



Speaker	Dialogue
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[MUSIC]

Dave DeMar We continued to dig into the side of the hill and that's when we uncovered something a little bit higher up than where the ribs were. It was a little bit smoother on the texture and as we started to expose it more, it started to take on a very, um, complex shape. And by the end of the day, we had exposed enough that to my eye and comparing it to the T. rex skull tattoo on my left arm.

Michael Holland In this particular instance, our fossil preservation department apparently was having a great day back then, 66 million years ago because this thing is really amazing.

Meredith Park *Prim told me a story that one tooth was starting to break, and it broke, and it was a lucky fall because it fell right into her hands.*

Thomas Carr the end of the day, the past has no other voice but the bones. And there's simply no other way of recovering the past without having the actual bodies in hand. Without that we have nothing.

[MUSIC]

Brandon Peacock I remember watching "Jurassic Park" for the first time...*my mind was blown at the possibility of being in contact with dinosaurs...And wondering how in the world did they know the size, shape and behavior of each one...*

Kristy Mar All I know is that ever since that movie first came out, people have been fascinated by the Tyrannosaurus Rex. Maybe they had before the movie, but I think that movie really put the T. rex into the spotlight.

Brandon Peacock People have been searching for dinosaur fossils for [hundreds] of years. The first noted discovery was [.....]. Since then, the search has expanded throughout the world... But, what have these discoveries told us about these specimens when they were alive? Did "Jurassic Park" get it right?

Kristy Mar Today we talk with several people about the recent discovery of a Tyrannosaurus rex skull – one of only about fifteen nearly complete skulls known to exist in the world. It's called the Tufts-Love T. rex. And it's not something you find and pull out of your backyard. At least not in my backyard.

Brandon Peacock No. To find a T. rex is incredibly rare. But, sometimes these discoveries happen right under our noses, when we least expect it. At least, that's what happened here

Brandon Peacock This show was produced by the Discoveries in Geosciences Field School, bringing real science to real people and into the classroom. The DIG Field School is a nonprofit education program for K-12 teachers and students, created by University of Washington paleontologists at the Burke Museum in Seattle.

[MUSIC]

- Brandon Peacock** Dr. Dave DeMar is from the National Museum of Natural History at the Smithsonian institution. Dave, like many of us paleontologists, got introduced to it through dinosaurs.
- Dave DeMar** When I was 11 years old in 1995, uh, there was a TV documentary called “Dinosaur” that was hosted by Christopher Reeves.
- Brandon** Superman.
- Dave DeMar** Yep. Superman. I was fascinated by that 30-minute film. Phil Tippett, the guy who did a lot of the stop-and-go animation for “Jurassic Park” some years later was involved with that. I was just blown away by, uh, you know, the imagery and, and dinosaurs in general.
- Brandon** So when you were 11, did you kind of have in mind that you wanted to be this, maybe you didn't know it was an academic thing, but to be a paleontologist or you thought dinosaurs were awesome?
- Dave DeMar** I think both. Okay. Yeah, because you know, some of the even famous dinosaur paleontologist today, like, you know, Jack Horner, Phil Curry were on there. Yeah. Now they're sort of colleagues. To me, it's a real treat to kind of come full circle there. It wasn't until, you know, some years later when Jurassic Park actually came out that that I really truly wanted to become a paleontologist.
- Brandon** That's an interesting thing, right? That, that, that movie certainly affected a lot of people. I think it was probably my hypothesis of course, is that it's just the raw vitality of seeing animals like that that you maybe are familiar with, but then seeing them moving and running and all that kind of stuff. It's just affected so many millions.
- Dave DeMar** Exactly. And you know, I went to see it in theaters, you know, upwards of 13 times. I was so intimidated. Yeah, man, he's so highly motivating me. And less than a year later I was joining the US Army to get money for college to be a paleontologist.
- Kristy Mar** **Before we get into more detail about the fossils found in the Hell Creek formation, let's talk about how and why they're there in the first place.**
- About 66 million years ago an asteroid crashed into the Yucatán Peninsula in Mexico. This crash triggered the event that put the dinosaurs and around 75% of all life on Earth into extinction. To give you an idea of the magnitude of such a crash, the asteroid hit Earth with the same energy as 100 million atomic bombs.**
- Brandon** **And over the next two million years or so, formations of deposit were created, producing fossil records of all living things in these areas prior to the crash. One of these places in the Hell Creek Formation, which is found in over portions of Montana, North Dakota, South Dakota and Wyoming. And it's made up of deposits mostly from the last part of the Cretaceous period.**
- The Hell Creek Formation has been a treasure trove for fossil findings of Chamops, Haptospherus, Didelphodon, and dinosaurs – such as Tyrannosaurus and Triceratops.**
- Kristy Mar** **Greg Wilson is the Curator at the Burke Museum, Director of the DIG Field School, Professor in the Biology Department at University of Washington, and he's been going to the Hell Creek Formation since 1998.**
- Greg Wilson** You know, really what we're trying to do is understand these last very last dinosaur dominated

ecosystems and the transition from those ecosystems to this complete changeover where mammals become the dominant members of the terrestrial ecosystem. So we're trying to really track those changes. And in Montana we have a section of, of rock. So, um, bad lands that are some 200 meters thick in those badlands. And those rock layers capture last 2 million years of the dinosaur era and the first million, million and a half years, um, after that, after that mass extinction. So we look, we try to look at different time points through that window and for each time point we try to collect enough fossils and primarily vertebrates. But now we're collecting plants and other things. Now to get a full understanding that ecosystem. And then after that, how does an area or an ecosystem recover from something so devastating as an asteroid impact and climate change and so on?

Brandon Peacock Is there a reason you're going to Montana to do this work?

Greg Wilson In this world, there are many places where you can do a study to look at this time interval in this depth with this sort of rigor. And you also can't go too many places where you can actually put your finger, like literally your finger on that layer that preserves the fallout from the asteroid impact that fell out all over the globe.

Brandon Peacock The fossil record is famous for a few things and I think one of them that everybody understands really well is mass extinction. You study mass extinction by studying the fossil record. It's really the only source of data probably we could ever get on it. Yeah, here's the best place to study the most famous one.

Yeah, exactly.

So can you tell us about the people in Montana that you're working with?

Greg Wilson You know, I've, I've already spoken about the fact that we have teachers out there. We there Grad students and Burke Museum volunteers and researchers from other, uh, universities and museums, but super important that we work with the locals out there and we work with the, the federal and state agencies like the Bureau of Land Management and Montana State Department of Natural Resources. The local community, you know, they've seen a lot of us come and go.

Sure.

And so they have a lot of knowledge about, you know, of course their land, but also, uh, you know, how to help us. And it has a lot of flavor to life out there as well.

Those relationships have to be so important. So I really cherish those relationships.

Kristy Mar **It was May of 2015 at the Hell Creek formation when two Burke Museum paleontology volunteers made their discover of the T. rex site.**

Here's Dave again to tell us about that moment.

Brandon Peacock you were in charge, if I remember correctly, of the actual excavation that summer. Is that right?

Dave DeMar Yeah. so I was physically on the ground the entire time to Tufts love T. rex was being collected in 2015 when Jason Love and Luke Tufts found a spot. They found it on the last day when they were prospecting for the year.

Brandon

Oh my gosh.

Dave DeMar

I think they said it was the last day in the last 15 minutes they were out there. So they went to the spot. They saw these huge, big boulders with some highly weathered and beaten up bone, uh, exposed. And some of it had weathered out and fallen on the ground and they picked up as a piece of a bone that was a highly spongy, like almost like honeycomb shaped honeycomb type bone is typical for large theropod dinosaurs

Brandon Peacock

And honeycomb, you mean the inside of the bone? It was broken open.

Dave DeMar

Exactly. Yes. So, uh, which later, once we got to the site, we determined that what they had found was the inside of the hip bones that kept vertebrae. But when they came back that year, they showed us some pictures and then later again in 2016, which is when we revisited the site, they showed us that piece of honeycomb bone. And so they were like, hmm, maybe this is a T. rex.

Dave DeMar

There was a little mound of sandstone that had some heavily splintered ribs and what I thought were gastralialia. Now gastralialia, are belly ribs and you often see them and some lizards and Crocodilians, but for dinosaurs in the Hell Creek formation, the only animals that have gastralialia, or these belly ribs are the theropod dinosaurs.

Brandon Peacock

So theropods are the big meat-eating dinosaurs or small-meeting dinosaurs, I guess.

Dave DeMar

Yeah, everything from like, you know, velociraptor to T. rex.

Dave DeMar

As folks were, um, excavating to the side of the hill, I decided to look around a little bit and off to the right hand side of the locality, I the top of a backbone, uh, the neuro spine, which is the little spine that sticks off the top of the backbone. And in tyrannosaurs, uh, like T. rex, the narrow spine, the one that I collected, was very broad and it had these very rugose or very bumpy projection sticking out the front and back of this narrow spine, which is typical of T. rex.

Kristy Mar

Brandon, how much a skeleton would you say is typically found when something like this happens?

Brandon

I'd say that most of the dinosaur elements people find are either isolated pieces or just a couple of bones of a skeleton.

Kristy

So it's not typical to find a whole skeleton like we see a museum, definitely not according to Dave, for more than a hundred years of people prospecting, there are just a few T. rexes that are like over 30% of the skeleton. So Dave and his team now have three clues that what they found could be a T. rex.

Dave DeMar

We continued to dig into the side of the hill and that's when we uncovered something a little bit higher up than where the ribs were. It was a little bit smoother on the texture and as we started to expose it more, it started to take on a very, um, complex shape. And by the end of the day, we had exposed enough that to my eye and comparing it to the T. rex skull tattoo on my left arm.

Dave DeMar

It looked like the back of a skull of a T. rex that had landed upside down.

Dave DeMar

Essentially, the whole process of collecting the skull, you know, occasionally I look at my arm and

say, yeah, that's what this is.

But, really wasn't until we uncovered the back of that skull that we had that Aha moment like, oh my gosh, you know, this could turn out to be something amazing. All my life I've wanted to find a T. rex and to finally visualize it right in front of me as we slowly picked away at that sediment and the shape of that skull started to match up perfectly with the back of this skull of a T. rex was truly a magical moment. It still gives me goosebumps today just thinking about it.

Kristy Mar **Now that Dave and his team realized they did find a T. rex skull, it's not likely they can just start chiseling away and pull it out.**

Brandon **No, especially not with such a fragile structure as a skull.**

Dave DeMar You know, it's exciting that you get a T. rex and you want to, you want to see what it looks like. But you also, you also have to be aware that this thing has to go back to the lab where it should be prepped, uh, under better conditions, you know, out of the sun, out of the wind, out of the rain.

Dave DeMar Just to digress for a second, um, Jack Horner had showed up on that fifth day. We were out there the five days later when we were out there, and he was sort of like the final say that we did have a T. rex and he sent me down - we both sat down next to skull and he's like, well, Dave, you've got yourself a T. rex. And I had, that has to be one of the most inspiring moments as a, as a paleontologist.

Brandon Peacock Wow.

Dave DeMar Knowing that the guy who's collected the most T. rex is ever set. You know, I had told me that that's spectacular. But it was, it was really exciting.

Brandon Peacock It sounds like you're getting a blessing. This thing you thought was right and then you felt was right and here comes this patron saint to give you the thumbs up.

Dave DeMar Exactly. Yeah, it's times like that that really got me excited about being a paleontologist and what I hope to find in the future.

Kristy Mar **We're going to take a quick break. But when we come back, we learn what it takes to transport 3,500 pounds of rock housing a 66-million-year-old fossil.**

[MUSIC]

Brandon Peacock **This is Brandon. And before the break we heard from Dave DeMar and Greg Wilson described the eureka moment when they discovered they had a nearly complete skull of a tyrannosaurus rex.**

Kristy Mar **Greg Wilson orchestrated the excavation while Dave DeMar led the team of more than forty-five people, for one month in the scorching heat, to get it properly out of the ground and then transport it safely to the Burke Museum in Seattle.**

Brandon Peacock **That's where Michael Holland comes in.**

Michael Holland Yeah. My name is Michael Holland. I am an exhibit fabricator and fossil preparator. So currently, I am attached to the Burke Museum where I'm the preparator for the Hell Creek project.

Kristy Mar Brandon had kind of given us the idea that takes a lot of teamwork going into bringing a specimen from its original location to something assessable for the public art museum. So who do, um, how

do you decide if who gets to be involved in a special project like that?

Michael Holland Generally speaking, when a fossil comes in from the field, that's not really in any condition to be exhibited yet. It needs to be stabilized and cleaned and basically just made safe for handling or mounting or, or even if it's not going on exhibit and it's just going to live in a collections cabinet, you still have to get it to the point of utility.

Michael Holland Once it finds its way to the museum, in this instance it was handed off to me and they said, okay, let's open this thing up and, and start going on it.

Michael Holland When I looked at it, my first thought was, I'm not really going to know which side is up because all sides we're going to need to be up at some point. If you're really want to have access to the thing, you know, you can expose as much as you can from the top, but then eventually you're going to, you're going to turn it over.

Brandon Peacock You're lifting it up off the ground, like it's suspended, like suspended. Very, very delicate, very, very heavy object.

Michael Holland Yes. And most of the time it's not just lifting it, it's lifting it and turning it right and then setting it down right. And trying not to crush any humans while you're at it. So it's kind of a, it's a scary experience.

Brandon Peacock What have I heard about some sort of rotisserie situation can of Burke's prep lab?

Michael Holland I knew what I wanted to be able to do with the specimen, but I wasn't a hundred percent sure how to get there. But I had some ideas and so I sat down and kind of put together a little napkin sketch of this device that would hold a big object like that, but enable you to just kind of roll it on a single axis.

Brandon Peacock This is peak creativity by the way. If it's being drawn on a Napkin.

Michael Yeah. Oh yeah. This is, this is the real, the best stuff happens on Napkins, right? Everybody knows that that is right. And if they're stained, it's even better. That's right. And Oh, there are stains. Anyway. I'm kind of a mess sometimes.

Brandon Peacock Once the rex is in the rotisserie and you've taken the plaster jacket off and you're looking at the of specimen itself, what tools are you guys using or what methods are you using? Sort of get the skull out of the rock.

Michael Holland We've got kind of a whole arsenal of tools at our disposal further and some of them are really low tech and simple. Sure. You know we use awls and chisels and toothbrushes, or you know, sometimes it's variable in the matrix. The rock matrix can be either really soft, like just kind of somewhat loosely consolidated sand. Like if you think of like, you know, that bag of dried out brown sugar that you've forgotten about in the back of your kitchen cabinet. You know like if you really kind of scratch out a little, it comes apart.

Brandon Peacock Well I remember the solid, I remember personally being at the Tufts-Love Rex site and I was using my fingernail and get sandstone out.

Michael Holland That is, that is like fossil preparer's dream right there because it's stable enough to have preserved

a fossil beautifully, but it's soft enough to be easy to remove. Sure. And we were lucky because a lot of this skull was contained within that kind of rock.

Brandon

Beautiful, soft.

Michael Holland

But, there was other rock within it also that was a little more like the concrete in your driveway.

Brandon

Less ideal.

Michael Holland

Really hard. And so when you get into that kind of material, you kind of want something a little more robust. And sometimes if you're far enough away from the fossil and you have absolute confidence that it's safe to go after it, that can mean things like chisels and hammers.

Brandon

To get a better understanding of these tools. We went into the lab with Michael.

Michael Holland

Well we have the scholar right now at somewhat of a strange angle. It's laying sideways.

Kind of sideways.

Yeah. Um, and we can do that largely because of the way in which we have it supported. We're looking at a wall of teeth. Uh, yes, that's coming right at us. Yes, yes we are.

Brandon Peacock

When working on the fossil, they use pneumatic air chisels called air scribes, and there's a series of those varying in size and power output. Those variations are important depending on the matrix of the fossil itself.

Michael Holland

You can see some areas like by these teeth. This is supremely soft matrix. Yeah. Much of the skull –

Brandon

It's like beach sand.

Michael Holland

Well, essentially is, or at least a nice riverbank. So sometimes we'll just get out things like, like these little dental tools, just scratch a little sand away here and you can watch how easily this stuff comes away.

[scraping]

You could, you could really do this with your fingernail, just about, it's, it's so soft. It's kind of like a dried sugar.

So most of what we got has, has that kind of matrix, which is great. But there have been some areas where it's quite a bit different. It's all sandstone, but the harder stuff is really hard.

Brandon

Okay. Like that's a pain.

Michael Like a sidewalk hard.

Brandon Oh Wow. Like concrete.

Yeah, yeah, yeah.

Michael Holland [drilling]

You can see that when I apply some pressure at the tip of the chisel, it's just oscillating back and forth. It's like a little Jack Hammer cutting its way through the rock. So that's the largest of our tools.

Michael Holland So we'll switch that one out and we'll go to somebody a little bit smaller. This air scribe is referred to as a micro Jack and it's going to do the same thing again, where you'll have that same reciprocating Jack Hammer kind of movement. But now the stylist that we're using is much, much smaller as this, probably only about two millimeters wide, so it's just a small tapered steel rod. It's got a pretty good sharp at the tip.

[drilling]

Michael Holland Much quieter. The material that's being released is much smaller.

Now I'm just moving the little chips of rock, but because of that lower force lighter impact, I can be a lot more confident getting much closer up near the surface of the fossil and not have to worry about shaking things apart so much. So it's really pretty ideal to be able to transition into those smaller tools as you need to.

Kristy Mar **Michael then went on to show us the smaller and smaller air scribes so that when working on the fossil, you're getting down right to the surface and getting that last little layer of rock off without damaging it.**

Brandon Peacock **But this whole process of preparing the fossil isn't just about scraping off rock. That's right. There are chemicals being used during the preparation process to keep the bone protected from the atmosphere. It's being exposed to for the first time in 66 million years.**

Michael Holland Really, it will look very much like what you're seeing right now. Just a lot less dusty.

Brandon Peacock I mean, I'm not a tyrannosaur expert, but I've seen a pretty good amount of the skulls that are around to different museums in the world. And I didn't expect something this gorgeous. Her horns on her above her eyes and, and sort of her forehead and all the rough texture there. So you could imagine the scaly or even cutaneous armored forehead and top of the nose that this animal would have had in life. I mean, you can see it, the smooth bone where there's muscle, the really rough, nasty bone where she would have had a horn.

Brandon Peacock Yeah. Oh man, it's kind of been, it's insane. Yeah. Any kind of nostrils or eyeball, like you can easily imagine some movement, it blinks at you at work or you know, sniffs and something like that. But just seeing that rough texture, I'll say this to the ball of, um, on the back of the skull where they'll conduct the exit little condo. That's where the backbone connects cause it's just such a perfect, like grapefruit size joint. And you can imagine that skull can turn all different directions, which of course it did. And it's just so cool to see a sphere like that so perfect on such a complicated object.

Michael Holland In this particular instance, our fossil preservation department apparently was having a great day back then, 66 million years ago because this thing is really amazing.

Brandon **When most people think of a skull, they think of one skull...In talking with Michael, I learned that they have found one-hundred percent of the dinosaur's skull and jaw bones. That is incredible. You have to imagine that... It's absolutely incredible...That is really difficult to get.**

Kristy Mar **Michael isn't the only person putting in the hours cleaning and preparing the skull. He told us earlier that they've logged over 7,200 hours working on it so far. And one of the people that was put in several thousand of those hours is Jean Primozich.**

Brandon Hello, Jean.

Jean Primozich Hi. Yeah, you should call me Prim. That's what most people call me. It's easier.

Brandon So what's your connection to the Tufts-Love Rex?

Jean Primozich Well, I am a volunteer prepared her at the Burke Museum in Seattle and I am presently, I'm working on the Tufts love T. rex skull and have been for nearly two years preparing the skull. That's what I've been doing for the last couple of years. Hanging out with the T. rex hanging out T. rex very intimately. Yes. All up inside this guy. Yeah.

Brandon Or Gal.

Jean Primozich I think it's a gal. It is hard to say except that I've always referred to her as Elvira.

Brandon Oh Wow.

Jean Primozich Yeah. From the get go. I was out in the field, um, when we were getting her out of the rock. And I said to Dave DeMar, who was the leader of the group, I said to him, it looks she's a girl. And I named her Elvira at that moment. So for two years I've been referring to her as the Elvira.

Brandon Peacock So you've worked with a lot of fossils then before the rex. Yeah. Because you've had this experience in the field. You've had been at the Burke for years. Yeah. How does everything before this compare does it?

Jean Primozich It doesn't.

Brandon All these turtles and horses can go home and go home?

Jean Primozich I'll tell you, the crocodile skull was, I did a crocodile skull and yeah, that was pretty awesome. Just the detail of the crocodile scowl was pretty awesome. But this, I mean obviously takes the cake. I mean, I started with the, a few of the rib pieces and um, and then the right-side dentary.

Brandon Peecook The lower jaw.

Jean Primozich Yeah. The lower jaw, that part with the teeth in it. And that was the most awesome experience I thought I could ever have.

Seriously, it's like become my pet. You know, the pet that doesn't, yeah, I do - I call her Elvira and, you know, I pat her on the nose when I leave at night and you know, I miss her when I'm gone and it's like, oh my God, nobody better touch her. I'm just very protective. Um, but yeah, I'm become quite intimate with Elvira.

Brandon Peecook It can get very dusty in the prep lab. Michael explained the noise from the exhaust fan, which is on all the time to help with the dust and particles from all of the tools being used. Are you listening to something, or are you blocking out the noise?

Jean Primozich I can't listen to books or podcasts, no offense about this, but I can't, I can't listen to anything that I need to concentrate on because I find myself concentrating so hard, um, on what I'm doing. Right. You know, because there's, it's as much as you're removing a lot of rock, there's a lot of decisions that are made the whole time. So, um, I, you know, have the headphones. I, but I'm always listening to the music.

Brandon Peecook So what's on your playlist?

Jean Primozich It's old music.

Brandon Peecook All right.

Jean Primozich Well, no, it depends. Sometimes I listen to opera. Okay. Yeah. Sometimes I listen to, uh, like things like Bonnie Raitt and blues. Um, you know, sometimes I'm really amped up. I get a little bit more rock and Raleigh, so, and then sometimes I listen to John Denver. I don't know why I do.

Brandon Peecook That's great.

Brandon Peecook **All of Prim's work has been viewable to the public as part of the new Burke museums design. All of the research and collection labs have clear glass windows. So the activity of scientists happening behind the scenes is out in the open for everyone to see.**

And I heard there are several people who regularly visit the museum to check in on the skull, and on Prim.

Shira Park *I'm Shira Park. I'm seven years old.*

Meredith Park *My name's Meredith Park. I'm five.*

Jean Primozich And they know everything about dinosaurs.

- Brandon Peecook** They are the Prim Fan Club. It's an exclusive club.
- Jean Primozich** They are the Prim Fan club. Yeah, absolutely. And their mother is wonderful. They dress in all dinosaur and everything there.
- Kristy**
That's adorable.
- Jean Primozich**
Their little rain boots have dinosaurs on them. Their barrettes in their hair have dinosaurs.
- Shira Park** *Megalodons, and hammer head sharks, Terradon*
- Jean Primozich** They have little dinosaur t-shirts. Their leggings are dinosaurs.
- Meredith Park** *Triceratops, dinosaurs, and a raptor.*
- Jean Primozich** One of the little girls actually did a first grade project where they had to pick a word and then they had to um, define the word or describe it in front of the class. And she went as a preparator. And she had all the little tools out. They actually carry a backpack with them everywhere they go in case they have to dig a fossil up.
- Brandon Peecook** That's very prepared.
- Jean Primozich** In their backpack they have sunscreen and they have a hat and they have, I've given them a few little tools
- Shira Park** *My books, shovel, a picture of a tooth, this is a brush, chisels, a hammer with a saw on the end.*
- Meredith Park** *Which does this [sawing], it makes a saw in the ground.*
- Jean Primozich** And they have some glue and they are totally prepared. So she did this thing for her first grade class as a preparer.
- Brandon Peecook** Have they helped with the preparation?
- Jean Primozich** Yeah, they've helped. I've given them brushes, so they've done some brushing and a little bit of digging. You know, they've been there from the beginning.
- Brandon Peecook** That is amazing.
- Jean Primozich** They're pretty cute, pretty cute.
- Shira Park** *It felt like being a real paleontologist.*
- Meredith Park** *It was smooth around the edges, and it has the serration around both sides. I talk with Prim and Michael a lot. We usually talk about the new bones that have been found and how everything is*

connected in the skull. Prim told me a story that one tooth was starting to break, and it broke, and it was a lucky fall because it fell right into her hands.

Brandon Peacock Dinosauars and paleontology more broadly is absolutely a gateway drug to all the other sciences.

/ Jean Primozich It is.

Any little kid, especially any little girl who's into dinosauars.

Totally. That's true.

Get them another dinosauar toy.

Jean Primozich Yeah, yeah, yeah. Get them another dinosauar with sunscreen, little tools.

That's right.

Get 'em going. I mean, get them another book. Let them read another book. I introduce them to as many fossils, you know, they can see and, you know, let them see them, touch them, you know, be part of it.

Shira Park *We actually found deer bones in our backyard's gravel pit.*

Meredith Park *Yes, we found an ammonite, a tooth, an Orthoceras shell. What was really cool was that the Orthoceras shell was embedded in marble. And we think that, maybe, in prehistoric times our home might have been the ocean, because, why would I find an ammonite there.*

I'm still not finding any fossils here.

Jean Primozich The touching part of it was what was so cool and being able to touch the serrations of the teeth, you know, it became real to them. This was just, it was real and that I love experiencing that myself, but to get the kids to experience it was really mind blowing. It was really great. I really enjoyed that part.

Brandon Peacock It sounds like you've been a fantastic ambassador for this guy, this girl, whatever it is.

Jean Primozich Let's just call it Elvira. The Tufts Love Rex. The Tufts-Love T. rex.

Brandon Peacock **When we asked Michael what he thought the best feature of the Tufts live, T. rex was, he answered with his favorite *viewpoint or perspective*.**

Michael Holland I really like getting right in front of the snout and looking kind of along the ridge of the nose, like all the way up to the top of the skull. Because from that spot there's all of this really gnarly, cool texture all over the, the front end of the skull. You can stare right at the orbits that I saw it right in the eyes. You really can get this sense of staring down that animal and there's some something kind of really visceral about that because it's so easy.

Brandon Peacock Imagine the little exhale. Imagine that.

Michael Holland Right? Yeah. So that's, that's probably my favorite view point as far as my favorite thing about the skull in general, I would just say the, the level of preservation, uh, it's, it really is exquisite. Every

time you get further into the thing, you find things that, you know anatomically are there, but you almost just can't believe that they're there because they're so well preserved.

Michael Holland There's a bone in the ear. Oh Wow. Like, like, you know, you have three little bones inside your ear that transmit sound. Well if you're a reptile or a bird, uh, you have one of those because the other two are part of your jaw instead. That little bone for us, it's the *stapes*. It's the smallest bone in your whole body. That is also true in dinosaurs, but if you're a bird or a reptile, we call it a *Columella*. It's a skinny little stick of bone that's like a couple of millimeters wide and in a T. rex it's like maybe eight inches long. But just the fact that those are even there at all is remarkable.

Kristy Mar **In my mind has created an image of what I think the T. rex skull will look like. But you know, I'm ready to see it in real life.**

Brandon Peacock **So far, we know that the Tufts-Love Rex is 66.3 million years old and lived at the end of the Cretaceous Period. The skull seems to be average size for an adult T. rex, about four feet long by three feet wide. Which doesn't sound that big, but the body of an adult T. rex was as long as a city bus and stood from fifteen to twenty feet tall. And basing on the size of the skull, they've estimated the Tufts-Love Rex was around nineteen or twenty years old.**

The world has been waiting to see the unveiling of the Tufts-Love T. rex for several years.

Kristy Mar **So we're going to take a quick break and when we return all eyes will be on the big prize.**

[MUSIC]

Kristy Mar **Brandon, I think the majority of people, scientists and nonscientists alike, except that the T. rex is the most popular dinosaur fossil.**

Brandon Peacock **Oh, absolutely. I can speak to it as a paleontologist though my special specialty doesn't focus on tyrannosaurs. So to get that assumption stamped and approved, we talked with one of the leading scientists studying tyrannosaurs, Dr. Thomas Carr. So he's an associate professor of biology at Carthage College and Director of the Carthage Institute of Paleontology.**

Kristy Mar I'm so curious, could you define your role as a scientist?

Thomas Carr I think my main role is to lift the lid on how nature truly operates and through application of the scientific method. And the particular corner that I've chosen of nature is the evolution of tyrannosaurs. And they grabbed me when I was figuratively speaking and I was very young and I find them to be very fascinating creatures with a good sample size. And so I've decided quite a while ago to do a deep dive in the figuring out how they grew up and how their growth can unlock the secrets of how they evolved. And I haven't looked back since. So that's my primary role is to contribute to the general body of knowledge that tries to work out how evolution naturally happened using tyrannosaurs as a model.

Brando Peacock And well, and, and that's what brought you to Seattle to see the Tufts-Love rex. You're here to get data from this specimen to add it so you can understand the growth of that species of animal.

Thomas Carr Indeed. And the Tufts-Love rex is an absolutely gorgeous specimen. Basically complete skull partial postcranial skeleton and you know, it's going to be a spectacular specimen, uh, once it's on display and the final version of the galleries. It was kind of nice having a sneak peek.

Thomas Carr And I must say that when I learned about it, I was so happy to learn that it was found on BLM land and that a real museum was collecting it. I was dreading that this would be yet another rex a that's

being carted off by a commercial company or a museum that's bought it out of the ground.

Thomas Carr So it was good news all around. I knew that the specimen was safe and then it would be accessible for science and public education.

Thomas Carr I guess just for starters, the Tufts-Love rex is a beautifully preserved specimen, like very few T. rexes in real museum collections, uh, even come close. Um, most of it's largely articulated, the jaws are there and that, but they're separate, which is, you know, very good.

Thomas Carr My first impression of the Tufts-Love rex, was that it was a young animal. So just in broad strokes, it's relatively young animal, probably in its reproductive Prime. And, uh, there's numerous sort of subtle features that give away its youth. I don't want to go into, you know, T. rex hyperspace on you. Those features are there.

Brandon Peacock Yeah. So can you just give us an idea of, you know, you come to a museum, you look at it individual specimen, what kind of data is it that you're collecting and how is that informing what you're trying to do? You're trying to understand how an animal goes from an egg to a big bad T. rex and this is helping you do that. And then of course, I'm assuming there's the other side, which is the family tree of tyrannosaurs.

Thomas Carr Well, I guess I'll have to confess that I am obsessed with tyrannosaurs and I want to know everything about each individual specimen. And so I have a, a master set of data that includes measurements and qualitative features. So, you know, I'll measure say the femur length, the skull length, I might want proportion. So, take the snout depth to get, you know, a ratio of the height of the skull. I also count things so I can't the number of teeth and I'll look at features like say the texture of the face and that changes with growth and I gather observations from the entire skeleton. And in total my masters' set of data includes around 11,000 data points for a single skull and skeleton.

And basically, fossils are sets of information if you want to just get right down to it. And they are individual sets of information that are unique to themselves but also fit into a larger context of say, growth and evolution and history of life on this planet in the context of larger environmental changes, extinctions and that sort of thing.

So, their value, their currency is information content. And they mean nothing without that.

Brandon Peacock I would say they have information content and they have a little bit of a, a wonderment content that's very hard to replicate with other things.

Thomas Carr I agree. That's, that's absolutely right.

Brandon **And because this T. rex specimen is so well preserved, other scientists like Dr. Carr are able to fill in the gaps of past research of tyrannosaurus rex. The Burke museum has received so many requests from researchers to study the Tufts-Love Rex, they think it could possibly become one of the most studied T. rex fossils in the world.**

Kristy **If I were a dentist, I would be incredibly excited just to study all of those teeth.**

Brandon Peacock So, we wanted to ask you sort of your take on this idea of why do dinosaurs matter? What can the public get from dinosaurs? I think everybody knows them, but what are they maybe not seeing that you can see?

Thomas Carr I think the public has to recognize that we all share a common heritage on this planet. And to truly know the history of the planet, we have to protect and conserve the vestiges of the past. Things like fossils, you know, archaeological remains, the whole gamut of the past. Origins are everything. And even though the day to day lives of a dinosaur 68 million years ago has no direct bearing on our data that day life right now, there's still a tremendous amount to learn in terms of evolutionary biology. So, people I think have to develop that understanding and appreciation. I think by and large people do. But it's the information that fossils contain that are important. At the end of the day, the past has no other voice but the bones. And there's simply no other way of recovering the past without having the actual bodies in hand. Without that we have nothing. And then that scientific knowledge informs all the generations of scientists to come for as long as civilization lasts and don't has any idea how long that will be. But I think there's this, there's a certain amount of urgency at play here.

Thomas Carr And so in the meantime, isn't it worth it to make sure that all of our information is secure and the only thing available to secure that information of the deep past of evolution and history of life on this planet are the institutions of museums and the academic academy that props those up. It's a necessary enterprise for the benefit of all, even though it might not translate into some immediate reward. But what we do get, the reward is a deep understanding of nature in the way that it truly is. We're not making anything up as long as we have the fossils.

Thomas Carr Yes, we're constantly refining our understanding of things at every scale from the subatomic to the, you know, galactic scale and beyond. So, paleontology is just a microcosm of science writ large. We don't know everything yet in, as a matter of fact, we hardly know anything about anything in terms of dinosaur biology evolution. We only have the bare outlines that we're filling in fossil records. Really crappy. It really, we don't have much of it.

Brandon Peacock It really is. We always tell people it's amazing. We know what we know. Everything you have to imagine like think about everything that's living and breathing and evolving and swimming and growing right now on the surface of the planet. And then if I talk to you 67 million years ago or 220 million years ago, we probably know a little bit about two different places on the surface of the earth and that's it. And there's no reason to suspect in any real meaningful way that that past world would be less diverse or less nuanced.

Thomas Carr Indeed. So, we're working with a very incomplete set of data that is being incrementally and painstakingly reassembled.

Kristy Mar And Thomas, do you think that is a method to kind of engage younger generations to want to pursue paleontology? I'm thinking exactly one more gone. Who's going to pick up the slack to, do we want more to be invested in this long-term discovery?

Thomas Carr Well, I think just the, the message of incompleteness, uh, really means there's plenty of opportunity for everyone who's interested and who has the ability to, you know, carry this, the torch of science in whatever capacity. You know, it could be a little kid who's inspired to do a PhD in some branch of Science, whether it be evolutionary biology or physics or whatever chemistry. It could be, you know, maybe someone who'd foot to develop software or a pipe fitter who might be inspired to, you know, come out and dig dinosaurs and actually collect fossils. And in a very real and material way contribute to, you know, the Great Library of fossils, the great library of evolution that's slowly building up in museum collections. So really the incompleteness in paleontology, uh, field biology, oh, just about every branch is science is an open invitation to the public at large to be citizen scientists.

Thomas Carr So, I think incompleteness means opportunity. And I think that it'll always be that way. Our knowledge will always be incomplete because the scale of the task is so monumentally vast. We're trying to understand the universe, and this is just one planet with a fairly thin crust and there's a hell of a lot to understand. It's almost overwhelming at times. But people can join in. That's the beauty of it. And really contribute, you know, by joining academic expeditions where the participants know that those fossils will make their way into a real museum collection for the benefit of all humankind. Whether it's a scientific paper here or a museum gallery there, it doesn't matter. Just as long as the contributions made in the fossil finds a safe home.

Kristy Mar **Brandon, I'm feeling so empowered listening to Dr. Carr. With your and his suggestions, I'm definitely going to pick up some articles and journals to continue educating myself.**

Brandon Peacock **Something about being an academic and how I cannot stop learning either. Let me know if you want to talk about early dinosaurs or mass extinction events...**

Kristy Mar **I look forward to reading them and sharing your knowledge with my students! In thinking about my students, I want to hear more from the people we've talked with about their thoughts on the future of paleontology and how we teachers and parents can get kids involved.**

Brandon Peacock **Well, let's ask one of my former teachers his thoughts on this topic, a committee member of mine - Greg Wilson.**

Kristy Mar And would you say it's fair that um, let's say a younger version of myself or Brandon, we're looking at a dinosaur book and just kind of thinking, well, everything we know about dinosaurs must be here, um, in this book itself. But you guys bringing in this t rock skull, uh, newly discovered has opened up new eyes, new minds to, um, paleontology being as relevant as ever in the 21st century.

Greg Wilson Yeah, I mean, I definitely think they're paleontology being a really an old science and one that, you know, we're talking about millions of years ago, people think we have figured everything out. And even in a place like the Hell Creek area where, uh, the first T. rex specimen was discovered in 1902, so more than a hundred years ago, we are still going into those hills, those same hills that they were tramping about in 1902. And finding new things, you know, each new thing has the possibility of, you know, changing the way that we see this major episode in Earth history. This is a very dynamic living science that is going to be important. And you know, in the way that we look at the world presently and into the future by looking at these experiments in the past.

Brandon Peacock So I think paleontologists have a very valuable sense they bring to conversations about most topics because there's a sense of time and scale that most people just aren't operating on. They're operating on maybe a decade tops when they look backwards and forwards in time, usually less. So, are there things that you think could benefit society that the perspective of a paleontologists could help with sort of bigger picture?

Greg Wilson Oh Gosh. This is a tough question.

Brandon Peacock It is.

Greg Wilson You know, a mass extinction event like that doesn't happen every day.

Brandon Peacock No, thank God. Yes.

Greg Wilson And because of that you can get some perspective on these rare that rare events do happen. And they can have disproportionate effect on the course of earth history.

Brandon Peacock Absolutely.

Greg Wilson You look around today and you can look forward and backward decades and you know, you can see what's happened within our lifetime or within human civilization lifetime. And that doesn't capture the realm of possibility.

Brandon Peacock Right.

Greg Wilson So I think paleontology offers that perspective and I think just broadening our horizons on, uh, what the world was like is, is important just for the, that, for the simple, that simple sake. It encapsulates everything exciting about the scientific process.

[MUSIC]

Kristy We've learned a lot about this specific Tyrannosaur Rex, the Tufts-Love T. rex, from the variety of teams that discovered it, prepared it and are researching it.

Brandon And I think I can speak for everyone by saying we are very lucky to have such a rare specimen available to see, touch and study.
Kristy, earlier we were talking about how studying the Tufts-Love Rex scientists can fill in gaps from previous tyrannosaurus rex research. Remarkably, they can use it to understand more about how T. rex grew and to what size, whether they were active predators or scavengers, and tell us more about what life on Earth was like when it was alive.

Kristy And like Dr. Carr said, it can also help us learn and understand what life on Earth will be like in the future.

[MUSIC]

Brandon To learn more about the ongoing adventures of people like those that found the Tufts-Love T. rex, check out the DIG Field School website, sign up for their newsletter, and follow their Instagram.

Kristy Or, better yet, like I did – sign up for one of the trips and be part of a working dig!
And be sure to visit the Burke Museum in Seattle, Washington, to see up close what their researchers are uncovering every day. Visit Burke-Museum-dot-org and Dig-Field-School-dot-org to see photos and read up to date news on all things paleontology.

Brandon A big thank you to Jason Love and Luke Tufts for the discover and work -- To the Bureau of Land Management for giving us permission to collect the T. rex fossil -- And to the ranchers of the Hell Creek Formation area. Without all of these people, the great and important work, discovery and

science we and others do would not be possible.

Brandon Thank you for listening. And thank you to our guests, Greg Wilson, Dave DeMar, Thomas Carr, Michael Holland, Jean Primozych, and Shira and Meredith Park.

We've included links to stories, images and resources to all we talked about today in our show notes, so if you're interested, definitely check those out.

Kristy Whether it's fossils, mammals, birds, insects, or 250 million-year-old amphibians – there are stories to be told, heard and seen.

Brandon Subscribe and stay tuned for more episodes where you'll hear about other great discoveries that teachers and paleontologists are finding today – and hope to find tomorrow.

Kristy And thanks again for listening, we're your hosts, Kristy Mar and Brandon Peacock.

Brandon You've been listening to "To Hell Creek and Back: The Story of the Tufts-Love T. rex"

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