Episode 16

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Patrick: I'm recording and ready I believe.

Charlie: Alright, so, should I just kick us off?

Ryan: Do it.

Announcer: Hello and welcome to Science sort of.

Music

Charlie: Alright, welcome to Science sort of, Episode 16. We are the Paleo Pals and we'd like to wish you a Merry Winter Solstice that is full of good tidings and cheer. I'm Charlie and with me tonight are my illustrious paleo brethren, Patrick.

Patrick: Hey guys.

Charlie: And Ryan.

Ryan: Howdy, howdy.

Charlie: And Justin is in absentiastan.

Ryan: Somewhere in Africa, official continent.

Charlie: It must be. So, the purpose of our show is to discuss things that are science, things that are sort of science and things that wish they were science. This week's theme is warm light on a winter's day. So, this week we take the edge off winter's chill with two hot topics. First off, there's a new tipping point in the global carbon cycle, ocean methane hydrates. And secondly, first they said some dinosaurs were birds now some people are saying that they may have even been warm blooded. So, let's get things started with what are we drinking. So, Ryan, you always have an excellent beer on tap, so, what do you have tonight?

Ryan: Well, tonight is no exception and I'm drinking a beer from up by your way Charlie, I'm having a Double Daddy Imperial India Pale Ale from the Speak Easy Brewing in San Francisco.

Charlie: Excellent.

Ryan: Oh, it's so good. It's one of my favorite beers and I actually feel bad that I haven't had it on the show yet because it's so tasty.

Charlie: What makes it a Double Daddy?

Ryan: Um, it's ah, let's see, "doubling down on malt and hops, Double Daddy raises the stakes with its good looks and no limit style." So, I guess it's ah, I know, I know a little bit about the whole India pale ale thing but it's just a more, hoppier, more flavorful, higher alcohol IPA. So, this is ah, 9.5% alcohol by volume.

Charlie: Do you know the IBU rating on it, perchance?

Ryan: I do not. It's not listed on the bottle. I wish, I could probably look it up.

Charlie: How about yourself Patrick?

Patrick: Ah, I'm drinking, what is probably Texas' favorite beer and that's Shiner Bock. And it's a lightly hopped American style bock and I always enjoy it so, tonight is no exception.

Charlie: That is one of the only really good beers out of Texas, right?

Patrick: Ah, yeah, there are um, there are some microbrews, you know, there are microbreweries in Texas. I guess they just aren't typically as wide reaching as some of the ones we drink from. Um, but, you know, I had some good ones while I was there.

Charlie: Well, I love all the music out of Austin so I'm sure the beer would be good out of Austin too because they go hand in hand.

Ryan: I'm seeing, I looked up the IBUs for the Double Daddy and I'm getting some different results but it looks like it's about 85.

Charlie: That's pretty high.

Ryan: But, IBUs are international bitter units, it's kind of an indication of how hoppy a beer is. A higher number is more hoppy.

Charlie: Well the reason I asked is I'm drinking Hop Stoopid spelled with two "o"s from the Laguanitas Brewing Company and it's, it's an IPA with ah, 102 IBUs. Which I kind of doubt even exists because I thought the scale only went to a 100 but...

Ryan: I don't know, I actually had a Hop Stoopid earlier today.

Patrick: They just drew on a number 11.

Ryan: This one goes to 11.

Charlie: But it's good because it's very bitter and it's pretty strong but that's okay because it's a Friday night.

Ryan: It does say that the technical limit for IBUs is around 100. Some have tried to surpass this number but there is no real gauge after 100 IBUs when it comes to taste threshold.

Charlie: So, as soon as you get past 100 you're into the Science sort of land.

Ryan: Sort of hoppy.

Patrick: It's the perfect beer for Science sort of then.

Music

Charlie: Alright, so, Patrick brings us a paper on ocean methane hydrates and what they may mean for the global carbon cycle. So, Patrick, what do you have for us?

4:58

Patrick: Um, well, this paper recently came out in the *Proceedings of the National Academy of Sciences* and it's a modeling paper so they just shove a bunch of loosely defined parameters into a computer program and start calculating and try to estimate, um, if, if we're going to run into trouble, we're going to run into some kind of tipping point in global warming where we warm things to a certain level and then, kind of, all hell breaks loose. Um, so they, what these authors are mostly worried about, and, ah, these authors being Archer et al. and I guess, at the time, this was the most recent issue of uh, *Proceedings of the National Academy*, ah, let's see, it's the December 8th issue. There's probably been more out since. Um, so, what they're actually worried about here are what are called methane hydrates or methane clathrates. And so, at, on the ocean floor it's, you know, I think it's really cold, right. It hovers around zero. And once you go a little bit underneath the actual ocean floor, like, you're inside the, the rock, the unconsolidated sediment, right, the pressure can climb so that you don't even have to be quite at freezing in order for ice to occur, right? Or, you know, salt water has a, a lower freezing point so it can it can even freeze salt water once you get under the pressure of some sediment. So, basically, what happens is methane produced by, either by just the heat of the Earth sort of riding organic matter or by microbes producing methane, um, under the surface of, under the crust, under the ocean can get trapped in water molecules, basically, and you get these, what are called, either methane hydrates or methane clathrates. And, so, basically, we have a lot of methane tied up right beneath the, just beneath the surface of the ocean floor. And, this is a problem because if the ocean warms very much more, you could warm it to the point that the ice that is keeping this methane underneath the ocean floor starts to melt and methane bubbles up and gets released into the atmosphere. And methane is a pretty nasty greenhouse gas so that can mean a lot more warming very quickly if we get to that point.

Charlie: Yeah, I've heard that, I've heard that two sources of methane are the rice patties and the cow stomachs and that's ah, I guess those are both biogenic methane sources and those were really nasty for global warming and apparently now this would be a third potential source, the trapped methane gasses deep underneath the ocean.

Patrick: Yeah, actually another source is landfills and if you buy green power from a local, you know, from your local power company, if you, if you sign-up, you pay a little extra money to supposedly buy, you know, green power from your power company, what you're actually, most likely, I don't know if this is true all over the

country, but in a lot of places, what you're actually buying is trapped methane from landfills. So, landfills sit and methane and release methane, so, if you can trap that gas you can use it to create energy with. So, you're still producing CO_2 and probably just as much CO_2 as you would burning coal but you're stopping methane from releasing to the atmosphere.

Ryan: Well, you're also, I mean, you're also putting a landfill to good, productive use, instead of...

Patrick: Right.

Charlie: Right.

Ryan: Tearing the heart out of a mountain for coal.

Charlie: So, the rice paddies and the cows and the landfills, those are all methanogens that are, well, oxygen is poisonous to them so they hide out in these nasty anoxic places. How did the methane get deep under the sea. Are there methanogens down there or is it some residual methane from dead stuff long ago?

Patrick: Right, it's a little...

Ryan: Methanogens, methanogens is a big word. I don't think I know what that means.

Charlie: Methane generating bacteria or they may, they're archaea, right?

Ryan: Whoa, another big word. You're just dropping them like it's hot today.

Patrick: I actually don't know if it's archaea or not. But, um, so, archaea, they're really primitive forms that, you know, to a laymen...

Ryan: You would say that. Mammal.

Patrick: ...basically going to be bacteria. Well, I guess they're, I mean, in this case, primitive is kind of justified because they probably were the first, the first life to evolve on Earth.

Ryan: Methanogens were once classified as archaea bacteria but now they're just archaea. Wait, they're responsible for marsh gas which means that they are responsible for UFOs.

10:06

Patrick: In some ways I guess. If UFOs are swamp gas then methanogens are also aliens.

Charlie: What does swamp gas do, make you hallucinate or something?

Ryan: Ah, a lot of times when they try to explain UFOs they'll say it was swamp gas, a bubble of methane that rose above the surface of the water and methane can spontaneously ignite. It's rare. It require's some pretty specific circumstances. I just listened to another podcast in the science and medicine area, ah, *Skeptoid*, where he talked about the naga fireballs and he explains what it takes for methane to spontaneously combust. And it's rare but it could create a flaming ball of light that was much closer to Earth than any star or shooting star or anything like that. So, it could be mistaken for a UFO. So, we've got these methanogens that are, how's it getting to the bottom of the ocean?

Patrick: So, either, so, yeah, methanogens can live, ah, beneath the sediment at the bottom of the ocean. So, some of it is created by methanogens. And some of it is just organic matter that's in, that's, um, gotten close enough to, you know, the as you go further down in the Earth, right, it gets warmer and warmer. So, when organic matter gets down there it, it actually gets hot enough to create methane and the methane rises to the point where it gets trapped in this ice.

Charlie: So, how quickly is this stuff melting and what do they mean in this paper by a slow tipping point. I thought, you know, a tipping point in the Malcom Gladwell sense of the word is this kind of, like, catastrophic paradigm shift but a slow tipping point kind of takes some of the zazz off of it I guess.

Patrick: Well, I, the main question here is if, when the, so if you oxidize this

methane you create CO_2 and so...

Charlie: Oh.

Patrick: ...what they don't know is if it's going to all come to the surface, or all go to the atmposhere as methane or if it's going to get oxidized to CO_2 and just be a crap load of CO_2 and those two things make a difference as far as how quickly things are going to warm.

Charlie: I guess it's still a tipping point in the sense that as soon as we get to the other side there's no going back.

Ryan: Do we know exactly where these bubbles are?

Patrick: Ah, well, no, we don't know exactly where they are .They're, um...

Ryan: We could just...

Charlie: Oil, oil rigs find them every once in the while.

Ryan: I was just, I was just saying we could station a Coast Guard rig out there with a lighter and when the bubble reaches the surface we could just light it.

Charlie: Oil rigs are, or have been destroyed or sunk by these things. They'll be drilling down into, looking for hydrocarbons beneath the sea and they'll tap into a zone of methane clathrates and they'll effervesce, I guess, for lack of a better word. And all the bubbles from the production of the methane at the bottom of the sea will bubble up to the surface right where the oil rig is and it will, all of the sudden, no longer be able to float because it's floating on air instead of water and it will totally sink.

Ryan: Isn't there some evidence that that's what's happened in the Bermuda Triangle?

Laughter

Ryan: No, I'm serious, we're venturing well into, ah, sort of territory. But I've heard

some theories that there is a methane deposit under the area of the Bermuda Triangle so one of the reasons that ships sink at a higher rate in that area is because these methane bubbles come up and change the buoyancy and they sink.

Charlie: I suppose that's a hypothesis. Now, in this paper, it seems like the methane clathrates tend to form at higher latitudes where it's colder, right?

Patrick: Right,right.

Ryan: So, not Bermuda.

Patrick: Well, I mean, it's not entirely impossible, you know. If you're, if you're, yeah, I mean I guess it could happen. I don't know, I don't know what the...

Charlie: I guess it's, it's a little more plausible than an alien or a black hole or something.

Patrick: Right. Or Atlantis.

Ryan: Or, yeah, ah, a portal opening up over Norway.

Patrick: So, methane, in terms of greenhouse gasses, one molecule of methane is about 30 times worse than one molecule of CO_2 in terms of trapping heat.

Ryan: 30!?

Patrick: Um, that's what I read. That seems a little high but, it's bad. It's much worse than CO_2. On the plus side though, it only hangs around for around for about 7 years.

Ryan: A few.

Patrick: Whereas CO_2 hangs for much longer.

Ryan: 30 years? 30x7 years?

Patrick: Possibly. Ah...

Charlie: No, wait a sec.

Laughter
Charlie: Let's get our math straight here. So, the thirty times worse is in terms of its capacity to trap infrared radiation, I assume.

Patrick: Right.

15:00

Charlie: And not in its longevity in the atmosphere.

Patrick: Right. Methane goes away quickly. About 7 years is the resonance time for methane in the atmosphere. But CO_2 hangs around much longer in the atmosphere. So, if you release CO_2 in the atmosphere, it's not as bad but it's going to be there for a long time.

Charlie: Okay, so methane is defined, it burns hot and bright but burns itself out quick.

Ryan: Well, that's also goes back to when we were talking about methane on Mars. Methane on Mars, when we say we know it had to be recent is because we know atmospheric methane dissipates quickly so it couldn't have just been there from back in the days when Mars was hot and wet.

Charlie: Right.

Patrick: Fair enough.

Charlie: But, some of this methane, though, that does get released will not only heat the atmosphere for seven years but its byproduct is, actually, carbon dioxide, right?

Patrick: Well, yeah, if it gets oxidized which, you know, there's a chance that, there's a decent chance that it could. So, yeah, there's a decent chance that it could be

around for awhile, that's true.

Ryan: So, Patrick, what do we do?

Patrick: Just not as methane. So, the carbon could be a... ah, um, well, I don't know what we can do. Because they say, you know, with, if we raise ocean temperatures in the high latitudes another half degree, you know, this is ocean temperatures at the bottom of the ocean, if we raise those half a degree we may start getting into trouble. And, you know, that's probably going to happen.

Ryan: Fortunately, climate change is not happening.

Patrick: Right.

Ryan: Listen, Charlie and I just got back from AGU, we went to the meeting. We were told the climate change story that we're supposed to spread to the public so we're all up to date on the conspiracy and we all know what we're supposed to say. And we're going to tow the party line. Right Charlie?

Charlie: Right. And all the nations over in Copenhagen seem to agree with this based on the decision to conduct the meeting in a state of entire disarray.

Laughter

Ryan: Yes. All scientists will tell you climate change is happening because we've all, 12,000 of us, been to the conspiracy meeting in San Francisco.

Patrick: I, I wasn't there.

Ryan: That's true but you're not part of the conspiracy. That's why you're talking about methanogens and ocean gas.

Patrick: So, let me get, I'll quickly get to their results and and we can deviate further here. And so, they, they caution that, you know, their results are really more of a progress report than real results and that, you know, updates to all the parameters in the models which they admit are kind of squirrelly, you know, could change

things.

Charlie: Right. I did read that, that caution at the end and, I don't know, it didn't seem to terribly convoluted and their idea and their presentation and the model that they employed. It seemed like, at least, they could get a conservative lower limit on the amount of methane that could be released due to a bit of warming.

Patrick: Sure. Um, you know, they don't know exactly how, how much carbon is tied up in methane clathrates. They don't know, exactly, where it's tied up in methane clathrates. They don't know whether this gas is going to hit the atmosphere as methane or CO_2. You know, there's a lot of things they don't know. But, you know, here again, scientists are generally trying to be conservative with their numbers so they are presenting what's probably a best case scenario here.

Ryan: Those conservative scientists.

Patrick: Ah, but anyways, so we have, in terms of the amount of carbon in our atmosphere, I think it's something, approximately 750 petagrams or, that's the equivalent of 750 gigatons and we've released about 150 gigatons into the atmosphere in the 20th century and most of that was in the latter half of the 20th century.

Ryan: Hmmm. That's fast.

Charlie: Just from happy motoring and building concrete structures.

Patrick: Yeah, just from burning oil and coal mostly. And, so, I think we're tracking about, we release, so, this is all a little convoluted but I think we're now, currently, releasing about 2 gigatons of carbon into the atmosphere a year. And so, keep in mind, we're at 750, they say that if we get to a thousand gigatons of carbon in the atmosphere that we release, you know, due to burning fossil fuels, then methane clathrates will add another 450, 400, I can't remember the exact number. 450. So, that's, you know, that's like, for every two we release we're going to get one extra dumped in there.

Charlie: So yeah, that's a huge bonus or, penalty, I guess.

Patrick: Right. Right. So, it, and it slows down after that. But if we release, ah, if we release 5,000 gigatons in the atmosphere which, that would be a lot, but, I wouldn't put it past us. We'll get 600 gigatons coming from the methane clathrates.

20:01

And this is, you know, it's already hard to, and if, if that winds up ultimately being in CO_2 it takes a long time to get rid of. So, things could be bad. And there's...

Charlie: Sweet.

Patrick: ...you know, you mention the tipping point factor, if you get to the point where you start releasing serious amounts of carbon from methane clathrates it's going to be hard to turn back.

Charlie: Yeah, because then the oceans will warm and there would be no way to get the methane back into clathrate form at the base of the ocean because it will be too hot down there for it to exist or to form.

Patrick: Right.

Ryan: Bad. Maybe by then we'll be able to get he methane to Mars though.

Patrick: Yeah, and we'll start terraforming Mars at that point.

Ryan: You know it.

Patrick: I guess we'd better. Okay, so, you know, we're definitely on track to hit a thousand gigatons of carbon in the atmosphere in the next 100 years. For sure and probably much faster than that.

Charlie: And now we're getting this bonus for playing the game so well we're getting comped bonus, bonus carbon.

Patrick: That's what I'm saying, we'll hit this tipping point. Well, there's a good chance we'll hit it in our lifetime. We're in our 30s, well, some of us are.

Ryan: Hello.

Patrick: Ryan has a really good chance of getting to see this.

Ryan: Yup. I have a really good chance of making it till we terraform Mars.

Patrick: That's true. Yeah, and you're volunteering to be one of the first people sent, right?

Ryan: I'm volunteering to be one of the first cyborgs created so I can definitely make it to Mars.

Patrick: Yeah, you'll be able to tolerate the CO_2.

Ryan: Oh yeah, I'm going to use CO_2 as the power source by the time I'm 100.

Charlie: Well, there are other power sources you could use. There's that power source you can put in the center of your sternum, what is that exactly? It's some sort of, like, induct, induction device?

Ryan: Ah, yeah, I think it is. Ah, what is it, it's something Tony Stark made. What is it called?

Charlie: It glows and creates a tremendous amount of power and makes you really strong, such that you can just carry a tremendous amount of iron covering your whole body.

Ryan: (hums the song *Iron Man*). I actually, I can't remember what the name of the little power source is. I'm blankin'.

Patrick: Yeah, I don't know what it is either. Flux capacitor.

Ryan: Yes, it is the flux capacitor. Obviously.

Charlie: It is the flux capacitor.

Ryan: This is going to bug me, we really need to figure out what this is. I feel like I'm

actually falling down on my...

Patrick: Yeah

Ryan: Repulser, repulser technology. I didn't even look that up, I just remembered, I swear.

Music

Announcer: Hey ya'll, it's Trailer Trash Talk.

Charlie: Alright, so, this week, this week's Trailer Trash is *Iron Man 2*.

Patrick: Well, Ryan probably knows the director and the major players.

Ryan: Ah, John Favreau is the director, the same director who directed the first one. And, ah, the obvious lead is Robert Downey Jr. and Pepper Potts is, who's Pepper Potts, she's Gwyneth...

Charlie: Gwyneth Paltrow.

Patrick: Oh, she came back, that's good.

Ryan: So, there's actually, even within the confines of the trailer there's a good bit of spoilers but I'm just going to go ahead and toss them out there. So, ah, Terrance Howard is no longer playing Rhodes, it's played by Don Cheadle, Scarlett Johansson is playing the Black Widow, Mickey Rourke is playing Whiplash, Sam Jackson reprises his role as Nick Fury.

Patrick: I don't like it when the sequel has so many more villains. They were like, oh, one villain was great in the first one, let's...

Ryan: I don't think they're doing that though. They're, cause, the only principle villain seems to, well, there's two, so, in the last movie he had one villain which was the dude.

Charlie: His dad or something?

Ryan: No, it was the Dude.

Charlie: Yeah.

Laughter

Ryan: From *Tron*. Ah, and in this movie he is going to take on Mickey Rourke as Whiplash and, um, his own battle with alcoholism. Which is an assumption, I'm assuming they're going to do the demon in a bottle. So, one of the, one of those famous *Iron Man* stories is called *The Demon in the Bottle* and it's about Tony Stark dealing with his alcoholism because if you are a billionaire with a suit that is capable ripping in half a tank, you probably shouldn't be drunk while you drive it.

Patrick: Man, this is, Robert Downey Jr. is the perfect cast, huh.

25:00

Charlie: Indeed, yeah.

Ryan: Aw, yeah, he's...

Patrick: That's got to be a little uncomfortable for him, I would think, to...

Ryan: I, um, actually, when I was doing summer field this year, my hair kind of grew out to kind of look like the Robert Downey Jr. Tony Stark's. I shaved my beard to get the little goatee. I got some pictures. I pull off a good Robert Downey Jr.

Patrick: You know, I actually thought we were on a field trip for the fossil record when we ran across the Iron Man set.

Ryan: We did, that's true. So, when Patrick and I were out, where were we? It was like the Mojave desert area, right?

Patrick: Well, yeah, we were out in the...

Ryan: Well, or, you know, Afghanistan if you're watching.

Patrick: We were near the Red, what was it, the Red Rock Canyon, is that right?

Ryan: Ah, I think so, Yeah.

Patrick: Basically, straight east of Bakersfield.

Ryan: Right.

Patrick: In the Sierra, on the west side of the Sierras, but just barely.

Ryan: And we came across, it's the movie set, even if you go back and watch the *Iron Man* 1 trailer, when he comes out of the terrorists cave and he's launching, or, you know, blowing flamethrowers, flamethrowers at everybody, that was the set we saw them building. And we asked them you know, what are you guys building. And they just shrugged, *Iron Man*, they just told us, they didn't care.

Charlie: Nice.

Ryan: They assumed we probably wouldn't survive the mountain. So... yeah.

Patrick: Yeah, it was cold.

Ryan: It was cold. We, we, it was, well, it was late in the year too, it was May or something and we had lunch. Even in the desert, we had lunch in the snow up on the mountain.

Patrick: Yeah.

Ryan: It was fun. Good trip.

Charlie: Deserts are cold. Mars is a desert.

Ryan: True. Except for 13 minutes a day.

Charlie: Yeah, desert just means dry.

Ryan: Ah, but back to the trailer, it looks like the government wants to get its hands

on the Iron Man's suit as you would if you were a government. And Tony Stark says no. And he's just living the high life as Iron Man, loving the celebrity, he's got his buddy, he hooked his buddy up, Don Cheadle, with a suit so he's going to be War Machine which is the actual character from the comics. And then Mickey Rourke decides to take him down.

Charlie: Well, I liked how he, he's, in the trailer at least, he's denied the government the use of his suit and, very coyly, and I thought it was very appropriate for this current economic climate, he was saying that he was going to privatize peace.

Ryan: Right. But he also gives a knockoff of his suit to his military liaison. So, not super consistent there. But, anyway, I, I don't know. I think it's, I'll probably, it's probably pretty obvious how we all feel about this trailer. Am I fair in saying that?

Charlie: Yeah.

Patrick: Ahhhh. Why not.

Ryan: I mean, I liked it. I loved *Iron Man 1*, that was great.

Patrick: I actually liked *Iron Man 1* better than I thought I was going to. So, I'm willing to give *Iron Man 2* a shot.

Ryan: Ah, Charlie?

Charlie: Yeah, I loved *Iron Man 1* and if this has got all of *Iron Man 1* plus alcoholism then it's going to be awesome.

Patrick: Yeah, the only hitch is that, the two, the two supervillains or whatever. Two villains.

Charlie: Yeah.

Ryan: I mean, you've got to up the ante. That's the problem. Well, I don't...

Patrick: I know. Thats' always a problem.

Ryan: I don't...

Charlie: What, what... I feel the same way as you Patrick. Why do these, why do the comic book movies have to have super villains. There's already enough wrong with the world, why can't they just be the guy...

Patrick: I don't even mind, I don't mind...

Charlie: ...these already intractable problems. Like methane clathrates.

Patrick: Right. I don't mind a super villain, I don't know why, like, the second one has to have two supervillains. And the third one has to have three supervillains. You have to have, you know, whatever number sequel it is, you have to have that many supervillains it seems like. If you follow the *Batman*...

Charlie: Till you have Mr. Freeze and then you fall off and start over again.

Patrick: Exactly.

Ryan: That's such a shame, Mr. Freeze has the potential to be...

Patrick: Well, yeah, once you get to three supervillains you have to add another, you have to add a sidekick.

Ryan: Well, he's getting a sidekick in the second movie.

Patrick: Yeah, well, yeah. So, it's two versus two. They're jumping the gun on that. They should have waited one more.

Ryan: No, they, they forecasted it in the first movie because...

Patrick: That's true.

Ryan: Ah, you know, Rhodes looks at the silver suit and just says next time.

Patrick: Yeah.

Ryan: I mean, he practically looks at the camera when he says it.

Patrick: Okay. Well, I'll still go long. Why not.

Charlie: I'll definitely go long, this is going to be rad.

Ryan: Oh yeah, I think we're a 100% long on this. I think, and I think we can all know what Justin would say. But Patrick has the best Justin impressions. So, let's hear it from the horse's mouth.

Patrick: Dude, that trailer was awesome.

Ryan: Yeah, I'll go see it, it looks great.

Patrick: I'll go see it, yeah, it looks great.

Ryan: So, we're four long on this one. I mean, how could we not be. This is, I mean, this is geek porn.

Charlie: Is there any other kind of porn?

Laughter

30:04

Music

Ryan: Is there any other kind of porn? I wouldn't know. How about that?

Charlie: Speaking of hot action, we'll now segue into warm blooded dinosaurs. Ryan's going to bring us this topic.

Ryan: Yeah. Yeehaw. I will. I'm going to bring it. Um, this is based, ah, this is based on an article I found on the Paleo Blog which is the blog of Michael J. Ryan, PhD at the University of Texas Austin. Patrick, you want to throw out a Hook'em Horns for all the listeners.

Patrick: Hook'em. Yeah, well, and, football national championship. It's a little early to start plugging that. I guess we've got another show before I have to do that.

Ryan: Sports.

Patrick: Sports.

Ryan: Um, so, this is a paper from Plos One, one of our favorite go-to journals, by Pontzer et al. coming out of Washington University in St. Louis and we had a request from a listener to get back to some dinotalk so that's what we're doin'. And this is that the biomechanics of running indicates that bipedal dinosaurs are warm blooded. So, or, to put it in the sciencey terms of the Plos One journal, said "Biomechanics of Running Indicates Endothermy in Bipedal Dinosaurs". So, did you guys have a chance to check this out?

Charlie: I did. So, they make measurements of the bones. That's all we got, right?

Ryan: Yes.

Patrick: Pretty much.

Charlie: And from the bones they can make some sort of estimate on the biomechanics or how these bones move against each other and how the animal may get around. And because of these measurements, the biomechanics are such that it would require enough energy demand on the muscles that are actually lifting and moving the bones that it would likely need an endothermic metabolism which is to say, a warm blooded metabolism. Is that half-way right? I'm a physicist.

Ryan: Yeah, pretty much. It's basically so that the height of the hip can predict the observed cost of locomotion with 98% accuracy for a wide variety of land animals. Um, so, looking at these fossilized leg bones we can make estimates that, as far as we know, are accurate with current living animals.

Patrick: Yeah, I feel like this argument mostly comes down to all the, all the animals that are still alive that are bipedal, also are endothermic or warm blooded.

Ryan: Well, what, I mean, you know, the prime example is you got things like us, kangaroos, most birds, but I mean, if we're talking, if we're trying to look at, ah, you

know, terrestrial dinosaurs, look at emus and ostriches, they're all warm blooded. All birds are bipedal and warm blooded.

Charlie: Well, I've, I've seen this lizard on YouTube once run across a stream.

Ryan: The basilisk lizard?

Patrick: Yeah.

Charlie: Yeah.

Patrick: Right.

Charlie: What about that guy?

Patrick: Ah, exactly. Like, he's, he's not endothermic.

Ryan: But he's also not...

Patrick: And so I think there are definitely ...

Ryan: He's not an obligate biped, he's...

Patrick: No, he's not, but he moves the same way, he has muscles that he can, that can move him, well, I, well, I don't know exactly, I'm not a 100% sure that he's moving the same way they are suggesting the dinosaurs moved in the paper. But I think he's capable of moving the way they are talking about.

Ryan: Mmmhmmm.

Patrick: Do you feel differently or are you just playing devil's advocate?

Ryan: Ah, I normally would, would admit to playing devil's advocate but, I mean, I think, the hip joint, so, when it comes to dinosaurs, the hip joint is so different than typical Lepidoptera, not Lepidoptera, that's not the right word, that's a butterfly. Ah, lepidosaur, a lizard...

Patrick: Yeah.

Ryan: ...the hip structure is so different that I don't think you can easily compare the bipedal locomotion of a lizard and a dinosaur. Maybe I'm completely off on that.

Charlie: No, that lizard definitely does have this like cowboy run to him.

Patrick: Yeah.

Ryan: Yeah, he looks like he's been riding a horse for awhile. One of the things, one of the most ancestral characteristics of dinosaurs is they have a really interesting hip joint. It's called a perforate acetabulum. Which means that it's basically, like, humans have a ball and socket hip joint so you've got ah, a rounded structure in your hip and then the top of your femur's got that ball on it. And it sits in there and rolls around all nice and smooth.

35:01

But it gives you a really nice range of motion and dinosaurs didn't have anything like that. And I don't know if I can explain it that well on audio but they basically, their hip had a hole in it and then the top of their femur was more like a peg that into a socket and just could really move really well in one plane of motion, back and forth but not so much in all directions.

Charlie: So, you couldn't get a roundhouse kick from a dinosaur.

Patrick: Yeah, probably not.

Ryan: No, no, you're safe. Feint to the left or the right, when you're kick fighting a dinosaur. Always.

Patrick: Yeah, Walker Texas Ranger could definitely take a dinosaur.

Ryan: Yes, definitely. Without a doubt.

Charlie: I had no doubt.

Ryan: I don't think any of us are worried about that. But the um, the basic idea of this paper is that some of the earliest dinosaurs were bipedal which means walking on two legs. And so they think, according to the conclusions of this paper that, ah, endothermy, which is also known as warm bloodedness, might have been an ancestral condition for all dinosaurs which is really interesting.

Patrick: You know, I, kind of been playing devil's advocate for this paper because I don't think it's the, the fact that there are bipedal, I don't think is the best evidence but I do think that probably, endothermy was an necessary condition for dinosaurs.

Ryan: Which is pretty crazy. I mean, that's pretty wild to think about. Because, I mean, you know, since, since all modern lizards are "cold blooded", and all modern birds are warm blooded. And those terms are not great terms especially in scientific circles, we tend to go with endothermy for warm blooded and ectothermy for cold blooded. But it's much more complicated than that. In biology, nothing is a clear distinction, it's all fuzzy, fuzzy lines and spectrums and things like that.

Charlie: As if there's been millions if not billions of years of evolution?

Ryan: Right. Exactly.

Laughter

Charlie: And that we weren't just created cookie cutter style.

Ryan: Ah, I mean, we were created in the image of something but most likely a hairless chimp. Um, but the idea, so, so, based on knowing that all reptiles are cold blooded and all birds are warm blooded and we know that birds evolved from dinosaurs, at some point you have to get a warm blooded dinosaur. Theoretically, which makes sense. And we always assume that it happened somewhere along the theropod line and theropods are the group that are the big T-Rex, velociraptor, you know, nasty...

Patrick: Running on two leg meat eaters.

Ryan: Yeah, yeah.

Patrick: Style dinosaur.

Ryan: Exactly. But now it's, they are pushing that development of endothermy much farther back, based on this line of evidence with the hip height and also the, just the evolutionary success of the dinosaurs. Because the dinosaurs were such a

successful group for so long, if they were competing against cold blooded reptiles, maybe being warm blooded was one of their best early advantages.

Patrick: I mean, I guess, I don't know. I mean, cockroaches have been really successful for a long time,their not warm blooded.

Ryan: But not against reptiles they haven't.

Patrick: I don't know. They're still pretty successful and we've got mammals and reptiles running around competing with them.

Ryan: True.

Charlie: Can you hunt at night if you are cold blooded?

Ryan: Not really. Unless you live on an thermal vent.

Patrick: Well, that's actually one of the, right, that's actually one of the, probably a split between mammals and reptiles, sort of early on, is that, and why most mammals smell much better than they see. Is because most mammals are nocturnal adapted. They're adapted for night hunting and reptiles are adapted for day living. And so, early on these two groups sort of, separated their, when they were out running around. They're not competing with each other directly.

Ryan: So, I actually ended up talking about a guy on the bus with this, because we were talking about the evolution of mammals and he was saying, you know, that mammals were reptiles at some point and I was, and Patrick, I think you understand this a little better than I do. But you've got the different skull types, the diapsids, the anapsids and the synapsids.

Patrick: Yeah.

Ryan: So, the synapsids are the ones that became mammals. This is all based on where the holes in the skull are, right.

Patrick: Yes.

Ryan: So, do we know at one point those synapsids became warm blooded?

Patrick: Ah, that's, no, that's really tricky. We probably more in the dark on that than we are on the reptile side of things.

Ryan: Alright. Cool.

Patrick: I'm just, I don't really study mammals so somebody may right in and tell me I'm crazy but...

Ryan: Hey, do it.

Patrick: You know, the things you would you know, mammary glands, or something you could look for but that, that doesn't fossilize well. Also, yeah, I don't know what else you'd look for.

40:02

Because, you, I was thinking, live young, but, you know, there's, you've still got the platypus and the echidna laying eggs in there that are definitely warm blooded so.

Ryan: Well, and mammary glands are the one, the one main thing that makes mammals mammals. That's where the word mammal comes from.

Patrick: Well, yeah, but, you know, we have a, we have a certain group we call mammals and it extends back into the fossil record and mammary glands may well have shown up before that.

Ryan: Yeah. So, I mean, this is a really expansive topic. There's a lot to talk about

here.

Charlie: Yeah.

Ryan: Especially, like, ah, there's some, there's some people that argue that some of the larger dinosaurs had what's called gigantothermy, which, basically, as you get bigger in size, the volume to surface area ratio changes pretty drastically, exponentially or geometrically or one of those really curvy graphs.

Charlie: Are you just saying, like, your conductive length scale gets large so you don't get rid of heat.

Ryan: Basically, yeah, you're...

Charlie: Get rid of heat is...

Ryan: ... so big that you hold in all your heat, exactly.

Patrick: It's basically why, if you have a really fat friend, you might find out, you might find that you get cold before they do in a movie theater or in an air conditioned car.

Ryan: Yep, yep.

Charlie: Or, less rudely put, it takes three hours to cook an ostrich egg and six minutes to cook a chicken egg.

Ryan: Yep. So, just the bigger you are the easier it is for heat to be retained and not seep out into the environment.

Patrick: Right.

Ryan: And, I mean, you know, like I said, there is a really fuzzy line between cold blooded and warm blooded. It's not simple at all. There's even warm blooded fish out there, tuna and great white sharks and makos and swordfish are all considered, for all intents and purposes, warm blooded, just because of how ah...

Patrick: Yeah, endothermic, they tend to maintain their body temperature pretty

well.

Ryan: Right.

Charlie: Does warm bloodedness make you delicious?

Ryan: I like cold blooded things too.

Patrick: Yeah. I suppose. Yeah, you know

Ryan: Lots of cold blooded fish that I eat. Probably going to eat some after the show.

Patrick: Salmon is probably cold blooded, pretty cold blooded.

Charlie: Yeah, you guys are making me hungry. I haven't eaten yet.

Ryan: Neither have I. It's a disaster. Yeah, but, the, I think the idea that the dinosaurs started off as warm blooded is pretty interesting. Have there been any other evolutionary lineages that have gone from being endothermic to ectothermic?

Patrick: Well, mammals had to do it at some point.

Ryan: What do you mean? We went from ectothermic...

Patrick: Oh, where you start as warm blooded and then go back...

Ryan: Right, because, I mean, um, yeah, well, one last thing to maybe touch on with this while researching a little bit more about just the whole science behind the different types of thermy out there, homeothermy, heterothermy, ah, ectothermy, gigantothermy, there's kleptothermy which is maybe my new favorite.

Patrick: Okay.

Ryan: Kelptothermy is where you're stealing heat from other animals. So, ah, a lot of animals will huddle...

Patrick: Yeah.

Ryan: Together to make warmth. Ah, elephant seals do this, they'll huddle together on the beach to stay warm.

Patrick: I mean, you can watch, you look at cows on a cold day and they are all standing right next to each other.

Ryan: Right. Which is...

Charlie: Yeah, I was going to say, humans do it.

Ryan: Humans do it and anacondas do it. Well, a lot of different snakes, actually, will do this. But I've read about young male anacondas will release female pheromones to attract larger, dominant males. Because anacondas form a breeding ball where there are all these males swarming around a single female, all trying to mate with her.

Patrick: Right.

Ryan: So, these, these young males will release the female pheromone, all the big males will come, wrap around the young male. They're all trying to mate with him but he kind of lacks the equipment, but what he's really doing is he's just stealing all their heat and then he get's super charged with warmth.

Patrick: Okay.

Ryan: Then he slithers off to hunt.

Patrick: He sneaks out of the ball, yeah. To hunt or he sneaks out to mate?

Ryan: Well, he sneaks out to do something.

Patrick: Okay.

Ryan: Not get mated with.

Charlie: There's definitely something klepto going on there.

Patrick: But I think he's...

Charlie: Somebody's making...

Ryan: Really, there are a lot of snakes that do that but I've seen footage of anacondas.
Patrick: So, I thought of ah, I think sloths are actually, you were asking me if any group had gone from being, sort of, endothermic to being, well, maybe...

Charlie: Ecto...

Patrick: Yeah, they're not really ectothermic, they don't really derive their heat from an external source which is what ectothermy implies, but they don't maintain a constant body temperature very well.

Ryan: Okay, so, really, really quickly, there's homeothermy and heterothermy, which, homeothermy is maintaining a consistent temperature all the time and then heterothermy is having a broader range of temperatures for which you can function. And then there's endothermy and ectothermy. And endothermy is creating heat from within you and ectothermy is getting heat from somewhere else. So there's...

45:02

Patrick: Right.

Ryan: So, there's, there's kind of a lot more terminology involved than just cold blooded. Sorry, I didn't mean to cut you off.

Patrick: Right. No, I was just saying that sloths actually fluctuate their temperatures, sort of fluctuate, rather...

Ryan: So, if you were sloth hunting you couldn't use thermal imaging to find them.

Patrick: Aaaahhh, I don't, I guess it would be less affective.

Ryan: They are also odorless.

Charlie: Well, they're also very hairy so the outside of their hair might be close to the environmental temperature.

Patrick: Hummingbirds also have a hard time maintaining the same temperature.

Ryan: Because they are so small?

Patrick: Yeah. It could be that crocodiles and alligators evolved from a lineage that was closer to being warm blooded than they are.

Ryan: Well, there's definitely a, there's a graph I was shown in one of my animal physiology classes that was on the x and y axis it was, you know, the spectrum between endothermy and ectothermy and on the, or, on the x axis it was endothermy to ectothermy, and on the y axis it was heterothermy to homeothermy and it had different examples of animals that fall within these different spectrums so you could...

Charlie: Oh, that sounds exactly like the political map where you have...

Ryan: Yeah.

Charlie: Fiscally liberal, fiscally conservative and then socially liberal and socially conservative.

Ryan: Exactly. Yup. So, I don't know. I find this stuff really interesting. And, ah, we were told to talk about dinosaurs. We listen to our listeners. How bout that? Cyclical.

Patrick: Unlike your congressman.

Ryan: Yeah. (Laughter) Yep. I can't remember which listener said that we need to talk about more dinosaurs and I've spent this entire segment trying to find that listener and I can't and I'm sorry but there's your dinotalk.

Patrick: Whenever our thirteen year old listener modified his review on iTunes, I think he asked for more dino-stuff originally.

Ryan: Did he? Well, the thirteen year old listener, which we should, write in, tell us your name so we can refer to you by name because you're awesome for listening to our show and we're sorry if we're a bad influence. I just want to throw that out there. Ah, it is s, sassdf, sassdf.

Music

Ryan: Um, well, should we move into listener feedback, now that we're...

Patrick: If we've got some, yeah. Bring it on.

Ryan: Well, okay, so, first of all, I really, really appreciate listener reviews and I think they're great and we got a great one this week by gonzo7497, I gave him a shoutout on the Facebook page, but he put up a great iTunes review and we've said it every episode but iTunes reviews really are the best. We're no longer listed on the new and notable. So, the more iTunes reviews we get the easier it is for people to find us and if you like the show you should also want people to find us. I think a couple of weeks ago we mentioned that Rob Jeffers gave us a great iTunes review. He was the guy that was running the 20 mile race and listened to the show during it and he wrote in so I was going to read out his email. It didn't really have a question in it but, well, it did have a question in it, so let's read out this email and we can try to tackle his question. So, you guys ready for a pop quiz?

Patrick: Ah, no, we're going to have to, I'm going to need some research time to address this question.

Ryan: Ah, right, well, that's what editing is for, so, here's this email.

Charlie: I have nothing to loose.

Ryan: "Paleo Pals, I recently had to do a 20 mile run. I usually listen to a podcast to keep my mind off of the discomfort associated with running. I happened upon your podcast and listened to four episodes that day. You got me through some tough miles and every time you mentioned that you were drinking it motivated me to finish so I could grab a brew. I'm a big fan of Guinness, or, I'm a big Guinness fan and I agree if it was the only, if I was only to have one type of beer for the rest of my

life it would be Guinness. Also agree that Chipotle beer sucks. Thanks for getting me through the miles. I look forward to new episodes. Not sure if you focus on biophysics much but would love to hear how endorphins work. I sure as hell don't feel them especially after running 20 miles." - Robert Jeffers. So...

Patrick: I don't know how endorphins work.

Ryan: Endorphins plug into your brain. They're, ah...

Charlie: Yeah, I don't know how they biophysically or biochemically work but as I understand it, if you are experiencing pain then you, something, some gland in your brain secretes endorphins and it, it helps mask, it masks these pain sensations, both mental and physical pain.

Ryan: Ah, I believe they are a polypeptide neurotransmitter, they're made in the pituitary gland and the hypothalamus invertebrates, and there's five, ah, five instances in which they are produced. They are produced during exercise, high levels of excitement, high levels of pain, ah, weirdly enough the consumption of spicy foods so when you were sweating last night Charlie, that was endorphins.

50:07

Charlie: Indian food is the best.

Ryan: And orgasms.

Charlie: So it's not, so it's not only, I guess, some food that get's rid of pain but it's also a reward.

Ryan: It's ah, it's an analgesic. So, ah, which is pain relief and a feeling of well being. So, endorphins are said to be like a natural pain reliever that your body creates. They are very chemically similar to opiates. So...

Charlie: It also sounds like a natural motivator because...

Ryan: Because you wanna work to get that, ah, it's the runner's high, so, the runner's high is created by endorphins.

Charlie: My laymen's interpretation of it was that it was something that would mask pain but it's, I mean, there's no pain in sex so it's obviously a motivator of sorts as well.

Ryan: Yes, it's a...

Patrick: Well right, like, they give you morphine when you're in pain in the hospital but people also, you know, take heroine when they're not in pain just because they like it.

Ryan: Well, I'm glad you brought up morphine and heroine because the endorphin chemical, the endogenous opioid polypeptide, which you might have noticed the word opioid in there, is ah, chemically, it is very, very similar to an opiate. And opiates are a class of chemicals that include morphine and heroine.

Patrick: Sure.

Ryan: So, you've got this, if you think of it like puzzle pieces in your brain, your brain has these kind of slots and some of those slots are endorphin shaped. So when the endorphins come along they plug into these slots and your brain experiences the sensation that your endorphin creates. So, if you were to take morphine or inject yourself with heroine, those chemicals are similar enough that they can fit in the endorphin slot.

Patrick: Yeah, people often describe heroine as feeling like an intense, long orgasm.

Ryan: Right and that's because you're actually plugging a foreign chemical into the slots that something, that's only supposed to be something that your brain produces. So, if you, when you get addicted to heroine, basically, your body will stop producing endorphins because if you are injecting opioids into your body all the time, you're plugging it into those receptors, you're body is recognizing that you're getting all of these endorphin plugins happening all the time, so why waste the energy making its own endorphins if you're going to put them in anyway. Which is why coming off of heroine is so difficult because you're not getting anything plugged into those pleasure receptors and you can basically no longer feel

pleasure.

Charlie: Well, coming off heroine can even be deadly so, do, endorphins fulfill some sort of bio functional role that's essential to our survival?

Ryan: That I do not know. That might just be part of the, you know, physiological acclimation to any type of new chemical stimuli but, ah...

Charlie: Right.

Ryan: But that's, that's a little bit about endorphins.

Patrick: Yeah, and I would say that, you know, Rob may not get the runner's, well, first of all, the runner's high is not, probably not just endorphins but it's epinephrine, serotonin and dopamine as well.

Charlie: Well, it sounds like he is going on incredibly long runs.

Ryan: 20 miles is insane.

Charlie: Yeah, it, that would cause a lot of trauma to the body. I've gone on long runs and it's definitely hard work and the fact that he can continue to run that length of distance and not, like, hole up in the fetal position and start crying means that there is something mitigating the pain.

Patrick: Right.

Ryan: Kids, don't do heroine.

Patrick: Or run 20 miles as far as I'm concerned.

Ryan: No, they can run 20 miles, I'll let them do that but don't do heroine.

Charlie: Yeah, there's no free lunch. You've got to earn it.

Ryan: Yeah, go get a prescription for morphine and do it legally.

Patrick: Um, so, I guess, some people, say that the runner's high doesn't...

Ryan: What were you about to say about the runner's high Patrick?

Patrick: Ah, some people think it's, it's from the challenge. So, Rob may be too good at running 20 miles now. He may need to run 30.

Ryan: We're sorry Rob.
Charlie: Or run faster or run uphill or run without shoes.

Patrick: Right. Ah, the other thing is, maybe you're just not that, you know, maybe, you know, some people are way more susceptible to heroine, or to addictions in general and maybe your brain is just not predisposed to feeling, you know, opiates or opioids, so, maybe that's a good thing though.

Ryan: But, okay, so Rob, here's what you do. Before your next 20 mile run, don't strenuously exercise, don't experience any excitement, don't experience any pain, don't eat anything spicy and don't orgasm and let your brain get ready for the rush of endorphins when you start running.

Patrick: Or, have the orgasm and skip the run.

Laughter

Charlie: I think that's better.

Patrick: That seems like a more surefire plan to me.

Ryan: Guys, we have, we have young listeners. This is inappropriate.

Patrick: It's not the first time anyone's said orgasms. Why are you, we've already said it like six times this...

Laughter

54:58

Ryan: I didn't know that we had young listeners before. Now we've got them on iTunes reviews. But, we did have one other, one other iTunes review that I wanted to mention very quickly. It's a short one. Ah, Dipping into the pit of despair wrote that he "can now get his weekly dose of science, entertainment and media all in one package! Thanks, the Paleo Pals are great." And we really, we really appreciate the iTunes review, we really love the emails, I hope we, ah, Rob, I hope we covered endorphins enough for you that you now know that you can either run twenty miles or simply have an orgasm.

Patrick: Ah, I would like to say that since we are no longer on the new and notable, or new release section on iTunes, that if people have an office or a place they feel comfortable hanging up a Science sort of flyer they should send us an email at paleopals@sciencesortof.com and express the fact that they have such a place of honor for a Science sort of flyer.

Ryan: That's way too much work. That's way too much work Patrick.

Patrick: What are you talking about? You just print it out and put a piece of tape on it. Hang it anywhere you want.

Ryan: No, I meant, it's way too much work for them to have to email us to get that flyer. We're going to put that flyer up on the website and if you want the flyer you can go download it there. It's a pdf, it's just one sheet, it's beautiful and it's color and if you want it you can go get it there. If you really want to email us to get the flyer I'd be happy to take care of the email but we can also put it on the website and make it super easy to get.

Patrick: Good call. Either way.

Charlie: I like that. I like how you made it easier and easier. It's kind of like the $39.95, no $29.95, $19.95.

Ryan: But wait, there's...

Patrick: Three payments, you have to visit the website three times.

Ryan: But wait, there's more. If you download the Paleo Pal flyer you'll get four new

friends. But the iTunes reviews, they're great. I love seeing when we get an iTunes review. It makes my day. And I also love all the Facebook, the Facebook action that's been happening.

Patrick: And if you're searching for, ah, last minute solstice gifts, it probably isn't too late to log on to Sciencesortof.com and check out the Paleo Pals about pages where we have individualized solstice shopping lists that you can link easily to and choose expedited shipping and get it there in time for solstice.

Ryan: Also, any of our previous episodes, ah, have plenty of stuff that we talk about that is available for purchase through amazon and there are links in any of the show notes. So, if you remember a specific show that you had something you liked you can get it there. And so, if you would also like to have yourself and your comments talked about for twenty minutes or longer, however long this got edited down to, ah, feel free to get in touch with us. You can email us at Paleopals@sciencesortof.com or go to the website sciencesortof.com and leave a comment on any of the show notes or go to our Facebook page, leave a comment there. I always respond to Facebook posts, every single one, nobody get's left out. And, ah, yeah, there's twitter, twitter.com/sciencesortof if you follow us we'll follow you back, will reply to your tweets and start the conversation that way, it's a lot of fun to be on Twitter. A lot of good tweets coming out of AGU in the past week. And that's pretty much it. You've got more ways to get in touch with us than excuses to not so go and do it.

Charlie: Right, and have a happy winter solstice and your Paleo Pals will be bringing you straight on through this decade into the next decade so be sure to tune in and download your podcasts all throughout 2010.

Ryan: As far as I know we're not taking a break. We're, ah, an episode a week. No joke, make it happen. I'm here.

Patrick: That's right. Since the beginning. For 16 straight weeks now.

Ryan: For 16 straight weeks and no holiday break. We're not like those tv shows that you watch, that take breaks. We're here every week. Although I did come up with an idea for a tv show for the Paleo Pals, by the way.

Patrick: The Paleo Pals?

Ryan: It would be like a Saturday morning cartoon show. It would be the four of us in lab coats and we'd all have, like, an element, like earth, fire, wind, water. So it would be like *Captain Planet* but we would be in lab coats and instead of summoning Captain Planet, we would summon the Brachiolope and he would wreak havoc on our enemies.

Patrick: Take care of business.

Ryan: He would, he would. He would spear them on his moose horns.

Patrick: Like, ah...

Charlie: Eat all the methane clathrates.

Ryan: He would.

Patrick: Like Elvis.

Ryan: Yes. Exactly like Elvis.

Patrick: Ah, alright, well...

Charlie: Alright. Thanks for listening to the 16th episode, the special solstice episode of Science sort of and we will see you again next week. Hopefully we kept you warm with our discussions of warm blooded dinosaurs and methane clathrates.

Patrick: Our winter warmers.

Ryan: I wonder if dinosaurs farted methane like cows?

Patrick: Ahhhh, the herbivorous ones probably did.

Ryan: I think you're right. Alright, anyway, byeeee.

Patrick: See you next week.

Charlie: Bye.

Patrick: Bye.

Announcer: Thanks for listening to Science... sort of. Our show notes are available at sciencesortof.com which will have links to all the stories we talked about today. You can follow us on twitter at twitter.com/sciencesortof. You can get in touch with us at paleopals@sciencesortof.com or on our Facebook fan page. A great way that you can support the show is by subscribing to our feed on iTunes and writing a review so other people have a better chance of finding the show. And if you have a friend who you think might be interested tell them to give us a try. That's all for this week, thanks for listening and see you next time on Science... sort of!

1:00:33

Music

Charlie: Alright. So, as the host, how do I introduce the topics? Do I just...

Ryan: As awkwardly as possible.

Charlie: We went to the California Academy of Science, it was awesome.

Ryan: We did, oh that was so much fun. We saw...

Patrick: When did you...

Ryan: We saw Jupiter with our eyes. What did you do Patrick?

Charlie: With our own eyes! Or with a telescope. A lens going through a lens going through the lens of our eyes.

Ryan: Well, it was really...

Charlie: It may not exist.

Ryan: And it was really just one of our eyes. Have your people call my people. My people is Justin.

Laughter

Patrick: He loves publicity.

Ryan: That's true.

Patrick: He's a media, a media hound.

Ryan: That's why he's not here. He's probably off hanging with Robert Siegel.

Patrick: Yeah.

Ryan: And Robert Siegel jokes.

Patrick: Ann Taylor.

Ryan: Terry Gross.

Patrick: Ira Glass.

Ryan: Again, Ira Glass is PRX, or PRI. He's...

Patrick: I think they're good buddies though.

Ryan: Ira Flatow is the NPR one. Both of the public radio networks have their Ira.

Patrick: Kai Ryssdal

Charlie: Michael Krasny.

Ryan: I really think that it's maybe the most dorky thing we've ever done. Just sit here and list the people that we know on NPR. So, I'm...

Patrick: Carl Kasell.

Ryan: Peter Sagal