Fighting feline worms: *Toxocara* in cats and its role in human toxocarosis

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Introduction

Toxocara spp. are a group of intestinal nematodes infecting dogs (*T. canis*) and cats (*T. cati*). They are the most common nematodes seen in small animal practice and there is some awareness of the zoonotic risk they pose among the public.

While the role of *T. canis* and environmental contamination through dog fouling is well recognised by veterinary professionals, government and the public, the role of *T. cati* in the epidemiology of human toxocarosis has been more overlooked; recently it has started to come to light as a likely significant contributor to this debilitating zoonosis.

This article discusses human toxocarosis, its control and the role of cats in its transmission.

Toxocara life cycle and transmission in cats

Figure 1. *Toxocara* spp. adults.

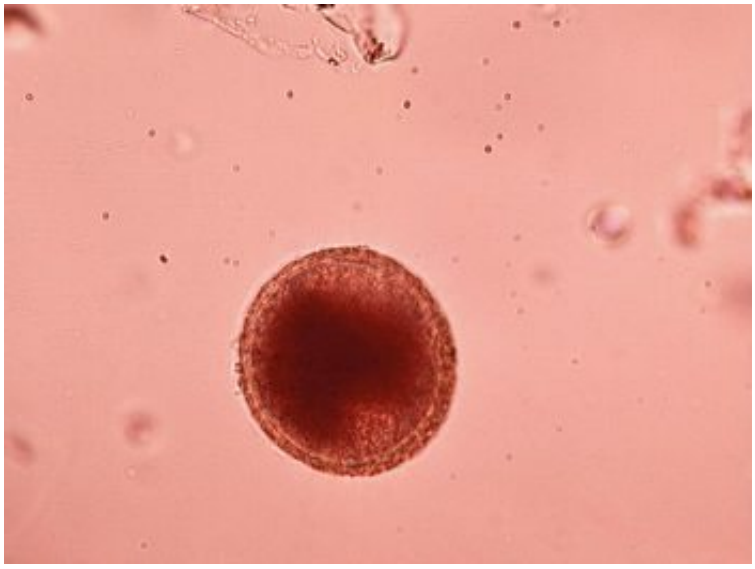

Figure 2. unembryonated *Toxocara* ovum.

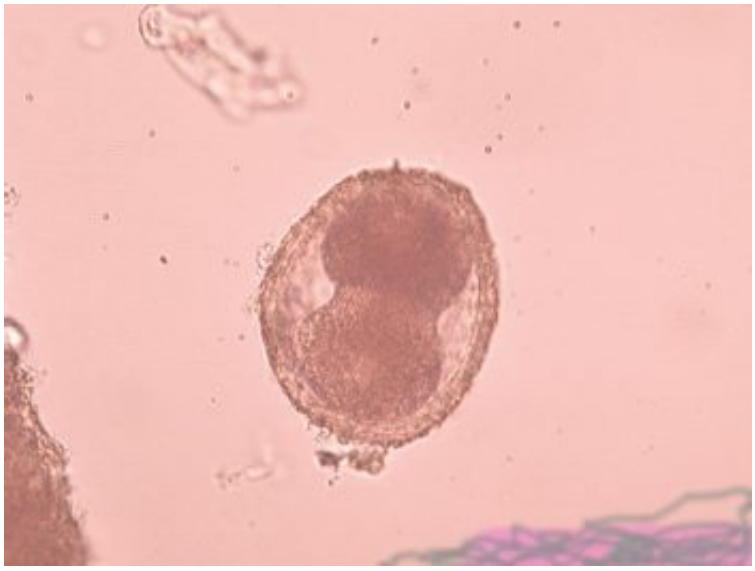

Figure 3. embryonating *Toxocara cati* ovum.

Adult worms (**Figure 1**) lie in the small intestine and shed eggs into the environment via the faeces

of the host.

The eggs when first shed are unembryonated (**Figure 2**) and are not infective. Progression to the embryonated stage is required for infection, so fresh faeces do not present a zoonotic risk.

Nuclear division takes place within the ova (**Figure 3**) until embryonation takes place in two to seven weeks under optimum conditions.

Although cats may be infected by ingesting embryonated eggs, the most important routes of feline infection are trans-mammary infection and consuming paratenic hosts such as rodents. Trans-mammary infection ensures a high prevalence, approaching 100%, in kittens without anthelmintic intervention.

As cats age, they develop a degree of immunity to the parasite, which reduces the chances of worms producing eggs and, as a result, the prevalence of patent infection in adult pets is lower than in kittens but can vary considerably.

The prevalence of *T. cati* in cats in Western Europe has varied between 8% and 76% in recent studies (Overgaauw & Van Knapen 2013). Populations with lifestyles that increase their exposure to paratenic hosts, such as strays and hunting pets, can be expected to have a higher prevalence.

A recent study in the UK found untreated adult domestic cats with outdoor access to have a prevalence of patent *T. cati* infection of 26% (Wright *et al.* 2016), demonstrating that prevalence can still be high in a domestic setting if preventative treatment is not implemented.

The prevalence of patent infection in a population of cats is not static, with shedding of ova being intermittent throughout an individual cat's life. When considering the reduction of environmental contamination, therefore, the potential for adult pets to be reservoirs of infection should not be underestimated.

Zoonotic transmission

Although it has been proposed that people can be infected by eating the undercooked meat of paratenic hosts, such as wild game (Sturchler *et al.* 1990), the most common route of human infection is by the ingestion of embryonated eggs.

It was originally thought that *T. canis* alone was the source of human infection by this route but there is now strong evidence to suggest that *T. cati* is significantly involved as well (Fisher 2003). Exposure to *T. cati* eggs in the environment can occur primarily through one of two routes.

- **Geophagia** – many studies have been carried out in the UK and around the world showing

that embryonated eggs are present in the soil of gardens, parks and children's play areas (Uga 1993, Kirchheimer & Jacobs 2008). Soil provides a more suitable environment than fresh faeces for survival and development of eggs as they need to be shielded from harmful UV light and desiccation. Cats have a predilection for burying their faeces, therefore inadvertently providing ideal conditions for *T. cati* egg survival. Soil may be ingested accidentally or deliberately, especially by children. Cats' preference for defaecation in sand pits and their access to food production areas, such as allotments and kitchen gardens, increase the risk for people playing in or consuming food from these areas.
- **Pica** – *Toxocara* spp. eggs may be transferred onto objects such as unwashed raw fruit and vegetables that are subsequently ingested, or onto toys that children place in their mouth.

A combination of these routes and possibly direct contact with dog fur (Wolfe & Wright 2003) has led to significant numbers of people being exposed to the parasite, with surveys across Europe showing that between 2% and 31% of people have antibodies to *Toxocara* spp. (Overgaauw & Van Knapen 2013).

Fortunately, the incidence of clinical disease is relatively low. Currently approximately two cases per million people are reported in the UK each year. However, this is likely to be a significant underestimate of human toxocarosis cases overall. The wide variety of clinical manifestations make recognition of clinical toxocarosis difficult. Even when cases are confirmed, they may go unreported as it is not a notifiable disease and medical reporting is voluntary.

Although adult infections regularly occur, the most at-risk group are children, commonly between two and four years of age. This may be due to poorer hygiene, pica and geophagia in this group, or a greater susceptibility to infection.

Clinical syndromes

Human toxocarosis presents predominantly in four manifestations:

- **Visceral larval migrans** – migrating larvae lodge in the lungs or liver leading to respiratory signs and/or hepatomegaly associated with a high eosinophilia. Associated clinical signs include fever, weight loss, abdominal pain, anorexia, lethargy and respiratory complications. Less commonly the heart can also be affected by myocarditis.
- **Ocular larval migrans** – migrating larvae in the eye set up a granulomatous reaction, with associated endophthalmitis, choroidoretinitis and uveitis sometimes occurring. This can lead to visual loss, strabismus and blepharospasm. Less commonly, retinal detachment can occur.
- **Neurological larval migrans** – migrating larvae in the nervous system can lead to infarction and meningoencephalitis with subsequent neurological signs, behavioural changes and sleep loss.

- **Covert toxocarosis** – seropositive patients can develop a mild or moderate eosinophilia and associated mild multiple clinical signs. Abdominal pain, headache, cough, lethargy and dermatitis have all been reported.

There is some overlap between syndromes, with *Toxocara* seropositivity also being recognised as a risk factor for a number of distinct medical conditions. Associations have been made between *Toxocara* spp. infection and asthma (Buijs *et al.* 1997, Pinelli *et al.* 2008), eczema, epilepsy (Quattrocchi *et al.* 2012) and cognitive dysfunction (Walsh & Haseeb 2012).

As more risk factors and associations are made, and with a seropositivity in the UK human population of approximately 2% (HPA figure), it can be concluded that morbidity caused by human toxocarosis in the UK is an underestimated and significant problem. Therefore, practical control measures are important to reduce exposure to infection as much as possible.

Control of human toxocarosis

With adequate control measures, human toxocarosis infection may be completely preventable. Control strategies for human toxocarosis involve a combination of measures and these have largely been centred around preventing *T. canis* exposure. Preventing *T. cati* exposure, however, is also important if control of human toxocarosis is to be achieved.

1. **Regular deworming of cats and dogs –** puppies and kittens provide the largest source of potential infection. Treatment of puppies should start at two weeks of age, repeated at two-weekly intervals until two weeks post weaning and then monthly until six months old to prevent egg shedding. Kittens should be treated in the same way but the first treatment can be given at three weeks old as there is no trans-placental transmission. It has been demonstrated that use of an effective anthelmintic every three months in adult dogs significantly reduces *Toxocara* spp. ova shedding (Wright & Wolfe 2007) and there is no evidence that less frequent deworming frequencies will have any effect on egg output. Therefore, this frequency should be a minimum recommendation in dogs and cats. Use of a monthly anthelmintic will reduce egg output by over 90% and whether this is necessary will depend on the pet's lifestyle. **Hunting cats, and those in contact with young children, immune suppressed individuals or individuals with poor hygiene should be dewormed monthly.** *T. cati* is susceptible to a wide range of anthelmintics summarised in **Table 1**.

Anthelmintic class	Examples of anthelmintics in class
Macrocyclic lactones	Eprinomectin (BROADLINE®), milbemycin oxime, moxidectin, selamectin
Tetrahydropyrimidines	Pyrantel
Benzimidazoles	Fenbendazole
Octadepsipeptides	Emodepside

Table 1. classes of anthelmintic suitable for *Toxocara* spp. treatment and prophylaxis in cats.

2. **Minimising environmental contamination with cat and dog faeces –** UK county councils are taking this threat increasingly seriously and have instituted a number of measures, including clearly visible convenient disposal bins, imposing fines for dog fouling, and banning dogs from children's playgrounds and sports fields. The same consideration has perhaps not been given to faecal contamination by cats. Covering sand pits when not in use will help to prevent faecal contamination, as will covering fruit and vegetables intended for raw consumption in allotments. Recent epidemiological modelling based on faecal contamination in urban environments suggest that stray cats may be the dominant contributors to *Toxocara* egg contamination (Nijsse *et al.* 2015), making stray cat control through neutering and rehoming a vital component of human toxocarosis control. This can be achieved through legislation and/or through support of cat charities in promoting neutering and responsible cat ownership.
3. **Good food and hand hygiene –** washing hands after outdoor activities and before eating will help to reduce oral transmission. The washing of fruit and vegetables intended for raw consumption is also important.

Future research and conclusions

Despite extensive research, much is still unknown about the contribution of *T. cati* to human toxocarosis. Future research must concentrate on the relationship between sero-prevalence and zoonotic disease, differentiating between *T. cati* and *T. canis* infection in the human patient, and developing more cost-effective techniques for distinguishing between *T. cati* and *T. canis* ova in the environment.

Until more research in these areas is done, establishing the contribution made by cats towards this

disease must be achieved from the bottom up through statistical modelling, prevalence studies and exposure to cats and cat defaecation areas as risk factors.

Veterinarians can play a role in carrying out prevalence studies in their patients through faecal examination as well as continuing to highlight the zoonotic risk to owners.

The irony is that although the physical and psychological health benefits of pet ownership are now rightly being recognised, the morbidity caused by chronic zoonotic infections such as toxocarosis goes largely unchecked and unquantified. In this respect, veterinarians have a vital role to educate the public and help reduce the incidence of disease.

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*About ESCCAP UK & Ireland.

The European Scientific Counsel for Companion Animal Parasites (ESCCAP) was formed in 2005. It is an independent not-for-profit organisation, comprising a group of eminent veterinarians across Europe, all with recognised expertise in the field of parasitology. ESCCAP is dedicated to providing access to clear and constructive information for veterinarians and pet owners with the aim of strengthening the animal-human bond. It works to provide the knowledge essential to help eradicate parasites in pets and the objective is to have a Europe where parasites are no longer a health issue for pets or humans.

ESCCAP UK & Ireland brings together the UK and Irish national associations of ESCCAP to form a group consisting of some of the leading experts in the field of veterinary parasitology. ESCCAP UK & Ireland works with pet owners and veterinary/animal care professionals to raise awareness of the threat from parasites and to provide relevant information and advice for the UK and Ireland.

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