

Natural History Notes

Hunting practices of feral pigs (*Sus scrofa*) and predation by vampire bats (*Desmodus rotundus*) as a potential route of rabies in the Brazilian Pantanal

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Abstract Exotic species are known to cause an impact on native species and the environment through various ecological processes. Their impact on disease dynamics is not completely understood, but their relationship with the local fauna can favour the emergence of zoonoses. We reported records of predation of feral pigs (*Sus scrofa*) by common vampire bats (*Desmodus rotundus*) in the Brazilian Pantanal wetland and detailed how the traditional hunting, which involves castration management and hunting dogs, can represent a risk to emergency of rabies virus. With 1.43% of attack probability recorded by camera traps, we highlight the potential role of this interaction in disseminating zoonosis, especially in a scenario where hunting management has been prioritised as a policy tool in the control of exotic species. We alerted for the danger of rabies onset. Moreover, we suggested that the ranchers avoid contact with the pigs' salivary secretions during hunting, to maintain up to date rabies vaccination on domestic animals, and pay attention to the clinical behaviours of rabies in their hunting dogs. Therefore, we must be aware of all the risks involved in interactions between humans and wildlife to reevaluate our practices and prevent viral outbreaks as we currently witness.

Key words: Chiroptera, exotic species, natural history, prey, public health, rabies epidemiology, wildlife diseases, zoonoses.

INTRODUCTION

Invasive species are known to cause impact on native species and on environment through various ecological processes, and also to inflict damage to human activities, causing financial losses and health impacts. Domestic pigs (*Sus scrofa*; Linnaeus, 1758, Suidae) were introduced into several parts of the world as an alternative food source for settlers, and many escaped individuals have become feral. This species is considered one of the most impactful invasive biological agents in the world (Barrios-García & Ballari 2012). Invasion in the Brazilian territory occurred in different waves, and today it is widely distributed, with a rapid population expansion recorded in the last

decade (Pedrosa *et al.* 2015). The consequences of its ubiquitous distribution are widely discussed in the literature regarding ecological interaction with native peccaries (Desbiez *et al.* 2009; Galetti *et al.* 2015), changes in plant community (Hone 2002; Cuevas *et al.* 2012; Barrios-García *et al.* 2014), soil structure and composition (Cuevas *et al.* 2012; Barrios-García *et al.* 2014), and hunt and damage management (Campbell & Long 2009; Desbiez *et al.* 2011).

Besides all those impacts, the epidemiological consequences of its presence are also highly relevant. *Sus scrofa* could act as reservoir for several diseases, such as rabies, leptospirosis, brucellosis and pseudorabies virus (Mason *et al.* 1998; Romero *et al.* 2001; Gresham *et al.* 2002; Silva *et al.* 2008; Pessoa *et al.* 2011). Furthermore, biological features like social and aggressive behaviours, movement and dispersal ability, and high-density occurrence may contribute

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to disease transmission. Thus, feral pigs might act as a potential reservoir and disseminator for many zoonoses in the environment they inhabit. For instance, Miller *et al.* (2017) identified 34 swine pathogens that caused clinical disease in livestock, poultry, wildlife and humans, and they alerted for the growing risk of cross-species transmission influenced by wild feral pigs. In this context, ecological scenarios that could favour the entry or spillover of diseases have not been completely elucidated, but changes in the environment that favour the interaction between wild species, domestic animals and humans could increase the flow of pathogens and lead to the emergence of diseases (Herrera *et al.* 2008).

Recent records of feral pig predation by common vampire bats (*Desmodus rotundus*) raised concerns about the possibility of rabies transmission (Galetti *et al.* 2016). Vampire bats are wild species that are considered to be some of the most important rabies reservoirs. Therefore, they represent a group of great ecological, epidemiological and economic interests (Anderson *et al.* 2014; Streicker & Allgeier 2016). The common vampire bats essentially feed on mammal's blood, mainly ungulates, such as cattle, horses, deer or pigs. The introduction of domestic animals has contributed to the increase in populations of vampire bats (Altringham 1996), which have shown a preference for blood consumption of those instead of wildlife in rural communities, especially pigs (Bobrowiec *et al.* 2015). Swine are susceptible to rabies virus, as reported in some regions of Brazil (Silva *et al.* 2008; Nociti *et al.* 2009), and transmission of the virus from *D. rotundus* has also been reported (Pessoa *et al.* 2011). Rabies is considered one of the most feared diseases in the world due to its high mortality rate and lack of effective treatment (Langoni & Fornazari 2014). In Brazil, from 2008 to 2017, 27 confirmed cases of human rabies were reported, with dogs and bats acting as the main transmitting agents (Brazil Health Ministry 2017).

We conducted a camera trap survey monitoring for medium and large mammals at Nhumirim farm (18°59'17"S; 56° 37'09"W), an experimental campus of Brazilian Agricultural Research Corporation in the municipality of Corumbá. Twenty camera traps (Tigrinus®, model 6.2d) were allocated ca. 500 metres away from each other in an area of 500 ha and programmed to monitor for 24 h day⁻¹. A survey was conducted in 12 months throughout 2011–2012 and achieved a total of 4361 camera traps per day. However, we considered only nocturnal (from 6 pm to 6 am) and independent (each night as an event) records to estimate predation risk probability, according to Galetti *et al.* (2016).

We obtained 139 feral pigs records, of which two were spotted as being preyed on by vampire bats. The first record consisted of a single bat and was



Fig. 1. Camera trap record of feral pig (*Sus scrofa*) predation by two specimens of common vampire bats (*Desmodus rotundus*) in Brazilian Pantanal.

taken on 3 October 2011, at 1:08 am. The second showed two specimens of *D. rotundus* clinging on the back of a feral pig on 27 June 2012, at 0:41 am (Fig. 1). These records portray a 1.43% predation probability. However, this probability may be higher because our sample includes only feral pigs moving and foraging (Galetti *et al.* 2016).

Predation risk observed in this work was on par with predation risk percentages registered for feral pigs in a previous study in Pantanal. Galetti *et al.* (2016) reported a 2% feral pigs predation risk by bats in Pantanal and 11% in the Atlantic Forest. The higher predation risk in Atlantic Forest may represent a consequence of defaunation processes that force vampire bats to look towards the abundant feral pig population (Galetti *et al.* 2016). Likewise, the fact that our record showed predation on a wounded animal raised the doubt of whether the injuries exert a higher predation pressure on feral pigs. These injuries might be associated with intra-specific conflicts but also with traditional hunting practices inflicted by local hunters.

In this context, some peculiarities of hunting tradition in Pantanal are of sanitary interest because they contribute an increased number of injured animals. The first aspect is that feral pig harvest is concentrated on previously castrated males than non-castrated individuals, which are usually discarded because of their strong-tasting meat, in conjunction with the fact that castrated males fat up quickly, providing a more advantageous carcass for meat and oil consumption (Desbiez *et al.* 2011). Therefore, traditional hunting practices involve castrating young males in the field for subsequent recapture. Ranchers usually cut off half of the ear and tail following castration for later identification and slaughter. All these

procedures are performed without any veterinary practices to heal the wounds. In this sense, although the selection of injured animals to prey is unknown, foraging strategies in vampire bats have direct implications for rabies transmission (Streicker & Allgeier 2016), and vampire bats have the sensory ability to perceive heat radiation that can be used to detect prey and suitable places to prey (Kürten & Schmidt 1982). Moreover, the proportion of castrated feral pigs in the population can be expressive, since it is estimated the number of these individuals is more than seven times the number of castrated pigs killed per month (Desbiez *et al.* 2011). The castration of males involves the manipulation of the live animal, and therefore this practice poses a risk of rabies transmission due to the bites deferred by feral pigs to humans as a defence.

The second relevant aspect is that 95% of hunts are carried out with the aid of hunting dogs (Desbiez *et al.* 2011). Dogs are useful not only to find and flush the groups from hiding in forest patches, but also to immobilise the animals until the hunter arrives. During this process, it is common for dogs to bite pigs and be injured by feral pigs, which could then contaminate dogs through bites suffered while handling. Hunting dogs, in turn, pose a direct risk to humans and other domestic animals (Jorge *et al.* 2010) whom they live with daily, and they favour the

maintenance and dissemination of the virus in the environment through the transmission to pigs and other species with which they interact (Fig. 2). Thus, given the close relationship between pigs, human and hunting dogs, the epidemiology behind the proposed transmission cycle should be investigated, as the clinical diagnosis of hunted feral pigs, which are the transmission link for humans and hunting dogs.

This is especially important in the current global scenario where the expansion of exotic species, such as feral pigs, has increased and hunting has been intensified as a public policy for management and control of exotic species in nature (Pedrosa *et al.* 2015; Galetti *et al.* 2016). In Brazil, hunting management has been the main tool for the control of feral pig populations. In 2013, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) considered the feral pig to be harmful to native wild species, the environment, agriculture and public health, and it regulated the Normative Instruction (NI) 03/2013, which permits the use of hunting for population control of invasive species outside of Pantanal (IBAMA 2013). Between 2014 and 2015, at least 2389 wild boars were hunted, and it has become the main method to control feral *S. scrofa* in Brazil (Rosa *et al.* 2018). Especially in Pantanal, feral pigs are an alternative food source to native species, and the hunting management of feral

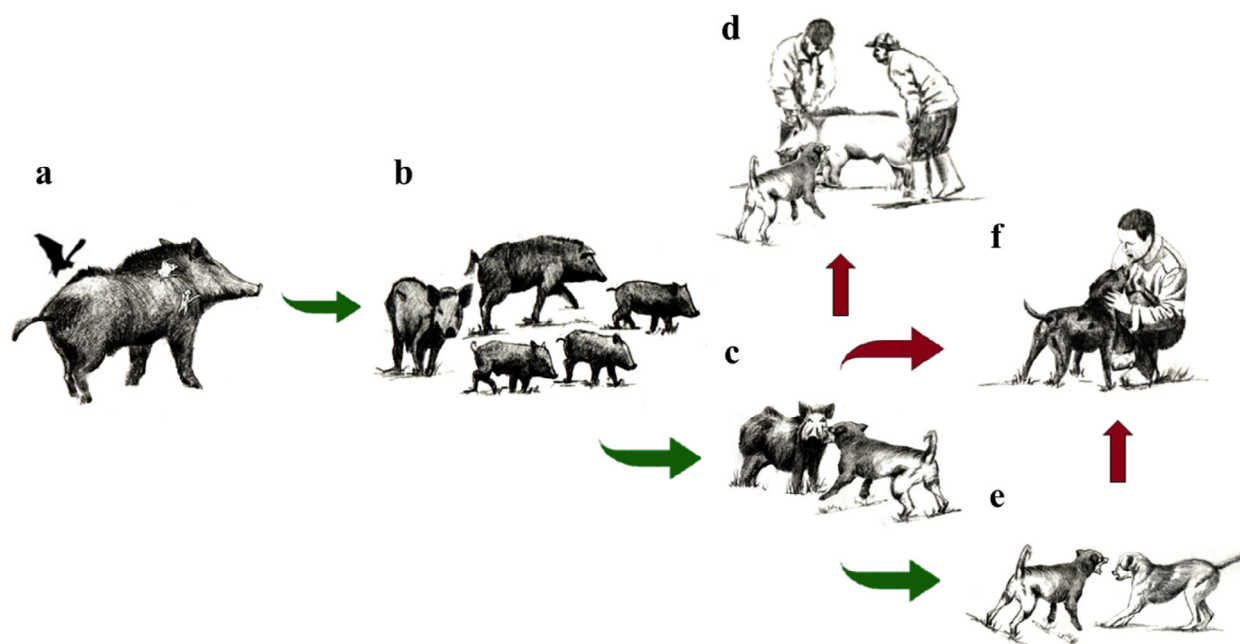


Fig. 2. F Hunting practices and interactions with wildlife that can favour the dissemination of the rabies virus from wild and domestic animals (green arrows) to human (red arrows). (a) Vampire bats (*Desmodus rotundus*) infected attacking feral pigs (*Sus scrofa*). (b) Rabies virus can be transmitted from other feral pigs by interactions within the groups. Dissemination of the virus can proceed through several routes. (c) Agonistic interaction between feral pigs contaminated and hunting dogs during the hunt and (d) management of feral pigs by human and hunting dogs. (e) Interactions between hunting dogs and (f) hunting dog with human.

pigs is considered as a tool for wildlife conservation (Desbiez *et al.* 2011). The incentive on the part of the government can increase the interactions between feral pigs with humans and hunting dogs, which may increase the spread of the rabies virus. In this sense, the government must consider the health risks involved when proposing hunting as a means of controlling wild boar populations.

Therefore, common vampire bats feeding on the constantly spreading feral pigs may be viewed as a potential risk to wildlife, livestock and humans (Galetti *et al.* 2016). During times when we live with the uncertainties of zoonoses that can be transmitted by bats and other wild animals, the precaution with the proximity of humans to the wildlife and with the consumption of products of animal origin can prevent viral diseases that we know little about or control, such as rabies and COVID-19. In relation to rabies, it is essential to maintain up to date rabies vaccination on domestic animals (Gnocchi & Srbek-Araujo 2017), especially for hunting dogs. Ranchers should avoid contact with the pigs' salivary secretions during hunting to prevent rabies transmission and pay attention to the clinical behaviours of rabies in their hunting dogs, such as aggression, excessive salivation and paralysis of limbs, and communicate quickly to public health agents if such symptoms are observed. Such recommendations and precautions are especially valid for traditional communities in the Pantanal, where we strongly recommend the vaccination of farm dogs. Thus, to avoid a possible emergency of rabies and other zoonoses, we must be aware of all the risks involved in the interactions between humans and wildlife to reevaluate our practices and prevent viral outbreaks as we currently witness.

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AUTHOR CONTRIBUTIONS

Francisco Grotta-Neto: Conceptualization (equal); Investigation (equal); Writing-original draft (lead);

Writing-review & editing (equal). **Pedro Peres:** Conceptualization (equal); Investigation (equal); Writing-original draft (equal); Writing-review & editing (equal). **Ubiratan Piovezan:** Conceptualization (equal); Investigation (equal); Writing-original draft (equal); Writing-review & editing (equal). **Fernando Passos:** Conceptualization (equal); Investigation (equal); Supervision (lead); Writing-original draft (equal); Writing-review & editing (equal). **José Maurício Barbanti Duarte:** Conceptualization (equal); Investigation (equal); Supervision (lead); Writing-original draft (equal); Writing-review & editing (equal).

CONFLICT OF INTEREST

We declare the availability of data and the permission to reproduce material exclusively for Austral Ecology and that there is no conflict of interest.

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