# The impact of ticks and tick-borne diseases on native animal species in Australia

*Inger-Marie Vilcins, Julie M Old and Elizabeth M Deane*

Division of Environmental and Life Sciences, Macquarie University, North Ryde, NSW, 2109.
Tel: (02) 9850 8418
Fax: (02) 9850 9671
E-mail: ivilcins@els.mq.edu.au
jold@els.mq.edu.au
edeane@els.mq.edu.au

## Introduction

Ectoparasites are a leading cause of arthropod-borne disease in animals, and humans [1,2]. Defined as arthropods which spend an entire portion of their life cycle on the host, ectoparasites include the ticks and mites (Acarina), and the lice and fleas of the insect family. Their role in human disease transmission has been well documented [1], as has their importance in agricultural [1,3] and domestic animals [4]. Little however has been done to comprehensively examine the role these organisms may play in disease transmission and their impact upon native Australian fauna. It is important to consider the effects of such disease agents on the survival of both captive and wild native animal populations, particularly as exposure to a novel pathogen may remove endangered animals that are a vital pool of genetic diversity [5].

In the late 1980s, captive breeding colonies were established to conserve, isolate and protect at risk populations of Australian native animals, such as the eastern barred bandicoot *(Perameles gunnii)* and the northern hairy-nosed wombat *(Lasiorhinus krefftii)* [6,7]. One aim of this strategy was to build-up population numbers for later re-introduction into the wild [7]. Many previously unrecognised problems are now becoming apparent in such captive-raised populations and include increased disease exposure and transmission arising from population concentration and abnormal interactions [5]. Moreover increased stress levels in native animals have been shown to increase parasite burdens and result in immunosuppression [2]. Upon release into the wild, exposure of naïve animals, bred in captivity, to ectoparasite infestation and their pathogens can prove fatal [8]. Pathogens introduced via domestic species [8], heightened stress levels from competition and predation and increased parasite burden [5] are all essential elements determining success of a species. Thus there is a real need to understand what Australian ectoparasites are in circulation, what potential pathogens they may harbour, what role ectoparasites play in transmitting disease within native animal populations and what threat they pose to the long-term survival of native species.

Figure 1. Wild caught common ring-tail possum infested with 'scrub' ticks (Ixodes holocyclus). This tick is a known carrier of Rickettsia australis the causative agent of Queensland typhus. Courtesy of Christine Rand.

Despite the size and significance of the problem, little research has been done to document ectoparasite-borne infection in Australian fauna. By far, most research has been undertaken on ticks, as these pose significant threat to domestic and agricultural animal health. This review focuses on what is known regarding the role of ticks in disease transmission and the implications for our wildlife.

Ticks transmit the largest range of known pathogens, including protozoa, bacteria, rickettsia and viruses, compared to all other arthropods [9]. What makes ticks significant in their disease transmission is the ability of some species to parasitise and feed on a wide range of host species. Disease in animals of agricultural importance has received significant attention [8], with efforts focusing primarily on cattle and the cattle tick, *Boophilus microplus* [8]. Tick fever is caused by a number of tick-borne protozoal species including *Babesia bovis,* the most pathogenic, as well as *B. bigemina* and *Anaplasma marginale* [8]. The fourth protozoan, *Theileria buffeli (mutens)* rarely results in acute disease [8].

*Babesia* species are known to cause haemoprotozoal disease in canines [10], with disease severity being dependant on the breed of dog and virulence of the species involved [10]. *B. canis* and *B. gibsoni* have been detected in Australian canines [10], but molecular techniques indicate that multiple species exist [10]. Two *Babesia* species have been identified in marsupials, the first, *B. thylacis,* was described in northern quolls *(Dasyurus hallucatus)* and has since been isolated from short and long-nosed bandicoots *(Isoodon macrourus and Perameles nasuta),* where it may be associated with post-mating mortality [11]. *B. tachyglossus* has been found in the short-beaked echidna *(Tachyglossus aculeatus)* but no apparent pathology has been recorded [11].

Ticks also harbour *Ehrlichia* species,

many of which have been implicated in haematological disease in several mammalian species worldwide [4,12]. *Ehrlichia platys* [4], (now *Anaplasma platys)* recently described in canines and transmitted by the brown dog tick *Rhipicephalus sanguineus* [12,13], appears to be the dominant species in Australia [13]. Infection with *E. canis,* is similar in its pathology but has not yet been found in Australian canines. The infection is treatable and rarely fatal [13]. However, *Ehrlichia* are capable of co-infection with other pathogens such as *Babesia canis,* increasing overall virulence [4,13], and highlighting a potential threat to naïve populations such as the dingo. With domestic dog infections often asymptomatic and a native reservoir yet to be identified [12], transmission to native species, unless causing severe disease, could go largely unnoticed.

*Coxiella burnetti,* the causative agent of Q fever, affects mainly those employed in agriculture and veterinary industries, who become infected through inhaling infected host faeces and parturition material [14]. This organism is carried by the tick vector *Amblyomma trigattatum trigattatum* which parasitises bandicoots, macropods, domestic animals and birds [14].

Most of these animals remain asymptomatic, but pathogenicity has been recorded in sheep and is known to affect sheep production [14]. The vector distribution has recently expanded, and is thought to be the result of climate change and human and domestic animal encroachment into previously isolated areas [14].

Rickettsiae are well known tick-borne pathogens of humans [9]. Queensland tick typhus is caused by *R. australis* and transmitted by *Ixodes holocyclus* and *I. tasmani* [9,15]. The ticks parasitise domestic dogs [15] and native rodents and bandicoots, which are thought to be reservoirs for the rickettsiae [14]. Asymptomatic canine populations may act as a source of infection for susceptible animal species [12]. Flinders Island spotted fever, caused by *R. honei* [9,16], is transmitted by *Aponomma hydrosauri,* a reptile tick commonly found on the blue tongue lizard *(Tiliqua nigrolutea)* and tiger *(Notechis scutatus)* and copperhead snakes *(Austrelaps superbus)* [16]. Although both Rickettsiae have been detected in native reservoir hosts [14,16], pathogenicity is yet to be described in native species.

The circulation of Flaviviruses, such as tick-borne encephalitis virus, amongst a number of wild mammalian reservoir populations has been documented [17]. However, other well known Flaviviruses, such as West Nile virus and Hendra virus, have yet to be detected in tick vectors in Australia. Migratory birds have been found to act as carriers of a number of tick-borne viruses [17]. Their threat as a vector and host lies in their ability to reach numerous animals across large distances via natural interactions and accidental encounters, such as those resulting from human involvement altering normal migratory patterns [17]. Migratory birds are capable of carrying a range of well known ectoparasite-borne pathogens, including viruses (such as tick-borne Crimean-Congo haemorrhagic fever), protozoa *(Babesia* species) and bacteria *(Rickettsia* species, Q fever and Lyme disease) [17]. This broad range, combined with the number of countries they can cover via migration routes and the difficulty associated with monitoring their movements, makes migratory birds a potentially large foci for disease transmission.

*Hepatozoons* (haemogregarines) are carried by all ectoparasites and transmitted to vertebrate definitive hosts via the ingestion of an infected vector during grooming or the consumption of an infected prey and their parasites [18]. They have extremely low host specificity, which is evidenced by a large vertebrate host range, including birds, mammals, amphibians and reptiles [18]. In Australia, infections have been recorded in tortoises, lizards and several snake species [18]. Some infections are asymptomatic, as seen in the southern Australian sleepy lizards *(Tiliqua rugosa)* infected with *Hemolivia mariae* [19]. However, they may also result in immunosuppression and death in well-adapted hosts and severe pathological effects after host shifts or accidental transmission, as recorded in immunologically naïve lizards exposed to *Hepatozoon mocessini* [20]. *Hepatozoon* infection in marsupials has been described in the long- and short-nosed bandicoot *(Perameles nasuta, Isoodon obesulus)* and Tasmanian eastern barred bandicoot *(Perameles gunnii)* [21]. Although the implications of these infections are yet to be determined in bandicoots, the high virulence associated with canine hepatozoonosis *(H. americanum)* transmitted by *Amblyomma macculatum* in the United States, a result of a host shift from an unknown wild host [18], highlights their potential threat to naïve populations.

Tick paralysis of humans and domestic animals by neurotoxins in the saliva of the 'scrub tick' *(Ixodes holocyclus),* is a common complication of tick bites [14]. Susceptible animals are those that have not been habituated to tick exposure and may experience cardiovascular abnormalities causing paralysis and death [22]. Marsupials appear to be unaffected by the toxin [22], however the spectacled flying fox *(Pteropus conspicillatus)* population in northern Queensland has rapidly declined as a consequence of increased infestation by the tick [22]. Climate and environment change, as well as habitat destruction are thought to be responsible for the increased exposure of the spectacled flying fox to the scrub tick [22].

In addition to transmission of infectious agents, ticks can cause a number of secondary complications. Anaemia, resulting from heavy infestation, is not only commonly seen in livestock such as cattle [3], but also in native species such as koalas *(Phascolarctos cinereus)* [23]. The effects of long-term infestation in koalas is unknown, however a study in northern brown bandicoots *(Isoodon macrourus)*

has shown that long-term exposure can result in lowered growth rates and haemocrit values, as well as an increase in immune response [24]. The inevitable exposure of wild and re-released captive-bred populations to tick infestation and the associated complications requires consideration when developing long-term animal management plans.

## Conclusion

The potential for indigenous and introduced ectoparasites, responsible for the infestation of native species [7] (Figure 1), to act as a source of novel or introduced disease transmission is a real threat to the survival of native species. An introduced pathogen is capable of causing rapid depopulation to numbers incapable of recovery, potentially resulting in local extinction [25]. Moreover the loss of a captive bred or re-released population may have long-lasting implications for the overall genetic diversity of the species [25].

Immunosuppression associated with normal ectoparasite infestation may even enhance pathogen transmission [2] and this, coupled with exposure to novel parasites and their agents, may have a strong impact on the long-term survivability of rare and endangered native animals [25]. The effects ectoparasites could have on already fragile populations, through infestation and which infectious organisms are present and capable of circulation, requires serious consideration when addressing long-term management strategies for rare and endangered species.

This review has highlighted what is and isn't known regarding the role of ticks in transmission of disease in native animal populations. Even less is known regarding the role of other ectoparasites, the mites, lice and fleas. This is an area in need of greater research focus.

## References


1. Estrada-Pena A. and F Jongejan (1999). Ticks feeding on humans: a review of records on human-biting Ixodoidea with special reference to pathogen transmission. *Experimental and Applied Acarology* 23:685-715.
2. Wikel SK (1999). Tick modulation of host immunity: an important factor in pathogen transmission. *International Journal for Parasitology* 29:851-859.
3. McLeod RS (1995). Costs of major parasites to the Australian livestock industries. *International Journal for Parasitology* 25:1363-1367.
4. Shaw SE, Day MJ, Birtles RJ and Breitschwerdt EB (2001). Tick-borne infectious diseases of dogs. *Trends in Parasitology* 17:74-80.
5. Dobson A and Foufopoulos J (2001). Emerging infectious pathogens of wildlife. *Philosophical Transactions of the Royal Society of London* 356:1001-1012.
6. Gerhardt K, Smales LR and McKillup SC (2000). Parasites of the Northern Hairy-Nosed Wombat *Lasorhinus Krefftii:* Implications for conservation. *Australian Mammalogy* 22:17-22.
7. Seebeck JH (2001). Perameles gunnii. *American society of Mammologists* 654:1-8.
8. Angus BM (1996). The history of the cattle tick *Boophilus microplus* in Australia and achievements in its control. *International Journal for Parasitology* 26:1341-1355.
9. Doggett S (2004). Ticks: Human health and tick bite prevention. *Medicine Today* 5:33-38.
10. Jefferies R, Ryan UM, Muhlnickel CJ, and Irwin PJ (2003). Two species of canine *Babesia* in Australia: Detection and characterisation by PCR. *Journal of Parasitology* 89:409-412.
11. Obendorf DL (1993). Diseases of Dasyurid Marsupials., p39-45. *In* Roberts M, Camio J, Crawshaw G, and Hutchins M (ed.), *The Biology and Management of Australian Carnivorous Marsupials,* vol 3, Toronto, Ontario, Canada.
12. Roberts T, Brown G, Martin A and Dunstan RH (2003). Going to the dogs: ticks and emerging diseases. *Today's Life Science* 15:32-34.
13. Brown GK, Martin AR, Roberts TK and Aitken RJ (2001). Detection of *Ehrlichia platys* in dogs in Australia. *Australian Veterinary Journal* 79:554-558.
14. Playford G and Whitby M (1996). Tick-borne diseases in Australia. *Australian Family Physician* 25:1841-1845.
15. Graves S (1998). Rickettsial Diseases: The Australian story so far. *Pathology* 30:147-152.
16. Stenos J, Graves S, Popov VL and Walker DH (2003). *Aponomma hydrosauri,* the reptile-associated tick reservoir of *Rickettsia honei* on Flinders Island, Australia. *American Journal of Tropical Medicine and Hygiene* 69:314-317.
17. Hubalek Z (2004). An annotated checklist of pathogenic microorganisms associated with migratory birds. *Journal of Wildlife Diseases* 40:639-659.
18. Smith TG (1996). The genus Hepatozoon (Apicomplexa: Adeleina). *Journal of Parasitology* 82:565-585.
19. Smallridge CJ and Bull CM (2000). Prevalence and intensity of the blood parasite *Hemolivia mariae* in a field population of the skink *Tiliqua rugosa. Parasitology Research* 86:655-660.
20. Wosniak EJ, Kazacos KR, Telford SR and McLaughlin GL (1996). Characterization of the clinical and anatomical pathological changes associated with *Hepatozoon Mocassini* infections in unnatural reptilian hosts. *International Journal for Parasitology* 26:141-146.
21. Bettiol SS, Goldsmid JM, Le DD and Driessen M (1996). The first record of a member of the genus Hepatozoon in the eastern barred bandicoot *(Perameles gunnii)* in Tasmania. *Journal of Parasitology* 82:829-830.
22. Campbell FE, Atwell RB and Smart L (2003). Effects of the paralysis tick, *Ixodes holocyclus,* on the electocardiogram of the spectacled flying fox, *Pteropus conspicillatus. Australian Veterinary Journal* 81:328-331.
23. Spencer AJ and Canfield PJ (1994). Haematological characterisation of heavy tick infestation in koalas *(Phascolarctos cinereus). Comparative Haematology* 3:225-229.
24. Gemmell RT, Cepon G, Green PE and Stewart NP (1991). Some effects of tick infestations on juvenile northern brown bandicoot *(Isoodon macrourus). Journal of Wildlife Diseases* 27:269-275.
25. Daszak P, Cunningham AA and Hyatt AD (2000). Emerging infectious diseases of wildlife: Threats to biodiversity and human health. *Science* 287:443-449.