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Rabies and wildlife: a conservation problem?

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ABSTRACT

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Understanding the behavioural ecology of wild mammals in rabies epizootics is a prerequisite to scientifically sound management of the disease. The principal vectors of wildlife rabies in a region tend to be abundant representatives of the Carnivora. Although the population dynamics of these species may be radically affected by rabies, and by attempts to control it, they are generally not threatened with widespread extinction as a result. However, the cases of the Blanford's fox, *Vulpes cana*, the Ethiopian wolf, *Canis simensis*, and the African wild dog, *Lycaon pictus*, illustrate how rabies and its control can pose grave conservation problems for rare carnivores. Disease monitoring is therefore an important element of recovery plans for rare species which are potential victims of rabies and other epizootic pathogens, and the benefits and disbenefits of prophylactic vaccination merit serious evaluation.

INTRODUCTION

The involvement of the red fox, *Vulpes vulpes*, in the European rabies epizootic which spread from Poland in the 1940s, attracted considerable scientific, and public, attention to wildlife rabies. Until the mid-1970s the tendency was for veterinary epidemiologists to analyze data on the occurrence of rabies in wild mammals with minimal attention to their behaviour or ecology (e.g. Bogel, Arata, Moegle & Knorpp 1974). During the same era the prevalent view was that rabies could be controlled by killing sufficient numbers of vectors (in Europe, the red fox) to reduce the contact rate amongst survivors below that at which the disease could persist (Bogel & Moegle 1980). However, it became apparent that killing large numbers of red foxes had not eradicated rabies in Europe, nor even slowed its spread, and at the same time it became clear that the behaviour of these vectors was much more complicated than had generally been acknowledged (Macdonald 1980; Macdonald & Voigt 1985). Furthermore, this complexity might explain regional differences in the behaviour of the epizootic (e.g. Macdonald, Bunce & Bacon 1981; Ball 1985), and suggested counter-productive elements in classical control approaches (e.g. Macdonald 1988), with implications for models of rabies spread and control (e.g. Bacon & Macdonald 1980; Macdonald & Bacon 1982). Simultaneously, and linked to a more ecological perspective of controlling wildlife rabies, trail-blazing studies began on the oral vaccination of wildlife against rabies (e.g. Steck, Wandeler, Bicksel, Capt, Haflinger & Schneider 1982). In Europe, despite early scepticism, this approach was to prove a great success, culminating in the effective eradication of fox-rabies from several countries (Wandeler 1993). By 1981, when a workshop was convened in Pretoria, South Africa, to consider rabies in African wildlife, it was already clear that Africa could learn an important lesson from the European experience (Macdonald 1982): a prerequisite to scientifically robust control of rabies in wildlife is a thorough understanding of the behaviour and ecology of the species concerned, and of how these affect the epizootiology of rabies amongst them.

The function of this paper is to introduce the session on *Rabies in African wildlife*. In doing so my purpose is briefly to emphasise only two points to serve as a backcloth to the papers in this session.

First, rabies can neither be understood nor controlled without detailed understanding of the behavioural ecology of its vectors. Understanding the intricacies of the individual behaviour of vector species is no less relevant than deciding upon the detailed sequence of a cluster of nucleotides in the virus genome. Ultimately, success will depend on the integration of understanding from both ends of this interdisciplinary spectrum. This point is illustrated by the intricacies of sex-biased prevalence of rabies in bat-eared foxes, *Otocyon megalotis*, described by Maas (1993). Even describing the social units of wild carnivores may be insufficient to reveal the detailed pattern of interactions between potential vector and victim: both in the cases of bat-eared foxes (Nel 1993) and black-backed jackals, *Canis mesomelas*, (McKenzie 1993) unexpected liaisons emerge between individuals from separate groups, and this added tier of complexity is emerging in the structure of other carnivore societies. For example, crab-eating foxes, *Cerdocyon thous*, may make occasional short-term visits to their natal range more than a year after dispersing (Macdonald & Courtenay, unpublished data).

Second, the last few years have seen cases of rabies in several rare and endangered canids. This adds a new dimension to concerns about the control of this disease and in particular focuses attention on the potential of oral vaccination as a tool not merely for control, but also for protection of rare species (Ginsberg & Macdonald 1990). Initially, in Europe, oral vaccination was an attractive possibility not because red foxes were endangered by rabies or rabies control, but because killing off wild vectors was not working. The issue was not one of sentiment or of species conservation, but a matter of management. However, I will devote the remainder of my remarks to case studies which illustrate that conservation considerations may be of paramount importance in the management of rabies in some regions. Indeed, I argue that strategies for preventing the decimation of endangered species by rabies, and for preventing their decimation by rabies control measures, will be vitally important in Africa.

CASE STUDIES

Blanford's fox (*Vulpes cana*)

The Blanford's fox was, until recently, one of the least known members of the Canidae, and it is arguably one of the rarest predatory mammals in south-west Asia (Novikov 1962). The species was believed to be confined to mountainous regions in north Iran, Afghanistan, north-west Pakistan and south-west Russia (Ginsberg & Macdonald 1990). However, Blanford's foxes have recently been discovered in several Middle Eastern locations, and in the early 1980s specimens were first reported from Israel (Mendelssohn, Yom-Tov, Ilany & Meninger 1987). The latter discovery was especially remarkable in revealing the presence of a previously unknown medium-sized mammal in a region of moderately high human population.

The discovery of the Israeli population of Blanford's foxes led to a detailed study of its behaviour (e.g. Geffen & Macdonald 1992) and concern about its conservation. A survey revealed that the species was found in several regions of Israel along the African-Syrian Rift Valley system, apparently being limited to cliff-side habitats (Geffen, Hefner, Macdonald & Ucko 1993).

The relevance of this account is that no sooner had the Blanford's fox been discovered in Israel when its existence was threatened directly and indirectly by rabies. Late in 1988 four radio-tagged Blanford's foxes were being radio-tracked by Geffen and his colleagues in the vicinity of Eilat, at the north of the Red Sea. Within a period of two weeks three of them suddenly died. By the time the corpses were retrieved they were too decomposed for necropsy. However, in succeeding months several dead red foxes were found in the vicinity, and were confirmed positive for rabies by the state veterinary service.

The following year, at Ein Gedi, an area bordering the Dead Sea, a total of eight Blanford's foxes were found dead within three months by hikers. During the previous eight years only six carcasses of this species had been found in the whole of Israel, so we judge the sudden influx of corpses as indicative of heavy mortality. Two of the dead Blanford's foxes at Ein Gedi were necropsied and confirmed positive for rabies (as were several red foxes and one ibex, *Capra ibex*)(E. Geffen, personal communication).

The Nature Reserves Authority responded to the outbreak of wildlife rabies by attempting to reduce the red fox population by shooting. This had no obvious effect on the progress of the epizootic in red foxes, which travelled north to the latitude of Jerusalem and Tel Aviv.

Ethiopian wolf (*Canis simensis*)

The Ethiopian wolf, or Simien jackal, is probably the rarest canid in the world (Ginsberg & Macdonald 1990). It is confined to a few afro-alpine plateaux in Ethiopia at altitudes above 3 000 m. As recently as 10 000 years ago the highlands of Ethiopia were much more expansive, and covered with afro-alpine moorland and grassland. Up to 100 000 km^2 of this habitat was probably available during the last glaciation, but today it has shrunk to only 2 700 km^2 (Gottelli & Sillero-Zubiri 1992).

The remnant populations of Ethiopian wolves have been surveyed by Gottelli & Sillero-Zubiri (1992). The entire population was estimated at no more than 500 individuals, of which more than half occurred in the Bale Mountains National Park on the south east rim of the Rift Valley, where they were studied in detail on the Sanetti Plateau and in the Web Valley. The Ethiopian wolf displays behaviour patterns, especially regarding its social organization, that are unique amongst canids. They feed largely on endemic rodents, such as giant mole rats, *Tachyoryctes macrocephalus*, and live at high density (*c.* one wolf/km^2) in multi-male packs of up to 13 adults typified by female dispersal (Sillero-Zubiri, unpublished data).

Between 1988–1991, Sillero-Zubiri (personal communication) observed Ethiopian wolves and Oromo pastoralists interacting minimally and coexisting peacefully. However, following the overthrow of the Mengistu government in May 1991, this changed. Automatic weapons sold by deserting soldiers became widely available and Ethiopian wolves and other wildlife became targets. In late 1991 at least six adult wolves were shot, including nursing females. This onslaught coincided with a catastrophic outbreak of disease. Sillero-Zubiri observed that, in 1990, 73 % of 34 known adults in Sanetti Plateau died, and in 1991–1992 75 % of 48 known adults in the Web Valley died. The high density at which Ethiopian wolves occur, high contact rates between and within packs, and the presence of sympatric dogs all increase the likelihood and severity of such outbreaks.

The diseased wolves suffered mass loss and diarhoea, and had empty digestive tracts. The brains of two of these animals were positive for rabies (A. King, personal communication). It seems that approximately half of the Bale population of this species died in a single rabies epizootic. The threat of such a catastrophe had loomed in the findings of Mebatsion, Sillero-Zubiri, Gottelli & Cox (1992) who reported a rabid dog in the nearby village of Dinsho, and found two of 15 wolf serum samples had detectable rabies antibody. Domestic dogs act not only as disease vectors but also hybridize with Ethiopian wolves (Gottelli, Sillero-Zubiri, Applebaum, Girman, Roy, Garcia-Moreno, Ostrander & Wayne 1993).

African wild dog (*Lycaon pictus*)

The African wild dog is a highly endangered flagship species, of which under 5 000 individuals survive across the continent (Fanshawe, Frame & Ginsberg 1991). The population of wild dogs in the Serengeti National Park and adjacent Masai Mara have been made famous by television documentaries. One such documentary recorded the deaths due to rabies of the large Aitong pack in the Mara in 1989 (Alexander, Richardson & Kat 1992). Subsequently rabies was also confirmed in a pack in the Serengeti National Park and this population declined drastically until, by 1992, only a few individuals remained. It later emerged that three of 12 Serengeti wild dogs examined before their disappearance had low levels of rabies neutralising antibodies in their sera (Gascoyne, Laurenson, Lelo & Borner 1993a). However, the role of rabies (or other candidate diseases such as distemper) in the disappearance of the Serengeti population is unknown because of insufficient data. For the same reason other hypotheses concerning their demise, for example, linking it with the stress of handling by biologists (Burrows 1992) cannot be decisively evaluated (Macdonald, Artois, Aubert, Bishop, Ginsberg, King, Kock & Perry 1992; Creel 1992), although handling does not appear to have been detrimental in other studies of this species (Ginsberg, Alexander, Creel, Kat, McNutt & Mills, unpublished data; Ginsberg & Macdonald, in press). Nonetheless, irrespective of its role in the recent disappearance of wild dogs from the Serengeti, rabies now emerges as a potentially important factor in the population dynamics of bat-eared foxes in the same ecosystem (Maas 1993). In principle rabies is therefore at least a serious risk for wild dog populations (Gascoyne, King, Laurenson, Borner, Schildger & Barrat 1993b), and the uncertainties surrounding the Serengeti die-off highlight the importance of disease-monitoring in the conservation of endangered canids. This is especially important when many countries in Africa are recording record numbers of confirmed rabies cases in dogs (Perry 1993; Swanepoel 1993).

CONCLUSION

Understanding the behavioural ecology of wildlife vectors is a prerequisite to the management of rabies. This dictum applies when the vector is numerous to the point of being a pest, but it applies all the more stringently when the species in question is endangered. The three case studies briefly outlined here illustrate that rabies in wildlife can be a serious conservation problem. The Blanford's fox, Ethiopian wolf and African wild dog are all rare and survive in small, fragmented populations. Such populations are extremely fragile in the face of epizootic disease. Indeed, the confinement of endangered species within reserves may even exacerbate the problem: artificially high densities of hosts that occur when animals are restricted in their movements to reserve boundaries, or lack of suitable dispersal habitat, will increase rates of transmission of all types of direct life cycle pathogens (Dobson & May 1986).

The perception of rabies as a conservation problem is especially important in Africa where such a richness of rare mammals survive. Wherever rabies occurs in African wildlife, whether it be the canid or herpestid strain of virus, a locally abundant principal vector is likely to involve much rarer species. Their involvement greatly complicates rabies control. An alternative view could be that rabies is not a problem in conservation areas because high species diversity generally precludes any one species reaching high population densities. However, the case studies mentioned here would appear to contradict any such complacency. Indeed, the potential for rabies seriously to imperil rare species is analogous to the potential of generalist predators to eradicate a rare prey while being sustained in high numbers by a common one.

Rabies is often a peri-domestic disease, principally associated with domestic dogs. Perry (1993) has reviewed the paucity of detail available on the behavioural ecology of free-ranging dogs in Africa. His review highlights the importance of studying the interface between dog-rabies and wildlife rabies. Studies of feral dog ecology elsewhere (e.g. Macdonald & Carr, in press), reveal the potential of dogs to penetrate wildlife habitats. Although there are few data of the extent to which this has fuelled wildlife rabies, the control of such dogs should anyway be a priority in the management of rabies in Africa.

The threat to rare canids from rabies is two-fold: not only can their small populations be annihilated by an outbreak of disease, but they can also fall indirect victims to attempts to kill more populace vectors. In this context the possibility of prophylactic vaccination against zoonoses demands careful evaluation as a conservation tool. In the case of rabies, oral vaccination has proved a remarkable success amongst red foxes in Europe, and appears promising in field trials for raccoons in the USA (Rupprecht, Hanlon, Niezgoda, Buchanan, Diehl & Koprowski 1993). On the other hand, potential immunization has proven controversial for the Serengeti wild dogs (Burrows 1992; Gascoyne *et al*. 1993, see also Ginsberg & Macdonald, in press). These issues emphasise the importance to conservation of studies of epizootic diseases, and make it essential to consider the threat of such diseases in planning the conservation of rare canids.

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