

Borrelia and Australian wildlife

Fact sheet

December 2016

Introductory statement

Bacteria from the genus *Borrelia* are known to cause disease (primarily in humans). This includes Lyme disease, which is also called Lyme borreliosis and is currently considered to be EXOTIC to Australia. This fact sheet focuses on what is known about tick-borne *Borrelia* species in Australian wildlife and is prompted by the on-going interest in the potential presence of *B. burgdorferi sensu lato*¹ and Lyme-like disease in people in Australia, and the potential role of wildlife in the epidemiology of these diseases.

Aetiology

Borrelia is a genus of spirochaete bacterial organisms, most commonly transmitted by the bites of hard-bodied and soft-bodied ticks. Some *Borrelia* are transmitted by lice, but are not discussed further here. Species or strains of *Borrelia* vary geographically around the world and may also vary among vectors and hosts ^[1].

Newly identified groupings of *Borrelia* include reptile-associated *Borrelia* sp. ^[2] and a novel group in Australia, associated with ticks from echidnas (*Tachyglossus aculeatus*) ^[3, 4].²

Natural hosts

Studies overseas have demonstrated the presence of *Borrelia* spp. in many species of mammals ^[1].

The presence of *Borrelia* spp. in bird and lizard species has been documented overseas although there remains limited understanding of the significance of these findings and of the potential role of these species in the ecology of the pathogen ^[1, 2].

World distribution

Borrelia spp. are found throughout the world. The causative agents for Lyme disease in people are considered endemic in North America and Europe, with infection in humans increasingly being reported in Asia ^[1].

¹ *Sensu lato* meaning in the broad sense.

² A group of *Borrelia*, known as the “relapsing fever” *Borrelia* cause disease in humans. Lyme disease in humans is caused by *Borrelia* within the grouping *B. burgdorferi sensu lato*; a complex consisting of at least 14 different genomic species **See Appendix 1.**

There have been reports suggesting the presence of isolated cases of *B. burgdorferi sensu lato* in people with Lyme-like skin lesions in Brazil via immunohistochemistry^[7] and from ticks (via PCR) in Uruguay^[8]. The presence of the agent in South America is not considered confirmed (C. Nelson pers. comm. Nov 2016).

Occurrences in Australia

There is little information on *Borrelia* spp. in wildlife in Australia:

- Spirochaetes typical in appearance of *Borrelia* spp. were found in the blood of bandicoots (*Isodon obesulus*) in south-east Qld and kangaroos in western Qld by Mackerras 1959 [9]. In both cases the species involved were not stated.
- Carley and Pope 1962 [10] described a new species, *B. queenslandica* in native long-haired or plague rats (*Rattus villosissimus*) during a population eruption in north-western Qld in 1956, and demonstrated a relapsing infection in experimentally infected laboratory rodents.
- Ladds 2009 [11] described an anecdotal report of the identification of a *Borrelia* sp. on DNA probe analysis of growth on tissue culture media of kidney and urine from a captive red kangaroo (*Macropus rufus*) held overseas, affected by acute uveitis and retinal degeneration.
- A novel *Borrelia* sp. was reported in numerous *Bothriocroton concolor* ticks and a single *Ixodes holocyclus* tick harvested from echidnas in Qld, NSW and Victoria^[3, 4]. It was proposed that the species identified formed a unique clade within the genus. A range of other bacteria with zoonotic potential were also identified in ticks during the study by Gofton et al. 2015 [3].

Testing of small numbers of native bush rats (*Rattus fuscipes*), long-nosed bandicoots (*Perameles nasuta*) and brown antechinus (*Antechinus stuartii*), trapped on the south coast of NSW, found no evidence of infection with *Borrelia* spp. in these putative hosts^{[12]3}.

Epidemiology

Rodents are considered the main vertebrate reservoir host for most species of *Borrelia*^[5, 6]. Deer are not considered competent reservoir hosts, but are necessary for maintenance of tick populations that support *Borrelia* spp. in many areas of the USA. The presence of *Borrelia* spp. has also been reported in bird and lizard species overseas but the significance of these findings is not understood^[1, 2].

It has also been suggested that migratory birds may transport tick vectors, play a role as biological carriers of *Borrelia* spp. (including zoonotic species) and be a potential source of introduction of *Borrelia* spp. to new geographic areas^[15]. However, further transfer to other maintenance hosts in Australia is considered unlikely^[16].

³ *Borrelia theileri* (cattle) and *B. anserina* (poultry) are endemic in Australia and were introduced through the agricultural industry more than 50 years ago. There have been no confirmed reports of *B. burgdorferi sensu lato* in wildlife, domestic animals or ticks in Australia. The role of Australian wildlife in the epidemiology of *B. theileri* and *B. anserina* in production animals in Australia is not known.

Black rats (*Rattus rattus*), house mice (*Mus musculus*), a range of feral deer species, red fox (*Vulpes vulpes*) and brown rats (*Rattus norvegicus*) are known reservoirs of *B. burgdorferi sensu lato* in the northern hemisphere, and are widespread as feral species in Australia ^[16]. Other rodent species, not present in Australia, are also considered important reservoirs of the agent in the northern hemisphere. It is considered less likely that Australian native marsupials would act as competent reservoirs for *B. burgdorferi sensu lato* (P. Irwin pers. comm. March 2016).

The epidemiology of the novel *Borrelia* sp. identified in echidna ticks is not known, nor is it understood if echidnas become bacteraemic following bites from infected *B. concolor*. The potential role of echidnas, or other mammalian species, as reservoirs for novel *Borrelia* spp. in Australia has yet to be explored. Research is ongoing to identify Australian ticks that could act as vectors for Australian *Borrelia* spp. and other tick-borne pathogens ^[3, 4] (P. Irwin pers. comm. March 2016).

Clinical signs

In other countries, infection with *Borrelia* spp. (including *B. burgdorferi sensu lato*) is reported to have little or no clinical effect on wildlife ^[1]. What little information is available suggests that this may also be the case with Australian wildlife (see Occurrences in Australia for citations).

Diagnosis

Detection of *Borrelia* spp. can be by culture or polymerase chain reaction (PCR); however *Borrelia* spp. are difficult to culture, making investigation and diagnosis of novel infections challenging ^[1]. Dark field microscopy or special stains are required to visualise the bacteria. *Borrelia* spp. in vertebrate hosts are not often found in blood, urine, joint fluid or CSF. The organism is more consistently found in connective tissue, synovia, skin or fibroblasts ^[17].

Serologic tests for antibodies against *Borrelia* spp. include enzyme-linked immunosorbent assays (ELISA), indirect fluorescent antibody assays and antigen preparations. An immunohistochemical method, focus floating microscopy (FFM), has been used for histopathological diagnosis ^[18] but may be prone to false positive results (C. Nelson pers. comm. Nov 2016).

Studies undertaken in zoo animals indicated the applicability of a non-host specific ELISA for serological diagnosis of *B. burgdorferi sensu lato* in a range of wildlife species held in zoos ^[19].

Specific diagnostic tests are not available for Australian native wildlife and the sensitivity and specificity of other commonly used tests is not known.

Pathology

There is no information on pathology associated with *Borrelia* spp. infection in Australian wildlife. Lesions relating to Lyme borreliosis in domestic animals include arthritis, glomerulonephritis and uveitis. Tissue damage may be immune-mediated in nature ^[17].

Laboratory procedures

Tissue sections for histopathological diagnosis are preferentially taken from skin around a tick bite area, or if possible, from the organ suspected to be most affected.

Treatment

There are currently no recommendations for treatment of *Borrelia* spp. infection in Australian wildlife. Domestic species clinically affected by *Borrelia* spp. may respond to tetracycline antibiotics.

Prevention and control

Prevention of tick-borne diseases (including *Borrelia* spp.) is primarily achieved through minimising tick bite exposure and prompt removal of attached ticks. If a significant tick-borne zoonotic *Borrelia* (or other bacteria) in Australian wildlife was to be identified, prevention and control measures may be warranted. Any such intervention would likely be informed by prevention and control strategies for Lyme disease that are applied overseas. At present, given the apparent lack of clinical effect of *Borrelia* found thus far in Australian native animals, prevention and control does not appear to be warranted.

Surveillance

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information <https://wildlifehealthaustralia.com.au/Our-Work/Surveillance> and <https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System>.

At 20 April 2016, eWHIS contained no reports of *Borrelia* spp. infection in any native or feral species. Wildlife Health Australia would welcome definitive, laboratory confirmed reports of infection of Australian wildlife with *Borrelia* spp. for inclusion in the national dataset.

Research

Current research priorities for *Borrelia* spp. in Australia are driven by on-going interest in the possible presence of a tick-borne Lyme-like pathogen. Potential areas of research have been summarised by Mackenzie 2013 [20] and Chalada et al. 2016 [16]:

- The potential presence (and prevalence) of *B. burgdorferi sensu lato* in Australian ticks (especially in *I. holocyclus*).
- The possibility for other Australian tick species to be infected with, maintain, and transmit *B. burgdorferi sensu lato* and other *Borrelia* spp.
- The likelihood that *B. burgdorferi sensu lato* (if introduced into Australia by e.g. migratory birds or infected humans) could establish itself in an endemic cycle with indigenous ticks and wildlife.
- The presence and prevalence of indigenous species of *Borrelia* able to infect humans and to cause Lyme-like disease.

- The presence of other pathogens transmitted by Australian ticks which cause Lyme-like disease.
- The potential vertebrate hosts and reservoirs for Australian *Borrelia* or other tick-borne pathogens.
- Identification of the vertebrate species that act as food sources for vector ticks, and hence may have a role in the disease ecology of tick-borne zoonotic diseases in Australia.
- The ecology of endemic ticks considered capable of transmitting pathogens, including zoonoses.
- The prevalence and significance of relapsing fever and other *Borrelia* spp. found in Australia.
- The potential role of *Borrelia* spp. or other tick-borne pathogens in disease syndromes in domestic animals, feral animals or wildlife in Australia.
- Reliable diagnostic tools to search for and identify tick-borne pathogens in Australia, including diagnostic tools for wildlife.

It would be useful to consider the role of Australian wildlife in all these areas.

Human health implications

Carley and Pope 1962 [10] inoculated a volunteer human subject with *B. queenslandica*, which they had isolated from *R. villosissimus*. The volunteer did not develop any signs consistent with spirochaete infection. Additional information on Lyme disease and Lyme-like disease in Australia is presented in Appendix 1.

Conclusions

There is on-going interest in the potential presence of *B. burgdorferi sensu lato* in Australia and the potential role of wildlife in its epidemiology. A novel *Borrelia* sp. of unknown significance has recently been identified from ticks present on echidnas. Further research is recommended on the presence of *Borrelia* spp. in Australian wildlife, their epidemiology and significance.

Appendix 1: Additional information on Lyme-like disease in Australia

For many years, there have been wide-spread reports of Lyme-like disease in humans in Australia, despite the lack of substantive evidence that the causative bacteria are present ^[16, 21]. Syndromes of illness in humans, similar to those seen in classical Lyme disease, have been reported in people who could not have acquired infection overseas. Specific geographic areas of Australia are considered to be “hot-spots” for apparent tick-borne Lyme-like disease e.g. northern beaches area of Sydney, central and north coast NSW and northern Qld (Akinci pers. comm.). Fact sheets providing information on Lyme disease in humans are available online and readers seeking more information should consult their health care professional.

In addition, there have been scattered anecdotal reports of Lyme-like disease in domestic animals in Australia ^[22]. Signs include lethargy and shifting lameness. Affected animals include dogs, horses and livestock. Geographic areas include the Hunter Valley and Manning River districts of NSW ^[23]. Regardless of the veracity of these reports, the situation with respect to potential tick-borne pathogens in Australia (particularly those causing a Lyme-like range of symptoms) remains unclear and would benefit from further research and clarification.

It has been argued to that any potential pathogen responsible for Lyme-like disease in Australia is likely to be significantly different from those described in the northern hemisphere and may fall outside the *Borrelia* genus. Additionally, such currently unrecognised pathogens may have substantially different disease ecology (including modes of transmission) to *B. burgdorferi sensu lato* ^[20]. Nevertheless, based on experience overseas, ticks as vectors and native wildlife as reservoir hosts are considered to be likely parts of the ecology of any infectious agents responsible for Lyme-like syndromes in Australia ^[3, 12, 16].

Prevention of tick borne-zoonoses

Prevention of Lyme disease and other tick-borne zoonoses in humans is primarily achieved through avoidance of tick-infested areas; the use of repellents (particularly those containing DEET); wearing of light-coloured clothing so that ticks are more easily seen; and prompt removal of attached ticks. The majority of tick bites received by humans in Australia are from *I. holocyclus* and *H. longicornis* Mackenzie 2013 [20]. Transmission of spirochaetes generally, and *Borrelia* spp. in particular, does not occur until more than 24 hours after attachment of the tick ^[6]. Attempts to reduce the incidence of human Lyme disease in endemic areas of the USA through reduction in white-tailed deer numbers (the primary host supporting vector ticks during their life cycle in the USA) were not considered successful ^[24].

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Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to

land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

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