



# The zoonotic risk of roundworms to pet owners and their families: are we doing enough?

## Key content

### Overview

### Disease in companion animals

### Pharmacokinetics of anthelmintics and the impact on shedding

### Underestimating the impact

### Human infection

### Conclusion

#### Overview

Toxocariasis is an infection caused by the larvae of *Toxocara* spp. roundworms in humans. It is a clinically significant zoonosis, yet it remains a persistent problem in dogs and cats worldwide despite readily available and effective anthelmintics.

Whilst toxocariasis is one of the most commonly reported zoonotic helminth infections globally<sup>1,2</sup> it is likely that many human cases are undiagnosed.<sup>3,4</sup> A growing body of research into the incidence and impact of toxocariasis on public health further highlights the role of animal health professionals in keeping pet owners informed of the importance of adhering to regular anthelmintic treatment protocols.

## Disease in companion animals

Three species of roundworms are known to infest dogs and cats: *Toxocara canis* (canine only), *Toxocara cati* (feline only) and *Toxascaris leonina* (canine and feline). *T. canis* and *T. cati* are the most clinically significant species due to their zoonotic potential and capacity to cause disease in dogs and cats.<sup>5</sup> A recent national study of gastrointestinal parasites of dogs and cats in Australia demonstrated prevalence of *T. canis* and *T. cati* as 1.2% and 3.2% respectively.<sup>6</sup>

Dogs and cats can be infested in the following ways:

🐾 **Ingestion of *Toxocara* spp. embryonated eggs** directly by dogs and cats (primary hosts) initiates infestation. Roundworm eggs are shed into the environment in the faeces of infested dogs and cats. The unembryonated eggs shed are not immediately infectious, but can become infective containing third stage (L3) larvae within as little as two to three weeks. Eggs are particularly resistant, with studies showing *T. canis* eggs can develop to the embryonated stage in a range of climates (development occurs quicker at higher temperatures).<sup>7</sup> Patent infestation in adult pet dogs is less common than in puppies. Despite this, due to a comparatively large ratio of adult dogs to puppies, adult dogs account for a significant proportion of eggs entering the environment.<sup>8</sup> When embryonated eggs are ingested by a primary host, the larvae hatch in the small intestine and penetrate the intestinal



## TECHNICAL PRODUCT UPDATE

wall. In puppies and kittens, larvae may develop directly into adults in the intestine, or they can move through the lymphatic or circulatory system to major organs before migrating to the lungs, pulmonary alveoli and bronchial tree. Larvae are subsequently swallowed and return to the intestines to develop into adult worms.

**Transplacental or transmammary transmission.** In older dogs and cats, roundworm commonly undergo arrested development. Larvae travel through the intestinal wall and undergo hepatopulmonary migration before becoming encysted in tissues and organs without completing their lifecycle. In female dogs, encysted larvae can remain infective for several years. Somatic arrested larvae of *T. canis* in mammary glands, muscle tissue and the uterus can reactivate in bitches during heat or late gestation, infesting pups either through transplacental or transmammary transmission. The life cycle of *T. cati* is similar to *T. canis* except there is no known in utero passage in queens; transmammary infestation with *T. cati* can still occur.<sup>9</sup> *T. leonina* differs from other roundworms in dogs as transplacental transmission has not been demonstrated and there is no larval migration of *T. leonina* outside the intestinal tract.<sup>10</sup>

**Cats and dogs that consume paratenic hosts (such as birds and rodents) can become infested.** If a paratenic host (a host which is infested with the sexually immature parasite, but in which no, or only limited development takes place) ingests eggs containing larvae, the larvae can migrate and persist in the tissues in a developmentally arrested stage. Cats and dogs that hunt and consume the paratenic hosts become infested. This mechanism is very important in the transmission of *T. leonina* and *T. cati* infestation.<sup>9</sup>

Clinical disease caused by *T. canis* or *T. cati* infestation typically affects dogs and cats less than one year of age.<sup>9</sup> In adult animals there is usually some degree of acquired immunity and patent infestations are rare, but may occur if immunity is impaired. Young animals are especially vulnerable given their limited resilience to infestation. Infestation can result in severe signs such as



Embryonated *T. canis* egg

pneumonia induced by migrating larvae and intestinal obstruction from adult worms. Puppies and kittens may have a classic 'potbellied' appearance, stunted growth, dull coat, inappetence and diarrhoea. Significant worm burdens can cause intussusception and/or intestinal laceration with fatal peritonitis. *T. leonina* infestation can be found in young and adult carnivores, but is typically asymptomatic and clinical disease is not common.<sup>11</sup>

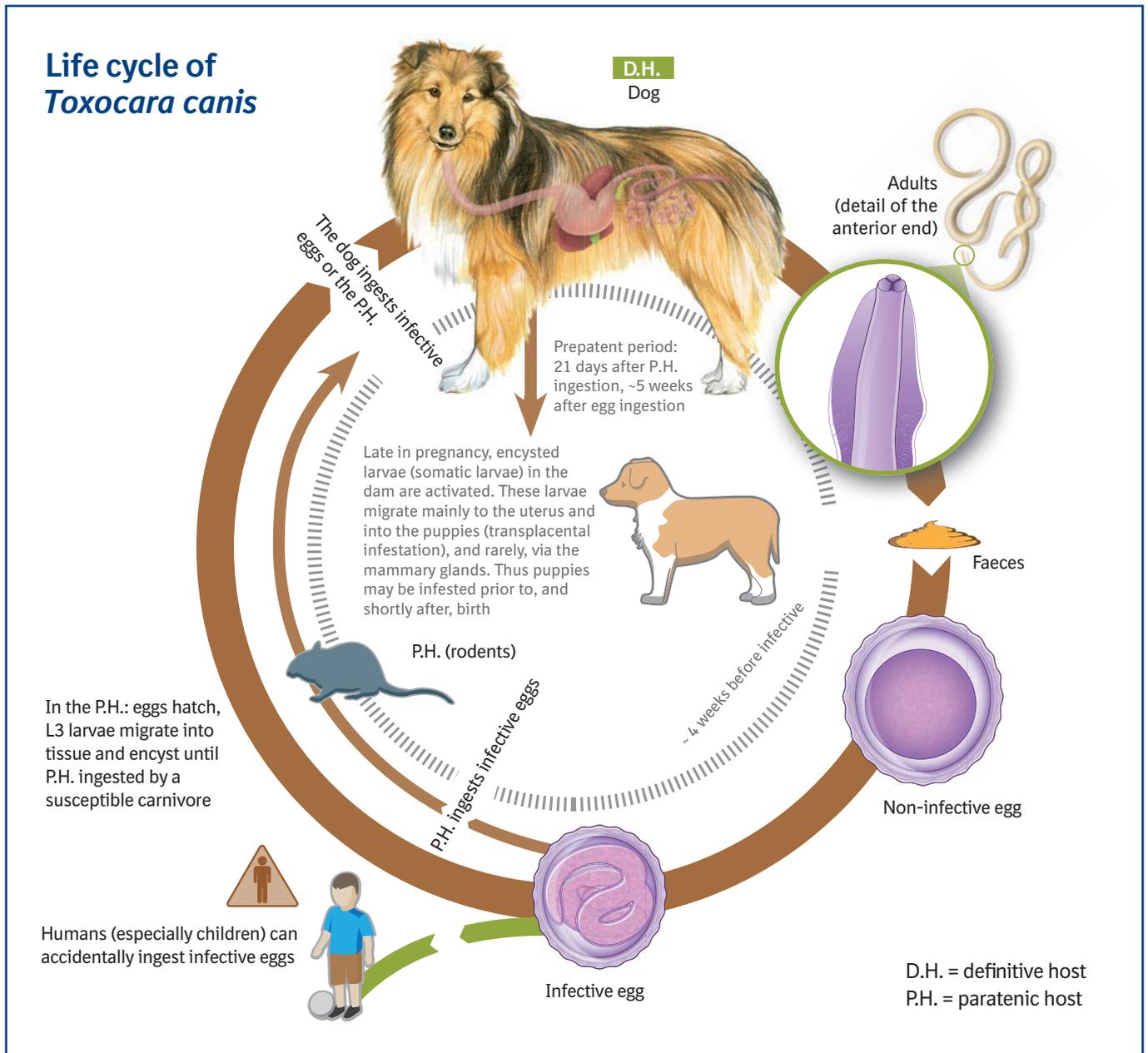
### Pharmacokinetics of anthelmintics and the impact on shedding

Most anthelmintics used in small animal practice will effectively kill adult worms present at the time of treatment, however reinfestation from a contaminated environment can occur within days as they generally provide no residual or ongoing protection. The pre-patent period of *Toxocara* spp. is approximately five weeks after egg ingestion,<sup>9</sup> so dogs and cats can develop a patent infestation with egg shedding in to the environment if deworming is performed less frequently than this.

Female roundworms are highly fecund, laying up to 200,000 eggs per day.<sup>1</sup> Eggs can survive a range of temperatures and are extremely resistant to common disinfectants. The eggs also possess a sticky outer coating, which makes them very difficult to remove from surfaces.<sup>12</sup>

For decades animal health professionals have advocated for a routine deworming regimen for pets of once every three months. However, the number of pets that actually receive treatment at this frequency is very low, with a survey of European pet owners finding that less than 2%





Life cycle of *Toxocara canis*<sup>9</sup>

### Minimise egg shedding with deworming:

Deworming of puppies and kittens must start early and continue monthly to minimise egg shedding by this high risk group. The risk of egg shedding gradually declines with increasing age, but it is important that adult dogs and cats are re-administered anthelmintics within the pre-patent period if egg shedding is to be controlled. Despite the low prevalence of patent infestation in adult animals, by virtue of population size, adult animals account for a significant proportion of environmental egg contamination.



# TECHNICAL PRODUCT UPDATE

of owners treated the recommended minimum of four times yearly.<sup>13</sup> The consequence of poor compliance to this minimum recommendation is significant. Whilst treatment every three months reduces, but does not eliminate patent infections, treatment once or twice per year has little effect on roundworm egg shedding.<sup>9,14</sup>

Globally, numerous parasite control guidelines recommend deworming puppies and kittens every two weeks until eight weeks of age, and then monthly thereafter.

- U The Companion Animal Parasite Council (CAPC) recommends that dogs should be maintained on monthly intestinal parasite control products with efficacy against ascarids.<sup>10</sup>
- U The Tropical Council for Companion Animal Parasites (TroCCAP) endorses control measures for *Toxocara* spp. including monthly deworming.<sup>11</sup>
- U The European Scientific Council for Companion Animal Parasitism (ESCCAP) guidelines recommends **‘As the pre-patent period for *Toxocara* spp. after ingestion of larvae via predation of paratenic hosts (rodents) or infective eggs from the environment is a little over four weeks, monthly treatment will minimise the risk of patent infections and is recommended in risk scenarios, for example when the pet shares a house with small children and has frequent risk of infection (free roaming, access to garden).’**<sup>15</sup>

## Underestimating the impact

Professor Eric Morgan, from the School of Biological Sciences at Queen’s University Belfast, researches the epidemiology of parasite transmission and subsequent impacts on animal health. He states that “the fact that *Toxocara* is ‘old news’ and subject to routine control without much attempt to assess its impact, is allowing continued zoonotic disease in even the most developed countries.”<sup>34</sup>

A major challenge in preventing zoonotic *Toxocara* infections is the ability of roundworm eggs to survive for years in the environment. Human infections occur



through the accidental ingestion of eggs from contaminated soil (gardens, sandpits and parks), or on unwashed hands, objects or raw vegetables.<sup>16,17</sup> Studies from all over the world have demonstrated high rates (13-35%) of soil contamination with *Toxocara* spp. eggs in public places such as sandpits, parks, playgrounds and beaches.<sup>18</sup> Whilst roundworm cannot complete maturation in humans, developing larvae can migrate through the body and result in signs of disease.

## Human infection

In humans, *Toxocara* larvae penetrate the intestinal mucosa and migrate to the liver, lungs and other organ systems (e.g. skeletal muscle, heart, brain and eyes). Migrating larvae are attacked by host immune responses, resulting in local inflammation. A recent, national large study in the United States reported a strong association between serologically confirmed infection with *Toxocara* spp. and diminished cognitive function in children aged 6-16 years in the general population.<sup>19</sup> This relationship was independent of factors such as socio-economic status, ethnicity, gender and rural residence.

**“It is very likely that the human health impacts of this parasite at population level are substantial and vastly underestimated.”<sup>34</sup>**

Prof. Eric Morgan, Queens University, Dublin



A number of clinical syndromes are recognised as being caused by *Toxocara* infection: visceral larva migrans (VLM), ocular larva migrans (OLM), covert or common toxocariasis, and neurotoxocariasis (NLM).<sup>20,21</sup> Severe consequences of human toxocariasis such as blindness, are fortunately rare. Undiagnosed covert infection is, however, likely common and is linked to a wide variety of clinical and subclinical effects, which are difficult to diagnose. A recent meta-analysis of published data estimated that 7.0% of Australians are seropositive for *Toxocara* antibodies, indicating current or prior infection.<sup>22</sup>

## Visceral larva migrans (VLM)

The term visceral larva migrans describes a disease where *Toxocara* larvae invade and systemically migrate through tissue. It is predominantly documented in young children<sup>21,23</sup> with most cases being asymptomatic or subclinical. Tissue migration elicits a host immune response and subsequent eosinophilic inflammation.<sup>5</sup> Clinical signs of VLM are associated with the organ system involved and may include coughing, wheezing, abdominal pain, hepatomegaly and myalgia. Lymphadenopathy, myocarditis and nephritis have also been reported.<sup>21,24</sup> Skin lesions are considered rare but may be associated with toxocariasis, with pruritus, rash and chronic urticaria being reported.<sup>25</sup>

A systemic review has demonstrated an association between the presence of circulating anti-*Toxocara* antibodies and asthma in children.<sup>26</sup>



OLM presenting as unilateral leukocoria © American Academy of Ophthalmology

“Given what we are learning about widespread human disease risks, especially concealed neurological damage, complacent approaches to worming are increasingly unacceptable, and veterinary practices ought to review their approach.”<sup>34</sup>

Prof. Eric Morgan, Queens University, Dublin

## Ocular larva migrans (OLM)

Ocular larva migrans is caused by migration of *Toxocara* larvae into the eye or optic nerve<sup>29</sup> and is primarily reported in children.<sup>27</sup> Migrating larvae can induce granulomatous reactions, which damage the eye and may impair vision.<sup>5</sup> OLM commonly presents as a unilateral disease, with clinical findings including strabismus, unilateral diminished vision, leukocoria, photophobia and ocular granulomas.<sup>21,28,29</sup> The extent of visual acuity impairment depends on the site involved and blindness may result due to scarring of the retina and retinal detachment. A 2004 survey in Ireland revealed a prevalence of almost seven in 100,000 ophthalmologist-diagnosed ocular toxocariasis in school-children.<sup>30</sup>

## Covert toxocariasis

Covert toxocariasis in children, also known as common toxocariasis in adults, is considered challenging to diagnose as symptoms are non-specific. Covert toxocariasis typically describes patients that demonstrate positive *Toxocara* serology linked to a number of systemic and localised clinical signs.<sup>31</sup> In children with covert toxocariasis clinical signs such as fever, abdominal pain, nausea, vomiting, wheezing, cervical lymphadenitis and hepatomegaly may be seen. Common toxocariasis of adults is characterised by weakness, rash, pruritus, pulmonary disease and abdominal pain.<sup>21,25</sup>



# TECHNICAL PRODUCT UPDATE

## Neurotoxocariasis (neural larval migrans - NLM)

Neurotoxocariasis or neural larval migrans (NLM) is a scarcely reported but known syndrome of *Toxocara* infection resulting from central nervous system damage from the migrating larvae. It predominantly occurs in middle aged people and less frequently in children.<sup>32</sup> The main clinical syndromes of neurotoxocariasis are myelitis, encephalitis, meningitis, encephalomyelitis and less commonly, fever.<sup>21,33</sup> Clinical manifestations vary depending on the degree of nervous tissue damage and associated inflammatory response.



## Conclusion

Australian data indicates that 61% of households own a pet, with just over 5 million dogs and an estimated 3.8 million cats in the nation.<sup>35</sup> Alongside growing information on the potential health impacts of zoonotic disease associated with companion animals, veterinarians play a pivotal part in owner education regarding deworming protocols. Most Australian dogs and cats fall into groups identified as at increased likelihood of parasitic infestation by the European Scientific Council for Companion Animal Parasitism (ESCCAP). This includes puppies and kittens, those that hunt, catch prey, eat raw meat diets, are in animal shelters or attend boarding facilities.<sup>15</sup> In addition, dogs and cats with unrestricted access to the outdoors are likely to contribute to contamination of soil with *Toxocara* eggs in parks, public places and backyards. Children, the elderly or immunocompromised individuals in regular contact with companion animals are at the greatest risk of zoonotic disease.<sup>15</sup> Special care should be made to ensure these groups are made aware of the potential health risks of parasitic infections and practical methods to reduce that risk, including the role of regular anthelmintic treatment of companion animals.

### Why does roundworm remain common after decades of treating dogs and cats with effective anthelmintics and council requirements for dog owners to dispose of faeces?

- Greater compliance with regular deworming is necessary to reduce egg shedding.
- Stray animals are likely to contribute to environmental contamination.
- Toxocara* eggs can remain infective for years in the environment.
- Zoonotic risk awareness is likely to be low and the importance of routine anthelmintic control in pets may be underestimated by pet owners.

Whilst the published incidence of human infection with *Toxocara* spp. is limited, the consequences of infection can be severe, and a growing body of literature suggests it is an under-recognised zoonosis. Client education regarding the zoonotic potential and preventative measures, including monthly deworming, is essential to increase awareness and drive behavioural change.



## Client Education

It is likely that community awareness of the zoonotic potential of *Toxocara* is low. Knowledge of the risks can be a driving force for owner behaviour change and veterinarians play a crucial role in driving owner compliance for regular anthelmintic treatment. As egg shedding begins well before the first veterinary consultation, engaging with breeders and owners of new puppies and kittens early regarding deworming protocols is essential.

Although a missed deworming dose will likely have no immediately noticeable consequence to pet owners, an owner's commitment to a deworming recommendation is likely to be increased when they understand the importance and reasoning behind it - including the risk to their own family's health. This need not be alarmist, since patent *Toxocara* infestations are entirely preventable.

## Engage pet owners in a variety of ways:

Education of the general public regarding control of *Toxocara* is crucial. This includes:

- 🐾 Prompt disposal of dog faeces on a daily basis
- 🐾 Protecting playgrounds, garden areas and covering sandpits
- 🐾 Ensuring good hygiene practices, washing hands after handling pets and prior to eating
- 🐾 Preventing children from ingesting soil and faeces
- 🐾 Deworming pets monthly
- 🐾 Limit pet's access to potential paratenic hosts (e.g. rodents)



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