

Rodrigo Hamede

My name is Rodrigo Hamede and I work at the University of Tasmania as a wildlife researcher. The first time that I saw a Tasmanian devil with facial tumor disease was actually 20 years ago in 2004 in a place called Bronte Park in the central highlands of Tasmania. It had massive tumors and I was surprised to see how these animals could get on with their tough lives with such large and disfiguring facial tumors. It was quite confronting because they are disfiguring tumors and you can see how horrible this disease is. And I had been working on my study site for about five years, this was in 2009, until I saw the first tumor regression. And I still remember that animal, it was a devil called Rattus rattus. I microchipped her as a juvenile and she had a very rodent-like expression and I decided to call her Rattus for that reason. And then two years later in May 2009, she contracted DFTD. And that happens a lot, you see these animals in the pouch and then you see them just dispersing and then suddenly and sadly you see them with tumors.

So I took biopsies of her tumor and let her go, as we do with diseased animals. And then three months later in August 2009 we caught an animal in one of our surveys. And as we do, we transfer animals from the traps into hessian sacks so we can handle them and collect our samples and collect our data. And the first thing we do when an animal is in a sack is to scan for a microchip to see whether we caught them in the past or not. We can refer to our database and look for samples that we may have taken in the past, their productive status of females, and other metadata. So when we realized that it was Rattus, we got everything ready for collecting our samples. I remember telling my research assistant to take the tumor biopsy kit, the blood sample kit so we could just resample this tumor again.

And when I exposed her face, I was perplexed because there was no tumor. So my first thought was that we got the microchip wrong and that was another animal. So I asked my assistant to check the number and we repeated this number to each other at least a dozen times. I remember scanning the microchip over and over again in disbelief. And she actually had a scar above her eye as well and she looked like Rattus so I knew it was her. So there was no doubt it was the same animal. And somehow that tumor had disappeared. There was only a small scar where that tumor used to be three months ago. And I knew this was something important. I was extremely happy, I remember just being absolutely jubilate with happiness seeing this animal not having this tumor anymore. But I knew it was a sort of a game changer.

Until then this disease was inevitably fatal, 100% mortality. So this was the first evidence that somehow some animals could recover from this cancer. And over the following years, we found more cases of tumor regressions, interestingly mostly in females. And this changed the direction of our research. It was sort of a parallel shift to understand this disease from an evolutionary perspective. And as a result, our long term conservation strategies also changed. And it was also a trigger for investigating how mechanisms against cancer arise and evolve in nature because these things usually happen in experimental settings when animals are manipulated, when treatment is undertaken. So this was an incredible opportunity to study the big picture of evolution and cancer in a natural setting.

TPWKY

(This Podcast Will Kill You intro theme)

Erin Welsh

What an amazing story.

Erin Allmann Updyke

I loved it so much.

Erin Welsh

So much. Like how cool would that have been? How amazing and also hopeful-

Erin Allmann Updyke

Yeah.

Erin Welsh: To be like oh this doesn't have to end this way.

Erin Allmann Updyke: I know. But it's hope. I'm still hopeful.

Erin Welsh: Yeah, me too. Dr. Hamede, thank you so much for sharing that story with us. And we are also so excited that we get to chat with Doctor Hamede later in this episode about many different things about DFTD, which we'll get into what that is. But first, hi, 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: And today we're talking about Tasmanian devils and their facial tumors, aka Devil Facial Tumor Disease. Which maybe a lot of people have absolutely never heard of and it's going to be a really exciting opportunity to learn about something unbelievably fascinating.

Erin Welsh: Truly, truly. I mean do you remember when you first learned about this?

Erin Allmann Updyke: Yes. It was at I think an EEID conference.

Erin Welsh: Yes! Yes! I really think it was the one in Santa Barbara, I think maybe.

Erin Allmann Updyke: Yes.

Erin Welsh: Or Athens? I don't know. Either way, I remember being like wait, what?

Erin Allmann Updyke: Yeah.

Erin Welsh: Transmissible cancer? Because that's what this disease is, everyone.

Erin Allmann Updyke: It is. And I misremembered it because I thought that it was viral. And so I got to relearn this for this episode and I will never stop thinking about this.

Erin Welsh: Yeah.

Erin Allmann Updyke: Because Tasmanian Devil Facial Tumor Disease, everyone who is listening, is a transmissible cancer, meaning it is a cancer that moves from Tasmanian devil to Tasmanian devil. We're going to get into so much detail. We are so lucky that we got to chat with Dr. Hamede who is on literally every single paper that has ever been written about this disease on every side of it, from the evolution to the behavior of these devils. Like every paper. I'm not kidding. We got to chat with such an expert. Oh my gosh, this is going to be such a fun episode.

Erin Welsh: Such a fun episode. And I think also just to not lose sight of the subject of the episode are the devils themselves, which Erin, I am in love.

Erin Allmann Updyke: I know you are.

Erin Welsh: I love them so, so much. I keep watching videos of them, like the little babies. I just, I can't. They're amazing.

Erin Allmann Updyke I'm really excited. I'm really excited. They're very, very, very cute.

Erin Welsh Yeah, they are. But first-

Erin Allmann Updyke But first, it's quarantini time.

Erin Welsh It is. What are we drinking this week?

Erin Allmann Updyke We're drinking With The Devil.

Erin Welsh Yeah, perfect. And okay, so I will admit to searching for Australian cocktails.

Erin Allmann Updyke I love that.

Erin Welsh I didn't know if there were like specific cocktails or cocktails specific to Australia.

Erin Allmann Updyke Okay.

Erin Welsh And so what came up on my searches was something called a lemon-lime bitters which is really delicious. It has lemonade, lime cordial, and bitters. And for this, to make it a quarantini, we'll add vodka. And if you want to keep it a placeborita, omit the vodka.

Erin Allmann Updyke Fantastic. And we'll post the full recipe for that quarantini as well as the non alcoholic placeborita on our website thispodcastwillkillyou.com and all of our social media channels.

Erin Welsh If you're not following us on social media, what are you waiting for? There's some great stuff there. We're doing reels.

Erin Allmann Updyke It really is.

Erin Welsh We're on TikTok, stuff like that. It's good. But also we have a website which you should also check out where we've got stuff like transcripts. We've got show notes for our episodes which have all of the sources that we use; we've got links to merch, links to music by Bloodmobile, links to our bookshop.org affiliate account; our Goodreads list. We've got a contact us form, we've got a firsthand account form. So if you're like hey, I want you to do this because I have this, whatever, I have experience with this, send us your thoughts.

Erin Allmann Updyke We love it. It's a great website. Check it out. Thispodcastwillkillyou.com. You can find a lot.

Erin Welsh Erin, let's get started.

Erin Allmann Updyke Okay.

Erin Welsh Let's just take a break and then get into it, yeah?

Erin Allmann Updyke Okay, let's do it.

TPWKY (transition theme)

Erin Allmann Updyke

So Tasmanian devils or *Sarcophilus harrisii*-

Erin Welsh

Do you want to know the etymology of that?

Erin Allmann Updyke

Of course I do.

Erin Welsh

Okay, hold on one second. Okay, got it. So *Sarcophilus* means flesh-loving.

Erin Allmann Updyke

Of course it does.

Erin Welsh

And *harrisii* is just one of the dudes who wrote one of the first descriptions about Tasmanian devils.

Erin Allmann Updyke

Some dude. Flesh-loving, ugh.

Erin Welsh

Flesh-loving. *Harrisii* is a flesh-loving animal.

Erin Allmann Updyke

So these flesh-loving animals, they are truly adorable. They're carnivorous marsupial mammals native to Tasmania. And Erin, that's where I literally end my description of these little bugs because I know that you're going to talk in a lot more detail about how cute they are and how awesome they are and their natural history. I'm going to focus on the topic at hand which is the thing that is rapidly, rapidly decimating Tasmanian devil populations across their native range. And that is Devil Facial Tumor Disease or DFTD. We have covered, Erin, a lot of weird stuff on this podcast. But I think that this might be one of the weirdest.

Erin Welsh

I mean I think just the phrase 'transmissible cancer' is really difficult to wrap your head around.

Erin Allmann Updyke

It is. And it's... I don't want to say terrifying because I don't think that that's the right word but it is fascinating in a way that really gets at questions of immunology and evolution that just are kind of mind boggling. And what is a cancer? What is a parasite? It really kind of makes you question these categories that we have. So let's keep going. So DFTD, it is a cancer. It's a highly fatal cancer. And cancers are proliferations of cells, usually somatic cells. So body cells that mutate in a way that causes uncontrolled and abnormal cellular proliferation. We've covered a number of other cancers on the podcast before. Devil Facial Tumor Disease is a highly fatal cancer that causes tumors, as you can probably guess, on the face, it's in its name, of Tasmanian devils. But this isn't something that just happens because of an environmental exposure or something like smoking or any of the things that you might think of that cause or are associated with cancers in humans.

Devil Facial Tumor Disease is a cancer that is transmitted from one devil to the next and has rapidly spread across the entire geographic range of Tasmanian devils and is nearly 100% fatal. So let's get into a little bit more detail about this transmissible cancer. Listeners who especially listen to this podcast a lot might think when I say transmissible cancer that this is something like HPV, right. HPV related cancers or even hepatitis C that causes cancer or EBV which can cause cancer. Any of these are transmissible viruses that we know cause DNA mutations that lead to cancer. That's not what this is. In Devil Facial Tumor Disease, it is actual cancer cells themselves that are transmitted from devil to devil as what is called an allograft, which essentially just means cells that come from someone else's body.

Erin Welsh

How?

Erin Allmann Updyke

How?

Erin Welsh

How?

Erin Allmann Updyke

So the how that this gets transmitted devil to devil is usually through biting. And this biting happens during a variety of devil social interactions. Also I just have to take a minute because I just have to keep saying 'devil' and it feels so weird to just... I know that's what these are called but... But these devils engage in a lot of behaviors that include biting, both because they're fighting each other or because they're mating, there's a lot of biting apparently, you're going to talk more about it, Erin, that happens. And you might say okay, so this is kind of like rabies where a sick animal bites and then transmits this cancer cells to another animal. But no, it gets weirder. Because it seems to be that the animals most likely to contract this cancer are the ones who are doing the biting. So it's thought that it's more likely animals biting into the tumors on the faces of infected animals that then end up contracting this disease, this cancer.

Erin Welsh

I have so many questions.

Erin Allmann Updyke

I know, I know, I still have so many questions too. But what that also means is that it tends to be, and there's some data to support this, that it's the most fit individuals, the ones who are either the most aggressive or who are the most reproductively fit who are actually more likely to get these cancers. Which from an evolutionary perspective is just fascinating because of how fatal this cancer tends to be.

Erin Welsh

Right.

Erin Allmann Updyke

And altogether the idea of these cancer cells being transmitted from one animal to another directly is really, really novel. There's only one other known cancer that is transmitted from creature to creature, I guess, and that's called canine transmissible venereal tumor or CTVT. This is a tumor that's found in domestic dogs and it's massively different than DFTD because it's not fatal. In most dogs it's usually eventually suppressed by that dog's own immune system.

Erin Welsh

Which maybe it once was fatal.

Erin Allmann Updyke

Oh my gosh, I did not go deep evolution on CTVT.

Erin Welsh

Well and I think that there are also other transmissible cancers in invertebrates. But for vertebrates it's like super limited.

Erin Allmann Updyke

Interesting.

Erin Welsh

Yeah, just a handful. Just a couple really, a few.

Erin Allmann Updyke

Erin, I don't think that I've ever thought about cancers in invertebrates.

Erin Welsh

Well because the immune system is totally different.

Erin Allmann Updyke

So different, yeah.

Erin Welsh

So yeah. I don't know.

Erin Allmann Updyke

Oh that's fascinating. Oh my gosh. Now I just feel like I need to do a lot more research. There do exist cases, case reports of cancers that are being spread person to person during pregnancy to the fetus or after things like bone marrow or other solid organ transplants. But this is where things get really, really interesting is that even in those exceptionally rare circumstances, most of the time, like two thirds of the time when a cancer is found to have arisen in a transplanted organ or arisen in a person who then has an organ transplant or something like that, most of the time, two thirds of the time this cancer doesn't end up progressing because that person's own immune system is able to fight it off. In Devil Facial Tumor Disease on the other hand, it's almost the exact opposite. Almost every single animal who contracts this disease will die from it and often within 6-12 months of the first signs of tumor development. This is an incredibly fatal disease and we're going to talk a lot more about the ecological effects that this has had across the range of Tasmanian devils, not just for the devils themselves but also for the entire ecosystem because they are a keystone species.

Erin Welsh

Yeah.

Erin Allmann Updyke

But what does this mean for this cancer? Why is it that these cancer cells which were thought to have arisen in a female Tasmanian devil back in the 90s in a Schwann cell?

Erin Welsh

Okay.

Erin Allmann Updyke

Now a Schwann cell is-

Erin Welsh

You knew I was gonna ask.

Erin Allmann Updyke

I knew you were gonna ask. A Schwann cell is a type of peripheral nervous system cell. So we have Schwann cells, vertebrates have Schwann cells, and these are cells that are involved in repair mechanisms and also in some degree to our immune response but of our nervous system in the periphery. So not our central nervous system but along our nerves and things like that. So this is a cancer that originated in one female and has since spread as like a clonal aggregate, this cell. Certainly it has evolved, it has changed, it has mutated as cancers are wont to do. But the widespread of this Devil Facial Tumor Disease can be traced back to this single cell. Why is it that in these devils this can be transmitted so easily? How is it able to infiltrate and then make a new cancer home in all of these other devils? That is a huge immunologic question because it doesn't happen in so many other animals, right?

One of the big thoughts as to how this happens is that this cancer downregulates the immune response. And that's something that we see a lot of other pathogens do as well. We've talked about it a number of times on this podcast. But in the case of Devil Facial Tumor Disease, it seems like there's specifically one class of immune cells called MHC class 1, it's really one type of protein. This is antigen-presenting proteins that help induce antibody responses. So it's part of that 'here, let me present these foreign peptides or these foreign proteins and then your body mounts an immune response against these proteins'. That whole class of immune response is downregulated in these cancer cells.

Erin Welsh

I can see that. But how did that first happen? Because I would imagine that in that first female where this cancer had first arisen, it was self. And so-

Erin Allmann Updyke

Right, it was self.

Erin Welsh

Right.

Erin Allmann Updyke

It was self cells.

Erin Welsh

Yeah.

Erin Allmann Updyke

It was a cancer the same way that normal cancers develop.

Erin Welsh

Right. And then now with every subsequent Tasmanian devil that has been infected, it is a non-self. So like to override that...

Erin Allmann Updyke

Right.

Erin Welsh

How did that get overridden? And then this is a question that like is a broader and probably rhetorical question but like the fact that this is so rare and not only that but as we'll get into, there's a second one-

Erin Allmann Updyke

Right.

Erin Welsh

Brings up the question of how much of it is the cancer, characteristics of this cancer vs how much of it is characteristics of the Tasmanian devil? And then because like what does this tell us for other transmissible cancers in wildlife populations and humans and livestock and like everything?

Erin Allmann Updyke

Right. And what does it teach us about even bigger picture the immune response in general and our immune response to cancers in general, regardless of whether or not they're transmissible?

Erin Welsh

Yes.

Erin Allmann Updyke

But you bring up a really good point, Erin, because there has been a big suggestion that part of the reason that this cancer and now we see that there is a second DFT2 which was first reported in 2015 and thought to have come from a male Tasmanian devil initially. This cancer which is a separate cancer but essentially the same, causes the same kind of tumors, it's also nearly 100% fatal but has been much more limited so far in its geographic range.

So one of the suggestions, and there's some evidence for this, is that the devils themselves are different than a lot of other mammals in that they have very low genetic diversity, especially specifically in some of these immune regulatory regions, including this MHC-1 region. So there's some thought that maybe it's because the MHC is so similar across all of these different Tasmanian devils that the fact that this particular cancer downregulates that response, even though it is different nonself cancer cells, the devil's immune system don't recognize it as such and so they don't mount a huge immune response to it. But skin allografts moved from devil to devil are rejected among devils. So it really doesn't entirely explain how this cancer can be so transmissible. To get even more interesting, I did say that this cancer is considered nearly 100% fatal. And you heard a little bit of that in our firsthand account that it's not always. And there is evidence even in natural populations that regression is possible. Why and how?

Erin Welsh

Yes.

Erin Allmann Updyke

That is a question that we still don't know. Is it certain genetic characteristics of particular devils that make them more resistant to this cancer? There is evidence of antibody response that can be mounted, both in lab populations but also in these natural populations where devils, individuals have mounted an immune response and have kind of regressed their own cancer spontaneously. But it's not clear if this is because of genetic characteristics that make those individual devils able to fight off that cancer or if there have been mutations in the cancer themselves, in the cancer cells that make them able to progress or essentially make them less fatal. Which again, from evolutionary perspective, from the point of view of the cancer, if you extinct your entire population, you also go extinct as a cancer.

Erin Welsh

Right.

Erin Allmann Updyke

So there's just so many things about this that are really interesting and fascinating. And we don't have full answers to them. It's like very much open questions still.

Erin Welsh

Yeah. I think it brings to mind so many questions about strategies.

Erin Allmann Updyke

Yeah.

Erin Welsh

What are the different outcomes that could possibly happen in terms of complete resistance, in terms of tolerance-

Erin Allmann Updyke

Yeah.

Erin Welsh

In terms of the cancers and sort of their evolutionary pressures-

Erin Allmann Updyke

Yeah.

Erin Welsh

For the high virulence, low virulence, all of these things. And then to throw a wrench into things, the competition. So yeah, with the other cancer. So it's a complete jumbled bag of fascinating questions-

Erin Allmann Updyke

It is.

Erin Welsh

That we have just like the tiniest sprinkle of answers to.

Erin Allmann Updyke

And it's so interesting too to even kind of, like we kind of mentioned, conceptualize this as a cancer. Because there are some papers who will say well at this point these cells that are being transmitted from devil to devil are acting like a parasite, right. They are reliant on a host to be able to continue to reproduce and to grow and they are nonself. So there's some really interesting kind of discussion as to is this now, like should we consider this a parasite? Is that different than considering it a cancer? And it's more like philosophical and a little bit pedantic but it's fascinating too, from an evolutionary perspective.

Erin Welsh

So these cancers are nearly 100% fatal.

Erin Allmann Updyke

Right.

Erin Welsh

How does that happen? Like what do these devils die of?

Erin Allmann Updyke

Yeah, great question. So let's talk about what this disease actually looks like. So as the name suggests and as I said, this cancer causes the formation of tumors. The tumors are all over the face of these devils and they can become very, very large. And they're soft tissue tumors that are very... Like cancer tumors in general are not normal cells. And so they don't grow, like these are not skin cells that are growing just like skin lumps. These are very dysregulated cells growing these massive soft tissue tumors. They can grow really large, they can ulcerate and kind of open up which can lead to secondary infections of these kind of open wounds. But they can cause death in the devils in a number of different ways.

One is that they can grow so large that they block the airway, making it difficult for the devil to breathe. They can grow so large that they make it difficult or impossible to eat. And so then these animals die of starvation. Or because it's a cancer, they also can metastasize to any and all other organs and then cause organ failure and death from organ failure. So it really is a terrible, terrible, very disfiguring and very, very fatal cancer. And at this point there is no treatment for this cancer. First, it would be exceptionally difficult to treat for cancer a lot of wild animals, right. It's very difficult to even treat humans for cancers. It's extensive, it takes a very long time. But right now we also don't have any treatment for this particular cancer.

There is a lot of work being done to produce a vaccine because a vaccine to be able to prevent the transmission of this transmissible cancer is plausible, right. Because we know that in the cases where these populations or where these individuals have been able to cause tumor regression that an antibody response is possible to kind of fight off this cancer. So theoretically it would then be possible to prevent it. Thus far there still isn't a vaccine but it's at least something that is theoretically possible and that people are really working on.

Erin Welsh

What's the incubation period?

Erin Allmann Updyke

That's a really good question. I don't actually know. Because what I don't know is whether you can fully tell if a devil is going to develop tumors before the tumors arise. But the time from first tumor growth, when you first are able to see those tumors, to death is usually a matter of months.

Erin Welsh

Right.

Erin Allmann Updyke

Yeah. And I still have a lot of open questions too. Like knowing that the transmission tends to be from biting and we think more likely from the devils who bite into tumors rather than just the devils who have tumors doing the biting, means that they're getting exposed from actually getting their teeth into that tissue of the tumor. But then where are the tumor cells going? Are they going directly into the bloodstream? Are they traveling through the lymphatics? How are they getting there? Where are they attaching? Where do they first start to develop a tumor? Is it wherever that devil happened to have a little cut and so that's where the cells got in? There are so many open questions still about this cancer. And not just the transmission, like so many questions about it.

Erin Welsh

Yeah.

Erin Allmann Updyke

But that's what I know thus far about the biology and the kind of pathophysiology of this transmissible cancer.

Erin Welsh

It's so bizarre and fascinating that I feel like I'm still wrapping my head around it.

Erin Allmann Updyke

I know. Well to that end, Erin, can you tell us a little bit about these Tasmanian devils? Who they are, where they came from, how important they are and why we need to care.

Erin Welsh	I certainly can. Let's take a quick break and I'll get into it.
TPWKY	(transition theme)
Erin Welsh	Now that we know everything that's going on with Devil Facial Tumor Disease-
Erin Allmann Updyke	Yeah right.
Erin Welsh	<p>Okay, well we know more than we did at the beginning of this episode. Now I kind of want to zoom out a bit to get to know these devils themselves. Where did they get their name? What do they look like? What do they eat? What's their reputation and is it based in truth, in lies, or in a mix of the two? And then after getting better acquainted with the devils is when I want to get into some of their history over the 20th century leading up to the first official recognition of Devil Facial Tumor Disease. In short, Tasmanian devils are marsupial carnivores about a couple of feet long. They're covered in black fur with white stripes around like their neck and their bum, and whose existence is severely threatened by this transmissible cancer. And then getting into more details now. How can I start any other way than with a quote?</p> <p>Quote: "These animals were very common on our first settling at Hobart town and were particularly destructive to poultry, etc. They however furnished the convicts with a fresh meal and the taste was said to be not unlike veal. They are easily procured by setting a trap in the most unfrequented parts of the woods baited with raw flesh, all kinds of which they eat indiscriminately and voraciously. They also, it is probable, prey on dead fish, blubber, etc, as their tracks are frequently found on the sands of the seashore. In a state of confinement, they appear to be untamably savage, biting severely and uttering at the same time a low, yelling growl. They frequently sat on their hind parts and use their fore paws to convey food to their mouths. The muscles of their jaws were very strong as they cracked the largest bones with ease asunder. And many of their actions as well as their gait strikingly resembled those of the bear. Its vulgar name is the native devil." End quote.</p>
Erin Allmann Updyke	You can just picture how cute it is. It's like don't put me in a cage!
Erin Welsh	And so this actually comes from one of the earliest descriptions of a Tasmanian devil by a European, George Harris, hence harrisi. Yep. So this is from 1806. So he's the namesake of the species name.
Erin Allmann Updyke	Okay.
Erin Welsh	So you might think based on this quote that Tasmanian devils are big, fearsome, vicious beasts that leave a path of destruction and carcasses in their wake. Like lock your doors and arm yourselves against their deadly attacks. But you'd be wrong. I mean some people probably would tell you to lock or at least close your doors because they might come in and grab like a few blankets or clothes or like clothes off the line or pillows to cozy up their dens.
Erin Allmann Updyke	Do they do that?
Erin Welsh	Yeah.
Erin Allmann Updyke	I love that so much. I love when animals make themselves cozy, Erin.
Erin Welsh	Or maybe they'll steal a pair of sunglasses to consume in their entirety. Yeah.

Erin Allmann Updyke

Oh no, that doesn't sound like a good plan.

Erin Welsh

No, I mean it doesn't seem to be that bad as far as I can tell. We'll get there. But Tasmanian devils don't attack humans. They're more likely to run away from you unless they're trapped or threatened. And also no self respecting devil is going to be leaving carcasses behind. They're going to be devouring those, every last bit of flesh and sinew and bone. They're incredibly, incredibly, I think one of the most powerful jaws for any carnivore.

Erin Allmann Updyke

Wow.

Erin Welsh

Enabling them to leave no trace.

Erin Allmann Updyke

That's amazing.

Erin Welsh

They are after all predator scavengers who eat as much as they can when they can get it. 40% of their body weight per meal apparently every 2-3 days.

Erin Allmann Updyke

Wow.

Erin Welsh

Yeah.

Erin Allmann Updyke

That is a high metabolism.

Erin Welsh

And even if this means taking a nap inside the carcass between meals, as they are known to do. So they'll be like there's a dead cow, they'll eat a bunch, they'll get really full, they'll nap because they can't go anywhere.

Erin Allmann Updyke

Burrow into the cow and take a nap?

Erin Welsh

And they'll take a little nap.

Erin Allmann Updyke

Oh that's a little horrific though.

Erin Welsh

I love it. It's very one of the Star Wars episodes.

Erin Allmann Updyke

Yes, you're right. Good job.

Erin Welsh

Yeah. Thank you.

Erin Allmann Updyke

I'm impressed with you, Erin.

Erin Welsh

It's been like 20 years since I've seen them but I remember that part vividly. But this scavenger role that they play is actually really helpful as an ecosystem function. They clean up dead carcasses of livestock, they break up the sheep tapeworm cycle, they reduce blow flies, and they cut down on stench. I think that a lot of the times when it comes to charismatic endangered species, we tend to be like oh they're so cute, they're so cool, look at what they do, how horrible would it be to lose the species? And like all of that is valid. But I think that sometimes what we also need to remember too is the role in the ecosystem is so profound and interconnected that it's not just about saving an adorable marsupial, it's also saving the function of the ecosystem as a whole.

Erin Allmann Updyke

Right.

Erin Welsh

And yeah, because I feel like we could be like get rid of all the ticks. I would agree with that in part but yeah.

Erin Allmann Updyke

Unfortunately.

Erin Welsh

No. But there's the bigger picture for all of these things. Anyway, in addition to being scavengers, devils are also predators, mostly like the ambush type. And their preferred prey is apparently wombats. They're not like quite fast enough to catch rabbits unfortunately, see myxomatosis and RHDV episodes. And I think that they're not quite fast enough either to reliably catch wallabies, like adult wallabies, maybe babies or sick ones.

Erin Allmann Updyke

Okay.

Erin Welsh

They have been recorded running in fast bursts. So one clocked in at 35 kilometers per hour for about 300 meters. But usually they're more endurance type and they run 10-12 kilometer per hour for hours, they can do that.

Erin Allmann Updyke

Wow.

Erin Welsh

Yeah. But they'll eat pretty much anything. So this is from a list of facts about the Tasmanian devil in an article by Nick Mooney titled 'The Devil You Know'. So these are some of the things that have been found in devil scats. Quote: "Part of a woolen sock; a wallaby foot complete with snare; part of a dog or cat collar; 27 whole echidna quills; stock ear tags and rubber lamb docking rings; the head of a tiger snake; aluminum foil, plastic, and styrofoam; a ring off of a bird's leg; half a pencil; leather jacket; a fish spine; a boobook owl foot; cigarette butt; part of a Steelo pot scraper-" and this person also mentioned that they also had "part of a leather boot and the knee of a pair of fat-stained jeans eaten after being left outside a tent, not with me in them." End quote.

Erin Allmann Updyke

Oh wow.

Erin Welsh

Yeah.

Erin Allmann Updyke

That's like more than a goat.

Erin Welsh

I know. I was just thinking how it's like a goat. Yeah.

Erin Allmann Updyke

Wow.

Erin Welsh: Yeah. It's pretty incredible. And their poops are evidently quite big for their size. So 15 centimeters or about 6 inches long on average. And these are not that big. Yeah.

Erin Allmann Updyke: A six inch poop. Like what sort of diameter are we talking?

Erin Welsh: So that I don't know. I did see a couple of pictures-

Erin Allmann Updyke: Okay.

Erin Welsh: But I couldn't get a scale, there was no bananas for scale or whatever.

Erin Allmann Updyke: I mean they're chewing out parts of boots. You can identify something as a part of a boot, that's a chunk.

Erin Welsh: I know. I mean their digestive systems must be... What is their microbiome?

Erin Allmann Updyke: What is their microbiome?

Erin Welsh: Questions. Unanswered questions. Talk about low priority for right now, I think. But the size of their poops has apparently, according to this book I read, helped to encourage the belief that thylacines are still out there. And they also poop in communal latrines which is somewhat unusual for carnivores. I think hyenas do it and maybe honey badgers do it, I'm not sure. But it does make potty training for wildlife rehabbers really easy because they're like this is your potty.

Erin Allmann Updyke: Go poop in this one hole.

Erin Welsh: Yeah. And before I forget, I do want to shout out, I meant to do this at the top of my section, I want to shout out the book that I read for this episode which was so great. I really enjoyed it. It is called 'Tasmanian Devil: A Unique and Threatened Animal' by David Owen and David Pemberton. Two Davids, the Davids.

Erin Allmann Updyke: The Davids.

Erin Welsh: But I really enjoyed it, it was a great book. And so that's where the vast majority of the bulk of this information comes from.

Erin Allmann Updyke: I love it.

Erin Welsh: Anyway, okay. Back to the devils. In terms of size, Tasmanian devils aren't huge beasts at all. Tasmanian devils are the largest living marsupial carnivore and that's a title that they claimed when the Thylacine, aka Tasmanian tiger went extinct in the 20th century, the early twenties century.

Erin Allmann Updyke: Okay.

Erin Welsh: Adult male devils top in at 8-10 kg, so 18-22 lbs.

Erin Allmann Updyke: Okay.

Erin Welsh: And adult females are around 5-7 kg or 11-16 lbs.

Erin Allmann Updyke: It's like a little kitty cat.

Erin Welsh: I know, I know. Yeah. They are about 570 millimeters or 650 millimeters long, so it's like 1.9-2.1 ft long roughly. And around 30 centimeters or 12 inches tall at the shoulder.

Erin Allmann Updyke: This is like a small cat. Like smaller than a cat.

Erin Welsh: I was thinking like dachshund, like a small dog, yeah.

Erin Allmann Updyke: Okay.

Erin Welsh: I'm mostly more around dogs than I am around cats.

Erin Allmann Updyke: That's fair.

Erin Welsh: But yeah, I feel like a cat/dog is like yeah, similar.

Erin Allmann Updyke: Bigger than a chihuahua.

Erin Welsh: Bigger than a chihuahua, smaller than a beagle.

Erin Allmann Updyke: Okay.

Erin Welsh: Depending on the beagle.

Erin Allmann Updyke: Like a puppy beagle.

Erin Welsh: Yeah. So I said dachshund size but I think a little bit taller and they have a much bigger head, like their head is comically huge. I love it.

Erin Allmann Updyke: Oh okay.

Erin Welsh: And it's to accommodate their powerful jaws. And then they have this stiff, thick tail where they store their fat. Like that's where their fat is stored in their tail.

Erin Allmann Updyke: It's a fatty tail?

Erin Welsh: Yeah.

Erin Allmann Updyke: Interesting. We're rubbing our hands trying to feel it in the air.

Erin Welsh: We are. And they kind of I feel like in some ways they resemble like a wolverine.

Erin Allmann Updyke: Okay.

Erin Welsh: If you know what a Wolverine looks like. But they're smaller than wolverines and they're less... Yeah. There are vibes. Wolverine/honey badger vibes.

Erin Allmann Updyke Right, right, right, right.

Erin Welsh And like those, they also have long claws which are great for digging or holding onto prey or climbing which they do when they're young as several zoos who had young found out later on.

Erin Allmann Updyke Cute.

Erin Welsh They were like oh this fencing is not sufficient for the babies.

Erin Allmann Updyke Oh okay.

Erin Welsh Yeah. But Tasmanian devils of course don't start out small to medium dog sized. After a short but intense breeding season about three weeks long where males will sometimes hold females in dens and not let them leave for days at a time, it can be a very violent from our perspective mating situation.

Erin Allmann Updyke Wow. Okay. Lots of transmission of this cancer.

Erin Welsh Exactly, yeah. Exactly. After this a female will give birth after an 18-21 day pregnancy.

Erin Allmann Updyke Okay.

Erin Welsh As marsupials they are born as teeny, tiny little nuggets, each about the size of a split pea or grain of rice.

Erin Allmann Updyke Oh my god, so tiny!

Erin Welsh So tiny. Like smaller than half of your pinky nail.

Erin Allmann Updyke Wow.

Erin Welsh Four could fit on a quarter. There was a picture in the book. I was like what is that? Oh my gosh. Amazing.

Erin Allmann Updyke And then they crawl their whole way up to get into the little pouch?

Erin Welsh Yep. So a female will give birth to about 20-40 babies or joeys. I've also seen them called imps.

Erin Allmann Updyke Wow!

Erin Welsh But only a few will survive. She only has four teats.

Erin Allmann Updyke Oh okay.

Erin Welsh Yeah.

Erin Allmann Updyke Oh gosh, brutal competition.

Erin Welsh: Yeah. It's very interesting. It's very interesting.

Erin Allmann Updyke: Yeah.

Erin Welsh: Just reproductive strategies, man.

Erin Allmann Updyke: Yeah.

Erin Welsh: Joeys are dependent on mom for about nine months, at the end of which is basically breeding season again.

Erin Allmann Updyke: Okay.

Erin Welsh: After they wean, they lead a pretty solo lifestyle, not territorial but covering a large area, fully mature at the age of two. And their lifespan even before Devil Facial Tumor Disease, DFTD, it wasn't much longer than five years, like rarely six. As they're doing their solo traveling, they're aided by a great sense of smell and whiskers all over their head which helps them sense movement at night. And like I mentioned, they're covered in mostly black fur with a few white markings around their chest and rump and their ears are mostly hairless and I think it's to help them regulate their temperature. So their ears look like pink or red in the sun. It's very cute.

Erin Allmann Updyke: I just really need to see pictures of this while you're...

Erin Welsh: Yes, please, please look them up. They are amazing. And also I feel like so many of us have this image of Tasmanian devils from the cartoon Taz, the Warner Brothers Looney Tunes.

Erin Allmann Updyke: Yeah.

Erin Welsh: In my eyes there's like nothing alike and I just am so baffled.

Erin Allmann Updyke: Now I need to look up with that... Oh my god.

Erin Welsh: Do you see it?

Erin Allmann Updyke: Their little bottom teeth.

Erin Welsh: Yes!

Erin Allmann Updyke: Oh they're kind of dweeby.

Erin Welsh: Yes, they are. I know. I love them.

Erin Allmann Updyke: Tasmanian devil cartoon. Now I have to remind myself what he looks like. Oh yeah, no, that's not even a little bit close.

Erin Welsh: No, right?

Erin Allmann Updyke: How weird.

Erin Welsh: I don't understand it.

Erin Allmann Updyke: Well Looney Tunes.

Erin Welsh: Looney Tunes. I mean well speaking of Looney Tunes or Warner Brothers specifically, the company trademarked the name Tasmanian Devil and so aside from Warner Brothers and one fishing lure company in Tasmania that got an exception, no one can use the name Tasmanian Devil on branding or products.

Erin Allmann Updyke: So is that why this is called Devil Facial Tumor Disease and not Tasmanian Devil Facial Tumor Disease?

Erin Welsh: I don't know. I mean but I know that kind of blew me away. Where I'm like can you trademark an animal name? That doesn't seem like you should be able to do that. Alas.

Erin Allmann Updyke: Who knows?

Erin Welsh: Yeah. Yep. But speaking of names, how did this cute dog-bear-looking thing get the name devil?

Erin Allmann Updyke: Look at it laying down. It's so cute.

Erin Welsh: It's so cute. Have you looked at babies?

Erin Allmann Updyke: Oh no, I want to see babies.

Erin Welsh: You have to see the babies.

Erin Allmann Updyke: Oh this is one eating. That's gross. Okay, keep going.

Erin Welsh: Okay, so how did it get the name devil? One idea is their feeding tendencies, as you just saw the picture of one and went ugh, gross. So first is just the association with flies around carcasses, so Beelzebub is also surrounded by flies, hence the nickname Beelzebub's pup. And then there's the behavior. Devils will often feed in groups, drawn to the carcass by the loud cries of those who are already there. Which is another contender, the noises, by the way, for their name. I'll get back to that in a second. But as researchers later learned, there's actually order, a hierarchy where certain devils will get their fill and then they'll relinquish the carcass to the rest, not stand guard over it as some other species will do. That being said, the noises that devils can make are varied to put it mildly and have been described as otherworldly. If you were to ask me, I would probably say Nazgûl-like.

Erin Allmann Updyke: Ooh okay.

Erin Welsh: Yeah. And I'm going to play a sample for you here.

Erin Allmann Updyke: Oh good.

Erin Welsh: Okay, okay.

TPWKY: (audio of Tasmanian devil screeching)

Erin Allmann Updyke

It's really good.

Erin Welsh

It's wild. And that's just one example. If you go on YouTube, there are videos where there is the like the full gamut of snorts and barks and growls and screams and shrieks. It's wonderful.

Erin Allmann Updyke

I love it.

Erin Welsh

I love it. And so one story goes that when Europeans first landed on Tasmania, they assumed that it was part of the Australian mainland which they were already familiar with. And so they also assumed that they knew all of the wildlife that they might encounter. But then at night as they lay in their tents, they heard the shrieks and screams of a mysterious creature and thought this must be the devil.

Erin Allmann Updyke

The devil!

Erin Welsh

Or a devil.

Erin Allmann Updyke

Oh that's a good story.

Erin Welsh

Because Tasmanian devils are now only, as the name indicates, found on Tasmania, an island state of Australia a couple 100 kilometers to the south of the mainland and which separated from the mainland around 12,000 years ago.

Erin Allmann Updyke

Okay.

Erin Welsh

Devils used to be on the mainland but went extinct there along with the Thylacine around 3000 years ago give or take.

Erin Allmann Updyke

Okay.

Erin Welsh

It was before Europeans arrived which was in the early 17th century. So it's unclear exactly why they went extinct but it could be due to changes in climate like the land becoming more arid and thus supporting fewer prey or competition from dingoes. Some people have suggested that over hunting by indigenous Australians drove down numbers but that idea does not seem to be well supported.

Erin Allmann Updyke

Okay.

Erin Welsh

Okay. So hopefully by this point I've convinced you that the ferocious, deadly, dangerous reputation that followed Tasmanian devils around for centuries is largely unfounded unless you're a wombat. This rebranding of the devils, like one chapter of the book that I read about them was titled 'From Antichrist to Ambassador' which I thought was great. This rebranding is relatively recent, beginning around the second half of the 20th century or so. Although there was still some animosity like even up until the Devil Facial Tumor Disease.

Erin Allmann Updyke

Yeah.

Erin Welsh

From the time that Europeans arrived in Tasmania, devils were firmly on the 'do not want' list. Trapping, poisoning, hunting, any way that these devils could be eliminated was a good way.

Erin Allmann Updyke

Wow.

Erin Welsh

They were blamed for killing livestock, eating animals out of snares, attacking children, causing general mayhem, a scapedevil, if you will. To give you an idea of the animosity poured over these creatures, I'm going to read you a couple of quotes from author and artist Louisa Anne Meredith from 1880. Quote: "If anyone desires to see a blacker, uglier, more savage, and more untamable beast than our devil, he must be difficult to please. That's my opinion. We hunt them down or set traps or dig pitfalls, any and every way we can to destroy them, we do. Why one winter some years ago, one of Papa's shepherds caught nearly 150." End quote. Isn't that wild?

Erin Allmann Updyke

Wow.

Erin Welsh

Yeah.

Erin Allmann Updyke

And this is like their native range. Like y'all went there. Okay?

Erin Welsh

Yeah, I know. And this sentiment is polar opposite of what Mary Roberts, who was a wealthy socialite who opened a zoo near Hobart, wrote just a few years after the one I just read. Quote: "Many visitors from the commonwealth have heard such exaggerated accounts of the ferocity and ugliness of the Tasmanian devil that they sometimes express surprise when they see them act so lively, sprightly, and excited running out to my call. I have derived much pleasure from studying the habits and disposition of the Tasmanian devils and have found that they respond to kindness and certainly show affection and pleasure when I approach them. Others who do not know or understand them may think of them as they like. But I, who love them, will always regard them as first favorites." End quote. I love that.

Erin Allmann Updyke

I love that.

Erin Welsh

It's so cute. Unfortunately this appreciation for devils was relatively rare and trapping, hunting, poisoning continued until the mid 20th century. And that's when people started to go guys, look what just happened to the Thylacine. Are we really going to do this to the Tasmanian devil too? So then with protections put into place and the devil being used to draw tourists to Tasmania, populations rebounded. And by the 1960s and into the 1970s, they had climbed to such a degree that some people complained that they were a plague, like a plague of Tasmanian devils. But then in 1996, things began to change or at least that's when people started to notice the change.

That year, Dutch wildlife photographer Christo Baars was working in Northeastern Tasmania near Mount William when he spotted a group of devils and naturally photographed them. But there was something very odd about this particular set of devils. Sometimes he would come across older devils with facial wounds or scars, torn ears, that sort of thing. But this was on a whole other level. These devils had extreme facial growths, lumps, and lesions. Devils are no stranger to cancer apparently, in fact it was known to be a major cause of mortality among the animals but those cancers were internal.

And so this photographer showed these photos around to researchers who were justifiably alarmed and had no idea what could be going on. Before these photos were taken, there had been a couple of mentions of devils with facial tumors, like one in 1984 and one in 1993, but nothing as extreme as this and nothing really suggesting a pattern. And around the same time as these pictures were taken, anecdotal reports of drops in devil populations were coming out of the same area where those photos were taken where devil concentrations had previously been among the highest. Farmers were reporting that dead cows or sheep were just laying there uneaten. Previously the devils would have made like really fast work of the carcass.

So what was happening? within a few years, researchers identified the disease as a transmissible cancer, one that was rapidly spreading throughout devil populations. And initially there was this question of whether this cancer was an old re-emerging disease, maybe one that had previously cycled through devils and contributed to past population declines, which we actually have very little data on to even say that there were clear boom and bust cycles. Like I read that the first dissertation about Tasmanian devils was published in 1991. And so I think that there's been-

Erin Allmann Updyke

Wow!

Erin Welsh

Yeah, there have been like over the years it was sort of not very much research and then within the past few decades, there's been a lot, a lot.

Erin Allmann Updyke

An uptick.

Erin Welsh

Yeah.

Erin Allmann Updyke

Interesting.

Erin Welsh

And while there are apparently some devil skulls from the 1800s that seem to have formations similar to those caused by the cancer, more recent genetic analysis revealed that the first strain of the cancer, DFT1, emerged sometime in 1986 roughly, plus or minus, with the second strain, DFT2, emerging seemingly independently in 2011. Within a few years of those 1996 photos, researchers began seeing the cancer pop up hundreds of kilometers away, suggesting that the disease was rapidly spreading throughout the population. By 2005, half of Tasmania was affected with no signs of slowing. In 2009, the Tasmanian devil was officially listed as endangered and research ramped up on understanding what this cancer was, how it was spreading, and especially how we might be able to control it. While this disease may no longer pose the existential threat it once was to Tasmanian devils, it still is very much up in the air what the near future will look like for these devils whose populations have declined 60-70%.

Erin Allmann Updyke

Yeah.

Erin Welsh

To have any hope at stopping this decline and working towards recovery means integrating knowledge from across so many different fields. From evolution to vaccines, behavioral ecology, to conservation strategies, cancer biology, and beyond. And we are so excited to be able to talk with someone who has expert knowledge in so many of these aspects.

Erin Allmann Updyke

Literally all of it.

Erin Welsh

As evidenced by the fact that like literally, like you said, he's on so many of these papers.

Erin Allmann Updyke

Like every one that I read.

Erin Welsh

Yeah. Let's take a quick break here and then we'll chat with Dr. Rodrigo Hamede, senior lecturer at the University of Tasmania.

TPWKY

(transition theme)

Rodrigo Hamede

Well my name is Rodrigo Hamede, I'm a disease ecologist here at the University of Tasmania. I've been investigating Tasmanian devils for 20 years now. I came to Tasmania 25 years ago as an enthusiast bushwalker and wildlife lover. My background was in arts and music, so I wasn't a scientist in those years. But I came with the expectation to see a Tasmanian devil in the wild. Tasmania has a lot of resemblance with Patagonia. They're both called Gondwana relics, so I was always interested in Tasmania. And I became so enchanted by these amazing creatures that I decided to have a career, change and study science. And here I am 20 years later still working with them.

Erin Welsh

That's incredible. Well thank you so much for chatting with me today. I can't wait to chat more about Tasmanian devils and get your expert knowledge about this incredibly fascinating animal and this unique and deadly disease that is threatening its existence. So far in this episode we've covered some of the biology of this transmissible cancer like how its spread, the tumors that it causes. And we've also discussed the devils themselves, their natural history, what charming little creatures they are. I am completely in love. And also we talked about when people first observed devils infected with this deadly transmissible cancer. Since those early observations, how have devil populations been affected throughout Tasmania? And have there also been downstream effects on the ecosystems where they're one of the top predators?

Rodrigo Hamede

Yes. So the disease was first observed by a wildlife photographer from Netherlands called Christo Baars in 1996. Molecular work that we've done now suggests that the disease was present in the late 1980s. But that was the first time in 1996 that we saw a devil with massive tumors. We didn't know this was a transmissible cancer, we just saw this poor devil has some weird malformations in the face. It was in the next following 3-4 years that in the eastern part of Tasmania more devils starting to look with these tumors. And then a few years later we realized this was a transmissible cancer. Since then we have lost 2/3 of the world's devil population because they're endemic to Tasmania, so that's the only place where they occur. And of course Tasmanian devils being an apex predator has a very important role in the ecosystem of our island Tasmania.

And that decline has had a lot of cascading ecological effects in other communities. We've seen an increase in some mesopredators, one of them is the eastern quoll. Areas where I used to travel, like my long term study site that I've been investigating for almost 20 years, for the first seven or eight years we never saw an eastern quoll. And now we get devils as a bycatch and 80% or 90% of our traps are eastern quolls and only a handful of animals are devils. Sadly we've also seen an increase in feral cats, which is the biggest conservation threat that Tasmania and Australia has. It is a horrible thing because there's nothing we can do about it, it's out of control. And of course less competition from an apex predator means more space and more archaeological niche for feral cats.

They're also interestingly changing the peak of their activity patterns. previously in areas with high devil densities, the peak of activity patterns was during the day. In the absence of high densities of devils, now they've shifted their activity patterns during the night. And of course most of our wildlife is nocturnal so there's much more opportunities for predation. We've seen behavioral changes in some prey species where they're much more relaxed. And so the ecological role of devils is sort of in some areas absent. Changes in parasitic communities of course because being scavengers, there's a lot of parasites, there's a lot of things that a lot of people don't care but some of us do care about these things. Carrion availability, the biomass of food in Tasmania is amazing, there's so much wildlife and they're scavengers so they act as ecological recyclers, clean up all that carrion. So this increase in carrion is also resulting in increasing other carrion feeders like forest ravens.

And lastly but not the least changes in humans. Believe it or not, when I started working a lot of farmers had negative thoughts about Tasmanian devils because every now and then they would lose a lamb during lambing season. The general public also didn't have this special relationship we have now with Tasmanian devils. They're quite important. Most farmers now are seeing that the carcass dumps where all these animals are put, they were cleaned in a couple of weeks. And now they're rotting and causing some diseases to emerge, flystrike disease and other things. So now they're seeing in the absence of devils, they are seen how important they are. And I must say the entire community, the entire Tasmanian community now is a lot more empathetic of our beloved apex predator than 20 years ago.

Erin Welsh

Beyond the dramatic impact on Tasmanian devil population numbers overall and as well as these cascading ecosystem effects that you discussed, has this cancer or have these cancers also led to any life history or behavioral changes in the Tasmanian devils themselves?

Rodrigo Hamede

Indeed it has. And when you think about it, diseases that affect fitness usually end up altering some of these evolutionary processes in their host. When you have a disease that is almost 100% lethal in such a short period of time, the pressure is immense. So the evolutionary response we've seen in Tasmanian devils is incredible, fast evolution. These things ought to happen over centuries or thousands of years but we've seen in it as little as 4-6 generations, that's 8-12 years. Perhaps the most important and immediate work is precaution breeding. So devils reach sexual maturity in the second year of their lives. And now in chronically affected populations, some females, not all but some females are able to breed in their first year which is astonishing because that shouldn't happen.

So this is driven by the availability of resources in the lack of high level abundances. There's a lot more resources, females can grow much faster and they can reach that minimum critical size to breed in the first year. There's also less competition by other adult females in the population because most populations affected by the disease are comprised of young animals. And that gives more scope for these one year old females to breed and manage to put a litter in the next generation before they succumb to the disease. Because when they mate, they contract the disease. So it's sort of a vicious circle in a sense. But it has caused at least the population to become stable, below carrying capacity but stable because they can still breed in the first year.

We've seen also behavioral changes in behaviors associated with transmission risk. You would think that a disease that is transmitted by aggressive behavior there would be a selection for shy phenotypes, for animals that are less aggressive to have more opportunities for breeding because they're not contracting the disease and those genes would be passed into the next generation. So you would expect the devils will become less aggressive. But of course the trade off of that is that aggressive behavior is associated with mate acquisition. And so there is a bit of a trade off there. But we have seen changes in animals where they didn't used to bite each other very much, particularly severe bite wounds, and now they're increasing the proportion of severe bite wounds. In the absence of these aggressive animals, they've overtaken that role of the older animals in the population.

And we've also seen sickness behavior, the behavior of those animals that are infected as the disease progresses become less and less isolated from their social network. And that is perhaps something good for avoiding transmission in lower population densities. These animals are less likely to infect others later in the disease progression. So most transmissions might happen during the early stages of the disease when the effect of the cancer has not made them less likely to interact with other individuals. And perhaps the most important one is the evolution of resilient mechanisms to cancer, the one that we were discussing before. Changes in allele frequencies in genes that are associated with cancer and immune function in humans have occurred, as I said before, in as little as 4-6, several generations, that 8-12 years.

Tolerance to cancer is also something that we have seen. So now animals are surviving at least up to two years but almost 50% more time. When they're infected they survive for much longer than 8-10 generations ago. The interesting thing is that tolerance is good for the cancer too because the animals living longer infectious with these massive tumors, I mean I've seen animals that have tumors the size of four tennis balls, like just half of the face is a tumor. And they're just hanging about. And that's good for the disease because it's increasing its basic reproductive number and it's increasing its magic R number that we all learned with COVID. So these animals surviving longer with the disease is a thing good for them and it's also a thing good for the cancer. And some of them are resisting the disease and not just tolerating it but causing tumor aggressions.

And what we don't know is true resistance is the ones that are getting infected but they don't develop tumors because we don't have a preclinical test. So we don't know if the animal is infected unless they have tumors. So there might be a proportion of animals that are challenged with this cancer and they're not developing tumors. But unfortunately we don't know that. We do know that a small proportion can show tumors and then create an immune response and cure themselves from cancer, which is quite interesting and quite exciting.

Erin Welsh

Getting into that a little bit more, are there ecological or behavioral characteristics of Tasmanian devils? You mentioned aggression and social networks. How does that sort of contribute to the spread of this cancer both in terms of the Tasmanian devils themselves but also external factors like habitat fragmentation, anything that influences these dynamics of transmission?

Rodrigo Hamede

Yeah. The big one is making mating season. So under lower densities there's less likelihood of these animals encountering each other. But we've done a fair bit of work with social networks using a marvelous technology called proximity sensing radio collars which interact with each other at a preprogrammed distance. So in the same way with the social networks with COVID and humans, we can do this with the Tasmanian devils. And it's fantastic because it's 24 hours a day, 7 days a week data. So we know that there's a peak of interactions during the mating season. We know that a lot of these bite wounds that come up in animals are the result of both mate guarding and copulation which is quite aggressive. And that even at low densities means that these animals will encounter with each other and then they will maintain the disease under low population density.

So mating season and aggressive behaviors is the big driver of transmission for this disease. Age structure is another one because populations are now biased towards one or two year olds, they will lead up to 5-6 years maximum in the wild. If you go to any chronically diseased population, 90% of the population will be composed of one or two year olds. And they're breeding once or twice and forced to come into the disease because when they mate is when they're most likely to contract the disease. So that's fuel for the epidemic. In terms of fragmentation, devils have overlapping home ranges and they have home ranges about 12 square kilometers. So the way the disease moves in areas with high density is much faster than in areas with lower density, of course. But the distributional range of Tasmanian devils has been now entirely affected by the DFTD. So there's only some pockets in the west coast or in the southwest that aren't affected but it's not prime habitat. So we could say that the entire distribution of Tasmanian devils' distributional range is affected by DFTD.

Erin Welsh

In the last decade, a second strain of transmissible cancer DFT2 has emerged seemingly independently. What does its emergence tell us about infection dynamics or where these cancers originated or about the devils themselves? Like is this just something that happens to them or they're more susceptible to this?

Rodrigo Hamede

Yeah, this is so interesting. And this is always... I use an analogy story with the lottery with my students when they ask me about this. I say imagine if you just want to have a great holiday and you buy one lottery ticket and you win it, you win lots of lots of money. You have a wonderful life. And 20 years later you run out of money and you decide to buy another lottery ticket. Imagine winning it again. So those are the odds of having two transmissible cancers in 20 years in the same species. These things don't happen, right? There's three transmissible cancers known to biology in vertebrates and 16 invertebrates, in mussels. But this is not coincidence. In the early 1990s, patient zero was a female and developed this cancer that somehow managed to evade the immune system and become transmissible. In 2014, patient zero was a male that had a cancer. Same story. It looks the same, it's completely different but it looks exactly the same, managed to evade the immune system.

So this is telling me at least and a few of our colleagues, using the most parsimonious explanation, that these animals may have a particular susceptibility to these malignancies. And in fact I would argue that this is not the second transmissible cancer that they've experienced through their evolutionary history. If they had two in 20 years, I would think that maybe this is not number two, this is number 12 or something like that. And they've managed to recover from them. So they may have, during the evolutionary history, figured out how to overcome cancer. When I say figure it out, I mean figuratively of course. And this is quite important because transmissible cancers, there's this theory about the perfect storm theory for transmissible cancers. That a number of coincidences both in the tumor and the host must coincide for these transmissible cancers to emerge. And the theory is that they are much more common than what we think, that they're not sustaining populations because not all these coincidences happen. So they might emerge but they die out. Somehow Tasmanian devils are proving that transmissible cancers can be sustained in populations.

And I think it's a fantastic story to learn a little bit more about cancer. We tend to forget that cancer is half a billion years old. It's a disease that is thought to have appeared with the transition of unicellularity to multicellularity. And we have evolved, over millions of years, mechanisms to avoid horizontal transmission and cancer dies when the host dies. So these two cancers are fantastic opportunity, sadly as it is, to learn a little bit more about the evolutionary trajectory of cancer cells in nature. And now not only that but also to learn about competition dynamics between these two cancers. Because the pressures that the devils are facing now are not the same that they faced 20 years ago. They are in a much lower abundance of hosts so there's less scope for mutations and transmission events. There's pressure for these two cancers to outcompete each other, shorter latent period, faster tumor growth rates. Are these evolutionary responses to the first cancer transferable to the second one? There's a lot of things we need to start figuring out now.

Erin Welsh

When a new wildlife disease emerges, conservation is the top priority. Like do what we can right now to save the animals while we figure the rest of this question out. What are some of the conservation efforts that have been employed for Tasmanian devil populations? And what are some of the challenges associated with conservation?

Rodrigo Hamede

We've changed a little bit our conservation strategies in the last few years. When this disease first emerged and we saw that devils were just declining in a matter of 2-3 years after disease arrival significantly. So we were in panic mode and our conservation strategies was to avoid extinction. And therefore we created, when I say we, I'm talking now about Tasmania, not myself. Don't wanna seem too presumptuous about that. This is all our work. The Tasmanian government had this mission to create insurance populations both in Tasmania and Australia mainland zoos. So captive insurance populations to preserve the genetic diversity of the species and to ensure that we had a stock of animals if things went dire towards extinction.

We also did a fantastic translocation to an island called Maria Island where there's now an abundance of too many devils now on the island. Of course free of disease, they were all sourced from captive institutions and on the basis of genetic diversity. It is a wild insurance population now, several generations have been born in the wild and we know that they are free of disease because disease won't get there. But I think the biggest conservation strategy that we have switched from managing for extension to managing for evolution, DFTD these days is no longer an extinction threatening disease. It has depleted devil populations by two thirds, it has not allowed devil recovery yet. But we have not seen any local extinction in any particular area almost 30 years after this disease because of these evolutionary responses.

So now we're starting to think do we need to trade off genetic rescue with evolutionary rescue? Is it more important to have devils that are adapted and have the genes to become more resilient to this disease and trade that off for maximum genetic diversity? One of the things that we were doing in the past was reintroductions from captive populations back into the wild to boost those numbers. And I don't think that was a good idea because one of them is gonna fuel epidemics, it's gonna fuel transmission because more susceptibles are added to the population. But also because if these animals that have never been exposed to DFTD mixed with the genotypes that are being selectively adapted to cope with the disease, we might dilute that evolutionary response.

So we are in a bit of a conundrum now to think how we need to manage this disease in the long term because it seems like the situation is the disease is not gonna go anywhere, right. It's here to stay for the foreseeable future. Devils are not going extinct either. So we need to start thinking about much more innovative solutions to make sure that our conservation strategies are long term and not short term.

Erin Welsh

And speaking of innovative solutions, what do you see as the most important next steps or the steps that you would most like to see in this field of DFTD research?

Rodrigo Hamede

Well we need to start using modern genomic tools to try to manage this population in the long term. We've realized that these tumor regressions, these devils that had tumor regressions have the expression of certain genes that devils that didn't have tumor regressions had. So we've isolated a few genes that have a role in cancer in humans as well and that are related with this tumor regression. So we need to model long term evolutionary dynamics and possibly co-evolutionary dynamics between devils and tumors. We need to understand whether these selective mechanisms for cancer resistance are heritable. That's very important, particularly to manage the genetic stock of insurance populations. And if they are heritable and they are present in these chronically affected populations, we need to make sure they are taken into account when managing the insurance populations.

I think one of the biggest challenges we have at the moment is particularly to understand how this is going to pan out in the next 10-20 years. These evolutionary dynamics we've seen might be transient. We need to realize that we're still dealing with the disease early in its evolutionary stages. We tend to think we've been working in this disease for 20 years, we've been working with those many devils for so long, that's only 10 generations. And when you put things in the evolutionary board, you may think okay, things are just starting. So we need to be very careful about what we do now and make sure that whatever we're doing now, we have tested that it's proven to be not detrimental into the future. So at least we have the benefit of time now, we're not like 10 or 15 years ago, we thought devils are gonna go extinct, we need to do things rapidly.

And we are translating our research, our cancer research, our genomic research with co-evolutionary models. We're working with oncologists, with cancer labs around the world. A lot of experts in cancer in humans are quite interested in our study system because it's a fantastic study system to see how cancer operates in nature and hopefully make a difference for the next generation of kids in Tasmania that love Tasmanian devils and make sure that we can path the way to recovery. It seems like the devils are doing that themselves, they may need a bit of help from us once we understand how these resilient mechanisms operate. And hopefully we'll have devils and facial tumors in the foreseeable future.

TPWKY

(transition theme)

Erin Welsh

That was incredible.

Erin Allmann Updyke

I still want to know so much more, Erin.

Erin Welsh

I know, I know. Me too, me too.

Erin Allmann Updyke

Thank you so, so much Dr. Hamede for sitting down with us and for talking us through all of this. And for all of your incredible work, like this is just wow.

Erin Welsh

Truly.

Erin Allmann Updyke

What a joy.

Erin Welsh

Thank you. Thank you. Thank you. Well-

Erin Allmann Updyke

Well?

Erin Welsh

I think at this point all that is remaining is sources, yeah?

Erin Allmann Updyke

Yeah. So that everyone can keep learning more-

Erin Welsh

Yeah.

Erin Allmann Updyke

About these incredible devils and this fascinating, fascinating disease.

Erin Welsh

I will shout out again the great book that I read titled 'Tasmanian Devil: A Unique and Threatened Animal' by the Davids, David Owen and David Pemberton. I hope they're okay with me saying the Davids. And there are a couple of papers that I'll post.

Erin Allmann Updyke

I had so many papers, so many papers to go through. I think some of the ones that were really great for like big picture of this disease. One of them was a 2006 paper by Hawkins et al which is kind of one of the big papers that often get cited about this disease. There's a few really detailed ones on the immunology of this disease. One by Siddle et al from 2013 titled 'Reversible Epigenetic Down-Regulation of MHC Molecules', da-da-da-da-da. It's a really good one, lots of detail there. And honestly there's so, so many other papers. We post the list of sources from this episode and every single one of our episodes on our website thispodcastwillkillyou.com under the EPISODES tab.

Erin Welsh

A big thank you to Bloodmobile for providing the music for this episode and all of our episodes.

Erin Allmann Updyke

Thank you to Tom Breyfogle and Lianna Squillace for the incredible audio mixing.

Erin Welsh

Thank you to Exactly Right.

Erin Allmann Updyke

And thank you to you, listeners. We hope that you had fun with this episode and learned a lot and have a little bit more love for Tasmanian devils.

Erin Welsh

Yeah. Who wants to meet us in Tasmania?

Erin Allmann Updyke

Yeah. Yeah, that would be fun.

Erin Welsh

For real.

Erin Allmann Updyke

Let's go on a field trip.

Erin Welsh

Yeah. And a special thank you as always to our wonderful, fantastic, generous patrons. We appreciate your support so very much.

Erin Allmann Updyke

So much. Thank you.

Erin Welsh

Well until next time, wash your hands.

Erin Allmann Updyke

You filthy animals.