

TPWKY	This is Exactly Right.
	(This Podcast Will Kill You intro theme)
Erin Welsh	Hi and welcome to This Podcast Will Kill You crossover edition.
Erin Allmann Updyke	(trumpeting sounds)
Erin Welsh	(laughs) I'm Erin Welsh.
Erin Allmann Updyke	And I'm Erin Allmann Updyke.
Erin Welsh	And this week we are joined by our good friend and fellow podcaster, Matt Candeias. Say hi Matt!
Matt Candeias	Hi Matt! I should never have done that. Hi. I'm ashamed of myself already.
Erin Welsh	(laughs) No! It's perfect. So Matt is a fellow grad student and host of the incredible podcast In Defense of Plants.
Matt Candeias	Thank you.
Erin Welsh	Matt, can you introduce yourself a bit and talk a little bit about what your podcast does?
Matt Candeias	Yeah. I'm Matt Candeias and I host In Defense of Plants. It is a weekly podcast that essentially is there to cure what we call 'plant blindness' and by we I just mean people that like plants.
Erin Welsh	We suffer from plant blindness, that's for sure.
Erin Allmann Updyke	Yeah big time, big time.
Matt Candeias	A lot of the world does and it's not a fault, it's just the way our species is programmed. But that's why the podcast exists and I think that's the niche it's filling is to celebrate plants and get people excited, maybe not obsessed, you don't have to become obsessed with them. But excitement and just appreciate the botanical world because really we wouldn't be here with it, so.
Erin Welsh	Yeah.
Erin Allmann Updyke	That's very true.
Erin Welsh	It's awesome and everyone go and check it out. In Defense of Plants.
Erin Allmann Updyke	Well especially because there's gonna be another episode that will exist.
Matt Candeias	Right. Cause this is a crossover.
Erin Allmann Updyke	Crossover!

Erin Welsh Reciprocal transplant.

Erin Allmann Updyke Where we're gonna be on Matt's podcast-

Matt Candeias That's what I do! That's what I study! Thank you.

Erin Welsh (laughs) So Matt's joining us this week and then upcoming we will be joining Matt on his podcast to talk about-

Erin Allmann Updyke Herbalism things, right?

Matt Candeias Yeah. Yeah so there's a lot of, I'll call it mysticism and folklore surrounding herbal remedies and though I'm not a practicing herbalist I know there's merit to some and a lot of misinformation about others. So who better to bring on than some disease ecologists to talk about the wild world of plant medicinals. So looking forward to that.

Erin Welsh Totally in our wheelhouse. Totally.

Erin Allmann Updyke 100% not.

Erin Welsh (laughs) We're gonna try.

Erin Allmann Updyke We'll research it.

Matt Candeias Yeah. We're smart people, right? That's what we have to do.

Erin Allmann Updyke Yeah exactly. That's literally our jobs.

Erin Welsh That's the hope.

Matt Candeias That's the hope, that's the hope. (laughs)

Erin Allmann Updyke So Matt is here because this week, as we said, we're doing something a little bit different. This is part one of a crossover series on poison.

Erin Welsh Ooh!

Erin Allmann Updyke We have at least a four part series, I feel like we could expand it eventually too.

Erin Welsh Yeah totally.

Erin Allmann Updyke But at a minimum we've got a four part series and each week we're gonna talk about a different poisonous plant, its use throughout human history, the effects it actually has on your body, and then the evolutionary ecology of the plant, meaning why does it produce the compounds that make you sick.

Erin Welsh It's gonna be super duper fun.

Erin Allmann Updyke Yeah.

Matt Candeias

I am so pumped. I can't even contain... Like we were messaging back and forth about this and I'm like bumping up and down on my chair, like yes!

Erin Welsh

I know, it was really hard to not go, oh my gosh, guess what I've just learned, you have to know about this, it's so cool. Yeah.

Erin Allmann Updyke

We're very excited.

Matt Candeias

Yeah this allows me to stretch some muscles that I don't ever get to stretch, it's not a wheelhouse I frequent so thanks for being open to this idea.

Erin Allmann Updyke

I love it.

Erin Welsh

We're pumped.

Erin Allmann Updyke

Of course.

Erin Welsh

Okay so because this is an episode of This Podcast Will Kill You, guess what we have?

Erin Allmann Updyke

A quarantini time!

Erin Welsh

Yes. What do we have this week?

Erin Allmann Updyke

This week we're drinking the Wolfsbane Potion because we're talking about what plant?

Erin Welsh

Well, it's a bunch of plants but monkshood essentially, in the genus Aconitum.

Erin Allmann Updyke

Fabulous.

Erin Welsh

Which also contains the plant wolfsbane, right? Or is that a different plant? Was it the same plant?

Erin Allmann Updyke

Plant blindness at work.

Erin Welsh

Yeah.

Matt Candeias

First lesson: common names are kinda of a pain in the a**. A lot of plants can be called the same thing and be called many different things throughout different cultures, and essentially this is in the buttercup family so the best example is a buttercup in the United States is different than a buttercup in England. But when you say 'wolfsbane' you're generally referring to a group of plants in the genus Aconitum or the monkshoods.

Erin Welsh

Okay.

Erin Allmann Updyke

Fabulous.

Erin Welsh

Awesome. So but what is in the Wolfsbane Potion this week is it's basically an Aviation, which if you haven't heard of it it's a really delicious drink. It's purple-

Erin Allmann Updyke	It's beautiful.
Matt Candeias	It's beautiful.
Erin Allmann Updyke	Jinx!
Matt Candeias	Jinx!
Erin Welsh	(laughs)
Matt Candeias	I just thought we could nail the jinx too but wishful thinking, yeah.
Erin Allmann Updyke	(laughs) We came really close.
Erin Welsh	Yeah and so we'll post the recipe and all that online along with some cool pictures, so.
Erin Allmann Updyke	Well cheers.
Erin Welsh	Cheers, cheers.
Matt Candeias	Cheers. Clink clink.
Erin Allmann Updyke	Clink.
Erin Welsh	That was an okay sound, it wasn't quite crystal but, you know.
Erin Allmann Updyke	(laughs)
TPWKY	(transition theme)
Erin Welsh	Now that that's out of the way.
Erin Allmann Updyke	Yep.
Erin Welsh	Intro is over.
Matt Candeias	Yeah.
Erin Welsh	I'll get started. So since we're doing a four-parter on this topic, I figured I would kind of split the history of poisons into four parts. So ancient, middle ages, victorian, and modern. I don't know if that's going to be how it ends up being, the boundaries are a little bit fluid. But in any case this week I'll be talking about the ancient history of poisons, so who first decided to use them, how were they used, what was their reputation, and then I'm gonna talk specifically about the history of the chosen poison of the week: wolfsbane aka aconite aka monkshood, etc. Turns out this beauty is not just the name of the werewolf preventative in Harry Potter and our quarantini.
Matt Candeias	(laughs)

Erin Allmann Updyke

(laughs)

Erin Welsh

So what's the difference between a physician, a pretender, a magician, and a poisoner?

Erin Allmann Updyke

Ooh.

Erin Welsh

The answer is that it depends. (laughs) Those lines have always been blurred in the history of medicine and medicinal plants, many of which have a dual nature of healing and harm. And those lines continue to be blurred in modern times, which is something we'll get to talk a lot more about in the herbal medicine crossover episode.

Erin Allmann Updyke

Yeah.

Erin Welsh

But this week we're here to talk about poisons. So poisons have been around for - I thought this was really cool - all of written human history.

Erin Allmann Updyke

Dang, dude.

Matt Candeias

Really?

Erin Welsh

Yeah. And also probably millennia before that.

Matt Candeias

I wouldn't doubt it.

Erin Welsh

Yeah.

Matt Candeias

I mean you gotta respect the fact that there's something there in human nature, you don't just invent writing and then start poisoning people. (laughs)

Erin Welsh

Yeah, exactly. That's the really interesting part because like in order to determine what plants are poisonous, what plants are helpful, what plants are food, it's going to involve a lot of trial and error, a lot of barfing, a lot of numb mouths, hallucinations, and death along the way.

Matt Candeias

And a big plug for rampant diarrhea. There's a lot of rampant diarrhea for this.

Erin Allmann Updyke

I was gonna say!

Erin Welsh

Oh dang, diarrhea. Did I not mention diarrhea. (laughs) Can't believe I didn't talk about poop.

Matt Candeias

To those who came before us.

Erin Allmann Updyke

Thank you.

Erin Welsh

(laughs) Yes, thank you. How is anyone alive is really the big question. Imagine that you're one of those early humans. You can't resort to Google like you can nowadays to tell you everything about a plant, you can't just watch what you eat but you have to remember how it made you feel, and you didn't just rely on firsthand experience for this knowledge. If you saw a cluster of dead birds or foxes or something next to a bush filled with red berries, maybe you'd make a note not to eat those berries.

Matt Candeias (laughs)

Erin Allmann Updyke We would hope.

Erin Welsh Yeah, one would hope. And yeah and then also if a friend told you about a digestive experience after feasting on a new salad creation, maybe you'd ask them to point out which plants they'd used, just like which Taco Bells to avoid. Cause there are good ones and bad ones.

Erin Allmann Updyke The answer is you should avoid them all.

Erin Welsh Yeah, I mean, we're weak.

Matt Candeias Yes. I'm only human.

Erin Welsh And before written language, this knowledge couldn't be stored in physical form, it had to be disseminated in a much different way through storytelling from one village to another, from one generation to the next. And slowly this knowledge spread. But one person's knowledge is another person's weapon, and it wouldn't have been long before someone would have snuck some parsley-looking hemlock into their rival's side salad. The first written records we have of a use of poisons comes from just a little bit after writing itself was thought to be invented, so around 5000 years ago.

Erin Allmann Updyke Wow.

Matt Candeias Ooh.

Erin Welsh And we see around that time descriptions of poisonous and medicinal plants pop up all over around the same time, which is kind of weird, in Egyptian papyri, Chinese and Indian texts, and Mesopotamian clay tablets.

Matt Candeias I mean is it weird or is it just humans were doing that and then they lumped it right now, they're like, 'Well we might as well write this down.'

Erin Allmann Updyke Right.

Erin Welsh Well and what's more important than like we need to eat every day a certain amount, we need to eat the things that we collect-

Erin Allmann Updyke And this is how you kill your enemies!

Erin Welsh Well and this is how you cure your wounds.

Matt Candeias I mean hey, we live in a valley, there's two families and enough food to support one of them.

Erin Allmann Updyke Yeah.

Erin Welsh (laughs) Wow, you guys are going straight to the 'how to poison someone' section of that tablet.

Matt Candeias Sorry. (laughs)

Erin Allmann Updyke

Yeah, that's where our heads are.

Erin Welsh

Yeah so also poisons featured prominently in Greek and Roman mythology where it seems like the reputation of poison as a woman's weapon had taken hold, which is really fun.

Erin Allmann Updyke

Ooh.

Erin Welsh

So Deianira, the second wife of Heracles aka Hercules, killed him with a poisoned shirt for being unfaithful to her.

Erin Allmann Updyke

Deserved it.

Matt Candeias

You go girl.

Erin Welsh

(laughs) Yeah, file that under stuff Disney left out of the movie along with the fact that Hercules, driven mad by Hera - I love like 'Disney did not tell you' - Hercules killed his first wife and children.

Matt Candeias

As you do.

Erin Welsh

We'll get to that later. Anyway, sidenote, Hercules' second wife, the one who killed him, her name Deianira means 'man-destroyer' or 'destroyer of her husband'.

Erin Allmann Updyke

Oh my god, okay, if I ever have kids, that's their name. (laughs)

Erin Welsh

Also in the Odyssey, Circe - which, you know, she's gotta be evil, right?

Erin Allmann Updyke

Yeah, we know everything about her already.

Erin Welsh

A goddess of magic uses mind-altering drugs to turn all of Odysseus' men into pigs, although to what end I have no idea.

Erin Allmann Updyke

Just for fun, I would assume.

Erin Welsh

For fun? Bacon? I don't know. It's really weird though, yeah, I couldn't find a reason for that. But jumping from myth into history, we see poisons play a huge role in the legal and political system of Ancient Rome, which isn't as boring as it may sound. Poisons were widely used to carry out death sentences and that's what happened with the famous philosopher Socrates. So he was convicted of moral corruption and impiety and he was ordered to drink a hemlock infusion.

Erin Allmann Updyke

What?

Erin Welsh

There are some great paintings of this. There's one where he's like angrily in a bath sheet or a toga I assume-

Matt Candeias

Same difference.

Erin Welsh

(laughs) I mean my experience with togas is frat party only, so.

Erin Allmann Updyke

Yeah.

Erin Welsh

It's gotta be a bath sheet. Yeah so I'll post some of those paintings cause they're really fun.

Erin Allmann Updyke

That's amazing.

Erin Welsh

But from this time, which was around 399 BC, around that exact date. (laughs)

Matt Candeias

Give or take.

Erin Welsh

Poisons seemed to become increasingly popular in Ancient Rome. The Hippocratic Oath, Erin I'm looking at you-

Erin Allmann Updyke

(gasps) I'll take that some day.

Erin Welsh

-written around then includes the phrase: "Neither will I administer a poison to anybody when asked to do so, nor will I suggest such a course."

Erin Allmann Updyke

Interesting.

Erin Welsh

It's pretty clear that poisoning was a problem in physicians as well.

Erin Allmann Updyke

Yes. Big time.

Matt Candeias

But even then, it goes back to what you originally said about blurred lines, I mean.

Erin Allmann Updyke

Right. How do you define... I mean chemotherapy, it's pretty poisonous but doctors do that-

Matt Candeias

Poison's in the dose. Yeah I mean most of the pills we take...

Erin Welsh

Is it dose? Is it intent? What defines a poison, really?

Erin Allmann Updyke

Ooh, this is philosophy questions.

Erin Welsh

I mean too bad Socrates was killed.

Erin Allmann Updyke

By a poison!

Matt Candeias

Fitting though.

Erin Welsh

Galen, who was another famous Greek physician and scholar, instructed doctors to collect herbs and prepare potions themselves rather than buying them at the market where one plant could be sold under the wrong name, leading to a deadly quote "mistake".

Erin Allmann Updyke

Yeah.

Erin Welsh

And to protect themselves also, the wealthy hired tasters, which is one of the odder status symbols I've heard of.

Erin Allmann Updyke

Like to taste their food, right?

Erin Welsh

Yes. So it became such a popular practice that there grew to be an official society of tasters. I don't know what you would gain...

Matt Candeias

We demand rights!

Erin Welsh

(laughs) Yeah.

Erin Allmann Updyke

Did they unionize?

Erin Welsh

If they did, awesome. Did they protect your family if you died? That'd be great.

Erin Allmann Updyke

Ooh, good question.

Erin Welsh

I don't know.

Matt Candeias

Which, to be honest, you're gonna die.

Erin Welsh

You're going to die.

Erin Allmann Updyke

Yeah as a taster you've signed up for that.

Matt Candeias

Yeah you know that job is going to kill you.

Erin Welsh

Well but the thing is having a taster wouldn't have done much good probably because if you were going to poison someone, you wouldn't choose a fast-acting poison because that would be very obvious, particularly if someone had a taster. And you would also probably be more accumulative poison.

Erin Allmann Updyke

Well you could do a fast-acting poison as long as no one knew it was you that put it in the food.

Erin Welsh

Right but the thing is if your intent was to kill your target and that person had a taster...

Erin Allmann Updyke

Yeah, yeah, you're right. If they had a taster.

Erin Welsh

Then they wouldn't have a delay because that person's gonna be way too hungry, I mean come on.

Matt Candeias

That's poisoning 101. If your poison subject has a taster...

Erin Welsh

We're not telling you how to poison someone.

Erin Allmann Updyke

But we're just telling you-

Matt Candeias

If you needed to.

Erin Welsh: We're talking hypotheticals here, everyone. So anyway, poisonings happened frequently and as per usual the law had to catch up with the popular trends. Eventually cultivating certain poisonous plants became a capital offense - really, a capital offense - and entire legal institutions were responsible for dishing out punishments for poisoners.

Matt Candeias: As a gardener, that upsets me.

Erin Welsh: (laughs) Why? Oh, the cultivation part.

Matt Candeias: Yeah the cultivation side of it. I don't wanna get arrested. Well I guess there still are plants I could get arrested for having in my garden. But no one should come after my monkshood. Don't tread on my monkshood.

Erin Allmann Updyke: (laughs) Don't tread on my monkshood! Oh, that's funny.

Erin Welsh: So yeah, these entire legal institutions were responsible for dishing out punishments for poisoners and those punishments weren't far from the crime itself. At one point in 331 BC, a whole slew of women, 170 actually-

Erin Allmann Updyke: Whoa.

Matt Candeias: Is that the unit of a slew? 170 women is one slew. Sorry, I'm so sorry.

Erin Welsh: It's like three pecks. (laughs)

Matt Candeias: And a bushel?

Erin Welsh: No, 1.5 bushels. (laughs) Anyway, these poor slew were accused, tried, and convicted of mass poisoning of men, husbands, lovers, people who stood in their way, etc. And during the trial, some were told to drink their prepared potions as proof of innocence. As I've said, there's a fine line between poison and medicine with dosage as one of the deciding factors, and all the women died.

Matt Candeias: Woops.

Erin Welsh: Or were put to death, yeah.

Erin Allmann Updyke: Wow.

Erin Welsh: So though poisons continued to be used in battle whether through poison-tipped arrows or intentionally contaminating water supplies, which did happen multiple times, they maintained their reputation as a woman's choice for murder. In fact the star of today's episode, aconite, was referred to as 'stepmother's poison' or 'the mother-in-law's poison'. So poison has this reputation for being a woman's weapon, right? And some women leaned into this, making lives for themselves as professional poisoners.

Matt Candeias: She's a witch!

Erin Welsh: Or poison consultants.

Erin Allmann Updyke: Ooh! That's a good business card name.

Matt Candeias

Oh my god.

Erin Welsh

Oh yeah, it's great. So Locusta - I don't know if that's how you say her name - was a former slave turned consultant for Nero, Roman Emperor Nero, later emperor, who was so thirsty for the emperor position. Seriously. And so she helped him kill the current emperor, Claudius' son, and then helped Claudius' wife to kill Claudius himself, clearing the path for Nero. And with the fall of the Roman Empire, the field of poisoning, toxicology, and medicinal plants both in research and in practice seemed to retreat to the shadows in that part of the world. But it would continue to be built upon and much expanded by physicians and scientists like Avicenna in the Islamic Golden Age. Okay, all right. So early history of poisons, check. We're done. But where does aconite fit into all this?

Erin Allmann Updyke

Yeah.

Erin Welsh

Well to answer that we're gonna dive back into some mythology briefly. Are you ready for this?

Erin Allmann Updyke

Always.

Matt Candeias

Yes.

Erin Welsh

All right. Let's take a trip back to the summer before 10th grade.

Matt Candeias

I don't wanna do this.

Erin Allmann Updyke

Like your 10th grade?

Erin Welsh

My 10th grade.

Erin Allmann Updyke

Okay.

Erin Welsh

So in between doing really cool, hip things-

Matt Candeias

I'm sure.

Erin Welsh

Like rereading Harry Potter 1-5, I worked on my summer assignment, Edith Hamilton's Mythology. So Edith Hamilton's Mythology and Harry Potter is where my love for Harry Potter met my love for trivia and origin stories.

Matt Candeias

You do love those things.

Erin Welsh

I do, I do.

Matt Candeias

Every movie I've ever watched with this Erin usually has a segment for trivia somewhere between halfway through and the end of the movie.

Erin Allmann Updyke

(laughs) It's why we love her.

Erin Welsh: All right, so basically when I read Edith Hamilton I learned about Cerberus who was the three-headed dog that guarded the entrance to the underworld and served as inspiration for... Erin, can you tell me?

Erin Allmann Updyke: Fluffy!

Erin Welsh: Yeah, you got it, girl! Fluffy was...?

Erin Allmann Updyke: The dog that guarded the place where they kept the philosopher's stone, the sorcerer's stone.

Erin Welsh: Yeah at least somewhere along that pathway.

Erin Allmann Updyke: Yep, exactly.

Erin Welsh: You got it. Anyway, so I was really excited to see that crossover there. (laughs) Okay so it turns out that Hercules, remember I told you that we were gonna circle back to this.

Erin Allmann Updyke: Right.

Erin Welsh: In order to repent for killing his wife and kids-

Erin Allmann Updyke: The first time.

Matt Candeias: As you should.

Erin Welsh: The first time, his first wife and his five kids, I think five.

Erin Allmann Updyke: Whoa!

Erin Welsh: Oh yeah. What, it was okay if he killed two?

Erin Allmann Updyke: I don't know! (laughs) Five just seems extreme, doesn't it? Wow.

Erin Welsh: He was crazy by Hera, who knows. Yeah. Well in order to repent for this he had to perform various feats of strength including capturing Cerberus and bringing him to the surface. While he was up there, Cerberus got all foamy-mouthed because he wasn't used to sunlight. Rabies? Sound like rabies to you?

Erin Allmann Updyke: Season 2!

Matt Candeias: Is he afraid of water?

Erin Welsh: Season 2!

Erin Allmann Updyke: Spoilers.

Matt Candeias: (whispers) You're doing a rabies episode?

Erin Allmann Updyke: Yeah it's gonna be our first episode of Season 2, everybody! Get excited.

Erin Welsh: Yep. In any case, Cerberus' spit flew everywhere and where it landed, aconite grew. And from these humble beginnings, aconite gained a reputation as one of the deadliest poisons in ancient times. Seriously forking deadly.

Erin Allmann Updyke: Wow, yeah.

Erin Welsh: Hecate, goddess of witchcraft and also in Shakespeare's Macbeth, one of the witches, discovered its use as a poison and Greek shepherds would smear aconite juice on arrows or mix the plant with raw meat to protect their sheep from wolves, hence the name wolfsbane.

Erin Allmann Updyke: Ooh! So they would put it on so that the wolves would die.

Erin Welsh: They would mix it with, yeah.

Erin Allmann Updyke: Interesting.

Erin Welsh: So what I learned in some of this reading about ancient poisons is that anything with 'wood' after it, if it was wormwood, used to treat worms; henbane, wolfsbane, you are trying to kill whatever.

Erin Allmann Updyke: Oh! The think you name it.

Matt Candeias: Yeah, the bane of your existence.

Erin Allmann Updyke: So what is monkshood? You're trying to kill monks?

Erin Welsh: No, no, no.

Matt Candeias: No, monkshood is just the shape of the flower, which we'll get into, which we'll get into.

Erin Allmann Updyke: Ah, see I haven't looked at any pictures yet, so.

Matt Candeias: I'm so excited.

Erin Welsh: Yeah. Other species in the aconite genus have been used to poison arrows in Japan, in the Himalayas, in China, and in Alaska. So all over, basically. On one Greek island, aconite was put in the drinks of old men when they were quote, "no longer of use to the community." Early references to aconite emphasize its extremely potent nature. If you were going to use aconite, you should be wearing protective clothing while gardening and avoid breathing in any of the aconite powder during preparation.

Erin Allmann Updyke: Wow!

Matt Candeias: Yeah.

Erin Welsh: Preparations for poisons, apparently.

Erin Allmann Updyke: Well of course.

Matt Candeias: Warnings that continue till this day.

Erin Welsh Yes, oh, absolutely.

Erin Allmann Updyke Wow, I can't wait to hear more about the plant itself.

Erin Welsh Oh yeah, okay. I'll get to it then, Erin. Excuse me!

Erin Allmann Updyke (laughs) That was just... I'm excited.

Matt Candeias We're all excited.

Erin Welsh Okay, okay. Yeah we are. The smell of the plant alone was thought to be strong enough to cause illness or death.

Erin Allmann Updyke Whoa!

Erin Welsh Somewhere along the way though, the language around aconite changed. It turned from poison to medicine. 'You name it, aconite will treat it' seemed to be the motto. And that happened around the mid 1700s. It was prescribed by many doctors when a good sweat was needed. This was back when the ancient concept of various bodily humors still held sway in the medical field. Oddly enough, aconite didn't prove to be a particularly reliable or safe treatment and gradually fell out of favor in the medical community after the treatment didn't agree with one too many patients.

Matt Candeias And by 'agree' we mean like it killed one too many patients. (laughs)

Erin Welsh Thank you. Exactly, exactly. But that didn't mark the end for aconite. Where it initially failed to gain support in the orthodox medical community, it found in homeopathy. Under the concept of like cures like, drugs such as aconite were used to treat diseases which had similar symptoms. Aconite was used for acute diseases, especially those characterized by fever and pain. It gained a reputation as a substitute for bloodletting, probably it's trading one evil for another.

Matt Candeias Drain my blood or poison me.

Erin Welsh Right.

Matt Candeias Party time.

Erin Welsh Which in these times, people were always looking for an excuse to bloodlet. Apparently aconite worked best on fearful, nervous patients and it was used to calm women down during nasty periods.

Erin Allmann Updyke Oh I'm about to rage.

Matt Candeias Death is the ultimate calm.

Erin Welsh Are you on your period? You might need some aconite.

Erin Allmann Updyke Maybe I need some aconite to calm myself down during my rageful period.

Matt Candeias: She's raging, better kill her.

Erin Allmann Updyke: Yeah, I'm raging.

Erin Welsh: I should mention though that the actual amount of aconite in many of these remedies was so teeny tiny small that it was negligible.

Erin Allmann Updyke: Right.

Erin Welsh: Homeopaths were publishing on aconite left and right. And around the mid 1800s, orthodox physicians started paying attention, which is kind of interesting. Aconite in certain carefully measured doses seemed to be effective as a neural suppressant, meaning a drug that inhibits activity of parts of the nervous system, particularly in controlling inflammation. Don't worry, I'm not gonna step on your toes.

Erin Allmann Updyke: Don't worry, I'll talk so much more about it.

Erin Welsh: Wonderful.

Erin Allmann Updyke: (laughs)

Erin Welsh: I might dabble in that as well.

Erin Allmann Updyke: Oh perfect, I love it!

Erin Welsh: But when it was found to actually have these effects it became all the rage. So throughout the 1800s and into the early 1900s, aconite or aconite mixed with other things like chloroform and belladonna-

Erin Allmann Updyke: Oh, good lord.

Erin Welsh: Yep. Was used as a painkiller or to treat infection, lung conditions, nerve pain, and so on.

Erin Allmann Updyke: Wow.

Erin Welsh: The adoption of aconite by orthodox physicians from homeopathy was also a big deal. But we're still talking about a poison here and just because something alters your physiology in a way that does not kill or maim does not make it good for you.

Erin Allmann Updyke: Word.

Matt Candeias: Yeah.

Erin Welsh: And so we circle back to the question I posed at the beginning of this: what is the difference between a physician and a pretender, a magician and a poisoner?

Erin Allmann Updyke: Ooh, yeah.

Erin Welsh: The answer lies somewhere between ignorance and intent.

Matt Candeias Oof.

Erin Welsh So Erin, tell us what exactly does aconite do that makes it a poison?

TPWKY (transition theme)

Erin Allmann Updyke All right, let me tell you about wolfsbane.

Matt Candeias Wolfsbane.

Erin Allmann Updyke Monkshood.

Matt Candeias Monkshood.

Erin Allmann Updyke Etc.

Matt Candeias Etc.

Erin Allmann Updyke All right. (laughs) So.

Matt Candeias Is there an echo in the room?

Erin Allmann Updyke Yeah. These plants, cause we know there's multiples.

Matt Candeias Yes.

Erin Allmann Updyke Contain a compound called aconitine. This is the compound that actually makes you sick. And later, in just a few minutes cause I'ma be quick.

Matt Candeias (laughs) I'ma be quick.

Erin Allmann Updyke Matt is going tell you about why these plants actually contain this compound to begin with. Like what's the point of having something that kills people in you as a plant tissue.

Erin Welsh Which is a really fun question.

Matt Candeias I have so much to say, I have so much to say.

Erin Allmann Updyke I can't wait to hear about it. But first let me tell you, so that I have a point to being here, what actually happens to your body when you ingest this plant, like what is actually making you sick.

Matt Candeias I'm gonna go out on a limb and say it's not pleasant.

Erin Allmann Updyke It's not at all. Okay so aconitine affects a bunch of different parts of your body but the effects that are most important are what it has on both your heart tissue and your nervous system. But the effects are pretty widespread. So it can affect your GI tract, your nervous system, your heart. It has a pretty widespread effect. So what actually happens when you take a bite of wolfsbane, for example? Of you take a pill that someone gave you that's like full of it.

Matt Candeias Or you take a wee little sip.

Erin Allmann Updyke Just a sip of a tincture or something, right. Within a really short amount of time, like as little as 10 minutes or maximum like 2 hours-

Matt Candeias Whoa. Really?

Erin Allmann Updyke Right. It's really fast-acting. You'll start to see symptoms that include numbness in your face or limbs, paresthesia which is a fancy word for you feel a tingling or a burning sensation.

Matt Candeias Could be fun.

Erin Allmann Updyke Could be, until it's not. (laughs) You might have some muscle weakness, you'll become hypotensive, which means your blood pressure drops really low.

Erin Welsh Uh oh, that's not good.

Erin Allmann Updyke It's never good. And then your heart - and this is important - it might begin to race really fast or it might slow way, way, way down.

Matt Candeias I don't like that.

Erin Allmann Updyke It could go either way.

Erin Welsh It could go either way?

Erin Allmann Updyke It could go either way.

Matt Candeias And that's the scariest thing to be confused about whether or not you've been poisoned.

Erin Allmann Updyke We'll talk a lot about it, don't worry.

Erin Welsh What, you flip a coin?

Erin Allmann Updyke You flip a coin, yeah.

Erin Welsh No, no.

Erin Allmann Updyke We'll talk about why, don't worry.

Erin Welsh This is why I don't wild forage.

Erin Allmann Updyke It's a good reason not to. And then on top of that you might also have things like nausea, vomiting, diarrhea, of course.

Matt Candeias You sound like a Pepto-Bismol commercial.

Erin Welsh I was gonna say!

Erin Allmann Updyke (singing) Nausea, heartburn, indigestion, upset stomach, diarrhea. Yep, all of that.

Erin Welsh Hey, Pepto-Bismol!

Erin Allmann Updyke (laughs) All of that. If you manage to get to a hospital and you don't die-

Matt Candeias I love 'manage'.

Erin Allmann Updyke If it's possible and you get to a hospital, the good news is that within 24 hours, you'll probably be fine.

Matt Candeias Really?

Erin Allmann Updyke Because this is very fast-acting but it's also a pretty quick recovery.

Erin Welsh So it has a very short half-life in your body.

Erin Allmann Updyke Exactly, right.

Matt Candeias So quick in, quick out.

Erin Allmann Updyke Your body digests it very quickly.

Erin Welsh Okay.

Erin Allmann Updyke And I didn't look up enough detail probably about the actual mortality rate, but at least in this article that I found, even in hospital cases the mortality rate is over 5%. So even if you managed to get to the hospital and get treatment, you still have an over 5% chance of dying.

Erin Welsh Well so that's really interesting because that mortality rate would have to do with modern cases, so either intentional poisoning or I ate way too much of this really weird thing.

Matt Candeias Which happens, which happens.

Erin Welsh Right?

Erin Allmann Updyke This is also a very common thing that's used in a lot of herbal remedies.

Erin Welsh Okay good, I was going to ask you about the current status of aconite... Yeah, okay.

Erin Allmann Updyke Yeah. So it is definitely a thing and there's a lot of information out there on what people tend to do to treat this, either the leaves or the roots that they're using, in order to make it less toxic but still have-

Matt Candeias (laughs) Less toxic.

Erin Allmann Updyke Yes, exactly. I think you'll probably talk more about that.

Matt Candeias: Yeah and the fact that this is a crossover, this is a subject we'll be covering probably a little bit more in depth on mine.

Erin Allmann Updyke: Next week. Exactly. But yeah so it is still very commonly used in a lot of sort of traditional medicine type things.

Erin Welsh: Okay.

Erin Allmann Updyke: Here's the question though: how on earth can just eating a plant cause so many different symptoms? Everything from numbness or muscle weakness to the general cause of death is actually heart failure. Your heart just fully stops, it can't handle it, it gives out.

Matt Candeias: Wow.

Erin Welsh: That's terrifying.

Erin Allmann Updyke: So how can a plant actually cause something that a lot of these symptoms, nausea, muscle weakness, these seem very disparate, right?

Matt Candeias: Right, different systems.

Erin Allmann Updyke: Right! So the question is what on earth is happening?

Erin Welsh: Are you gonna tell us?

Erin Allmann Updyke: Let me tell ya.

Matt Candeias: I'd love it if she didn't.

Erin Welsh: (laughs)

Erin Allmann Updyke: (laughs) I'm just like go ahead and google it. Here's what happens. The major compound that's in these plants, aconitine, attacks your sodium channels. Bom-bom-bom! Here's what you need to know to understand how this compound aconitine actually affects your system. Number one. You all know, hopefully, that your nervous system is generally in charge of your body, right? It sends signals to different parts of your body that say things like 'contract this muscle' or 'release this hormone' etc.

Matt Candeias: Or 'go to the bathroom, now!'

Erin Allmann Updyke: Exactly, yeah. (laughs)

Erin Welsh: That's what it's telling you.

Erin Allmann Updyke: So the way that it sends these signals is by moving ions, which just means a charged molecule, across membranes. Okay? Sodium, which is a positive ion, is one of the most important things involved in sending these signals. So sodium tends to be really high in concentration outside of cells and lower inside of cells. With me so far?

Matt Candeias: Sure.

Erin Allmann Updyke

Great. So the other ion that's important is potassium. Potassium is higher inside of cells and lower outside of cells.

Erin Welsh

The opposite of sodium.

Erin Allmann Updyke

Exactly. Sodium outside, potassium inside. And overall the insides of your cells are negatively charged compared to the outside of your cells.

Matt Candeias

I did not know that.

Erin Allmann Updyke

There we go, we're learning new things.

Matt Candeias

That's why I love you two.

Erin Welsh

(laughs)

Erin Allmann Updyke

(laughs) All right so ions, these charged molecules, cannot cross your cellular membranes because they're charged. And your cell membranes are basically fat globules, okay.

Matt Candeias

(laughs) More than my cell membranes. My fat globules, that is.

Erin Allmann Updyke

(laughs) So these charged molecules can't cross the fat, they don't like each other, okay. So the way that they cross is by channels which are like doors that open and close and allow these ions to cross this membrane. With me?

Matt Candeias

Totally.

Erin Allmann Updyke

Excellent. The way that your nervous system actually sends these signals to tell everything else in your body what to do is by propagating what we call action potentials, which basically just means that they open a channel and it's a channel that is specific to sodium, which we know is at high concentrations outside of your cell. And then a bunch of sodium rushes into the cell and then they close that channel and they're like, 'Okay, now we've got a bunch of sodium inside of the cell.' And then they open another channel and they're like, 'Potassium, it's your turn!' And potassium rushes out of the cell. Okay?

Erin Welsh

Okay.

Erin Allmann Updyke

So that is how they propagate these signals.

Erin Welsh

So that's how it transfers down.

Erin Allmann Updyke

Exactly. So you for example, you touch something that's hot, right? And your skin feels that and it's like, 'This thing is hot.' So then that sends a signal that says, 'Sodium, go!' And then your sodium channels open, sodium rushes into your cells, those doors close, and then they open ones that say, 'Potassium, it's your turn.' Potassium rushes out, etc. you can google some really great YouTube videos of this.

Matt Candeias

But essentially what your saying is this is holding to the whole universal constant of things move from high to low concentrations.

Erin Allmann Updyke

Precisely, Matt.

Matt Candeias

(sighs) I did something I don't regret.

Erin Welsh

(laughs) And so this means that if you touch that hot stove, that action potential or that whole sequence of events is telling you or is allowing you to move. Or telling you to move?

Erin Allmann Updyke

Right, so it tells your nervous system something bad is happening here. That action potential travels all the way down your nerve to your brain which goes, 'Something bad is happening.' It travels all the way back to your muscles which go, 'Move,' and then you move.

Erin Welsh

So it's like a two parallel domino system going in the opposite direction. Okay.

Erin Allmann Updyke

Exactly. Right. And it happens instantaneously, right. So these sodium channels have to be able to open and close extremely rapidly for these signals to be able to propagate so that you can do literally anything. Right?

Erin Welsh

Okay.

Erin Allmann Updyke

So sodium channels are really, really important in you literally being able to survive.

Matt Candeias

Being a living thing.

Erin Allmann Updyke

Right. So what's the point of me telling you all this? Why did I just give you like an intro to physiology?

Matt Candeias

I have my suspicions.

Erin Allmann Updyke

As it turns out, aconitine, the compound that's in monkshood, wolfsbane, etc-

Matt Candeias

All of the above.

Erin Allmann Updyke

-binds to sodium channels and it forces them to stay open.

Matt Candeias

No!

Erin Welsh

Oh, that's not good.

Erin Allmann Updyke

It's not good. So what happens is you end up with a huge influx of sodium that comes into the cell but then you can't close that channel in order to continue to propagate the signal, right.

Erin Welsh

Okay.

Erin Allmann Updyke

So that means that anytime you get a future signal, you can't react to it because your sodium channels are already open.

Erin Welsh

Hmm.

Matt Candeias

Hmm.

Erin Allmann Updyke: That was such a good reaction, wow.

Erin Welsh: Understanding is dawning upon us.

Erin Allmann Updyke: (laughs) Okay so what does this mean in real life? So you take a big bite of wolfsbane and you're chewing on it and now your sodium channels are open.

Erin Welsh: That's a nightmare scenario.

Erin Allmann Updyke: It's a nightmare. What's happening? In your nervous system, you're not getting any new signals being past, you have this one giant influx of sodium and then that's it, you can't make any new signals because your sodium channels are stuck in the open position. They can't basically reset themselves which they have to do to be able to detect a new signal.

Matt Candeias: So it's like you're trying to get a call but every time you pick up the phone someone's just screaming and you can't hear what's happening.

Erin Allmann Updyke: Yeah. Or like back in the old days when there was like a busy signal cause someone left your phone off the hook, it's like that.

Matt Candeias: Yeah, I remember that.

Erin Welsh: Old days.

Erin Allmann Updyke: The old days, like ten years ago.

Matt Candeias: Like our ancestors ten years ago did.

Erin Allmann Updyke: (laughs) It's just like that. Yep.

Matt Candeias: Yeah.

Erin Allmann Updyke: So that's why you end up with things like numbness or tingling because your nerves are not propagating signals the way that they're supposed to.

Matt Candeias: Hyper firing.

Erin Allmann Updyke: Exactly. Well not really hyper firing, they're not able to pick up any new signals so they're not firing the way they're supposed to.

Matt Candeias: Oh, okay.

Erin Allmann Updyke: But then the question is why is this affecting your heart? Right? Cause like that's weird. Except it's not that weird cause it turns out your heart doesn't actually need any nervous input in order to beat. So you can take a heart out of a human body and it will still beat.

Matt Candeias: I've seen those videos, it's creepy.

Erin Welsh: I've seen that on ER.

Erin Allmann Updyke

You should google it, it's fantastic. And that's because your heart actually generates its own action potentials.

Erin Welsh

Right.

Erin Allmann Updyke

Right, it's very cool. And the way that it does that is a very similar mechanism to your nervous system, it's the same sodium channels etc. so that means-

Erin Welsh

Oh!

Erin Allmann Updyke

Exactly. If you're opening the sodium channels in your nervous system, you're also opening them in your heart cells. And so your heart cells normally all communicate with each other almost simultaneously and that's why your heart beats as if it's one thing. Right?

Matt Candeias

I never knew that.

Erin Allmann Updyke

Yeah it's a bunch of little cells, right, but they communicate with each other so seamlessly that your heart can beat as if it's one thing even though it's these billions of little cells. So when you open a whole bunch of sodium channels, that screws everything up. So you can end up with what we call fibrillations which means your heart is no longer beating in sync with each other, different fibers are firing at different times. It's not good. You also can end up with your heart not being able to beat as effectively because these sodium channels are open so it can't, again just like your nervous system, get a new signal to tell it to beat. Right?

Matt Candeias

Right.

Erin Allmann Updyke

So that would slow your heart rate down.

Matt Candeias

Oh!

Erin Allmann Updyke

Exactly, right.

Matt Candeias

Wow.

Erin Allmann Updyke

On the other hand, though your heart doesn't need nervous input in order to beat, your central nervous system like your brain controls via what's called your vagus nerve how fast your heart beats. So it can tell your heart, if you're scared or something, it'll say, 'Beat a little quicker, this is scary!'

Erin Welsh

Okay.

Erin Allmann Updyke

Or if everything is okay it'll say, 'Just relax, man, beat a little slower.' So that nervous system is impaired and it actually blocks your parasympathetic nervous system which is your rest and digest nervous system. So it blocks the signals that are telling your heart, aconitine specifically, is blocking the part of your nervous system that tells your heart, 'Chill out, everything is fine,' which makes your heart beat faster.

Matt Candeias

Wow. So it's whichever one wins out in that battle.

Erin Allmann Updyke

Exactly!

Matt Candeias: Wow.

Erin Allmann Updyke: Right? So that's why you can have all these various cardiac symptoms. You can have fibrillations, you're heart's not beating in sync; you can have bradycardia, your heart's beating too slowly; you can have tachycardia, your heart's beating too quickly.

Matt Candeias: Sure.

Erin Allmann Updyke: And literally all of this is because of its effect on sodium channels.

Erin Welsh: That's really interesting.

Erin Allmann Updyke: I know!

Erin Welsh: So then if someone, this might be jumping the gun, but like if someone had aconite poisoning, how would you know that it was aconite and not something else?

Erin Allmann Updyke: Great question.

Matt Candeias: Yeah.

Erin Allmann Updyke: Yeah, it's a really great question. And so I will say that from what I've read, I have no... Okay, cause I'm gonna be a future physician, right, I have no idea how you would diagnose this. I wanna ask someone. Does anyone know who like works in an ER? Okay, they've told us so far that one of the most important things you can do as a physician is get a really good history. And I think that this is the type of thing that you would really be able to diagnose based on history. If someone said they ate something weird or they took these pills-

Matt Candeias: Or they're a forager.

Erin Allmann Updyke: Or they're a forager, exactly. So this is the type of thing that it's really important to talk to your patient or talk to a person and get that history from them because yeah, the symptoms are kind of all over the place and they can be so varied. But at the end what you die from is your heart just basically giving out.

Erin Welsh: That's really sad.

Erin Allmann Updyke: I know.

Matt Candeias: And this is why when people say plants are boring, I just want to slap them. Just slap them silly.

Erin Welsh: (laughs)

Erin Allmann Updyke: Yeah, so yeah. That's how it affects your body.

Matt Candeias: That is terrifying. That's terrifying.

TPWKY: (transition theme)

Erin Allmann Updyke

So then the question is why on earth do these plants make this compound to begin with? Like what's the point? Are they just trying to kill people? Do plants hate people, Matt?

Matt Candeias

Yeah they do, that's all it is actually. They, despite being around for many millions of years before we even came onto the scene, they had it out for us. They knew it was coming.

Erin Welsh

Listen Matt, it's all about us. It's all about humans.

Matt Candeias

It is, yeah.

Erin Allmann Updyke

Evolution has a point and is predictive.

Matt Candeias

It's hierarchal, it's directed. No. And that's a really good question and I'm really happy to be here to talk about that because it's something I hold near and dear to my heart. But I think with all this talk about the plants, it would be worth kind of mentioning what these plants are and what they look like.

Erin Allmann Updyke

Yes!

Matt Candeias

And to do that, I think you might have noticed this ginormous, unnecessarily large book I brought. This is called 'The Illustrative Treasury of Cultivated Flowers' by Anderson. Beautiful illustrations and there's a whole section on monkshood or the Aconitum genus. And it's because they are extremely popular to this day as horticultural specimens. I mean I can count four or five houses within a few blocks of where I live that have them prolifically seeding into their gardens. It's still extremely popular. So I figured I would bring this book to show both of you because one of you at least had mentioned you hadn't googled what the plant looked like.

Erin Allmann Updyke

That's me.

Erin Welsh

That's California Erin.

Matt Candeias

But essentially these are perennial plants, so they come back year after year from mountainous regions around the globe. There's about 250 different species of them and they all have these beautiful, what they call palmately compound leaves. So essentially what that means is the stem of the leaf comes up like your wrist and attaches to your hand and if you picture the dissection on these leaves, they're like a hand with just over 20 fingers, it's just a very dissected thing with a single attachment point where your palm would be, essentially. So palmately compound.

Erin Allmann Updyke

Okay, right.

Erin Welsh

Yeah, that makes sense.

Matt Candeias

But the real showstopper about these plants are their flowers, right. So you get these tall spikes, and I mean tall. These plants can come up to about my chin and I'm not a tall person by any means but you know, four or five feet tall is pretty big for an herb.

Erin Welsh

Wow.

Erin Allmann Updyke

That's tall!

Matt Candeias

And some can get taller. But their real selling point is their flowers. And these are gorgeous plants, they are popular for a reason and their flower color ranges from yellows to deep purples but essentially the name 'monkshood' comes from the fact that their petals are highly derived for bee pollination. So kind of setting up the stage for the shape of a bee to come and visit their flowers, and two of the petals come up to the top and form a hood over their reproductive parts. So it kind of looks like a beautiful blue knight wearing a blue hoodie.

Erin Allmann Updyke

(laughs)

Matt Candeias

They're gorgeous plants, right, I mean this is a beautiful picture. This is *Aconitum napellus* but there's plenty of others, like is aid there's about 250 different species of these plants.

Erin Allmann Updyke

Wow!

Matt Candeias

Now it's worth mentioning that they are members of the buttercup family and most of that family, which is *Ranunculaceae*, have a lot of alkaloids, they're known for their alkaloid production. And they're toxic, they're very toxic and for good reason, we'll get to that. But the wolfsbane we've probably been most referring to is *Aconitum lycoctonum* and that one's native to most of Europe and northern Asia. So that's the one that most of white European history would have probably been writing about, but that's not to say that there aren't others. Like I said, this is a genus of 250 give or take species, all of them extremely toxic to humans.

Erin Welsh

Right.

Matt Candeias

There's also within the guise of herbalism wolfsbane, there is *Aconitum chasmanthum*, there's *Aconitum heterophyllum*, and *Aconitum violaceum*. And these are all largely Himalayan in their distribution so India, Pakistan, Nepal, and I think a little bit into Iraq but I could be mistaken about that. And they have been very important in all of those cultures. So you talked a lot about the history but essentially all of the history you gave has been used in various cultures throughout history.

Erin Welsh

Right.

Matt Candeias

So more than one group of humans stumbled onto the fact that you eat these and you're gonna be in tough shape.

Erin Welsh

Oh yeah.

Erin Allmann Updyke

You can kill your enemies.

Matt Candeias

Yeah. And you mentioned aconitine, right, and that's really the one that a lot of people focus on with wolfsbane but it's worth mentioning that they produce lots of alkaloids.

Erin Allmann Updyke

Yeah I didn't even talk about all the various... They all act in similar ways but yeah I didn't even mention all the other names.

Matt Candeias

Yeah. And alkaloids come in many forms but in the context that we're talking about tonight, they're what we call secondary metabolites in plants. And what that means is that these are compounds that plants produce that aren't involved in growth and reproduction.

Erin Allmann Updyke

Oh!

Erin Welsh

Okay.

Matt Candeias: So secondary, yeah.

Erin Allmann Updyke: Right, not necessary.

Erin Welsh: So like what's the purpose of them?

Erin Allmann Updyke: What are they for?

Matt Candeias: Yeah, we're gonna get to that. Secondary compounds are largely defense compounds and there's a lot of different ways a plant can go to defend itself. And you gotta think about it from a plant's perspective, right? They're not animals, they can't run from danger.

Erin Allmann Updyke: Right.

Matt Candeias: Plants are stuck where they are for the most part. There's exceptions to that rule for anyone listening that's a plant person here. We don't need to talk about those. But yeah, if you're stuck in a place and you're a tasty nitrogen-filled plant, things are gonna want to eat you. And you in the plant sense are going to need to defend yourself. And one of the many ways that plants do that are through very toxic chemical compounds, and that's where most of secondary metabolites come in when we talk about the ecology and survival of plant species. They're to either make you so distasteful that nothing wants to eat you or if something makes that mistake, it's the last mistake it ever makes.

Erin Allmann Updyke: (laughs)

Erin Welsh: Very cool, very cool.

Erin Allmann Updyke: Yeah.

Matt Candeias: The thing to keep in mind about alkaloids is that they're nitrogen-rich compounds, so these are usually plants that come from good soils, right. And so Aconitum is largely a plant species in the Northern Hemisphere that's native to temperate areas, mountainous areas, but generally pretty rich soil types.

Erin Allmann Updyke: Okay.

Erin Welsh: Okay.

Matt Candeias: Cause it takes a lot to produce these compounds, right?

Erin Allmann Updyke: Yeah!

Matt Candeias: Evolutionarily speaking, why would you produce them if you didn't have to?

Erin Allmann Updyke: Yeah.

Matt Candeias

And the amount of energy and vital compounds that go into making them kinda bleeds into the fact that they are very necessary for these plants' long-term survival. So the big thing about these plants is that they just simply don't want to be eaten. And that's what's amazing about plant compounds and that's something that humans have used for centuries is the fact that the compounds that they're producing have to be biologically active. And this is why I love your idea of it's all in the dose, right. What's a poison and what's a medicine?

Erin Allmann Updyke

Right.

Matt Candeias

Well how much are you taking and why are you taking it, right? And that's key to this is that these plants don't wanna be eaten. Plants are trying to kill whatever's eating them or at least make them never want to eat it again. And that's where these alkaloids start to come into place. So ecologically, evolutionarily speaking, these are all defense compounds at least in the context of this, there's probably other functions that we don't quite understand yet because again, the science is truly in its infancy in a lot of ways. But it's fascinating to think about what these plants are doing just to keep things from biting off pieces. And that brings up a really good point here is that there's variations in the composition and concentration between species, between individuals within a species, and even between parts of the same plant.

Erin Welsh

Really?

Erin Allmann Updyke

Yeah! That was a big thing I saw when they were talking about people that use this in different remedies was like are you using the root or the stem or the leaves. Does the species variation, does that depend on what organism is the primary consumer of that plant?

Matt Candeias

It can, it very much can.

Erin Welsh

Ooh!

Matt Candeias

So you will often see plants that get into areas where, say islands where there aren't large predators or mammals don't make it to quite easily, you still have to deal with your insect constituency but you see kind of a reduction in a lot of compounds. Because why would you produce something if you didn't have to? These are expensive products to produce for a plant.

Erin Allmann Updyke

Yeah. so why make something that's strong enough to kill a mammal if all you have to kill is like a grasshopper?

Matt Candeias

Right, right.

Erin Allmann Updyke

Which it doesn't take nearly the concentration or whatever to kill a grasshopper as it would a fox.

Erin Welsh

It fits into the whole energy budget. What am I spending my energy on?

Erin Allmann Updyke

Yeah! This is so fun.

Matt Candeias

Yes, I know, I love that the ecology side is coming out right now.

Erin Welsh

Yeah.

Matt Candeias

But exactly, you've hit the nail on the head. And we'll talk about insects and just that evolutionary arms race in which you get around those sorts of things. But again all of these are to deter herbivores to any extent possible.

Erin Allmann Updyke

Yeah.

Matt Candeias

So as far that we know from what we've been able to establish at this point, of the 54 phytochemically investigated species of Aconitum - so essentially that's just saying of the 54 species that we've decided to analyze the chemical composition - they all contain aconitine-like alkaloids which are neurotoxic, as we decided, cardiotoxic, for mammals and insects. And it's important to note that... You talking about sodium channels, right? RAID, our favorite bee spray, also opens up those sodium channels and that's the way in which it works.

Erin Allmann Updyke

These sodium channels are highly conserved across evolutionary taxa.

Matt Candeias

Right. That's a very effective way to kill any sort of living animal.

Erin Allmann Updyke

Yeah, definitely.

Matt Candeias

Or again, make it never want to eat you.

Erin Welsh

Yeah.

Matt Candeias

So the fact that different organs can vary is pretty interesting because the localization of the secondary metabolite says a lot about, from a survival standpoint, what these plants are really trying to protect. So most of the stuff you want to avoid with Aconitum, although I recommend avoiding the whole frickin plant in terms of digestion are the growth tips, so any part that's actively growing, so a leaf bud; the flowers, right, so reproduction is the key to any sort of species.

Erin Allmann Updyke

That make sense.

Matt Candeias

Yeah so you want to protect the parts that do that.

Erin Allmann Updyke

So they should be the most dangerous for herbivores.

Matt Candeias

Yes. And the roots because essentially a plant is nothing without its roots and most of the deaths that I encountered in my trying to avoid encountering them were from people eating the tubers.

Erin Allmann Updyke

Yeah.

Erin Welsh

What's leftover at that point?

Matt Candeias

Stems. Old leaves.

Erin Welsh

So if you are going to use aconite-

Erin Allmann Updyke

Use the stems?

Erin Welsh

Right but also don't use any part of it. Seems like the lesson.

Matt Candeias

Just don't, just don't. If you're gonna use it, think twice and don't.

Erin Allmann Updyke

Second guess yourself.

Erin Welsh (laughs) Okay.

Matt Candeias Right. But that brings up a really interesting point because it's not just herbivores that are interacting with these plants. They're flowering plants, they're an angiosperm, and what do we know about angiosperms?

Erin Allmann Updyke Lots of flying bees and pollinators.

Matt Candeias Pollinators, right?

Erin Welsh Pollinators! Erin got there somehow.

Erin Allmann Updyke He was doing like a wink thing to give us a hint.

Matt Candeias Yeah, cuing you.

Erin Welsh He was flapping his hands. (laughs)

Erin Allmann Updyke Flapping his hands. We got there eventually.

Matt Candeias So when people started looking at the levels of these toxic alkaloids which again, aconitine is just one of them, there's at least ten different very toxic alkaloids to consider when considering this plant, I don't know why we just focus on one of them. Regardless, when people looked at which parts of the plant were producing that it made a lot of sense because the highest levels you see are in the roots. I brought a graph.

Erin Allmann Updyke I saw there's a graph on your notes! (laughs)

Erin Welsh That's amazing.

Matt Candeias Yes, yes. First with the highest concentration are the roots, second is the pollen, third is the flower, so the flower being the sepals and the petals.

Erin Welsh Oh wow.

Erin Allmann Updyke Interesting. Yeah.

Matt Candeias The pollen, which is really interesting because that's a floral reward right. It's xenogamy, you need it to get from one plant to another for sexual reproduction but there's-

Erin Allmann Updyke You've got a ton of it.

Matt Candeias Within reason, yeah. But why would a plant want to protect its pollen when that's the key... You know, something needs to pick that up and take it, usually a bee in this case because it's worth mentioning that most Aconitum are bee pollinated to the point that in Europe at least and in Asia too, there are bees that pollinate nothing else.

Erin Welsh Right.

Erin Allmann Updyke

Oh.

Matt Candeias

Their entire life history overlaps only with the blooming period of that specific monkshood species.

Erin Allmann Updyke

Wow.

Matt Candeias

So this question became why the hell are these plants putting this in their pollen? And why is that second to the root but then beats out the flower and the leaf which are parts you generally assume are pretty important for a plant. Well that brings up a really weird idea of the fact that certain insects start to benefit from these compounds.

Erin Allmann Updyke

Oh! What?

Matt Candeias

Yeah. And this is still largely hypothetical and remains to be tested, but think about it this way: everyone's really familiar with the monarch butterfly. It eats milkweed and part of what it does is that milkweed is full of other alkaloids which we can talk about in a later episode, but they sequester those poisons and all that means is that they're storing them in their tissues and that keeps birds from wanting to eat the caterpillars and the butterflies.

Erin Allmann Updyke

Oh my god this is so exciting.

Matt Candeias

Yes. It's extremely exciting because someone, Gosling and others in 2013 put this idea to the test. And this was a really cool, one of the coolest papers I found in researching this. And it kinda comes down to this idea of attraction vs protection, you want to protect your parts that are really important to you but you also need to attract insect pollinators in this case.

Erin Welsh

Right.

Matt Candeias

So could it be that these bees are collecting the pollen, feeding it to their offspring, and then sequestering at least some of these alkaloids in their tissues? And what they found is that yes. It's happening. They do not know if it's enough to deter potential predators on the bees but this concept of potentially reinforcing the fact that you're bolstering and protecting your flowers but also kind of encouraging your pollinators to keep coming back.

Erin Allmann Updyke

That is so cool.

Matt Candeias

There's enough evidence to suggest that further work should investigate this to a higher degree.

Erin Welsh

That's really cool.

Erin Allmann Updyke

That is really cool.

Erin Welsh

And so just to like recap.

Erin Allmann Updyke

Yeah.

Erin Welsh

So we're talking about these bees being able to take these poisonous things which are poisonous to some many vertebrates-

Erin Allmann Updyke

Other organisms.

Erin Welsh: So many arthropods, so many animals, and use that to also be toxic or poisonous.

Erin Allmann Updyke: So that if something eats them then they're gonna get poisoned by that same poison that the plant made.

Matt Candeias: Exactly.

Erin Allmann Updyke: That's super cool.

Matt Candeias: This is evolution at its best and why I'm in the field that I'm in.

Erin Allmann Updyke: Yeah!

Erin Welsh: That's really exciting.

Matt Candeias: So you get this dual benefit, right. You've got this poison in your very sensitive tissues that are protecting you from generalists, not to say things don't feed on these plants, they do. I came across a list of plenty of butterfly and moth larvae that will feed on these plants, specialization goes both ways, right. (laughs)

Erin Allmann Updyke: Yeah, yeah.

Matt Candeias: But it reduces the amount of animals that could potentially feed on you but then this also added benefit of adding to reproductive fitness by kind of helping out your so-called symbiont in this case.

Erin Allmann Updyke: Yeah, that is so awesome.

Matt Candeias: These are really neat plants and I'm so happy these are the ones that we're covering. And that's not to say that the species we mentioned are the only ones here that we're considering. I mean, Aconitum is a Northern Hemisphere species, we have them in North America, unfortunately a lot of ours are endangered.

Erin Welsh: Why are they endangered?

Matt Candeias: The ones in North America are largely due to habitat loss, I mean that the number one reduction of any species on this planet, it's the one thing we should be fighting is just gobbling up habitat to preserve instead of to build malls on it. But so the IUCN Red List which is the International Union of Conservation of Nature lists at least a handful of Aconitum species as critically or at least endangered on one level or another.

Erin Allmann Updyke: Whoa.

Matt Candeias: So a lot of them are the ones that are native to the Himalayan region of India, Pakistan, and Nepal. And what ends up happening there is this is where a lot of the contention with herbalism practice comes from, right. So I'm not trying to crap on anyone's culture, that's not what I'm doing here, I'm simply stating the facts that a lot of these species are important to cultural practices. But any plants that become very popular or very important in those cultures are obviously sought after, right? So the IUCN Red List, all of the species of Aconitum that they listed are endangered because of over-harvesting for these medicinal practices.

Erin Allmann Updyke Oh wow. So it's not like they're growing their own to be harvested, they're going out in the wild and harvesting.

Matt Candeias Yes and that's the sad fact about at least western herbalism is the fact that they value naturally sourced product over product that has been grown horticulturally or at least in an agricultural setting.

Erin Allmann Updyke Wow.

Matt Candeias Which is very counterintuitive.

Erin Allmann Updyke Yeah!

Matt Candeias Because one thing is that despite the fact these plants are producing these compounds, the fact that natural selection is what it is an you're not going to have the same pressures everywhere, these compounds are not always in the same doses.

Erin Allmann Updyke Concentrations, yeah.

Matt Candeias So what ends up happening is like we mentioned, not all parts of the plant are as equally toxic and if you want to get the most potent, generally that means harvesting the root. So all of these plants are taken roots and all. There's no regenerative capabilities ones you've harvested the root of a plant. So that's why a lot of these end up being put on the endangered species list is because you've harvested every chance this plant has of coming back. And that's to me kind of tragic.

Erin Welsh I mean it seems like one of the things that we keep coming back to in this podcast is the impact of urbanization. And so like that in a vacuum, over-harvesting cannot be possible without the habitat reduction at the same time.

Erin Allmann Updyke Yeah. That's a really good point.

Erin Welsh And so it's a one-two punch where we have these urban communities spreading into areas and we have a lack of conservation which in so many cases it's not financially feasible to conserve these areas.

Matt Candeias Yes, very true.

Erin Allmann Updyke Right.

Erin Welsh So this is almost an inevitable factor of urbanization.

Erin Allmann Updyke Yeah.

Matt Candeias
The question then becomes A) is this an effective way of treating and is there educational ways of getting past that. But then as you mentioned and I'm really happy you did is this idea of diminishing returns. And that is where my contention with a lot of the foraging community comes from. It would be awesome if everyone could adopt foraging practices if we have enough land to support that. But unfortunately this largely becomes a practice of people that are comfortable in areas where there isn't a lot of natural areas left. So as our natural areas shrink and people take up this practice and go into the forest and treat it like the bulk bin at your grocery store, this is something we're gonna see time and time again and it's really important to mention that you do not have to take very last individual of a species to doom it to extinction.

Erin Allmann Updyke
Yeah.

Erin Welsh
You can reduce its genetic diversity or its population numbers to levels in which they're just gonna stagnate and die anyway, and that's the fear with a lot of these medicinal plants.

Erin Allmann Updyke
Ooh, that was fun!

Matt Candeias
Yeah, that was.

Erin Welsh
Yeah this was a really fun...

Erin Allmann Updyke
I learned a crap ton including what monkshood actually looks like. (laughs)

Matt Candeias
Y'all blew my mind. (laughs) Again, once next fall comes around I will happily show you all the monkshood in our neighborhood.

Erin Allmann Updyke
That would be so fun.

Matt Candeias
Hood in the hood.

Erin Allmann Updyke
Hood in the hood!

Erin Welsh
Ooh, spooky time!

TPWKY
(transition theme)

Matt Candeias
Well I learned a ton.

Erin Allmann Updyke
Me too!

Erin Welsh
Yeah.

Matt Candeias
Thank you for letting me exercise a set of muscles that I don't generally get to exercise, this has been a blast.

Erin Welsh
This was really great.

Erin Allmann Updyke
Super fun blast.

Matt Candeias
It lived up to all of the expectations I had.

Erin Welsh	Yes, absolutely.
Erin Allmann Updyke	And we have multiple more episodes left.
Erin Welsh	Yeah we have more coming to you. So I guess...
Erin Allmann Updyke	Is that all we have?
Erin Welsh	I think so.
Erin Allmann Updyke	We don't really need to tell you to wash your hands this time.
Erin Welsh	Wash your plants.
Erin Allmann Updyke	Ooh!
Matt Candeias	Nope.
Erin Welsh	Boil your plants.
Matt Candeias	Don't eat everything you're growing I think I probably the better thing here.
Erin Allmann Updyke	Don't eat that plant, ya filthy animals.
Erin Welsh	Ya filthy animals.
Erin Allmann Updyke	(laughs)