



Phylogenetic Analysis and Epidemiological Investigation of *Brucella* spp.
in a One Health Context

One Health Perspective

Intended Learning Objectives

Specific objectives of this session:

1. Learn about One Health concept
2. Learn about the global context of *Brucella* spp.
3. Learn about the human, animal and environmental relationships

Outline

This session consists of the following elements:

1. Introduction to the One Health concept
2. Explanation of prevalence, incidence, transmission
3. Explanation of the global context of *Brucella* spp.
4. Showcasing the human, animal and environmental relationships



Have you heard about One Health concept before?

The 'One Health' concept ¹



Quadripartite collaboration on One Health



FAO: Food and Agriculture Organization of the United Nations

UNEP: United Nations Environment Programme

WHO: World Health Organisation

WOAH: World Organisation for Animal Health

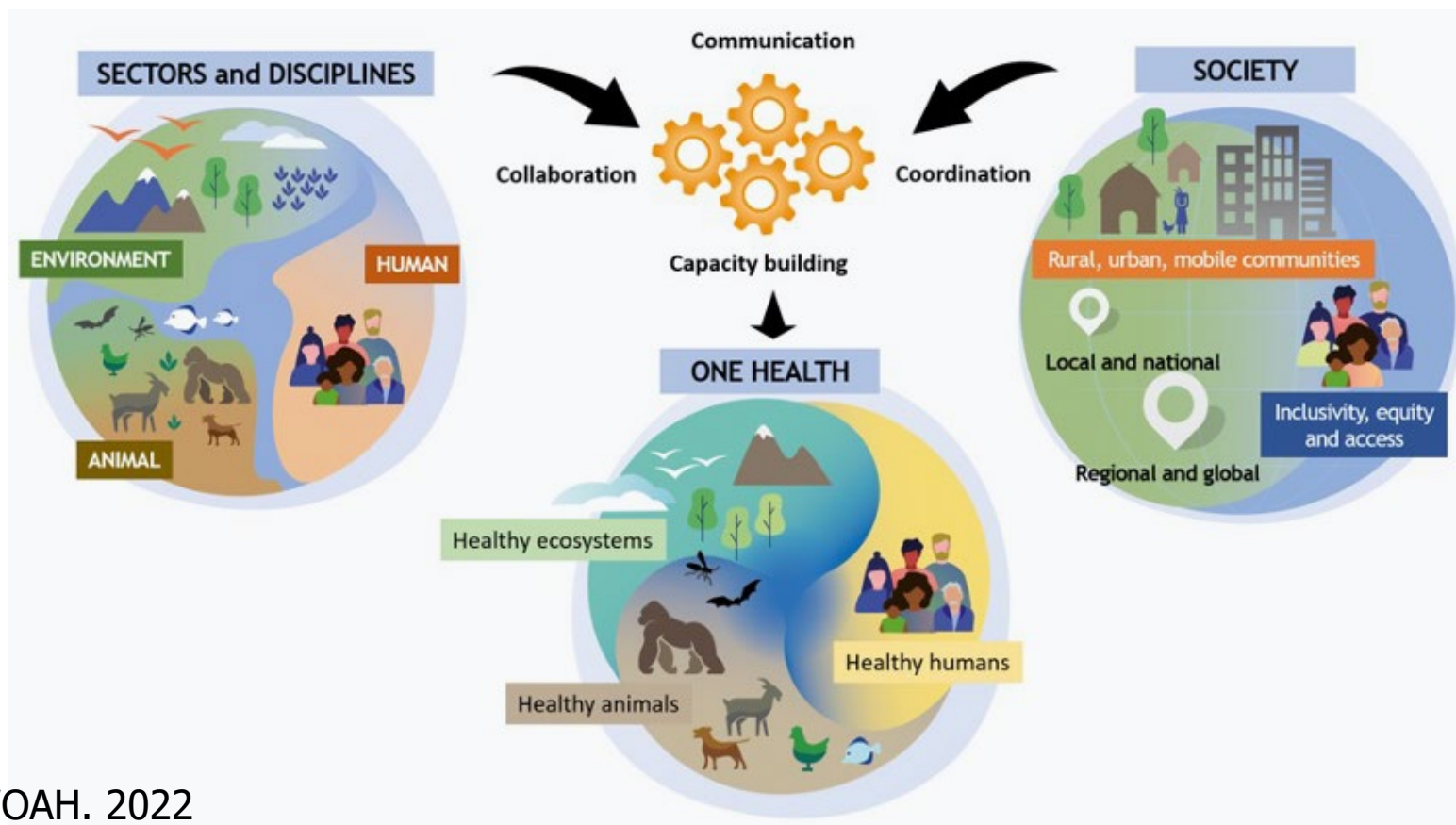
'Collaborate to drive the change and transformation required to mitigate the impact of current and future health challenges at the human–animal– plant–environment interface at global, regional and country level'



One Health Joint Plan of Action, 2022–2026
Annual country self-assessment survey for AMR (TrACSS)

The 'One Health' concept ¹

One Health is an integrated, unifying approach to sustainably balance and optimize the health of humans, animals, plants and ecosystems. It recognizes the health of humans, domestic and wild animals, plants and the wider environment are closely linked and interdependent.



The 'One Health' concept ¹



*Infectious diseases are among the **most significant** health and security challenges.*

*In low-income countries, infectious diseases account for **more than 60 percent** of the human disease burden and are **the major cause** of animal disease.*

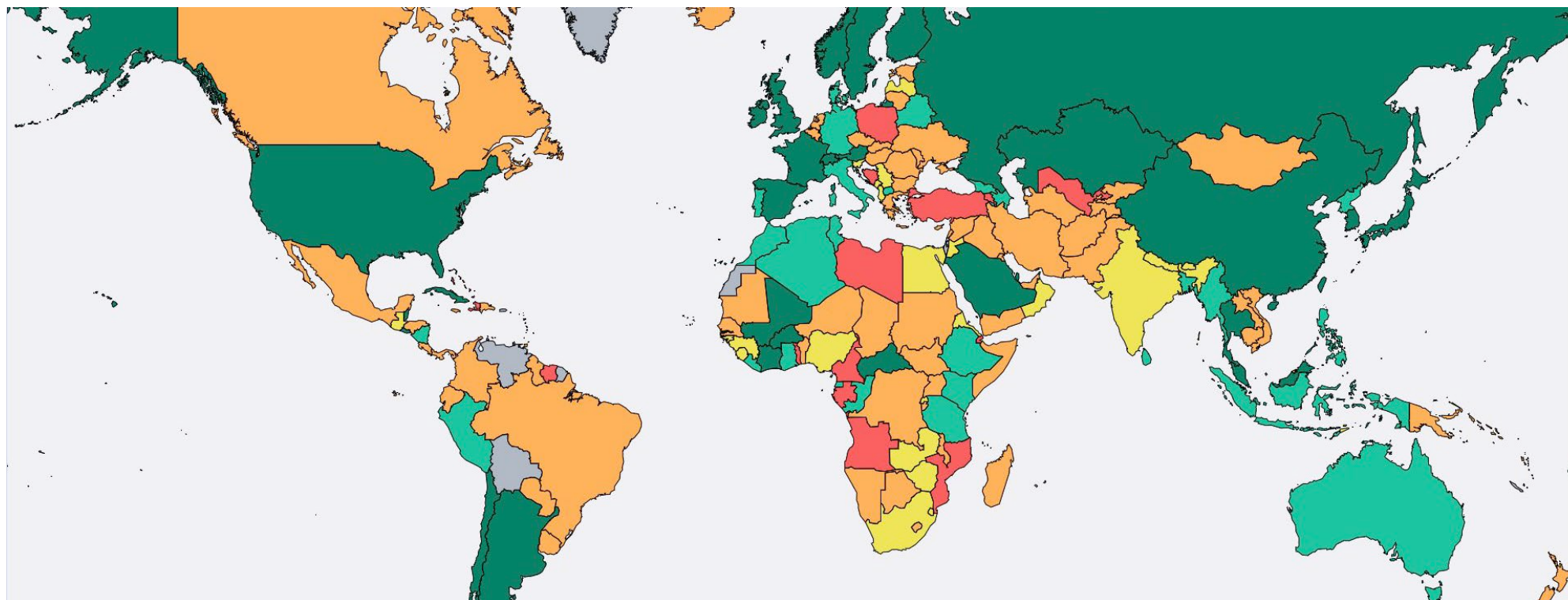
***Endemic zoonoses** constitute a constant **social and economic burden**. In endemic areas, they perpetuate poverty by damaging not only human health, but also the health and welfare of domestic and wild animals, affecting livelihoods and food security.*

*This group includes ... **brucellosis** ...*

*They are rarely targeted by formal surveillance systems, so their incidence and burden are greatly underestimated. This, in turn, leads to **neglect** by policymakers and funding agencies.*

The 'One Health' concept ²

TrACSS: Multi-sector and One Health collaboration/coordination, all regions, 2025



- A** A - No formal multi-sectoral governance or coordination mechanism on AMR exists.
- B** B - Multi-sectoral coordination mechanism on AMR established with Government leadership.
- C** C - Formalized Multisector coordination mechanism with technical working groups established with clear terms of reference, regular meetings, and funding for working group(s) with activities and reporting/accountability arrangements defined.
- D** D - Joint working on issues including agreement on common objectives.
- E** E - Integrated approaches used to implement the national AMR action plan with relevant data and lessons learned from all sectors used to adapt implementation of the action plan.

Brucella spp. incidence, prevalence, transmission ^{3,4}



- Brucellosis is found **globally**. It mainly affects cattle (*B. abortus*), swine (*B. suis*), goats and sheep (*B. ovis*), and dogs (*B. canis*).
- *Brucella melitensis* is the most prevalent species causing **human brucellosis**, owing in part to difficulties in immunizing free-ranging goats and sheep.
- Most cases of human infection are caused by **ingesting** unpasteurized milk or cheese from infected goats or sheep.
- It is also considered an **occupational hazard** for people who work in the livestock sector (contact with blood, placenta, fetuses and uterine secretions). This method of transmission primarily affects farmers, butchers, hunters, veterinarians and laboratory personnel.
- Person-to-person transmission is rare.

Brucella spp. incidence, prevalence, transmission ^{3,4}

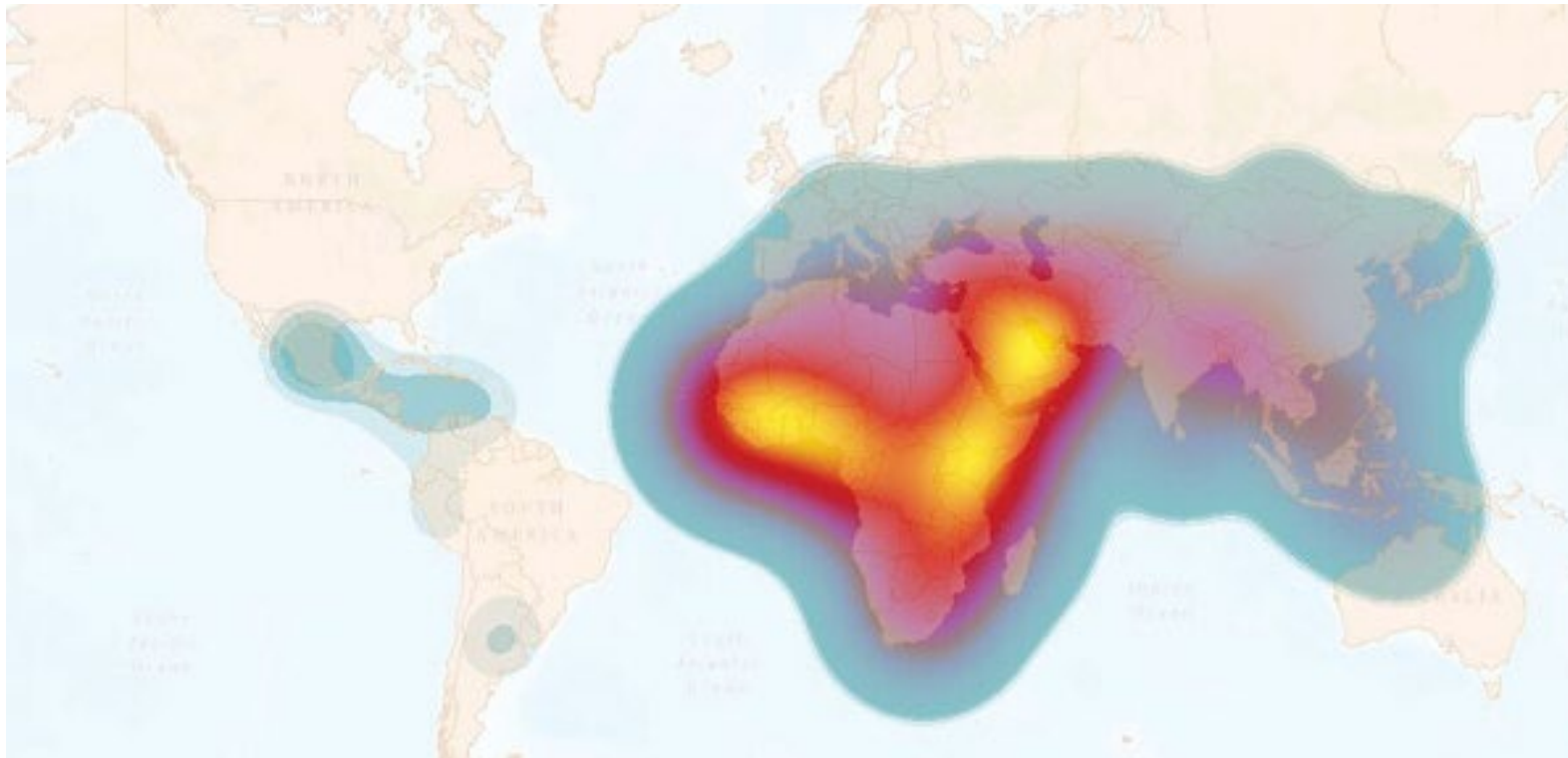


- Brucellosis is one of the **most widespread zoonoses**.
- The **highest incidence** is observed in the Middle East, the Mediterranean region, sub-Saharan Africa, China, India, Peru, and Mexico. Countries in central and southwest Asia are seeing the greatest increase in cases.
- Expansion of animal industries and urbanization, and the lack of hygienic measures in animal husbandry and in food handling, partly account for brucellosis remaining a public health hazard.
- **Prevention strategies in animals:** serological tests, milk tests, treating and/or vaccinating animals, culling.
- **Prevention of human infection:** pasteurization, policies on sale of unpasteurized products, other food-safety measures, occupational hygiene and laboratory safety.

Global context of *Brucella* spp. ⁵

TOTAL INCIDENCE = 2.1 Million cases per year

Heat map of global annual incidence of human brucellosis



The heat scale shows high risk to low risk; yellow ($\geq 4,000$ cases) to blue (≤ 1 case).

**The global average is
 ≈ 500 new cases per 1
million persons at risk *.**

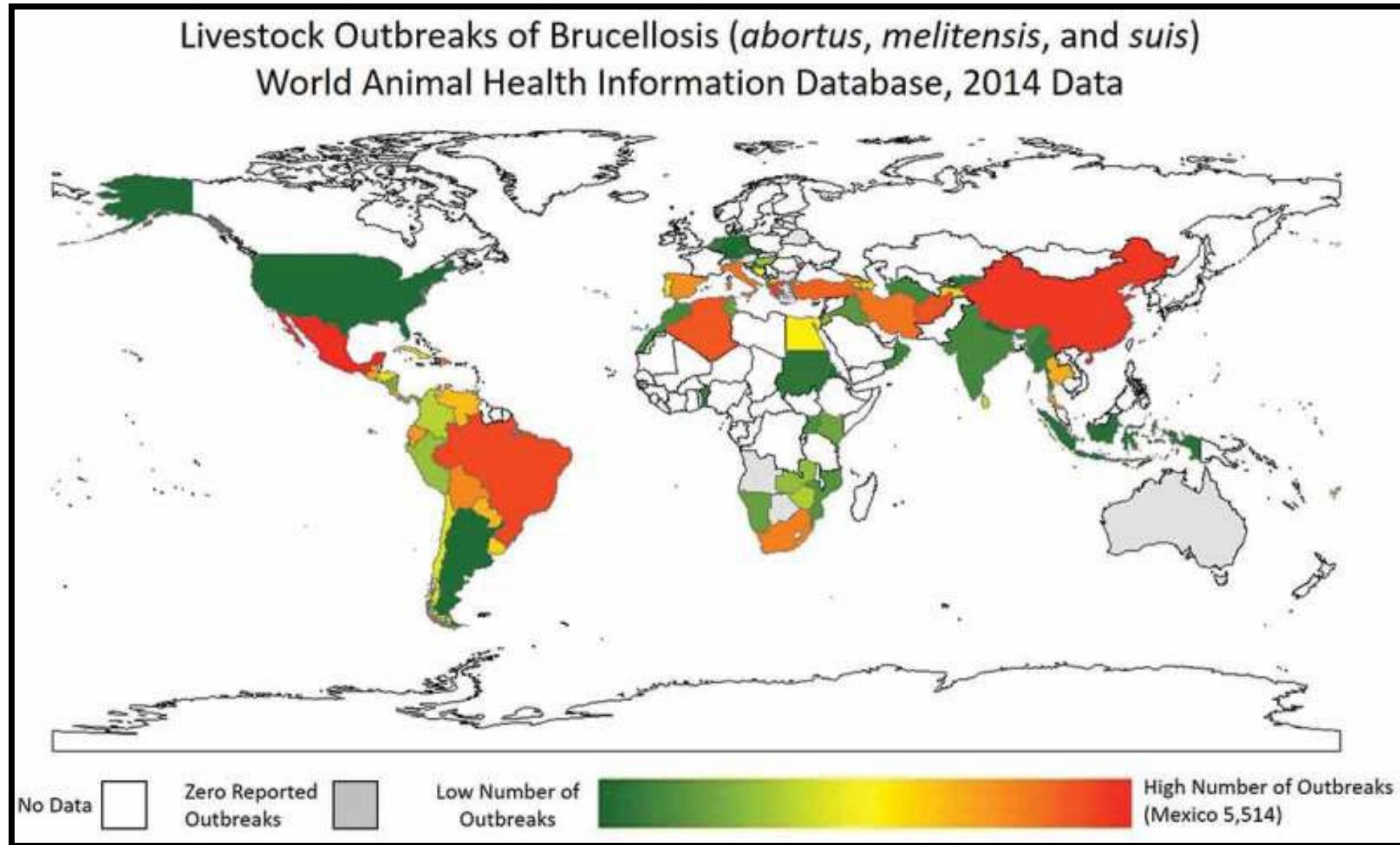
* At risk worldwide:

82.3% of countries
(144/175)

43.2% of persons (3.2
billion/7.4 billion)

Global context of *Brucella* spp. ⁶

Hull 2018



Human, animal and environmental relationships ⁶

Species	Natural host	Zoonotic Potential [8]
<i>B. melitensis</i>	Sheep, goats, and camels	Yes – High
<i>B. abortus</i>	Cattle, elk, and bison	Yes – High
<i>B. suis</i>	Pigs, hare, reindeer/caribou	Yes – High
<i>B. canis</i>	Dogs (domestic and wild)	Yes – Moderate
<i>B. ovis</i>	Sheep	No reported infections
<i>B. neotomae</i>	Desert wood rats	No reported infections
<i>B. ceti</i>	Cetaceans	Yes – Low
<i>B. pinnipedialis</i>	Pinnipeds	Yes – Low
<i>B. microti</i>	Red foxes and common voles	No reported infections
<i>B. inopinata</i>	Unknown	Yes – High

<i>B. papionis</i>	Non-Human Primates	No reported infections
<i>B. vulpis</i>	Red fox	No reported infections
<i>Brucella</i> NFXXXX	Australian rat	No reported infections
<i>B. unnamed</i>	Blue dotted ray	No reported infections
<i>B. inopinata-like</i> 09RB8471	African bullfrogs and Big-eyed tree frog	No reported infections
<i>Brucella</i> UK8/14	White's tree frog	No reported infections

Human, animal and environmental relationships

European Union Reference Laboratory for BRUCELLOSIS

<https://sitesv2.anses.fr/en/minisite/lrue-brucellose/brucellosis-neglected-disease>

BRUCELLOSIS IN WILDLIFE AND TERRESTRIAL MAMMALS

A wide range of hosts!



Brucella spp. at the Wildlife-Livestock Interface. Godfroid J. Vet Sci, 2018, 5, 81



Revisiting Brucellosis in the Greater Yellowstone Area. National Academies of Sciences, Engineering, and Medicine. 2017



Brucellosis Transmission between Wildlife and Livestock in the Greater Yellowstone Ecosystem: Inferences from DNA Genotyping. Journal of Wildlife Diseases, 2017, 53, 2: 339-343



Comparative Ecology of Bartonella and Brucella Infections in Wild Carnivores. Kosovo & Goodrich. Front Vet Sci. 2019;5:322



Brucella vulpis sp. nov., isolated from mandibular lymph nodes of red foxes (Vulpes vulpes) . Scholz et al, 2016



EQUINE BRUCELLOSIS: Review on Epidemiology, Pathogenesis, Clinical signs, Prevention & Control. Karthik et al, 2016



Brucella papionis sp. nov., isolated from baboons (Papio spp.). Whatmore A et al. Int J Syst Evol Microbiol. 2014;64, 4120–4128



Experimental Infection of White-tailed Deer with Rangiferine Brucellosis. Qureshi et al, 1999



Brucella microti sp. nov., isolated from the common vole Microtus arvalis. Scholtz HC et al. Int J Syst Evol Microbiol. 2008 Feb;58(Pt 2):375-82.



Brucellosis caused by the wood rat pathogen Brucella neotomae: two case reports. Villalobos-Vindas JM et al. J Med Case Rep. 2017;11(1):352

BRUCELLOSIS IN MARINE MAMMALS

Review, Open Resources



A review of Brucella infection in Marine Mammals. Nymo et al. Vet Res 2011, 42:93



Brucella ceti and brucellosis in cetaceans. Guzman-Venri et al. Front. Cell. Infect. Microbiol., 2012



Brucellosis in Marine Mammals (CFSPH Factsheet)

BRUCELLA INFECTION IN AMPHIBIANS

Atypical emerging Brucella species



The Change of a Medically Important Genus: Worldwide Occurrence of Genetically Diverse Novel Brucella Species in Exotic Frogs. Scholtz HC et al, PLoS ONE 11(12): e0168872



Brucella spp. of amphibians comprise genomically diverse motile strains competent for replication in macrophages and survival in mammalian hosts. Al Dahouk S. et al. Scientific reports, 2017, 7: 44420



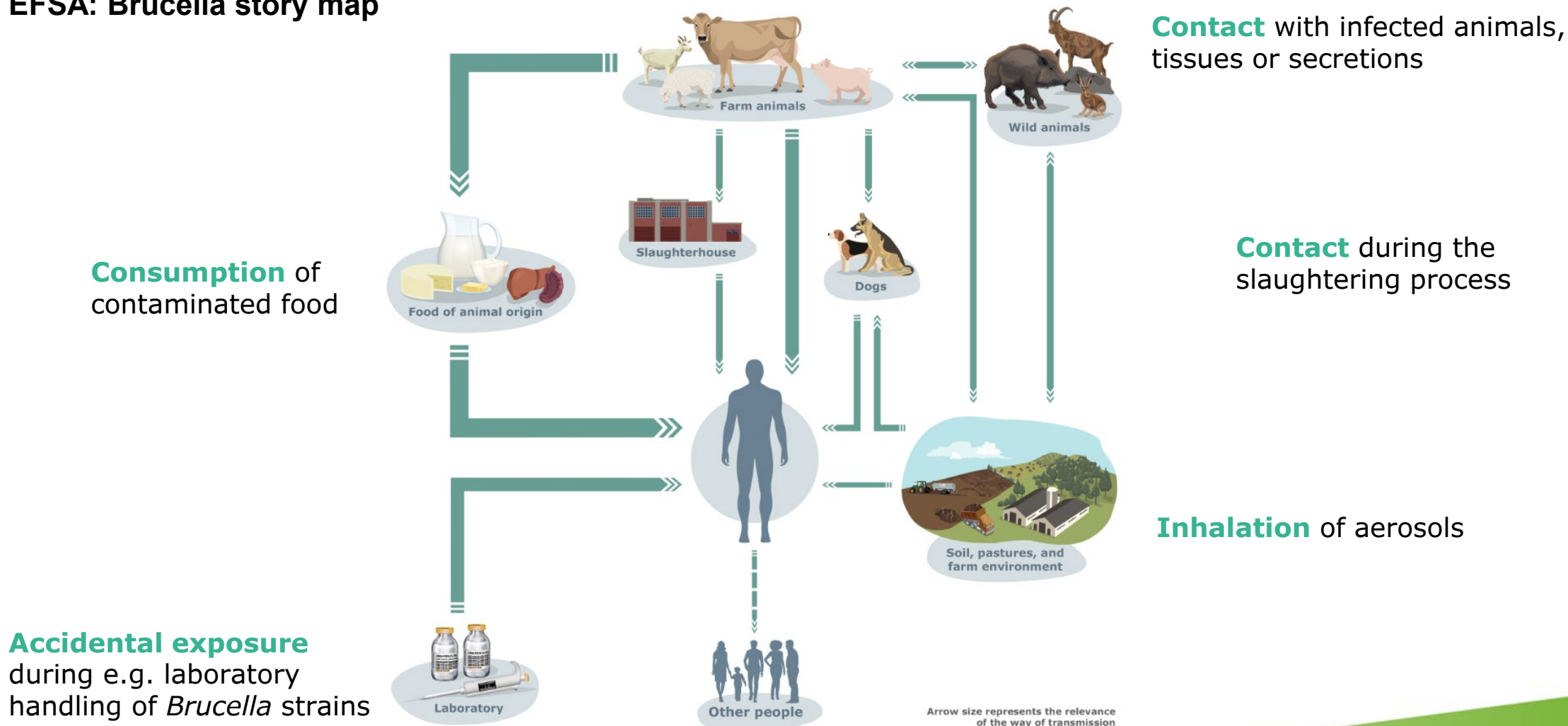
Phenotypic and Molecular Characterization of Brucella microti-Like Bacteria From a Domestic Marsh Frog (Pelophylax ridibundus). Jay et al. Front. Vet. Sci., 15 November 2018



Which One Health sectors are affected by *Brucella* spp.?

Human, animal and environmental relationships ⁷

EFSA: Brucella story map



Human, animal and environmental relationships ⁷



- *Brucella* can colonise the mammary glands and contaminate the milk.
- Food products and the environment can be contaminated by infected materials (tissues, secretions).
- Animals may harbour the bacteria for life and excrete it to the environment.

The survival of *Brucella* in the environment depends on the presence of moisture and the absence of direct sunlight. *Brucella* can survive:

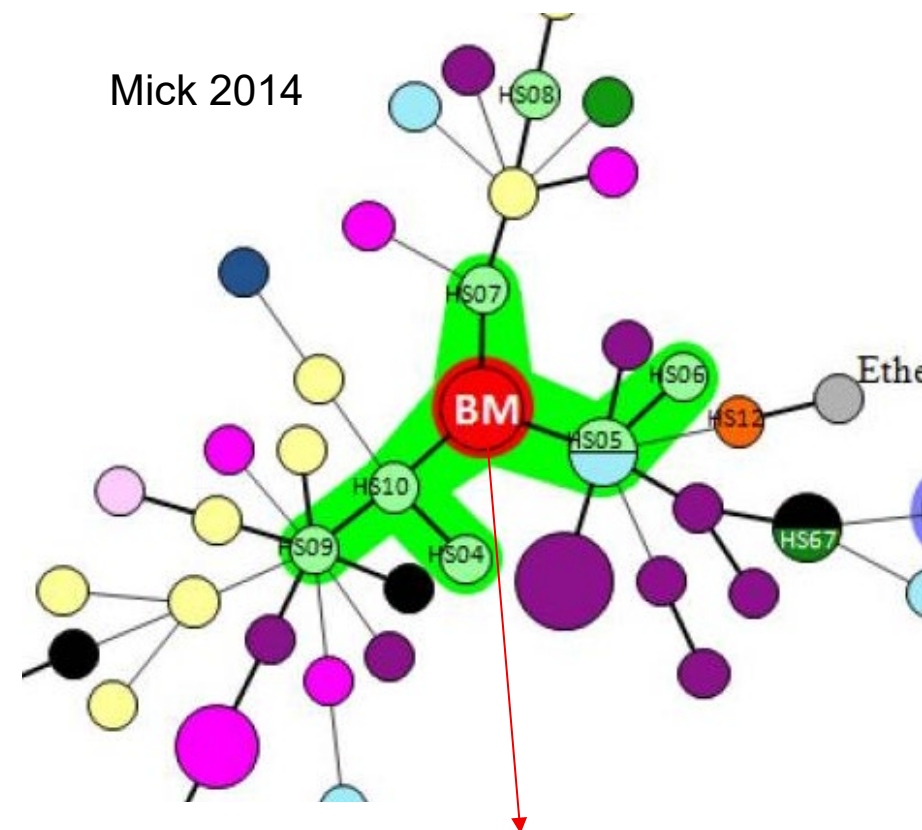
- **In soil and pastures** - for up to two months in humid conditions and low temperatures, and for more than eight months in liquid manure
- **In farm environments, in released infected materials**, such as aborted fetuses and foetal membranes, faeces and liquid manure, water, wool and hay, as well as on equipment and clothes

Human, animal and environmental relationships ⁸

The French case study (Mick 2014):

- France was officially free from bovine brucellosis since 2005 (no cases reported since 2003).
- In January 2012 there was a human case of brucellosis.
- In April 2012 an outbreak of *B. melitensis* was detected in a dairy herd (cows).
- Epidemiology showed that the isolates were related to wild goats.
- Seroprevalence was 45% in Alpine ibex and 3% in Chamois.

'Spillover' from wildlife to domestic animals can affect eradication efforts.



Herd outbreak + human

Green: Apex and Chamois

In summary

List of learning points in this session:

- Brucellosis is one of the **most common zoonoses**.
- Infection in humans and animals has **high societal cost**.
- *Brucella* are disseminated through the **world** and have **multiple natural hosts**.
- *Brucella* can exist in **domestic and wild animals**, as well as persist in the **environment**.
- Prevention and control of brucellosis requires a **One Health approach**.

References



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3. WHO. **Brucellosis**. 2025. <https://www.who.int/news-room/fact-sheets/detail/brucellosis>
4. WOA. **Brucellosis**. 2025. <https://www.woah.org/en/disease/brucellosis/>
5. Laine CG, et al. **Global Estimate of Human Brucellosis Incidence**. Emerg Infect Dis. 2023 Sep;29(9):1789–1797. doi: 10.3201/eid2909.230052
6. Hull NC, et al. **Comparisons of brucellosis between human and veterinary medicine**. Infect Ecol Epidemiol. 2018 Jul 24;8(1):1500846. doi: 10.1080/20008686.2018.1500846.
7. EFSA: **Brucella story map**. 2025. <https://storymaps.arcgis.com/stories/8f560383d90b47e8a6f2223384a09c5f>
8. Mick V, et al. **Brucella melitensis in France: persistence in wildlife and probable spillover from Alpine ibex to domestic animals**. PLoS One. 2014 Apr 14;9(4):e94168. doi: 10.1371/journal.pone.0094168.

Acknowledgements

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