Giardia infection in Australian wildlife

Fact sheet

January 2023

Key points

- *Giardia* spp. are enteric protozoal parasites capable of infecting a wide range of hosts.
- Infection with *Giardia* occurs in wild Australian mammals, birds, amphibians and fish.
- Clinical gastrointestinal disease appears to be extremely rare in wildlife hosts.
- *Giardia* organisms are extremely environmentally robust.
- Further research is required to investigate the impact of *Giardia* infection on the health of Australian species.

Aetiology

Giardia is a genus of flagellate protozoa within the family *Hexamitidae* that infects the gastrointestinal tract of vertebrate animals (Ryan and Zahedi 2019). Eight *Giardia* species have been formally described, many of which are relatively host-specific, with the exception of *G. duodenalis* (also known as *G. intestinalis* and *G. lamblia*) which has been detected in a wide variety of host species (Santin 2020). *Giardia duodenalis* is subdivided into at least eight assemblages (A-H) with each having variable host specificity (Ryan et al. 2019). Ongoing studies of *Giardia* in wildlife continues to lead to the discovery of novel genotypes (Wait et al. 2017).

One Health implications

Humans: infectious diarrheal diseases such as giardiasis represent a major public health concern, particularly for children and the immunocompromised in developing countries (Dixon 2021). *Giardia duodenalis* is the most common intestinal parasite found infecting humans in developed countries (Cacciò and Ryan 2008). Risk points of concern for zoonotic transmission from wildlife into the human population in Australia include roof-harvested rainwater tanks, natural shared water sources and water catchments for major cities (Waters et al. 2019).

Domestic animals: transmission of *Giardia* can occur between species and clinical disease has been reported in domestic species.

Wildlife and the environment: clinical disease as a result of *Giardia* infection is very rarely reported in Australian wildlife species.

Natural hosts

Giardia spp. parasitise an extensive vertebrate host range. *Giardia duodenalis* assemblages A and B typically infect a variety of mammalian hosts, with cases also recorded in birds, reptiles and fish (Ryan and Zahedi 2019). Assemblages C-H are assumed to be more host-specific (C and D are found in canids, E in livestock, F in felids, G in rodents and H in pinnipeds), however variability of susceptible hosts has also been observed (Heyworth 2016).

Generally, *G. peramelis* tends to infect marsupials, *G. cricetidarum*, *G. microti* and *G. muris* rodents, *G. ardeae* and *G. psittaci* birds and *G. agilis* amphibians (Santin 2020).

World distribution

Giardia is globally distributed, excluding Antarctica (Palacios et al. 2010). Wildlife infection has been reported in Africa (Sak et al. 2013), Asia (Zhang et al. 2021), Oceania (Barbosa et al. 2017), North America (Fayer et al. 2006), South America (Fehlberg et al. 2021) and Europe (Solarczyk et al. 2019). The prevalence, distribution, parasite species and affected hosts varies with region.

Occurrences in Australia

Giardia has been detected widely in wildlife across Australia and in a wide variety of host species, with marsupials making up the vast majority of reported infections. Appendix 1 summarises the reported wildlife host range in Australia. Estimated prevalence of *G. duodenalis* in marsupials is generally lower on the mainland (typically 1.3–13.8 %) than in Tasmania (6.25–61.5%) (Wait et al. 2017), perhaps due to differences in climate.

Marsupials most commonly carry *G. duodenalis*, often the zoonotic assemblages A and B. Quendas (*Isoodon obesulus*) and Tasmanian devils (*Sarcophilus harrisii*) have been confirmed to also carry their own largely host-specific genotypes: *G. peramelis* (Hillman et al. 2016) and *Giardia* sp. TD type 1 and 2 (Wait et al. 2017). *Giardia cricetidarum* and *G. muris* are the only species *not* reported in Australian wildlife. Given the limited studies in Australian wildlife, it is likely that new types of *Giardia* will continue to be described, and it may be that these new types have a wider host range.

Epidemiology

Giardia is transmitted faecal-orally (directly and indirectly) via the cyst stage of the parasite lifecycle. The cyst is environmentally robust and can persist in the both soil and water (Dixon 2021). Transmission typically occurs via shared food or water sources and, given the broad host range of some *Giardia* assemblages, can occur between different species, including between animals and humans (Jones and Tardieu 2021).

Once the infectious cysts have been ingested, they release their replicative trophozoite stage in the small intestine where they attach to the epithelial cells and absorb host nutrients. Trophozoites complete the lifecycle by transforming into new cysts that are excreted in faeces. The incubation period is typically 1-2 weeks (Mughal et al. 2021).

The spread and transmission of *Giardia* is impacted by a changing climate. Increased frequency and severity of precipitation events and rising temperatures are likely to see a corresponding increase in *Giardia* outbreaks (Chhetri et al. 2019). The risk of outbreaks can be exacerbated if these rainfall events follow periods of drought and associated pathogen build-up in groundwater is flushed out when the environment becomes saturated (Lal et al. 2013). As *Giardia* is prone to spillover between humans and animals, proximity to urban centres corresponds with higher prevalence of *Giardia* in Australian wildlife populations (Delport et al. 2014). Developing a more robust understanding of *Giardia* epidemiology in Australian wildlife will be necessary for the continued ability to monitor how increased urbanisation of natural habitats, unnatural species mixing, and climate change may drive shifts in the host-parasite relationship in the future.

Clinical signs

Infections in Australian wildlife are frequently asymptomatic. Juveniles and the immunocompromised are at greater risk of developing clinical disease, which can range from mild to fatal (Filippich et al. 1998). Disease, when it occurs in domestic livestock, typically presents with watery diarrhoea and associated dehydration, gastroenteritis, appetite loss, reduced weight gain, lethargy and, occasionally, death (Santin 2020). Infected birds may also exhibit erythema and a loss of normal escape behaviour (Ladds 2009). Signs of disease in wildlife have not been described.

Diagnosis

Giardia infection may be diagnosed by detection of cysts or trophozoites in faecal samples by microscopy and immunofluorescence techniques, or by PCR (Filippich et al. 1998). Molecular techniques can identify *Giardia* to species and assemblage level (Thompson and Ash 2019). *Giardia* cysts are shed intermittently and so multiple faecal samples from each individual taken over a period of time are recommended (Piggott and Taylor 2003; Adams et al. 2004).

Diagnostic methods are not standardised for wildlife and the most suitable method may vary with context. Microscopy can be a useful tool in non-laboratory settings. PCR is typically a first choice but is not always reliable, outside of testing for *G. duodenalis* (Thompson and Ash 2019). Rapid faecal antigen detection tests, including enzyme-linked immunosorbent assay (ELISA) may have low accuracy (Dixon 2021).

Laboratory diagnostic specimens and procedures

For light microscopy and antigen detection: Fresh faecal samples collected into sterile containers and preserved in 10% formalin, merthiolate-iodine-formalin (MIF), sodium acetate-acetic acid-formalin or polyvinyl alcohol (PVA) (Chaudhry et al. 2020).

For molecular testing: Fresh faecal samples collected into sterile containers stored unpreserved at 4°C for short periods of time or mixed with 2.5% potassium dichromate for up to one month before testing (Dixon 2021).

Direct faecal examination: light microscopy of wet mounts and concentrated faecal smears is used to detect *Giardia* cysts or trophozoites. Concentration and staining techniques may be helpful (Dixon 2021).

DNA sequencing: PCR testing is used to identify the species and assemblages of *Giardia*, as well as confirming the presence of infection.

Antigen detection: Commercially available immunochromatographic assays allow for quick diagnosis in the field. These include faecal ELISA kits such as the SNAP® Giardia test and Speed® Giardia that have been developed for companion animals and livestock respectively (Mughal et al. 2021).

Pathology

Pathological changes are rare in Australian wildlife and are typically restricted to the small intestine. In birds, gross lesions include hyperaemic intestinal mucosa (Ladds 2009), but lesions in other wildlife species are not described.

Histologically, in affected domestic species, large numbers of *Giardia* cysts and pear-shaped trophozoites may be visible in the epithelial intestinal lumen (Ludlage and Mansfield 2003). Villus atrophy, decreased villus length, villi fusion and lamina propria infiltration by lymphocytes may also be observed (Santin 2020).

Differential diagnoses

When present, the clinical signs associated with giardiasis are typical of generic gastrointestinal disease. Due to the infrequency of *Giardia* infection resulting in disease in wildlife species, other, more common causes of diarrhoea, gastroenteritis and failure to thrive should be considered if these signs occur, including other enteric pathogens such as *Salmonella* spp., *Coccidia* or *Escherichia coli*.

Treatment

The principles of treating giardiasis involve maintaining hydration and electrolyte balance throughout the course of diarrhoea, while minimising cyst transmission (Dixon 2021). No treatment drugs are registered for use in wildlife. However, budgerigars (*Melopsittacus undulatus*) treated for five days with metronidazole were shown to test negative for *Giardia* infection (Filippich et al. 1998). The use of probiotics has also seen some success in animal trials (Jones and Tardieu 2021).

Prevention and control

Preventing outbreaks in captive wildlife relies on regular cleaning of enclosures, quarantining new individuals and regular health assessments and screening for parasites. Organic matter should be removed from floors and other surfaces and 10% ammonia-based solution used for disinfection. Cysts in drinking water can be killed by boiling or with ultraviolet irradiation, chlorine dioxide or ozone treatment (Mughal et al. 2021).

While vaccines against *Giardia* exist for cats and dogs, none currently exist for wildlife species, and the parasite's antigenic variation mechanism makes developing effective vaccines challenging (Dixon 2021). Controlling infection in the wild is difficult as environmental reservoirs of *Giardia* provide sources of ongoing transmission to free-ranging populations.

Research

The species diversity and host ranges of *Giardia* continue to be investigated globally. Key areas of research needed to improve understanding of *Giardia* in Australian wildlife include:

- Clinical and pathological impacts of infection on native species, particularly marsupials. This includes investigation of how such changes may affect populations in the context of multiple stressors and conservation threats.
- Standardisation of *Giardia* detection and reporting methods in wildlife to achieve a more comprehensive understanding of the parasite's true prevalence in Australia.
- The effect of climate change on parasite transmission and impact. The general absence of clinical disease associated with *Giardia* infection in Australian wildlife is attributable to a stable host-pathogen relationship (Hillman et al. 2016). The potential for this balance to be threatened by climate change requires investigation.
- The effectiveness and safety of livestock and companion animal treatment drugs for use in wildlife species.

Surveillance and management

Wildlife disease surveillance in Australia is coordinated by Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. See the WHA website for more information: https://wildlifehealthaustralia.com.au/ProgramsProjects/eWHIS-WildlifeHealthInformationSystem.aspx.

Giardia infection in animals is not a notifiable disease in Australia.

Appendix 1

Giardia species and assemblages that have been identified in Australian wildlife hosts, including both native and invasive species.

***Giardia* species**	**Host species**
G. agilis	Cane toad (*Rhinella marina*)
G. ardeae	Straw-necked ibis (*Threskiornis spinicollis*)[1]
G. canis [2]	Quenda (*Isoodon obesulus*)
G. duodenalis assemblage A	Eastern grey kangaroo (*Macropus giganteus*), quenda, brush-tailed rock-wallaby (*Petrogale penicillata*), common wombat (*Vombatus ursinus*), rabbit (*Oryctolagus cuniculus*), dog (*Canis familiaris*), common planigale (*Planigale maculata*), rufous bettong (*Aepyprymnus rufescens*), tammar wallaby (*Macropus eugenii*), western grey kangaroo (*M. fuliginosus*), parma wallaby, (*M. parma*), red kangaroo (*M. rufus*), yellow-footed rock-wallaby (*Petrogale xanthopus*), southern hairy-nosed wombat (*Lasiorhinus latifrons*), koala (*Phascolarctos cinereus*), long-nosed potoroo (*Potorous tridactylus*), quokka (*Setonix brachyurus*), mountain brushtail possum (*Trichosurus cunninghami*), common brushtail possum (*T. vulpecula*), swamp wallaby (*Wallabia bicolor*), Australian sea lion (*Neophoca cinerea*) , barramundi (*Lates calcarifer*), black bream (*Acanthopagrus butcheri*), mulloway (*Argyrosomus japonicus*), snapper (*Pagrus auratus*), sea mullet (*Mugil cephalus*), water birds[3], and feral deer[3]
G. duodenalis assemblage B	EG kangaroo, quenda, Tasmanian devil (*Sarcophilus harrisii*), brush-tailed rock-wallaby, spotted quoll (*Dasyurus maculatus*), rabbit, tammar wallaby, WG kangaroo, parma wallaby, red kangaroo, yellow-footed rock-wallaby, quokka, swamp wallaby, Australian sea lion, barramundi, black bream, mulloway, snapper, western minnow (*Galaxias occidentalis*), sea mullet
G. duodenalis assemblage C	EG kangaroo, bush rat (*Rattus fuscipes*), dingo (*Canis lupus dingo*), dog
G. duodenalis assemblage D	EG kangaroo, fox (*Vulpes vulpes*)
G. duodenalis assemblage E	EG kangaroo, water buffalo (*Bubalus bubalis*), ash-grey mouse (*Pseudomys albocinereus*), quenda, dingo, fox, dog, barramundi, mulloway, feral deer[c]
G. duodenalis assemblage F	Bush rat
G. microti	Barramundi
G. peramelis	Quenda, common brushtail possum, northern quoll (*Dasyurus hallucatus*), and brush-tailed rabbit-rat (*Conilurus penicillatus*)
G. psittaci	Budgerigar (*Melopsittacus undulatus*)
Giardia sp. TD type 1 and 2	T devil

[1] *Giardia* species differed genetically from *G. ardeae* reference sample used but researchers suggest that they are different strains of the same species

[2] The validity of *G. canis* appears to be contentious as it is frequently omitted from the reported lists of recognised *Giardia* species.

[3] Host species name not provided

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