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Canine Strongyloidiasis (25-Sep-2001)

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Introduction

Strongyloides stercoralis is a small nematode that infects the intestine of dogs and primates (including humans). It has also been reported from cats, which may harbor at least 3 other members of this genus (*S. felis*, *S. planiceps* and *S. tubefasciens*). *S. stercoralis* is an unusual parasitic nematode in several respects: it can multiply within the host, it has a free living life cycle in addition to its parasitic one, and only parthenogenic females are found in the host.

Life Cycle

The adult parthenogenic females of *S. stercoralis* (Fig. 1) live in the crypts of the small intestine, although some can be also found in the large intestine. These adults measure about 2 mm long and are sometimes referred to as threadworms. Eggs are laid and hatch in the crypts and rhabditiform first-stage larvae (L1) emerge into the intestinal lumen and pass out with the feces (Fig. 2).

Figure 1. A parasitic adult female *S. stercoralis*. Note the long esophagus that is 20 to 25% of the length of the 1 mm long worm. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 2. First stage larva (L1) of *S. stercoralis*. Note the very prominent genital primodium (GR). The esophagus is rhabditiform in shape, and this stage is sometimes called a rhabditiform larva. This stage is found in the feces of the infected dog. - To view this image in full size go to the IVIS website at www.ivis.org . -

Outside the host (at 26ºC) the L1 molt in about 6 hours to the L2, which molts in about 4 hours to the free-living L3. Molts to the L4 and then to the free-living adult have both occurred by 18 hours after leaving the host (Fig. 3). There are both male and female free-living adults, although females significantly outnumber the males. After mating, females will lay eggs for 2 or 3 days, before dying. The eggs hatch, releasing rhabditiform L1, which will go through the L2 and eventually to the infectious (filariform) third-stage (L3i, see Fig. 4, Fig. 5).

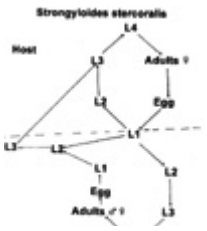

Figure 3. Life cycle of *S. stercoralis*. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 4. Infective third stage larva (L3i) of *S. stercoralis*. Note the long esophagus that may extend along 40 to 50% of the length of the worm and the notched tail. - To view this image in full size go to the IVIS website at www.ivis.org . -

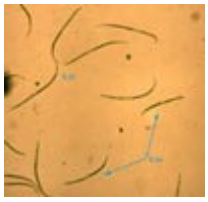

Figure 5. Autoinfective third stage larvae (L3a) and infective third stage larvae (L3i) of *S. stercoralis*. L3a develop within the intestine of the dog and invade the dog through the wall of the large intestine. L3i develop in the environment and invade the dog through the skin. - To view this image in full size go to the IVIS website at www.ivis.org . -

S. stercoralis has only one generation of free-living adults, although other species of Strongyloides, such as *S. planiceps* from the cat, may have more. The L3 will penetrate the skin of their host and migrate through the body to the small intestine where they will molt to the L4. The L4 will molt in about a day to the parthenogenic adult female. When L1 emerge from the host in the feces, they have 2 options: to go through the free-living life cycle described above (the heterogonic route) or to go through 2 molts and become L3i (the homogonic route, Fig. 3). Both the host and the external environment influence this second option. Very early in the infection, probably before the host's immune response has gotten started, a large number of the L1 go directly to the L3i, while later in the infection a smaller percentage make this choice.
The choice between the homogonic and heterogonic routes is also strain dependent, some strains will always prefer one route to the other, but this preference is still modified by conditions in the host. At higher environmental temperatures (30ºC), the homogonic route is also favored [1]. One final modification of the life cycle is autoinfection. As depicted in Fig. 3, the L1 which hatches in the intestine of its host has 2 options, first to pass out with the feces as described above, or second to undergo 2 molts within the intestine to the autoinfective (filariform) larva (L3a, Fig. 5). Autoinfection is favored under several circumstances regarding the host. Dogs on steroids (prednisolone) will develop autoinfection [2,3], both migrating L3a and increased numbers of adult females can be recovered. Infection in neonatal dogs also leads to autoinfection [4]. The term hyperinfection refers to the condition that develops when autoinfection proceeds at an uncontrolled rate and large numbers of L3a are migrating throughout the body. A disseminated infection is a rate condition in which adult worms are found at extra-intestinal sites.

Infection
Infectious third stage larvae (L3i) of *S. stercoralis* enter the host by penetrating through the skin. In the rare instance where the bitch has migrating L3 in her tissues while nursing, the larvae may be passed to the pups via the milk [5,6], but no evidence of transplacental transmission has been seen [7]. From the skin the larvae migrate through the tissues of the body, perhaps entering and leaving the vasculature along the way, and eventually end up in the small intestine [8]. This migration takes 4 to 5 days. In the small intestine they molt to the forth-stage (L4) and about a day later, molt to the adult stage. In dogs, the prepatent period is about 10 days (range: 5 to 21 days in patent infections). Dogs may be patent for up to a year or more, although most will stop shedding larvae after 2 to 3 months. However, some infected dogs never shed larvae. Cats generally have light, transient *S. stercoralis* infections, lasting no more than 6 weeks [9], and autoinfection is rare. Symptoms and signs of infection vary markedly with respect to the individual. Most infected dogs are asymptomatic and become occult in 8 to 12 weeks. Barren adult females may survive embedded in the intestinal mucosa for several months after the L1 are no longer found in the feces. These infections can be reactivated by immunosuppression attributable to either chemotherapy, concurrent disease, or perhaps pregnancy [7]. Dogs that have self-cured are resistant to re-infection. Mature dogs seldom become severely infected and autoinfection is rare in these dogs. In young pups, autoinfective strongyloidiasis occurs spontaneously [4]. Although these infections are usually mild and self-limiting, in some animals the worm burden may increase to clinically significant levels associated with watery or mucus diarrhea and with signs of bronchopneumonia due the migrating autoinfective third-stage larvae.

Diagnosis
First-stage larvae (Fig. 2) are passed in the feces, making concentration techniques using saturated salt solutions unreliable, as the larvae become so crenated as to be almost unrecognizable. However, fecal flotations done with zinc sulfate yield

readily identifiable larvae provided that the preparation is examined promptly, before the larvae shrink. When zinc sulfate flotation solution is unavailable, a Baermann apparatus can then be used to obtain clean, intact larvae from feces for a definitive diagnosis. The first-stage larvae are easily recognized, their genital primordium being exceptionally prominent (Fig. 2), making it easy to tell *S. stercoralis* L1 from *Filaroides* spp. L1 which may also be in the feces of dogs (Fig. 6).

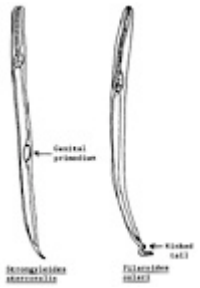

Figure 6. Diagram of nematode larvae that may be found in fresh dog feces. *S. stercoralis* is characterized by a very large genital rudiment (primodium) and a straight tail. Filaroides has a small, barely noticeable GR and a "kinked" tail. - To view this image in full size go to the IVIS website at www.ivis.org . -

Many cases of *S. stercoralis* infection are probably first suspected when larvae are seen either in a direct smear or when an L1 is seen in a saturated salt flotation. In animals showing respiratory symptoms, a tracheal wash may reveal migrating third-stage larvae. This stage is easily identifiable by its long filariform esophagus and its notched tail (Fig. 4).
A small percentage of the larvae present in a fecal sample may be autoinfectious third-stage larvae, particularly in recently acquired infections in young pups. Feces held at room- humidity and temperature for 24 hours or more may contain a variety of stages, including free-living adults. Diagnosis of *S. stercoralis* infection is complicated by the fact that larvae may be very low in number or absent from the feces, even in symptomatic cases. In these cases feces can be tested multiple times (3 times over the course 5 to 7 days), or culture techniques which increase the sensitivity of the test by allowing expansion via the free-living cycle can be used. One culture technique is the Agar-plate method [10] and another is the Harada-Mori filter paper technique [11].

Pathology
Intestinal pathology varies with intensity of the infection which in turn varies with the strain of the worm and the age of the dog. In asymptomatic infected dogs, the intestinal tissues may be grossly normal and worms and larvae exceedingly difficult to find by histological methods. In symptomatic cases, gross intestinal changes range from congestion of mucosal surface with an abnormal abundance of mucus in the lumen, to confluent ulceration that may penetrate to the muscular layer. In cases of severe infection, large numbers of parasites will be present in the intestinal wall [12].
The full spectrum of parasite life history stages may be found in the gastrointestinal tract and filariform larvae in the lungs may be associated with pulmonary hemorrhage (Fig. 7). The number of migrating larvae frequently does not correlate with the amount of pulmonary hemorrhage.

Figure 7. An autoinfective third stage larva in the lung of its host. Note the blood filling the alveolar spaces. Although only a few L3a can be found in the lung at any one time, the damage to the lung can be severe. - To view this image in full size go to the IVIS website at www.ivis.org . -

Treatment
Treatment of dogs with an active hyperinfection is difficult because available drugs do not kill the migrating autoinfective L3. However, unless a dog is very young or immunosuppressed, it is unlikely to have many migrating autoinfective larvae at any one time. The following anthelmintic treatments will remove adult *S. stercoralis* from dogs (these would all be extra-label uses):
- albendazole, twice daily for 3 consecutive days at 100 mg/kg;
- thiabendazole, once a day for 3 consecutive days at 50 mg/kg;
- fenbendazole, once a day for 3 days at 50 mg/kg;
- ivermectin, one dose at 200 µg/kg [13-15].

In all cases, follow-up fecal examinations should be done weekly for 2 to 3 weeks to verify that no migrating larvae survived the treatment and matured. In cases where hyperinfection is suspected, the following treatments can be used: fenbendazole, once daily for 7 to 14 days at 50 mg/kg or ivermectin once every 4 days for 3 or 4 doses at 200 µg/kg.
Although these treatments may not kill migrating larvae, they will remove adults as they mature in the small intestine and therefore prevent new autoinfective larvae from being produced. The life-span of migrating autoinfective larvae is unknown,

as it is partially dependent on the dogs immune response, and, therefore, follow-up fecal examinations should be done to confirm that a parasitological cure has been achieved. Ivermectin and fenbendazole should also be effective against *S. stercoralis* and other *Strongyloides* spp. infections in cats.

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