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China Animal Health and Epidemiology Center

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GLOBAL FRAMEWORK FOR THE
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Systematic Review and Meta-analysis on PPR in Atypical and wildlife Hosts (2015-2025)

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Systematic Review and Meta-analysis on PPR in Atypical and Wildlife Hosts (2015-2025)

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- **Methodology** for systematic review
- **Results**
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 - Meta-analysis and review for atypical host and Knowledge Gaps 2015-2025 (H. Ishag)
 - Meta-analysis and review for Wildlife host and Knowledge Gaps 2015-2025 (V. Kumar)

Background: PPR in atypical host and wildlife

- Peste des petits ruminants PPR is **a highly contagious** viral disease of small ruminants that threatens the livelihoods and food security of millions of pastoral and mixed production communities across Africa Asia and the Middle East.
- **Caused** by Peste des petits ruminants virus PPRV a morbillivirus the disease has historically been associated with sheep and goats the primary maintenance and transmission hosts.
- In many regions PPRV has been **detected** in a range of **atypical hosts** such as camels cattle, buffalo, yak and suids as well as numerous **wildlife species** including antelopes gazelles, ibex and other ungulates.
- This **expanding** host range raises critical questions about the virus's ecology, transmission pathways and the potential role of **atypical and wildlife hosts** in the PPR epidemiology.

Objectives

- **Frequency** of seropositivity and PCR-positivity in atypical and wildlife host
- Indication of **spillover**.
- Whether atypical & Wildlife hosts **show**:
 - Clinical signs
 - Subclinical infection
- Summarize **pooled prevalence** estimates from the meta-analysis.

Methodology:

- A systematic review & Meta-analysis to estimate the prevalence & spill-over infection of PPRV in atypical(bovine, camel and suis) and wildlife species (published in 2015-2025)

Inclusion criteria:

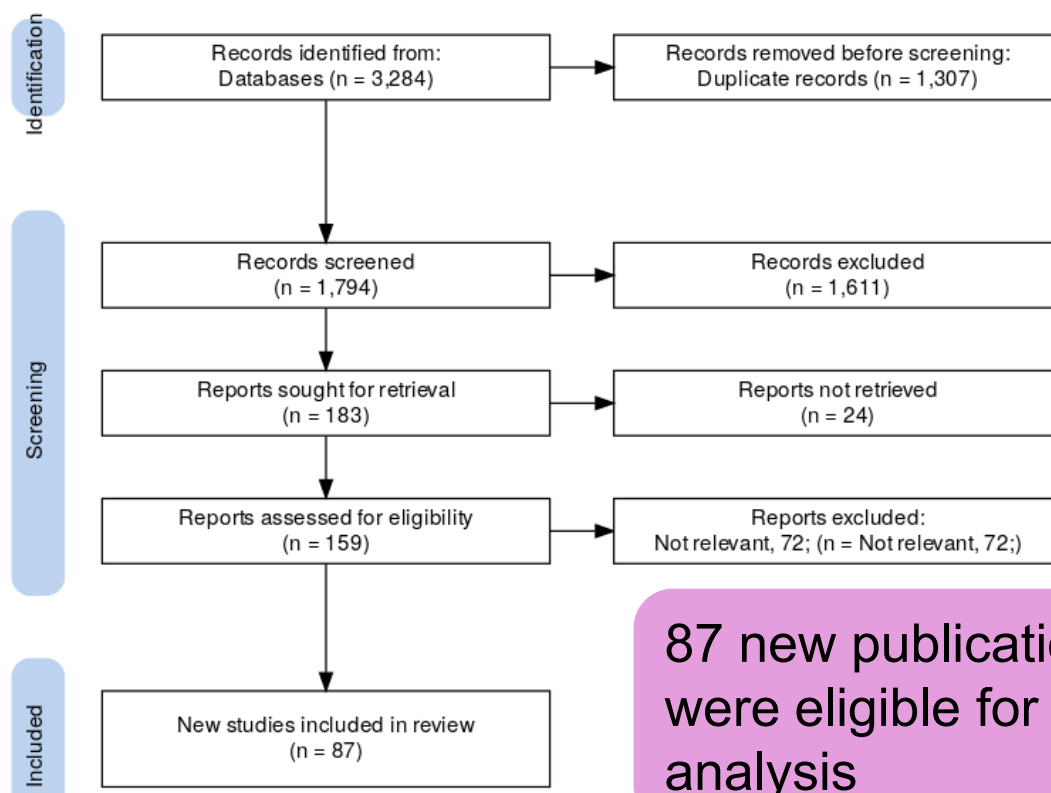
- Detection/prevalence of PPRV in cattle, buffalo, Camelids and relates species, Pigs and wildlife population)

Exclusion criteria:

- Only sheep or goats,
- lack of prevalence data,
- experimental trial,
- test evaluation,
- Reviews
- written in other languages or
- Duplicates
- published before 2015

- The prevalence was estimated by random effect meta-analysis model.

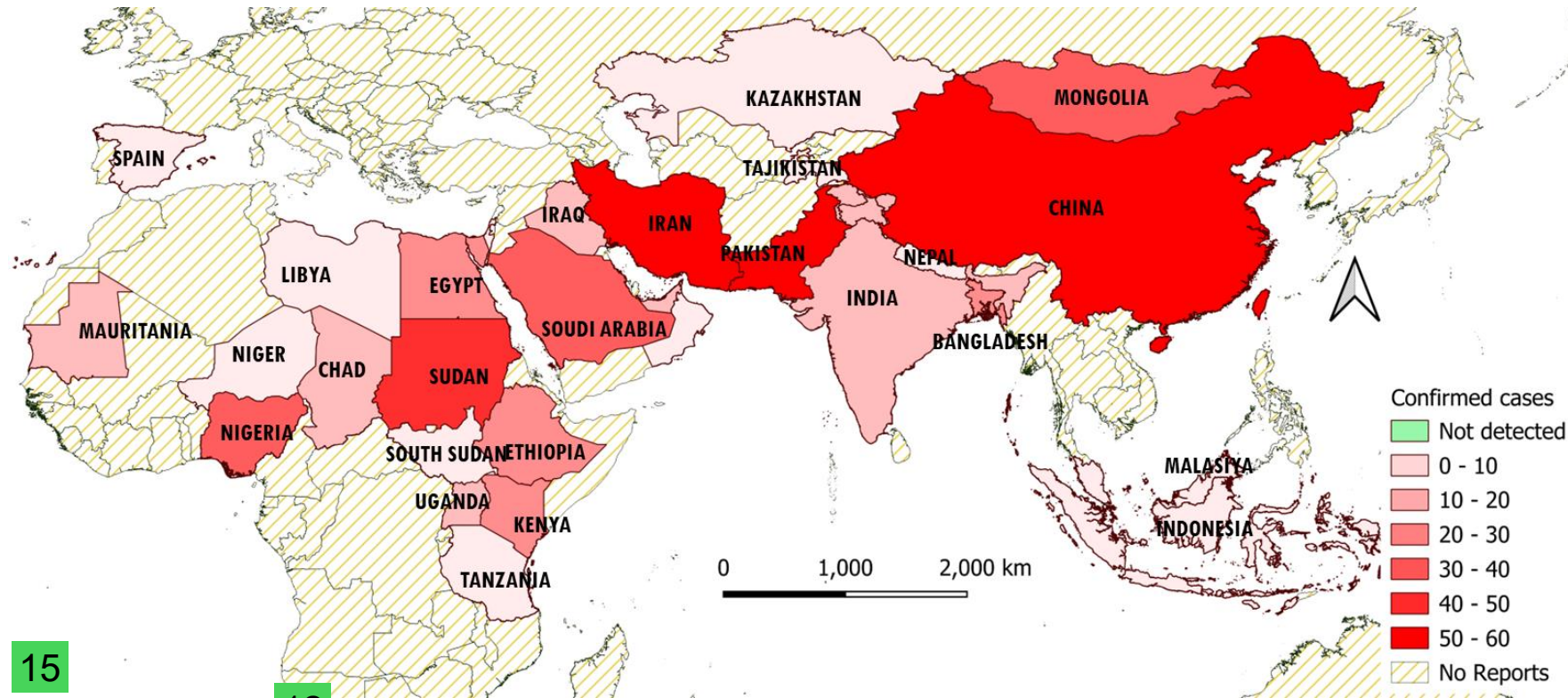
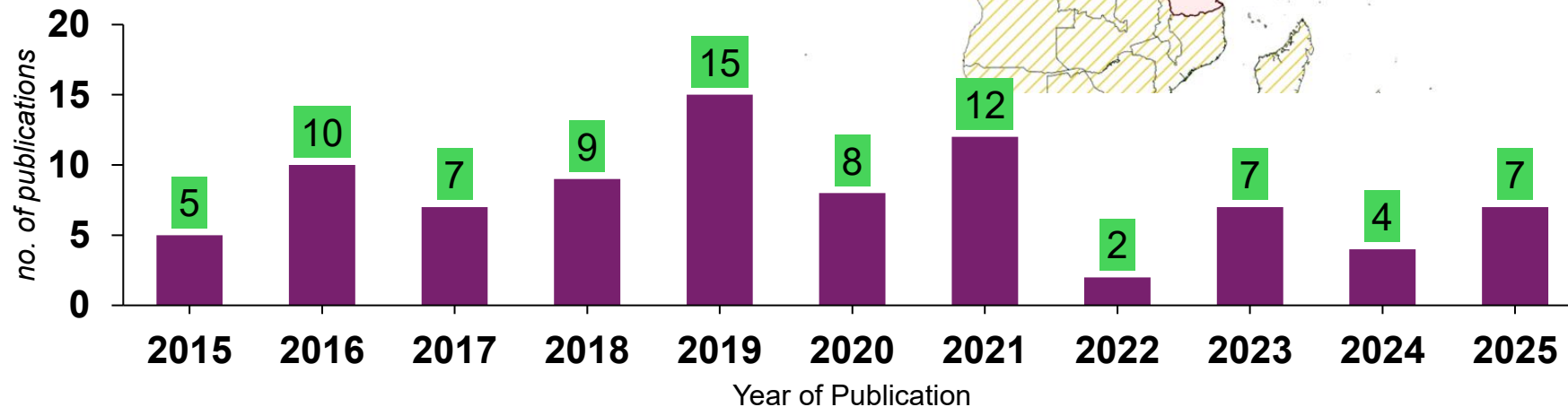
PRISMA checklist flow diagram



87 new publication- 67 were eligible for meta analysis

Wildlife and Atypical based articles

Study reports from 29 countries

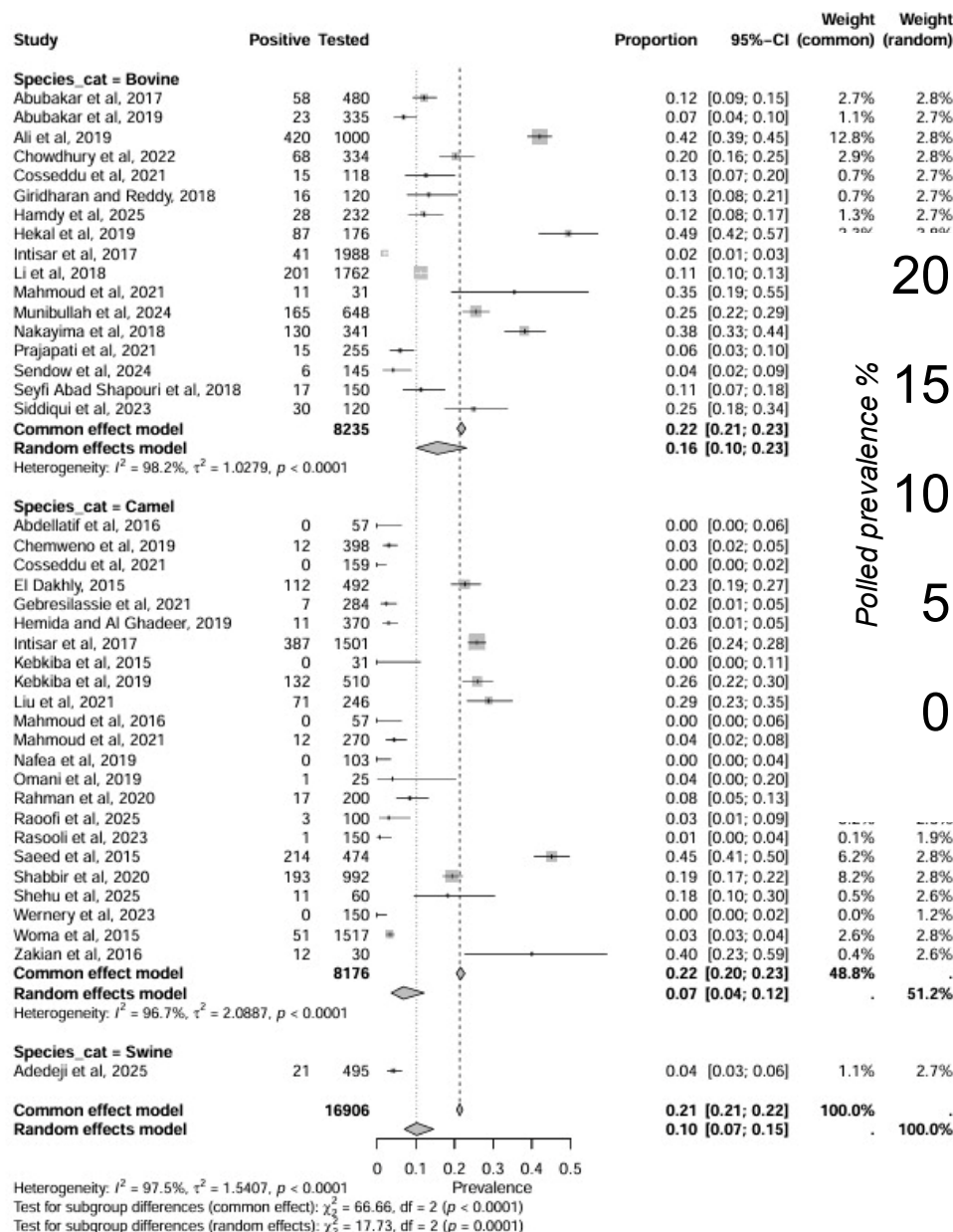


Meta analysis was performed using random effects models to **estimate pooled PPR seroprevalence** across atypical host species from studies published **between 2015 and 2025**.

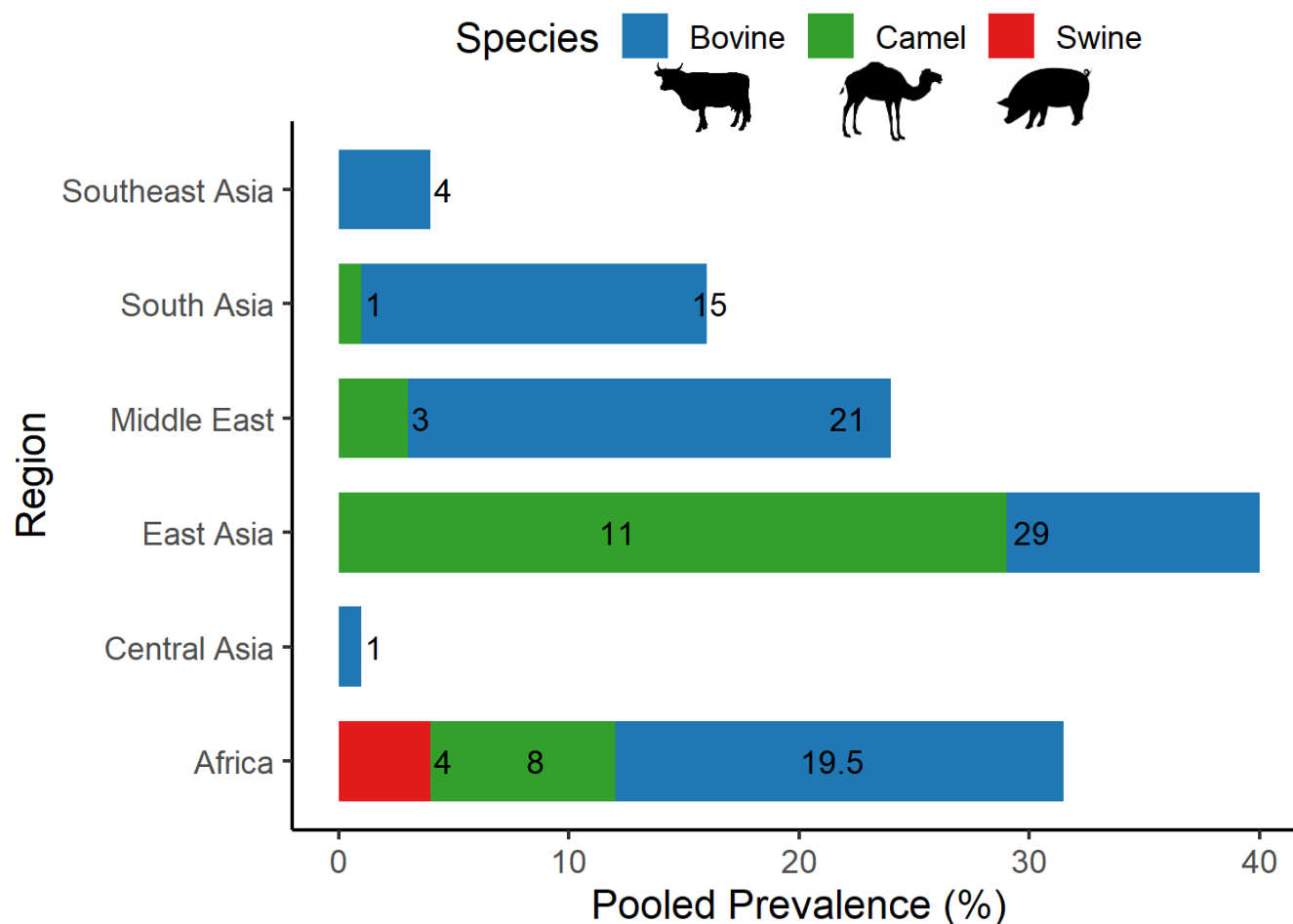
The **forest plot** presents pooled PPR seroprevalence estimates in **bovine, camel, and swine**

Shows antibody prevalence across atypical hosts with variation between species.

Supports their role as **sentinel animals for tracking PPR** circulation in small ruminants.

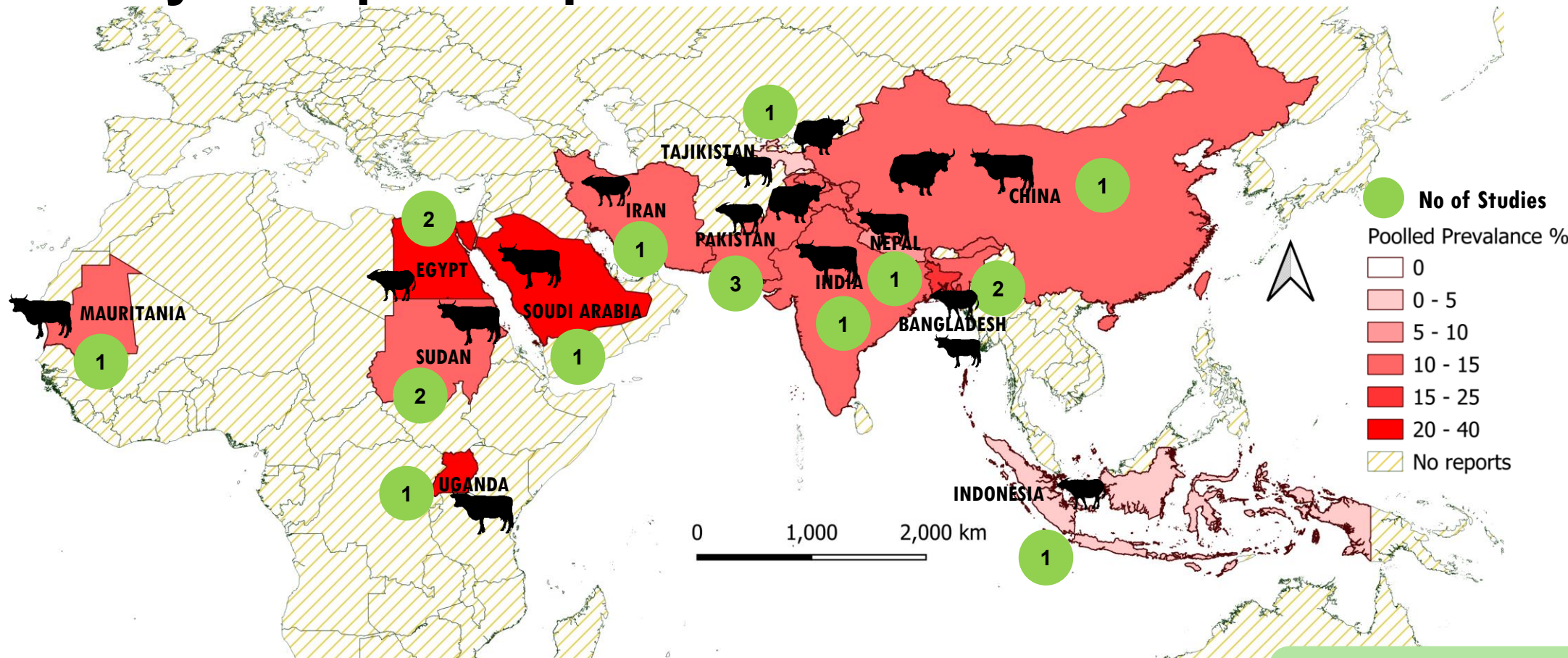


PPR Prevalence per Species per Region

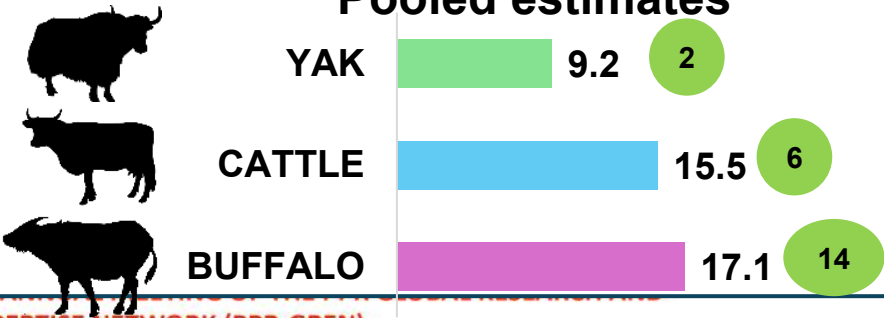


PPR prevalence is highest in camels in East Asia (29%) and in bovines in the Middle East (21%), Africa (19.5%), and South Asia (15%).

Country wise pooled prevalence estimate in bovine 2015-2025



Pooled estimates

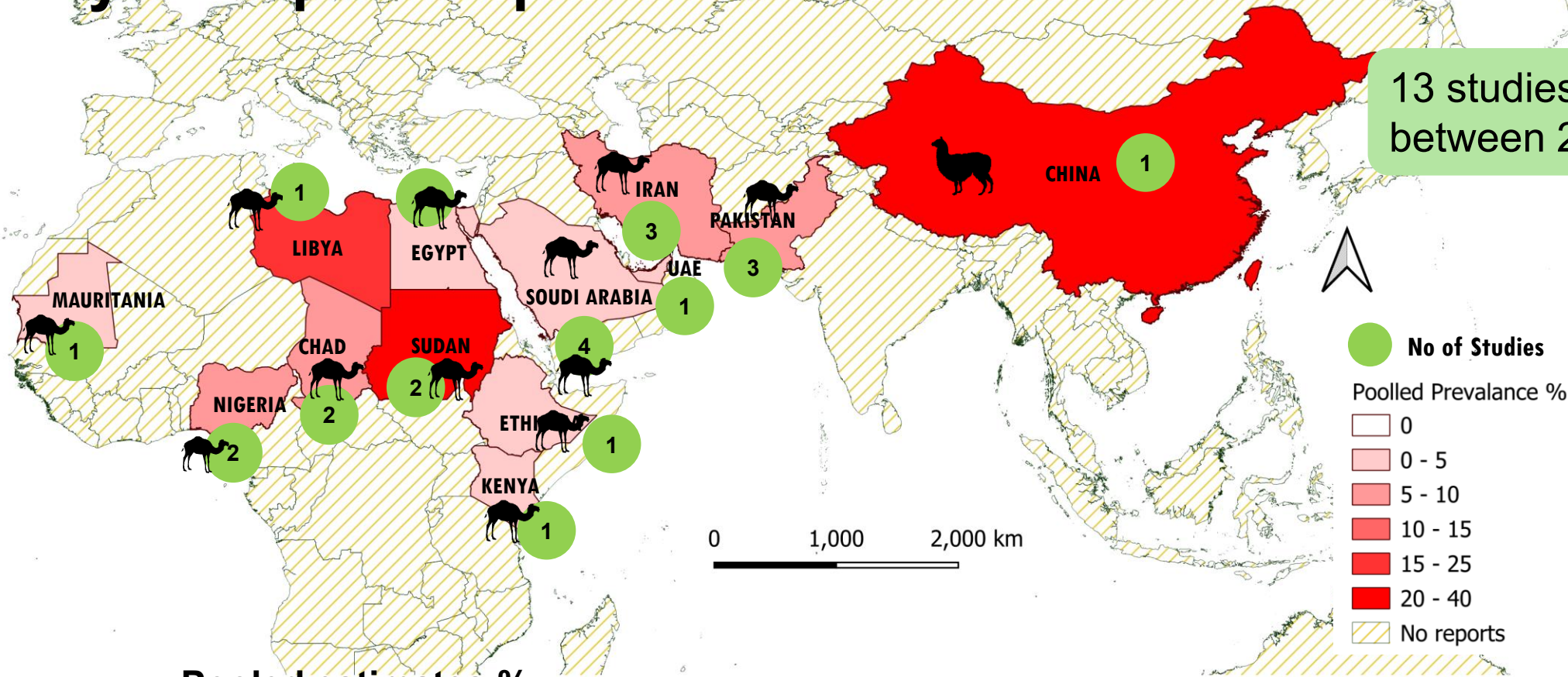


13 studies reported between 2015 to 2025

Map boundaries and geographic representations shown here are for illustrative purposes only and do not imply any official position or recognition regarding legal status, sovereignty, or territorial claims.

Country wise pooled prevalence estimate in camelid 2015-2025

13 studies reported
between 2015 to 2025



Pooled estimates %



**DROMEDARY
CAMEL**



ALPACAS



Bactrian camel



**9 sample were
tested in
Pakistan with
no positives**

Map boundaries and geographic representations shown here are for illustrative purposes only and do not imply any official position or recognition regarding legal status, sovereignty, or territorial claims.

Single study was reported in swine from Nigeria 2015-2025

Adedeji et al. *Veterinary Research* (2025) 56:49
<https://doi.org/10.1186/s13567-025-01482-3>

RESEARCH ARTICLE

Veterinary Research

Open Access



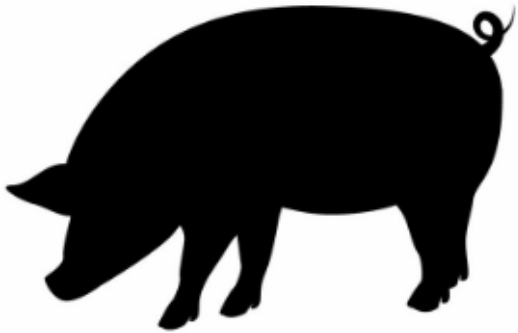
Can pigs add another “P” to the PPR? Serological evidence of frequent Peste des petits ruminants infections in pigs in Nigeria

Adeyinka Jeremy Adedeji^{1†}, Milovan Milovanovic^{2†}, Banenat Bajehson Dogonyaro¹, Jolly Amoche Adole¹, Mark Samson¹, David Oludare Omoniwa³, Toyin Olubade-Olatokunbo¹, Logyang Lot Emmanuel¹, Kenneth Oluwalanlajo¹, Kikelomo Kikelomo¹, Ekechukwu Ekechukwu¹, Akinola Olatunji¹, Akinola Olatunji¹

First field evidence of PPRV exposure in pigs in Nigeria

Sampling from healthy animals

Dec 2022 – Jan 2023

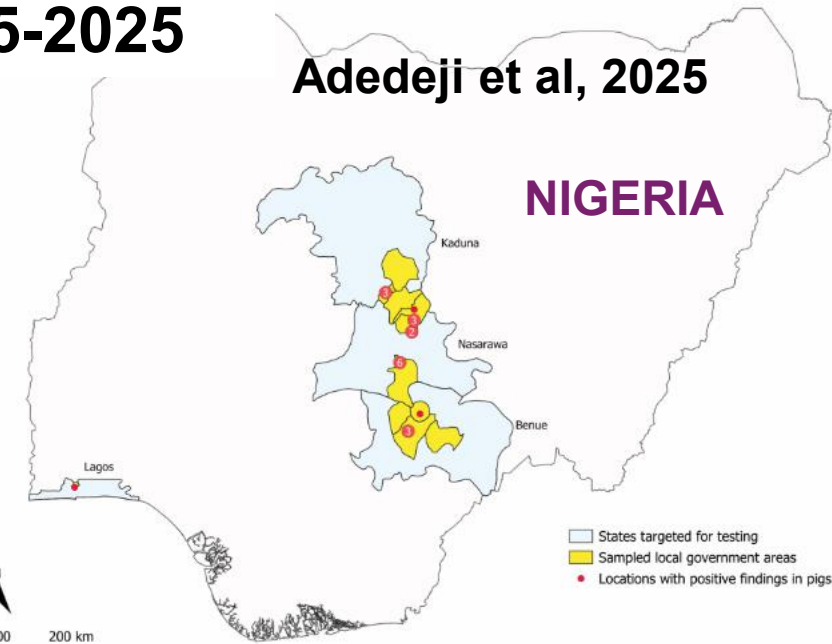


Sus scrofa domesticus

Serological (ELISA + VNT confirmed); RT-qPCR negative
ID Vet; cut-off 30 % (pigs), VNT titre > 10

21/495 (4.2%)
(95 % CI 2.6–6.5)

Adedeji et al, 2025



Mixed livestock households sharing
grazing and water points

Sheep and goat 25.68 %
(95 % CI 19.5–32.7)

Transmission & **spillover** evidence for PPRV in atypical interface



Camel

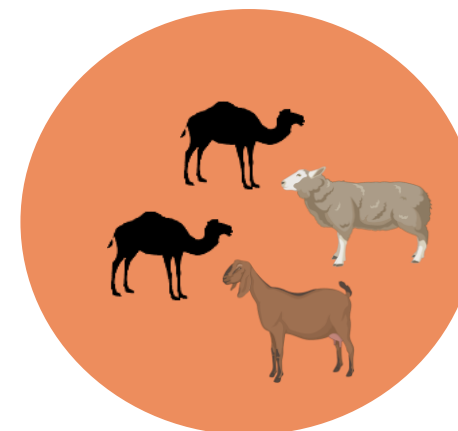
Zakian et al., 2016



Sheep & Goat

- Existence of disease in small ruminant of Krit camp, 2 weeks before the emergence of the disease in camel
- Homology to Iranian sub-strain.
- Lineage IV

Omani et al., 2019



Co-herding

Camels likely act as **spillover hosts**, not maintenance hosts (so far).

- Camel kept together with small ruminants (4 co-herds sampled)
- 60.29% identity between goat & camel PPRV identified
- Lineage III

The first report of peste des petits ruminants (PPR) in camels (*Camelus dromedarius*) in Iran

Amir Zakian¹ · Mohammad Nouri¹ · Houman Kahroba² · Babak Mohammadian³ ·
Mohammad-Reza Mokhber-Dezfouli⁴

Research Article

Peste Des Petits Ruminants (PPR) in Dromedary Camels and Small Ruminants in Mandera and Wajir Counties of Kenya

R. N. Omani¹,^{*} G. C. Gitao,¹ J. Gachohi,² P. K. Gathumbi,¹ B. A. Bwihangane,³
K. Abbey,⁴ and V. J. Chemweno¹

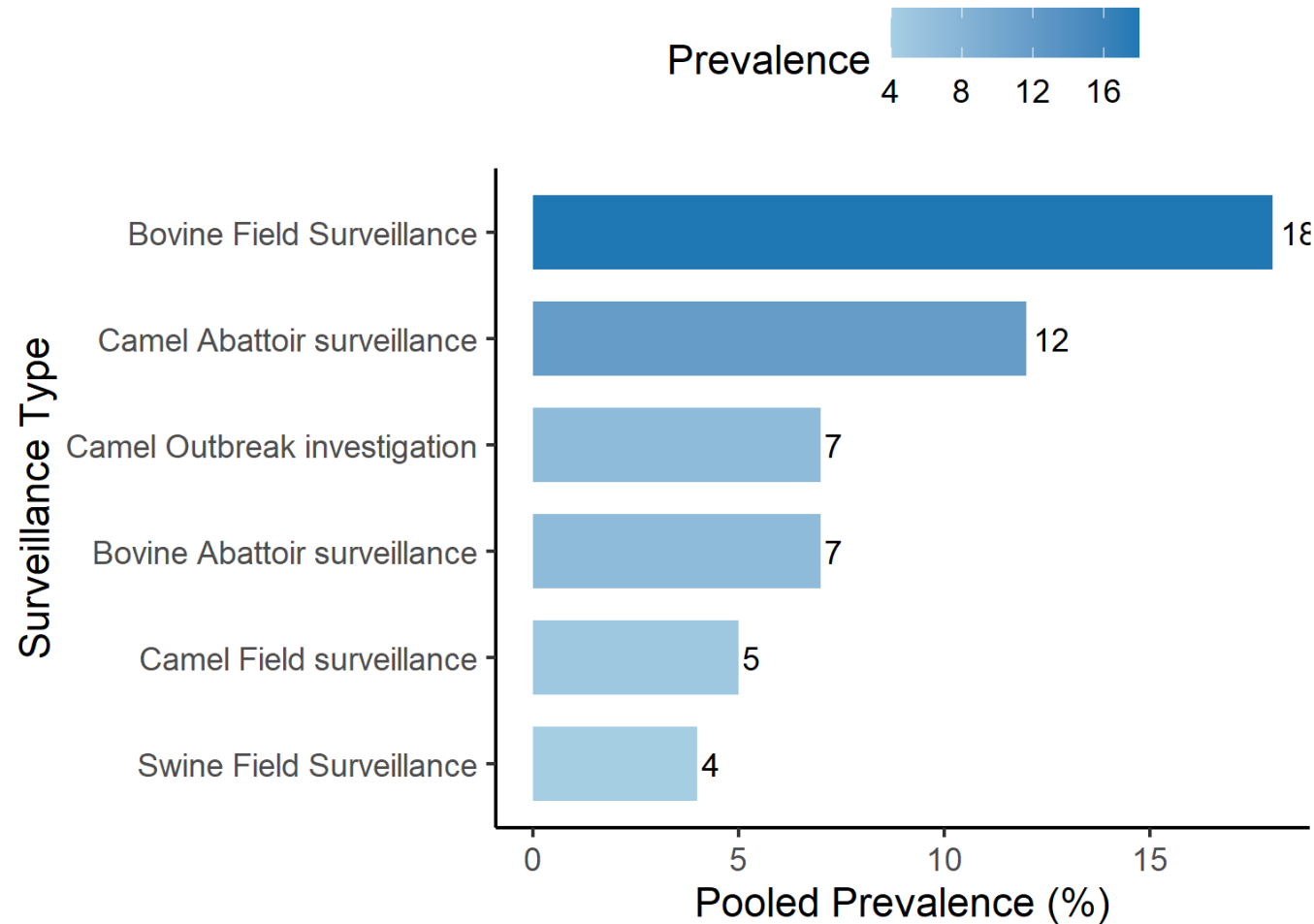
¹Department of Veterinary Pathology, Microbiology and Parasitology, University of Nairobi, P.O. Box 29053, Kangemi, Kenya
²Jomo Kenyatta University of Science and Technology, P.O. Box 62000-00200, Nairobi, Kenya
³International Livestock Research Institute P.O. Box 30709-00100, Nairobi, Kenya
⁴Kenya Camel Association, P.O. Box 6067-00100, Nairobi, Kenya

Feature	Clinical signs	Zakian et al 2016	Omani et al, 2019
Clinical signs	Sudden death	✓	✓
	Fever	✓	✓
	Oral erosion	✓	
	Ecthyma like lesions	✓	
	Yellowish diarrhea,	✓	
	Pneumonia and respiratory dis tress	✓	
	Enlargement of lymph node	✓	
	Severe dehydration	✓	
	Dermatitis	✓	
	Ulcerative keratitis	✓	
	Conjunctivitis	✓	✓
	Keratoconjunctivitis	✓	
	Oculonasal discharges		✓
	General weakness		✓
Confirmation		PCR & Sequencing	PCR & Sequencing
Lineage		IV	III



Sampling type

PPR Prevalence per Surveillance Type



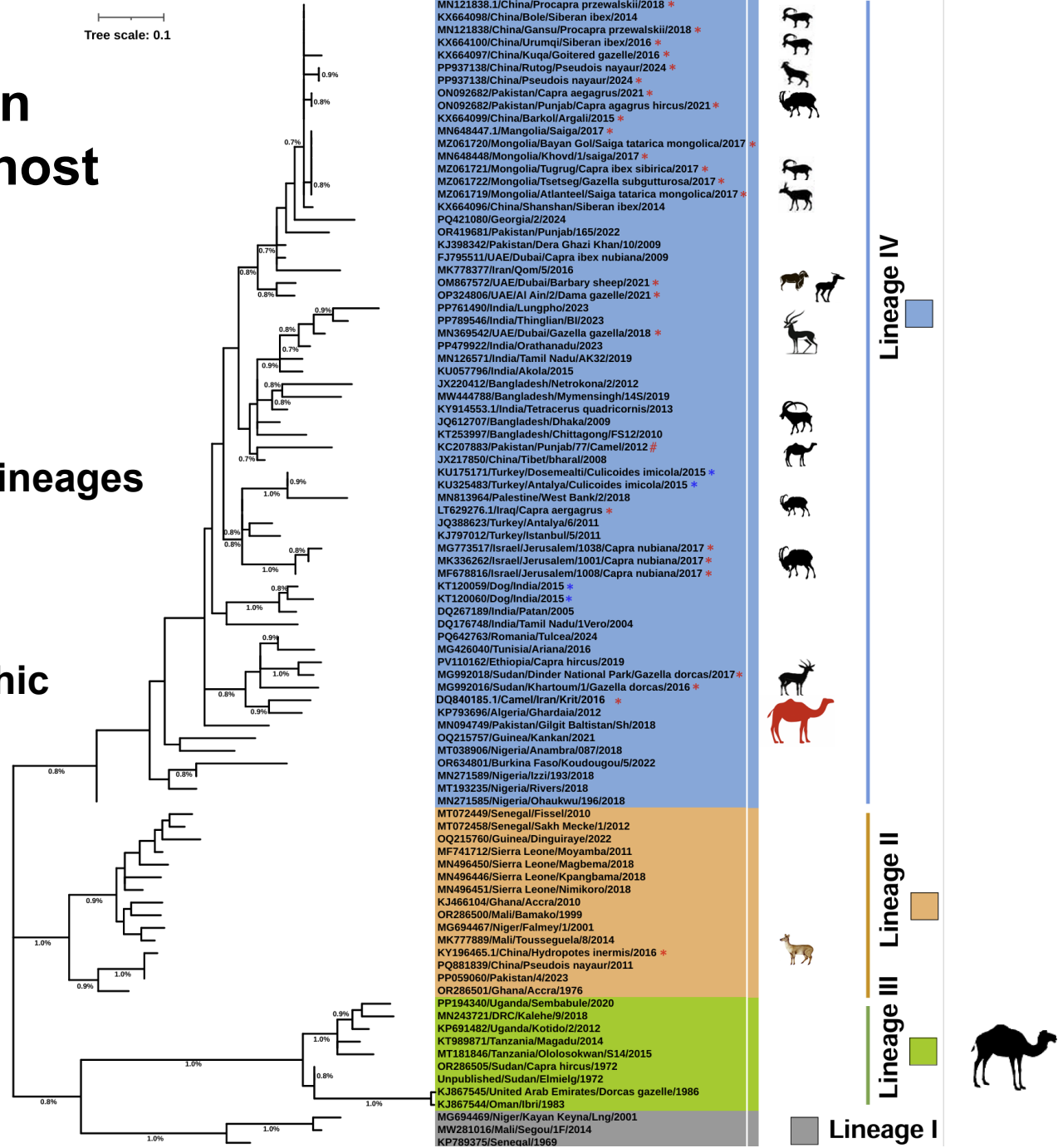
PPR prevalence is highest in Bovine Field Surveillance (18%), followed by Camel Abattoir Surveillance (12%).

Lineage distribution in Atypical and wildlife host (Year 2015 to 2025)

Between 2015 to 2025, the Lineages involved (II, III & IV mainly).

This reinforces the geographic stability of this virus

Phylogenetic Tree based on N gene alignment of sequences for the I-IV with focus on atypical & wildlife sequences. Three is cons Maximum Likelihood of 1000 bootstrap replicates. Sequences obtain <https://www.ppr-labs-oie-network.org/materials-and-protocols/pprv-si-datasets> and NCBI nt db.



Paper	Species	Lineage
Omani et al, 2019	Camel	III

Conclusion

PPR exposure in atypical hosts shows **consistent serological** evidence from 2015 to 2025, with **pooled prevalence** highest in bovines, followed by camels and swine.

Transmission patterns indicate that atypical hosts behave mainly as **spillover hosts** at the livestock interface rather than maintenance hosts.

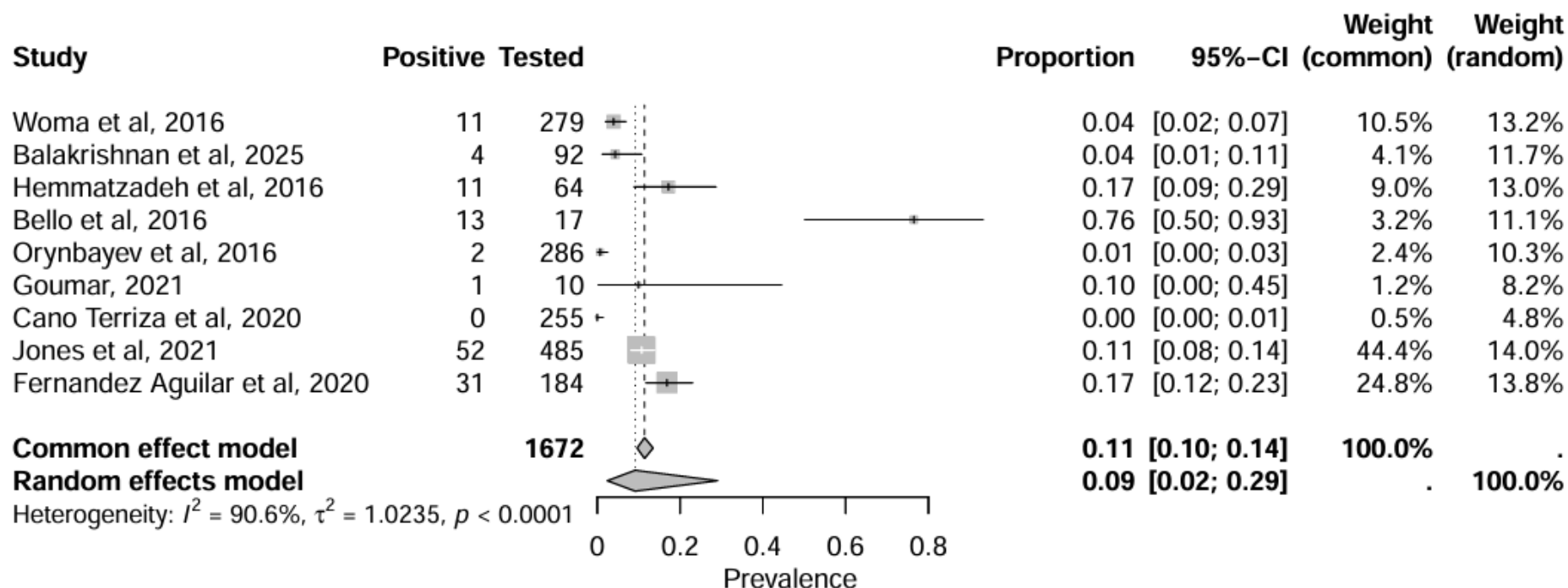
These findings highlight their value as **sentinel** species for detecting silent PPR circulation and emphasize the need for strengthened surveillance and molecular confirmation in non sheep and goat populations.



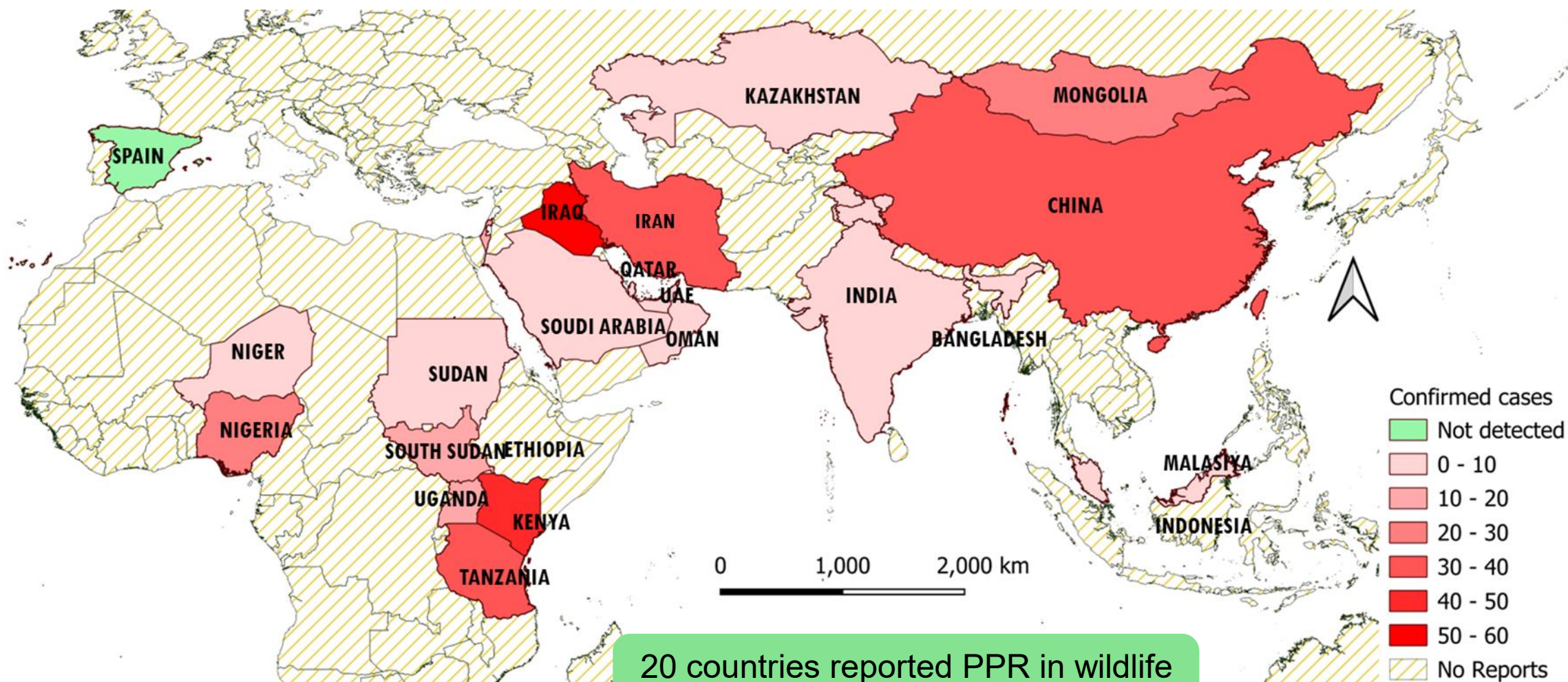
Meta-analysis and review for Wildlife host and Knowledge Gaps 2015-2025



Among the nine cross section study reported during 2015 to 2025
in wildlife the pooled estimate prevalence was 9%



Meta-analysis and review for wildlife host and Knowledge Gaps 2015-2025

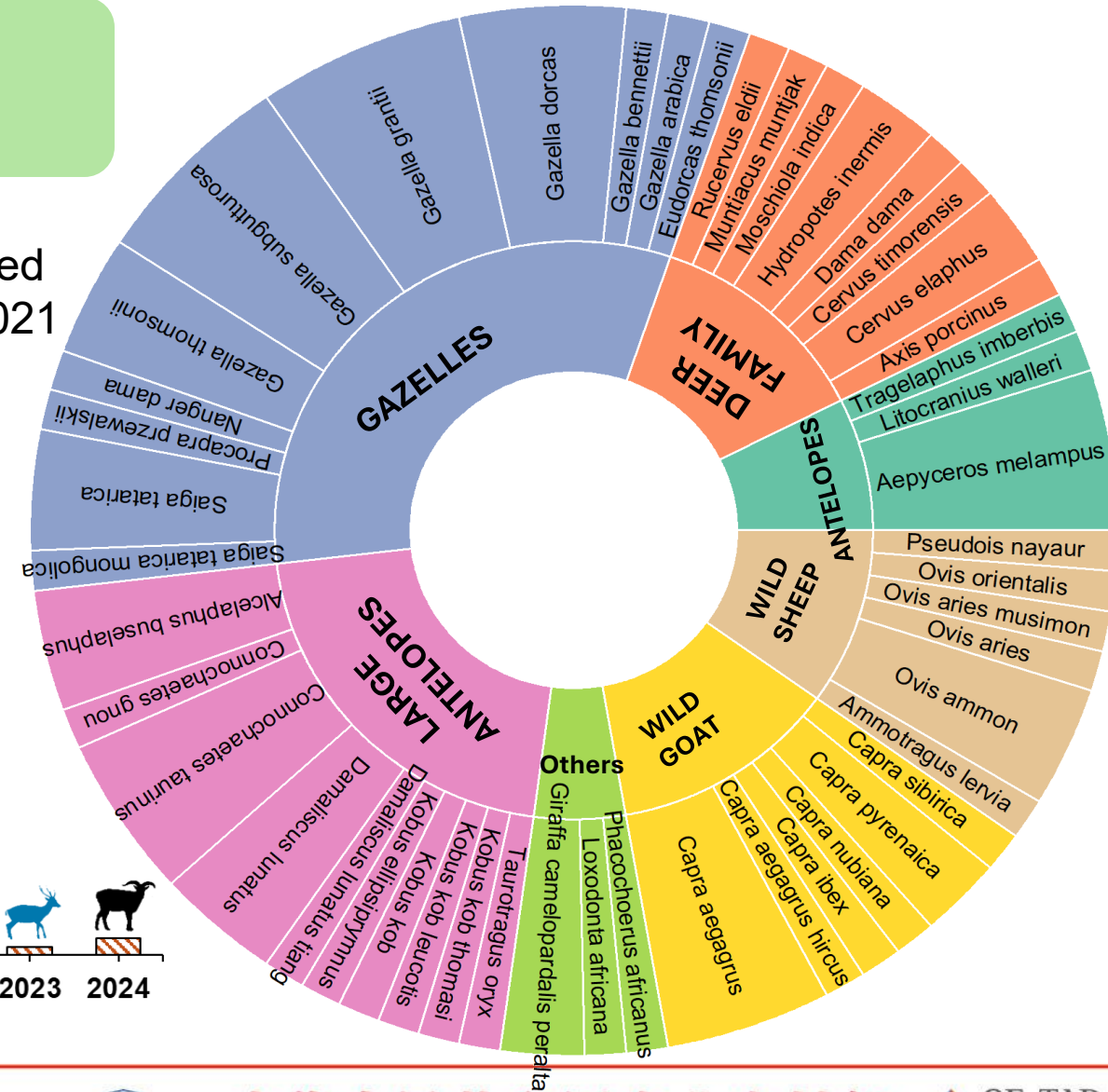
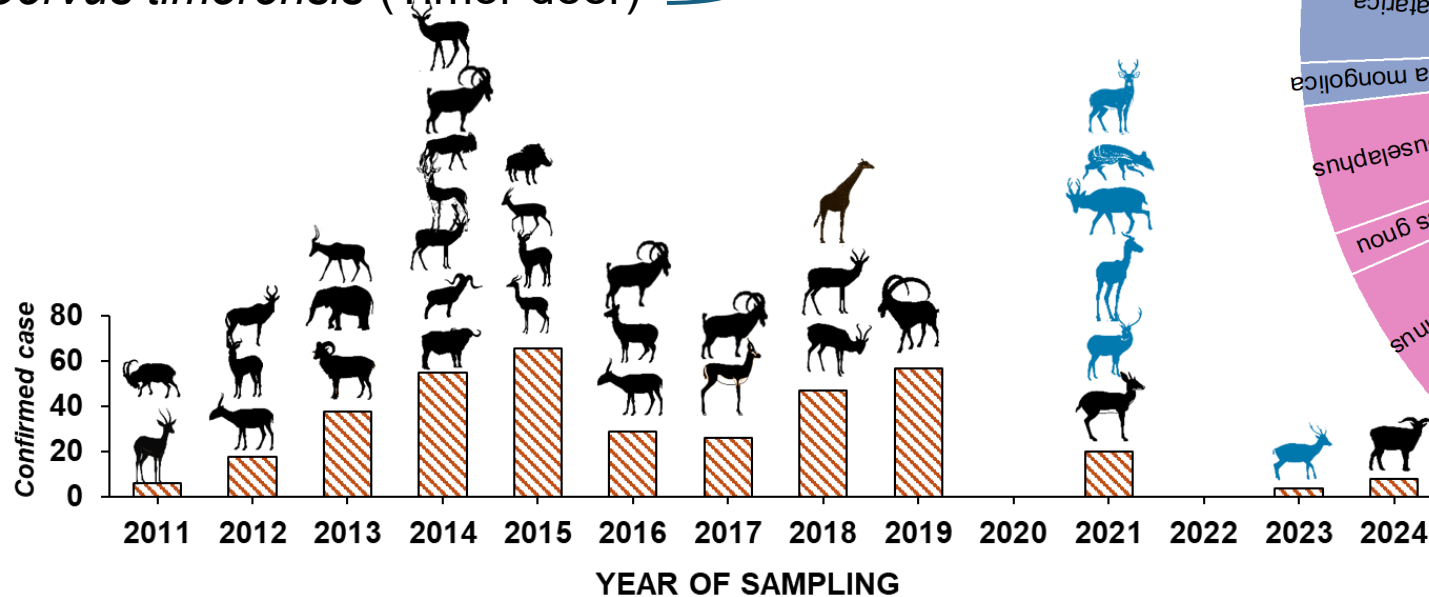


PPR in different wildlife species

47 different species/subspecies
reported for PPR in 2015 to 2025

Axis porcinus (Hog deer)
Moschiola indica (Mouse deer)
Muntiacus muntjak (Barking deer)
Nanger dama (Dama gazelle)
Rucervus eldii (Eld's deer)
Cervus timorensis (Timor deer)

New species reported
in last five years (2021
to 2025) for the first
time



Clinical Signs in wildlife

Clinical signs were poorly documented across the eligible studies, and many reports lacked complete or systematic descriptions. This highlights the need for proper clinical documentation and consistent reporting standards in future investigations.

Species	Fever	Nasal discharge	Oculonasal discharge	Ocular discharge	Cough	Dyspnoea	Diarrhea	Pneumonia	Oral erosions or ulceration	Oral congestion or necrosis	Mouth lesions	Conjunctivitis	Keratitis	Bronchoalveolitis	Respiratory distress	Emaciation	Dehydration	Lymph node enlargement	Abortion	Paralysis	Sudden death	Mortality only	Hemorrhagic enteritis	Dermatitis
<i>Nanger dama</i>																								
<i>Gazella dorcas</i>																								
<i>Saiga tatarica mongolica</i>																								
<i>Gazella subgutturosa</i>																								
<i>Capra sibirica</i>																								
<i>Ovis ammon</i>																								
<i>Capra aegagrus</i>																								
<i>Gazella arabica</i>																								
<i>Hydropotes inermis</i>																								
<i>Pseudois nayaur</i>																								
<i>Muntiacus muntjak</i>																								
<i>Tetracerus quadricornis</i>																								
<i>Axis porcinus</i>																								
<i>Rucervus eldii</i>																								
<i>Moschiola indica</i>																								
<i>Capra nubiana</i>																								
<i>Capra ibex sibirica</i>																								
<i>Procapra przewalskii</i>																								

5. Clinical, pathological & Some EpiData collection:

Clinical and pathologic findings (similar to domesticated goats):

- Mucopurulent nasal discharge
- Ulcerative keratitis along with conjunctivitis
- Mortalities in young
- Pinpoint greyish areas of necrosis in the buccal cavity
- Rumen is usually congested.
- Abomasum exhibits tiny haemorrhagic erosions with marked congestion Large intestine with Zebra striping due to congestion and hemorrhages.
- Consolidated lungs leading to pneumonia

a) ocular discharges,
b) erosion on the
buccal cavity, gums
(Hassan et al., 2023).



Mucopurulent nasal discharge (Hoffman et al., 2011)

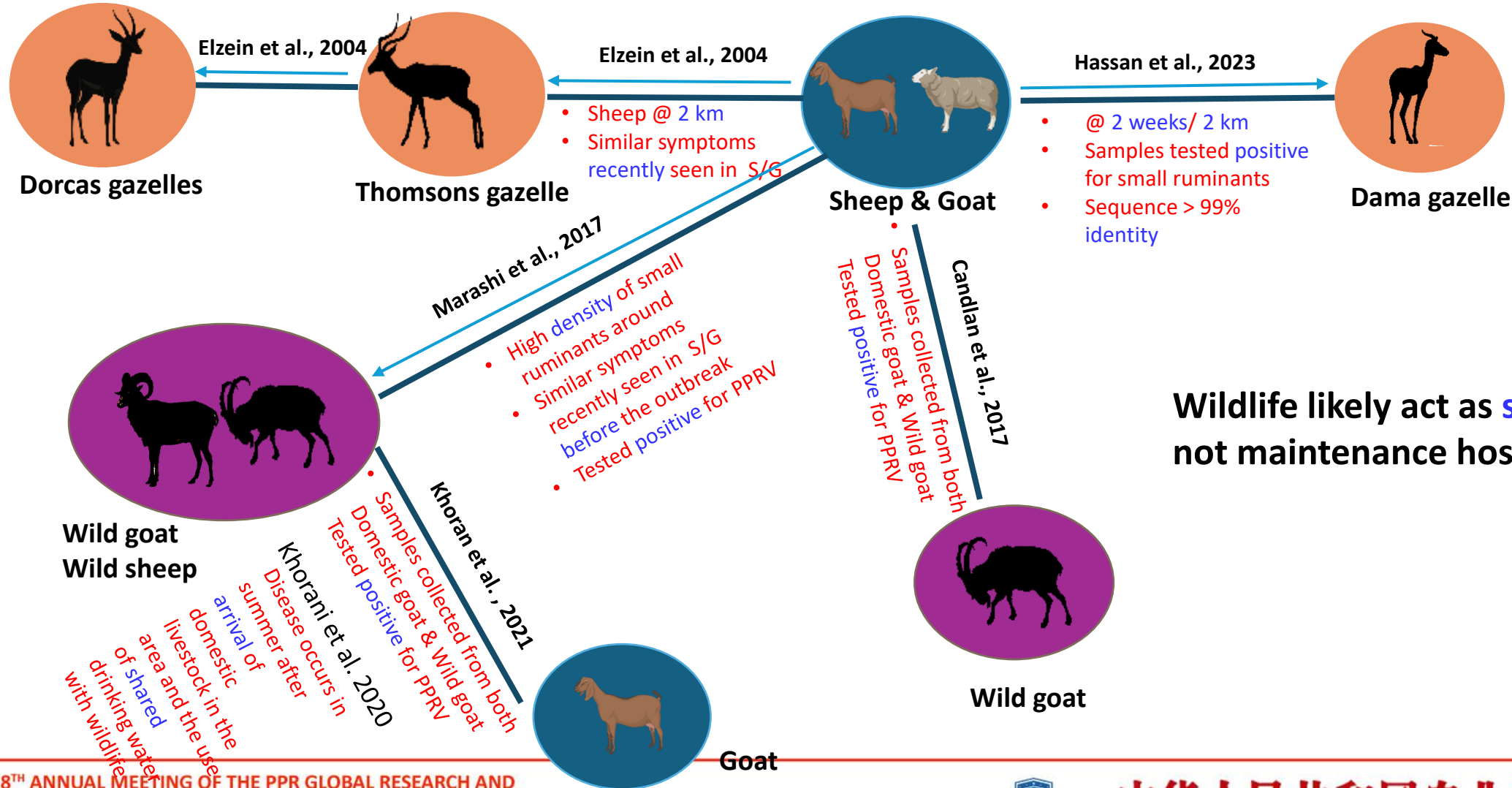


Ulcerative keratitis and conjunctivitis (Hoffman et al., 2011).

Postmortem lesions of PPR virus infection observed in domestic and captive wild goats. Panels A-F: A&B: Hemorrhages and congestion of the lungs and trachea contained foamy fluid; C: Hemorrhages and congestion on the abdominal mesenteric tissue; D: Hemorrhage and congestion of the brain; E: Zebra stripes in the mucous membranes of colon and rectum; F: Hemorrhage and congestion of liver



Transmission & spillover evidence for PPRV in wildlife-livestock interface



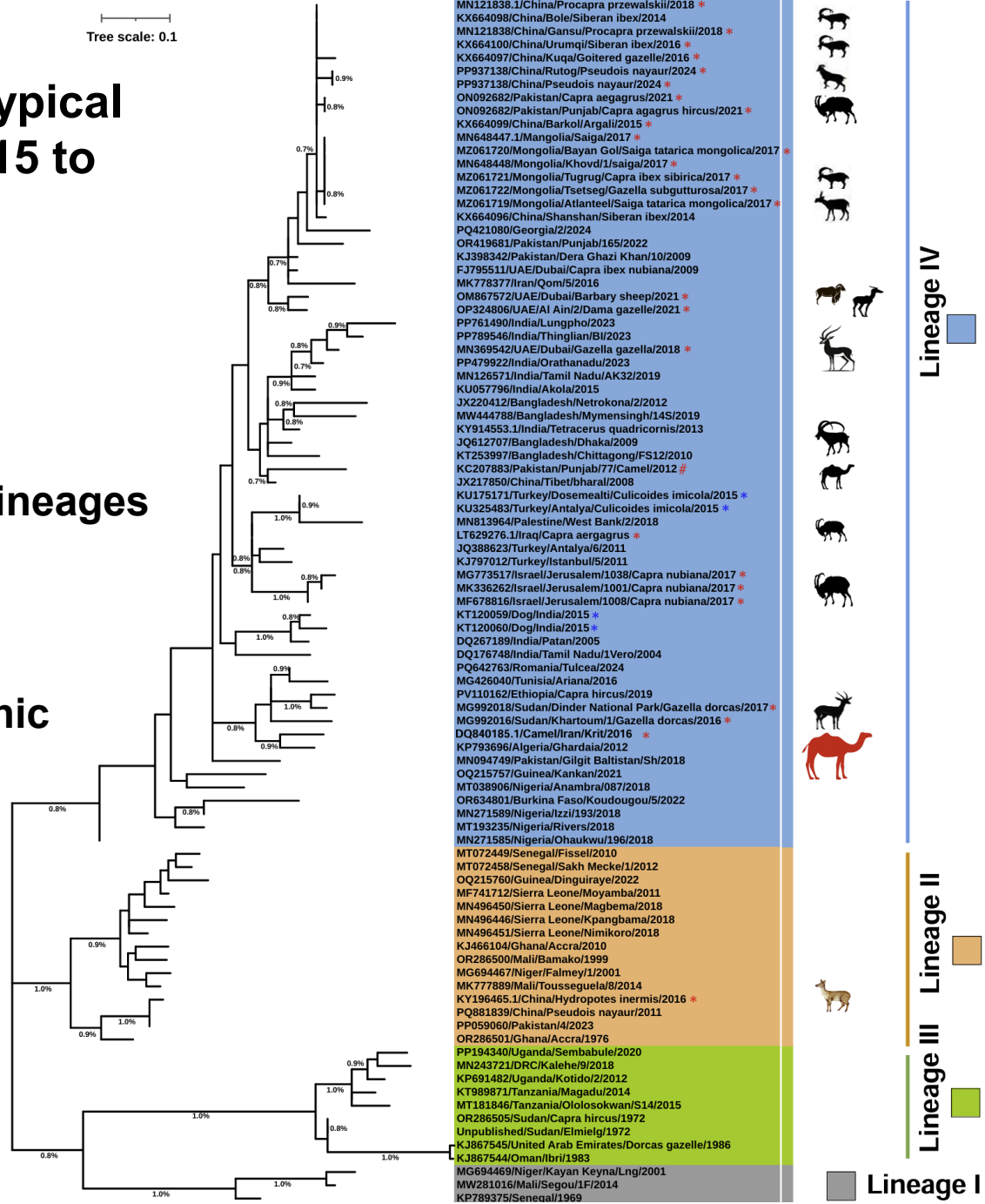
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Paper	Species	Lineage
Omani et al, 2019	Camel	III

Conclusion

PPR reports in wildlife have expanded to twenty countries and forty seven species during 2015 to 2025, including several newly identified hosts in recent years.

Evidence continues to show that wildlife mainly act as spillover hosts at the livestock interface rather than reservoirs, while the virus lineages involved remain geographically stable.

These findings highlight major gaps in clinical reporting, surveillance and molecular data, reinforcing the need for strengthened wildlife monitoring within the PPR global eradication framework.

Thanks

Acknowledgments:

- 1. Martin (Data collection)*
- 2. Bryony Johns (Shorting articles)*
- 3. Richard Kock*
- 4. Alexander*
- 5. Etc.....*
- 6. Arnaud (sequence information form the curated PPR sequences)*
- 7. Etc...*

- ✓ WOAH (sponsoring + PPR GREN Reports)
- ✓ CAHEC for hosting
- ✓ PPR WOAH Secretariat
- ✓ FAO
- ✓ PPR GREN
- ✓ ADASFA
- ✓ ICAR-NIVEDI
- ✓ ICMR-NIOH