborations with developing countries with high incidence of tick infestations and TBDs

Correspondence | Published: 25 June 2024

Increasing access to biotech products for animal agriculture in Sub-Saharan Africa through partnerships

José de la Fuente, Christian Gortázar, Marinela Contreras, Frederick Kabi, Paul Kasaija, Swidiq Mugerwa & Justus Rutaisire

https://doi.org/10.1038/s41587-024-02300-5

NARO

UGANDA

Registered veterinary vaccines in Sub-Saharan Africa

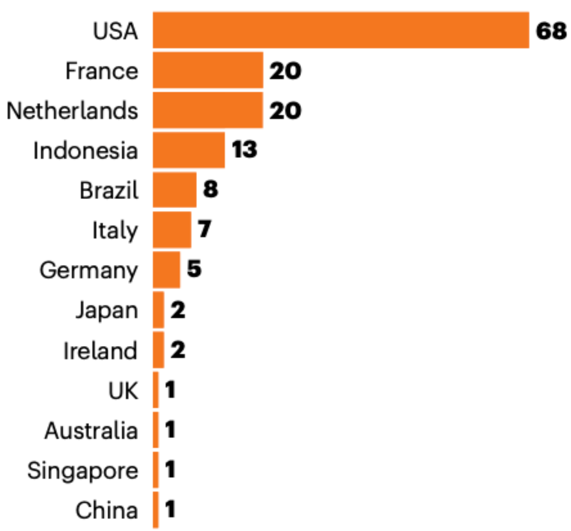
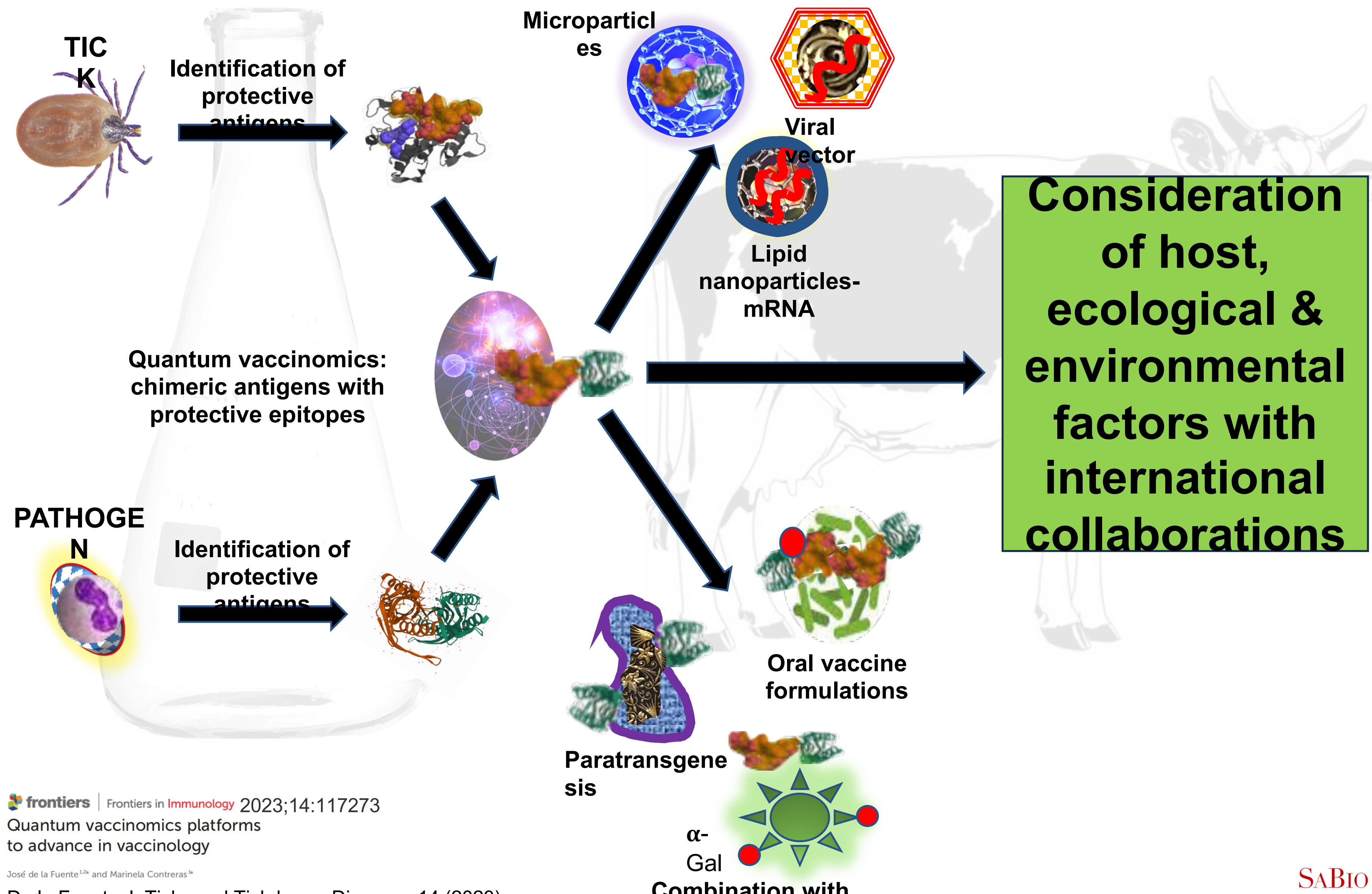


Fig. 1 | Countries of origin and manufacturing for registered veterinary vaccines.

Future directions for the development of control interventions against ectoparasite vectors and vector-borne diseases



frontiers | Frontiers in Immunology 2023;14:117273
Quantum vaccinomics platforms
to advance in vaccinology

José de la Fuente[1,2*] and Marinela Contreras[1*]

De la Fuente J. Ticks and Tick-borne Diseases 14 (2023)

THANK YOU

Healthy wildlife, healthy livestock, healthy humans

SaBio
Sanidad y Biotecnología
Health and Biotechnology

GENOMICS, PROTEOMICS & BIOTECHNOLOGY

IREC National Wildlife Research Institute; Established 1999; Ciudad Real & Albacete
National Research Council CSIC and Universidad de Castilla – La Mancha UCLM

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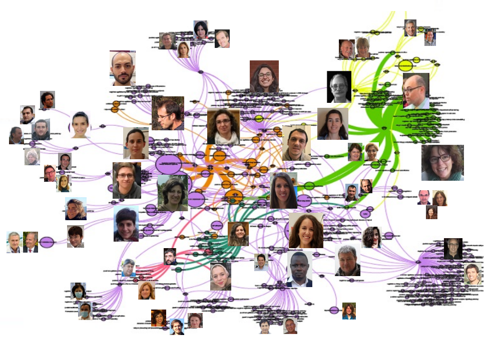
BIOGAL [PID2020-116761GB-I00]

Castilla-La Mancha
CCM17-PIC-036
(SBPLY/17/180501/000185)

Thanks to our collaborators



NARO

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Day 2: Application to Tick-Borne Virus infections

Lunch break, back in 1h30

With the next session:

Social sciences

Day 2: Application to Tick-Borne Virus infections

A sociologist's view of tick-borne diseases: representation and impact

By Costanza Puppo

A Social Psychologist's view on tick-borne diseases:
Representations and Impact

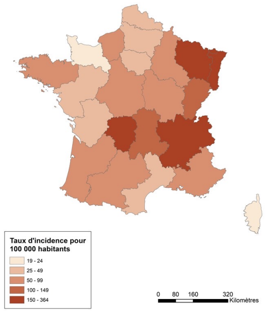
Arbo-France, 24-25th October 2024

Costanza Puppo
Social Psychologist of Health
costanza.puppo@univ-lyon2.fr

Lyme borreliosis: a public health issue

Tick borne and vectorial disease (1976, US)

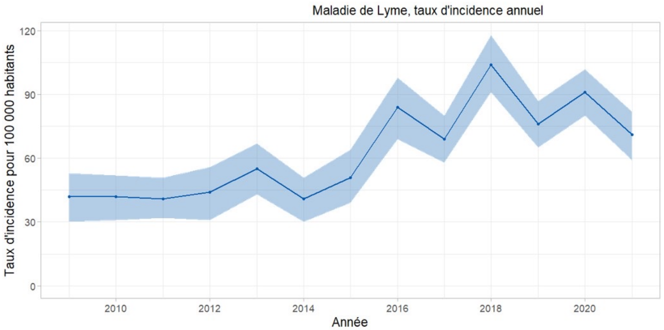
- Zoonosis transmitted by *Ixodes ricinus*
- *Borrelia burgdorferi* bacterium
- North Europe and US (Steere et al., 2004)



2015-2016 / 2017-2018

Significant **increase** in the incidence in metropolitan France

- Peak of 104 cases per 100,000 inhabitants (2018) (Santé Publique France, 2023)
- In 2021, the incidence was estimated at 71 cases per 100,000



Controversial context

- Orthodox vs. heterodox discourse (Hinds & Sutcliffe, 2019)
- Chronic nature of the disease, interpretation of symptoms, serological tests

Aim

Even though Lyme borreliosis is not an arbovirosis, it could be useful to reflect on **how social sciences can contribute to the study of vector-borne diseases**

- **Aim 1**: Introducing a psychosocial perspective
- **Aim 2**: Taking into account the complexity of the representations and behaviors
- **Aim 3**: Considering the impact that representations can have on public health issues

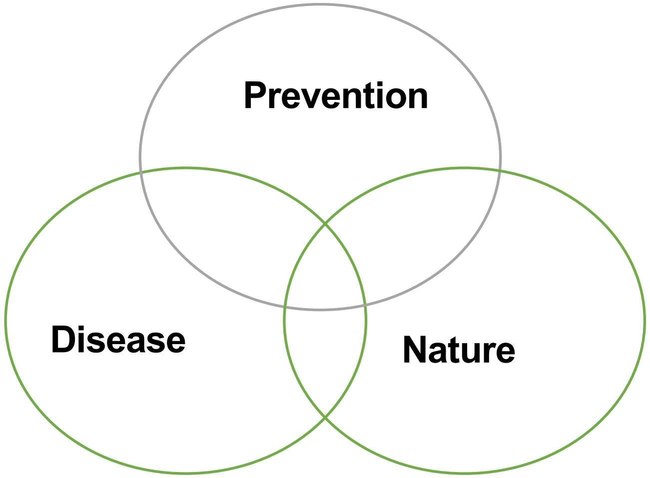
Prevention practices: an individual-based approach

Social science literature especially focused on:

Prevention acceptability	Difficult management of the disease
• Gap between knowledge and practices • Prevention practices not sufficiently implemented	• Medical nomadism • Mental and physical QoL • Poor information about the disease

Puppo & Préau, 2018 ; Barbour & Fish, 1993 ; Beaujean et al., 2013 ; Bhate & Schwartz, 2011 ; Guittard, 2019 ; Nawrocki & Hinckley, 2021).

Implementing a psychosocial approach



Social representations are interconnected and vehiculated between different social groups

- Common sense knowledge (Jodelet, 2004; Moscovici, 1961)

First study (Explo-quali-PIQTIQ)

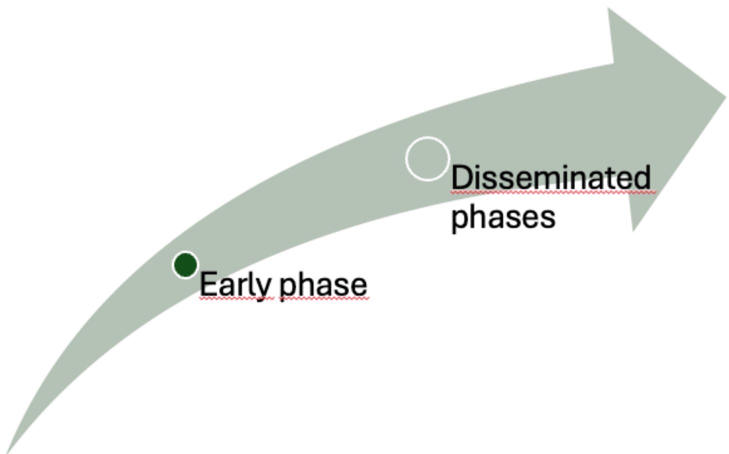
- Patient trajectory after a tick bite
- Different clinical situations
- 24 participants

Second study (ReLyMeG)

- Semi-directive interviews
- General practitioners' representations of LB
- 19 participants

Comprehensive and qualitative approach

The impact of health problems on the QoL



Medically unexplained symptoms (MUS, Eriksen et Risør 2014)

- Subjective and invisible health problems
- Fatigue, headache, backpain, burning sensation, etc.
- Illness without disease (Blaxter, 2009)

Physical QoL

It's not sharp pain, it's more stiffness, a lot of stiffness in my elbows, wrists, fingers... my legs, all over my legs... hips, knees, ankles, and... (W, 38 years old)

Mental QoL

- "Feeling no 'desire to live and do'"
- Rejecting the psychological explanation

Social QoL

When it started to get a bit worse, it was almost like she got a little angry, saying to me, 'You're talking nonsense, that's impossible.' (M, 42 years old)

How do patients interpret their own symptoms in a controversial context?

- Role played by media, friends, family
- (Auto)diagnosis is co-constructed, even though with uncertainty

Attribution to	Identification as	Participants' verbatims
"Other factors" (age, profession, personality)	Healthy individual	*I sometimes have pain… My back, yeah, I often get back pain. But it's work, you know, a lot of work. (M, 41 years old)*
A disease, still to be diagnosed	Sick individual	*It's not completely out of the question… Because I know that medicine doesn't really, how should I put it, well, they don't have all the knowledge they need about this disease yet. I think there could still be a lot of pain like that that might be related to this illness. (W, 53 years old)*
After a first diagnosis		
To LB sequelae	Healed individual	*I mean, anyway, there was something [the bacteria], and then there was nothing. But there are still consequences and everything, so I've kind of taken it that way. (W, 78 years old)*
To LB symptoms (chronic disease)	Chronic patient	*So I saw the infectious disease specialist several months later, and they told me, 'But ma'am, you had the antibiotic treatment, you're cured.' 'You're cured.' Honestly, I feel like they really treat people like they're idiots, you know? (W, 55 years old)*

Interpreting own's symptoms

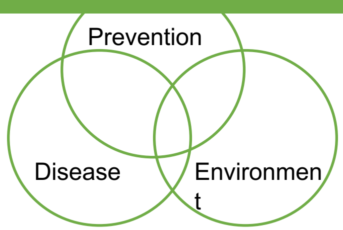
MUS are not explained by health-care providers, but patients find their own explication

- Common-sense explications : social and not only clinical factors
- Based on the social influences, past experiences, social identity
- Integration of scientific knowledge in their discourse to justify their explanation
    - Humanisation and agency
    - «Disease without illness»

This Lyme disease was hiding in the body, and it's like, uh, how should I put it, the bacteria, they form cysts and kind of hide. That's why, for now, we still can't detect it... and that really resonates with me. (W, 53 years old)

"Once a year, we did a blood test for Lyme disease, just to see where I was at, but it was mostly just a check-up. After the bite in 2017, we started doing it more often because we noticed there was a reaction, there were numbers."(W, 60 years old)

The impact on prevention and therapeutic care



Attribution to	Identification as	Prevention practices	Therapeutic care
"Other factors" (age, profession, personality)	Healthy individual	Post-bite prevention (endemic areas)	Asking for antibiotic as prevention treatment
A disease, still to be diagnosed	Sick individual	Pre- and post-bite prevention LB as an open option	Medical nomadism
After a first medical diagnosis of LB			
To LB sequelae	Healed individual	Post-bite prevention	Alternative medicine
To LB symptoms (chronic disease)	Chronic patient	Pre- and post-bite prevention Anxiety Avoidance behavior towards nature	Alternative medicine + long-term antibiotic treatments

Conclusions

- Tick-born diseases are an important public health issue
- **Social sciences** help understanding the representations and behaviors associated with these diseases

- Social representations of disease, prevention and nature are **interconnected**
- They have a **real impact** on symptoms' attribution, prevention and therapeutic behaviors

Thank you !

Day 2: Application to Tick-Borne Virus infections

Participative science for tick-borne diseases

By Jonas Durand

Arbo-France
Réseau Français d'étude des arboviroses

Annual scientific symposium of th… …twork 2024

Participativ… …ce for tick-b… …iseases

À voir sur le replay

… Pascale Frey-Klett

….durand@anses.fr

Day 2: Application to Tick-Borne Virus infections

Round table: TBV research priorities for a better preparedness and response plan

With Costanza Puppo
Ali Mirazimi
Jose de la Fuente
Laurence Vial

CLOSING REMARKS:
ARBO-FRANCE & ANRS MIE

Merci d'avoir suivi cette deuxième journée !

3ème colloque scientifique du réseau Arbo-France

24-25 octobre 2023, Institut Pasteur - Paris