

# *Dirofilaria immitis* in Cats: Anatomy of a Disease\*

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**ABSTRACT:** It is now understood that wherever heartworm infection exists in the local canine population, it will also be found in the feline population. However, this does not mean that the parasite and resulting disease behave the same way in both species. For example, heartworms rarely reach the adult stage in cats, but they can cause respiratory sequelae nonetheless.

**D**espite recent advances in the understanding and prevention of heartworm disease in dogs, the question remains: Is *Dirofilaria immitis* a significant health risk in cats? After speaking with practitioners across the country, I have found that there are definitely more skeptics than believers; indeed, I was once a skeptic myself. That changed in 1997, however, when I conducted a necropsy survey on shelter cats in southeast Texas and discovered that 10% of them had adult heartworms.<sup>1</sup> I also learned that the heartworm infection rate in this area was greater than that for FIV or FeLV.<sup>1</sup>

The past decade has seen major additions to the knowledge base for heartworm disease in cats (Box 1), and this information has been widely disseminated via trade magazines and journals. Nonetheless, fewer than 5% of cats in the United States are on a preventive regimen.<sup>2</sup> Why? Because most veterinarians have never

diagnosed a case of heartworm disease in a cat, and although practitioners may believe that the disease exists in highly endemic areas such as the Gulf Coast, they tend to discount it as a problem elsewhere.

## HISTORY

Heartworms were first reported in dogs in Italy in 1626<sup>3</sup> and in cats in Brazil in 1921.<sup>4</sup> They were found in cats in the United States and the Philippines in 1922.<sup>5,6</sup> Over the next 73 years, feline heartworm infections were noted in 30 US states and 15 other countries, reflecting the widening reach of canine infections.<sup>7</sup> The increased incidence of heartworms in cats has led to further research into the pathogenesis, prevention, and diagnosis of heartworm disease; in 1998, 60% of the research presentations at the annual Heartworm Symposium focused on feline disease.

\*A companion article on diagnosis and management begins on page 393.

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## Box 1. Online Resources

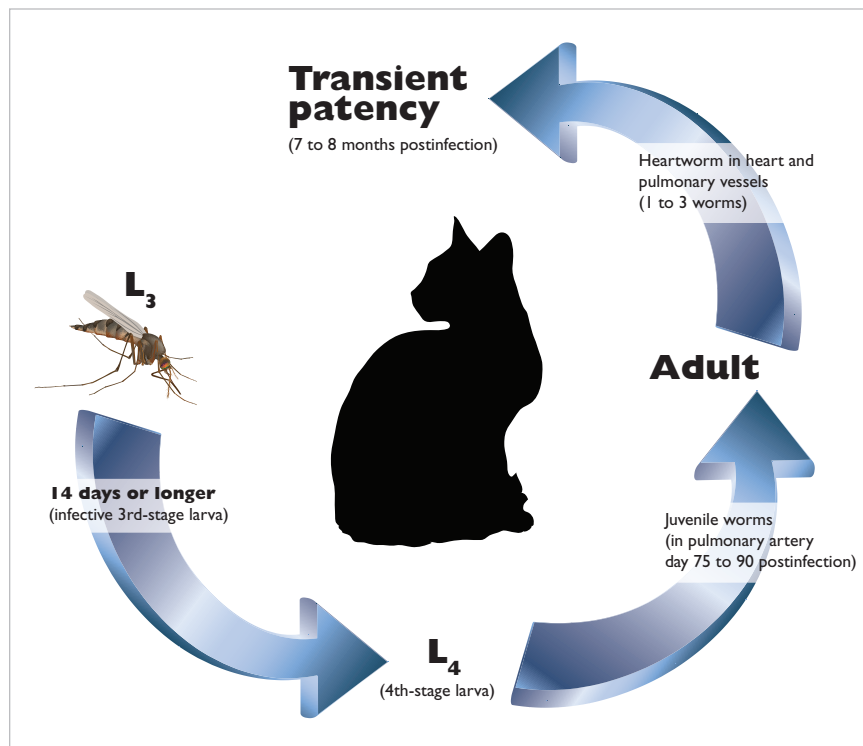
Additional information about feline heartworm disease is available on the following Web sites:

- The American Heartworm Society: [heartwormsociety.org](http://heartwormsociety.org)
- Know Heartworms: [knowheartworms.org](http://knowheartworms.org)
- The Companion Animal Parasite Council: [capcvet.org](http://capcvet.org)

- Take CE tests
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CompendiumVet.com





**Figure 1.** *Dirofilaria immitis* life cycle in cats. (© Know Heartworms Campaign, 2008)

## PREVALENCE

A review of necropsy data and antigen serology results indicates that heartworms exist in cats wherever they are found in dogs. The infection rate for mature adult heartworms in cats, as determined by prevalence studies, ranges from 5% to 20% of the rate in the local dog population.<sup>7</sup>

## EPIDEMIOLOGY

Female mosquitoes feeding on heartworm-infected dogs ingest circulating microfilariae. These microfilariae transform into first-stage (L1) larvae within hours of entering the mosquito. The larvae undergo two molts over the next 2 to 4 weeks, depending on the average ambient temperature, ultimately becoming infective (L3) larvae. The L3 larvae are deposited on the skin of a new host in the saliva of a feeding female mosquito. They enter through the bite wound into the subcutaneous tissue, where they molt to L4 larvae within a couple of days. The L4 larvae migrate into the subcutaneous adipose tissue and muscle over the next 2 months, ultimately undergoing a final molt to a juvenile worm stage and entering a peripheral vein.<sup>8</sup> Historically, juvenile worms have been viewed as L5 larvae; however, because this stage does not undergo subsequent molts, it is more properly considered an immature or juvenile worm. This worm matures into an adult over the next several months.

Immature worms in peripheral veins are carried in the bloodstream to and through the heart, arriving in the caudal pulmonary arteries at 75 to 90 days postinfection. By day 100, the juvenile worms are two inches long. In dogs, most juvenile worms mature into adults that can live for 5 to 7 years. In cats, most juvenile worms die shortly after arriving in the pulmonary arteries, ini-

tiating an inflammatory response. In a small percentage of cats, a few worms become mature adults that can live for 2 to 4 years<sup>9,10</sup> (Figure 1).

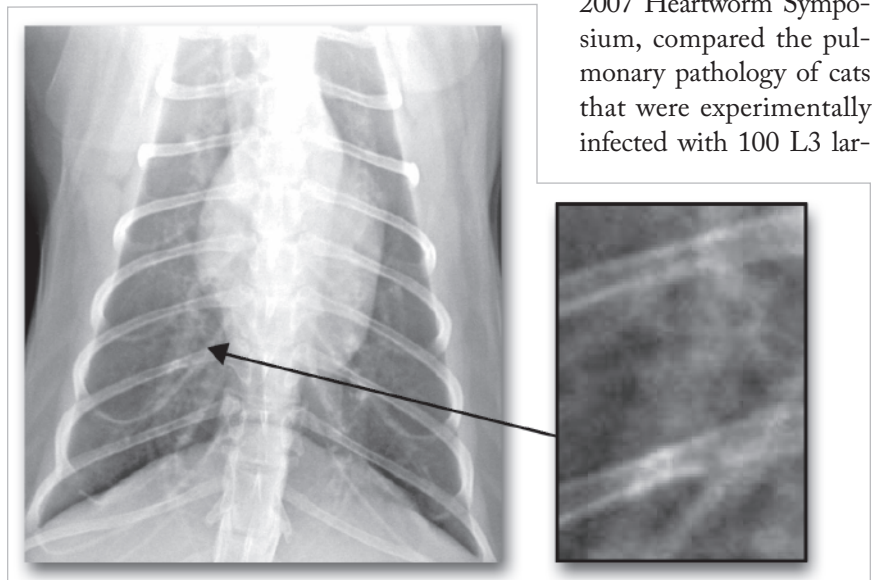
### PATHOPHYSIOLOGY

There are three stages of heartworm disease in cats. The first stage begins soon after the arrival of the juvenile worms in the caudal pulmonary arteries as an acute vascular and parenchymal inflammatory reaction to the presence and subsequent death of most of these worms. The most common clinical signs are coughing or dyspnea (64%) and intermittent vomiting unrelated to eating (38%), but 28% of cats are asymptomatic.<sup>11</sup> The significant number of asymptomatic cats is probably a result of their characteristic sedentary lifestyle; exercise has been shown to be a major factor influencing the severity of heartworm disease in dogs.<sup>12</sup>

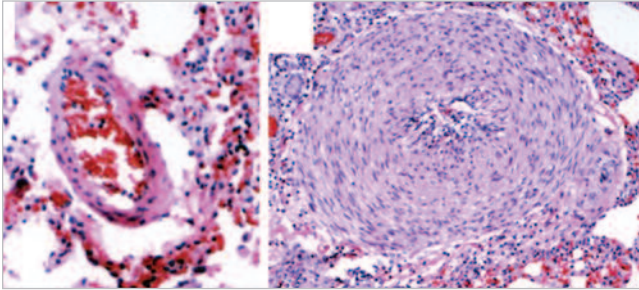
Thoracic radiography may show a bronchointerstitial lung pattern and what appears to be an enlarged right caudal lobar artery (Figure 2). This apparent enlargement is a result of inflammatory infiltrates surrounding the vessel and producing a radiographic shadow. The bronchointerstitial lung pattern may be misinterpreted as allergic bronchitis or asthma, and glucocorticosteroid administration will improve the radiographic signs, further supporting the misdiagnosis.

Evidence of this initial phase (i.e., radiographic signs of pulmonary parenchymal disease by 3 months postinfection) was reported by Donahoe et al<sup>13</sup> in 1976. In a later study (1992), Holmes et al<sup>14</sup> demonstrated vascular disease in the caudal lung lobes by day 75 postinfection, followed by interstitial and alveolar disease by day 90. The vascular lesions were described as severe muscular hypertrophy of the medium and small arteries (Figure 3). Browne et al<sup>15</sup> found the same type of lesions in cats that were positive for heartworm antibodies but were determined to be free of adult heartworms by necropsy, providing evidence that cats need not have fully mature adult worms to have disease.

A recent study by Dillon et al,<sup>16</sup> the results of which were presented at the 2007 Heartworm Symposium, compared the pulmonary pathology of cats that were experimentally infected with 100 L3 lar-



**Figure 2.** Enlarged right caudal lobar artery.



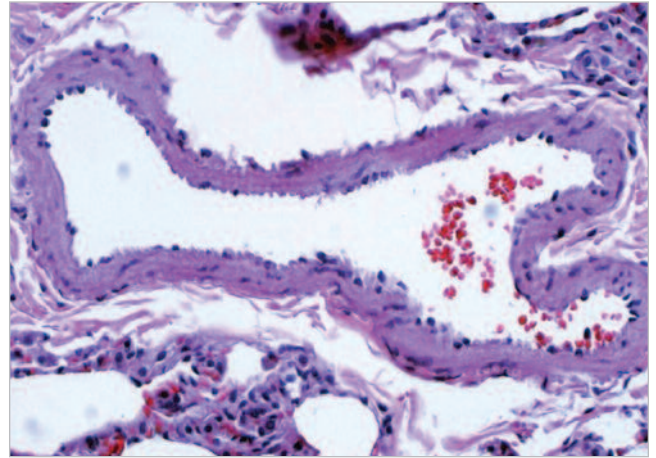
**Figure 3. Heartworm-associated vascular changes.** Normal arteriole (left). Arteriole from heartworm antibody-positive cat without adult heartworms (right). (Images courtesy of Julie Levy, DVM, PhD, DACVIM, University of Florida)

vae while receiving selamectin prevention, cats with abbreviated juvenile worm infections, and cats with adult heartworms (Figure 4). These infections reproduced the vascular lesions described by Holmes et al<sup>14</sup> and Browne et al.<sup>15</sup> In addition, the researchers noted lesions in the bronchioles and alveoli of the cats with abbreviated juvenile worm infections that were almost identical to those found in cats with adult worm infections (Figures 5 and 6). Furthermore, despite the severity of the pulmonary lesions in the abbreviated juvenile infections, 50% of the cats were antibody negative 8 months postinfection. The cats that received preventive therapy had no histopathologic lesions.

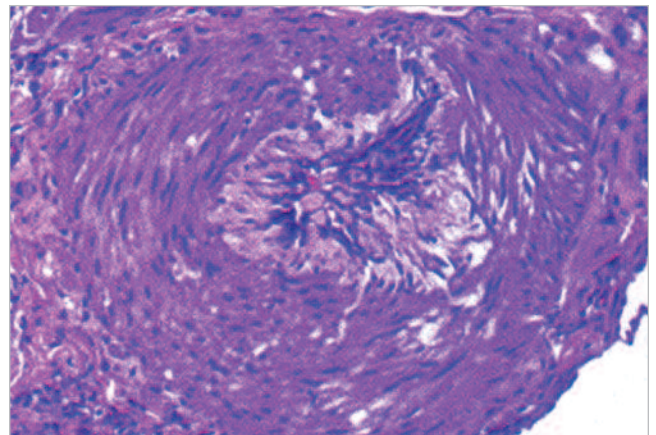
Findings from all of these studies provided additional evidence that pulmonary disease occurs in cats as a result of juvenile worm infections, even if the infections do not progress to the mature adult worm stage. This has led to the adoption of a new term to describe heartworm infections in cats, *heartworm-associated respiratory disease (HARD)*.<sup>17</sup>

In cats, if a juvenile worm matures to adulthood, the host immune response is suppressed and there may be some resolution of clinical signs. Two studies have demonstrated the ability of heartworms to suppress the activity of the pulmonary intravascular macrophage, the main component of the cat's reticuloendothelial system.<sup>18,19</sup> When the worm dies, this down-regulation of the immune system ceases and the second stage of disease begins. The degenerating parasite causes an intense inflammatory reaction and thromboembolism, which can lead to catastrophic acute lung injury and sudden death. Sudden death has been reported in 10% to 20% of cats with mature adult heartworm infections.<sup>9-11</sup> If the cat survives this stage, hyperplasia of type II alveolar cells replaces the normal type I cells, which may cause permanent lung injury.<sup>20</sup> This can lead to chronic respiratory disease, the third stage of heartworm disease in cats.

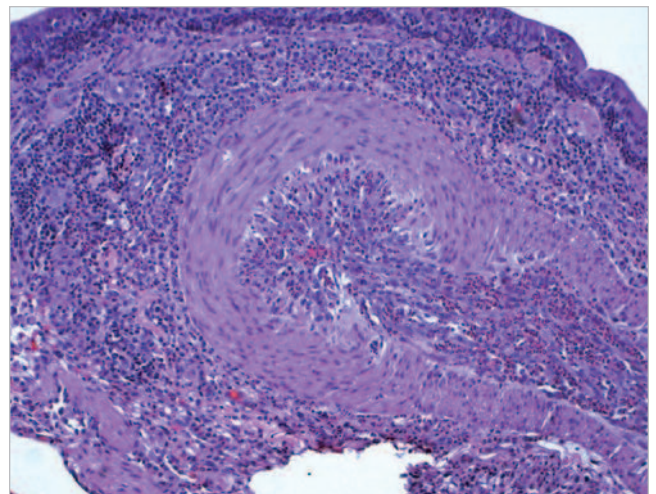
**Figure 4. Arteriolar lesions caused by heartworm infection.** (Images courtesy of Ray Dillon, DVM, MS, DACVIM, and Byron Blagburn, MS, PhD, Auburn University)



Heartworm-challenged cat receiving monthly heartworm preventative.

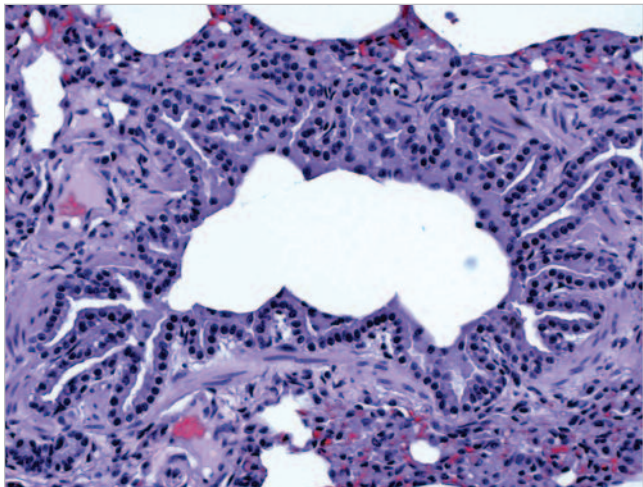


Abbreviated juvenile worm infection.

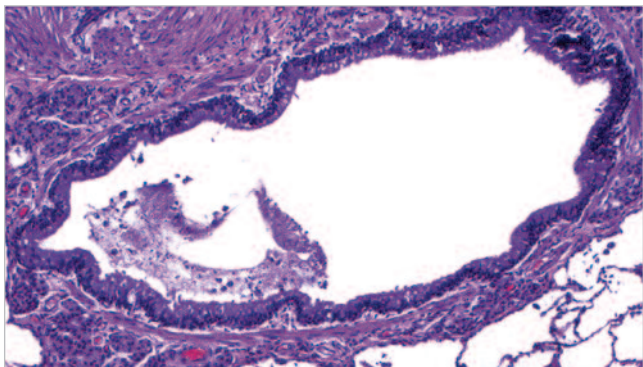


Adult heartworm infection.

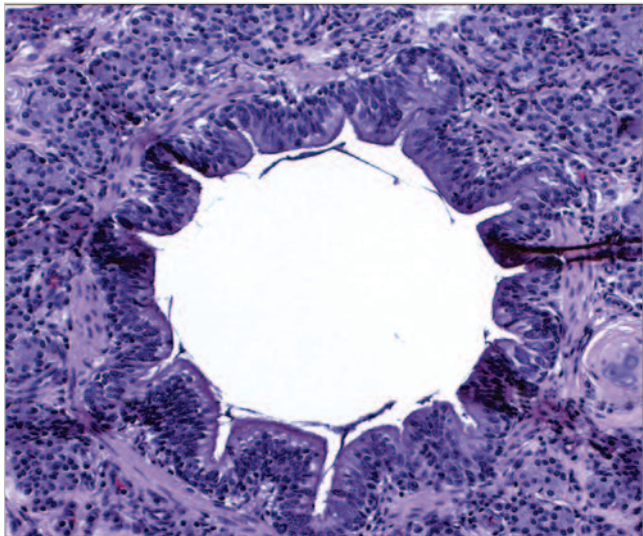
**Figure 5. Bronchiolar lesions caused by heartworm infection.** (Images courtesy of Drs. Dillon and Blagburn)



Heartworm-challenged cat receiving monthly heartworm preventative.

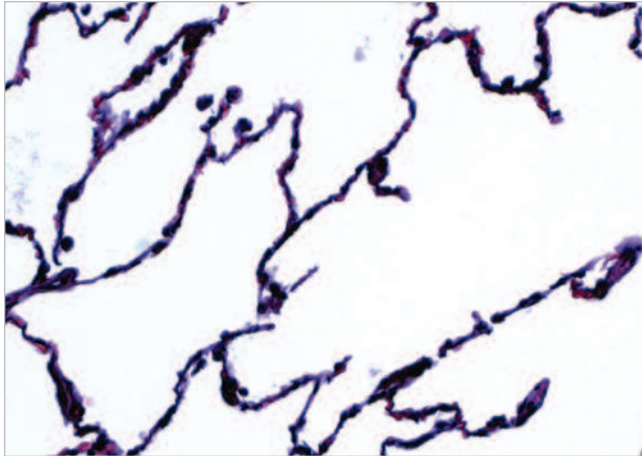


Abbreviated juvenile worm infection.

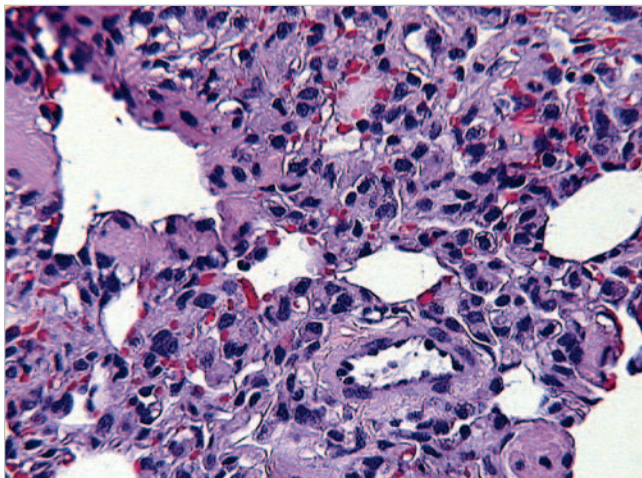


Adult heartworm infection.

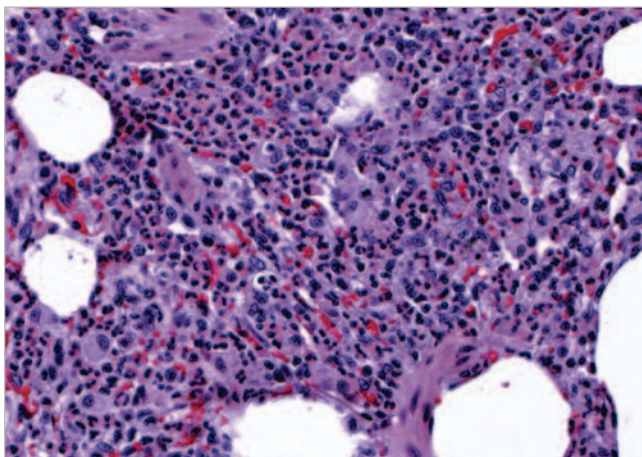
**Figure 6. Alveolar lesions caused by heartworm infection.** (Images courtesy of Drs. Dillon and Blagburn)



Heartworm-challenged cat receiving monthly heartworm preventative.



Abbreviated juvenile worm infection.



Adult heartworm infection.

## CONCLUSION

Although the existence of feline heartworm infection is now well established, veterinarians (and therefore cat owners) have been slow to recognize and react to the problem. Moreover, practitioners need to understand that, whereas infected cats seldom harbor adult worms, they can still be subject to serious respiratory consequences. Clearly, this is a widespread disease that can no longer be ignored.

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## ARTICLE #1 CE TEST



This article qualifies for 2 contact hours of continuing education credit from the Auburn University College of Veterinary Medicine. **Subscribers may take individual CE tests or sign up for our annual CE program.** Those who wish to apply this credit to fulfill state relicensure requirements should consult their respective state authorities regarding the applicability of this program. CE subscribers can take CE tests online and get real-time scores at [CompendiumVet.com](http://CompendiumVet.com).

- Roughly what percentage of cats in the United States is currently receiving heartworm prevention?**
  - 1%
  - 5%
  - 8%
  - 10%
- Feline adult heartworm infection is estimated to occur at what proportion of canine heartworm infection in a given area?**
  - 1% to 5%
  - 7% to 10%
  - 5% to 20%
  - 15% to 40%
- Heartworm larvae are infective at what stage?**
  - L1
  - L2
  - L3
  - L4
- The fifth stage of heartworm development is properly termed**
  - L5
  - microfilarial
  - migratory
  - juvenile
- How long do adult heartworms generally survive in cats?**
  - <6 months
  - 1-2 years
  - 2-4 years
  - 5-7 years
- The first stage of heartworm disease in cats is primarily a**
  - pulmonary inflammatory reaction.
  - gastric reaction.
  - skin reaction.
  - cardiovascular reaction.
- In the rare feline cases where the juvenile worm reaches adulthood, the host immune response**
  - causes the worm to be contained.
  - is suppressed.
  - can lead to widespread scarring.
  - continues to intensify.
- Respiratory disease due to heartworm infection in cats is described as**
  - juvenile abbreviated.
  - foreign-body induced.
  - pulmonary colonizing.
  - heartworm associated.
- The second stage of feline heartworm disease consists of a pulmonary inflammatory reaction due to**
  - parasite reproduction.
  - the death of the adult parasite.
  - parasite migration into the heart.
  - parasite migration into the intestines.
- Approximately what percentage of cats with heartworm infection is asymptomatic?**
  - 2%
  - 12%
  - 18%
  - 28%