TAPEWORMS
OVERLOOKED, UNDERDIAGNOSED, AND UNDERTREATED

A ROUNDTABLE DISCUSSION

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TAPEWORMS

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MODERATOR
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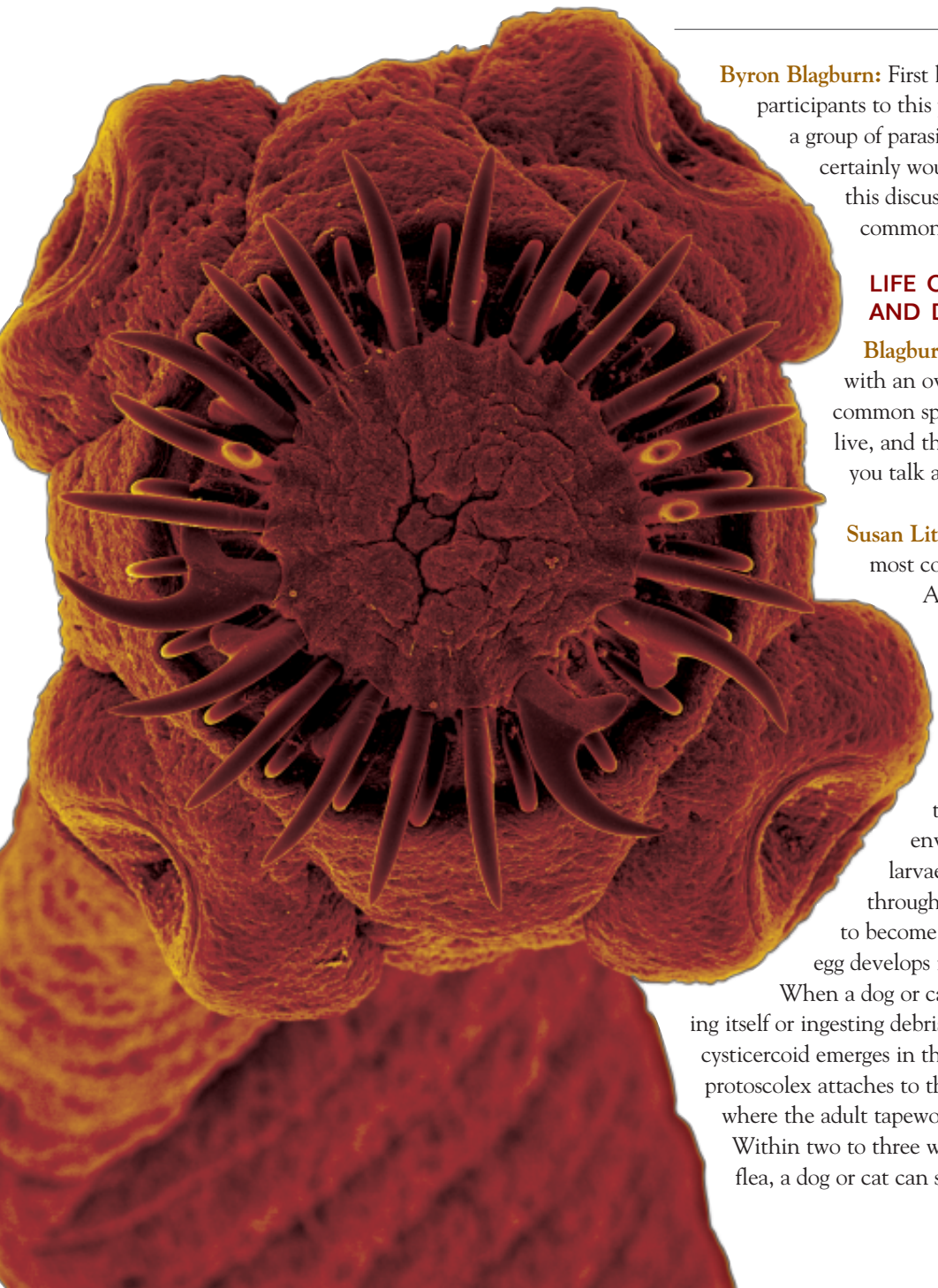

Byron Blagburn: First let me welcome each of our participants to this panel discussion on tapeworms, a group of parasites important to all of us. We certainly would all agree that the title of this discussion reflects our opinion about common tapeworms of dogs and cats.

LIFE CYCLE, DISTRIBUTION, AND DIAGNOSIS

Blagburn: Let's start our discussion with an overview of tapeworms: what the common species look like, where they live, and their life cycles. Dr. Little, would you talk about *Dipylidium caninum*?

Susan Little: *Dipylidium caninum* is the most common tapeworm in North American dogs and cats. As most veterinarians know, it is acquired by ingesting infected fleas. A dog or cat with a *Dipylidium caninum* adult in its small intestine sheds proglottids in its feces, and those proglottids in the environment are consumed by flea larvae. As the flea larva goes through pupation and metamorphosis to become an adult flea, the tapeworm egg develops into an infectious cysticercoid. When a dog or cat ingests the flea while grooming itself or ingesting debris from the environment, the cysticercoid emerges in the animal's small intestine. The protoscolex attaches to the wall of the small intestine, where the adult tapeworm forms. It is a rapid process. Within two to three weeks of ingesting an infected flea, a dog or cat can shed proglottids in its feces.

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Blagburn: Would the same process occur if a small child happened to ingest a flea?

Little: Yes. *Dipylidium* tapeworms can develop and produce proglottids in a child when that child inadvertently ingests a flea containing the cysticercoid. The tapeworm will continue to develop in that child's small intestine, and the parents may find proglottids in the diaper or on the anus.

Blagburn: Why is *Dipylidium caninum* called the cucumber seed tapeworm?

Little: The proglottids resemble cucumber seeds; they have an oval appearance. If they dry out, they can become harder to recognize. In that case, the veterinarian or veterinary technician may need to rehydrate and dissect the proglottid by adding a small amount of saline and then teasing the proglottid apart under a microscope to identify the characteristic eggs, which are shed in packets of 20 to 40. If you see the proglottid fresh and moving around on an animal or on the couch where the pet lies, it has a softer appearance. I think the cucumber seed image is used to distinguish *Dipylidium caninum* from *Taenia* species—the other tapeworm we commonly see in dogs and cats. Those proglottids have a more angular shape.

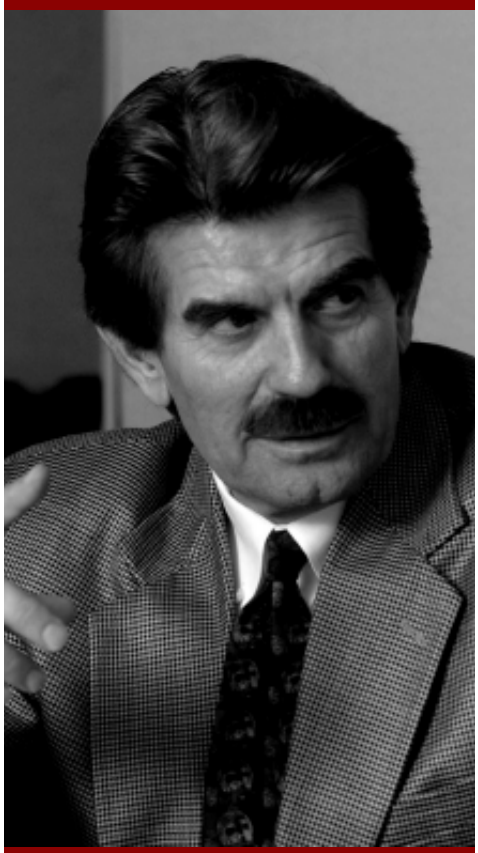
Blagburn: Dr. Cooper, when your clients complain to you about tapeworms, what do they tell you they see?

Jonathan Cooper: Normally they describe what appears to be a grain of rice around the perineum or on the feces. Some pet owners refer to the proglottid as appearing like a sesame seed. We hear these comments every day and every week. This intestinal parasite is so prevalent that often our receptionists will identify tapeworms based on the pet owner's description.

Blagburn: One of the challenges of determining the true prevalence of tapeworm infection is the fact that the proglottids are shed intermittently. If you sample an animal at a time when it is not shedding proglottids—or if the client does not mention anything unusual—then you miss it. Any thoughts on the true prevalence of *Dipylidium* infection?

Little: The estimates for infection rates are all over the map—from 4% to 50% or higher. It really depends on the flea prevalence in a particular area—the prevalence of *Dipylidium* follows. In addition, the proglottids are not evenly distributed throughout the feces. So if you do a fecal flotation on just 4 grams of feces, the odds of finding a proglottid are low. Fecal exams are just not a good screening tool for *Dipylidium* infection.

Blagburn: In some of our earlier studies with cestocides, we would study dogs at animal control facilities. During the times of year when fleas are prevalent in the deep South, we could go to a facility, pick 20 or 30 dogs, and at study termination virtually



"Pet owners think their little dog, Snookers, would never eat another animal, but it's instinctive."

Byron Blagburn, MS, PhD

all of them were infected with *Dipylidium*. But in our 1996 national parasite survey, less than 1% of 6,500 samples actually showed evidence of *Dipylidium* egg packets or proglottids in the feces.[1] It's difficult to confirm this parasite's presence. Unless you're examining a fecal sample at the right time, you'll miss it.

Dr. Kazacos, can you talk about our second most common tapeworm, *Taenia* species? I realize there are a number of them and they often use different intermediate hosts and have different larval stages, but could you give us a general overview?

Kevin Kazacos: The life cycle of *Taenia* species involves other mammals. Infected dogs and cats shed *Taenia* proglottids in their feces, just like with *Dipylidium*, but then other mammals pick up the organism by ingesting the eggs. The eggs hatch in that mammal and the larvae migrate into the viscera, usually the liver or contiguous body cavity, and grow to form large fluid-filled larvae. The dog or cat becomes infected again by eating that infected mammal. The larva contains the tapeworm scolex—the tapeworm head that attaches to the intestinal wall and generates proglottids. So for *Taenia* species, carnivorism is necessary for tapeworm transmission back to the dog or cat.

Dogs pick up *Taenia pisiformis* by eating cottontail rabbits, and cats pick up *Taenia taeniaeformis* by eating infected mice. These are the two most common taeniids we see. As you mentioned, there are other *Taenia* species in wildlife, and several of them occasionally show up in dogs and cats. But most veterinarians can't differentiate these other taeniids from *Taenia pisiformis* or *Taenia taeniaeformis*, so we generally just discuss those two.

As with *Dipylidium*, *Taenia* is diagnosed by finding proglottids in the feces, on the rear end, or in the environment of dogs and cats. The proglottids of these tapeworms are distinguished from *Dipylidium* by their larger size, rectangular shape, and single lateral genital pore, which looks like a small protrusion on the side. The eggs, which are recoverable by fecal flotation, are small and ellipsoidal to round, with a thick striated "shell" (embryophore) and a prominent six-hooked embryo inside. The eggs are heavy and thus don't float well unless one uses a higher specific gravity flotation solution (>1.20). It's important to note that taeniid eggs all look alike and cannot be differentiated from each other.

Dwight Bowman: Most people don't think about how much pets hunt. The only way dogs and cats can become infected with *Taenia* is to eat a rabbit or a rodent, and they do it all the time.

Blagburn: And it's natural, isn't it? Pet owners think their little dog, Snookers, would never eat another animal, but it's instinctive. So we call *Taenia pisiformis* the rabbit tapeworm because the dog often contracts it by eating cottontail rabbits. We sometimes call *Dipylidium* the flea tapeworm. That's an easy way to help us remember how they get it.

Kazacos: Another tapeworm we should mention is *Echinococcus*. These are tiny taeniid tapeworms, only about 2 to 5 mm in size, as opposed to *Taenia* species, which are generally big—a foot or more in length. As adults *Echinococcus* are

innocuous, even in large numbers, but the larval forms are important zoonotic pathogens. Called hydatid cysts, they occur in rodents in the case of *Echinococcus multilocularis* and large ungulates such as sheep and moose in the case of *Echinococcus granulosus*.

Blagburn: And that multilocular larval stage is almost like a cancer, isn't it?

Kazacos: It is a terrible larval stage, slow-growing, invasive, and metastatic like a cancer. It is important to treat *Echinococcus* infection, not just to eliminate the adult tapeworms but to prevent zoonotic transmission.

Blagburn: Dr. Bowman, you and Dr. Kazacos are in the northern tiers of the country. What do you see up there?

Bowman: We mainly see *Taenia taeniaeformis* and *Taenia pisiformis*. We also have plenty of *Dipylidium*, but it's more seasonal.

Blagburn: Dr. Cooper, what do you see most often down in Houston?

Cooper: We see *Dipylidium* most often as a result of the overwhelming presence of fleas in our area. Fleas are an ongoing, year-round issue in the South. To my knowledge we don't see a lot of *Echinococcus*, although it is certainly possible as people travel with their pets and relocate around the country.

Kazacos: We should explain that although *Dipylidium* and *Taenia* species are found across the country, *Echinococcus* species aren't. *Echinococcus multilocularis* is found primarily in the north. In North America, its current distribution involves 13 north-central states, Alaska, and contiguous parts of Canada. *Echinococcus granulosus* is more restricted and spotty; it's found in California and parts of Arizona, parts of the Rocky Mountain states, and northern Michigan. It has recently shown up in New York state, Tennessee, and other areas primarily due to the translocation of infected elk.

Little: Along that same vein there is also the Pseudophyllidea order. We have been talking about true tapeworms, the ones we are all most familiar with, but *Spirometra* and *Diphyllobothrium* also occur in dogs and cats and are more regional in their distribution. *Spirometra* is common in cats in Gulf Coast states. In Florida, *Spirometra* is considered the second most common tapeworm in cats behind *Dipylidium*. We also see it in dogs, but there are probably 10 feline cases for every one canine.

Bowman: We have it in New York also.

Little: It is found sporadically throughout the United States. Also, *Diphyllobothrium* is in the Great Lakes area.

Kazacos: We should also mention that the Pseudophyllidea are different in that they actually lay their eggs. So the veterinarian will find operculated eggs in the fecal sample, either by flotation or sedimentation. They look like fluke eggs, being operculated, but are lighter in color. As opposed to "true" tapeworms, pseudophyllideans have a different life cycle (aquatic), a different egg structure, and a different way of shedding proglottids. The others shed proglottids individually, but when the pseudophyllideans are finished shedding eggs from their terminal segments, they release a whole chain of empty segments. So the owner may notice a big long flat worm in the animal's feces. In some cases, they see it hanging out of the animal's rear end. So the pseudophyllideans are different in several respects, and we need to realize that to make a proper diagnosis.

Blagburn: Dr. Cooper, do you recognize these parasites much in practice?

TAPEWORM TIDBITS

Cyclophyllidean cestodes*

These species are sometimes called "true" tapeworms:

Canine

- *Dipylidium caninum*
- *Taenia crassiceps*
- *Taenia hydatigena*
- *Taenia multiceps*
- *Taenia pisiformis*
- *Taenia serialis*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*

Feline

- *Dipylidium caninum*
- *Taenia taeniaeformis*
- *Echinococcus multilocularis*

Pseudophyllidean cestodes

These species are sometimes called "primitive" tapeworms:

- *Diphyllobothrium latum*
- *Spirometra* species

*All Tapeworm Tidbits facts come from the Companion Animal Parasite Council guidelines, found at www.capcvet.org.

TAPEWORM TIDBITS

Life cycle overview

Cyclophyllidean tapeworms have indirect life cycles that require specific intermediate hosts. Dogs and cats infected with adult tapeworms shed egg-laden proglottids in their feces. When eggs are consumed by the intermediate host, larval cysts develop. Dogs and cats are infected when they ingest these cysts.

Life stages

1. Infectious egg
2. Larval cyst, which can take the following forms:
   - compact cysticercoid (tapeworm species that use an arthropod intermediate host)
   - bladder-like cysticercus (species that use a vertebrate intermediate host)
   - large, bladder-like coenurus (*Taenia multiceps*)
   - large, thick-walled unilocular hydatid cyst (*Echinococcus granulosus*)
   - large, thin-walled alveolar hydatid cyst (*Echinococcus multilocularis*)
3. Proglottid shed in the feces of an infected dog or cat
4. Adult cyclophyllidean tapeworm found in the small intestine of a dog or cat

Cooper: We don't go to great lengths to distinguish between tapeworm species other than recognizing that the flat and long tapeworm is *Dipylidium* and the wide and short tapeworm is *Taenia*. Usually when we see a proglottid, we call it a tapeworm.

Blagburn: So other tapeworms might be regionally important, but none are as widely distributed as *Dipylidium* and *Taenia*. *Echinococcus* is perhaps much more focal than *Dipylidium* or *Taenia*. Dr. Cooper, to what extent do you think pet owners are aware of tapeworms?

Cooper: They are certainly aware of the tapeworms' presence when they see a proglottid, but I don't think they understand their clinical manifestations or zoonotic potential. They just know the tapeworms are there and they're revolting and they don't want them on the pet, on the couch, or especially on the bed.

Blagburn: So if someone brings in this rice grain and you tell them what it is, what percentage of your clients know what you mean?

Cooper: Most of the time they've heard of tapeworms, but they don't know much about them.

Kazacos: In the Midwest and elsewhere, hunters are familiar with tapeworms. When they go rabbit or squirrel hunting and they field-dress the animals, they see the larvae in the viscera. They know that if the dog eats those larvae, it will get tapeworms.

INFECTION

Blagburn: Let's talk about disease associated with adult and larval tapeworms. What are the effects of tapeworm infection in dogs and cats and on the owners who see it?

Bowman: Usually we think of adult tapeworms as fairly benign in dogs and cats. But there are reports of impactions, sometimes fatal, in young puppies with *Dipylidium* infection. I have a paper under review on *Taenia taeniaeformis* in cats causing impaction that required surgery and removal of the worm. Although these cases occur, they are often not reported.

Blagburn: By impaction you mean the tapeworm balling up and blocking the intestine. Does that occur after treatment? Does it occur spontaneously in heavily infected animals?

Bowman: The cases I'm talking about were spontaneous.

Blagburn: We hear about rare soft or diarrheic feces, restlessness, abdominal pain, dull coat, and excessive grooming of the perineum. How much of that do you attribute to adult tapeworms?

Cooper: We most commonly see scooting and perianal pruritus. Occasionally, in more severe cases, there is some abdominal discomfort or anxiety. But typically the pet scoots its rear end on the carpet.

Blagburn: What causes that? Why would tapeworms that live way up in the intestine cause the rear end to itch?

Little: As the proglottids exit the intestine and crawl around on the perianal region, they cause some localized inflammation and irritation along their path.

Kazacos: *Echinococcus* adults, on the other hand, are so tiny that they really don't do much. We've had animals with nearly a hundred thousand adult worms in the small intestine and they didn't show any clinical signs. *Echinococcus* species are almost silent as an adult infection, but their larvae are so deadly that we need to consider them in any tapeworm control program.

Blagburn: Could we talk about the effects of Pseudophyllidea infection? There are reports of *Diphyllobothrium* being associated with blood dyscrasias and vitamin B_{12} absorption problems in people. Have we seen a similar problem in animals?

Bowman: Justus Mueller discussed that effect in cats way back in his early work on these parasites in the 1930s and 1940s.[2] The tapeworms will turn pink, probably as a result of vitamin B_{12} absorption. That research hasn't been followed up in any detail that I know of. I've heard that it's been talked about in dogs, but my understanding is that dogs handle vitamin B_{12} differently, so *Diphyllobothrium* does not cause the same problems in dogs as it does in people.

Little: *Spirometra* causes vomiting and weight loss in cats, and it can be a pronounced clinical disease. Upon treatment the clinical signs resolve. That has been reported by clinicians in endemic areas, and we have also seen it in experimental infections, suggesting that the pseudophyllideans do have direct clinical implications.

ZOONOSIS

Blagburn: Let's talk about human exposure and infection.

Bowman: *Dipylidium* infection is probably the most common tapeworm zoonosis in the continental United States. It may be a little less common than it once was, probably because of better flea control. Again, it occurs through ingestion of the flea and not ingestion of the stage passed by the dog or cat. So a person becomes infected by eating the intermediate host.

Kazacos: With the taeniids, people become infected with the larval stages, and the method of infection is also different. With *Dipylidium*, you have to eat the flea and ingest the larvae to become infected with adult tapeworms. With the taeniids, you ingest infective eggs and become infected with tapeworm larvae. It is important to realize that an animal can have infective eggs in its perianal area and in its fur.

Bowman: Unlike hookworms or roundworms, these taeniids are infectious when they come out.

> "Usually we think of adult tapeworms as fairly benign in dogs and cats. But there are reports of impactions, sometimes fatal, in young puppies with *Dipylidium* infection."
>
> *Dwight Bowman, MS, PhD*

Kazacos: That's correct. Simple contact and accidental ingestion of those eggs can cause infection, and that is an important distinction. The hooked larvae from those eggs will migrate into the human viscera and vesiculate, becoming the large, fluid-filled tapeworm larvae we normally see in intermediate hosts. Some of them can be quite pathogenic depending on their location and size. The *Taenia* species that are zoonotic—not *Taenia pisiformis*, but some wildlife taeniids that can infect dogs, like *Taenia multiceps*—can produce nasty infections in people, especially if the larvae develop in the eye or the nervous system. The problem is, if you see *Taenia* proglottids or eggs, you don't really know which one you are dealing with. You could be dealing with a zoonotic species that could infect people, or with *Taenia pisiformis*, which won't be a problem. Proper sanitation and handwashing in the clinic are always good ideas.

Blagburn: That is an important point. What about *Echinococcus*?

Kazacos: With *Echinococcus*, you up the ante because those species are deadly. *Echinococcus granulosus* produces a large, slow-growing, thick-walled cystic larva in the liver or lung that can reach the size of an orange or grapefruit. As it

"It is our duty to educate clients when there is the threat of a zoonotic disease. If we fail ... we are letting them down."
Jonathan Cooper, DVM, PhD

impinges on surrounding tissues, it eventually causes clinical disease as a space-occupying mass, although people also react immunologically. *Echinococcus multilocularis* produces a thin-walled cyst that invades tissue by sending out little extensions—these larvae can wrap themselves around vessels and spread to other areas. The behavior is similar to a malignant neoplasm, and it has one of the highest case mortality ratios of any of the known helminths.

Blagburn: Humans become infected with both species just by being exposed to environments in which eggs or proglottids have been deposited by infected dogs.

Kazacos: That's right, or by being exposed to eggs on an animal's fur. And, unlike roundworms and other parasites where the more eggs you ingest the worse it is, with *Echinococcus granulosus* and *multilocularis*, technically you only need to ingest one egg because the larva can grow and proliferate in humans. Infection with *Echinococcus* larvae has grave consequences for the patient, which is why we consider it to be so important.

Blagburn: Although a practitioner in the south, such as Dr. Cooper, might not see *Echinococcus* because of its distribution, it's important to remember that we are a mobile society and anything can show up anywhere these days.

Kazacos: Dr. Little, what about Pseudophyllidea larval infection in people?

Little: With *Diphyllobothrium*, people serve as the definitive host for the adult tapeworm, and ingestion of the plerocercoid in undercooked or raw fish can result in vitamin B_{12} deficiency and anemia in the infected person. *Spirometra* is different. Humans can serve as an intermediate host of *Spirometra*, in which case the larvae develop in a subcutaneous location or, more rarely, subcorneally. Cases of proliferative sparganosis have also been described where the larvae multiply in tissues, particularly neurologic tissue.

Kazacos: So people are infected with *Spirometra* through the food chain by eating lower vertebrates?

Little: Yes, either by ingesting the second intermediate host, which could be any nonfish vertebrate, or by ingesting infected copepods—small crustaceans that are the first intermediate host—in contaminated water. Feral pigs and frogs are a common source of *Spirometra* larvae, and people who ingest undercooked pork or frog legs are at risk of infection. However, infected dogs and cats are not the source of zoonosis with the pseudophyllideans the way they can be with taeniids.

Blagburn: Dr. Cooper, are veterinarians aware that when they see a taeniid egg in feces, they might in fact be dealing with *Echinococcus*?

Cooper: Veterinarians in the northern states might be more aware of *Echinococcus* than those in the South, but *Echinococcus* doesn't show up on our radar very often. For us it is not high on the list, but perhaps it should be.

Kazacos: *Echinococcus* proglottids are so small that they are not easily seen. If you

see taeniid eggs on a flotation but can't find any proglottids from that animal or in the fecal sample, you may be dealing with *Echinococcus*. That animal should immediately be quarantined and treated with caution. You can also have mixed infections, so finding *Taenia* proglottids doesn't mean you are out of the woods altogether. We found *Echinococcus* for the first time in Indiana in a coyote that came in for other reasons. It was shedding large numbers of taeniid eggs in its feces, but we never could find any proglottids. We had never seen *Echinococcus* in our state before, but that case was the tip-off that it was present. We subsequently found it to be widespread in wild canids in northern Indiana and southern Michigan.

Blagburn: Many veterinarians are fearful of talking about zoonosis. They don't like to discuss the fact that pets might be a source of infection to clients or their children. Do you think veterinarians are more comfortable talking about zoonosis than they were 10 years ago?

Cooper: I think we are, and I think we have to continue to do a better job educating our clients about the potential of zoonosis. We have a better understanding of zoonotic diseases and can communicate the potential for disease transmission more effectively. As the human-animal bond continues to strengthen and pets come in closer proximity to their owners, it is our duty to educate clients when there is the threat of a zoonotic disease. If we fail, we risk being held accountable by the legal system and the litigous society we live in. If we don't educate our clients about zoonosis, we are letting them down.

TREATMENT AND PREVENTION

Blagburn: Let's move on to a discussion of treatment. Dr. Cooper, what is your historical approach to removing tapeworms?

Cooper: We use praziquantel as our tapeworm treatment and find it to be very effective. Oftentimes, if there is a major flea infestation and potential for reinfection, we readminister the praziquantel. We use both the injectable and oral forms.

Blagburn: Do you ever have clients return time and time again, even after repeated treatments for *Dipylidium* infection?

Cooper: Yes, that does happen. My assumption is that the animals are being reinfested with fleas that transmit the tapeworms, so generally I discuss flea control with the pet owner.

Little: Reinfection is very common. In fact, many practitioners will go ahead and prescribe a second treatment of praziquantel two weeks after the first treatment. The initial treatment is fully effective for the current infection, but it takes some time to get a flea problem under control, so these veterinarians assume reinfection will occur before the flea problem is resolved.

Blagburn: Dr. Bowman, what are you doing in New York state?

Bowman: The same approach as Dr. Little. We give the treatment and then treat again two to three weeks later.

Blagburn: Suppose the treatment did not eliminate every last scolex. If the scolex was left to its own devices, how long would it live and produce proglottids?

Bowman: Months to years, depending on the species.

Little: I would say years.

Kazacos: I agree. There is little tissue reaction to tapeworms and tapeworm scoleces, so they don't face much resistance from the host.

TAPEWORM TIDBITS

Prevalence

- The reported prevalence of tapeworms in published studies varies from 4% to 60% in dogs and 1.8% to 52.7% in cats. A number of factors influence the likelihood that a dog or cat will become infected with tapeworms, including geographic region and an animal's opportunity to ingest an infected intermediate host. Prevalence data generated by fecal flotation alone almost certainly underestimate the frequency of infection with cyclophyllidean tapeworms because proglottids, and thus eggs, are focally distributed in fecal material; a given fecal sample may be negative for tapeworm proglottids or eggs even in the presence of an infection.

- *Dipylidium caninum* and *Taenia* species are found throughout North America. At present, the *Echinococcus* species are thought to be largely limited to areas of the north-central, midwestern, and southwestern United States, as well as areas of Canada and Alaska.

TAPEWORM TIDBITS

Transmission between hosts

Both dogs and cats are susceptible to infection with *Dipylidium caninum* following ingestion of infected fleas or, more rarely, lice. *Echinococcus multilocularis* will also infect both dogs and cats upon ingestion of rodents with alveolar hydatid cysts. *Echinococcus granulosus* and *Taenia pisiformis* are only known to infect dogs and wild canids. Dogs are infected after they ingest cysts in ungulate viscera or rabbit tissue, respectively. *Taenia taeniaeformis* only infects cats and wild felids and is acquired by ingestion of infected rodents.

Site of infection: Pathogenesis

Tapeworms are found in the small intestine of dogs and cats. Motile proglottids may be seen in the perianal region as they exit the animal, in the pet's environment (*e.g.,* on bedding), or in the fecal material itself. Common cyclophyllidean tapeworms do not cause significant disease in dogs and cats, but they are aesthetically unpleasant and may pose a zoonotic health risk, thus treatment is warranted.

Blagburn: So what I'm hearing is that we tend to retreat at an interval that equates with the developmental period, which makes sense. For *Dipylidium*, we emphasize the importance of flea control, realizing that even the compliant client may see an occasional tapeworm. What are we going to tell them about *Taenia*?

Kazacos: If clients are dealing with *Taenia* and they want to avoid reinfection, they have to try to curb the animal's hunting and scavenging behavior, because as long as it has access to wild animals like rabbits or rodents, it's going to get reinfected. The same goes for *Echinococcus*. But preventing rodent ingestion is difficult with some animals, especially cats. They are strong hunters. Even some dogs eat a lot of rodents and rabbits.

Blagburn: If we can keep our dogs from getting fleas and if we can keep them from going outside and hunting little furry creatures, we never have to worry about tapeworms, right?

Kazacos: Unless they eat raw fish.

Blagburn: And that is probably less likely. Obviously there is an interest in our industry to move toward more frequent administration of tapeworm medicines the way we've done with heartworm preventives and broad-spectrum internal parasiticides. Dr. Cooper, what do you think about administering a product like praziquantel monthly as part of a broad-spectrum continuous parasite control program?

Cooper: In regions of the country where fleas are a huge problem and in areas where tapeworms are endemic, it would make a lot of sense. Similarly, in areas where *Dipylidium* as well as *Taenia* and *Echinocoocus* are diagnosed, the benefit of preventing zoonotic disease has real value.

Blagburn: Dr. Little, how do you feel about monthly control?

Little: The *Taenia* and *Dipylidium* tapeworms don't tend to cause serious disease in dogs and cats, and they are readily treated. Plus, in many areas of the country we don't have *Echinococcus*, so the serious zoonotic threat isn't there. However, tapeworms are one of the most aesthetically unpleasant parasitic infections clients deal with. These parasites can discourage pet ownership and fracture the human-animal bond. People sleep with their pets. Their dogs lie on the couch, and people don't want to see those proglottids moving around. So keeping animals free of tapeworms and eliminating proglottids from pets and the environment are important ways to support pet ownership.

Bowman: As long as the treatment is part of another protocol, such as heartworm prevention or internal parasite control, I think most practitioners and owners would accept it. It would be different if the product was just targeting tapeworms.

Kazacos: Unless you are in an *Echinococcus*-endemic area, as I am—and the entire north central part of the United States is. Standard recommendations for praziquantel treatment for *Echinococcus multilocularis* are to use it every 21 to 26 days in dogs regularly exposed via infected rodents. So in our area monthly usage would be fine. As Dr. Bowman said, if you are delivering it with heartworm prevention and gastrointestinal nematode control, all the better.

You know, in the Midwest we have seen spillover of *Echinococcus* from coyotes and foxes through rodents into dogs and cats. In the Dakotas as many as 5% of farm cats carry the parasite, putting their owners at direct risk. We have seen similar spillover into farm dogs that hunt and eat rodents. With the zoonotic nature of

Echinococcus multilocularis, even though we don't have a lot of human cases in the continental United States, it's a serious enough infection that monthly treatment would be justified.

Blagburn: In east central Alabama, the only way we can manage chronic *Dipylidium* infection is by administering praziquantel every three to four weeks. There are times of year when administering it four or five months in a row is the only way we can bring the infection under control.

CLIENT EDUCATION

Blagburn: Do you think clients might be afraid of frequent-use medications? They're used to monthly heartworm preventives with additional label claims and other products added. But do you think clients may react to the addition of another product?

Cooper: There might be some concern if they're not convinced that tapeworms are harmful. They might question whether the medication is essential and whether there are any potential side effects. I think clients are concerned about what they give their pets.

Blagburn: We also have to remember that we're dealing with parasites that are hard to diagnose. We really don't know their true prevalence.

Cooper: It's not difficult to convince somebody when you have a reasonable explanation for using a specific product.

Blagburn: OK. Let me do a little role playing. We're talking about *Dipylidium*. "Dr. Cooper, I never see fleas on my pets. How are they getting tapeworms if they don't have fleas?"

Cooper: I would respond, "I think you're in flea denial. The fleas may be in low numbers, or perhaps you're not looking in the right place, but I feel certain that fleas are present because they are part of this tapeworm's life cycle. So appropriate flea control is necessary."

Blagburn: OK, let's go one step further. "Then why double up on trying to control a parasite that is effectively controlled by adequate flea prevention?"

Cooper: Clearly flea control is not 100% effective. We often see fleas on dogs that are being treated with flea products, so it's not uncommon to see tapeworms in dogs that are on a flea product. There is still a need to treat for tapeworms.

Kazacos: We could add that the pet is not the only source of fleas. It is well-known that suburban wildlife, like raccoons and opossums, also carry *Ctenocephalides felis*. At night, suburban wildlife seed people's yards with flea eggs and thus help maintain the flea life cycle. So animals can become infected from other sources even though they are on appropriate flea control.

Cooper: I think people have become complacent regarding flea control. They think that applying a product topically or administering a medication orally cures a flea problem, when fleas in

"Tapeworms are one of the most aesthetically unpleasant parasitic infections clients deal with. These parasites can discourage pet ownership and fracture the human-animal bond."

Susan Little, DVM, PhD

"If you have a drug that is essentially 100% effective, then you don't have any survivors to contribute genetic material, so the likelihood of resistance developing isn't there."

Kevin Kazacos, DVM, PhD

the environment are still a huge factor.

Blagburn: I might add, how often does a client tell you they don't see fleas, but you can drag a comb through the hair coat and point out the flea dirt?

Cooper: Every day. Clients just don't want to see them or admit that their pet has a flea problem.

Blagburn: So tapeworm control is additional insurance when we know that flea control products, while very good, are not 100% effective all of the time. Just a few fleas can propagate a tapeworm infection. What about *Taenia*? Pets have to consume an animal to get infected with *Taenia*. How are you going to deal with that one, Dr. Kazacos?

Kazacos: Well, my dog is a good example. She will catch rodents and rabbits and play with them, but she won't usually kill and eat them. However, she periodically becomes infected with *Taenia*, so I know she is finding dead rabbits and eating on them, thereby becoming infected with the tapeworm. We see *Taenia* fairly commonly in dogs and cats consuming wildlife, either hunting them or finding them dead and scavenging on them. So I think regular treatment is a good idea in those situations. An added benefit would be treatment of any *Echinococcus* or pseudophyllideans they might pick up.

Blagburn: It's fair to say that pet owners are familiar with products that prevent heartworm and gastrointestinal parasites. Do you think that when they see proglottids or you discuss tapeworms with them, they might think the heartworm-gastrointestinal product isn't working?

Cooper: When pets are receiving heartworm prevention with a gastrointestinal dewormer added, clients sometimes wonder why they see tapeworms. We have to educate them that this parasite is treated specifically with praziquantel, and those other medications are not effective against tapeworms. And if we use praziquantel or another drug specific for tapeworms, it won't treat other types of intestinal parasites. This subject requires additional client education.

Kazacos: That's a very good point. There are some veterinarians who think that if dogs are on a standard monthly heartworm combination product, all parasites are taken care of. I have even seen some veterinarians stop doing routine fecal diagnostics for that very reason. Nothing could be further from the truth. Heartworm combination products, as good as they are, actually have a fairly narrow treatment spectrum. We have to consider that animals on these products may become infected with a variety of other parasites, including tapeworms.

Blagburn: So you think it wouldn't be hard to convince clients to use a broad-spectrum agent that included praziquantel if the cost weren't prohibitive? Particularly in *Dipylidium*- and *Taenia*-endemic areas?

Cooper: I think they would accept it if they and their veterinarian were convinced it was an effective and safe product.

Kazacos: How important is it to mention the zoonotic potential of children becoming infected with *Dipylidium*?

Cooper: It is very important. I don't know that owners really understand or recognize the zoonotic potential, so making them aware of it certainly helps us convey the importance of parasite control.

Little: Clients accept many of our current preventive strategies, so I don't see this as any different. We don't know from month to month if a dog has been bitten by a mosquito carrying heartworm larvae. We don't know whether that dog has ingested hookworm larvae or had skin penetration from hookworm larvae. We make the assumption and we treat accordingly to protect the pet's health. This is no different. I agree with what Dr. Bowman said earlier: If controlling tapeworms required one more visit, one more product to pick up, or one more pill to administer, then compliance would be more difficult. But when it's combined with these other products, it's simply an added benefit. I see it as being justified in much the same way as routine hookworm, ascarid, and heartworm control.

Kazacos: I agree with all of that. I think it's a good way to approach the tapeworm issue.

RESISTANCE

Blagburn: Resistance is a powerful and pervasive phenomenon. We deal with it all the time on the large animal side, particularly in insects and some nematodes. These organisms replicate so fast that some individuals develop the genetic machinery to get around the drug's effects. Then as you keep administering it, you select for the ones you can't kill. I'm interested in what you think the response will be from the veterinary community about the potential for tapeworm resistance and how tapeworms might differ from nematodes or heartworms.

Kazacos: I have actually had to address that question before, based on our work on treating *Echinococcus* using praziquantel. The resistance question came up because of the recommendation for three- to four-week use in at-risk animals in endemic areas. There was a very simple answer. If you have a drug that is essentially 100% effective, then you don't have any survivors to contribute genetic material for resistance, so the likelihood of resistance developing isn't there.

Blagburn: What if veterinarians administer praziquantel, but to save their clients money they split tablets, use the wrong dose, or underdose animals?

Kazacos: That's a different situation. Praziquantel does, however, have a fairly wide efficacy range, so even if the dosage is decreased a bit, treatment is effective. You will lose efficacy if you drop down too far, but there should be a buffer.

Blagburn: Dr. Bowman, do you think we have anything to worry about?

Bowman: I'm not too worried. Pets are individuals. They are not treated as herd animals like sheep, cattle, and horses.

Blagburn: I don't know. I have five pets; I have a herd.

Bowman: But you don't treat them as a herd; you handle each one as an individual pet. You're not treating 500 cattle and then not checking to see which got cleared. If your pet is shedding segments and they come back, you treat it again. If it doesn't clear, you change drugs and treat it again, and those worms won't genetically be able to enter the pool. Because pets are individuals, they will be treated until they are cured.

Little: I agree with Dr. Bowman. With small animal parasites we have so much refugia—untreated parasites—out there that development of resistance is less likely. Many parasites won't ever see the drug

TAPEWORM TIDBITS

Diagnosis

Diagnosis of infection is reached by identifying proglottids in fecal material or recognizing eggs on fecal flotation. However, because proglottids are not uniformly distributed in fecal material, fecal flotation alone is not a reliable means of diagnosing infection in dogs and cats.

Treatment

- Praziquantel, epsiprantel, and fenbendazole are approved for the treatment of tapeworm infections in dogs and cats.
- Praziquantel (5 mg/kg) and epsiprantel are considered the treatments of choice because they are highly effective against *Dipylidium caninum*, the most common tapeworm of dogs and cats, as well as *Taenia* species.
- In the United States, only praziquantel (5 mg/kg) is labeled as effective against *Echinococcus* species.
- Treatment of tapeworms in dogs and cats must be combined with effective flea control and prevention of ingestion of prey species; in the absence of these changes, reinfection is likely to occur.

TAPEWORM TIDBITS

Public health considerations

- *Echinococcus* infections of people are rare but do occur in North America, and isolated reports of zoonotic infection with larval *Taenia* species also exist. Dogs and cats infected with these tapeworms create a potential zoonotic risk.
- Infections of children with *Dipylidium caninum* after ingestion of an infected flea are occasionally reported. The disease is generally mild, confined to the intestinal tract, and readily treated, but can still be distressing to the family.

Control and prevention

- To prevent zoonotic tapeworm infections in endemic areas and to preserve the human-animal bond, routine monthly deworming with praziquantel is justified.
- Stringent flea control is required to prevent *Dipylidium caninum* infection in dogs and cats.
- Keeping cats indoors and dogs confined to a leash or yard will limit the opportunity for pets to become infected with *Taenia* or *Echinococcus* species.

because they're in wild or neglected animals. Feral cats harbor plenty of untreated tapeworms. Roaming dogs, coyotes, wild animals—there's no shortage of tapeworms that won't ever see this drug. So we're not treating an entire herd of animals in a large pasture where every parasite in the population sees the same drug.

Kazacos: When you combine that with the high efficacy of the product—which at the prescribed dosage of 5 mg/kg is essentially 100% against *Dipylidium*, *Taenia*, and *Echinococcus*—we are less likely to see resistance. But we do have to increase the dose for pseudophyllideans.

Little: Right. We routinely have to go as high as 25 mg/kg daily for two days to clear *Spirometra* from cats. Because praziquantel is very safe, there is not a risk with that high a dose.

Blagburn: Dr. Cooper, how many of your clients know anything about resistance?

Cooper: I think a lot of people are familiar with the concept as it pertains to antimicrobials in the human population. I have had people inquire about resistance, mostly with antibiotics and occasionally with flea control products. I've never been asked about resistance regarding heartworm prevention. I think most people think of resistance as an antibiotic problem.

TAPEWORM CONTROL PRODUCTS

Blagburn: Let's discuss briefly the more common products available for removing tapeworms. We are all aware that two commonly used products contain either praziquantel or epsiprantel. Fenbendazole is effective. There are also additional over-the-counter tapeworm remedies.

Little: Most veterinarians use praziquantel or epsiprantel to treat tapeworm infections because they are labeled for the major tapeworms of dogs and cats, which are *Dipylidium caninum* and the *Taenia* species. Praziquantel has the added label claim against *Echinococcus*, which epsiprantel does not have. So that distinction may be important in areas where *Echinococcus* is endemic. Fenbendazole is labeled only against *Taenia* species. Since it's not effective against *Dipylidium*, which is much more common in pets, many veterinarians don't think of it as a tapeworm treatment.

Blagburn: Dr. Bowman, what do you think about over-the-counter treatments?

Bowman: Many of these older products are combinations of toluene, which is basically airplane glue, and dichlorophen. These products do not destroy the scolex, and I really don't think we can recommend them because there are safety issues, especially with toluene. There are toxicity problems in dogs and a very low margin of safety.

Blagburn: I think that is a very good point. I'll close by saying that all the parasitologists at this roundtable discussion are members of the Companion Animal Parasite Council. The council and its websites, www.capcvet.org and www.petsandparasites.org, are valuable sources of information on all these parasites and available products, and we certainly recommend that our readers visit the websites. Thank you all for your participation. I think we have had a productive discussion on the varied problems associated with tapeworms.

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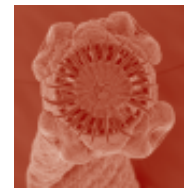
NOTES

Use the space below to record key points from your reading.



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