Better Training for Safer Food Initiative

PPRV infection and disease in wildlife

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SHEEP AND GOAT PLAGUE (PPR)

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Outline

- Role of wild animals in PPR epidemiology
- Evidence of infection and disease in wild animals
  - Disease outbreaks
  - Serological evidence
  - Experimental infections
- Implications for PPR surveillance and control

1. African buffalo (*Syncerus caffer*)
2. Bharals (*Pseudois nayaur*)
**PPRV hosts**

*Domestic species*
- Sheep and goat
- Cattle, buffalo, yak, camel, pig

*Wild animals – Order Artiodactyla*
- Ruminants
  - Deer
  - Impala
  - Wildebeest, hartebeest, topi
  - Antelopes – gazelle, saiga
  - African buffalo, eland
  - Caprines; ibex, wild sheep & goats
  - Duiker
  - Oryx
  - Waterbuck, Kob
- Suids – pigs
Which species of wild animals are present in Bulgaria and Greece?

Ruminants?

Suids?
Why is wild animal PPRV infection important?

- Risk to endangered species
- Possible role in spread of PPRV
- Possible role in maintenance of PPRV
- Wild species as sentinels

Saiga antelope (Saiga tatarica)
What is the role of wild animals in PPR epidemiology?

**Dead end hosts:** virus spill-over from small ruminants to wild species followed by burn-out

**Bridge hosts:** virus spill-over from small ruminants to wild species, with subsequent spill-back into domestic animals, connecting otherwise unconnected domestic populations

**Maintenance hosts:** PPR virus transmission is maintained by one or more species, or a community of species, in the absence of domestic animal infection
Dead-end host?
- virus spill-over from small ruminants to wild species, followed by burn-out.
- If we eliminate PPRV from sheep and goats there will be no source of infection for wildlife.

PPR infection

Virus transmission
Sheep and goats

Wildlife

Sheep and goats

**Bridge host?** virus spill-over from small ruminants to wild species, spill-back into domestic animals. Infection burns out in wildlife without repeated spill-over. Elimination of PPRV from sheep and goats removes source of infection for wildlife.
Maintenance host? PPRV transmission is maintained by one or more wildlife species, or community of species, in the absence of domestic animal infection. If PPRV is eliminated from small ruminants, there is risk of re-infection from wildlife.
What evidence is there of infection and disease in wild animals?

- Clinical outbreaks in wild populations
- Clinical outbreaks in captive/managed animals
- Natural infection – sero-positive animals
- Experimental infection
PPR outbreaks in wild animal populations

Outbreak in wild population
Bharals (Himalayan blue sheep) in Tibet, China (Bao et al, 2011)

- 2007-08 clinical disease - bharals (*Pseudois nayaur*), Mongolian gazelle (*Procarpa gutturosa*), Tibetan antelope (*Pantholops hodgsoni*)
- Confirmed PPR antigen in bharals
- Sequenced virus – closely related to PPRV in sheep and goats in Tibet
- PPR outbreaks confirmed in sheep and goats in 2007 in same area
- 1.2 million bharals in Tibet, also in Himalayas of Nepal, India, Pakistan, Bhutan
Sindh ibex in Pakistan (Abubakar et al, 2011)

- 2009 high mortality outbreak in ibex (*Capra aegagrus blythi*) in a national park, Pakistan
- History of PPR in sheep and goats in the area - contact with sheep and goats through grazing and watering
- Approx. 15,000 ibex in the park, also deer and markhor goats

Fig. 1 Female ibex showing clinical signs: oculonasal discharges and emaciation

Fig. 2 Caseous material on gums and mouth lesions
Wild goat (bezoar ibex) in Kurdistan, Iraq (Hoffman et al., 2012)

- 2010-2011 high mortality in wild goats (*Capra aegagrus*), >2,700 deaths
- Confirmed PPR antigen, sequencing showed similar to a Turkish strain
- Sheep and goats PCR positive in the area, routine vaccination of small ruminants in region
- Wild goat – rare, ancestor of domestic goats, related to Sindh ibex

(a) Mucopurulent nasal discharge

(b) Ulcerative keratitis and conjunctivitis
Siberian ibex in Xinjiang, China (Zhu et al., 2016, Xia et al., 2016, Li et al, 2017)

- Deaths of ibex (*Capra ibex sibirica*); PPR-like signs (fever, ocular & nasal discharge, mouth lesions, pneumonia, diarrhoea), 2014-2015
- PCR positives; ibex, argali (*Ovis ammon*), goitered gazelle (*Gazella subgutturosa*)
- PPRV isolated, sequence closely related to 2013 virus from sheep & goats
- South Xinjiang - large grassland with ibex, argali, wild yak and deer, sharing pasture and water with livestock

Source: https://commons.wikimedia.org/wiki/File:Siberian_ibex_(Capra_sibirica)_04.jpg
Wild goats and wild sheep, Iran (Marashi et al 2017)

- PPRV confirmed in wild goats (Capra aegagrus) and wild sheep (Ovis orientalis)
- PPR-like signs, high mortality
- six national parks affected, 2014-2015
- PPR disease confirmed in sheep and goats around one of the parks prior to wild animal deaths.

Source: http://awwp.alwabra.com/?page_id=1362
Saiga antelope, Mongolia (Kock and Bolortuya, 2017)

- Outbreak in sheep and goats in confirmed Sept 2016
- Dec 2016 – Feb 2017 – PPR-like signs, 5-6,000 deaths of saiga (Saiga tartaric mongolica), 50-60% mortality
- Confirmed by PCR, sequencing showed closely related to sheep and goat virus
- Sibirian ibex, goitered gazelle also infected

Source: Richard Kock
PPR outbreaks in wild animal populations

Outbreak in wild population
Outbreak in captive/managed animals
Clinical PPR outbreaks in captive/managed animals

- **Dorcas gazelle, Laristan sheep, Nubian ibex, gemsbok – United Arab Emirates (Furley 1987)**
  - Likely source was nearby flock of goats with recent high mortality
  - Unaffected – Arabian oryx, scimitar-horned oryx, red deer, defassa waterbuck, nilgai, dama gazelle, bontebok, blackbuck.
- **Dorcas gazelle, Thomson’s gazelle - Saudi Arabia (Abu Elzein et al 2004)**
  - PPR in Saudi Arabia since 1990, PPR-like disease seen in sheep and goats in the area
  - Unaffected – blesbok, gemsbok, fallow deer, zebra
- **Impala, springbok, Arabian mountain gazelle, Rheem gazelle, bushbuck, Nubian ibex, Markhor goat, Barbary sheep – 2 outbreaks in UAE (Kinne 2010)**
  - Source unknown
- **Arabian mountain gazelle – Saudi Arabia (Sharawi 2010)**
  - One flock affected, neighbouring sheep and goats flocks with PPR-like disease
- **Chowsingha – India (Jaisree et al., 2017)**
  - Chowsingha antelope (Tetracerus quadricornis) in a zoological park, 20/25 animals died with acute respiratory signs
  - No direct contact with domestic animals
- **Chinese water deer – China (Zhou et al., 2017)**
  - Chinese water deer (Hydropotes inermis) on farm in Anhui Province, east China
  - Sequence showed close relationship to sheep and goat virus
Food safety

Outbreak in wild population
Outbreak in captive/managed animals
Antigen in healthy animals
Positive serology

PPR outbreaks, antigen detection, serology in wild animal populations
PPR serology in Turkey

- 10/82 sera (12%) sero-positive from goitered gazelle (Gur and Albayrak, 2010)
- No clinical disease
- Endangered native species, approx. 850 animals kept on a state farm, south-east Anatolia
- PPR previously confirmed in sheep and goats in this region
PPR serology in West and Central Africa

- 2/247 (0.8%) seropositive from parks in Cote d’Ivoire (Couacy-Hymann et al., 2005)
  - Positives - buffalo, waterbuck
  - Negatives - kob, hartebeest, roan antelope, bushbuck, red-flanked duikers, blue duikers, warthogs
- Sero-positives in Burkina Faso, Chad and CAR - hartebeest, kob and buffalo (PACE Veterinary Wildlife Project, Chardonnet and Kock 2001)
- Benin 3/16 (19%) buffaloes seropositive (PACE project, 2003)
- African grey duiker 4/38 (10.5%) sero-positive, Nigeria (Ogunsanmi et al 2003)
PPR serology in East and Central Africa 1990-early 2000s

- 1994-2003 rinderpest (RP) surveillance in East Africa (Kock et al 2006)
  - 10/675 seropositive (1.5%) – buffalo, eland, topi and warthog from southwest Ethiopia
- 1996-2004 RP surveillance, East and Central Africa (Kock 2008) - 998 sera collected
  - 30/576 (5%) buffalo and 1/33 eland (3%) seropositive – in Kenya, Ethiopia-Sudan, DRC-Chad-CAR
  - All other species sampled were negative: Grant’s gazelle, giraffe, hartebeest, impala, kob, kudu, nyala, oryx, roan antelope, topi, warthog, waterbuck, wildebeest, bushbuck, gerenuk, sable antelope
- Uganda and Tanzania all negative
PPR serology in East and Central Africa - recent

- **Uganda** - *PPR reported in sheep and goats 2003, official report to OIE 2007*
  - 15/51 buffalo (29%) sero-positive - 2005 (Kock 2008)
  - 12/67 buffalo (17.9%), 5/39 kob (12.8%) sero-positive – 2015*
  - 5/30 buffalo (16.7%) sero-positive – 2017*
- **Kenya** - *Major outbreak in sheep and goats 2006-2008*
  - 15/115 (13.0%) sero-positive; buffalo, impala, Thomson’s gazelle, Grant’s gazelle, wildebeest, gerenuk, warthog, 2016*
- **Tanzania** – *2008 outbreak in sheep and goats in north, spread to south by 2010*
  - Buffalo, Thomson’s gazelle, Grant’s gazelle samples collected 2010-2012 in northern protected areas, all negative (Lembo et al. 2013)
  - 29/46 (63%) sero-positive – 2014; buffalo, Grant’s gazelle, wildebeest, impala*
  - 11/18 (61%) sero-positive – 2015; buffalo, Grant’s gazelle, topi, hartebeest*

*unpublished data from EU ANIHWA ERANET Improved Understanding of PPR (IUEPPR) Project*
Experimental infection

- American white-tailed deer; developed clinical disease, transmitted to other deer (Hamdy and Dardiri, 1976)
- Wild boar; developed mild-moderate clinical signs (fever, diarrhoea, nasal discharge, conjunctivitis, leucopenia) and infected in-contact goats*

*unpublished data from EU ANIHWA ERANET Improved Understanding of PPR (IUEPPR) Project
In summary

▪ “wild” outbreaks – only in Asia (so far), mainly in wild caprines

▪ no clinical PPR disease seen in Africa (so far)

▪ African species are susceptible to disease in captivity or managed conditions in Middle East

▪ All outbreaks were per-acute or acute, typical PPR clinical signs, high mortality – but has milder disease gone unnoticed?

▪ All outbreaks were associated with confirmed or suspected disease in domestic sheep and goats
Discussion

- What are the implications of these findings for PPR surveillance and control in Europe?
- Possible susceptible wild species?
- Role of wild animals:
  - sentinel of domestic animal infection ✓
  - bridge host ?
  - maintenance host ?

Beisa oryx in Ethiopia photo: B Jones
References


References


