Wildlife Health AUSTRALIA

Babesia and *Theileria* (piroplasms) in Australian wildlife

Fact Sheet

March 2024

Key points

- Piroplasms are protozoan parasites that infect the red blood cells of various mammals and birds worldwide.
- *Babesia* and *Theileria* are piroplasms which are known to infect Australian wildlife.
- Ticks are the likely vectors for piroplasms, posing a potential risk of spillover from wildlife to domestic animals and people.
- The clinical significance of piroplasms in Australian animals is not well understood. However, there are isolated reports linking these parasites to diseases in native wildlife, mainly associated with immunocompromised animals.
- Additional investigations are required to better understand the epidemiology, biology, pathogenicity and zoonotic potential of these pathogens.

Aetiology and natural hosts

The Order Piroplasmida includes three genera: *Babesia*, *Theileria* and *Cytauxzoon*. Of these, *Babesia* and *Theileria* are known to infect Australian wildlife. Species of *Babesia* and *Theileria* are known to infect a wide range of native and non-native mammals. Ticks removed from Australian native mammals have been found to contain DNA from *Babesia* and *Theileria*, but more research is needed to confirm if these ticks are capable of transmitting these parasites to wildlife.

One Health implications

Wildlife and the environment: some reports suggest piroplasms can cause disease in Australian wild mammals. Infections with *Babesia* and/or *Theileria* might pose an additional threat to native animals already stressed by factors such as human encroachment and habitat degradation.

Domestic animals: in general, piroplasms described in native Australian wildlife have not been found in domestic animals in Australia. *Babesia vogeli* (originally known as *B. canis*) has been reported in domestic dogs (*C. lupus familiaris*), dingoes (*Canis lupus dingo*), and dingo/domestic dog hybrids.

Humans: piroplasms infecting native Australian animals are not known to be zoonotic. A single case of human babesiosis caused by the exotic *B. microti* in an Australian patient with no recent travel history has been reported [1, 2]. Despite investigations, including large-scale blood donor screening, no additional cases have been identified [3]. The origin of the infection, possibly linked to a local tick and introduced rodents, remains unclear.

World distribution and occurrences in Australia

Babesia and *Theileria* spp. have been recorded worldwide. A range of indigenous species and genotypes of *Babesia* and *Theileria* have been described in Australian native animals (Table 1), in most states and territories of Australia [4]. Piroplasms have been reported in a range of monotreme, dasyurid, macropod, possum and potoroo species, as well as in little penguins. However, there has been no systematic investigation of their epidemiology, life-cycle, pathogenicity and zoonotic potential.

Table 1. Piroplasms recorded in Australian free-ranging wildlife

Piroplasm species	Host	Reference
Babesia tachyglossi/ (*Theileria tachyglossi)*	Short-beaked echidna (*Tachyglossus aculeatus*)	Priestley 1915 [5], Backhouse and Bolliger 1959 [6], Mackerras 1959 [7], Šlapeta et al. 2017 [8]
T. ornithorhynchi	Platypus (*Ornithorhynchus anatinus*)	Šlapeta et al. 2017 [8], Mackerras 1959 [9], Whittington and Grant 1984 [10], Collins et al. 1986 [11], Munday et al. 1998 [12], Kessell et al. 2014 [13], Paparini et al. 2015 [14]
B. lohae	Brush-tailed possum (*Trichosurus vulpecula*)	Egan et al. 2021 [15], Gofton et al. 2022 [16]
B. macropus	Agile wallaby (*Macropus agilis*) Swamp wallaby (*Wallabia bicolor*) Red-necked wallaby (*M. rufogriseus*) Eastern grey kangaroo (*M. giganteus*) Eastern bettong (*Bettongia gaimardi*)	Vogelnest and Portas 2008 [17], Dawood et al. 2013 [18], Donahoe et al. 2015 [19], Barbosa et al. 2019 [20]
B. thylacis	Northern brown bandicoot (*Isoodon macrourus*) Northern quoll (*Dasyurus hallucatus*) Southern brown bandicoot (*I. obesulus*)	Mackerras 1959 [7], Bangs and Purnomo 1996 [21]
B. vogeli	Dingo (*Canis lupus dingo*) Dingo/ domestic dog (*C. lupus familiaris*) hybrids	Clark et al. 2004 [22], Barker et al. 2012 [23]
Babesia sp.	Agile antechinus (*Antechinus agilis*) Brown antechinus (*A. stuartii*) Proserpine rock-wallaby (*Petrogale persephone*)	Clark et al. 2004 [22], Barker et al. 1978 [24], O'Donoghue and Adlard 2000 [25]
Babesia sp.	Brush-tailed bettong (*B. penicillata*)	Paparini et al. 2012 [26]
Babesia sp.	Northern brown bandicoot	Barbosa et al. 2017 [27]
Babesia sp.	Brush-tailed bettong	Vogelnest and Portas 2008 [17], Northover et al. 2019 [28]
Babesia sp.	Tasmanian devil (*Sarcophilus harrisii*)	Egan et al. 2020 [29]
Babesia sp.	Brush-tailed possum	Egan et al. 2021 [15]
Babesia sp.	Little penguins (*Eudyptula minor*)	Vanstreels et al. 2015 [30]

Piroplasm species	Host	Reference
T. apogeana	Brush-tailed bettong	Northover et al. 2019 [28]
T. brachyuri	Quokka (*Setonix brachyurus*)	Clark and Spencer 2007 [31]
T. fuliginosa	Western grey kangaroo (*M. fuliginosus*)	Clark and Spencer 2007 [31]
T. gilberti	Gilbert's potoroo (*Potorous gilbertii*)	Lee et al. 2009 [32]
T. lupei	Eastern quoll (*Dasyurus viverrinus*) Quokka Swamp wallaby	Barbosa et al. 2019 [20]
Theileria cf. *paparinii*	Burrowing bettong (*B. lesueur*) Brush-tailed rock-wallaby (*P. penicillata*) Eastern bettong Eastern grey kangaroo (*M. giganteus*) Eastern quoll Long-nosed potoroo (*P. tridactylus*) Quokka Swamp wallaby Yellow-footed rock-wallaby (*P. xanthopus*)	Barbosa et al. 2019 [20], Paparini et al. 2012 [26], Lee et al. 2009 [32], Portas et al. 2020 [33]
T. penicillata	Brush-tailed bettong Long-nosed potoroo (*P. tridactylus*)	Clark and Spencer 2007 [31], Lee et al. 2009 [32], Rong et al. 2012 [34]
T. peramelis	Long-nosed bandicoot (*Perameles nasuta*) Long-nosed potoroo Northern brown bandicoot (*I. macrourus*)	Mackerras 1959 [7]
Theileria cf. *peramelis*	Long-nosed bandicoot	Egan et al. 2021 [15], Gofton et al. 2022 [16]
T. worthingtonorum	Gilbert's potoroo	Barbosa et al. 2019 [20]
Theileria sp. clade E	Quokka	Barbosa et al. 2019 [20]

Epidemiology

Babesia and *Theileria* spp. are transmitted to the vertebrate host by a tick vector during a blood meal. *Babesia* spp. injected into the host bloodstream enter the red blood cells (RBC) and multiply through asexual division, while *Theileria* spp. also invade the lymphocytes where multiplication occurs. Eventually host cells are ruptured allowing the parasites to invade other blood cells.

Studies of piroplasms in Australian mammals give some idea of possible prevalence, host-range and geographic distribution. However, our understanding of the epidemiology of these pathogens in Australia remains relatively limited.

Observations of *Babesia* spp. and *Theileria* spp. within many apparently clinically normal Australian wildlife species suggest that these species of piroplasms are usually non-pathogenic. However, immunosuppressed hosts may suffer clinical disease. For example, *B. macropus* infection has been associated with a syndrome of anaemia and debility in hand-reared and free-ranging juvenile eastern grey kangaroos (*Macropus giganteus*) and other macropods from coastal NSW and south-eastern Qld [17-19]. As most of the infected kangaroos were hand-reared, it is possible that the stress of handling and captivity contributed to the development of disease. Hand-reared kangaroos may also be more susceptible to developing babesiosis due to lack of protective antibodies acquired from their mother's milk, and reduced exposure to natural parasites compared to free-ranging kangaroos [18]. Ticks belonging to *Haemaphysalis* spp. *and Ixodes* spp. are believed to be potential carriers of *B. macropus*, transmitting it to macropod hosts. More research is required to confirm this.

Clinical signs

In domestic animals, clinical signs depend on the infecting species and susceptibility of the host. Signs generally include anaemia, as well as fever, anorexia, depression and blood-stained faeces [35].

Male mortality in the brown antechinus after mating has been associated with high levels of *Babesia* sp., haemoglobinuria and haemosiderosis [24, 36]. Infection with piroplasms was implicated in the deaths of 12 captive short-beaked echidnas [37], anaemia in bandicoots [7], and fatal haemolytic anaemia in a platypus [13].

The syndrome of haemolytic anaemia and debility in free-ranging juvenile macropods, attributed to *B. macropus* infection, is characterised by regenerative anaemia, lethargy and neurological signs, often leading to death. Clinical signs also include polydipsia, polyuria, and tendency to bleed excessively from venipuncture and tick attachment sites. Neurological signs are believed to be linked to the sequestration of parasitised erythrocytes in the central nervous system [17-19].

Diagnosis

- Examination of peripheral blood smears stained with a Giemsa, Leishman's or Wrights stain. Species of *Babesia* and *Theileria* can be observed in the RBC, while *Theileria* spp. may also be seen in the lymphocytes (see Figure 1).
- It is extremely difficult to identify genus and species with basic techniques, due to similar morphology of the piroplasms. PCR methods can be used for species identification.
- PCR is more sensitive than microscopy for detection, particularly in chronic or subclinical cases.
- Indirect fluorescent antibody (IFA) tests are useful for detecting low levels of parasitaemia.

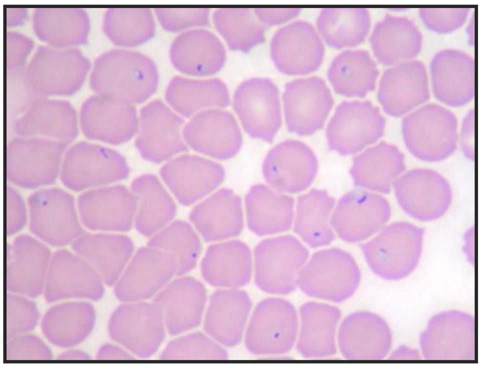

Figure 1. Giemsa stained blood smear from a Gilbert's potoroo. *Theileria gilberti* observed in erythrocytes (credit Jeremy Lee).

Pathology

Anaemia associated with intravascular haemolysis is typically observed in clinical cases. A packed cell volume of less than 10% is common in macropods with severe babesiosis. There may also be hypoproteinaemia (with total protein levels as low as 30 g/L), thrombocytopaenia, neutropaenia, hyperamylasemia, azotaemia and bilirubinaemia [17]. Necropsy findings in affected animals include diffuse pallor, thin blood, widespread petechiae, ecchymoses, tissue oedema, splenomegaly and generalised lymphadenomegaly [19].

Differential diagnoses

Differential diagnosis will include other causes of haemolytic anaemia.

Laboratory diagnostic specimens

- Whole blood smears air dried and stained for microscopy analysis. If not staining immediately, allow slide to dry and then fix in 100% methanol or 70% ethanol for later staining.
- Whole blood stored in EDTA tubes and frozen can be used for later molecular characterisation. Haematological evaluation must be done on fresh samples before freezing.

Treatment, prevention and control

Supportive care including fluid therapy, nutritional and thermal support is indicated for individuals with clinical signs associated with piroplasmosis. A wide range of antiprotozoal drugs are available for the treatment of babesiosis in domestic animals but these often have toxic side effects. There is anecdotal evidence of macropods with babesiosis responding to treatment with imidocarb.

Prevention and control can only be achieved by limiting exposure to the tick vector which is not considered feasible for wild populations.

Research

Current research is focused on the molecular identification, phylogeny, epidemiology and ecology of these parasites, as well as investigation of their vector tick species (Irwin P, pers. comm.). More research is required on the biology and clinical significance of haemoparasites in Australian native animals.

Surveillance and management

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.

We encourage those with laboratory confirmed cases of this condition in native Australian or feral animals to submit this information to the national system for consideration for inclusion in the national database. Please contact us at admin@wildlifehealthaustralia.com.au.

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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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