

## The Unholy Trinity: Hookworm, Whipworm and Roundworm

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Dogs can become infected with many infectious agents, but the “unholy trinity” of roundworm, hookworm and whipworm, are among some of the most common and well-known. For many reasons, including persistence of infectious stages in the environment and zoonotic potential, it is advantageous to prevent these parasites. Excellent information about these parasites can be found at <http://www.capcvet.org>.

### Roundworm

Roundworm is the common name for the canine ascarid, *Toxocara canis*. It is extremely common in puppies, and treatment is relatively straightforward. As with other parasites, by understanding the life cycle, we can understand how to treat and prevent transmission of the parasite. For an excellent summary of the life cycle, please refer to: <http://www.cdc.gov/parasites/toxocariasis/biology.html>.

As with all parasites, it is easiest to start our discussion with the adult worm. Adult *T. canis* can be easily seen, as they are 4 to 6 inches in length. It is important to be able to identify the adults, since clients will often bring the worm to you that they found in either their dog's vomit or feces. As a rule, *T. canis* is found primarily in puppies, although some studies have suggested that worms may be present in up to 33% of adult dogs. The reason for the predisposition in puppies is explained by the migration patterns (detailed below) in puppies versus adult dogs. The adults, which are separate sexes, will mate in the intestine. The female will then produce literally thousands of eggs per day, which are shed into the environment in the feces. These eggs are shed unembryonated, and are not immediately infective. Depending on temperature, eggs will be infective 2 to 4 weeks after being excreted into the environment. At this point, they contain the infective third-stage larvae (L3).

The egg is EXTREMELY resistant to disinfectants and environmental changes. What makes their presence even more insidious is that the eggs have a sticky outer coating, which makes them very difficult to remove from surfaces, including concrete. Eggs can survive for years, although extreme heat and prolonged exposure to sunlight will kill the larvae. Because of the resilience of eggs in the environment, humans, particularly children, can ingest these eggs. Once ingested by a suitable host, whether it is a definitive canid host or accidental human host, these eggs will “hatch” and the L3 will be released into the intestine.

Upon entering the intestine, the L3 will penetrate the intestine, and travel via the blood to the liver, after which the larvae will then travel to the lungs. Once in the lungs, the larvae will literally burst out of the alveoli. When this occurs in large numbers in puppies, the resulting condition is verminous pneumonitis. After entering the alveolus proper, the L3 can take one of two paths. It is important to understand both paths.

First, the larvae can travel up the trachea in what is known as “tracheal migration.” After ascending the trachea, the larvae are swallowed, and travel to the intestine, where they will mature to adults. In the second pathway, the larvae will reenter the alveolar blood vessels and travel to the muscles or organs, where they will arrest. This is known as somatic migration, and it is the migration path that occurs in humans, and results in the condition known as larva migrans.

Larva migrans is typically associated with the eye (ocular larva migrans), or viscera (visceral larva migrans). As mentioned above, this disease occurs primarily in children, as a result of their propensity to eat dirt, which can potentially contain infectious eggs. The easiest way to prevent this horrible disease is to deworm puppies prior to the worms becoming adults. If the worms are not adults, then they cannot produce eggs. The other obvious way is to pick up the dog's feces upon defecation.

For the main reason as to why puppies are infected, we have to refer back to the life cycle. After somatic migration, worms will be encysted in tissues. In the pregnant bitch, these larvae will become reactivated and will

travel via the umbilical vein to the in utero puppies' liver and lungs. Upon birth, the lungs inflate; the larvae burst out and travel to the intestine via tracheal migration, where they mature. These worms will become mature in 3 weeks. Encysted larvae can also infect the puppies by the transmammary route, although the primary route is considered to be transplacental. By deworming the puppies every 2 weeks up to 12 weeks, you prevent any maturation of these transplacental or transmammary transmitted larvae. By preventing maturation, you prevent egg shedding, environmental contamination and reduce the risk of a child becoming infected.

### **Hookworm**

While there are several hookworms, I will focus this discussion on the canine hookworm, *Ancylostoma caninum*. As with the roundworms, adults live in the intestines where they mate and produce eggs. They are roughly the diameter of a penny, and literally are shaped like a "hook." Like roundworms, they produce a large number of eggs. The eggs are shed into the environment where they will develop and hatch in a period of 2 or so days. At this point the larvae are L1s, and will molt to the infectious L3s during the next week (or in other words, up to 8 days after being shed). The L3s can then infect the host either through ingestion or skin penetration.

As with roundworms, some larvae will become arrested in the tissues. These larvae can become reactivated during parturition, and as a result can be transmitted to puppies through the bitch's milk. Transmammary transmission is a very important route of infection for puppies. Regardless of the means of infection, hookworms are going to attach to the small intestinal mucosa, after which they will suck blood, LOTS of blood. The loss of blood is the primary cause of pathology and clinical disease due to hookworm.

There are 4 types of clinical disease that I will briefly summarize:

1. Peracute: This involves dramatic anemia and is usually associated with newborn puppies (~1 week of age), secondary to transmammary transmission. This is a life-threatening situation. Eggs will not be detected on a fecal exam as the worms are not yet patent. Deworm the puppy and provide supportive care, including transfusions.

2. Acute: Acute disease is not as dramatic as peracute disease, but could be potentially life-threatening if untreated. This is observed in slightly older puppies. Eggs can be detected on fecal float. These puppies will be anemic.

3. Compensated: Adult dogs are more resistant to hookworm infection than puppies. Some adult dogs can still be infected with some level of hookworms, potentially due to a phenomenon known as "larval leak." These animals appear clinically normal.

4. Decompensated: Dogs that have compensated hookworm disease can become decompensated, which means they are showing signs consistent with hookworm disease, specifically anemia. This decompensation is typically secondary to a chronic disease (e.g. cancer, etc.)

As for prevention of hookworm, the same strategies that are used for roundworm apply to hookworm. That is deworming of puppies every two weeks, and prompt removal of feces.

### **Whipworms**

*Trichuris vulpis* is the third member of the unholy trinity, but the one people seem to consider the least.

Whipworm is important, and there is a very good chance you will diagnose it. Whipworms are named for their thin anterior end (esophagus) and thick posterior end (reproductive portion). Adults live in the large intestine, but especially the cecum. As with roundworms, adult whipworms produce environmentally resistant eggs, which are extremely difficult to destroy. Environmental contamination is the key to development of severe disease, since the eggs are resistant, they can accumulate in the environment and therefore be ingested in large numbers. After ingestion of the eggs containing the infective L1, the larvae will develop into patent adults after approximately 3 months. In comparison to roundworms, there is no migration outside of the intestinal tract. Therefore, there is no somatic migration into tissues, no migration of larvae to the pups in utero, and no transmammary transmission.

Because of the long prepatent time, whipworms are normally only diagnosed in dogs > 6 months of age.

Adult whipworms burrow their anterior end into the mucosa. This causes hemorrhage and irritation secondary to the subepithelial movement of adult worms during feeding. Also, chemical damage due to worm by-products can occur. The severity of disease is related to the number of worms—the larger number of worms, the more severe and debilitating the disease. If there are enough whipworms, death is possible.

The clinical signs of infection are those commonly seen with mild large bowel diarrhea. Diarrhea will be mucoid and/or bloody in nature. Also, tenesmus, and weight loss may be observed. Sometimes whipworm may be suspected on the basis of clinical signs, but no whipworm eggs are observed on a fecal float. This is because diagnosis by fecal flotation can be difficult. The eggs are shed in low numbers and do not float well.

Furthermore, because of the long prepatent period, disease may occur before worms are mature and shedding eggs.

In order to prevent whipworm, you may recommend deworming the dog 4 times a year or using a monthly heartworm preventive with efficacy against whipworms (i.e. one that contains milbemycin oxime or moxidectin). Finally, the point cannot be emphasized enough that one easy method for control of all 3 of these parasites is routine fecal pick-up. Practice it at your clinic, and convince your clients to do it at home.