

Managing Hookworms in the Landscape¹

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"Hookworms" properly refers to many genera of nematodes in the Family Ancylostomatidae of the Order Strongylida, but this discussion addresses primarily those in the genus *Ancylostoma*, which many animal health professionals consider to be the most important genus of hookworms. This genus includes the most common hookworms of domestic dogs and cats in tropical and warm temperate climates, the hookworms with which most people in Florida come into contact. The "northern carnivore hookworm," *Uncinaria stenocephala*, also occurs in Florida but much less frequently than *Ancylostoma* spp.

Four species are significant in Florida; the three *Ancylostoma* spp. represent 90 - 95% of hookworms identified here:

- *Ancylostoma caninum*, the dog hookworm, is found in the small intestine of dogs, foxes, coyotes, wolves, bears, and other wild carnivores throughout the world; it is the most common hookworm of dogs in the U.S.
- *A. braziliense* has been reported from the small intestine of dogs, cats, several wild felines, and various carnivores. It is also considered the main cause of "creeping eruption" in man.

- *A. tubaeforme* is the common hookworm of cats, distributed world-wide; similar to *A. caninum*, but generally smaller.
- *Uncinaria stenocephala* occurs in the small intestine of dogs, cats, foxes, wolves, and related carnivores. It is occasionally recovered from stray dogs in Florida, but may not occur endemically here -- the infections that are detected may have occurred farther north, before the host animals came to Florida.

Importance as Animal and Human Parasites

Widely distributed wherever dogs and cats are kept as pets, hookworms are found commonly in the small intestines of hosts in which they can complete their life cycles. Hookworms suck blood from the intestinal wall. The degree of blood sucking varies among these hookworms. Some species feed more by biting off pieces of the gut lining and then changing positions. The tiny bite wounds continue to bleed after the worm has dislodged, at least for a short time. Some parasitologists consider them to be the most pathogenic parasites of young dogs and cats. Principal damage is by loss of blood, due to both

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ingestion by the worms and leakage from the intestinal lacerations caused by them. The esophageal glands of *A. caninum* produce a proteolytic enzyme that prevents coagulation of blood.

The signs of infection include anemia, emaciation, edema, weakness, listlessness, and rough hair coat and other effects of blood loss. Heavily infected pups often have diarrhea, with black and tarry feces which consist almost entirely of concentrated blood. Death may occur, particularly in puppies and kittens.

A. braziliense is considered the main cause of creeping eruption (also sometimes called "cutaneous larva migrans") in people. Creeping eruption is caused by infective juveniles penetrating the skin and migrating subcutaneously until the host finally kills them or they are killed by anthelmintics. The route of the migration becomes highly inflamed and itchy, leaving a red trail along the random migration path.

Description: What They Look Like

A. caninum is rather stout-bodied, grayish or reddish; its subglobular buccal cavity has 3 pairs of ventral teeth at the margin and a pair of triangular dorsal teeth in its depths. Esophagus muscular and club-shaped, about 1.2 mm long. Males are 11 - 13 mm (0.43 - 0.51 inch) long and 0.34 - 0.39 mm wide; male spicules are 790 - 960 micrometers long. Females are 14.0 - 20.5 mm (0.55 - 0.81 inch) long by 0.50 - 0.56 mm wide. Eggs are 56 - 75 micrometers long X 34 - 47 micrometers wide.

A. braziliense is smaller than *A. caninum* and has only 2 ventral teeth on each side of the buccal cavity. The males are 5.0 - 7.5 mm (0.20 - 0.30 inch) long and 0.19 - 0.27 mm wide; male spicules are 700 - 1000 micrometers long. Females are 6.5 - 10.6 mm long (0.26 - 0.42 inch) and 0.22 - 0.32 mm wide. Eggs are 75 - 95 micrometers long X 41 - 45 micrometers wide.

A. tubaeforme is intermediate in size between *A. caninum* and *A. braziliense*. It has three teeth on each side of the buccal cavity. Males are 9.5 - 11.0 mm (0.37 - 0.43 inch) long and 0.3 - 0.35 mm wide; spicules are 640 - 760 micrometers long. Females are 12 - 15 mm (0.47 - 0.59 inch) long and 0.38 - 0.43

mm wide. Eggs are 55 - 76 micrometers long X 34-45 micrometers wide.

U. stenocephala is a small hookworm which does not have teeth, but merely two cutting plates in its mouth cavity. Males are 5 - 9 mm (0.20 - 0.35 inch) long and 0.2 mm wide; spicules are 640 - 760 micrometers long. Females are 7 - 13 mm long and 0.2 - 0.25 mm (0.28 - 0.51 inch) wide. Eggs are 63 - 76 micrometers long X 32 - 38 micrometers wide.

Life/Parasitic Cycle

Adult *A. caninum* can lay 7,000 - 28,000 **eggs per day**; *A. braziliense* about 4,000 eggs per day. As adult population density increases or as they age, the number of eggs decreases dramatically.

Eggs develop in the presence of oxygen when moisture and temperature are also favorable; they do not develop in the center of undisturbed feces, but do so when the feces are broken up as by arthropods, earthworms, rain, or normal mechanical means. The ideal situation is a slightly sandy, moist loam in shade.

Temperature optimum for *A. caninum* is 23 - 30°C; that for *A. braziliense* is higher, and for *Uncinaria stenocephala* is lower (about 20°C).

The first and second stages of *A. caninum* are *rhabditiform* larvae with tapering, pointed tails; L1 are 300 - 340 micrometers long and L2 are 400 - 430 micrometers long. Both feed on bacteria in the feces. The third stage (infective) larvae, termed "strongyliform" or "filariform," are ensheathed in the cuticle of the L2 which protect them against desiccation and chemical agents. They do not develop to this stage below 15°C; infective larvae may appear in the feces 22 days after passage at 15°C, and in as little as 47 hours at 37°C. Most die at temperatures above 37°C. Optimum temperature for free-living development of *A. caninum* is about 30°C.

Eggs and free-living larvae of *A. caninum* are relatively susceptible to freezing; those of *U. stenocephala* are much more tolerant of low temperatures, and have lower optima for development of all free-living stages.

Free-living larvae of hookworms (mixed species) from dog feces were observed to emerge for about 4 weeks under summer conditions at Gainesville, Florida.

Infective larvae crawl out of the feces into the soil or onto vegetation and wait until a host comes along. They may enter a host directly through the skin or by ingestion. They may also gain access to puppies via the milk from the mother while suckling.

L3's which penetrate directly through the skin bore through the tissues until they reach a blood vessel or lymphatic duct; they then pass via either to the heart and then to the lungs. They bore out of the capillaries of the lungs into the alveoli, then move up the bronchioles, bronchi, and trachea to the pharynx. This migration to the trachea takes about 2 - 7 days. They are then swallowed and pass down through the digestive tract to reach the small intestine.

L3's which are swallowed usually pass directly to the small intestine, where they may molt to the L4 as soon as 3 days after infection, and then to the adult stage. Eggs first appear in the feces 15 - 18 days after infection in young dogs, sometimes a bit slower in older dogs, in which few will mature. Adults can live a few months to 2 years.

The larger the infective dose of larvae, the smaller the % that develops to adulthood.

If L3 enter an aberrant host or a resistant normal host, they may migrate in the body without ever entering the intestinal tract and maturing.

Managing Hookworms in Dogs and Cats

Inquiries about controlling hookworms in the yard, especially in living grass, are particularly difficult to deal with. Many people simply do not realize that the problem must be addressed by a combination of:

1. **Veterinary animal therapy** with effective anthelmintics;
2. **Disinfestation of lounging areas** that are already infested;

3. **Daily sanitation** of the yard and home environment of the pets.

Veterinary Animal Therapy

Pet owners are accustomed to taking listless pets to the vet to have them "wormed" (more properly, "dewormed"). All puppies and the mother should be treated at 1, 2, 4, 6 and 8 weeks post partum. Veterinarians have several effective drugs from which to choose. However, veterinary treatment of infected pets is only part of what must be done to correct the problem. The part of the hookworm life cycle outside of the pet can serve as a source of infection or reinfection to animals or people.

Prevention and Sanitation

Because the eggs are deposited in feces, sanitation is critical to avoiding infection/reinfection of pets. Ideally, feces should be removed daily and not allowed to collect where the animals or humans spend time. Juvenile hookworms are sensitive to sunlight, desiccation, and temperature extremes. Foliage of turf or other plants may protect the infective forms from all of these factors, so turfgrass is the least desirable surface for lounging areas for animals from the standpoint of hookworm infections, even though it is the most commonly used for household pets. When acquiring a new puppy, train it to use one part of the yard for its latrine; this expedites clean-up and limits the area with greatest potential for contamination. Keeping dogs on concrete or gravel runs will minimize survival of hookworms and facilitate cleanup. Sunlight should directly hit all parts of the area at least 2 hours each day, to help keep it dry and to reduce the survival of infective hookworm juveniles.

Sanitation to prevent carry-over of eggs and juveniles in feces and providing plenty of room so animals are not forced into prolonged close contact with feces are most important in minimizing the recycling of pet hookworm infections. Since recent evidence indicates that infectious larvae can survive after emerging from feces for up to 4 weeks under summer conditions (perhaps longer in winter), careful attention to sanitation, including old feces, is critical for successful management of hookworm in the yard. Mature dogs develop good immunity to

hookworms, but even they can have small populations of adult hookworms producing low numbers of eggs which contribute to the contamination of the yard.

If infection reaches serious proportion, all individual pets should be treated by a veterinarian at the same time. When they are returned home, they should be kept off the most contaminated areas if those can be identified, and should not be crowded into a small space. Feces should still be picked up daily and disposed of properly because most deworming drugs do not kill the eggs immediately and some kill the adults slowly. Err on the side of caution. Remember that the hookworms in the dog are only the tip of the iceberg, with those in the environment constituting the hidden bulk of the iceberg. If the pets have a run or kennel, it should be cleaned of all feces and treated with a product to control hookworm juveniles if one can be located. Several treatments, including common salt brine (1.5 lb common salt per gallon of water, applied at 1 pt per sq ft) or borax, can be used successfully on bare ground, gravel or concrete. However, there is at present no available product that is known to be both effective for control of infective larvae on/in living turf or other plants and safe for plants.

Recent loss of a widely-used product, Hill's VIP Hookworm Control, has caused many veterinarians to refer clients who have hookworm-infested yards to local pest control companies. However, at this time, pest control operators also have nothing registered or recommended to control hookworms. It is possible that some pesticide(s) now registered for control of other pests on turf might be effective, but research to identify such treatments apparently has not yet been completed. Management of the soil-borne stages of animal parasites is not studied by many. Most veterinary scientists who work with hookworms are interested in the parasite life-cycle in the animal host. Nematologists who are familiar with managing soil-borne nematode pests of plants are rarely familiar with animal parasites. Moreover, the stage of hookworms that occurs in soil or on turf is very difficult to distinguish from dozens of harmless "free-living" nematodes. **In the meantime**, minimizing hookworm infections in pets requires

attention to all the steps in the integrated management program we have outlined:

- **Treat** the animals with pharmaceutical products at the veterinary office, or as prescribed by a veterinarian.
- **Clean up** the area in which the animals spend most of their time, to remove feces every day that can be a source of continued recontamination.
- **Keep it clean**; the antihelminthic drugs used/prescribed by your veterinarian do not immediately eradicate all living hookworms in the intestines of your pet(s), so their feces may still contain living eggs for some time after treatment is initiated. Daily removal (and disinfestation with chemicals that may be appropriate for the site, if there are any) will minimize the risk of reinfection of pets after they have been successfully treated.