Tuberkulose: Forschungstätigkeiten in Südafrika und lokale Herausforderungen in Europa

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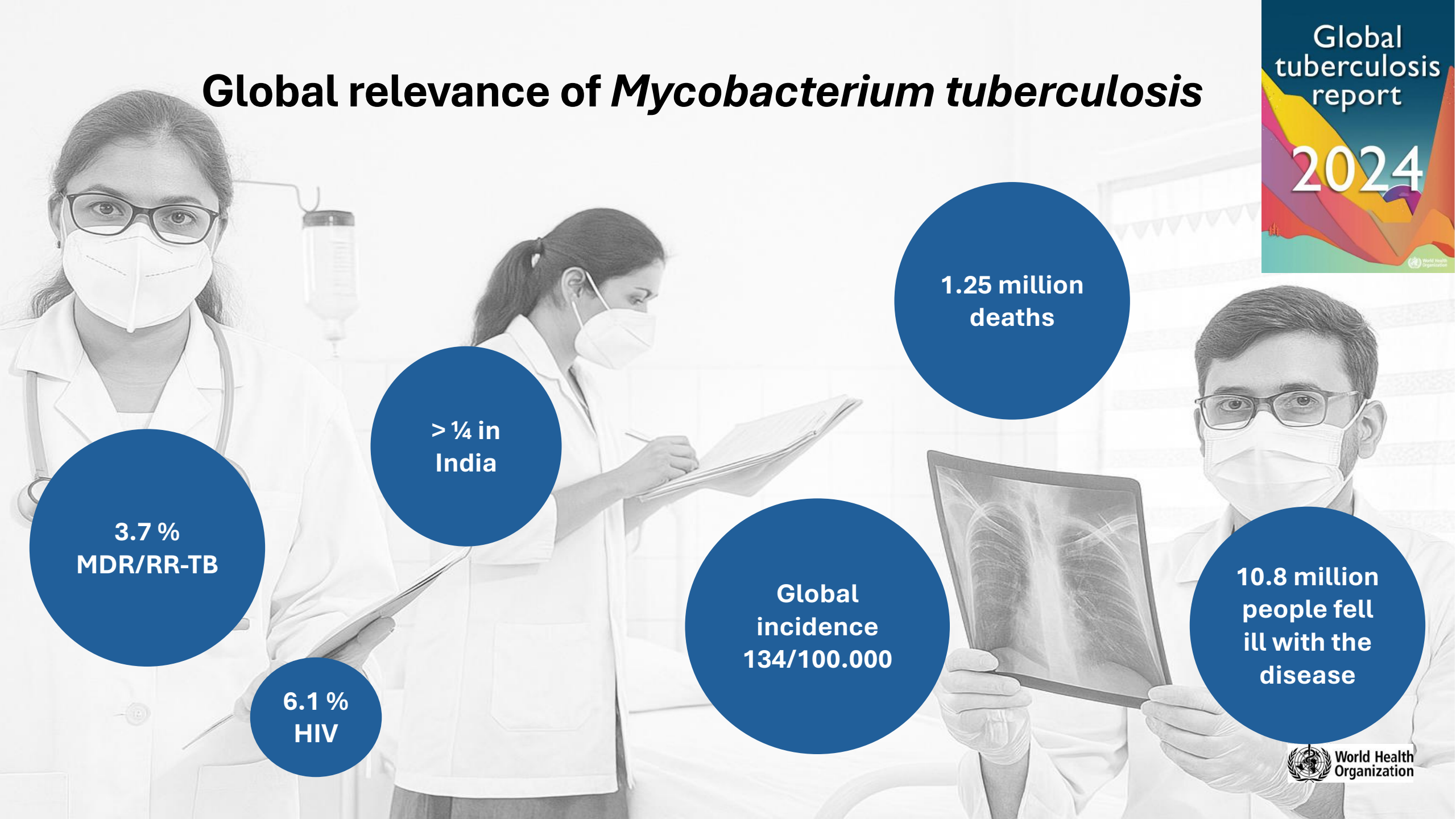
Zollikofen - 24. September 2025

Outline

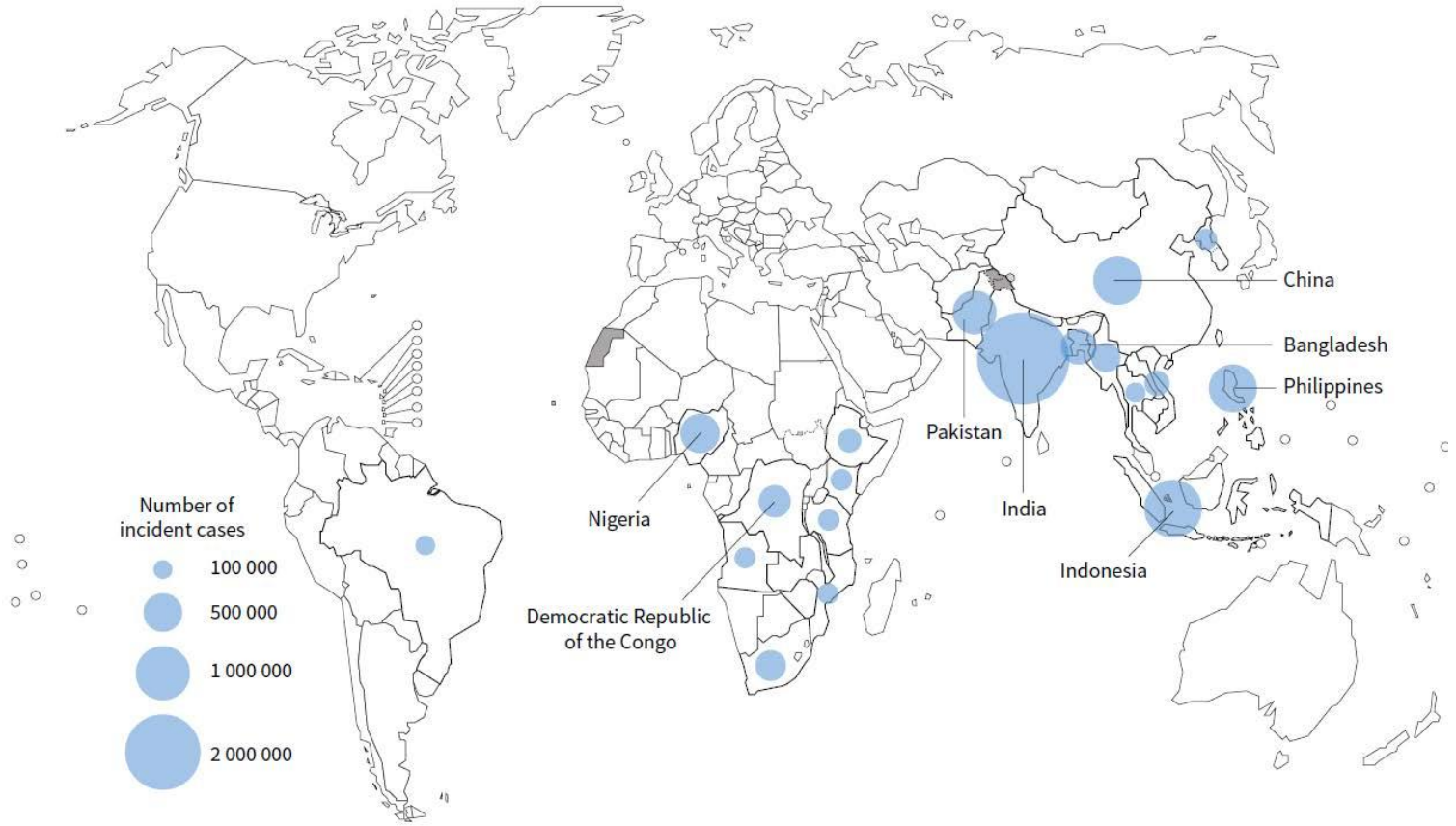
- **Classification and clinical relevance of the *M. tuberculosis* complex**
- Intra- and interspecies transmission events: the South African approach
- Unlocking the «Mycobacteriome»: from method to application
- Dynamics of within-host diversity and microevolution

Global relevance of *Mycobacterium tuberculosis*



8 countries, 67% of global cases in 2023

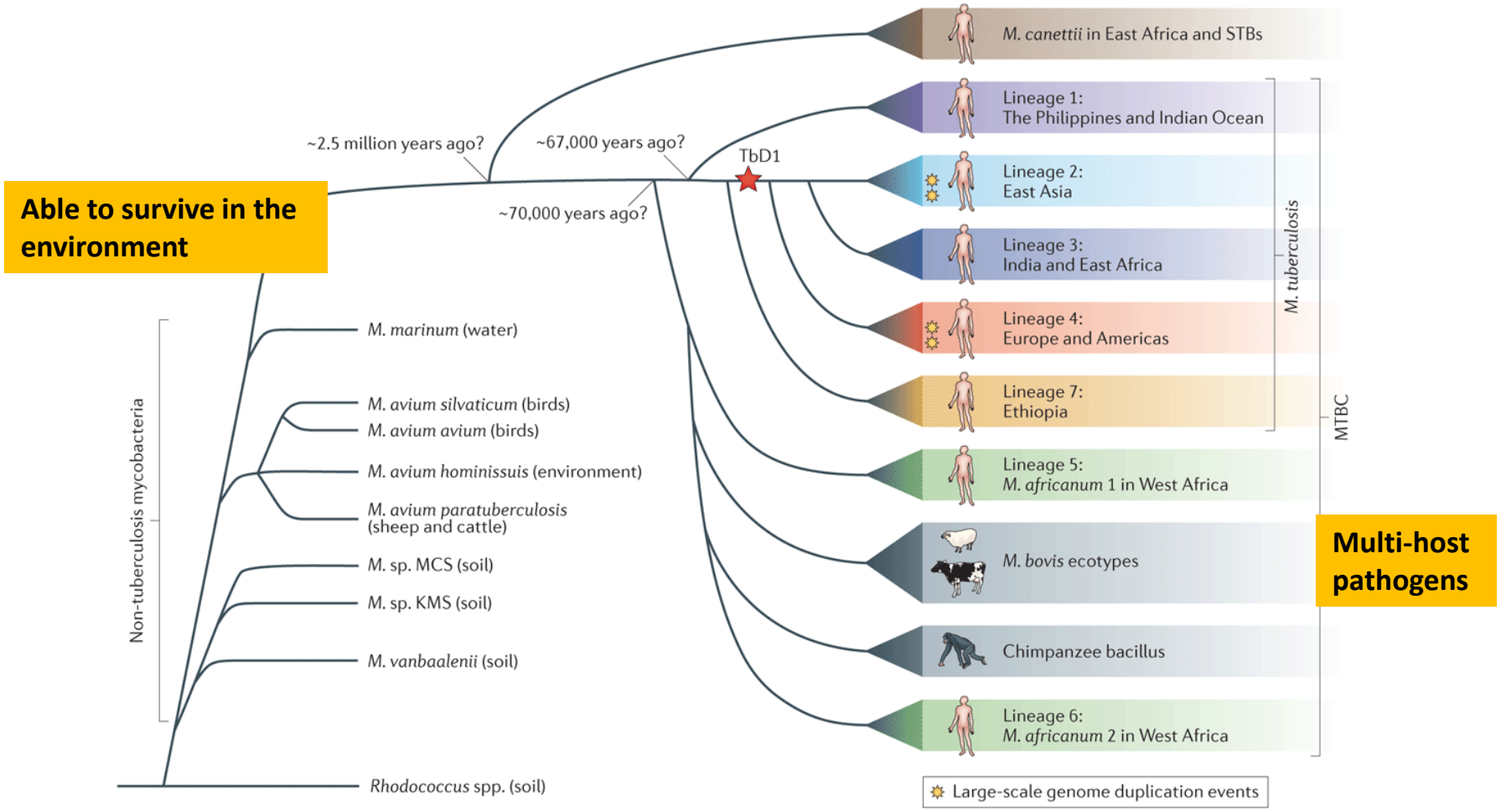
87% in 30 high TB burden countries



Circles shown for countries with at least 100 000 estimated cases

World Health Organization

Phylogenomics of the genus *Mycobacterium*



Able to survive in the environment

Multi-host pathogens

Modified from Galagan J.E., 2014

Zoonotic TB and reverse zTB

SocioEconomic challenges

- Impact on rural communities and the farming industry
- Eradication costs
- Trade barriers for live animals and animal products
- Farmers, consumer, authorities loss of trust

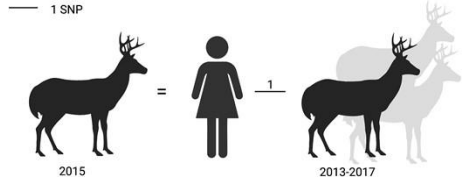
OIEPanorama2019

Anecdotal events vs. hidden burden of continuous infections

▸ Emerg Infect Dis. 2021 Jul;27(7):1997–1999. doi: 10.3201/eid2707.204399

Occupational Exposure to Zoonotic Tuberculosis Caused by *Mycobacterium caprae*, Northern Greece, 2019

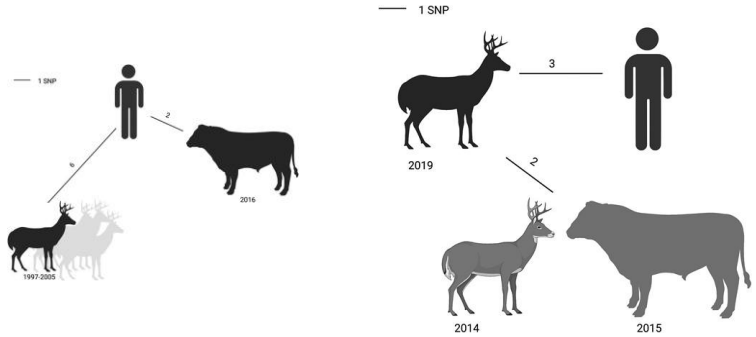
Dimitrios Papaventsis [1,2,3,✉], George Dougas [1,2,3], Ourania Kalkouni [1,2,3], Simona Karabela [1,2,3], Katerina Manika [1,2,3]



Review › Infection. 2025 Feb;53(1):481-487. doi: 10.1007/s15010-024-02364-0.
Epub 2024 Aug 14.

Disseminated, fatal reactivation of bovine tuberculosis in a patient treated with adalimumab: a case report and review of the literature

Gioele Capoferri [1], Giovanni Ghielmetti [2], Bettina Glatz [3], Markus R Mutke [3], Alexandar Tzankov [4], Roger Stephan [2], Peter M Keller [5], Niklaus D Labhardt [6 7]



Sunstrum, et al. Clin Infect Dis. 2024

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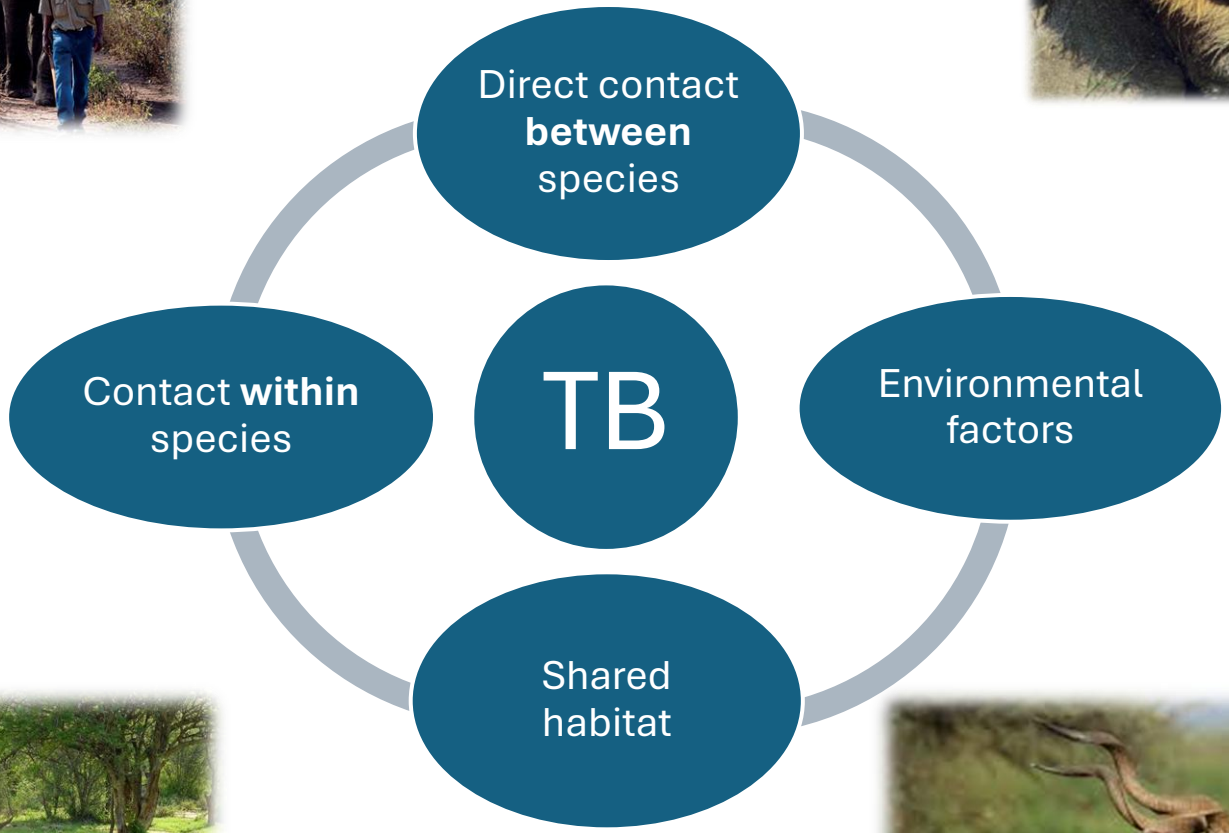
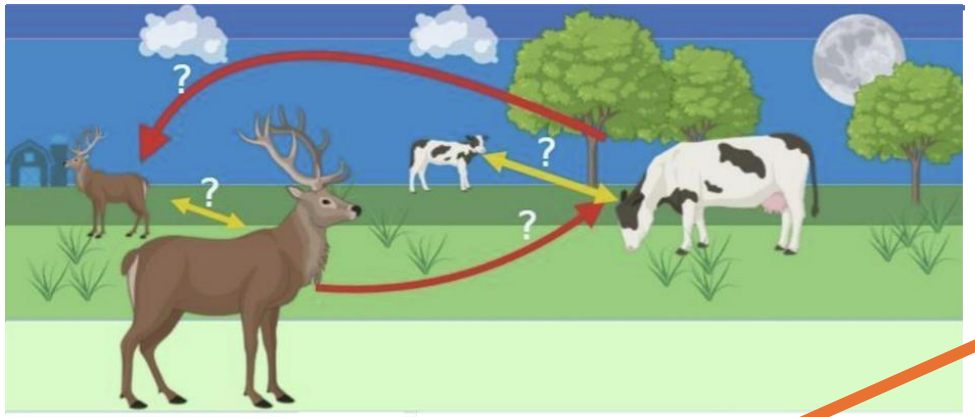
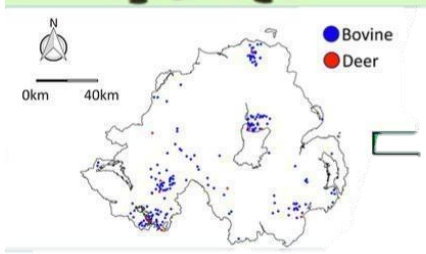
How is TB transmitted in South African wildlife?

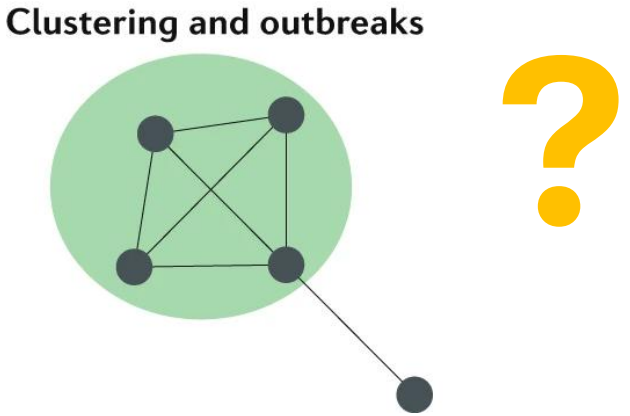
Interfaces


Direct contact **between** species
Environmental factors
Shared habitat
Contact **within** species
TB

Tracking *M. bovis* transmission in the genomic era

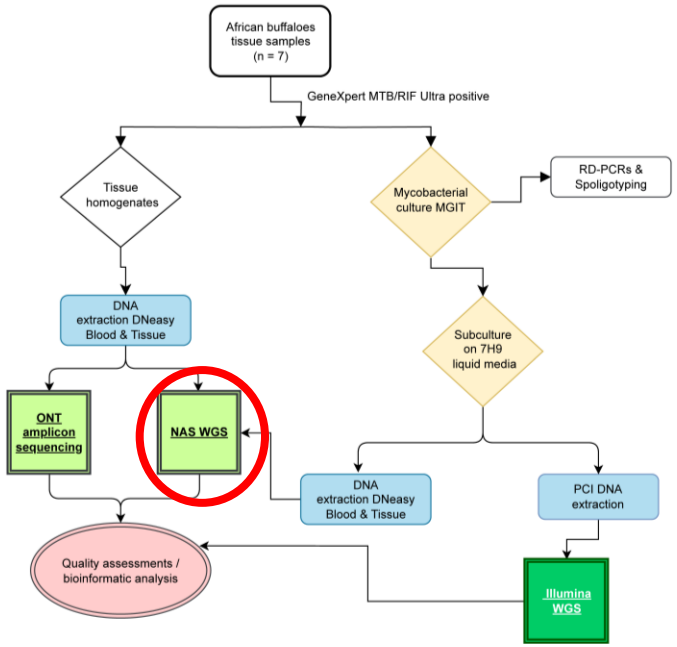


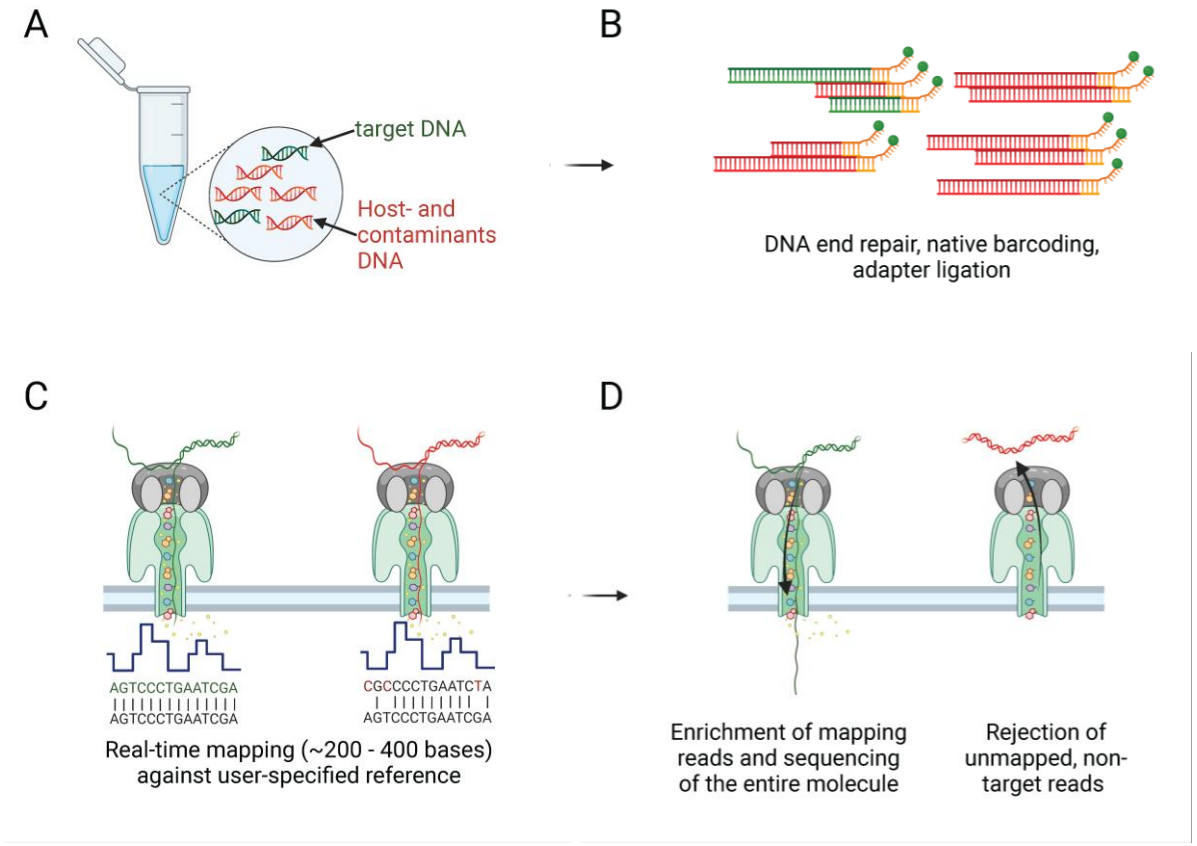




Allen et al. Infection, Genetics and Evolution 2025

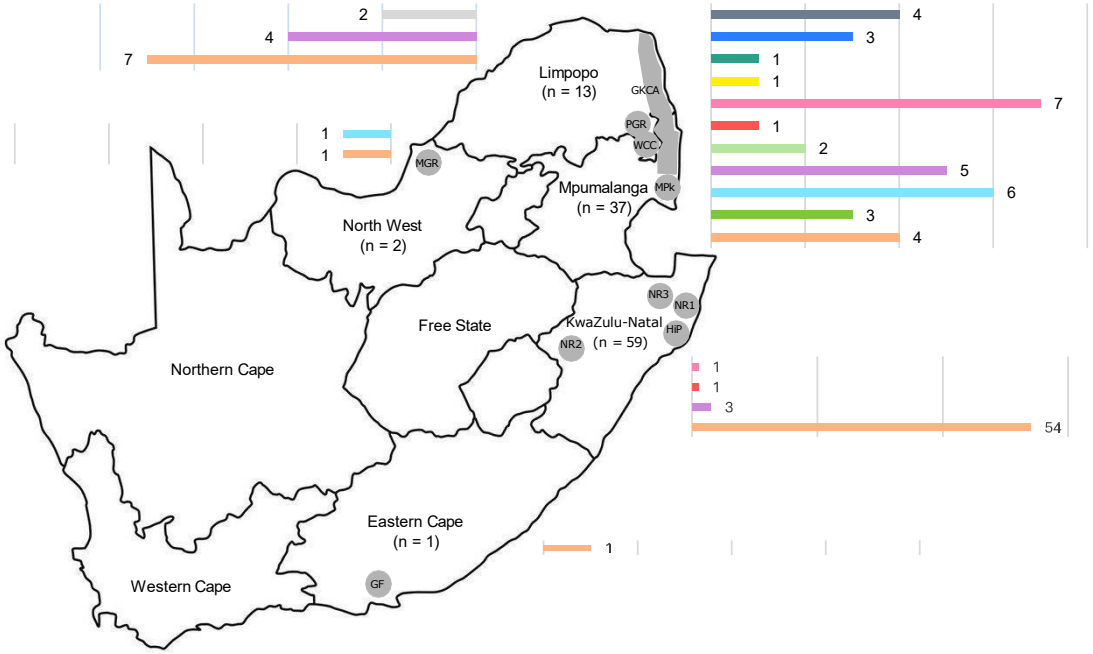
Retrieving whole-genome sequences from tissues samples: a culture-independent approach

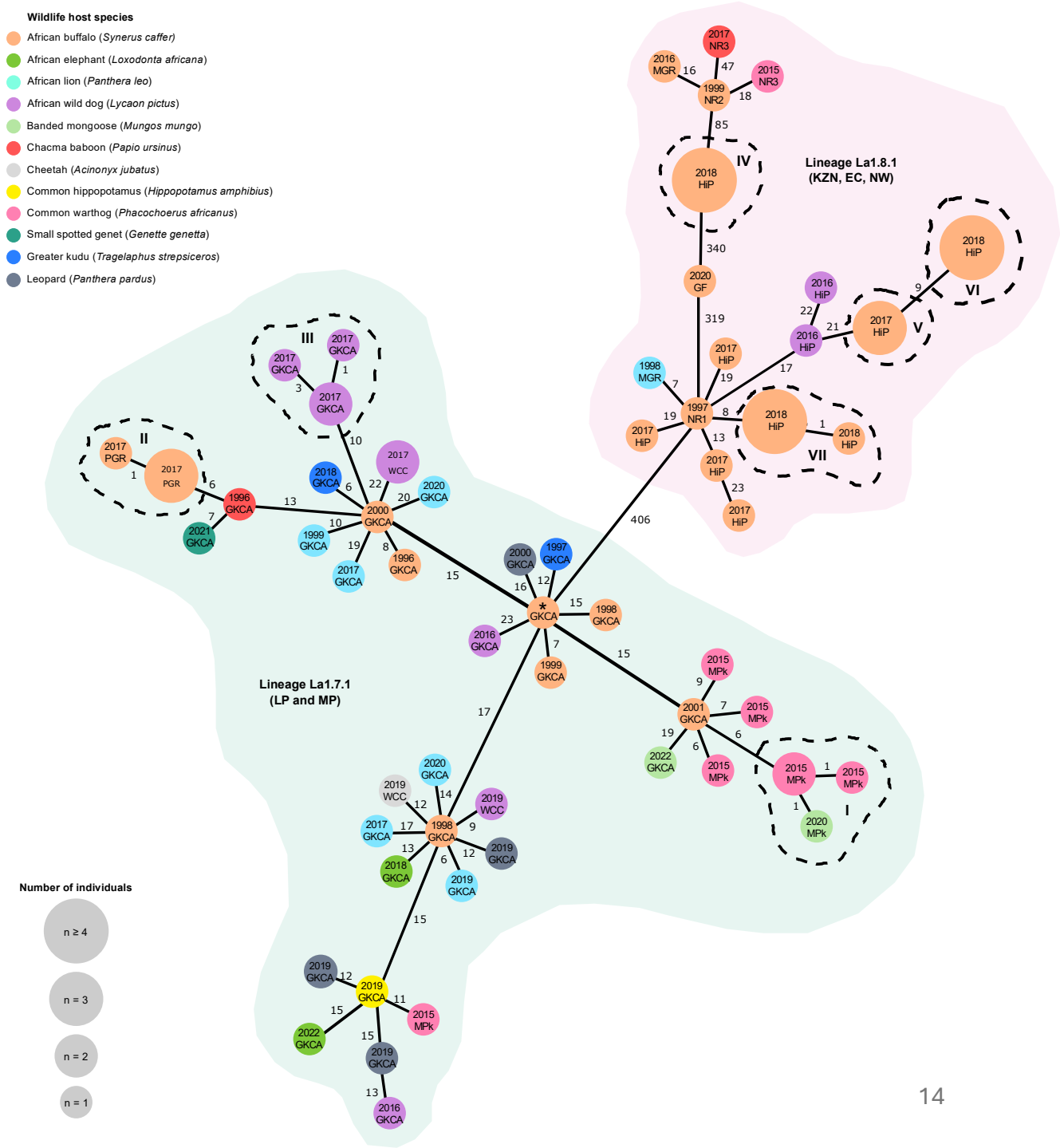




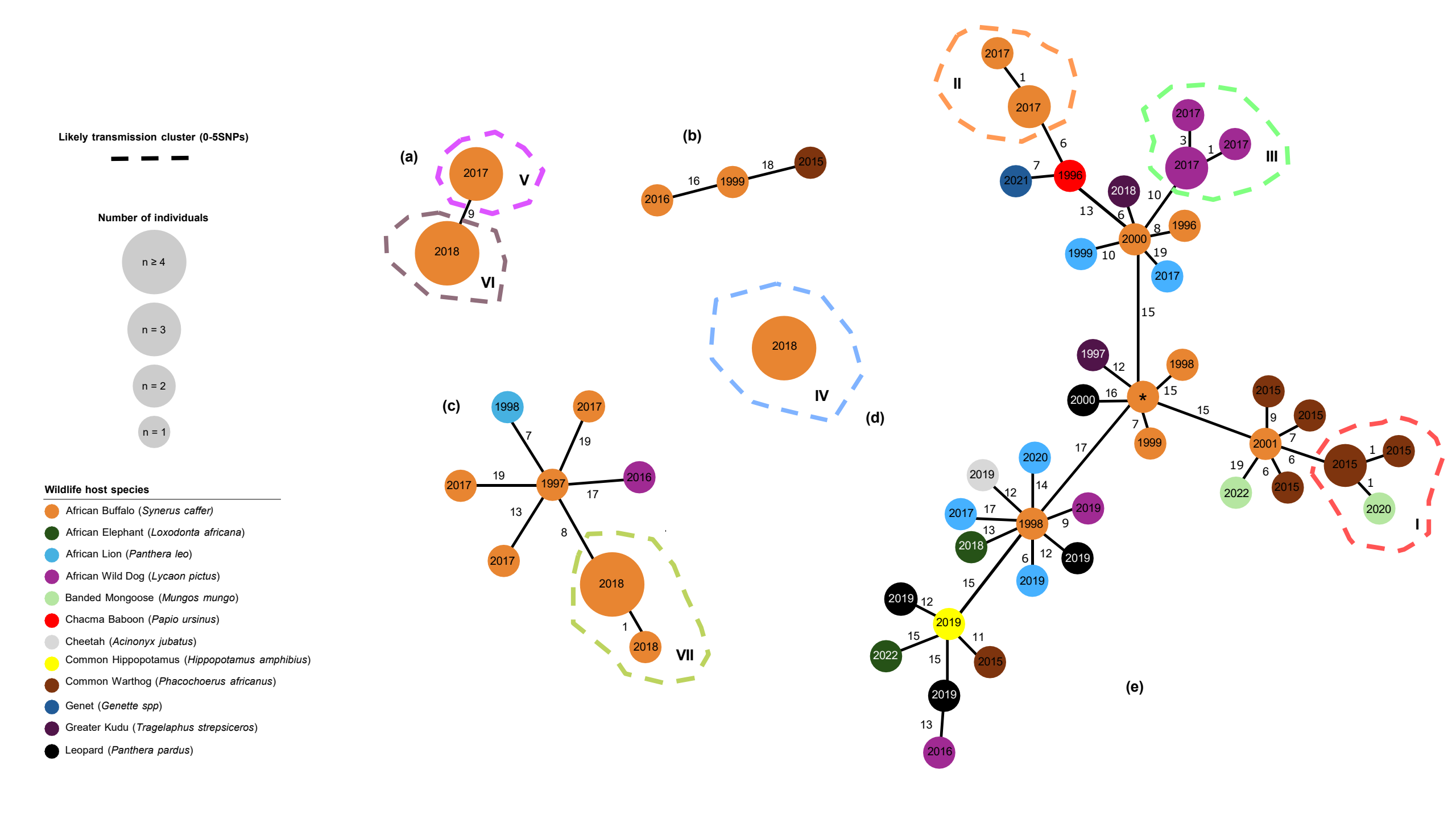
Ghielmetti *et al.*, *Frontiers Microbiology* 2023

Genetic diversity and transmission dynamics of *M. bovis* in South African wildlife





Okunola et al., submitted


Likely transmission cluster (0-5SNPs)
Number of individuals
n ≥ 4
n = 3
n = 2
n = 1
Wildlife host species
African Buffalo (Synerus caffer)
African Elephant (Loxodonta africana)
African Lion (Panthera leo)
African Wild Dog (Lycaon pictus)
Banded Mongoose (Mungos mungo)
Chacma Baboon (Papio ursinus)
Cheetah (Acinonyx jubatus)
Common Hippopotamus (Hippopotamus amphibius)
Common Warthog (Phacochoerus africanus)
Genet (Genette spp)
Greater Kudu (Tragelaphus strepsiceros)
Leopard (Panthera pardus)
(a)
(b)
(c)
(d)
(e)
I
II
III
IV
V
VI
VII

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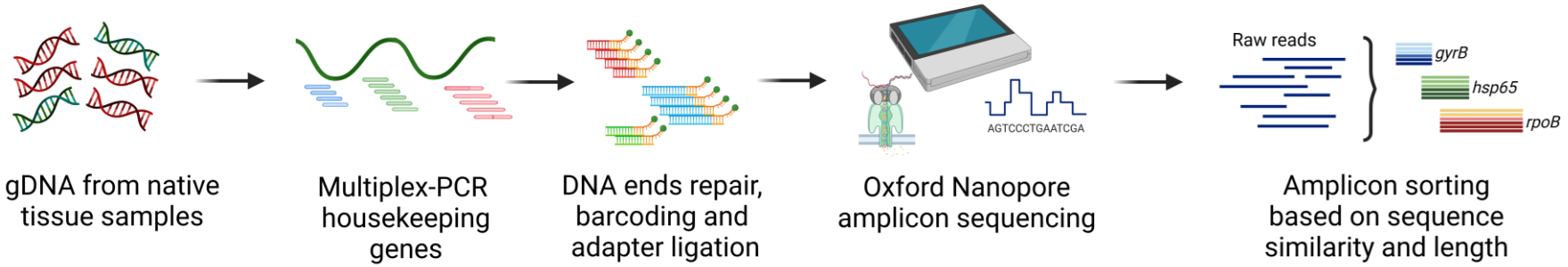
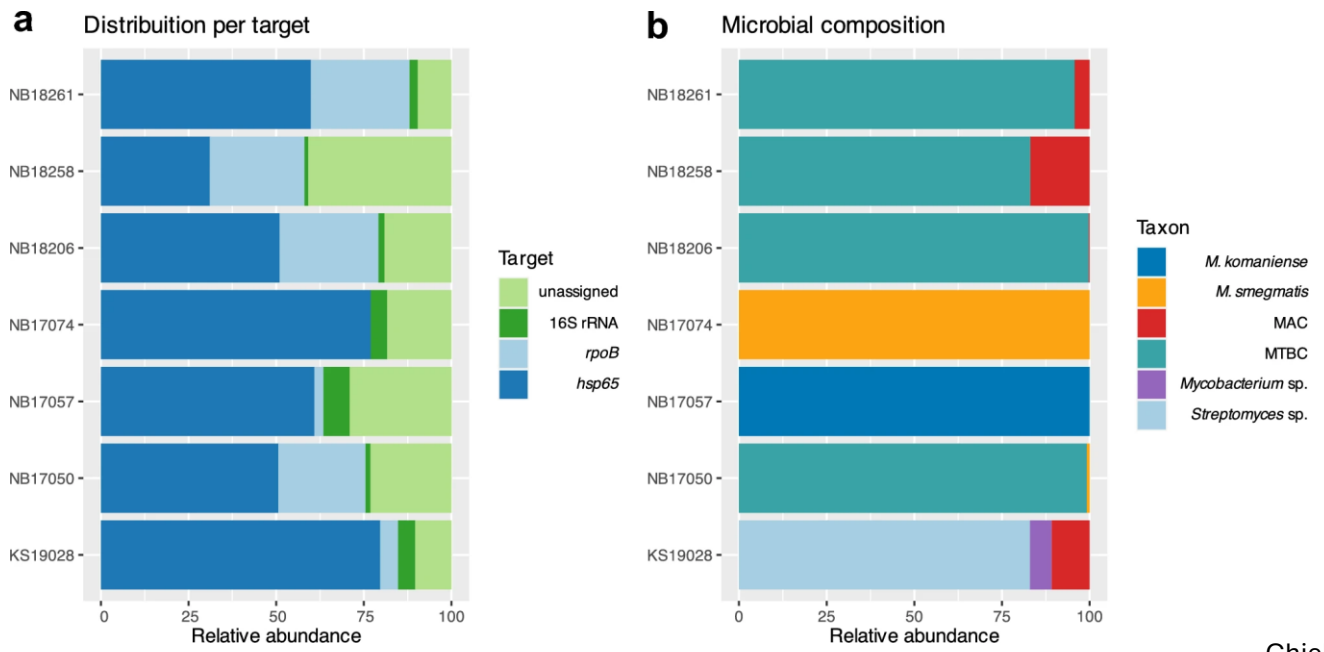
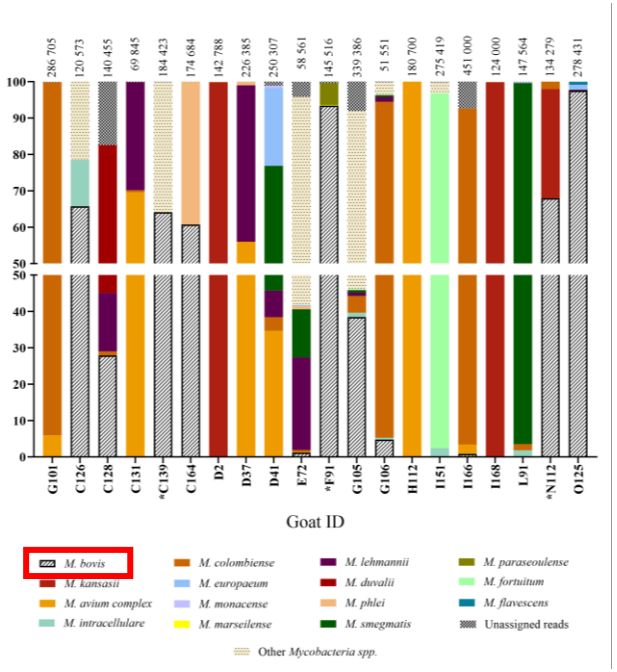
Mycobacteriome composition in *M. bovis*-infected African buffalo tissue samples

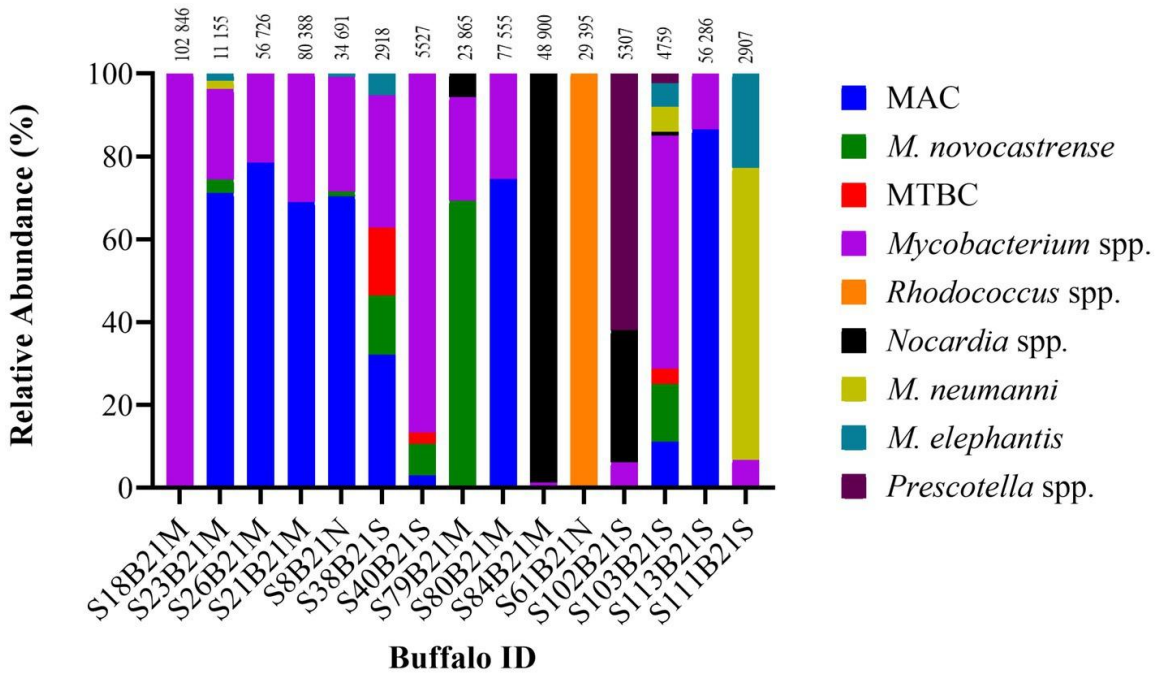




Ghielmetti *et al*. Scientific Reports 2024

Targeted NGS – Nasal mycobacteriome composition





Cooke *et al*. Front Microbiol. 2024

Mhlophe *et al*. Front. Vet. Sci. 2025

Zoonotic TB in GeneXpert MTB/RIF Ultra-positive, culture-negative sputum samples from a rural community in KwaZulu-Natal

nature africa

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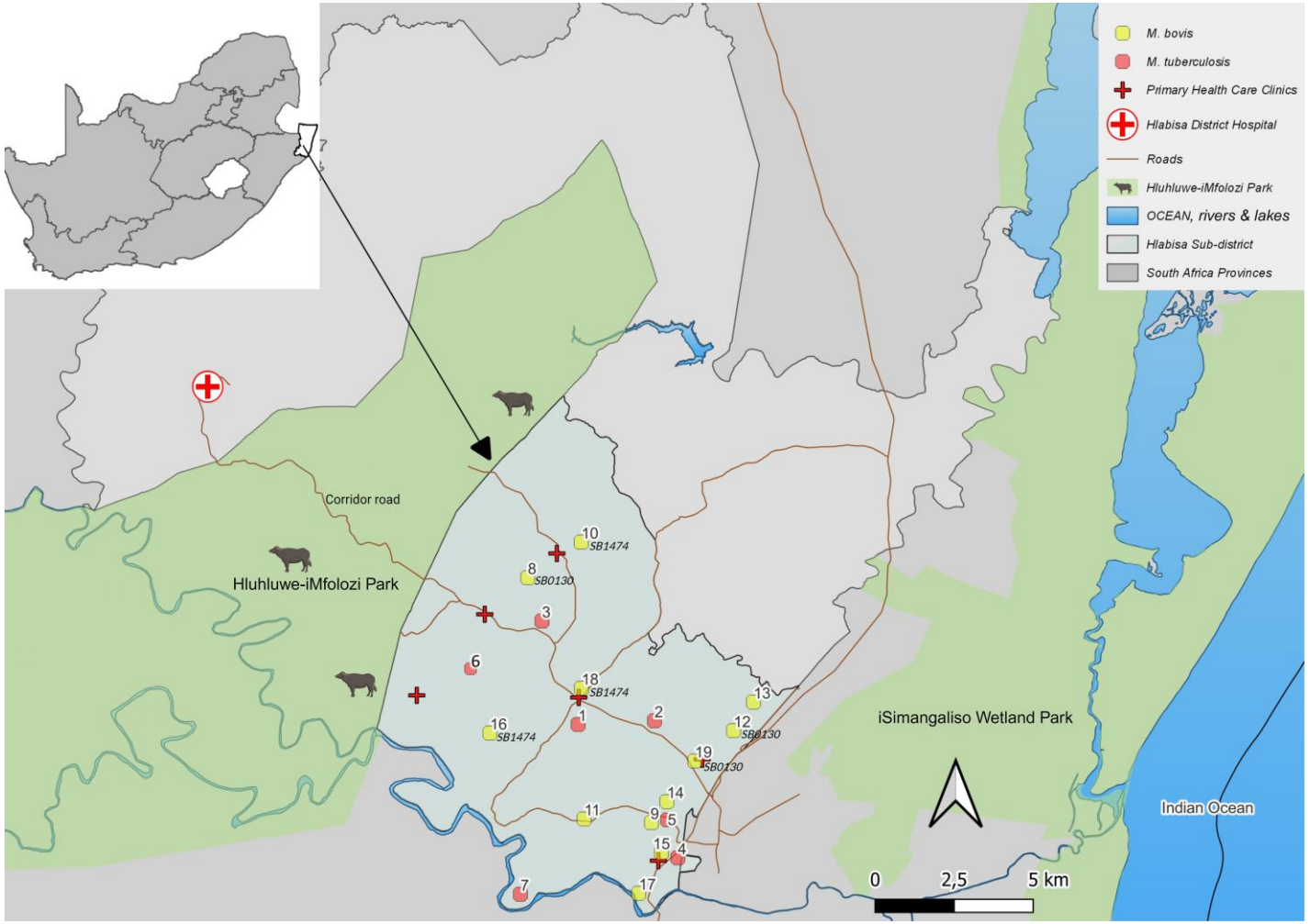
NEWS | 26 March 2024

Researchers detect first cases of zoonotic TB in human sputum samples in South Africa

Bovine TB found in human samples for first time in country

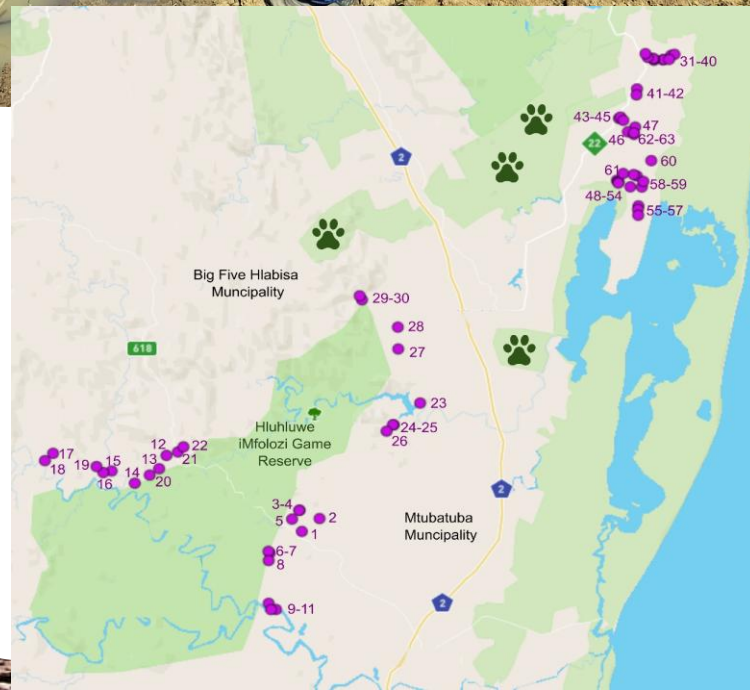


Environmental sampling for MTBC and NTM detection

Understanding indirect transmission

Shared Water sources

63 sites, 164 sample
10/164 (6%) *M. bovis*



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Interspecies transmission of *Mycobacterium tuberculosis*

abo+ ZOO BASEL

Tuberkulose-Fall im Zolli: Was bedeutet das für Pfleger und Besuchende?

Der Elefanten-Bulle Tusker im Basler Zolli musste am Mittwochmorgen eingeschläfert werden. Das Tier litt an offener Tuberkulose. Sorgen müssten sich die Zolli-Besucherinnen und -Besucher aber trotzdem keine machen, sagt die stellvertretende Basler Kantonsärztin Eva Würfel.

Benjamin Wieland
09.08.2023, 18.28 Uhr

Merken Drucken Teilen

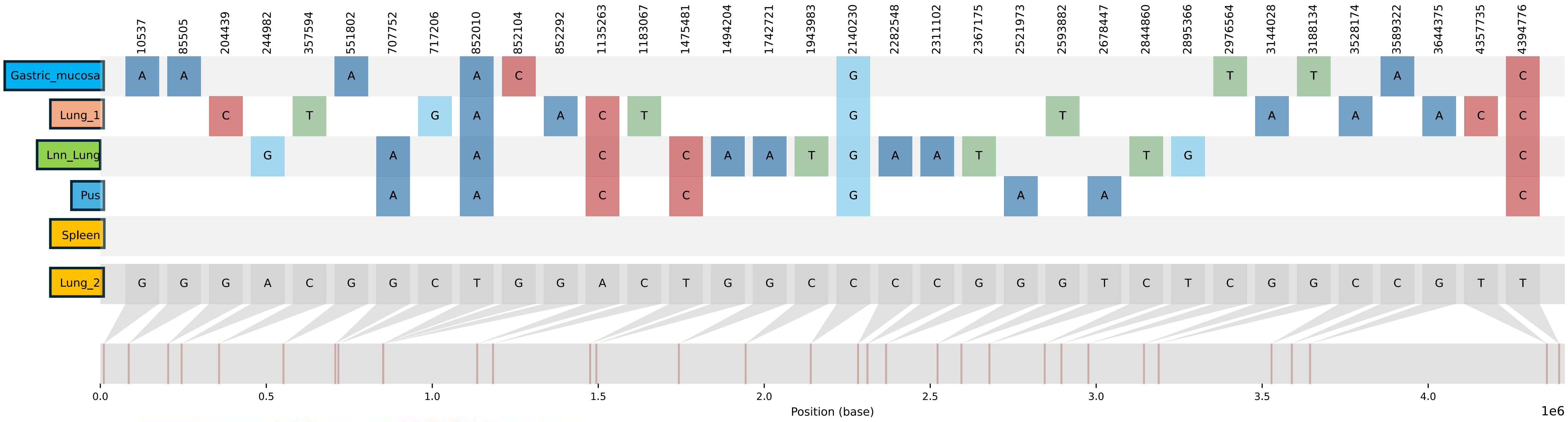
SRF

Star-Elefant ist tot

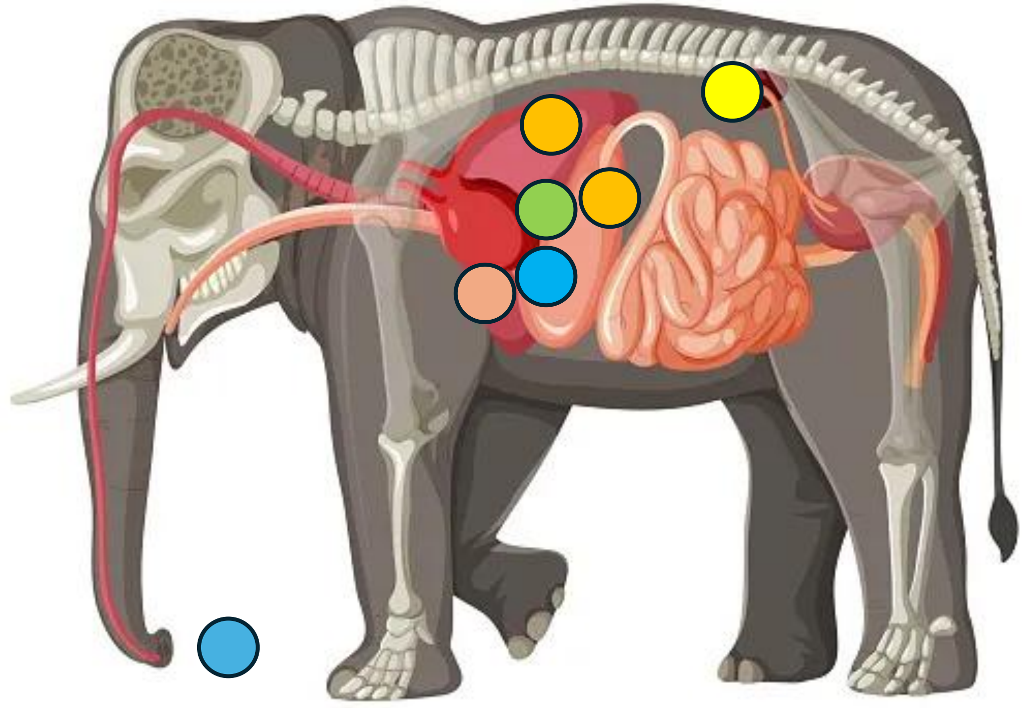
Elefantenbulle Tusker im Zoo Basel eingeschläfert

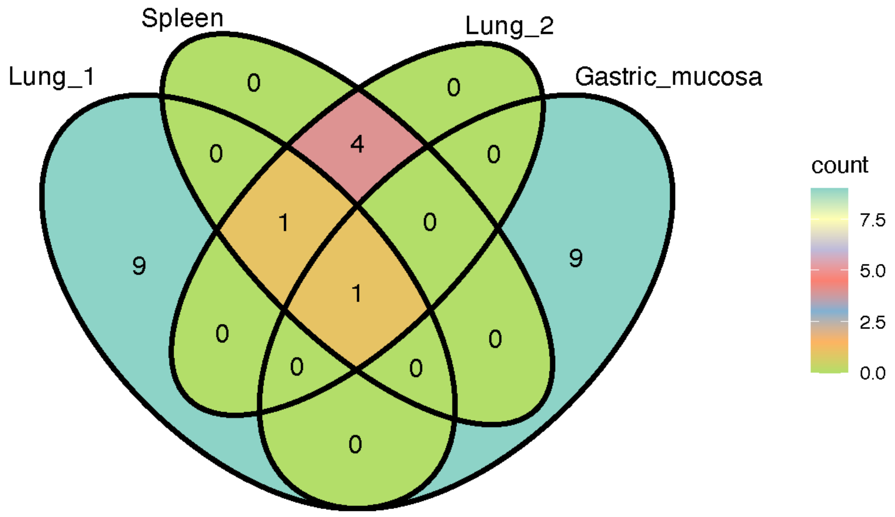
Das Tier war in den sozialen Medien ein Star. Wegen Tuberkulose musste der Elefant eingeschläfert werden.

Mittwoch, 09.08.2023, 11:01 Uhr
Aktualisiert um 13:19 Uhr



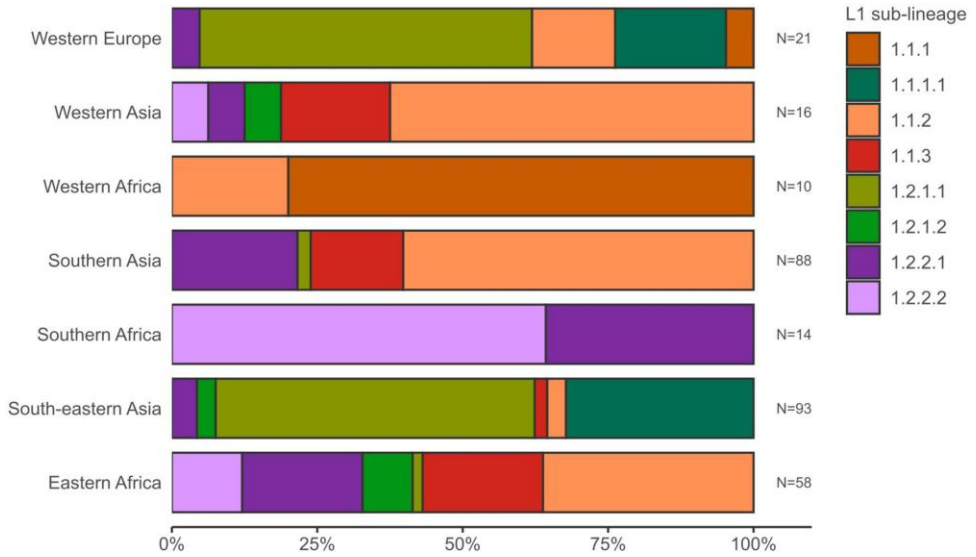
10537
85505
204439
244982
357594
551802
707752
717206
852010
852104
852292
1135263
1183067
1475481
1494204
1742721
1943983
2140230
2282548
2311102
2367175
2521973
2593882
2678447
2844860
2895366
2976564
3144028
3188134
3528174
3589322
3644375
4357735
4394776
Gastric_mucosa A A A A C G T T A C
Lung_1 C T G A A C T G T A A A C C
Lnn_Lung G A A C C A A T G A A T T G C
Pus A A C C G A A C
Spleen
Lung_2 G G G A C G G C T G G A C T G G C C C C G G G T C T C G G C C G T T
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Position (base)
1e6



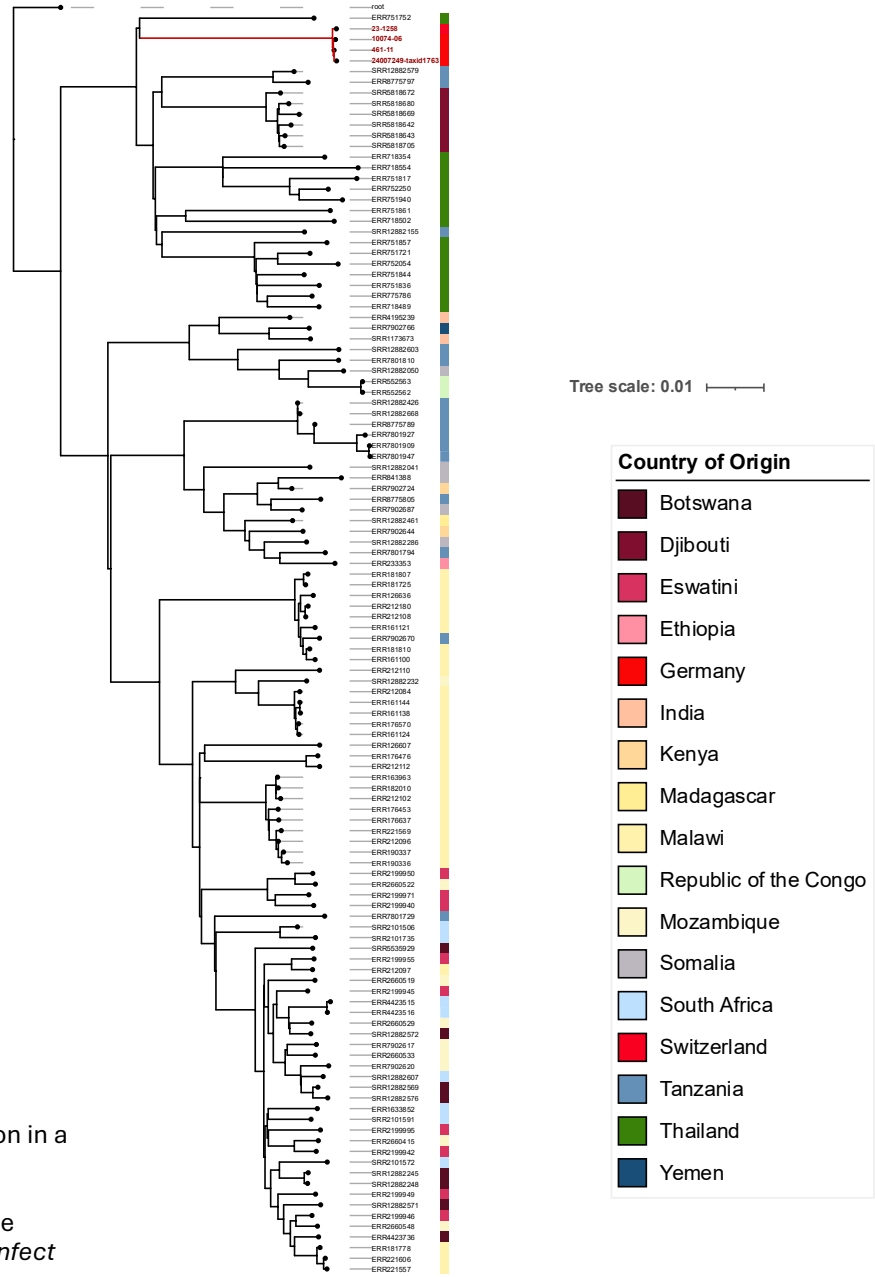


Spleen
Lung_2
Lung_1
Gastric_mucosa
0
0
4
0
0
1
0
9
1
9
0
0
0
0
0
count
7.5
5.0
2.5
0.0

Mycobacterium tuberculosis L1.2.2.2



Gisch et al. Front Microbiol. 2022



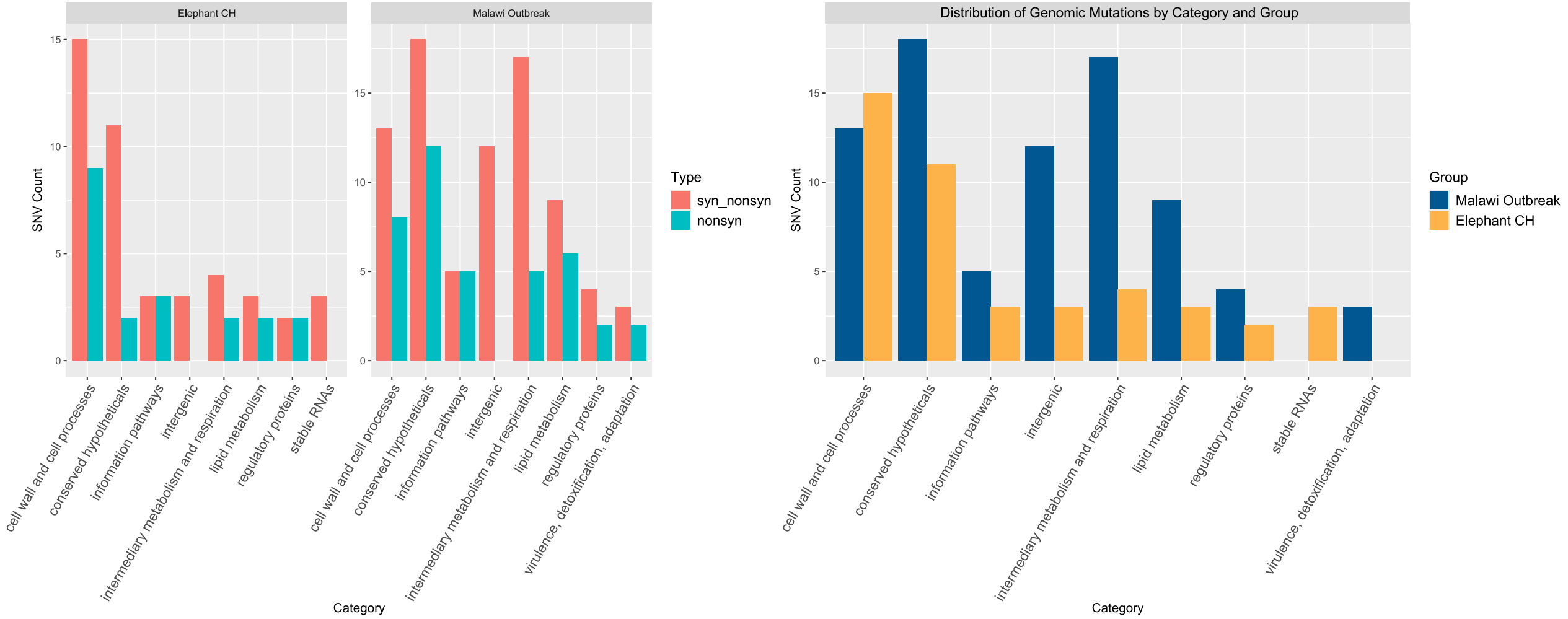
Previous large-scale investigations revealed that ***M. tb* lineage 1** had the **highest mutation rate** (0.58 SNPs/year) compared to other lineages, while lineage 2 had the lowest (0.11 SNPs/year).

•Guerra-Assunção JA *et al.*, "Large-scale whole genome sequencing of *M. tuberculosis* provides insights into transmission in a high prevalence area.", *Elife*, 2015 Mar 3;4

•Guerra-Assunção JA *et al.*, "Recurrence due to relapse or reinfection with *Mycobacterium tuberculosis*: a whole-genome sequencing approach in a large, population-based cohort with a high HIV infection prevalence and active follow-up.", *J Infect Dis*, 2015 Apr 1;211(7):1154-63

1 30

L1.2.2.2 - JSFiddle - Code Playground



- **Genomic variant** analysis of ***M. tb*** isolates from the **elephant (n = 7)** and a **human (n = 9) outbreak in Malawi (**both **L1.2.2.2)** revealed **potential host immune-driven modulation**.
- **Elephant isolates** presented **significantly (*p* = 0.025) higher variations in cell wall and cell process-associated proteins** compared to a Malawian human cohort, suggesting adaptive mechanisms across hosts.

TB in Wild Elephants

Fatal case in KNP - 2016

Miller *et al.*, Front. Vet. Sci. 2019

DAILY MAVERICK

OUR BURNING PLANET

IN PICTURES

A jumbo operation to test Kruger Park elephant for TB

- Different epidemiology of *M. tb* and *M. bovis*
- The impact of surrounding communities and tourism is to be evaluated

Summary

- Human and animal adapted *Mycobacterium tuberculosis* complex ecotypes are distinct, yet interspecies transmission can occur in both directions.
- Understanding the complexity of tuberculosis requires investigations within real-life ecological settings.
- Portable, high-throughput sequencing platforms offer valuable insights into transmission dynamics.
- Animal hosts can serve as models for studying human infectious diseases.

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advancinglife

NRF National Research Foundation

Research Center Borstel
Leibniz Lung Center

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Swiss TPH
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