

## Are Hookworms Hiding in Your Favorite Dog Park?

Hookworms are finding a new home - dog parks - and dogs that frequent them may be 70% more likely to become infected. Worse, about half of the infections in the US are now resistant to the standard three classes of medications, putting younger pets and older dogs at a higher risk for death.

**Analysis by Dr. Karen Shaw Becker**

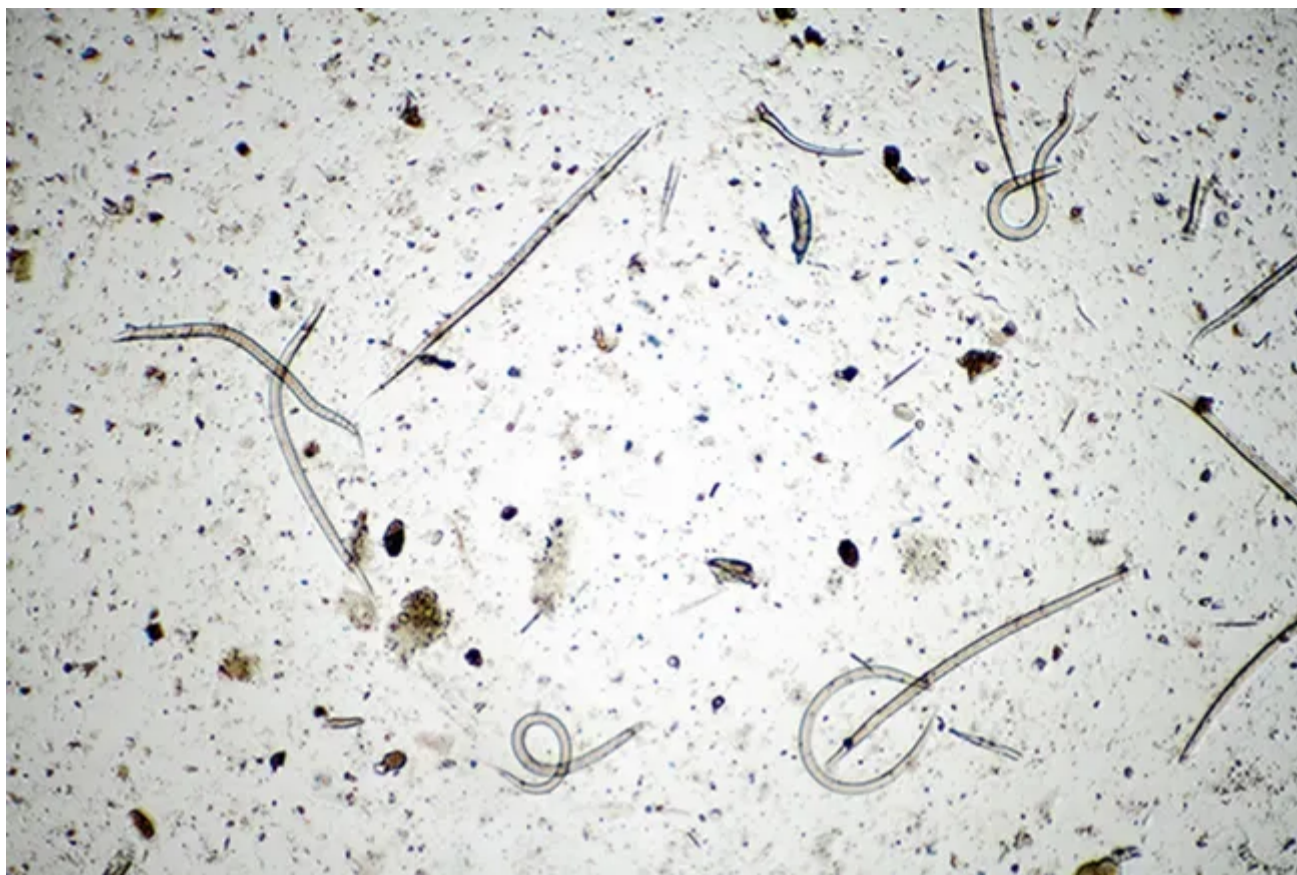
### STORY AT-A-GLANCE

- Parasitologist and veterinarian Ray Kaplan and colleagues have published a series of three studies over the last few years that trace the origin, evolution and spread of drug-resistant hookworms in dogs; drug resistant infections are a significant issue in veterinary medicine today
- The study findings suggest that mismanagement of parasite control (e.g., chronic deworming, even in the absence of infection) in the group of research dogs has led to "superparasite" hookworms that are resistant to the three classes of drugs typically used to treat them
- In the third study in the series, published in March 2023, the researchers learned that in about 50% of U.S. dogs with a hookworm infection are resistant to at least one of the three classes of treatment drugs; fortunately, drug resistant hookworms aren't fatal to most dogs, and barring reinfection and further spread, they die off
- The number of dog parks in major U.S. cities grew 74% from 2009 to 2019, with the result that resistant hookworms are already circulating in the U.S. canine population — there are about 100 million dogs in the U.S., and the prevalence of the parasite is about 4%

About six years ago, veterinarians across the U.S. began encountering resistant parasitic infections in dogs. The parasite involved in subsequent research studies was the hookworm. It's important to note that **drug resistant infections** are a significant problem in veterinary medicine today.

### Hookworm Is an Intestinal Parasite

Hookworms attach to the intestinal wall and suck the blood of the host. They're pale grey or slightly pink in color, and the head (at the front of the body) is bent a bit in relation to the rest of the body, forming a hook shape.



Hookworm

They're primarily transmitted fecal-orally to animals, meaning your dog may eat contaminated feces or dirt, or he might walk through contaminated soil, then lick his paws and ingest the eggs.

Puppies can acquire hookworm from an infected mother's milk and become lethargic, weak, malnourished and **anemic**. It isn't uncommon for young pets to die from a hookworm infestation. Infected adult pets may show symptoms of poor appetite and weight loss. Chronic hookworm infestation is a common cause of illness in older dogs.

Humans can also acquire a hookworm infection, typically by picking up the eggs or larvae on the skin from soil contaminated by infected wild animal or pet poop. Hookworm larvae can penetrate human skin, and they aren't visible to the naked eye.

To prevent a hookworm infestation, it's important to get rid of any potentially infective feces from wild or stray animals around your property that might tempt your dog. It's also a good idea to keep your pet away from the poop of other animals while you're **walking outdoors** or hiking.

## Tracing the Origin of Drug Resistant Hookworms

According to a recent report in the Scientific American written by science journalist and parasitologist Bradley van Paridon, another parasitologist and veterinarian, Ray Kaplan, and colleagues have published a series of studies over the last few years that trace the origin, evolution and spread of drug-resistant hookworms in dogs.

*"Their findings implicate the greyhound racing industry in the rise of these superparasites," writes van Paridon. "Once a national pastime, greyhound racing is now nearly extinct in the U.S. But it may have left a dangerous legacy that poses a risk to all dogs. The researchers' discoveries also offer a cautionary tale for the management of human parasite infections."<sup>1</sup>*

To determine if dog hookworms are resistant to the three classes of antiparasitic drugs typically used to treat them (benzimidazoles, macrocyclic lactones, and tetrahydropyrimidines), Kaplan ran tests on hookworm samples from three dogs with persistent infections, including one greyhound named Worthy

Greyhounds are known to develop resistant hookworm infections, and it was assumed the cause was "larval leak" — the parasite's ability to lie dormant in tissue and re-emerge after the original infection is cleared. However, Kaplan's **2019 study** showed that the worms in all three dogs were resistant to each of the three classes of drugs.<sup>2</sup>

Kaplan's team also tested for benzimidazole tolerance in worms from Worthy's housemate and another retired greyhound, both of whom were prone to stubborn infections, and found they were resistant. These findings, coupled with the known problem of persistent infections in greyhounds, led the researchers to theorize that something was occurring on greyhound "farms."

*"What [Kaplan] found on further investigation was the perfect combination of factors to promote the evolution of drug resistance," writes von Paridon.*

Thankfully, the greyhound racing industry has, for the most part, lost its popularity, but the residual effects of the industry's long-term medical mismanagement is at the root of this issue.

## **The Culprit: Overuse of Dewormers in An Exploited Breed**

Twenty years ago, greyhound racing in the U.S. was very much a thing, with dozens of tracks across 19 states and around 40,000 dogs born each year. However, in the early 2000s, the sport lost favor thanks to efforts by animal welfare organizations, and many states banned it. By 2020, fewer than 5,000 greyhounds were born on farms, and today, dog racing is illegal in 42 states. Just two active tracks remain, however, around 100 breeding farms continue to produce dogs.

At these farms, it's standard practice for all the dogs to receive regular deworming, whether they have an active parasite infection or not. "That's exactly what you don't want to do if you want to avoid resistance," hookworm expert John Hawdon of George Washington University, told Scientific American.

*"Constant drug exposure means any worms that survive have a reproductive advantage and dominate the next generation," writes von Paridon. "Moreover, the exercise pens for these dogs are set up on sand or dirt, which can be the perfect habitat for developing hookworm larvae. After dogs defecate in the pens, the hookworm eggs hatch, and the larvae eventually molt, reaching their infective stage within five to 10 days. Thus, every day when the greyhounds go out to run, they are exposed to resistant hookworm larvae from other dogs, and they seed the environment with resistant hookworms of their own."*

Greyhounds are the default victims in this situation, however, as I've written about repeatedly, a similar situation is occurring with canine **heartworm**. In addition to concerns about the toxicity of insecticides used against parasites and other pests, there's also evidence that heartworms are becoming resistant to them.

## **Drug-Resistant Hookworms and the General Pet Population**

In Kaplan's **second study published in 2021**, his team sampled worms from two greyhound adoption kennels in Birmingham, AL and Dallas, TX, along with an active racing kennel in Sanford, FL, and tested them for drug resistance.<sup>3</sup>

In Sanford, samples were collected from the ground, so the individual dogs they came from weren't known. But since the dogs at that kennel came from four other states (Colorado, Arkansas, Oklahoma, and West Virginia), resistant worms in Sanford meant the likelihood of resistant worms in those locations as well. The results replicated those of the



2019 study involving Worthy — the hookworms had high levels of resistance to all three drug classes.

*"Worms that are resistant to benzimidazoles have up to three known single-nucleotide mutations in their DNA that confer resistance," writes von Paridon. "These changes, each to one DNA building block, occur at three locations in the sequence of a single gene, making it possible to quickly screen worms' DNA and find out whether they are resistant to benzimidazoles. In the 2021 study of greyhound farms, 99% of the samples sequenced had one of the three resistance mutations."*

*The presence of drug-resistant hookworms at greyhound farms, Kaplan realized, poses a threat to the pet population. As the racing industry began its decline in the early 2000s, organizations sprang up to rehome the dogs, leading to thousands of greyhounds being adopted across the country in the past two decades. Greyhounds infected with drug-resistant hookworm could pass the parasites to other pet dogs."*

## **50% of Hookworm Infections in Dogs May Be Drug Resistant**

Historically, hookworm infections in dogs have been relatively rare. However, between 2009 and 2019, the number of dog parks saw growth of 74%, and these spaces are a perfect environment for the spread of parasites. Once hookworms have set up camp in a dog park, it's nearly impossible to get rid of them, and according to von Paridon, two recent studies revealed that canine family members who frequented dog parks had a 70% higher prevalence of hookworm infections compared with the overall population.

Kaplan's next move was to team up with John Gilleard at the University of Calgary in Canada to use Gilleard's DNA-sequencing technique capable of screening hundreds of hookworm eggs from a single dog simultaneously for resistance mutations. They applied the technique to fecal samples containing hookworms from labs in Tennessee, Massachusetts, Illinois and California, and the results were stunning.

Expecting maybe a 5% or 10% prevalence, the researchers were astonished to find one of the known resistance mutations present in 49% of fecal samples, and a novel mutation that also proved resistant, present in 31%. Kaplan and colleagues published their **2023 study results** in March in PLOS Pathogens,<sup>4</sup> suggesting that in about 50% of U.S. dogs with infection, the hookworms are resistant to benzimidazole drugs.

While genetic screens for drug resistance are not possible for the other two drug classes, Kaplan thinks it is likely that some of the worms will be resistant to them, too.

## **Hookworm Infection Risks and Prevention Steps**

Fortunately, for most dogs, resistant hookworms aren't fatal. Barring reinfection, the parasites eventually die. However, as von Paridon explains, the more these worms circulate in the dog population, the greater the risk to puppies and other vulnerable individuals. In addition, hookworms can also infect humans.

*"Despite these worrying trends, Kaplan and Hawdon emphasize that we shouldn't blame the greyhounds," writes von Paridon. "It's a shame to stigmatize them because as the last of these tracks die, there's going to be even more of these dogs to adopt," says Hawdon."*

*"Resistant worms are already circulating in the U.S. canine population, meaning all dogs can catch and spread them," von Paridon continues. "Putting the risk to other dogs into perspective, Kaplan argues that although hookworms are present in most greyhounds, other breeds are the likely carriers when it comes to pet exposure. 'There are only a few thousand greyhounds that are being adopted in a year,' he says. But 'there are 100 million dogs in the U.S.,' and we know that the prevalence of the parasite in that population is about 4%."*

Veterinarian Pablo David Jimenez Castro, lead author of the 2019 and 2021 studies, is now co-chair of the American Association of Veterinary Parasitologists Hookworm Task Force. He advises that the best thing dog owners can do to protect their pets from hookworm is to have their vet administer fecal egg tests for worms four times a year. If your dog has worms, be diligent with both the treatment protocol and cleaning up after your pet.<sup>5</sup> Most importantly, if your pet has been diagnosed with a GI parasite, recheck the stool sample after treatment to assure yourself the infection has been cleared.

Jimenez Castro emphasizes that if pet parents can prevent infected dogs from reinfection and passing the parasite to other pets in the home, the worms will run their course and die. Drastic action isn't required. There's no need to "burn the backyard, the lawn, all of it" to control hookworms. Disposing of feces within 48 hours is enough to get any eggs they contain away from the area before they hatch and become infective.

Jimenez Castro also says owners shouldn't be afraid of dog parks. "In big cities [such as] New York, the only place for a dog to be a dog is going to be the dog park," he says. What you should do, however, is understand the risk and stay on top of checkups with your veterinarian. There's not much anyone can do to eliminate hookworm in parks, because once larvae are in the grass and soil, they're impossible to find and kill.

## **Sources and References**

<sup>1,5</sup> [von Paridon, B. How Greyhound Racing Drove the Evolution of a Superparasite, Scientific American, June 1, 2023](#)

<sup>2</sup> [Jimenez Castro, P.D. et al. Parasites & Vectors, Volume 12, Article number: 576 \(2019\).](#)

<sup>3</sup> [Jimenez Castro, P.D. et al. Int J Parasitol Drugs, Drug Resist. 2021 Dec;17:107-117](#)

<sup>4</sup> [Venkatesan, A. et al. PLOS Pathogens, March 2, 2023](#)

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