

TPWKY

This is Exactly Right.

Erin Welsh

"The smart aleck scientists were not satisfied to declare our cows stumbling symbols of certain death, they declared that hookworms were literally gnawing us into the grave. We had never heard of Charles Wardell Stiles who had headed a commission to eradicate the hookworm or the writer Walter Hines Page who promoted his efforts or the St. Gotthard tunnel in Italy where the dread parasites had caused the death of so many of the workers. The crusade against our unseen enemy was sprung on us suddenly. I August 1912 the Winston County Journal ran a bloodcurdling illustration of a greatly enlarged female hookworm that resembled a diamond rattlesnake more than a worm. We were told the worm had laid 3000 eggs a day but without an explanation of who counted them. Alongside the illustration of the voracious monster was that of an emaciated boy teetering on the brink of the grave.

The Journal listed times and places when a representative of the Rockefeller Sanitary Commission and the Mississippi Department of Health would be on hand to gather fecal specimens for hookworm tests. I became so frightened at the prospect that I was constipated for a week. In the end my test proved negative and I could look forward to a healthy existence, provided the scientists did not discover some other deadly menace."

TPWKY

(This Podcast Will Kill You intro theme)

Erin Allmann Updyke

(laughs) That was really great.

Erin Welsh

(laughs) Isn't that joyous?

Erin Allmann Updyke

Yeah. I love it. 'I was so terrified I was constipated for a week!' I feel like I can relate to that.

Erin Welsh

I know. So that was from a book called 'My Century in History: Memoirs' by Thomas D. Clark. Hello everyone, I'm Erin Welsh.

Erin Allmann Updyke

And I'm Erin Allmann Updyke.

Erin Welsh

And this is This Podcast Will Kill You.

Erin Allmann Updyke

Today we're talking about hookworm!

Erin Welsh

Which is so exciting.

Erin Allmann Updyke

It's thrilling! This is our first macroparasite.

Erin Welsh

It is. I was thinking like did we do... Nope, no this is it.

Erin Allmann Updyke

I did the same thing. I was like no, we haven't done any worms.

Erin Welsh

And I love worms.

Erin Allmann Updyke

I know you do. I know they're one of your little loves.

Erin Welsh

They are one of my little loves. One of my many little loves. Okay so to celebrate the hookworm, the glorious hookworm, what are we drinking today?

Erin Allmann Updyke: Our quarantini today is Dew Poison.

Erin Welsh: Ooh, D-E-W. And it's called that because...?

Erin Allmann Updyke: That was one of its common names. Is that correct?

Erin Welsh: It is. It's because you would walk through dewy grass.

Erin Allmann Updyke: Morning dew, yeah.

Erin Welsh: Yeah and then the little larval hookworms would burrow their way into you.

Erin Allmann Updyke: So lovely.

Erin Welsh: So what's in Dew Poison?

Erin Allmann Updyke: So we've of course got whiskey, preferably bourbon but you could use rye.

Erin Welsh: You could.

Erin Allmann Updyke: Chocolate liqueur, hazelnut syrup or hazelnut liqueur up to you, go nuts, top it with whipped cream and of course dirt in the form of chocolate cookies and the all important vodka-soaked gummy worm.

Erin Welsh: Yes. Booze-soaked preferred.

Erin Allmann Updyke: But don't forget that we'll post the full recipe for our quarantini as well as our nonalcoholic placeborita on all of our social media channels as well as our website.

Erin Welsh: That's right. Cool, well now that we've got that really delicious looking drink in our hands, can you tell me about hookworms? Tell me all about the biology.

Erin Allmann Updyke: Absolutely. We'll take a quick break before we get started.

TPWKY: (transition theme)

Erin Welsh: Just before we dive into the episode we wanna let you know that we have a very special treat waiting for you at the end. It's a song specifically dedicated to parasites and your going to love it. So if you usually tune out right as we start listing our sources, do yourself a favor and keep listening until the very end.

Erin Allmann Updyke: Let's get into the biology. So hookworm. The way that you get infected with a hookworm is when like you said, the baby larvae drill their way into your skin.

Erin Welsh: It's so cool.

Erin Allmann Updyke: It's so cool. And this mostly commonly happens when you're walking barefoot across soil or grass or leaf litter that's just teeming with tiny baby larval worms. Although it is possible to get infected in other parts of your body, so if you're digging in the soil you can get in your hands, taking a nap in the grass, why not anywhere in your body? Why not?

Erin Welsh: Ugh.

Erin Allmann Updyke: And there are two main species of hookworm that infect humans, *Necator americanus* and *Ancylostoma duodenale*. In the case of *Ancylostoma* you can also get infected by ingesting the worms, eating them.

Erin Welsh: Wait, ingesting the larval worms.

Erin Allmann Updyke: Yes, the larval worms, right. Weird right?

Erin Welsh: Yeah.

Erin Allmann Updyke: But that's all I'm gonna say about that cause like no one talks about it, it's just a thing that exists.

Erin Welsh: Okay.

Erin Allmann Updyke: So let's go over the life cycle of how these worms get to the point where they're going to infect you cause it's so cool and I know you love it.

Erin Welsh: It's so much fun! It's one of my favorites.

Erin Allmann Updyke: Okay so it all starts of course as it almost always does with an egg. Just a little unassuming egg chilling in some soil. About 24 hours after it pops into the soil it'll hatch into a tiny little L1 larval worm which will just scoot along its way for like a week until it grows big enough to molt again. Now we call it L2. It's not gonna hurt anyone, it's just a worm in the soil doing wormy things. But then once that gets big and strong enough it'll molt one more time into an L3 larva. This guy is strong enough to slither - do you say 'slither' for a worm?

Erin Welsh: Sure.

Erin Allmann Updyke: To slither its way up to the top of some grass or some leaf litter and wait for you foot.

Erin Welsh: How big is this L3?

Erin Allmann Updyke: Very, very small. (laughs) I know how big the adults are and this is smaller than the adults.

Erin Welsh: Like could you see it?

Erin Allmann Updyke: Yes, you can see it.

Erin Welsh: Is it like bigger or smaller than a nymphal tick?

Erin Allmann Updyke: Bigger.

Erin Welsh: Okay.

Erin Allmann Updyke: Yeah. So the adults are between 5-13 millimeters.

Erin Welsh: Okay.

Erin Allmann Updyke: So I don't know exactly how much smaller the L3 larva are, I didn't see that in my research, but I presume they're smaller. But definitely still visible as far as I can tell.

Erin Welsh: How are they growing? Where are they getting the energy to grow?

Erin Allmann Updyke: So they eat microbes in the soil.

Erin Welsh: Oh.

Erin Allmann Updyke: Yeah so when they hatch out of an egg they'll eat little microbes but they're not hurting anybody, they're just like chilling, eating microbes, living in the soil like normal worms. But then once they get to this L3 stage they're like, 'Now I'm ready for the big kid meal' and that is human flesh and blood. So this L3 larva waiting on top of the grass for you, you come along, I don't know just out for a walk in the woods without your shoes on because of course, why not? The grass feels great between your toes. And this little larva burrows its way into your foot, goes straight for your bloodstream, travels through your bloodstream back to your heart where all your blood goes, out of your heart and into your lungs.

Erin Welsh: Yep. I love it!

Erin Allmann Updyke: Once it's in the capillaries of your lungs it'll bust its way out into your alveoli which are the air sacs where gas exchange actually happens. So it literally bursts out of your blood vessels into the air sacs of your lungs and then it swims its way up your bronchioles through your bronchi all the way to your trachea to the top of your trachea which is called the epiglottis, that's the flap that normally makes it so you don't swallow your food into your lungs, maybe gives you a little tickle right there and maybe you-

Erin Welsh: (coughing sounds)

Erin Allmann Updyke: Just a little. And then it's gonna pop up and over that epiglottis and down back into your esophagus. It's gonna travel all the way down your esophagus, through your stomach and into your small intestine.

Erin Welsh: And then it's like, 'Mm, I'm home!'

Erin Allmann Updyke: I'm finally home. It'll molt into an adult worm at this stage and then it attaches. Do you wanna know how it does this?

Erin Welsh: Yeah.

Erin Allmann Updyke

It has these two hook things, that's why they're called hookworms and they basically gouge their way into your mucosa or in some cases all the way through to your submucosa which is like through an entire layer of flesh inside of your intestine. And they attach in there and they mate. So you do have to have at least two worms for them to be successful. They mate and then they start laying eggs and then you poop out those eggs, they find their way back to the soil, and the beautiful cycle of hookworm life begins anew. Isn't that gorgeous?

Erin Welsh

It's just... I still even after reading about this cycle and being amazed, I'm amazed every single time that it will go up through your heart into your lungs, you cough it up, you swallow. It's incredible.

Erin Allmann Updyke

It's so complicated.

Erin Welsh

It's inspiring.

Erin Allmann Updyke

Yeah.

Erin Welsh

We should all seek to succeed in a journey such as that.

Erin Allmann Updyke

What a journey. Yeah. So that whole process from initial penetration of your foot until egg-laying adult takes between 5-9 weeks. So it's a pretty long process.

Erin Welsh

Okay.

Erin Allmann Updyke

So let's talk about what's happening in your body, do you even know you're infected? You already mentioned one of the first symptoms that you might get which is ground itch. And so that's something that can happen at that initial site of penetration where you just have kind of an allergic reaction. You get itching, you get redness, right from where the site where the worms burrowed in. That's your first hint that something might be amiss.

Erin Welsh

Okay anytime that any of you have an itchy foot, it's probably hookworm.

Erin Allmann Updyke

(laughs) It's probably not hookworm.

Erin Welsh

(laughs) But that's what you're all thinking, isn't it?

Erin Allmann Updyke

It could also be totally asymptomatic and in a lot of cases hookworm infection is almost entirely asymptomatic and we'll talk about when it is vs when it isn't. So once you get past the ground itch, the worm is just swimming through your circulatory system and it makes its way to your lungs. And since it's bursting out of your capillaries and busting its way into your alveoli, you can imagine that might cause some damage in your lungs.

Erin Welsh

Yeah.

Erin Allmann Updyke

So you might get some cough, you might get pneumonitis which just means inflammation in your lungs and that's just a result, mostly directly a result of the worms causing damage but it also can be from the immune response that you mount in response to the damage that the worms cause. And then as they make their way into your gut you might have some minor diarrhea, some intestinal upset, but if you just have a few worms you might not ever know it because just a few worms, these are small, they're not doing a ton of damage, NBD. The problem is-

Erin Welsh

Unless one happens to die and you poop it out and you see it in your poop?

Erin Allmann Updyke

Well I mean that's gonna do you some psychological damage maybe, you mean?

Erin Welsh

Sure. It's sort of like if you see one cockroach you know that there are thousands more in your walls.

Erin Allmann Updyke

Yeah, yeah.

Erin Welsh

So is it the same with hookworms and intestinal walls?

Erin Allmann Updyke

No I think if you had thousands of hookworms in your walls you'd know it.

Erin Welsh

Maybe tens. What's the scale at which we start to see infestation become...?

Erin Allmann Updyke

Let's talk about it. So the problem here is that because the worms in your gut can produce, if we're talking about *Necator americanus*, 9-10,000 eggs a day. If we're talking about *Ancylostoma duodenale* we're up to 30,000 eggs per day.

Erin Welsh

That's incredible.

Erin Allmann Updyke

It's incredible. And these worms are not reproducing in your body, so you're not going to get multiple worms from just two worms, they're not gonna reproduce adult worms in your body. However if you're being constantly exposed to soil that's contaminated with human feces and humans are pooping out 9-30,000 eggs per day, you can end up with an extremely high parasite burden. And the reason that that's problematic is because when the adult worms use their little hooks and they cut their way into your mucosa they use negative pressure, they contract their esophagus to suck out your blood. And they use both their physical sucking and biting as well as hydrolytic enzymes to burst open your capillaries and arterioles, suck out a plug of your tissue into their open mouth, anti-coagulate the crap out of you so that you don't stop bleeding, and then they're drinking your blood.

Erin Welsh

Oh boy. And there are species differences between the amount of blood that they take as well?

Erin Allmann Updyke

Yeah so the smaller worms which are *Necator americanus* take much less blood than *Ancylostoma duodenale*. Even *A. duodenale* would take a maximum of about 0.3 milliliters of blood per day which isn't a lot, right, 0.3 mL, that's basically nothing. However I did some math cause you know whenever we start talking numbers I'm gonna do some math. The human body has five liters of blood, okay? On average your red blood cells reproduce in 120 days. So we can assume that your blood volume replaces itself every 120 days. So if you back calculate you're making on average about 45 milliliters of blood every day, that's how much new blood your body is producing every day. So if you have just one worm and you're losing 0.3 mL of blood per day, no big deal. But once you get to let's say 100 worms, that's 30 mL of blood loss per day.

Erin Welsh

Wow.

Erin Allmann Updyke

That's more than half of the blood that you're able to make every day.

Erin Welsh

That's only 100 worms too.

Erin Allmann Updyke

That's only 100 worms, right.

Erin Welsh

That's not that extreme.

Erin Allmann Updyke

Yeah it's not. And so your body, if you are losing blood, your body will start to upregulate red blood cell production, that's what your body does. If something happens it will respond, that's why if you give blood and you lose a pint you don't die immediately, your body is like, 'No problem, we'll use our iron stores and we'll make new red blood cells faster than we normally would.' But if you're constantly losing 30 or more mL of blood per day, eventually those iron stores run out and you can't make new blood. You just can't, you don't have the materials in your body to actually do it. So the biggest thing that we see in people who have high worm burdens is iron deficiency anemia.

Erin Welsh

Right.

Erin Allmann Updyke

So that's the kind of hallmark sign. And so much of the sort of downstream effects that we see are all due to this iron deficiency anemia that just results from blood loss itself.

Erin Welsh

Wow.

Erin Allmann Updyke

Yeah. And you can start to see this especially depending on who you're talking about. So women, if you are a woman of reproductive age who has a uterus, you're probably losing blood every month which means that you're already more susceptible to iron deficiency anemia. If you are a child you don't have a full 5 liters of blood which means you're already more susceptible to iron deficiency anemia because you don't have as much blood and you don't have as much iron stores, you're just a smaller human.

Erin Welsh

Right.

Erin Allmann Updyke

It's actually adults who have the highest burden of hookworm which is totally the opposite of most other soil-transmitted helminths where you see the highest burden in children. And it's thought that this is because hookworms are really good at evading our immune system so while other worms you get a high burden and then you can eventually clear them with your immune system, not so. So it's just a linear trend where you're exposed over your whole life and the older you get, the more worms you have.

Erin Welsh

Oh I see.

Erin Allmann Updyke

Isn't that crazy?

Erin Welsh

Yeah.

Erin Allmann Updyke

So yeah, that's how you end up with iron deficiency anemia, that's the biggest issue with hookworm infection. And children especially are at really high risk because when children suffer from high burdens of hookworm and they end up with iron deficiency anemia, they can also have growth retardation and cognitive impairments which are lifelong. And so overall you can start to see the effects of iron deficiency anemia with as few as 40-160 worms, that's the range that I found. And it's not uncommon to find people with much, much higher worm burdens than 40-160 worms.

Erin Welsh

Yeah.

Erin Allmann Updyke

So that's hookworm in a nutshell. The good news about it is that it is quite treatable, it usually only takes a few doses over a few days of antihelminthics, albendazole or another benzimidazole if you're interested in what you treat it with. And you can pretty much get rid of all of them. However the biggest problem is that if you don't address the sanitation issues that often are the cause of hookworm infection then reinfection is almost inevitable.

Erin Welsh

Right. I have a question that's a little bit out there.

Erin Allmann Updyke

Okay.

Erin Welsh

You mentioned that hookworms are really good at evading your immune system. Do they suppress your immune system? That's not my out there question.

Erin Allmann Updyke

(laughs) So I don't know if they suppress your immune system directly. They do and there's a lot of interesting evidence that they modulate your immune system. So they do have big effects on changing the way that your immune system responds to them. The interconnectedness between the human immune system and parasitic worms is so amazing, it's so cool.

Erin Welsh

Yeah. It is because they are ancient enemies and friends at the same time. It's incredible, yeah.

Erin Allmann Updyke

It's so, so interesting.

Erin Welsh

But so my out there question is I remember during my master's I ran into many different studies on people self-treating with hookworms to treat MS, to treat Crohn's, to treat IBS and other sort of autoimmune disorders.

Erin Allmann Updyke

Yeah.

Erin Welsh

What's going on there?

Erin Allmann Updyke

So I had all of this in the current events section but we can talk about it now.

Erin Welsh

Okay. I wasn't sure if I was jumping the gun.

Erin Allmann Updyke

Yeah so this all stems from this idea of what's called the hygiene hypothesis which I think we've talked about before on this...I don't remember.

Erin Welsh

Let's do a refresher anyway.

Erin Allmann Updyke

Okay so a quick refresher. The hygiene hypothesis which is also sometimes called the old friends hypothesis is this idea that the reason that we see such high rates of allergies and autoimmune diseases in a lot of wealthy nations is because we have eliminated all of the diseases that we normally are exposed to, especially parasitic worms which our immune system essentially evolved under constant attack in conjunction with constantly being exposed to things like parasitic worms. And so it's the idea that our immune system evolved to respond at a baseline level, assuming that we were always going to be infected with something. When you take all of that away your immune system's like, 'Well, what the heck am I gonna do? Guess I'll start attacking myself.'

Erin Welsh

Yeah.

Erin Allmann Updyke

That's the very simplified hygiene hypothesis.

Erin Welsh

Right.

Erin Allmann Updyke

So people have suggested purposefully infecting people with helminths such as hookworms can help to control autoimmune diseases especially gastrointestinal autoimmune diseases like ulcerative colitis, Crohn's, celiac disease and also to help control allergies and autoimmune diseases like you said like MS. So the basic idea is that if you give patients a few worms, not a high burden cause we know that's terrible but just a few, they'll attach to the gut like they would normally and it induces a certain amount of inflammation but it also modulates your immune system in ways we don't fully understand and this will then reduce the symptoms of these other hyperinflammatory autoimmune type diseases.

Erin Welsh

And it seems anecdotally to sometimes work but what are the stats on that?

Erin Allmann Updyke

So there's a really interesting review article, it came out I believe in 2015, I'll definitely post it on our website. It's very mixed results leaning towards it doesn't seem to be working.

Erin Welsh

Okay.

Erin Allmann Updyke

So in animal studies it definitely works.

Erin Welsh

Oh.

Erin Allmann Updyke

But in clinical trials it hasn't been successful and so one of the ideas is that maybe you need to have been exposed to worms before the onset of this hyperinflammatory state, which I thought that's super interesting that like maybe once you already have Crohn's you cannot heal it with a worm but maybe if you had had worms, you would be less likely to get Crohn's or something like that. So at this point there isn't really a lot of clinical evidence that it works at all.

Erin Welsh

Okay.

Erin Allmann Updyke

But it is still a cool concept and there is definitely still research that's being done on it.

Erin Welsh

Cool.

Erin Allmann Updyke

Yeah so that's pretty much the biology and a little bit of the current research just for fun. So Erin, how'd we get to this point? Where do these guys come from?

Erin Welsh

Okay I'll tell you.

Erin Allmann Updyke

Right after we sell you more things.

TPWKY

(transition theme)

Erin Welsh
Though there have been exceptions like with leprosy and tuberculosis, we've mostly been dealing with pathogens that leave no physical trace of infection on bones or in fossil form so our search of the history of a pathogen can't really extend much beyond the earliest writings. Of course we can make guesses based on the evolutionary history and current geographic distribution but we mostly can't rely on physical specimens to confirm those guesses. But here in dealing with our first lovely, wormy parasite suddenly we can start saying words like archaeoparasitologist and paleoparasitologist and my favorite, coprolite which means fossilized poop.

Erin Allmann Updyke
Oh my god. (laughs) Poop. Oh my gosh, I never thought about how cool that is that we have so much more evidence because the worm eggs are there.

Erin Welsh
The worm eggs are there. You can do paleoepidemiology.

Erin Allmann Updyke
Ugh, stop it.

Erin Welsh
I got chills. How cool!

Erin Allmann Updyke
That is amazing.

Erin Welsh
Yes. Yeah. So these worms, they sometimes, rarely but they do sometimes have what it takes to survive the extensive fossilization or mummification process. Researchers, paleoparasitologists, have found evidence of fossilized hookworms dating back as far as 7200 years before present. So about 5000 BCE. And there have been other more recent archeological findings of hookworm eggs in fossilized poop or in at least one case, adult hookworms in the intestine of a mummy.

Erin Allmann Updyke
Whoa!

Erin Welsh
Which is the species *Ancylostoma duodenale*.

Erin Allmann Updyke
Which of course I pronounced wrong, that's cool.

Erin Welsh
I don't know how you pronounce it.

Erin Allmann Updyke
You know what? It's fine.

Erin Welsh
It's fine. (laughs) Someone will let us know maybe. But I'm guessing that it's probably not that surprising to you that we have this ancient evidence of hookworms, you probably would expect this relationship between hookworms and humans to be quite ancient. But here's the kicker: most of these findings come from the New World, aka North and South America.

Erin Allmann Updyke
Huh.

Erin Welsh
Why is that the kicker?

Erin Allmann Updyke
Because that's weird.

Erin Welsh
(laughs) Well it's probably not that it's the majority that is found there, that could just be sampling bias. It's that they're found there at all.

Erin Allmann Updyke

That means that people, they came over with them. They came over infected.

Erin Welsh

Yes. Exactly. But how did that happen? So let's talk for a minute about the peopling of the Americas.

Erin Allmann Updyke

Okay.

Erin Welsh

There are still many, many open questions about when North and South America were settled and how people got there. There are a couple of things though that are generally accepted. One is that the people probably came from Asia and they probably arrived over 10,000 years ago, probably even longer like 14,000. And you probably learned like I did that the most commonly accepted route is overland migration via Beringia which is that piece of land that connected Eastern Siberia and Western Alaska where there's now water, the Bering Strait. Once over the land bridge they dispersed throughout the two continents fairly rapidly, I don't know exactly how rapidly, not like over the course of months but over the course of a few hundred years.

Erin Allmann Updyke

Just like 3 weeks. (laughs)

Erin Welsh

Yeah. (laughs)

Erin Allmann Updyke

Traveled all the way down to the tip.

Erin Welsh

Okay but where do hookworms fit into this? Like I said, fossilized hookworm eggs and mummified hookworm bodies have been found at archeological sites in North and South America pre-Columbian indicating that during these early migrations, they brought the parasites with them.

Erin Allmann Updyke

Right.

Erin Welsh

But this poses a pretty substantial problem for hookworms which require time outside the host in a suitable environment in order to develop into larvae and infect something new.

Erin Allmann Updyke

That's true. And they're kind of finicky too.

Erin Welsh

Yeah. They're generally restricted to the tropical and temperate zones of the earth between I think 36 degrees north and 30 degrees south latitude.

Erin Allmann Updyke

Nice. That's some deep knowledge there.

Erin Welsh

(laughs) It's the hookworm belt. So they can't establish in these more northern areas because the climate is too harsh. So how then could hookworms have been brought over the Beringia land bridge?

Erin Allmann Updyke

Cause they're in your body forever, dude.

Erin Welsh

Okay, yes. They can live for 5-10 years. But it's not like this migration took place over 5-10 years.

Erin Allmann Updyke

That's true.

Erin Welsh

It probably took hundreds of years for people to migrate up, over, and down and this would have also required that the people who migrated would've had hookworm infection in the first place which if they were living far enough north would not be likely. Basically this discovery of pre-Columbian hookworms in the New World, if that is what they are, strongly points towards an alternative migration route such as along the Pacific coast which is not a new hypothesis.

Erin Allmann Updyke

Stop it.

Erin Welsh

Yeah! So I do need to point out that these findings and their implications are debated amongst some researchers. In fact I haven't seen so much sniping and shade and just straight up insults in scientific articles for a long time. I was like oh my, when's the next response coming? Response to Fuller, response to whatever.

Erin Allmann Updyke

Like even more than the dilution effect debate? Ayo!

Erin Welsh

It felt more personal. So but yeah. One of the primary opponents of these conclusions doubts that the fossils belong to hookworms in the first place since evidence is scarce, there are only a few eggs, sometimes one egg in one location. And it's hard to tell tiny ova apart when they're in fossilized poop.

Erin Allmann Updyke

That's true. It's almost impossible.

Erin Welsh

And some of these archeological sites are in locations that are inhospitable for hookworm development. So for instance in a very arid region of Peru where there really aren't hookworms now because the hookworms couldn't live in the very arid sand.

Erin Allmann Updyke

Could they be animal hookworms?

Erin Welsh

So that would point towards the dog hookworm would be the most likely, that's one of the only other ones that can infect humans but it doesn't often complete its life cycle.

Erin Allmann Updyke

Oh I've got stories on those if you wanna talk about dog hookworm in humans.

Erin Welsh

Sure! But I don't know, I think that the point is it would require a pretty substantial burden in order to be established in a population. And this person also doubts that the dating was done correctly and all these other things. This person also says or also doubts that a heavily infested person could've gone on or survived in over-water transpacific migration. Ancient DNA analysis could of course address all of these or some of these at the very least but these samples are quite precious and the researchers maybe rightly don't want to destroy them for a procedure that might not work. Ancient DNA analysis from what I understand is really hard.

Erin Allmann Updyke

Yeah.

Erin Welsh

Has low success rates sometimes, it's probably getting better but...

Erin Allmann Updyke

Yeah.

Erin Welsh

However there's also the fact that studies of more modern hookworm distributions somewhat lend support to the pre-Columbian presence of hookworms in the New World as well. So a study of the intestinal parasites of an indigenous group in Paraguay found a much higher ratio of *Ancylostoma duodenale* to *Necator americanus* which is the opposite of what was found in settlers of European origin and also is the same species that was found in a mummy from Peru. Okay. So this to me is extremely thrilling, like I find this to be mind blowing that you could look at a piece of fossilized poop or at a mummy's intestine and say, 'Oh you know what? Humans settled in North America in a completely different way than what we had been thinking the whole time.' Or maybe it was an additional route.

Erin Allmann Updyke

Right.

Erin Welsh

But I also don't know how this is perceived in the anthropology community. So if there are any anthropologists or paleontologists out there, please let me know. I've tried to find some current status on these and like updated articles and I just maybe didn't have the right search terms. But didn't find anything.

Erin Allmann Updyke

Yeah. That is just so, so interesting though.

Erin Welsh

Isn't that amazing? I love it. Okay moving on.

Erin Allmann Updyke

Okay.

Erin Welsh

It wouldn't be an episode of This Podcast Will Kill You if I didn't mention-

Erin Allmann Updyke

Ancient Rome.

Erin Welsh

Ancient Egypt or Greece, yeah.

Erin Allmann Updyke

So ancient civilization please.

Erin Welsh

Ancient something, yeah. Hookworm appears to get a shout out in the Ebers Papyrus which is a collection of medical and herbal knowledge from Ancient Egypt around 1550 BCE. I've mentioned it before on this podcast a few times, I don't remember on what. In this papyrus there is something called AAA disease that could be describing hookworm anemia but might also be schistosomiasis. And Hippocrates described a condition that included the combination of dirt-eating, geophagy, intestinal distress, and a yellowish complexion that could be hookworm infection.

Erin Allmann Updyke

Yeah.

Erin Welsh

There are also a few other random reports in the Mediterranean basin in ancient and early medieval periods that are thought to refer to hookworm infection. In any case we can assume that hookworms were not only present throughout human history but most likely pretty abundant. Despite this and despite their size and visibility, I mean you can see them-

Erin Allmann Updyke

Right.

Erin Welsh

Human hookworms weren't described until 1838.

Erin Allmann Updyke

Wow.

Erin Welsh

Animal hookworms had been known to occur for decades but it wasn't until 1838 that an Italian physician named Angelo Dubini was dissecting a young cadaver and notices some worms attached to the intestinal wall. He checked them out under the scope and realized they were different from roundworms and they had these plates in their mouth end. It has a mouth and a butt end.

Erin Allmann Updyke

Oh, of course.

Erin Welsh

Okay. (laughs) That seem to hook onto the intestinal wall. So he named it 'hookworm'.

Erin Allmann Updyke

So clever.

Erin Welsh

Anclyostoma is how it was spelled back then. Yeah, who knows. Other cadavers he looked at also appeared to be infested with this hookworm but he didn't believe that they were the cause of death in any of these cases. In fact the hookworm didn't outwardly appear to have harmed its human host at all except for some inflammation at the site of attachment. After this announcement of hookworm discovery people started finding it everywhere. And a few decades after this new parasite was described, a trio of Italian scientists connected the adult hookworm to the eggs it produced which appeared in the stool of infected people. So then if you had a microscope and a willing donor you could check for hookworm infection.

Erin Allmann Updyke

Just looking at poop.

Erin Welsh

Yeah. But there was still a lot about hookworms left to discover like transmission route, treatment, other species, and linking the infestation with disease symptoms. Because hookworms were discovered sort of incidentally, like Dubini wasn't exactly on a quest to find hookworms, he just sort of found them, the modern description of symptoms came after the discovery of the infectious agent which is not what you're used to seeing, what we're used to seeing.

Erin Allmann Updyke

Right.

Erin Welsh

And one of the tricky things about hookworm is that the intensity of symptoms can depend on the intensity of infestation so it can make linking the parasite to the disease a little bit more difficult. Anemia for instance was tentatively linked to hookworm infection early after its discovery but there are a lot of things that could cause anemia, one being just poor nutrition. And so it would take a substantial event to make that link and that would occur in Italy, which again Italy, I didn't know how much of hookworm history is linked to Italy-

Erin Allmann Updyke

Yeah.

Erin Welsh

In 1880 during an outbreak of anemia in a bunch of miners who were working on the St. Gotthard tunnel in the alps. Stool inspections of hundreds of miners - which aren't you glad you don't have that job?

Erin Allmann Updyke

I would love that job.

Erin Welsh

Just looking at poop all day?

Erin Allmann Updyke

Why not? I bet they were full of things.

Erin Welsh: I'm sure that they were but you wouldn't get sick of looking at poop after?

Erin Allmann Updyke: I don't know.

Erin Welsh: And the smell?

Erin Allmann Updyke: I mean it's just a few hundred miners.

Erin Welsh: Just a few hundred.

Erin Allmann Updyke: Sounds like a small research study. (laughs) Seems manageable.

Erin Welsh: (laughs) Well if you had been one of these researchers you would have found rampant hookworm infestation.

Erin Allmann Updyke: Ooh so fun!

Erin Welsh: In one miner who actually died over 1500 hookworms were found.

Erin Allmann Updyke: Oh my gracious!

Erin Welsh: Yeah. 1500. So I don't know about the math on that in terms of blood loss but-

Erin Allmann Updyke: Wow. Let's do it. And these are Ancylostoma?

Erin Welsh: Yeah.

Erin Allmann Updyke: Okay so we can assume higher rates of blood loss. That's 375 mL a day or more. Dang dude.

Erin Welsh: That's amazing.

Erin Allmann Updyke: Wow.

Erin Welsh: So the physician who counted those 1500 hookworms basically was like, 'Okay guys, I'm pretty sure that hookworm causes anemia so maybe we should do something about this.'

Erin Allmann Updyke: (laughs) Like I've got a pretty strong feeling on this one.

Erin Welsh: (laughs) It's kind of a hunch but it's also pretty certain. And so the next year actually a successful treatment was developed which is super fast.

Erin Allmann Updyke: One year later?

Erin Welsh: One year after this outbreak.

Erin Allmann Updyke: Wow.

Erin Welsh: So the treatment, thymol, could be extremely dangerous but still that's less than 50 years after the first human hookworm infection was described.

Erin Allmann Updyke

Wow.

Erin Welsh

Yeah. But still the question of transmission route remained. And I honestly don't know whether it was suspected that hookworm and other intestinal worms were transmitted through feces in some manner at that time but the exact details of hookworm transmission were uncovered by someone named Arthur Looss. One day he was working in a lab and accidentally spilled a beaker of water containing hookworm larvae on his hand.

Erin Allmann Updyke

Like you do.

Erin Welsh

Yeah. He noticed that the spot where he had spilled the water burned and turned red and was very itchy. So he was like, 'I'm gonna bet that's hookworm larvae.' And he started checking his poop for signs of hookworm eggs which he found a couple of months later.

Erin Allmann Updyke

Yeah, 5-9 weeks.

Erin Welsh

5-9 weeks. And he started telling people about this and people did not buy it. Like I'm sorry, you did what?

Erin Allmann Updyke

I love imagining this guy being like, 'No seriously, check my poop! I've got all these eggs, I know it came from when I spilled that water on my hand.'

Erin Welsh

Yeah. (laughs)

Erin Allmann Updyke

Oh this poor guy, man.

Erin Welsh

I know, right? Poor Arthur. Artie.

Erin Allmann Updyke

Artie.

Erin Welsh

Yeah I don't know why people didn't quite buy it but you know, poor guy. But eventually they had to because more testing confirmed not only this percutaneous route but all of the nitty gritty of the entire migratory paths of that parasite. By the late 1800s and into the early 1900s there had been substantial progress made on getting the sense of the global distribution of hookworm and on understanding various aspects of hookworm ecology, biology, and pathology. But much of the research and awareness was limited to Europe and parts of North Africa, the Americas really lagged behind and the parasite was largely unknown until well after the first treatment was developed. It would take Charles Wardell Stiles, the discoverer of hookworm in North America, to change that. Originally from New York, Stiles left the U.S. in the late 1800s to study zoology in Europe. While he was there he spent much of his time in Germany learning from the leading medical zoologists and parasitologists of the day and he developed a passion for worms.

Erin Allmann Updyke

(laughs) Of course he did, who wouldn't?

Erin Welsh

I know, right? After he got his doctorate at the age of 23-

Erin Allmann Updyke

Oh stop.

Erin Welsh

He returned to the U.S. to work at the Department of Agriculture to find ways to increase production by decreasing disease. As a European-educated scientist he was in super high demand not only at his official job but also as a part-time lecturer. He was shocked by how few physicians had ever heard of hookworm, period. And he spent a chunk of his lectures describing the worm, showing slides of its life stages, and then suggesting that if the future doctors at these lectures ever come across anemic patients in the tropics or in the south to suspect hookworm. One future doctor that was present at one of these lectures, Bailed Ashford, would move to Puerto Rico shortly after graduation as an army surgeon. While there he noticed that a huge number of people, especially among the more impoverished agricultural workers, seemed to be anemic and that anemia was a commonly accepted cause of death.

Erin Allmann Updyke

Whoa.

Erin Welsh

He was like what's going on here? What is causing this? He tried a protein-rich diet and that didn't help. Malaria didn't seem to be present in the blood. But what what about the poop?

Erin Allmann Updyke

What about the poop?

Erin Welsh

The eternal question. Sure enough, he found hookworm eggs in their stool. He made his announcement of discovering the cause of widespread anemia in Puerto Rico and sent off some adult worm specimens which he assumed to be *Ancylostoma duodenale* to Stiles as a gesture of professional courtesy. Though Ashford later claimed to have noticed that these worms looked a bit different, it was Stiles who would formally describe them as a new species of human hookworm, giving it the name *Necator americanus* to indicate that it was a New World hookworm. Despite this name the species was found to be widespread in Africa, India, and Australia and probably made its way to the Americas during the import of slaves from Africa. Seeing how rampant and detrimental hookworm-caused anemia was in Puerto Rico, Ashford was able to wrestle up some funds to start the anemia commission of Puerto Rico in 1903 which at that time was the first and largest anti-hookworm campaign in the world.

Erin Allmann Updyke

Whoa.

Erin Welsh

And poor Ashford, because it seems like everything he did was overshadowed by Stiles. Both of them deserve credit for raising awareness and providing treatment of hookworm but Stiles gets most of the acclaim/notoriety. Stiles really was the one who discovered that hookworm was incredibly widespread in the American South. He was sent there to hunt for hookworms specifically, to see how many people were infected and what soil or environmental or living conditions seemed most linked with infection. In many of the places he went, more than he expected he saw the characteristic symptoms of hookworm infection: geophagy, fatigue, and a yellowish or greenish hue.

Erin Allmann Updyke

Do you wanna know why people are eating dirt?

Erin Welsh

Is it because they have pica for like iron deficiency?

Erin Allmann Updyke

Yeah, yeah. I just thought listeners might like to know that if they didn't know that.

Erin Welsh

Oh yeah, yeah. Well and I know that it's not necessarily linked to hookworms, like you can have pica without having hookworms.

Erin Allmann Updyke

It's a really common symptom of iron deficiency anemia.

Erin Welsh: Not only was hookworm present in the American South, it appeared to be one of the most prevalent diseases there. In his 1902 report which was made public, he announced quote: "There is not the slightest room for doubt that uncinariasis is one of the most important diseases of the South, especially on farms and plantations in sandy districts and that much of the troubles popularly attributed to dirt-eating and even some of the proverbial laziness of the poorer classes of white populations are manifestations of uncinariasis."

Erin Allmann Updyke: Uncinariasis is an interesting word for it.

Erin Welsh: Yeah, yeah. Stiles' conclusion was picked up by a journalist who wrote the headline that would give hookworm a catchy nickname and breed justified resentment across the South. Quote: "Germ of Laziness Found?"

Erin Allmann Updyke: Oh.

Erin Welsh: Yeah. Immediately the story and phrase spread leading to many jokes and cartoons and poems and satires all about how laziness was all because of this worm. Obviously this was not well received by people in the South who were being targeted by these jokes and articles and were being told that not only are you lazy but you are also filthy and riddled with parasites.

Erin Allmann Updyke: Right. That's so terrible. Goodness gracious.

Erin Welsh: And there was also the implication that, 'Don't worry, those parasites are the cause of your laziness and we all-knowing doctors know how to get rid of it for you so you can be a productive member of society again, because you aren't right now.'

Erin Allmann Updyke: Right.

Erin Welsh: The hookworm was being blamed for the South remaining separate, distinct from the U.S. rather than racism, poverty, and a lack of access to education. Hookworm was this easy fix and was viewed as a worthy social cause whereas the more entrenched issues such as racism and education were much more controversial and would need an entire shift in the way things were done for anything to become better. These headlines and articles painted this picture of the South as a filthy, backwards place full of uneducated, lazy people. It was hugely damaging and the stereotype and myth remained long after hookworm disappeared from these places. For all of the negative feeling the term 'germ of laziness' fostered, it did do one positive thing. It put hookworm on the map. People were talking, writing, thinking about this parasite that until then had pretty much not been known. And so when Stiles teamed up with Surgeon General Wyman to begin a campaign against hookworms in the South, people at least already knew what hookworms were so they could shut the door in Stiles' face that much faster.

Erin Allmann Updyke: (laughs)

Erin Welsh: Apparently he wasn't the most easy to get along with guy and I would go as far as to say that he was often downright condescending and insulting towards rural Southerners.

Erin Allmann Updyke: Shocking.

Erin Welsh: Also he was pro-child labor.

Erin Allmann Updyke: Cool. So great guy overall.

Erin Welsh: Great guy.

Erin Allmann Updyke

Really great guy.

Erin Welsh

I mean he did do a lot by way of treatment and promotion but I think he just said, 'I know better than you.' Anyway his and Wyman's campaign had a two-pronged approach. Improve sanitary conditions, especially privies and spread the word about hookworm and offer treatment. They weren't super successful with either but Stiles would not let the issue drop. He talked on and on about hookworm to anyone that would listen and eventually someone did pay attention. And that someone was Frederick T. Gates who was John D. Rockefeller's - you know, mega rich man - principal philanthropic advisor. In 1909, with a \$1 million budget, the Rockefeller Sanitation Commission began its goal of eradicating hookworm disease in the South.

Erin Allmann Updyke

\$1 million in 1909?

Erin Welsh

Yes.

Erin Allmann Updyke

That's so much! I don't even know how much money that is.

Erin Welsh

Yeah I don't know, let's look up what the inflation is.

Erin Allmann Updyke

The conversion is, yeah.

Erin Welsh

Let's see. Wow, okay. So now it's worth 27,594,175. So \$27.5 million dollars.

Erin Allmann Updyke

Million dollars. Goodness gracious.

Erin Welsh

Good gravy.

Erin Allmann Updyke

Good gravy is right.

Erin Welsh

So they had this goal to eradicate hookworm and Stiles was like, 'That's not gonna be possible. You have no idea how rampant hookworm is, that's not possible.' But they tried anyway. And their approach was similar to Stiles and Wyman's, so one aspect was immediate treatment and the other was education, primarily focused on how you can prevent getting hookworm infection. And this was a massive undertaking that required the involvement of hundreds of people on the ground. The first step was getting a sense of just how enormous their task was going to be by conducting prevalence surveys. Were Rockefeller and Stiles and the like blowing it out of proportion? Probably not. Surveys from the first couple of years showed that over 90% of counties surveyed had hookworm infections and overall prevalence hovered around 43% with some areas experiencing 90% or 100% prevalence of infection.

Erin Allmann Updyke

Wow.

Erin Welsh

Yeah. It was very, very prevalent. While the states involved in the Sanitation Commission never truly accepted Rockefeller's support, eventually most did come around to accept that hookworm was a big problem and that treatment and infrastructure changes should be made. And a big part of this shift was because the commission worked directly with state health departments which at that time were pretty dinky and unorganized and so this really kind of helped spur them into motion to have a direction and a focus and to see how things worked at different levels. The commission also hired Southern doctors as inspectors and fieldworkers which also helped inspire a level of trust. Interestingly women played quite a large role in the lab side of things where they were hired over medical students to process samples, aka look at poop. Women were quoted as, "doing better work, doing it faster and more satisfactory in every way." Which included costing half as much as the male med students that they replaced. (laughs)

Erin Allmann Updyke

Of course. Of course. I was like where is the catch here? What is the real reason? They're cheaper!

Erin Welsh

(old-timey voice) Our money can stretch so far!

Erin Allmann Updyke

Excellent.

Erin Welsh

Kentucky-

Erin Allmann Updyke

Woo woo!

Erin Welsh

-started the trend of hiring women and apparently Kentucky women were so amazing at looking at poop and doing their jobs that they were lent out to other states.

Erin Allmann Updyke

(laughs) Kentucky women, you need a shirt now that says 'Kentucky Woman'. And just has poop on it.

Erin Welsh

Well I was just about to say if we had the rights I would play Neil Diamond's 'Kentucky Woman' right now. (laughs) Momentum for the commission grew and doctors would travel to towns all over the South, carrying with them their microscope, glass jars containing hookworm specimens, and plenty of pamphlets. These hookworm dispensaries were like old tent revivals. Almost the whole town would show up and show people would bring fried chicken, biscuits, boiled eggs, pound cake, peaches, and those I'm quoting directly from someone who was at one of these dispensaries. And they would bring a blanket and just spend their whole day watching these displays of hookworms. There was also this traveling train car that was sort of this interactive exhibit on hookworm where you could go and you could do the same sort of thing but it would travel all throughout on the railroads of the South.

Erin Allmann Updyke

That is so cool.

Erin Welsh

How cool. I don't know if that exists in a museum format today but I would love to see that.

Erin Allmann Updyke

Yeah.

Erin Welsh

Even though the sanitation commission had the broad goal of eradicating hookworm in the South, what that meant in practice was treating white communities for hookworm infection. Many people including politicians and scientists blamed black people for bringing the parasite to the South via slave trade. And most of the very few campaigns that did actually focus on black communities were motivated more by the fear that they were spreading hookworm to white communities. The Rockefeller Sanitation Commission lasted 5 years only, 1909-1914, over which time 700,000 people were treated for hookworm infection which is quite a feat.

Erin Allmann Updyke

Yeah.

Erin Welsh

But barely any long-term changes were made that would have any lasting impact on the prevalence of hookworm in the South. The commission had failed in its stated goal even though they wouldn't admit that. They stopped after that time because I think in part Gates, who was the head of the philanthropy division, got bored with the issue and recognized that not enough true progress was being made. Prevalence was 43% at the beginning and 39% at the end but that number would climb up immediately once the commission left.

Erin Allmann Updyke

Right.

Erin Welsh

After withdrawing from the South, the Rockefeller Foundation went global and they set up programs in China, South and Central America, Northern Africa, and many other countries and places. And again, even though the dispensaries and many thousands or millions of people were treated, there was no permanent change in hookworm prevalence because the underlying causes were still there. In the southern U.S. hookworm did eventually mostly disappear due to things like indoor plumbing, cheap and healthy foods, mechanized agriculture, but it was still prevalent well into the 60s and 70s. And in so many other places of the world it hasn't shrunk one bit. And I focused only on the U.S. because the story of the Rockefeller Foundation is so important in terms of the development of global health initiatives and programs but while that was going on, while people were being treated in the American South, many people all around the world still had hookworm infection, it was still prevalent.

Hookworms are not germs of laziness but they do perpetuate the cycle of poverty which is only possible to break by changing infrastructure to promote access to clean water and improved sanitation. Erin, I know you've probably got some jaw-dropping numbers for the epi, so tell me where do we stand with hookworm today?

Erin Allmann Updyke

I can't wait to do that after a quick break.

TPWKY

(transition theme)

Erin Allmann Updyke

You're so right, Erin. I have some jaw-dropping numbers for you.

Erin Welsh

Oh good.

Erin Allmann Updyke

So it's actually a little bit hard to get numbers directly from the World Health Organization on hookworm itself and that's because the World Health Organization addresses hookworm in combination with several other diseases which all shared this heading of soil-transmitted helminth infections. So if you look at all soil-transmitted helminths, we are talking about an estimated 1.5 billion people currently infected.

Erin Welsh

That is 20%.

Erin Allmann Updyke

20%, yeah. And again this is all soil-transmitted helminths and for most other soil-transmitted helminth infections, soil-transmitted worms, that's what 'helminth' means, it's primarily a disease of children. Not so with hookworm. Hookworm infections just seem to get worse as you get older and actually adult males tend to have the highest burdens of infection and that's likely due to occupational exposures. So especially in certain occupations like you said miners, miners are still at really high risk. Also people who work in the tea industry, so picking tea or in other agricultural industries, they tend to have the highest burdens of hookworm infection.

So the World Health Organization has a lot of initiatives to help deal with soil-transmitted helminths but they mostly focus on the periodic treatment of preschool and school-aged children and they say also women of childbearing age and adults in certain high-risk professions. In endemic areas they recommend periodic deworming treatment once a year if the baseline prevalence in that community is over 20% and twice a year if the baseline prevalence is over 50%. The problem, which we've already talked about, is that you have to combine these deworming treatments with both health and hygiene education but mostly with sanitation infrastructure.

Erin Welsh

Right.

Erin Allmann Updyke	And the sanitation infrastructure is the most difficult part to accomplish and it's most often not accomplished. So while they have done tons of deworming every year for a number of years, in 2016 they treated over 385 million school-aged children with antihelminthics.
Erin Welsh	Wow.
Erin Allmann Updyke	That's 68% of all children who are at risk, 68%. So that's pretty good.
Erin Welsh	Is treatment free?
Erin Allmann Updyke	Yes, so treatment is donated by WHO to the health ministries in each of these countries and then they're administered through the health ministries.
Erin Welsh	Okay.
Erin Allmann Updyke	Their current goal is to, quote: "Eliminate morbidity due to soil-transmitted helminths in children by 2020." So they're one year out, I have a feeling they're not gonna make it.
Erin Welsh	Just to clarify the distinction between morbidity and mortality and what exactly...
Erin Allmann Updyke	Yeah, so I actually have some better numbers from a 2016 review that's about hookworm specifically. So it's estimated that if we're just talking about hookworm, probably almost 500 million people are infected. And hookworm infection likely accounts for over 4 million disability-adjusted life years which is a measure of disease burden that takes into account the number of years lost due to poor health, disability, or early death. So we're not only looking at mortality but we're also looking at just the number of years that you lose because you're so sick, essentially.
Erin Welsh	Yeah. Which it's very easy to look at things like plague and smallpox and tuberculosis and go okay, those are those big mortality numbers. With the number of people that are infected, this is hugely impactful and I think in a way that seems to be more invisible but it shouldn't be.
Erin Allmann Updyke	Right. It's really problematic. It's also estimated that it causes an economic burden of \$139 billion every year.
Erin Welsh	Wow. What about a vaccine? I know that there was some Peter Hotez vaccine initiative.
Erin Allmann Updyke	Yeah, yeah that still exists from what I can tell. It doesn't seem to be moving along all that rapidly. In 2013 and again in 2015 when they published updates they were still in phase 1 trials. So that's the most that I found about it. If you're interested in the specific areas where hookworm infection is the biggest problem and where soil-transmitted helminths in general are at their highest burden, there's a really cool interactive map that the WHO has that I'll post on our website where you can look at every country and you can at least get an idea of the number of school-aged children that they estimate need to be receiving preventative therapy. So it's not a perfect estimate because it doesn't include adults at all but I do think it's interesting.
Erin Welsh	That's very cool. And interactive map, I love that.

Erin Allmann Updyke

Yeah it's really cool. It's very interesting. But in 2017 a paper came out that got some popular press that, it's a very, very small sample size but they did a survey in Alabama in a county that is one of the poorest in the entire state that has over 30% of the population live under the poverty line and in many of the homes they do not have access to sanitation. So waste from their houses are going either through ditches or pipes just directly away from the residence with no actual sanitation system, aka primo grounds for helminth infections. And in stool samples of 55 people, again very small sample size, 55 people in this county, they found 30% of them infected with hookworm.

Erin Welsh

Yeah.

Erin Allmann Updyke

So this idea that hookworm does not exist anymore in the U.S. is not true.

Erin Welsh

Not at all.

Erin Allmann Updyke

So that's something I think that's important to keep in mind. We in the U.S. really like to pretend that things are 'over there' and are problems that don't affect anyone back here at home but that's just plain not true.

Erin Welsh

Yeah. Even in 1939, so the Rockefeller Sanitation Commission ended in 1914 and in 1939 I think they published this report that said, 'Human hookworm infection all but gone in the Southern U.S.' At that time, 40% of people were still infected.

Erin Allmann Updyke

(laughs) It's interesting because when this article came out, which again I'll post this on the website, the popular press that I read that referenced it, they started, 'Hookworm was once eradicated in the U.S., thought to be gone but now it's back.' And I'm like it was never gone, it was just nobody cared.

Erin Welsh

No it's still in certain populations extremely prevalent.

Erin Allmann Updyke

Yeah. Hookworm, it's still around, it's a huge problem worldwide. Do you wanna ask me how scared we should be?

Erin Welsh

How scared should we be?

Erin Allmann Updyke

I think you should be very concerned, how about that?

Erin Welsh

Can you say more about that?

Erin Allmann Updyke

I think that hookworm is like many neglected tropical diseases, it's something that just perpetuates this cycle of poverty and I think that if you are a human that should be really concerning to you.

Erin Welsh

Yes. Well and the fact that we have the technology, the resources, the personnel to make this a disease of the past and yet it's not happening because there's no money in it. And there are tons of people doing great work on fighting that, on fighting hookworm and other neglected tropical diseases including WHO, including Bill and Melinda Gates Foundation, including Peter Hotez who is like a superstar.

Erin Allmann Updyke

Bless his heart.

Erin Welsh (laughs) And lots of other people. Yeah. But yeah there is concern. 500 million people. 500 million people are infected.

Erin Allmann Updyke Yep.

Erin Welsh If you walk away from this episode with any number, let it be that one.

Erin Allmann Updyke Yeah. So, sources?

Erin Welsh Sources. I'll post a bunch of articles on this paleoparasitology early pre-Columbian evidence of hookworm infection.

Erin Allmann Updyke Cool.

Erin Welsh But a few things that I do wanna shout out, the first and foremost is this book called 'The Germ of Laziness' by John Ettling. And then there was this great article on the PBS website called 'How a worm gave the South a bad name' by Rachel Nuwer. And in that article there was a link to a YouTube channel called Gross Science from Nova which I had never heard of but it's full of shortish videos, like under 5 minutes I think, that are just about many, many, many different things but among these there's a whole section on parasites and pathogens. And so in one of the episodes the focus was hookworms. It was so well presented and so fun so seriously if you guys want some multimedia, check that channel out. Gross Science.

Erin Allmann Updyke That sounds awesome. I have a bunch of really cool articles, we will post all of them on our website thispodcastwillkillyou.com, you can find all of our sources from every single episode there.

Erin Welsh Thank you to Bloodmobile for providing the music for this episode and all of our episodes.

Erin Allmann Updyke And thank you for listening to us ramble and for writing us and emailing us and tweeting at us and following us on Instagram. It's like this is really cool that we get to do this.

Erin Welsh It is. Also you really need to check out this song called 'Hookworm Blues' by someone named Blind Blake, it came out in 1929. It's a blues song about hookworm, what could be cooler?

Erin Allmann Updyke It's fantastic.

Erin Welsh We'll post it.

Erin Allmann Updyke Yeah.

Erin Welsh Until next time, wash your hands.

Erin Allmann Updyke You filthy animals.

Erin Welsh And now listen to this fantastic song by our good friend Meramec Valley Girl. It's called 'Parasite Love Song' and it's basically the most perfect song for this podcast ever. You can find more of her music and gigs on meramecvalleygirl.com and her Instagram @meramecvalleygirl. We'll include the links in the show notes and on our social media pages. Okay, here is 'Parasite Love Song'.