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REGULAR ARTICLES

Peste des petits ruminants in wild ungulates

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Abstract

Peste des petits ruminants (PPR) is a contagious viral disease of domestic small ruminants. It also affects wild ungulates but there are comparatively few studies of the incidence of natural infection, clinical signs and pathology, and confirmation of the virus, and in these species. In this article, we list the wild ungulates in which PPRV infection has been confirmed and summarize available information about the presentation of the disease, its identification, and impact of virus on wildlife populations. Considering recent reports of outbreaks by the World Organization for Animal Health (OIE), it is important to understand the transmission of this disease within wildlife populations in PPR endemic regions.

Keywords PPR virus · Wild ungulates · Genetic depletion · Interspecies transmission

Introduction

Peste des petits ruminants virus (PPRV) is the cause of peste des petits ruminants (PPR), a contagious, transboundary disease of small domestic ruminants and some wild ungulates (Kinne et al. 2010; Munir et al. 2012). Because of its impact on small ruminants, and its similarity to the recently eradicated rinderpest virus, the World Organization for Animal Health (OIE) and the Food and Agricultural Organization (FAO) launched a joint program to eradicate PPRV by 2030 (FAO 2015). PPR is also a threat to wildlife and therefore to the conservation of endangered species (Munir 2014).

It was first assumed that PPRV only affected sheep and goats (Lefevre and Diallo 1990), but it has since been observed clinically and pathologically in a wider range of species and confirmed diagnostically either directly through detection of virus, viral antigens, or specific viral RNA or indirectly through detection of antibodies in wild ruminants (Kinne et al. 2010), cattle and domestic buffaloes (Balamurugan et al. 2012a), yaks (Abubakar et al. 2015), camels (Kwiatek et al. 2011), Asiatic lion (Balamurugan et al. 2012b), and dogs (Ratta et al. 2016). Some wild ruminant species are at high risk from PPRV (Rossiter 2008) and domestic small ruminants most likely play a role in the spread of the virus to them. However, disease may also be disseminated from infected wildlife to other susceptible wildlife. Most of the available data on the disease and on PPRV are from domestic small ruminants, and data from wildlife is more limited. Host and virus-related factors in the spread of PPRV infection need better understanding if PPR is to be eradicated locally and globally. This brief report lists the known wild ungulates in which PPRV infection has been confirmed and highlights some key emerging issues regarding this infection in these species. The term “wild” covers free-ranging, semi-captive, and captive animals. In the text, species are referred to by their English or colloquial names, with their Latin binomials being given in Table 1.

Aziz-ul-Rahman and Jonas Johansson Wensman contributed equally to this work.

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Table 1 Evidence of natural or experimental PPRV infection in wild ungulates

Common name	Scientific name	Country	References
Wild species from which PPR virus has been isolated in cell culture			
Water deer*	*Hydropotes inermis*	China	Zhou et al. 2018
Wild ibex*	*Capra ibex*	China	Zhu et al. 2016
Bushbuck	*Tragelaphus scriptus*	UAE	Kinne et al. 2010
Springbuck	*Antidorcas marsupialis*	UAE	Kinne et al. 2010
Arabian gazelle	*Gazella gazella*	UAE	Kinne et al. 2010
Arabian mountain gazelle	*Gazella gazella cora*	UAE	Kinne et al. 2010
Dorcas gazelle*	*Gazella dorcas*	UAE, KSA	Furley et al. 1987, Abu-Elzein et al. 2004
Thomson's gazelle*	*Eudorcas thomsonii*	KSA	Abu-Elzein et al. 2004
Goitered gazelle	*Gazella subgutturosa*	UAE	Kinne et al. 2010
Impala	*Aepyceros melampus*	UAE	Kinne et al. 2010
Gemsbok	*Oryx gazella*	UAE	Furley et al. 1987
Afghan markhor goat	*Capra falconeri*	UAE	Kinne et al. 2010
Nubian ibex	*Capra nubiana*	UAE	Furley et al. 1987
Wild species from which PPR virus antigen or nucleic acid has been identified using ELISA/PCR/sequencing			
Water deer*	*Hydropotes inermis*	China	Zhou et al. 2018
Chowsingha	*Tetracerus quadricornis*	India	Jaisree et al. 2018
African buffalo*	*Syncerus caffer*	Côte d'Ivoire	Couacy-Hymann et al. 2005
Saiga antelope	*Saiga tatarica*	Mongolia	FAO 2017; OIE 2017b
Blackbuck	*Antilope cervicapra*	Pakistan	FAO-UN Project (GCP/PAK/127/USA) 2017
Goitered gazelle	*Gazella subgutturosa*	Mongolia, China	OIE 2017b; Li et al. 2017
Grant's gazelle	*Nanger granti*	Tanzania	Mahapatra et al. 2015
Kob	*Kobus kob*	Côte d'Ivoire	Couacy-Hymann et al. 2005
Nile lechwe	*Kobus megaceros*	Sudan	OIE-WAHID 2008
Defassa waterbuck	*Kobus ellipsiprymnus*	Côte d'Ivoire	Couacy-Hymann et al. 2005
Bubal hartebeest	*Alcelaphus buselaphus*	Côte d'Ivoire	Couacy-Hymann et al. 2005
Wild goat	*Capra aegagrus*	Kurdistan, Iran	Hoffmann et al. 2012; Marashi et al. 2017
Sindh ibex	*Capra aegagrus blythi*	Pakistan	Abubakar et al. 2011
Siberian ibex	*Capra sibirica*	Mongolia	OIE 2017b
Wild ibex*	*Capra ibex*	China	Xia et al. 2016; Zhu et al. 2016; Li et al. 2017
Nubian ibex	*Capra nubiana*	UAE, Israel	Kinne et al. 2010; OIE 2017a
Bharal*	*Pseudois nayaur*	China	Bao et al. 2011
Argali	*Ovis ammon*	China	Li et al. 2017
Wild species in which PPRV antibodies have been found using ELISA			
African buffalo*	*Syncerus caffer*	Côte d'Ivoire, Tanzania	Couacy-Hymann et al. 2005; Mahapatra et al. 2015
Goitered gazelle	*Gazella subgutturosa*	Turkey	Gur and Albayrak 2010
Dorcas gazelle	*Gazella dorcas*	Sudan, Nigeria	Intisar et al. 2017; Bello et al. 2016
Grant's gazelle	*Nanger granti*	Tanzania	Mahapatra et al. 2015
African gray duiker	*Sylvicapra grimmia*	Nigeria	Ogunsanmi et al. 2003
Defassa waterbuck*	*Kobus ellipsiprymnus*	Côte d'Ivoire	Couacy-Hymann et al. 2005
Impala	*Aepyceros melampus*	Tanzania	Mahapatra et al. 2015
Blue wildebeest	*Connochaetes taurinus*	Tanzania	Mahapatra et al. 2015
Bharal*	*Pseudois nayaur*	China	Bao et al. 2011
Wild species in which PPRV antibodies have been found using cross-serum neutralization tests (CSNT)			
Dorcas gazelle*	*Gazella dorcas*	KSA	Abu-Elzein et al. 2004
Thomson's gazelle*	*Eudorcas thomsonii*	KSA	Abu-Elzein et al. 2004
Wild species infected experimentally with PPRV			
White-tailed deer	*Odocoileus virginianus*	USA	Hamdy and Dardiri 1976

*Species for which PPR infection was found by more than one method

KSA, Kingdom of Saudi Arabia; *UAE*, the United Arab Emirates; *USA*, the United States of America

Virus transmission in wild small ruminants

In many areas where PPR is endemic, domestic animals intermingle with wildlife, allowing interspecies transmission of PPRV during grazing and at water sources (Banyard and Parida 2015). Abubakar et al. (2011) speculated that an outbreak of PPR in Sindh ibex was due to spillover of virus from a recent outbreak of PPR in nearby domestic small ruminants.

Similar spillovers to wild hosts are believed to have occurred in Tibet (Bao et al. 2011) and in the Ngorongoro Conservation Area in northern Tanzania (Mahapatra et al. 2015).

From an epidemiological point of view, there is potential for interspecies transmission between wild species and from wild species back to domestic ruminants, but the dynamics of such transmission mechanisms are uncertain. The transfer of wildlife to zoological collections and seasonal migration of animals are two possibilities for disease spread over significant distances and across country borders (Mallon and Kingswood 2001).

Clinical and pathological presentation

The clinical presentation of PPRV in wild ungulates is essentially the same as in domestic small ruminants. Initial involvement of the respiratory system causes lacrimation and nasal and ocular discharges (Bao et al. 2011; Abubakar et al. 2011; Hoffmann et al. 2012) which may lead to crusts forming over the nostrils and lip commissure (reported in antelopes; Kinne et al. 2010). Subsequent involvement of the alimentary tract epithelia causes cheesy necrotic material on the gums (reported in ibex; Abubakar et al. 2011) and erosions of the oral cavity membranes (reported in gazelle; Sharawi et al. 2010). Unilateral corneal opacity has also been observed in gazelle (Abu-Elzein et al. 2004). Death from respiratory arrest has been reported in gazelle, ibex, gemsbok, and Laristan sheep (Furley et al. 1987; Abu-Elzein et al. 2004).

The severity of PPR infection (Bao et al. 2011) is seen from pathological changes in different visceral organs, including syncytia and multifocal hepatocellular coagulation via necrosis (Kinne et al. 2010), and postmortem histopathology was used to confirm PPRV infection in dorcas and Thomson's gazelles (Furley et al. 1987). Similar features are found in infected small domestic ruminants (Brown et al. 1991).

Impact of PPR on genetic depletion

According to the International Union for Conservation of Nature and Natural Resources (IUCN), rare species are at risk of genetic depletion when outbreaks of serious disease, such as PPR, lead to high mortality (Osofsky 2005). The global attention and response to the recent high mortalities of free-ranging saiga antelope, including one outbreak confirmed to be caused by PPRV in Mongolia where at least 10% of the population was depleted (FAO 2017), is a clear example of the potential impact of PPRV on rare species. Rare wildlife kept and raised under captive or semi-captive conditions for conservation purposes is also at risk, as seen in the 70% mortality reported for Nubian ibex in an Israeli zoo (OIE 2017a). Implementation of quarantine measures and transfer of only seronegative animals should reduce the incidence of such events (Rossiter 2008) but global eradication offers a longer lasting solution.

Concluding remarks

In this article, we have briefly summarized the current knowledge on PPRV occurrence in wild ungulates and listed (Table 1) those wild species of in which disease has been recorded and confirmed, some of which are endangered and at elevated risk of genetic losses if infected by PPRV. The list can be expected to change: growing as more species are found to be susceptible to PPRV, altering as the classification of closely related host species and subspecies is refined, and as new and more accurate information about PPRV infection in these species becomes available.

To date, there is no evidence that wild species play a different epidemiological role in PPR to that played in the past by wild species infected by rinderpest virus. Wildlife proved incapable of permanently maintaining rinderpest virus but was valuable clinical and serological sentinels for virus in nearby cattle, and more study is required to establish the contribution wild species can play as sentinels during the eradication of PPRV (Couacy-Hymann et al. 2005). Additional study is also needed on the impact of PPRV on the genetic diversification capacity of wild host species, and on the transmission pathways for PPRV into and within wild populations. The existing evidence of the severity of PPRV infection in endangered wildlife that associate with infected small ruminants is compelling support for global eradication of the virus and for better control strategies targeted at these wildlife-livestock interfaces.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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