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CENTRE *for*
HUMAN
GENETICS

Emerging High Consequence Viruses: Surveillance and Immunity

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High Consequence Emerging Viruses

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2nd March 2024

Dhaka



Roger Hewson



Viral Emergence

Two general patterns

I. Almost all have RNA rather than DNA genomes

RNA viruses have mutation edge over DNA viruses

Genetic adaptability

II. Almost all have an animal reservoir Zoonosis - Cross species transmission

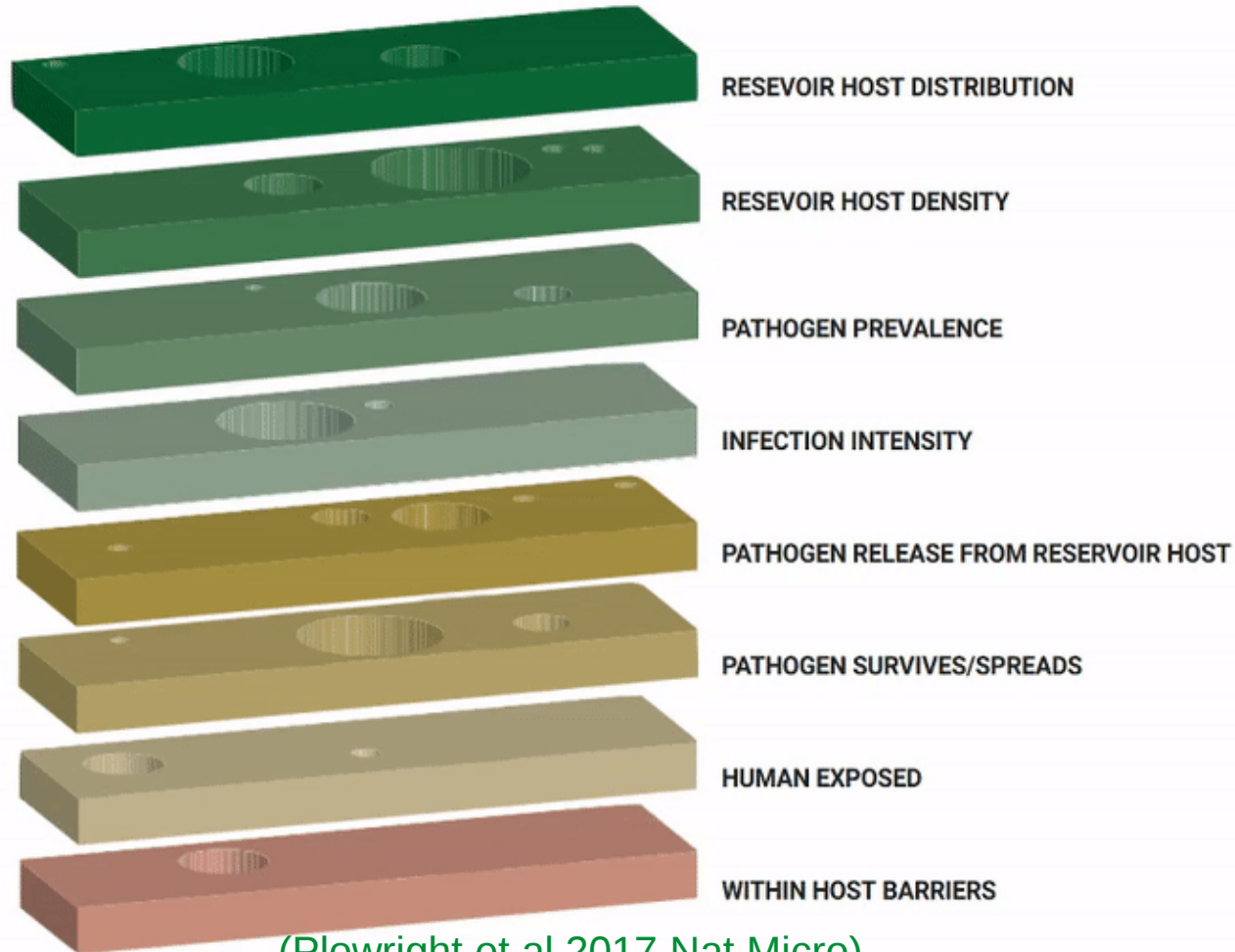
- HIV
- Influenza
- SARS-CoV-1/2
- Ebola / Marburg
- Lassa
- CHK
- CCHF
- ORO



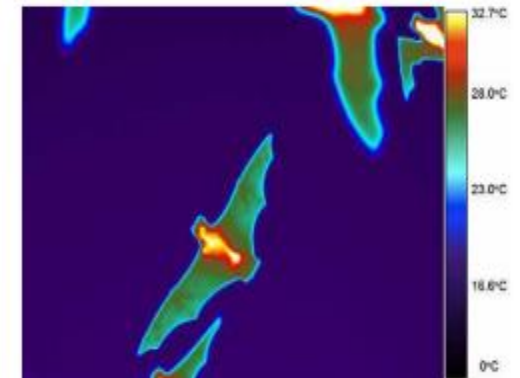
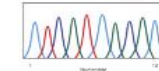
- **>1.6 million** unknown virus species in mammalian and avian populations
- **>700,000** have the potential to cause disease in humans and livestock
- Only **0.1%** have been identified to date

Spillover Mapping for Emerging Pathogens

Spillover Percolation Model



(Plowright et al 2017 Nat Micro)



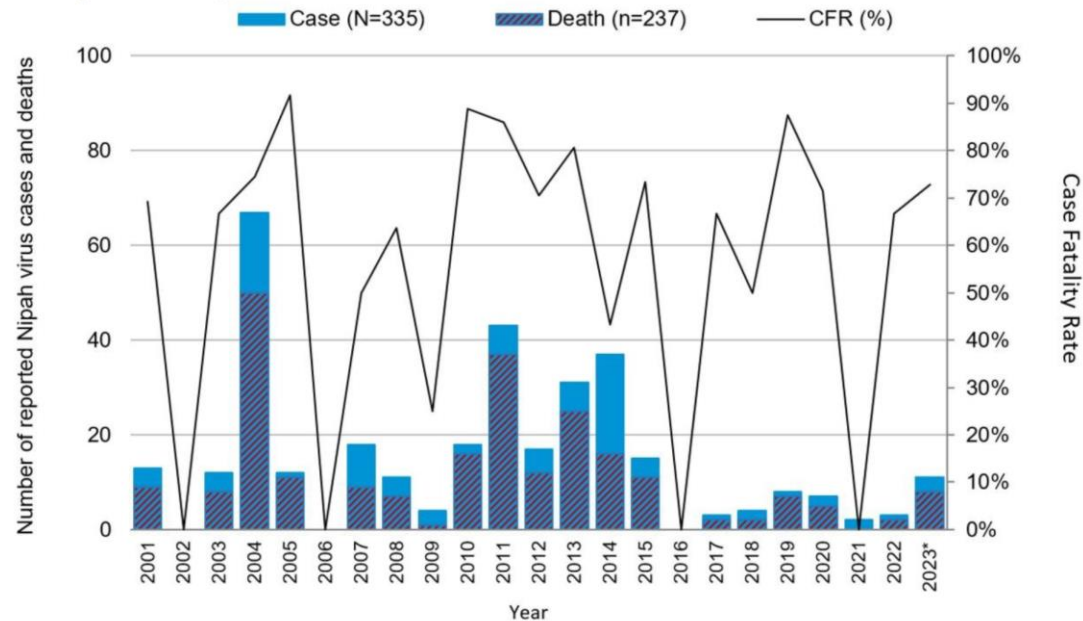
Bangladesh reports 2 fatal Nipah virus cases

News brief | January 29, 2024

Lisa Schnirring

Topics: Nipah

Figure 1. Number of reported Nipah virus cases and deaths by year, 1 January 2001 – 13 February 2023, Bangladesh.

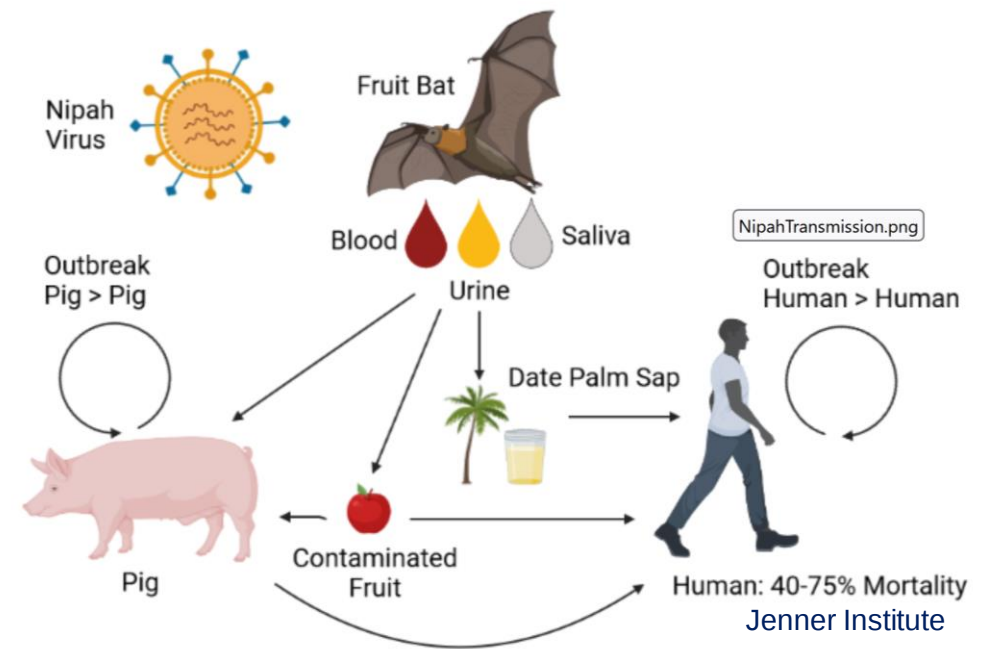


Source: Bangladesh Ministry of Health and Family Welfare

*as of 16 February 2023



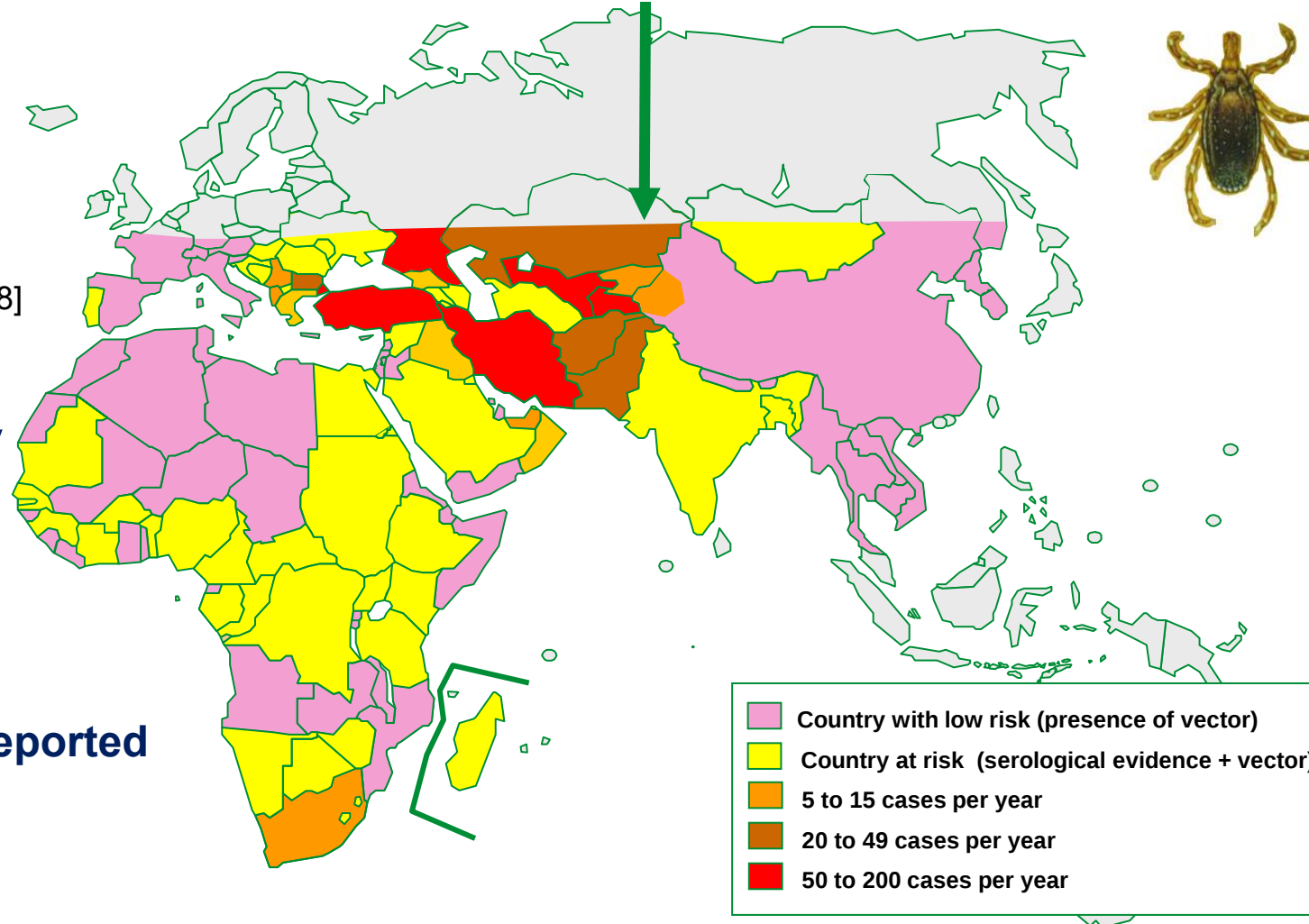
Nipah Virus Transmission and Mortality



Crimean-Congo Haemorrhagic Fever (CCHF) virus

Geographic Distribution: Impact of Climate Change

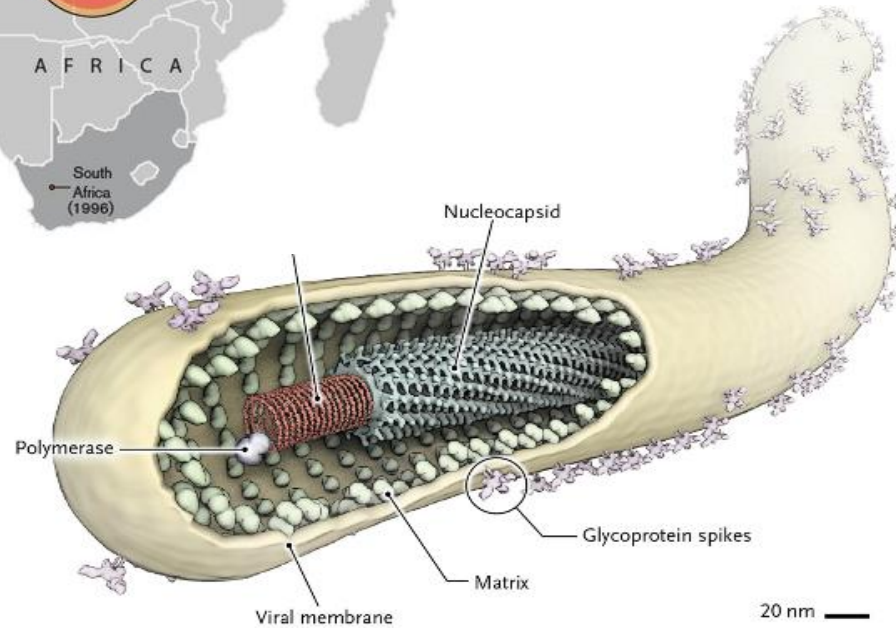
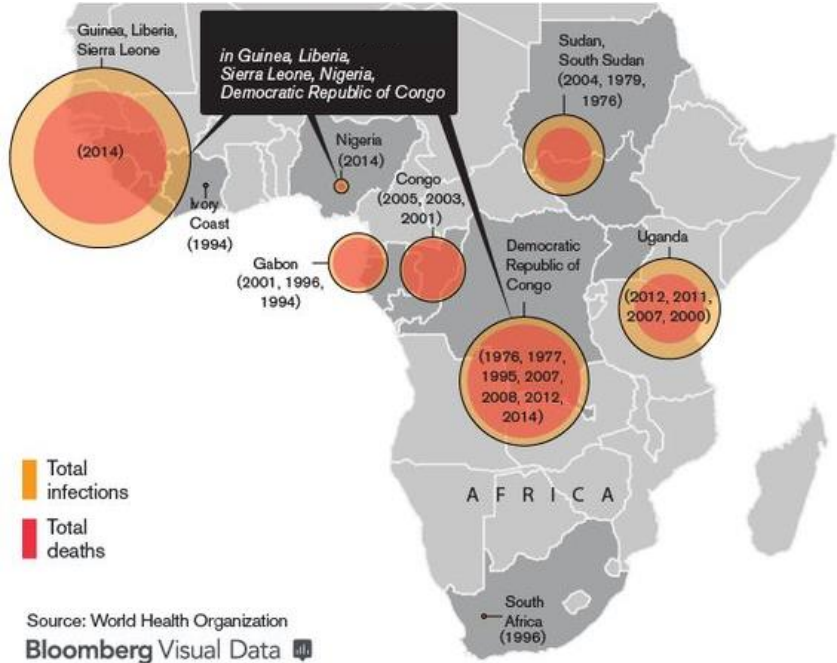
50° North limit for the geographic distribution of genus *Hyalomma* ticks



The most
widespread HFv
CFR: ~20%

But why isn't CCHF reported
in Bangladesh????

Ebola Virus: 2013-2016 West Africa Epidemic



Case Fatality Rate: 50%

Ebola Virus Ecology and Transmission

Ebola virus disease is a zoonotic disease. Zoonotic diseases involve animals and humans.

Animal-to-Animal Transmission

Evidence suggests that bats are the reservoir hosts for the Ebola virus. Bats carrying the virus can transmit it to other animals, like apes, monkeys, and duikers (antelopes), as well as to humans.

Spillover Event

A "spillover event" occurs when an animal (bat, ape, monkey, duiker) or human becomes infected with Ebola virus through contact with the reservoir host. This contact could occur through hunting or preparing the animal's meat for eating.

Human-to-Human Transmission

Once the Ebola virus has infected the first human, transmission of the virus from one human to another can occur through contact with the blood and body fluids of sick people or with the bodies of those who have died of Ebola.

Survivor

Ebola survivors face new challenges after recovery. Some survivors report effects such as tiredness and muscle aches, and can face stigma as they re-enter their communities.



European Mobile Laboratory Guinea: 2013-2016 Epidemic

Early Diagnostics are Essential



23.03.14



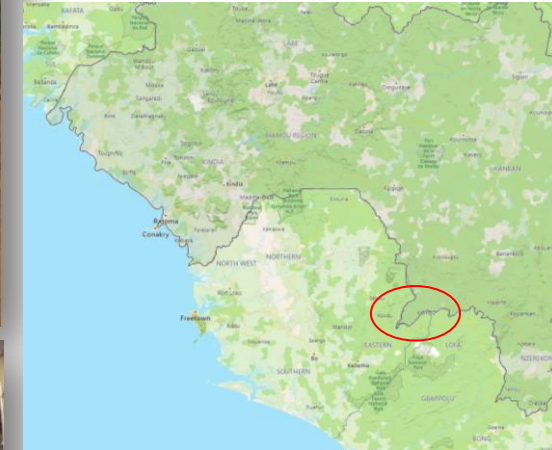
WHO
Global Outbreak Alert &
Response Network

20.03.14

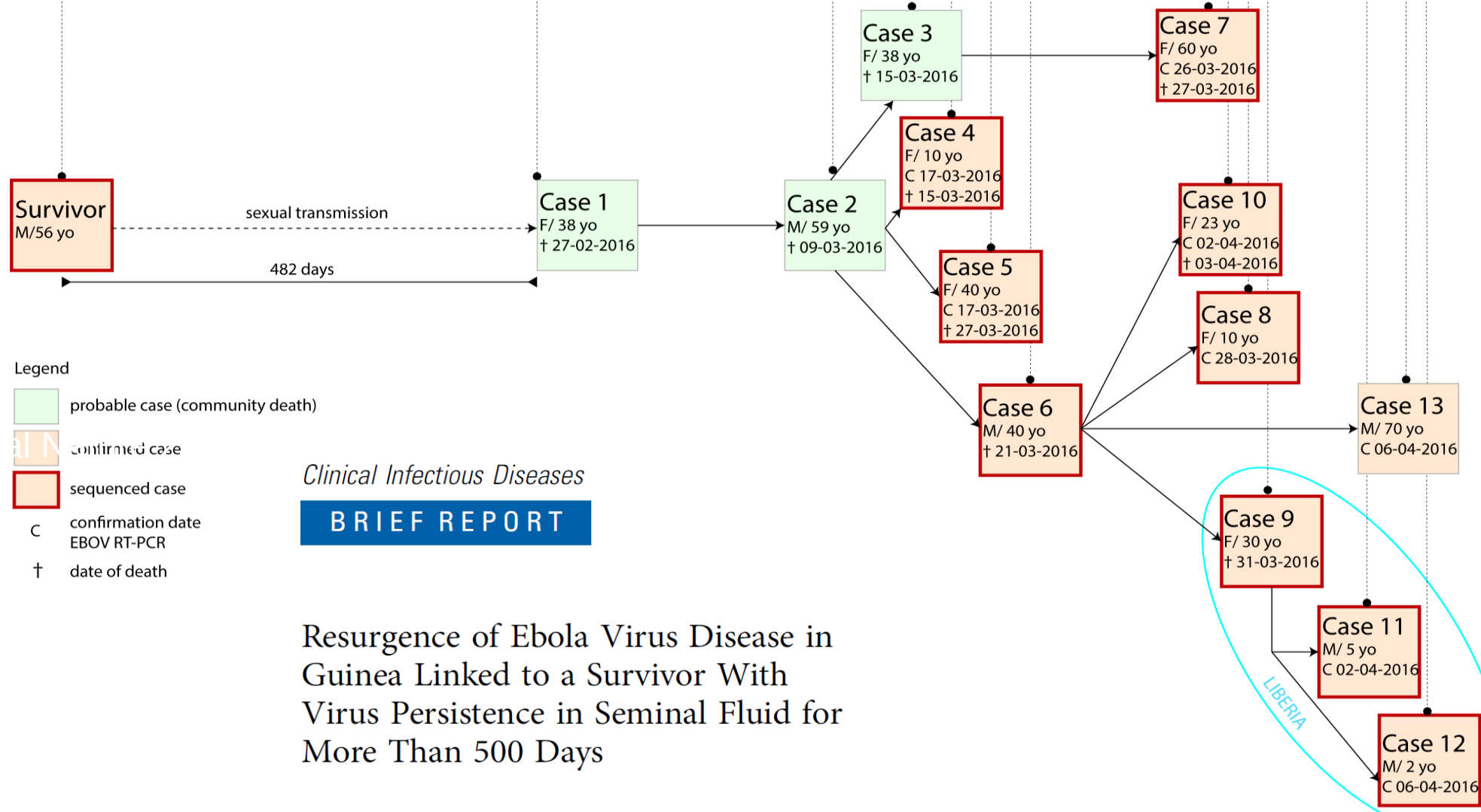
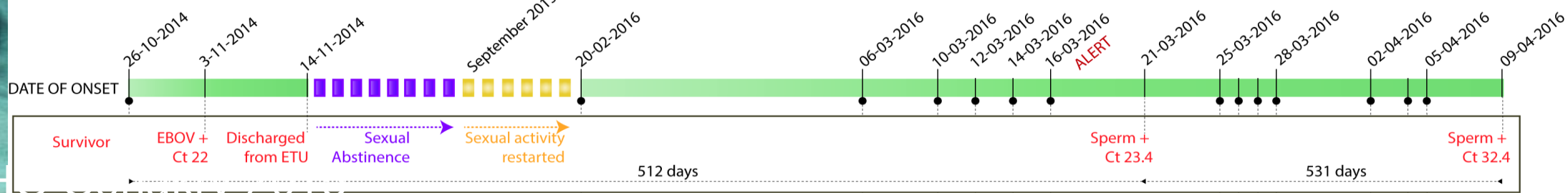


MEDECINS SANS FRONTIERES
DOCTORS WITHOUT BORDERS

18.03.14



Kilian Stoecker



- Legend
- probable case (community death)
 - confirmed case
 - sequenced case
 - C confirmation date EBOV RT-PCR
 - † date of death

Clinical Infectious Diseases

BRIEF REPORT

Resurgence of Ebola Virus Disease in Guinea Linked to a Survivor With Virus Persistence in Seminal Fluid for More Than 500 Days

2021 Guinea EBOV Outbreak: Persistence >5 years

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Ebola

Man who survived Ebola five years ago may be source of Guinea outbreak

Finding raises questions about virus's ability to lurk long term in outwardly healthy bodies

Lisa O'Carroll
@lisaocarroll
Wed 17 Mar 2021 07:00 GMT

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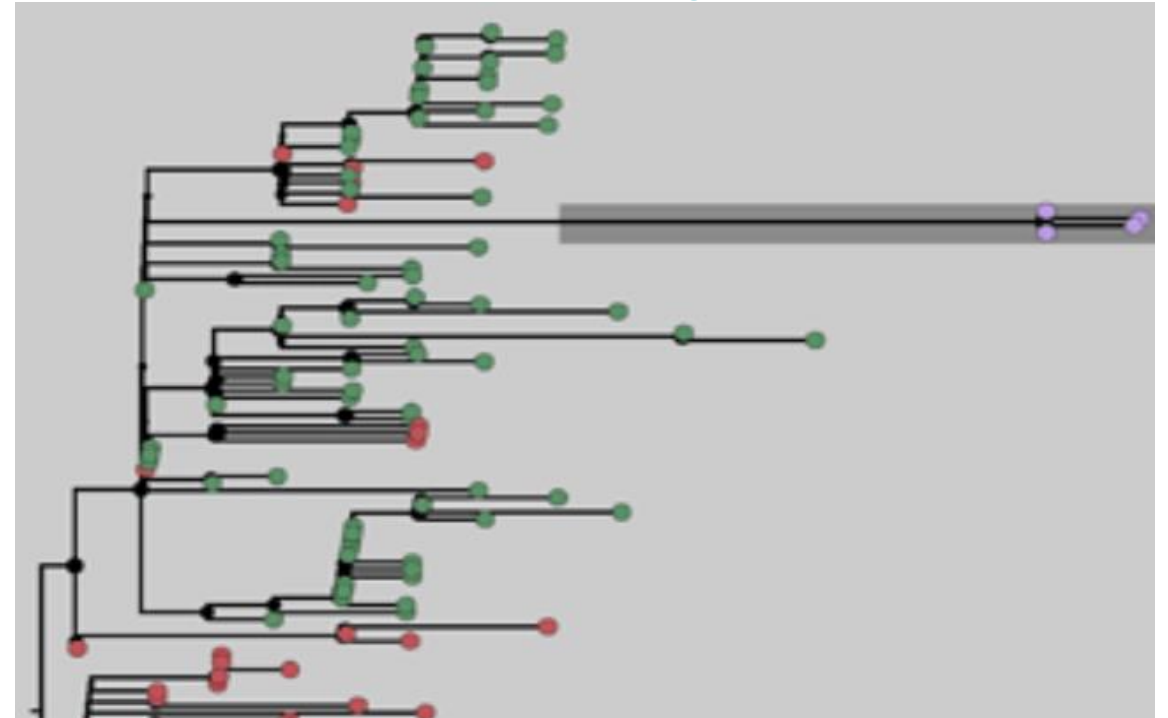
▲ The 2013-2016 Ebola outbreak in west Africa killed 11,000 people. Photograph: Ahmed Jallanzo/EPA

An Ebola survivor is likely to have triggered the current outbreak in **Guinea**, scientists have said, in a shock discovery that means the virus may remain dormant for five years.

The finding, which comes after 29 cases and 13 deaths, raises fresh questions about the ability of **Ebola** to lurk in the body long term even while the survivor remains outwardly healthy.

"This is pretty shocking," virologist Angela Rasmussen of Georgetown University told **Science magazine**. "Ebola viruses aren't herpesviruses (which are known to cause long-lasting infections) and generally RNA viruses don't just hang around not replicating at all."

[Release - 4 EBOV genomes from Guinea 2021 outbreak - Ebolavirus / Guinea 2021 - Virological](#)



Resurgence of Ebola virus in 2021 in Guinea suggests a new paradigm for outbreaks

Nature 2021

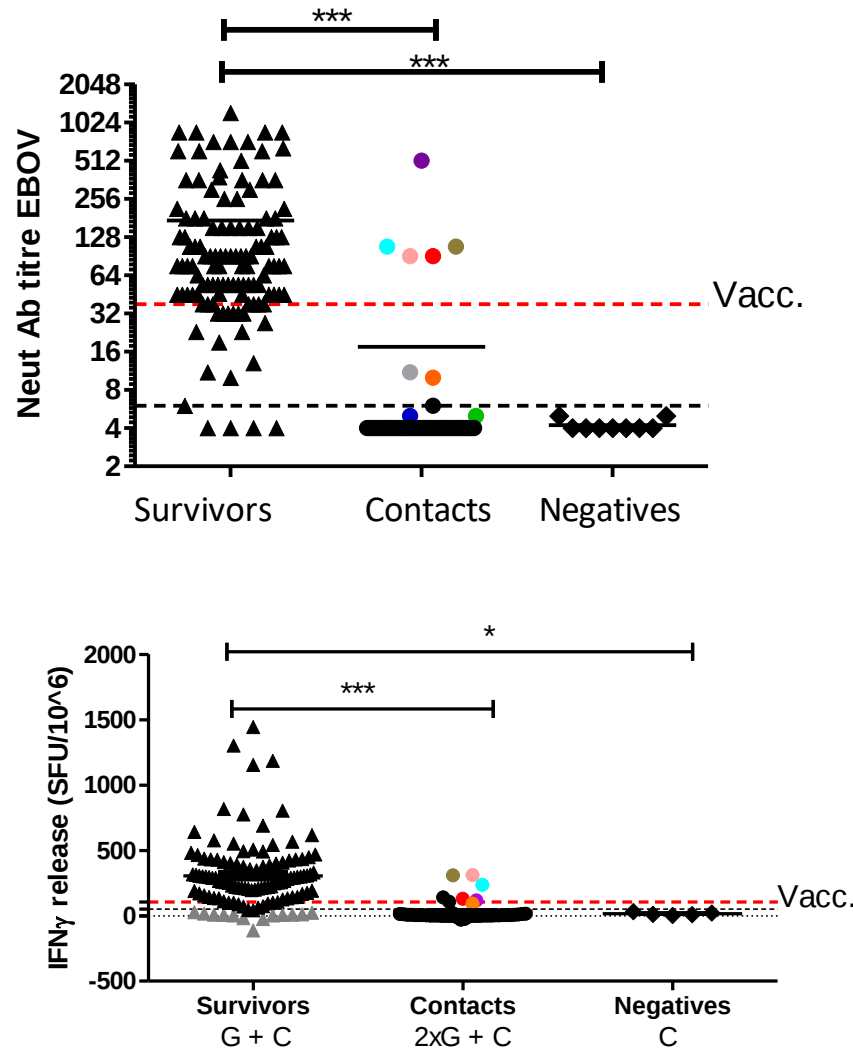
<https://doi.org/10.1038/s41586-021-03901-9>

Alpha Kabinet Keita^{1,2,26}, Fara R. Koundouno^{3,4,26}, Martin Faye^{5,26}, Ariane Düx^{6,26},

Understanding Naturally Acquired Immunity



Antibody & T Cell Responses In EVD Survivors & Contacts



- Naturally acquired immunity approx. 10-fold higher than vaccination
- No detectable circulating Ab or T cell response in some individuals
- A symptomatic infections do occur
- Long term “protective” immunity?

T Cell & Antibody Titre Over 4 Years: Long half-life but No Wax and Waning

- Both Ab & T Cell show a durable response following natural infection
- Ab half-life calculated to be ~10 years
- T cell half-life ~4 years

Article

Ebola virus antibody decay–stimulation in a high proportion of survivors

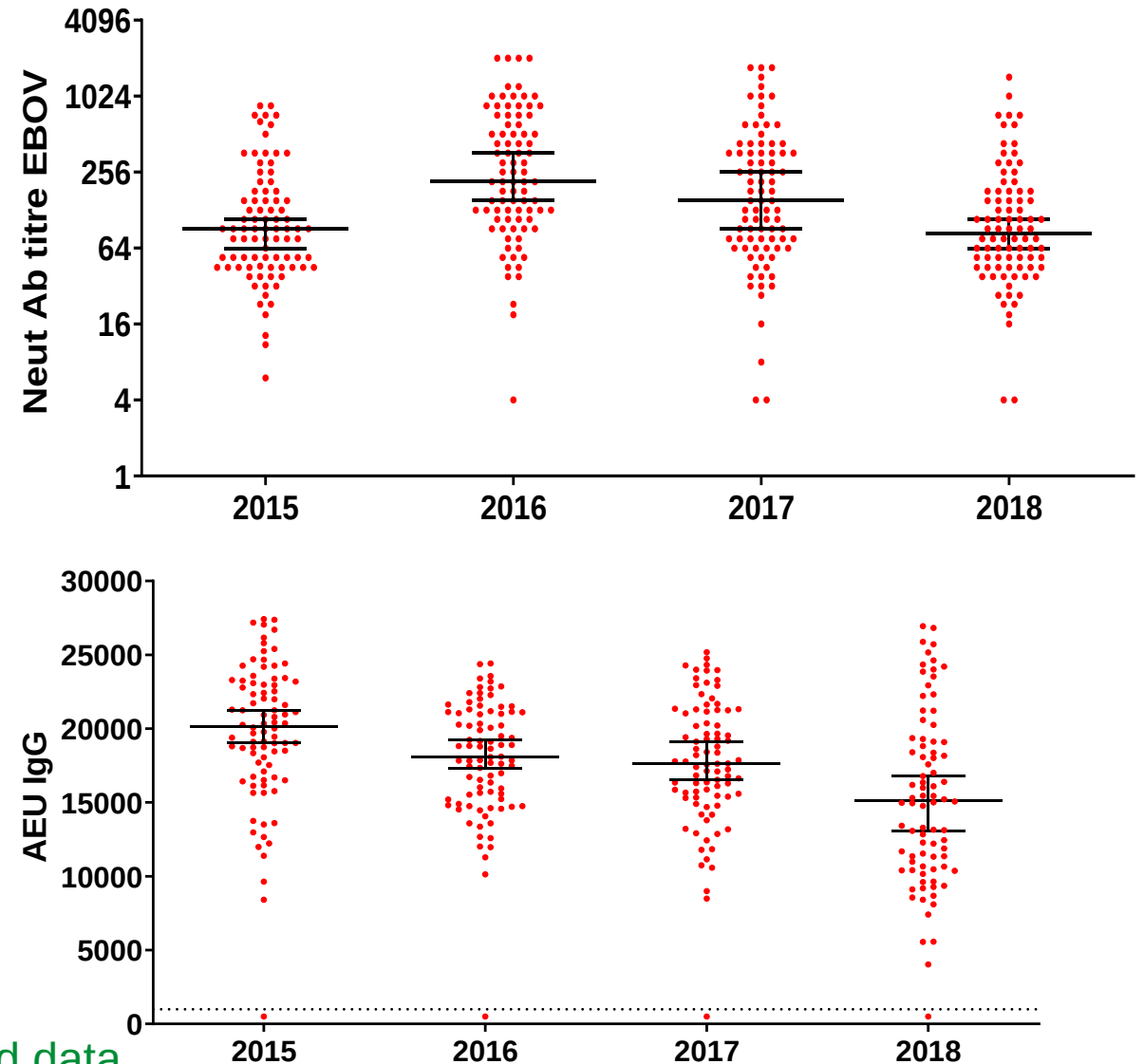
<https://doi.org/10.1038/s41586-020-03146-y>

Received: 19 November 2019

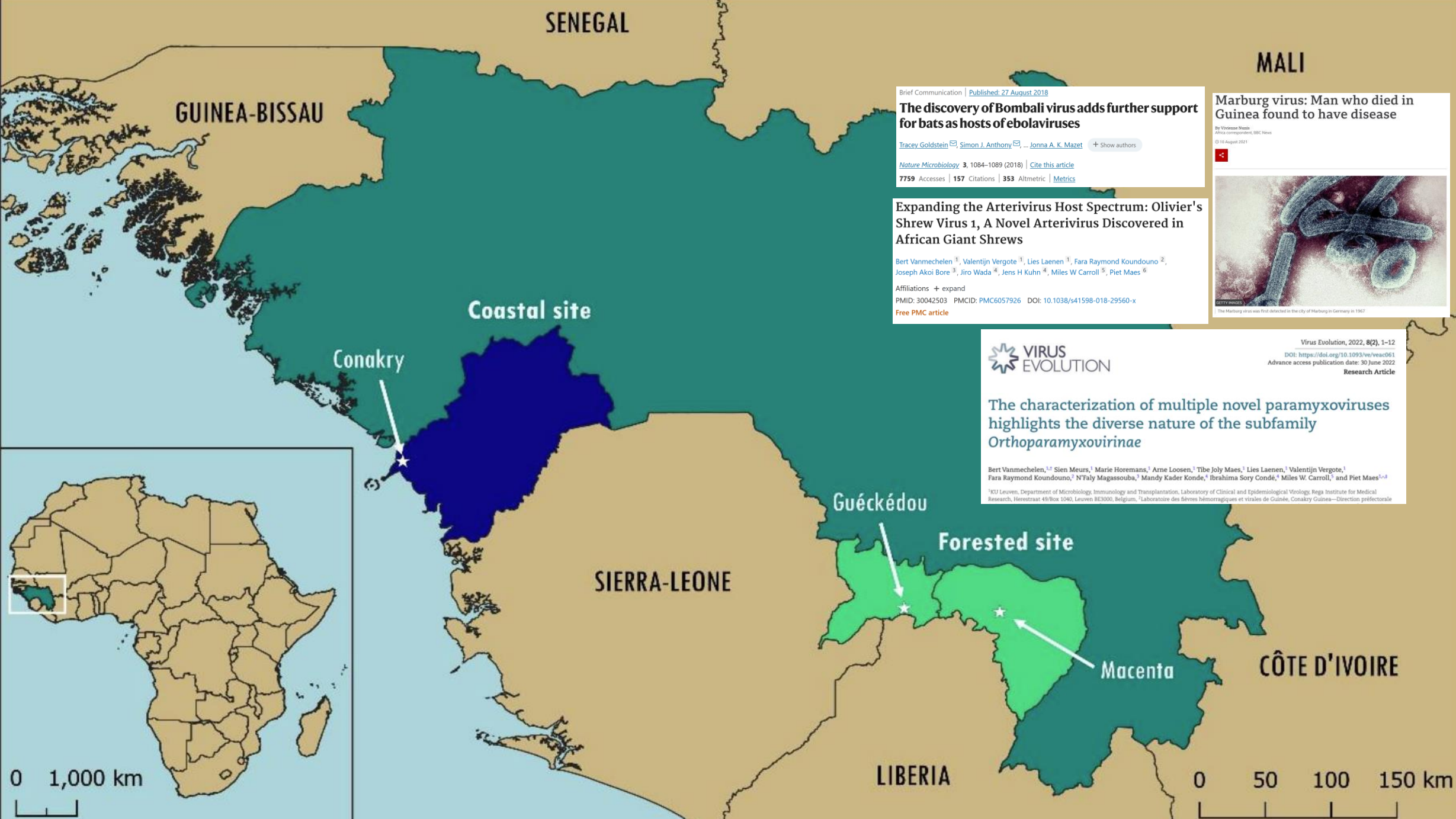
Accepted: 18 December 2020

Published online: 27 January 2021

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Unpublished data



Brief Communication | Published: 27 August 2018

The discovery of Bombali virus adds further support for bats as hosts of ebolaviruses

Tracey Goldstein  Simon J. Anthony  ... Jonna A. K. Mazet  [+ Show authors](#)

[Nature Microbiology](#) 3, 1084–1089 (2018) | [Cite this article](#)

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Expanding the Arterivirus Host Spectrum: Olivier's Shrew Virus 1, A Novel Arterivirus Discovered in African Giant Shrews

Bert Vanmechelen ¹, Valentijn Vergote ¹, Lies Laenen ¹, Fara Raymond Koundouno ², Joseph Akoi Bore ³, Jiro Wada ⁴, Jens H Kuhn ⁴, Miles W Carroll ⁵, Piet Maes ⁶

Affiliations [+ expand](#)

PMID: 30042503 PMCID: PMC6057926 DOI: 10.1038/s41598-018-29560-x

[Free PMC article](#)

Marburg virus: Man who died in Guinea found to have disease

By Vivienne Rennie
Africa Correspondent, BBC News
© 10 August 2021



The Marburg virus was first detected in the city of Marburg in Germany in 1967

 **VIRUS EVOLUTION**

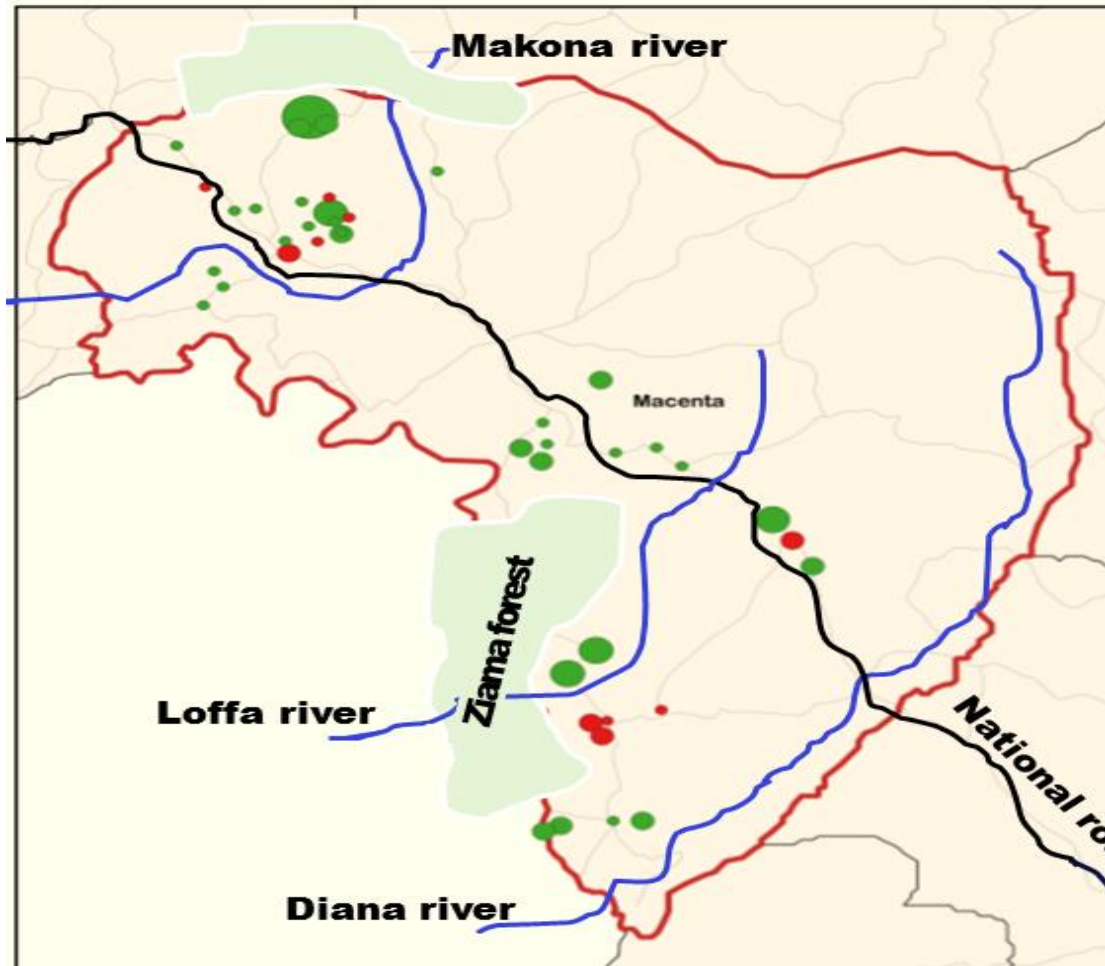
Virus Evolution, 2022, 8(2), 1–12
DOI: <https://doi.org/10.1093/ve/veac061>
Advance access publication date: 30 June 2022
Research Article

The characterization of multiple novel paramyxoviruses highlights the diverse nature of the subfamily Orthoparamyxovirinae

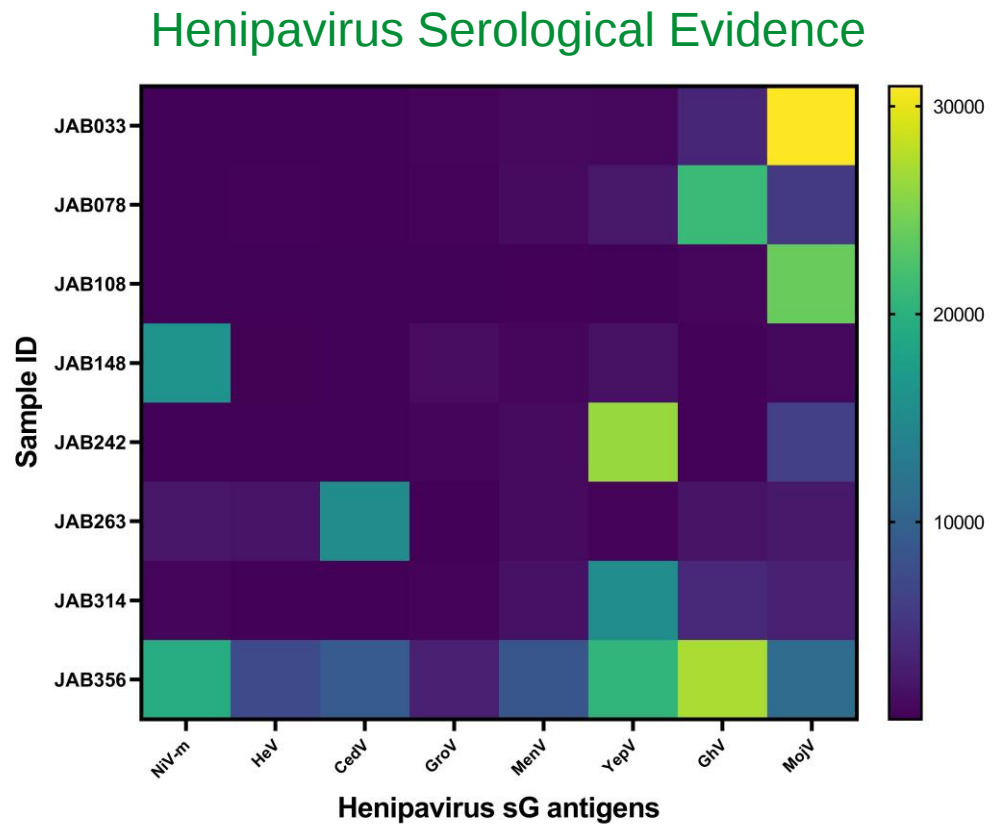
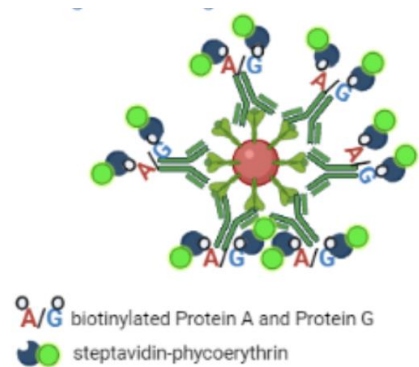
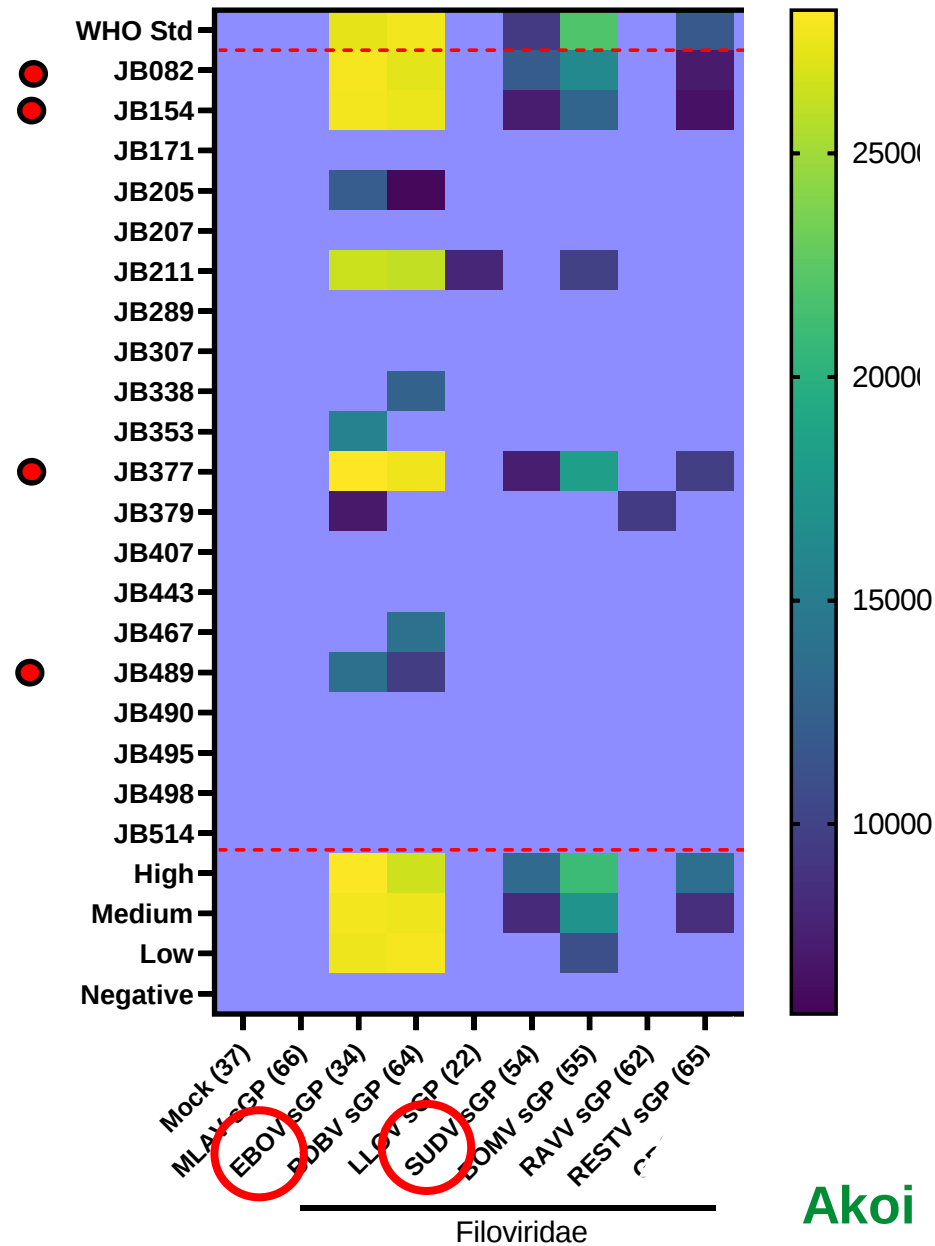
Bert Vanmechelen,^{1,2} Sien Meurs,¹ Marie Horemans,¹ Arne Loosen,¹ Tibe Joly Maes,¹ Lies Laenen,¹ Valentijn Vergote,¹ Fara Raymond Koundouno,² N'Faly Magassouba,² Mandy Kader Konde,⁴ Ibrahima Sory Condé,⁴ Miles W. Carroll,⁵ and Piet Maes^{1,3,4}

¹KU Leuven, Department of Microbiology, Immunology and Transplantation, Laboratory of Clinical and Epidemiological Virology, Rega Institute for Medical Research, Herestraat 49/Box 1040, Leuven BE3000, Belgium, ²Laboratoire des fièvres hémorragiques et virales de Guinée, Conakry Guinée—Direction préfectorale

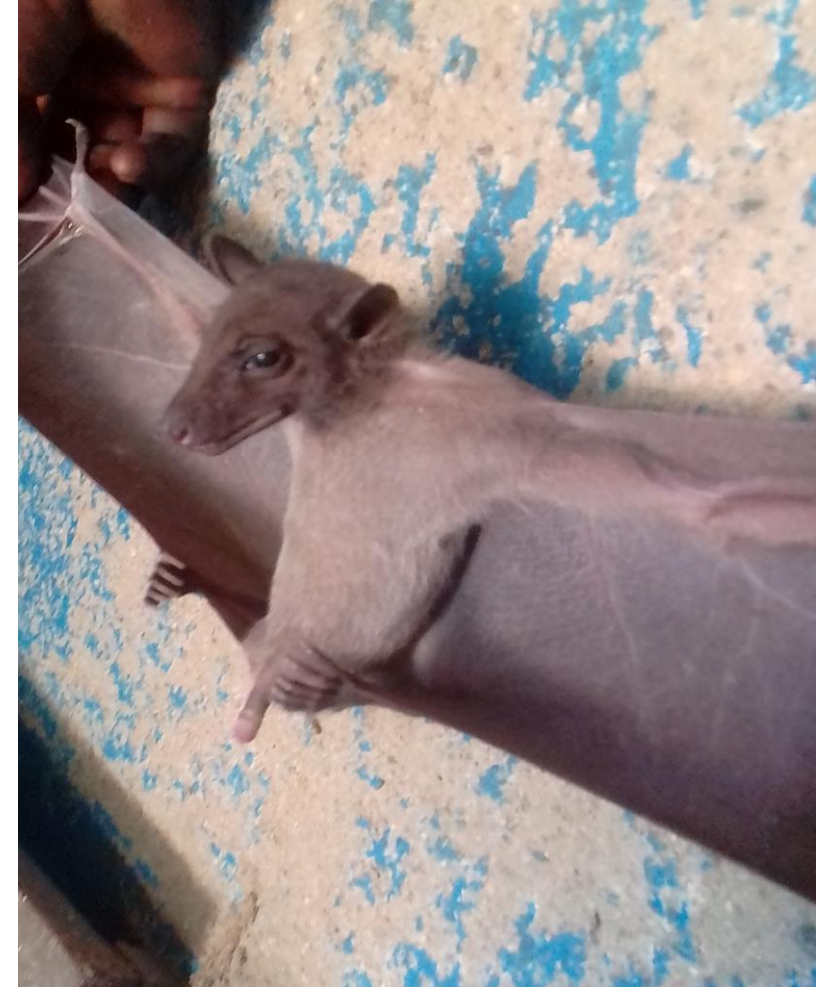
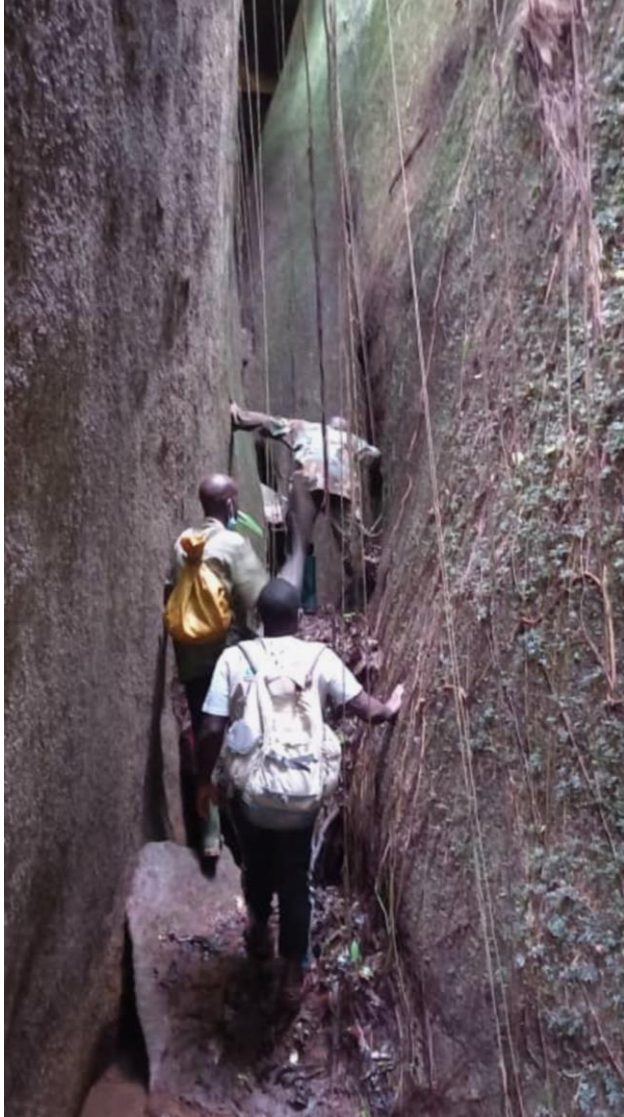
Did EBOV Spill Over In Guinea Prior to 2013-2016 Epidemic? (Jo Akoi Bore)



Filovirus Luminex Analysis: Evidence of Prior Spillover



Re-sampling Original Transect (2017): BMH Serology, Bat Sampling and Studying the Animal-Human Interface



Joseph Akoi Bore

WHO 2018 Pathogen Prioritisation Panel Conclusions



The 2018 annual review determined that given their potential to cause a public health emergency and the absence of efficacious drugs and/or vaccines, there is an urgent need for accelerated research and development for:⁴

- Crimean-Congo Hemorrhagic Fever (CCHF)
- Ebola Viral Disease and Marburg Viral Disease
- Lassa Fever
- Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS)
- Nipah and henipaviral diseases
- Rift Valley Fever (RVF)
- Zika disease
- Disease X

- **Paucity of surveillance data**
- **2018 Panel concluded that the next pan/epidemic will most likely be caused by a pathogenic respiratory coronavirus.**

Summary



- Viruses are continually emerging and future epidemics will occur
- Climate change and deforestation result in increased vector distribution and incidence of human animal interaction
- Capacity building to increase detection of spillover events & enhance response
- Looking for pathogen footprints, and assessing EID within reservoir and analyzing interactions with humans support the development of risk maps
- **Is CCFHv circulating in Bangladesh: animal/tick & human?**
- **What is the true distribution of Nipah virus and human exposure & immunity?**

Acknowledgements



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Birmingham University

Nick Loman

Josh Quick

Liverpool University

Julian Hiscox

Edinburgh University

Andrew Rambaut

Marburg University

Thomas Strecker



Rega Institute

Piet Maes



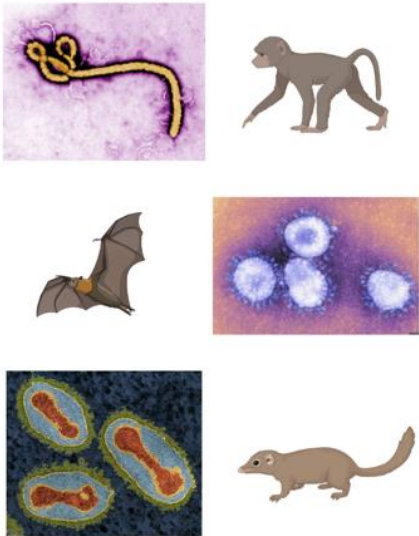
Emerging High Consequence Viruses Group

High threat viruses that are adapting to human hosts & whose prevalence is increasing in the human population



Pathogen surveillance & discovery

NIHR & US FDA: Collaboration with **Guinea & Malaysia** serological and molecular surveillance and discovery of emerging high consequence pathogens.

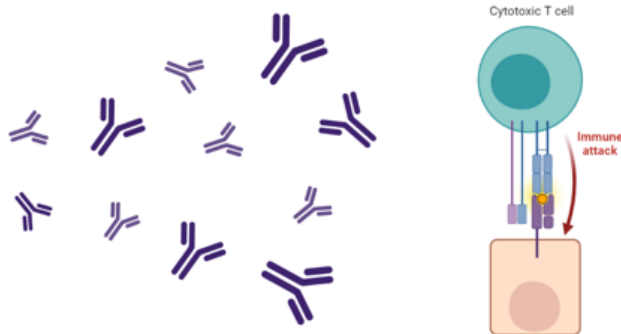


RST/LSHTM, CRAM, Malaysia



Immunity, CoP & safety

FDA: Human immunity to EBOV & SARS-2: infection vs vaccination.
CEPI: Dissecting immunity to vaccination in NHP challenge studies.



Medawar & PITCH, UKHSA



Vaccines, therapeutics & diagnostics

MRC CCHF vaccine Phase I study.
MRC: Pan-coronavirus anti-virals
Wellcome: Nano-body antivirals.
Gates: Henipavirus antivirals
DSTL: Henipavirus response (ACDP4)
FDA: Neuro tropism and SARS-2



Dunn, STRUBI, Chemistry, RFI, DSTL