



# Mosquito-borne Dog Heartworm Disease<sup>1</sup>

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Each year thousands of dogs become disabled or die from lung, heart or circulatory problems caused by heartworm disease. Heartworm disease in dogs and related canines is caused by a filarial nematode (a large thread-like round worm), *Dirofilaria immitis*. The adult worms live in the right side of the heart (right ventricle) and adjacent blood vessels (pulmonary arteries), and because of their location, are commonly called “dog heartworms.”

## Distribution of Heartworm Disease

Heartworm disease occurs worldwide in most tropical and subtropical regions, with increasing frequency in temperate climates. Until the late sixties, the disease was restricted to southern and eastern coastal regions of the United States. Now, however, cases have been reported in all 50 states and in several provinces of Canada (Figure 1). For most of North America, the danger of infection is greatest during the summer when temperatures are favorable for mosquito

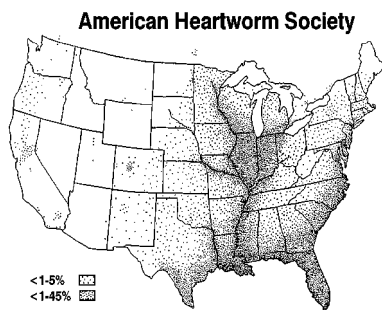


Figure 1. Heartworm infection, 1995.

breeding. In the southern U. S., especially the Gulf Coast and Florida, where mosquitoes are present year-round, the threat of heartworm disease is constant.

## The Heartworm Parasite

The complete development of the nematode parasite requires two hosts: dog and mosquito (Figure 2). In the dog, sexually mature adult nematodes are large (females up to 14 in. and males up to 7 in.) and cause disease by clogging the heart and major blood vessels leading from the heart. By clogging the main blood vessels, the blood supply to

other organs of the body is reduced, particularly the lungs, liver and kidneys, leading to malfunction of these organs. Once infected a dog is infected for life. The sexually mature nematodes discharge tiny (less than 1/800" long) immature worms called microfilariae into the blood stream of a dog. They do not develop further in the dog, but they can survive in

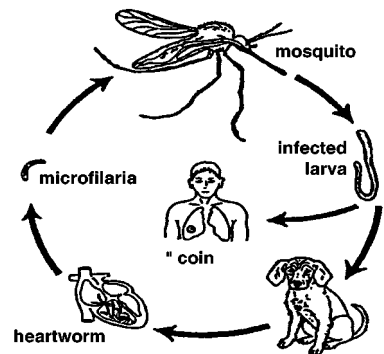


Figure 2. Life cycle of the dog heartworm.

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the blood for up to three years. They must be ingested by a mosquito before they can progress further in their development. There are more microfilariae in the blood during the day than at night. Optimum numbers of microfilariae in the blood close to the skin coincide with times of peak feeding activity of mosquitoes. Microfilariae may also be more abundant in the summer when mosquitoes are abundant.

### **Development In The Mosquito**

Development of heartworm in the vector starts when microfilariae are ingested by the female mosquito during blood feeding on an infected dog. Microfilariae leave the midgut of the mosquito soon after ingestion and migrate into the Malpighian tubules cells (the mosquito kidney). At a temperature of about 27° C. the parasite becomes immobile, shortens and thickens, and develop into the so-called "sausage form" larva in about 4-5 days. This larval form is followed by the first stage larva and the first molt occurs in the Malpighian tubule cells at 8 days. During the second larval stage, the internal organs of the worms are formed. The second molt occurs at 11-12 days, resulting in third stage larvae which resemble miniature adults. During the next 2-3 days, they increase in length, break out of the Malpighian tubules, migrate through the body to the head and accumulate in the mouthparts. These third stage larvae are now called infective larvae. Thus, in 2-3 weeks, microfilariae transform into infective larva. Further development can only take place when mosquitoes feed on a dog.

Infective larvae are concentrated in the proboscis, or mouth parts of the mosquito. As the infected mosquito feeds on a dog, the infective larvae emerge from the tip of the proboscis and on to the skin of the animal. A drop of mosquito blood protects the larvae from drying prior to their entry into the host. The infective larvae penetrate the skin through the puncture wound that remains after the mosquito withdraws her mouthparts.

### **Development In The Dog**

After penetrating the skin, the larvae stay close to the entry site and grow very little during the next few days. The molt from third- to fourth-stage larvae occurs 6-10 days after infection. Fourth-stage larvae

migrate through subcutaneous tissue and muscle toward the upper abdomen and thoracic cavity. Fourth-stage larvae grow to about 1/10" in length during the next 40-60 days and then molt to the fifth and final larval stage, or young adults. The young adults penetrate veins to get into the blood stream and eventually, after 70-90 days in the dog, reach the heart. For unknown reasons, the percentage of infective third-stage larvae that reach maturity vary in different breeds of dogs.

Upon reaching the heart, the young adults continue to grow. Up to now there has been no evidence of disease in the dog. It is only after adult worms mate and start to discharge tiny motile microfilariae that circulate in the blood that disease becomes apparent. Microfilariae appear in the blood about 200 days after infection.

### **The Symptoms**

Visible signs of heartworm disease may not appear until a full year after bitten by infected mosquitoes. In fact, the disease may be well advanced before the dog shows any symptoms. Dogs with typical heartworm disease fatigue easily, cough, and appear rough and not thriving. Blood and worms from ruptured vessels may be coughed up. Blockage of major blood vessels can cause the animal to collapse suddenly and die within a few days.

Dogs with 50-100 mature worms exhibit moderate to severe heartworm disease. Dogs with 10-25 worms that receive little exercise may never show signs of heartworm disease, and one may not be able to find microfilariae in the blood. Heartworm infection without detectable microfilariaemia is called occult dirofilariasis.

### **Dog Heartworm Disease In Cats**

Heartworm disease in cats is less frequent than in dogs. Cats are susceptible but appear to be poorer hosts than dogs. The most prominent clinical signs include coughing, dyspnea, vomiting, lethargy and anorexia. Acute collapse and death can occur. Because less than 20% of infected cats have microfilariae in the blood, diagnosis is best confirmed by either X-rays or new serological methods.

## Dog Heartworm Disease In Humans

Heartworm is also an occasional parasite of humans. The parasite is usually found in the lung (pulmonary dirofilariasis), and less often in the heart. Although the worm forms "coin lesion" in the lung, which may be confused with other diseases on x-rays, such as carcinoma, its clinical significance in man has not been fully determined. During the last 30 years about 100 cases of human pulmonary dirofilariasis have been reported from Florida.

## Mosquito Vectors

More than 70 of the nearly 3,000 known species of mosquitoes worldwide have been identified as capable of sustaining the development of dog heartworm microfilariae to the infective stage. Sixteen species of mosquitoes (*Aedes albopictus*, *Ae. canadensis*, *Ae. cantator*, *Ae. excrucians*, *Ae. sollicitans*, *Ae. sticticus*, *Ae. stimulans*, *Ae. taeniorhynchus*, *Ae. vexans*, *Anopheles bradleyi*, *An. punctipennis*, *An. quadrimaculatus*, *Culex nigripalpus*, *Cx. quinquefasciatus*, *Cx. salinarius* and *Psorophora ferox*) have been identified as natural hosts of *D. immitis* (Dog Heartworm) in the United States east of the Mississippi River. Among these, only 11 species are found in any abundance in Florida. Collection of mosquitoes in residential areas in Vero Beach showed that 4 species (*Ae. taeniorhynchus*, *An. quadrimaculatus*, *Cx. nigripalpus* and *Cx. quinquefasciatus*) are natural hosts of *D. immitis*. At least seven mosquito species (*An. quadrimaculatus*, *Ae. taeniorhynchus*, *Ae. sollicitans*, *Ae. aegypti*, *Cx. nigripalpus*, *Cx. quinquefasciatus*, and *Mansonia titillans*) can be infected with *D. immitis* when they are fed on an infected dog.

In Florida, about 20 out of the 70 known species are potential vectors. The main vectors near the coasts are two mosquitoes that breed in salt marshes (*Ae. taeniorhynchus* and *Ae. sollicitans*) and one freshwater species (*Cx. nigripalpus*). The inland vectors that breed in fresh water are *Cx. quinquefasciatus*, *Cx. salinarius*, *Ae. aegypti*, *An. quadrimaculatus* and *Mn. titillans*. These mosquitoes breed in a wide variety of habitats, including marshes, swamps, ponds, ditches, old tires and trash piles.

## Diagnosis

A veterinarian can usually detect heartworm infection by finding microfilariae in a blood sample drawn from the dog by either 1) looking for microfilariae using a microscope or 2) using several new serological diagnostic tests which can detect of heartworm antibodies even when microfilariae can not be seen under a microscope. Early detection is important to enable prompt treatment to destroy the adult heartworms. Another reliable method is to take X-rays. When heartworm disease is confirmed, a treatment program is set up to remove both adult worms and microfilariae.

## Treatment, Prevention And Control

Heartworm disease in dogs and cats is a serious and potentially fatal disease. Always consult your veterinarian for treatment and prevention of the heartworm disease in dogs and cats. The adulticide treatment is expensive and involves some risk to the animals. Much of the damage caused by heartworms occurs before there are any outward signs of the disease. Heartworm disease in dogs and cats cannot be eliminated but it can be controlled or prevented. Therefore, prevention is the key element in protecting a dog. A dog not on preventive medication can be infected with numerous worms.

**a) Kill the adult worms:** The first step in ridding a dog of the parasites is to administer a chemical to kill the adult worms. Capasolate (Arsenamide, Thiacetarsamide), and Immiticide<sup>R</sup> (Melarsomine, dihydrochloride) are arsenical compounds used to kill adult heartworms in both dogs and cats. These compounds are given as an intravenous injection and one or two doses are given each day for two days followed by restriction of physical activity for one to two months. As the worms die they are carried by the bloodstream to the lungs. One dog in twenty may be expected to die as a result of complications from this therapy. There are fewer complications with cats. Adult female worms and immature forms are somewhat resistant to Capasolate and, consequently, this drug may be less than 100 percent effective.

**b) Kill the microfilariae:** After the adult worms have been eliminated, the next step is to kill the microfilariae. Dithiazanine iodide is the recommended microfilaricide. The compound is given orally; the dosage varies with the weight of the dog. After 7 days on this program, the dog's blood should be re-examined. If microfilariae are still present, and there has been no drug reaction, the dosage may be continued until the blood is microfilariae free.

**c) Prevent larval development:** Only after the adult heartworms and the microfilariae have been eliminated may an infected dog be put on a program to prevent reinfection. Filaribits (Diethylcarbamazine--DEC, Caricide, Hetrazan) and Filaribits Plus<sup>®</sup> kill the infective larval stage, but is less effective against adult heartworms. It should be administered daily throughout the mosquito season when dogs are exposed to infective larvae. It is a safe and efficacious drug in noninfected dogs, but may cause a fatal shock reaction if given to dogs with microfilariae. Sudden destruction of large numbers of microfilariae occasionally causes severe shock-like symptoms that may kill the dog. Cypip can be mixed with dog meal for continuous administration of DEC in feed.

Heartgard-30<sup>®</sup> (ivermectin) and Interceptor (Milbemycin oxime) Flavor Tabs<sup>®</sup> are indicated for use in the prevention of heartworm disease, controls adult hookworms, and removes adult roundworms and whipworms only if administered on a monthly dosing schedule. They eliminate infective larvae before they reach the heart. They also kill microfilariae. In certain dogs, particularly of the Collie breed, Heartgard has been reported to cause serious adverse reaction. The major advantage is that it need be given only once every 30 days. The disadvantages are that the dog owner may forget to give the medication and that there are risks of a mild reaction and transient diarrhea if given to a heartworm infected dog.

**d) Control mosquitoes:** In addition to drug therapy for dogs and cats, mosquito control in residential areas where dogs and cats live can break the transmission cycle of heartworm disease. Dog owners should keep their animals out of mosquito infested areas. Dog's living quarters should be mosquito-free. Indoor dogs usually show much lower incidence of infection. Insect repellents can be used on dogs and are safe and effective when applied properly.