

***Thelazia callipaeda* Eyeworms in American Black Bear, Pennsylvania, USA, 2023**

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[D. Peter Drotman] This podcast series is brought to you by *Emerging Infectious Diseases*, often referred to simply as EID. I'm Dr. D. Peter Drotman, Editor-in-Chief. EID is an open access, high impact, peer reviewed scientific journal published monthly by CDC. EID publishes articles on new and reemerging infectious diseases that occur anywhere around the world so as to improve the understanding of factors involved in disease emergence, control, and prevention.

[Candice Hoffmann] Welcome to the *Emerging Infectious Diseases* podcast. I'm Candice Hoffmann. On this episode, we'll discuss the paper, "*Thelazia callipaeda* Eyeworms in American Black Bear, Pennsylvania, USA, 2023" which was published in the September 2024 issue of EID.

[Carol Sobotytk] I'm Carol Sobotytk. I'm an assistant professor of clinical parasitology here at the School of Veterinary Medicine at the University of Pennsylvania or Penn Vet. I'm a professor and I teach parasitic disease from animals in different blocks during the vet curriculum. I also run the diagnostic lab, the clinical infections disease lab together with my colleague, Dr. Stephen Cole, he's a microbiologist and I'm the leader of the parasitology section. So, we provide diagnostic service for clients from the hospital and also for external clients outside of Penn Vet (so, other clinicians) and technical support for Wildlife Futures Program from Penn Vet and Pennsylvania Animal Diagnostic Laboratory System as well.

[Carol Sobotytk] So, I'm from Brazil. I got my DVM in Brazil and I became a parasitologist before a vet, for sure. Brazil is a tropical country in South America, so it's the paradise of parasites. So, during vet school, I found this diagnostic parasitology lab in my vet school. And I fell in love about parasites and those very small organisms and complex life cycles. And I did my master's and my PhD over there, working with vectorborne disease. Then I moved to the US to do my residency at Texas A&M University, and then Philadelphia to work as an assistant professor here.

Parasites are fascinating. I'm biased, of course, but I think they are amazing, and we can learn...they can cause disease, of course, and we should be concerned about that, but we can learn a lot from parasites. They were here before us. Parasite diversity, it's important, like animal diversity. And we can learn about evolution. We can learn about epidemiological disease, we can learn about transmissions, we can learn about infectious diseases. And I believe that everything is connected—so animals, humans, and environment. So, there is this interface between all of us, and with all this changing in the environment and the climate, this is going to be more and more common. So, I think it's crucial to understand which kind of disease we have, which kind of disease those parasites can cause. How can we control? How can we do better to protect not only us, but our environment and our pets and other animals?

[Candice Hoffmann] One of the parasites Dr. Sobotytk studies is *Thelazia callipaeda*. This parasite causes eyeworm infections and has an interesting history.

[Carol Sobotytk] So, this parasite was detected for the first time in China for two French parasitologists in 1910 (a long time ago). But until there, until like 2003, around 2003, all those cases were concentrated in East Asia, and we had reports in different countries, including China,

Japan, Russia as well, and other countries around there. But in 2003, researchers found the first case in a dog in Italy, and after that, a number of other countries also reported *Thelazia callipaeda* infections (*Thelazia callipaeda* infections) in dogs, cats and wild animals, including Germany, Spain, Portugal and a number of different countries from Europe. Here in the US, a fun fact about this disease is because we found the vector first before the parasite. So, the vector was found by accident in 2014 or around that (2014 and 2016) in New York. And the first case of *Thelazia callipaeda* in a dog from New York was in 2020. So makes a lot of sense, right? The epidemiology of the disease and the progression of the disease in the US. And since then, we are seeing a number of different cases in dogs and cats across the US.

[Candice Hoffmann] In 2023, Dr. Sobotyk learned of an unusual case of *Thelazia callipaeda* infection. The infected animal was not a cat or dog. Instead, it was an American black bear in Pennsylvania.

[Carol Sobotyk] How did we find this case? So, this is a very fun history. So, after so many cases that we have seen in the Northeast of *Thelazia* infections in dogs and cats, I was thinking about wildlife because all the information that we have, it's from Europe and over there, wild animals play an important role in the epidemiology of the disease. So, I did what I do best, that is professional gossip. And I talked with my colleagues about, have you seen this? I explained about the disease. I talked about my concerns and shared some clinical case and one colleague from Wildlife Futures Program talked with vets from the field and we found that yes, they have seen a case of eye worm infection, and all those cases were from November of last year in American black bears. Luckily, they saved the samples from one specific case, and I was able to identify the worm based on morphology and morphological analysis and we confirmed this specific case in this population.

[Candice Hoffmann] This parasite has been found before in dogs, cats, and other mammals.

[Carol Sobotyk] Yes, so this parasite can infect different mammals and domestic animals, *Thelazia callipaeda* specifically because we have different species of *Thelazia*, but *Thelazia callipaeda* can infect dogs, cats, carnivores (wild carnivores), and lagomorphs (so, rabbits), and also humans. So, all those cases that we have seen in the US before were restricted to dogs and cats so far. So, this was the first evidence of infection in wildlife population.

[Candice Hoffmann] People and animals that are infected with this parasite don't always show signs and symptoms at first.

[Carol Sobotyk] So, this parasite can cause not very specific clinical signs of ocular disease in both animals and humans. Most of the cases are subclinical or do not present any clinical signs at all. But animals and humans can present mild clinical signs like conjunctivitis, excessive lacrimation, or severe like corneal ulcers.

[Candice Hoffmann] Conjunctivitis is inflammation of the eyes, sometimes referred to as pink eye. Lacrimation is the shedding or secretion of tears. Corneal ulcers, if left untreated, can cause vision loss or blindness.

[Carol Sobotyk] So, this is one of the concerns about this specific parasite because first, it's not very easy to identify clinically because of the very nonspecific clinical signs. And second, because it's zoonotic, so humans are susceptible as well. Although it's not very common in humans, they are also susceptible to this infection, zoonotic infection.

[Candice Hoffmann] So, why is it concerning to find this parasite in a black bear?

[Carol Sobotytk] I'm biased because I'm a parasitologist and a vet. My first concern is because until 2020, it was considered an exotic parasitic disease in the US. Now it's not anymore. So, this is my first concern. It's an emerging zoonotic disease.

Second, because this specific parasite has a wide range of different hosts, so a number of different mammals are susceptible to this infection and can carry this parasite and can be a source of transmission as well. And the last point, it's because it's a zoonotic infection, so it can cause disease in humans.

So, this parasite can affect different domains, it can affect domestic animals and the general health of domestic animals, it can affect wild animals and those populations, and we don't know yet how much it can impact this specific population in terms of conservation or animal behavior, and it can also affect human health. So, there is all those different concerns. Another concern is about the spreading of this disease. Since a lot of different hosts are susceptible, we potentially have a number of different hosts playing a role in the epidemiology of this disease and spreading this disease. Like in this case of the American black bear, bears can walk miles and miles every day. So, the same bear that was positive here in Pennsylvania can also be a positive animal in New York, New Jersey, and all those regions. Besides that, bears can be found from across North America, from Mexico to Canada. So, this is...it's evidence that this parasite can be found in all those different countries and regions.

[Candice Hoffmann] Dr. Sobotytk explained how the parasite uses different animals to complete its life cycle and spread.

[Carol Sobotytk] Yes. So, *Thelazia callipaeda*, it's a vectorborne disease and has an indirect life cycle. What does this mean? This means that this parasite requires a definitive host that is a mammal, that could be an animal or a human, and also an indirect host, that in this case, it's a fruit fly named *Phortica variegata*. So, as the name suggests, vectorborne disease means that this parasite is transmitted by a vector (so, the fruit fly). And this specific parasite or this specific fly has a very interesting life cycle, and the fun fact is that only the male fly can transmit the disease.

We have female flies and male flies, right? And probably you are asking yourself, since this is a fruit fly, why they are related with us? But this specific fly occasionally feeds on lacrimal secretion. And this is when this fly transmits parasite to us or other animals. So, an infected fly with the third stage larvae (that is the infected form), when they feed on lacrimal secretion of mammals, they transmit these larvae and inside of our eyes, specifically in the conjunctival sac or behind the third eyelid usually, they become adults, and they are going to release more larvae. So, another fly gets infected when it feeds on the lacrimal secretions of the infected animal and the cycle begins again.

When I say lacrimal secretions, means that tears. So, basically those flies feed on tears from animals and humans. Why these specific flies feed on lacrimal secretions and why only males? Based on information that we have and evidence that we have from Europe, this specific fly...the male fly requires a higher level of protein in comparison with the female fly. So occasionally, this fly feeds on lacrimal secretions to get the amount of protein necessary for reproduction. Since fruit flies are involved in the life cycle, this is also an evidence or at least epidemiological factor because we need to have fruit or at least organic material in the region to attract those vectors, right? So, this seems to be related with the fruit production of the

Northeast—we have productions of different fruits—and probably the vector distribution is why we have seen so many cases in the Northeast.

[Candice Hoffmann] You may be wondering, should I be concerned if I see fruit flies buzzing around my fruit?

[Carol Sobotytk] It's a great question. Yes, we have a number of different species of fruit flies, right? In the case of *Thelazia callipaeda*, only one single species is involved as far as we know, that is *Phortica variegata*. I know in reality, it's hard for us to identify, oh this is *Phortica variegata* or not, right? Even for me, and I'm a parasitologist. So, in general, I would say that avoid crepuscular hours. Flies...this specific fly has a peak during specific temperatures—so, around 70 Fahrenheit or 20 or 25 degrees Celsius. And if you have a fly around your face, just remove and avoid this contact with your face. Besides that, you're going to be fine. For some, we...again, all the information that we have, it's from Europe. So, I believe we need more research here to understand the behavior of this specific fly in our region and in our biome, right? But as far as we know, flies seem to be more attracted by animals and large animals than humans. So, in general, the risk is higher for animals, for dogs, cats and wild animals (large wild animals) than humans.

[Candice Hoffmann] If the risk is higher for animals, should cat and dog owners be concerned about this parasite? How would you know if your pet has it?

[Carol Sobotytk] Usually pet owners are very good on that. They can notice like a different behavior from their pets. But I think the first sign that they notice is the excessive lacrimation. But you are going to see this kind of clinical signs of ocular disease. Although most of the people are not able to describe exactly, it's enough to bring the animal (the dog or cat) to the vet and the vet is going to perform an eye exam and he's going to see the parasite. So, it's very easy to notice there is something that is wrong, it's not correct as usual. The problem is when the parasite does not produce any clinical signs. So, this...that remains the, the animals that we cannot detect, and we cannot treat, or we are not able to treat. So, this is challenging because so far, we do not have commercial diagnostic tests available for detection of *Thelazia* and the detection remains on the clinical exam only.

[Candice Hoffmann] Dr. Sobotytk stresses we shouldn't be too worried if we encounter an animal that might have this parasite.

[Carol Sobotytk] Be aware about the parasite, but don't be afraid of the animal. I mean, the bear, yes, right? It's a bear. But don't be afraid that the animal, your pet, or any other animal, is going to transmit the disease to you. It's not. This is not going to happen. We need the vector. So, the fly is the only organism responsible for transmitting the disease. I think this is very important to highlight because people tend to be afraid to get disease from those animals and in this case, they are just...they are susceptible like us. We know we are in the same group.

[Candice Hoffmann] Should we be concerned about the spread of *Thelazia callipaeda* to new places and new animals?

[Carol Sobotytk] The potential spread of *Thelazia callipaeda* to different species or geographic areas could have several significant consequences for both animal health and human health and can be direct or indirect. I'm going start with the domestic animals.

So, dogs and cats being susceptible or exposed to *Thelazia callipaeda* can cause first ocular disease, so it's the first concern, right? And animals unfortunately cannot talk. So...and this

specific disease does not produce specific clinical signs. So, veterinarians should be aware and should include thelaziosis in their differential diagnosis list. Why? Because this is going to help us first identify earlier this disease and avoid progression of the clinical signs and potentially like severe lesions are going to avoid misidentification so we can avoid treatment with unnecessary antibiotics, for example, we can avoid secondary infections with the bacteria or other pathogens as well. So, there is a number of different consequences of thelaziosis in domestic animals.

And wild animals, my concern, it's more related first with the spreading of this disease across the country because wild animals are distributed across the US and can walk miles and miles and be in different places in the same day. Second, the consequences for the conservation of those populations, because we don't know which kind of disease can cause on those animals and how this is going to affect their behavior or their ability to hunt or their ability to survive. So, there is a number of different consequences that should be investigated as well. And for humans, it's the risk of a zoonotic disease. And again, it's a disease that should be in the differential list of physicians as well to avoid unnecessary treatment with other medications and diagnose this disease as early as much as possible.

[Candice Hoffmann] We asked Dr. Sobotyk what's next for research on *Thalezia callipaeda*.

[Carol Sobotyk] I think we have a lot of gaps here. First, we should focus on the vector distribution for sure and understand the vector behavior in those different environments because we have the sylvatic environment, we have the urban environment. So, we should understand if it's only *Phortica variegata*, only this fruit fly species involved in the transmission of this specific parasite, or if we have other different factors as well, we should understand the risk factors involved for the transmission of the disease, including which areas are more susceptible to *Thalezia callipaeda* infections, which hosts are also more susceptible to *Thalezia callipaeda* infections and why. We need to understand which hosts are involved or might play a role in the epidemiology of this disease as well, including not only dogs and cat, but wild animals. And we need to understand the consequences of this disease in all those different populations. So, right now, we do not have data enough for that. I'm currently working in a research project, collecting positive samples from domestic and wild animals to have this information. We don't know exactly the origin of this disease as well, based on what we have, the molecular analysis that we have.

This species, this parasite, seems to be identical, genetically identical to *Thalezia callipaeda* from Europe, from domestic animals from Europe. But again, we need more data, right? We have very, very limited data, and this is one of the reasons why I'm trying to collect positive samples. I think with this information, we can start to understand how the disease is spreading here in the US and how can we prevent and how can we control, and we can also help other people to understand the disease—so, educate people to help themselves, like to protect themselves from those parasites as well.

[Candice Hoffmann] Dr. Sobotyk has this advice for future researchers who want to know more about *Thalezia callipaeda* and other parasites.

[Carol Sobotyk] First, talk with me. I always need help and I believe research is a collaboration. I love to work with other people and have different perspectives. I think research is not like an individual work. It's interdisciplinary work and we need to learn, and I'm going to include myself on that as well. We need to learn how to include other disciplines in our research because this is going to help us to communicate better with our community and with other vets and physicians,

and we can learn together how to control infectious disease in general, not only parasitic disease, and the control and prevention of those disease is a collaboration of different groups. So, I tell my students all the time, you need to learn how to talk with your clients because your clients deserve to know about parasitic disease. They deserve to know about how to control, how to prevent and which kind of pathogens they are susceptible to. So, if you are interested in research with parasitology, it's an amazing field. There is a lot of potential. We have a number of gaps because we have more parasites than hosts on this planet. So, for sure, we don't know enough, and we have so much more to learn. I learn every day a different thing. And if you're looking for collaboration, just let me know. I'm always open to new topics.

[Candice Hoffmann] We hope that this episode has gotten you interested in *Thelazia callipaeda* and other parasitic diseases featured in EID, and that you'll become a regular reader like Dr. Sobotytk.

[Carol Sobotytk] I think CDC in general does beautiful work telling people about infectious disease. I was in contact with *Emerging Infectious Diseases* journal since I was in Brazil. It was like a goal that at some point in life I'm going to publish in this journal. I think this case was very... a huge opportunity to publish, and I know this journal has a huge impact and a lot of people have access and look for information on this journal. I publish in other journals as well more, more focused on parasites or veterinary parasitology, but I feel like...remains restricted to a very specific group and I believe that infectious diseases should be open access to different people in different groups in a very easy way.

[Candice Hoffmann] Thanks for listening to our podcast. You can read the *Emerging Infectious Diseases* journal at cdc.gov/eid. You can also follow EID on X and Instagram @eidjournal, and on LinkedIn @eid-journal.

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