00:00 Sarah Crespi: This week's episode of the Science Podcast is brought to you by Bayer. Bayer develops digital tools to help farmers use less water to grow their crops. From advances in health to Innovations in agriculture, Bayer is Advancing Science for a Better Life. At Bayer, this is why we science.

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00:22 SC: Welcome to the Science Podcast for November 20th 2019, I'm Sarah Crespi. So this is our last episode of 2019. We'll be off next week and then back the first week of January, and in this special round up edition of the Science Podcast. We have online news editor, David Grimm. He's gonna walk us through some of the most remarkable online news stories from the year, news editor Tim Appenzeller, is gonna reveal the breakthrough of the year, and some other runners up, as well as some breakdowns in science and politics. Last up, we have books editor, Valerie Thompson, she's gonna share the top science themed books, films and games from 2019. These are things you might wanna read yourself or maybe give someone else as a present. For the first segment of our year in review episode we have David Grimm, online news editor for Science, he's gonna walk us through some of the remarkable stories from 2019. Hi Dave.

01:22 David Grimm: Hey, Sarah, how are you?

01:23 SC: I'm good. So I say remarkable because these aren't necessarily somehow quantitatively the best stories from the online site, right? How did you compile this list?

01:36 DG: So every year, we do our top 10 favorite science news stories of the year and these are very rarely the biggest breakthrough discoveries of the year. We leave that to the breakthrough of the year team for that but these are our collection of our most popular stories of year along with some of our personal favorites as well. The stories that we just really loved reading, or we thought it was a really interesting topic, even if it wasn't going to necessarily change the world.

02:01 SC: I wanna warn our listeners. We're gonna only do a couple and then they'll have to see the rest online.

02:06 DG: That's right. That's right.

02:06 SC: I wanna start with this one, about self-domestication, which actually first learned about doing a podcast interview with you. But this was on self-domesticating mice.

02:21 DG: Right.

02:21 SC: Can you just tell us what self-domestication is.

02:24 DG: We all know what domestication is, right? Dogs used to be wolves, and when wolves

became dogs, they didn't just become friendly, a lot of things changed. They were able to wag their tails and their colors changed and they got floppy ears, and all this other stuff. And we see that when most animals become domesticated. It's not just a matter of tameness it's actually their physical features change as well. And what's really interesting about people is, our physical features have changed as well over time, for example, compared to our distant ancestors, our brains are bigger, but our skulls are actually a bit smaller. We have less pronounced brow ridges. There's this idea that... Well, we must have undergone some process of domestication. And there was nobody to domesticate us. So we must have...

03:07 SC: Yeah. Unless you believe Alien Overlords.

03:09 DG: That's right, right now unless you believe in something like Prometheus.

03:12 SC: This is the idea that there might be human self-domestication.

03:16 DG: Exactly.

03:16 SC: How did that work?

03:17 DG: Well basically the idea is: Is that when we first started to come together and form more stable social groups and societies, it would have been very disadvantageous to have people in that group that were highly aggressive. Super-bullies very anti-social. Because then the group the village the society wouldn't work, and so the idea is that we may have kicked these bullies out and by doing so we sort of selected against perhaps certain themes, certain traits and over thousands, tens of thousands, perhaps, even hundreds of thousands of years, this wouldn't have just selected for people that were nicer and more cooperative with each other, but actually according to this study, which looks at a particular gene that seems to be involved in domestication of other animals. This gene is showing a lot of selection in humans and it's not showing some of our other relatives like Neanderthals and Denisovans the idea is that it wasn't just our temperament that changed, but there also may have been physical features that changed as well.

04:12 SC: Oh, so we're nicer than Denisovans, we're prettier than Neanderthals.

04:17 DG: Well, something like that right exactly... Or at least, the group that gave rise to modern humans was theoretically more anti-social, and maybe not as attractive at least as we view attractive in the modern age, as we are today.

04:30 SC: We're all beautiful people, Dave.

04:31 DG: We all are beautiful people.

04:33 SC: Okay, my favorite from this list is actually more like a thought experiment, it's this idea that, If dark matter were all around us we would be in big trouble.

04:46 DG: Yeah, this is also one of my favorite stories of the year, just because it's so weird. And

so, the basic idea is that scientists have been looking for evidence of dark matter for a long time. Dark matter is this stuff. It's just a really elusive substance, it makes up about 85% of the universe. But we haven't found a good way of actually detecting it. So the idea is, if there's this type of dark matter, very heavy particles known as macros. And if they existed, they would be very destructive and so destructive, in fact that there would be basically people dying all around us. Well, I don't know how frequent it would happen. But there would be a lot of unexplained deaths. There would be sort of gruesome deaths. You'll be seeing people dying unexplained at these gunshot like wounds, these tubular wounds through these bodies that vaporize their flesh as they pass through.

05:32 SC: Wow. I haven't seen... Yes, okay.

05:35 DG: And so what these researchers did, they looked at all these death records for a bunch of different countries and they said, "Well of the unexplained death cases are we seeing any wounds like this? And they did not, and so their conclusion is, "Well this particular type of dark matter probably doesn't exist.

05:50 SC: Oh, okay, one thing that we do know exist, but that's very hard to find, is this hidden continent buried beneath Europe. It's kind of a shocker. I think for a lot of people. This did really well on the site.

06:04 DG: It did.

06:05 SC: How can you hide a continent under another continent?

06:08 DG: Yeah, this is also a really cool story, this is a cool geology story. So this is a continent that was known as greater Adria. And it was around a couple hundred million years ago, and we knew it existed, and we sort of knew that today it sort of exists below Southern Europe, it's sort of buried under Southern Europe, but we just didn't really know exactly how it got there. And so, what this team did, in this study way back from September, is they used some geological samples some other data to try to reconstruct the history of this continent, where it started out. And how it got under Europe.

06:43 DG: And basically what they concluded is that about 140 million years ago, this thing was about a Greenland-sized landmass. It was largely submerged in a tropical sea. And basically then it collided with Europe around 100 million to 120 million years ago. And as it did so, it shattered into pieces and was shoved beneath the continent. And what's really cool is there's actually remnants of Greater Adria today. There's a... Some of its rocks that were scraped off the collision, still remain on Earth's surface and actually can be studied and analyzed by geologists. But it's fun because we always think of... When we think of lost continents, we think of something like Atlantis which is... But this is...

07:18 SC: No, but it's under the sea, Dave. That's...

07:20 DG: I'm sorry. I won't say it's a myth, it has yet to be discovered. But this is the real deal. This is an actual lost continent, we know where it is, and we even have some pieces of it left that we

can find today, which is pretty cool.

07:33 SC: Yeah. Well, the last story we're gonna talk about is something that basically really attracted my attention because of the headline, has the term Wood Wide Web in it. So what is that?

07:46 DG: It's not trees using the Internet, as fun as that would be, but it's...

07:50 SC: Or a tree-based internet.

07:52 DG: Or a tree-based internet. [chuckle] What it is is basically there are lots and lots of trees around the world. A lot of the forests are actually interconnected, and what helps interconnect them are these millions of species of fungi and bacteria. They swap nutrients between the soil and the roots of trees. They essentially form this vast interconnected web of organisms throughout the woods, hence Wood Wide Web. And for the first time in this study, scientists actually map this Wood Wide Web on a global scale. They looked at 28,000 different tree species living in more than 70 countries. And they really got a sense for how this thing is spread out throughout the Earth, and how it functions in the places where it's very active.

08:30 DG: And they found some cool things like in the tropics where wood and organic matter decay quickly, there's a certain type of fungi that dominates in the Wood Wide Web there. And in other places like temperate, and boreal forests, where the wood and organic matter decay more slowly, there's a different kind of fungi that rules. So it all seems a little bit esoteric. But these researchers feel if they can get a real good handle on this, this is a big question. As the climate changes, as more greenhouse gases are pumped into the atmosphere, how much are trees gonna be able to help us in terms of sequestering some of this carbon dioxide, and potentially help us combat climate change a little bit? And studies like this can give us a better sense of not just the trees themselves, but how the communities that they live in can really affect this process.

09:16 SC: Very cool. Okay Dave. That's the short run down that we're gonna do. There's a few more favorites, including the Top Number One from 2019 online. And then also tomorrow, you're gonna put out an article for the Top Online News Stories from the Decade.

09:33 DG: That's right. So today on the site, we'll have our Top 10 of the year, and that will include our Number One, which is also our most popular story of the year.

09:41 SC: Wow. And it's from what? November?

09:44 DG: Yeah, it actually... It just came up a few weeks ago. It's amazing it's generated as much traffic as it has. When you see it, you won't be surprised. And you'll actually even be able to interact with it a little bit, if you want to.

09:54 SC: So many clues.

09:56 DG: And yes, tomorrow on Friday we will be, for the first time in our history, we'll be posting the Top Stories of the Decade, or at least our favorite stories of the decade. That's culled

from our Top 10 list of the past 10 years. Which are the stories have stood the test of time, which have remained our favorites over the years. So that'll be a really fun list as well.

10:17 SC: For sure. Okay, thank you so much, Dave.

10:19 DG: Thanks, Sarah.

10:19 SC: David Grimm is the Online News Editor for Science. You can find a link to his round-up of the Top 2019 stories online. And eventually I'll add a link to the notable stories for the decade, all at sciencemag.org/podcasts. Stay tuned for an interview with Science News Editor Tim Appenzeller, about the Top Science in 2019.

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10:46 SC: This week's episode is also brought to you in part by LightStream. The holidays are here. This year give yourself the gift of extra money in your pocket. Pay off your credit card balances, and save with a credit card consolidation loan from LightStream. Roll your high interest credit card payments into just one payment at a lower fixed rate. LightStream's credit card consolidation loans have rates as low as 5.95% APR with auto pay. You could save thousands in interest. There are no fees, absolutely no fees, no application fees, no origination fees, no transaction fees, no pre-payment penalties. The application is quick and easy, and you can apply right from your phone.

11:30 SC: LightStream believes that people with good credit deserve a better loan experience, and that's exactly what they deliver. For just our listeners, apply now to get a special interest rate discount. The only way to get this discount is go to lightstream.com/sciencemag. That's L-I-G-H-T-S-T-R-E-A-M.com/sciencemag. Subject to credit approval. Rate includes 0.5% auto pay discount. Terms and conditions apply. And offers are subject to change without notice. Visit lightstream.com/sciencemag for more information. This week's episode is also brought to you in part by KiwiCo. KiwiCo creates hands-on projects for kids of all ages to make learning about STEAM fun. This holiday season, a KiwiCo subscription makes a perfect gift for every young explorer, engineer and artist in your life. KiwiCo is defining the future of play, by making it engaging, enriching, and seriously fun. They create hands-on projects and toys, designed to expose kids to concepts in STEM, art and design. Their mission: To help kids build creative, confidence and problem solving skills, and have a blast while doing it.

12:45 SC: There are seven lines to choose from, catering to different age groups and topics, like the Panda Crate for babies, or the Eureka Crate for kids 14 plus. Each box comes with all the supplies needed for that month's project, plus detailed kid-friendly instructions. KiwiCo projects are available via flexible monthly subscriptions, or for individual purchase. They have gifts for kids of all ages. So there's something for everyone on your list. You can buy one box, you can buy a couple of months. Options are endless. KiwiCo is offering you the chance to get your first month for free. To redeem this offer and learn more about their projects, visit kiwico.com/magazine. That's K-I-W-I-C-O.com/magazine.

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13:32 SC: Now, we have sciences news editor Tim Appenzeller, he's here to talk about the breakthrough of the year, the runners up and a few breakdowns. Hi Tim.

13:44 Tim Appenzeller: Hi Sarah.

13:45 SC: I'm gonna break with tradition a little bit this year and start with our breakdowns, then we'll go to the runners up and finally the breakthrough. I figure we'll just build a little suspense here.

13:57 TA: Sure.

13:58 SC: First I wanna talk about one of the so-called breakdowns. This is when things don't go right. What exactly is categorized as a breakdown?

14:06 TA: So, well in the world of science, things don't always go well. And we acknowledge that every year, and this year we chose some of the biggest breakdowns, not necessarily in Science itself, but in topics that are related to science.

14:21 SC: Yeah, it always seems to be that politics are involved with the scientific breakdowns.

14:26 TA: They are in basically in all of the breakdowns that we chose this year.

14:33 SC: This first one that we're gonna talk about is a really good example of that. So it talks about a little bit about the science of climate change, but it also talks a lot about how political bodies are dealing with it. Can you talk about it a little bit?

14:44 TA: This year we saw a weird gulf between popular perceptions of climate change, and what's happening at the political level. Poll after poll showed this year that the public, in particular in the US, is really waking up to the reality of it. People are accepting that it's happening, that it's caused by human activity and that it's urgent, that's the majorities of people and that's a big change from earlier years.

15:10 SC: Yeah.

15:11 TA: But we're not seeing political action to match, instead in the US and several other countries things are really going backwards.

15:20 SC: This is a loosening of regulations, a lack of commitments at the international level, those kinds of things.

15:26 TA: That's right. On the bigger scale, the global energy picture, it's not very bright, the renewable energy is increasing fast, but it's such a small proportion of global energy that it hasn't bent the curve much. Greenhouse emissions are continuing to rise.

15:42 SC: There are a few more breakdowns on the site and you can check those out, but I now

wanna switch to our runners up Tim, how does something become a runner up for Breakthrough of the Year?

15:54 TA: We come up with 10 developments, any of which could be the breakthrough. And then we have a lot of wrangling about what actually is the breakthrough. So, a runner-up is really a runner-up. It could be the breakthrough, if our debates had gone another way.

16:09 SC: Whatever people describe this process, there's a list, there's a spreadsheet, there's meetings, but it actually is kind of interesting to be in on those talks and hear people make the case for these different runners.

16:21 TA: Yeah, to tell you the truth, we actually had three different breakthroughs on different occasions this year and we finally settled on one we're very, very happy with.

16:30 SC: Oh, for sure, let's first tackle this one, that's a runner-up. It's not the breakthrough, it's on computing. This is an AI that can play poker really well. What makes this so noteworthy?

16:42 TA: Well, it's the first AI that can beat humans at multi-player games. It has a far more flexible strategy than earlier game playing AIs.

16:53 SC: So those ones were good at checkers or Go even, which has a lot of moves, but it's still just two players. Is this computers are just gonna be better at us at all games from now going forward?

17:04 TA: Well, it's kind of looking that way. As our writer said at the end of his item, it may be time that humans cash in their chips.

17:13 SC: Yeah, I feel like Adrian had the best kickers in all the runner ups this year. Okay. Let's talk about this next runner-up that kinda ran away with the People's Choice votes, it didn't get the nod from the editors. But this is the people's choice vote, and this is a new Denisovan bone, new Denisovan proteins from a new most excitingly location. What makes this find so important?

17:37 TA: Well, it's actually two finds. The first one is, as you say, proteins from a jaw bone in Tibet, found in a monastery. Now Denisovans, until now, had only been known from one cave in Siberia, so we didn't really know how widely they ranged. Now they found a jaw bone, identified from proteins as you say, as Denisovan that comes from hundreds and hundreds of kilometers away. So, we know they were wide ranging, but there was a second discovery, which is the use of a new technique based on modifications the DNA which can turn off genes, and they analyzed Denisovan DNA from that cave in Siberia that I mentioned, using this technique which gives you an idea of what genes were active and they matched that to what's known about genes and anatomy in people today. They were actually able to reconstruct the general outlines of a Denisovan face.

18:30 SC: You have the DNA methylation but you also have a jaw bone, which can kind of confirm this facial planning that you did from the genes.

18:37 TA: Yeah, exactly, it was a nice match.

18:40 SC: Alright, let's go really far back in time. We have a runner-up that basically gets at the branches at the very base of the Tree of Life. We're talking about the origin of eukaryotes, can you tell us what those are and what's the big mystery here?

18:54 TA: It's really about the deepest question you could ask about life. How many giant branches of life are there? And there are people who have said there're really three, there are bacteria, there are eukaryotes, creatures like us with cell nuclei and there are these weird microbes called archaea. Well, other people have argued that actually archaea are the ancestors of eukaryotes as well, so there're really only two big branches or domains of life, archaea and bacteria with us and mushrooms and plants, as offshoots of the archaea.

19:31 SC: But we're talking about something that happened, what? 3 billion years ago. So, how are the researchers getting at this?

19:37 TA: They do it through genetics, but this year they found a new clue, which is a kind of archaean called Lokiarchaeota and they were able to culture it and sequence its DNA. And they found that it has genes that resemble the genes in eukaryotes which really supports the idea that eukaryotes evolved from some microbe like this, of course, it wasn't exactly like this 3 billion years ago. And what's more, it has tentacles and those suggest a way that the ancestral eukaryote, which was still an archaeal microbe, could have engulfed other microbes to create complex cells.

20:16 SC: Wow. One more runner-up, and this one from, basically, very recent time. This is about the ongoing crisis with Ebola and the fact that there might actually be a treatment that could help with some of these outbreaks that you've seen. What happened in 2019?

20:34 TA: Well, 2019 saw a terrible outbreak in the Democratic Republic of Congo, which is still going on. In the course of that outbreak, researchers were able to test four potential drugs for treating people with Ebola. Two of them are antibody drugs, and they worked, they reduced mortality substantially. This is the first actual treatment for Ebola, effective treatment for Ebola. There is a vaccine that appears to work and there is supportive treatment. But this is a drug you could give people who are suffering.

21:07 SC: This is really amazing that it was developed and rolled out in the midst of an ongoing crisis.

21:13 TA: That's right, and one of the antibody drugs is derived from the antibody of someone who developed Ebola decades ago, in Congo.

21:22 SC: Wow. Well, I think we should leave the rest of the runners-up. There are five more, you can find them on the site, and we're gonna move on to the breakthrough of the year. Okay, Tim, what is Science's 2019 Breakthrough of the Year?

21:36 TA: Well, it sounds like magic. It's the first picture of a black hole.

21:40 SC: [chuckle] And what does it look like, for people who are not looking at the cover or the inside of the magazine, right now?

21:47 TA: Well, it's a glowing ring that kind of outlines the shadow of the black hole itself. Of course, black holes pull in light and everything else, you can't see into the black hole. But this is a ring of light from matter whipping around the black hole, right at its very edge, it's so called "event horizon." And it's such a sharp picture, although it looks a bit fuzzy on the page, that you can actually see the shadow of the black hole itself.

22:12 SC: So what makes this a breakthrough?

22:17 TA: Well, two things. First of all, it's just amazing, right? This is one of the most mysterious objects in the universe, something that, by definition, you can't see. And yet, we figured out a way to image it. And the second thing is that it was such a feat of technology. The first thing it took was really, really high resolution, because black holes are small, even the most massive of them are small. And this is a very heavy black hole, weighing millions of times the mass of the sun, of the center of another galaxy. It's really quite tiny, so they needed a really high resolution telescope to see it. And they did it by networking radio telescopes on several continents, and then combining their data to create the equivalent of a telescope that was almost the size of the whole earth. And the size of the telescope translates into really high resolution.

23:09 SC: Which black hole are we looking at?

23:12 TA: It's at the center of a neighboring galaxy called M87.

23:15 SC: So we have our own black hole, and it's closer to the center of our galaxy. Why did the researchers choose to focus on M87, and not Sagittarius A star?

23:26 TA: For one thing, the M87 black hole is a whole lot bigger, it's also a whole lot farther. So it's as big on the sky as our own black hole, in the center of the Milky Way. But it also, because it's bigger, it changes more slowly. These observations by radio telescopes took quite a while. And, during that time, our own galaxy's black hole changes, as stuff swirls around it and the jet that squirts out of the pole of the black hole changes. And so, basically, all that blurred the image, just the way something moving blurs a photo. The changes in the M87 black hole are slower, so they got a crisper image.

24:03 SC: So is that what's next though, trying to get a look at our own black hole?

24:06 TA: Yes, they would like to create an even bigger network of telescopes and take sharper observations of our black hole, and maybe see it changing over time. Basically, creating a black hole movie.

24:17 SC: Are some of the observations in this picture or in our ability to take it, do they help us understand black holes?

24:25 TA: So, so far, the image is sort of triumphant confirmation of what we knew about black holes and how they behave. But when they get sharper images, and especially when they get images of how the matter around the black hole changes over time, they'll almost certainly learn something new about how these monsters work.

24:44 SC: Thank you so much for coming on.

24:45 TA: Well, thanks for having me.

24:47 SC: Tim Appenzeller is the news editor for Science. You can read more about the breakthrough, runners-up and breakdowns at vis, that's vis.sciencemag.org/breakthrough2019. Don't touch that dial. Books editor Valerie Thompson is up next, with books, films and games for the science lover in your life.

[music]

25:14 SC: And we're gonna end the show, and the year, with our books editor, Valerie Thompson, welcome back. Hi, Valerie.

25:20 Valerie Thompson: Hi, Sarah.

25:21 SC: Okay, we got a great mix of things to talk about, books, films, even games. You've really expanded your empire beyond the written word this year.

25:30 VT: Books are always gonna be our bread and butter, but there's so many other interesting platforms out there that we're interested in covering: Films, and exhibitions, and performances. And I think our readers probably are interested in learning about these other areas too. So that's why we're doing it.

25:47 SC: Yeah. Well, let's talk about a few of the books that you really enjoyed this year, kind of your top picks.

25:53 VT: Okay, so the first one, so this year marks 150th anniversary of Mendeleev's Periodic Table. So I knew I wanted to choose a chemistry book, and this book that I've chosen, I would have recommended, regardless. So, Kit Chapman's Superheavy. The name for this book comes from the so-called "superheavy elements". Those are the elements with atomic numbers greater than 103. These elements aren't found in nature. We can make them in the lab, temporarily. Some of them have half-lives of hours, if not seconds, and at great expense. They don't really have any known uses, so it's like kind of, "Why do we do this?"

26:16 SC: [chuckle] Right. So it's climbing a mountain, you could just do it to get there.

26:16 VT: [chuckle] Well, I think element hunters say that it's important, because we wanna understand what happens at these extreme limits of matter, and that these elements could have

unexpected chemical properties that could change how we think about the rest of the periodic table, so...

26:16 SC: And we... We don't actually know if there's a peak to the mountain. I mean, it could be that the table just goes on forever.

26:16 VT: Yeah. And I mean, like, don't you wanna... Like, I wanna know. I wanna know that. The book doesn't exactly wade into the debate of whether or not we should be doing this. It just sticks to the stories, mostly of the scientists who've done this work, which is something else that I liked. It doesn't just talk about the big name scientists that we know like Ernest Lawrence or Glenn Seaborg, people who have elements named after them. It talks about people like James Harris who is an African-American nuclear chemist who helped discover, elements 104 and 105, and Darleane Hoffman, who was told all along during her training that she should set her sights on becoming a chemistry teacher. But instead, she became a nuclear chemist, and helped discover element 106. So it's... This project in and of itself, this idea of telling these exciting stories about the people behind the research.

27:35 SC: Yeah. So what else should people take a look at from 2019?

27:40 VT: I'm gonna start with a fact that may or may not surprise you, which is that, of the more than 1500 craters on the moon that are named after individuals, only 28 are named after women.

27:50 SC: Yeah, everything about that surprises me.

[laughter]

27:52 SC: There are craters named after people, and that so few are named after women.

27:57 VT: That part doesn't really surprise me.

28:00 SC: Right. Yeah, the fact.

[laughter]

28:01 VT: In this book "The Women Of The Moon" by Daniel Altschuler and Fernando Ballesteros, they've compiled biographies of these women. Aside from Marie Curie, these are women that I think a lot of people might not have heard of. So there's Anne Sheepshanks for example, about whom we know very little other than that she was a wealthy patron of astronomical research at Cambridge in the early 19th century. A more modern one, Williamina Fleming who was one of the original Harvard computers, who catalogued the stars in the late 19th century.

28:30 SC: Oh yeah.

28:31 VT: And then there's Mary Blagg whose work actually helped standardize lunar nomenclature in the beginning of the 20th century. So she's helped set up this whole system of how

we name things on the moon.

28:41 SC: It sounds like all these women had something to do with the moon or astronomy. Are all 1500 names including the men similarly moon-related?

28:51 VT: Some of the craters are named after philosophers.

28:53 SC: I know.

28:54 VT: Aristotle has a crater. [chuckle] Plato has a crater, Sigmund Freud has a crater. So for the other people that are named on the moon, it's just could be really anything. But most of the women who are named have some sort of tie to astronomical research.

29:09 SC: So you're gonna get some lunar history in there as well.

29:12 VT: Yeah. And it's really interesting too, because the authors really make an effort to show writing samples from the women themselves and let the women speak in their own words. When you read the biographies together, you really get the sense of all the work that women have done in this arena.

29:30 SC: Let's talk about some of the kids' books that you highlighted this year, anything that really stuck out to you?

29:37 VT: So one of my favorite books, and one that I would have loved as a child was called "When Sue Found Sue: Sue Hendrickson Discovers Her T-Rex" by Toni Buzzeo. As the title suggests, this book tells the story of when Sue Hendrickson discovered the largest most complete T-Rex skeleton in 1990, and they named the T-rex Sue in her honor and now you can go see it at the Chicago Field Museum. When I was a child, I was like "I am going to discover a dinosaur."

[laughter]

30:02 VT: Like any... Everyday, I was like, "This is the day it's gonna happen."

30:08 SC: What were you doing? [laughter]

30:08 VT: I wasn't like... It was just like in my backyard.

30:12 SC: Oh my gosh.

30:12 VT: I just thought that's where I was gonna find it.

30:15 SC: Yeah.

30:15 VT: But this story is kind of fun because it frames her as an outsider. She didn't have a lot of formal schooling and then she becomes an integral part of this team of paleontologists. And so it's a

human story in addition to being a science story.

30:30 SC: And so, that one's for the younger age group. Do you have anything for middle schoolers?

30:35 VT: Yeah. So for a little bit older group, I would recommend "Can You Crack the Code" by Ella Schwartz. So Schwartz is a cyber-security expert and this book is part history of encryption and part beginner's how-to manual. So she...

30:48 SC: Cool.

30:48 VT: Yeah. So she begins with a simple substitution cipher that was actually used by Julius Caesar in which every letter of the alphabet is signified by another letter, a specific number of spots away. And then she works into more complicated ciphers, symbolic ciphers. She talks about Enigma, that complex cipher used by the Germans and cracked by the British during World War II. I think that kids will get a kick out of being able to create their own ciphers after reading it.

31:13 SC: Definitely. Those are all books that you covered in the pages of the magazine and strongly endorse. What about something that you wish we had covered?

31:23 VT: The book that I've chosen for this it's not one that we skipped for any... [chuckle] For any reason, we just can't cover them all. But I read it later and was like, "Oh this is so good." And I wish that we had covered it.

31:33 SC: I'm so impressed that you read books when you're not working.

[laughter]

31:37 VT: I mean Sarah... [chuckle] This is literally my job. How do you think I got it? It's because I loved reading... [laughter]

31:42 SC: Yeah. You must really like books, Valerie.

31:45 TA: It's true. So this book is called "Lost Feast", it's written by Lenore Newman. Probably our listeners know that we're in the midst of a sixth extinction on Earth.

31:55 SC: Yeah.

31:55 VT: But what something I didn't know before I read this book, is that the species that we eat, historically have had an extinction rate roughly five times as high as the background rate. So in this book, Newman traces the history of these... She calls them 'foods we've loved to death.' She talks about the Passenger Pigeon for example, which went from being the most abundant bird in North America, to completely extinct within about 100 years.

32:19 SC: I've never tasted pigeon but I gather there are people were eating it at that time.

32:23 VT: People were eating it. And from the descriptions, it sounds like they weren't necessarily enjoying it. [laughter] It didn't sound like it was very delicious, but it was so abundant and it was just really easy to procure and some of the loss was due to habitat destruction. But a lot of it really was, they think because we hunted it to extinction.

32:45 SC: Wow.

32:46 VT: Yeah. So and then in another chapter, she talks about this Ansault pear which was apparently this creamy, decadent cultivar that came about in mid-1800s. And the problem with the Ansault pear wasn't that we overate it. It was that it was really hard to produce. So the trees were really irregularly shaped. They weren't suitable for orchards. And during the late 19th century, we were shifting toward a more commercial orchard approach to food production. So people just stopped propagating it, and now it just doesn't exist anymore.

33:07 SC: That's really sad.

33:19 VT: Yeah, I know. I'm a sucker for food writing in general. And so...

33:23 SC: Yeah.

33:24 VT: "It Was Fun to Read to You" includes these things she calls extinction dinners. She talks about the environmental problems posed by modern domesticated cows. For example, the food writing is beautiful...

33:35 SC: Right.

33:35 VT: And interesting. And then you're getting a little ecology primer, and it's just a really interesting take on extinction.

33:42 SC: And it's food that you're never gonna get to eat, so the writing is really key. Alright, let's move to movies. So this is something that you covered quite a few of this year and I was kind of surprised to see "The Inventor" on your list. This is about the troubled company Theranos, and you also covered the book on the same topic about a year ago.

34:06 VT: Yeah, so we covered "Bad Blood" by John Carreyrou when it came out last year. Now, this is a new film called "The Inventor." It's looking at the same thing. So, in 2003, at the age of 19, Elizabeth Holmes decided she was going to transform the healthcare industry, and she promised this technology where we were gonna be able to conduct a bunch of tests on small blood samples that were derived from a finger-stick. And it was...

34:32 SC: Yeah. Like 20 tests on one drop of blood.

34:35 VT: Maybe even more. She raised all this money, and the company was eventually valued at $9 billion, but the problem was that the technology just didn't exist.

34:44 SC: So the money was there, the business was there but there was the technology problem. And we have a really good clip, that kinda illustrates that from the film.

34:54 S5: When I think of Theranos, I really feel like there were two entirely different worlds. There was the carpeted world, and there was the tiled world. In the carpeted world, was where Elizabeth was a goddess. Everyone, almost worshiped the ground she walked on. She could do no wrong, she was the next Steve Jobs. Theranos was changing the world. And then you go onto the tile side and nothing works, we're on a sinking ship. Everything's a lie. Reconciling the differences between those two worlds was really hard for me to do.

35:28 SC: The person that you hear in that clip Tyler Shultz was a team member at Theranos, and he was also the grandson of Theranos board member, George Shultz. The film makes use of people like Tyler and Erika Cheung who were these junior employees there who are among the first to really sort of saying, "Hey something's not right here, we can't keep doing this." Holmes was really relentless in the promotion of her company, and so this led to this video trail that really, the film is able to capitalize on. There's a lot of footage along the way that's kind of, it's really fascinating to see what was coming out officially in these PR channels. Then you get these behind the scenes looks of what was really happening.

36:10 VT: Let's move to the last film we have here, this is called "Sea of Shadows." Can we start with the quote? It's pretty powerful.

36:17 SC: Yes.

36:19 S6: "We're not a virus here to kill our host. To sit there and let an entire ocean down because of the greed to a few. And to be okay with that? That is unacceptable, as a species that is unacceptable. If that happens, we should be ashamed."

36:37 VT: To give context to that quote, this film Sea of Shadows, is about the Vaquita, which is this tiny adorable porpoise that lives in Mexico, Sea of Cortez. They're just hurdling towards extinction. There's fewer than 15 individual animals. It's actually endangered because of another animal, the Totoaba fish, so the Chinese mafia and Mexican drug cartel...

37:01 SC: What?

37:01 VT: Yeah, yeah, I know it's a crazy story. The Chinese mafia, Mexican drug cartels make million shipping the swim bladders of the Totoaba fish to Asia, where it's valued for purported medical uses. The local fishermen use these things called gillnets to catch the Totoaba and Vaquita get caught in these gillnets and they die. The film is really needed. Highlights the people that are trying to stop their extinction. So the journalists who are putting the spotlight on the cartels and undercover agents who are trying to expose the criminal syndicate, it looks at scientists who are trying to corral the last Vaquitas, and figure out if we can keep them somewhere safe. And then the individual that you heard in that clip, is one of the members of the crew of the Sea Shepherd, which tracks down poachers with drones...

37:49 SC: Wow.

37:50 VT: And pulls their nets from the sea. It's this amazing thrill ride of a film.

37:57 SC: Let's switch gears now to science-themed games. What was on the roster for this year?

38:03 VT: So I wanted to talk about my favorite science game...

38:06 SC: Alright.

38:07 VT: My favorite science game that we covered this year is a game called "Wingspan." The premise of "Wingspan" is that you are a bird enthusiast, trying to attract birds to your aviar.

38:17 SC: I am a bird enthusiast.

38:19 VT: Oh my gosh, you would love this game. So you attract birds with food tokens that match their diets and they earn points, you earn points from the birds you collect and the eggs they lay. And by attracting birds to flock with your other birds and by preying on smaller birds and competing in these little contests throughout the game.

38:36 SC: This is a board game? For... What's the age group?

38:40 VT: It's a board game, and I would say that it is for adults, so I'm like a board game enthusiast so I think sometimes people are like, "Oh, should I get this game for my child?" And I guess, yes, if you have a very mature child. [laughter]

38:54 SC: It's okay. I believe in games for adults.

38:57 VT: Yeah. This game is really fun 'cause it has a fun engine building mechanism, so each bird that you get gives you a special ability that can be activated repeatedly through the game and you can combine it with others to gain more food or to lay more eggs for example.

39:12 SC: Are these real birds?

39:13 VT: Yes. The birds in the original game are North American birds. Each card is beautifully illustrated, includes facts about the birds and the habitats and their diets and what kind of nests they make. And the data all came from e-bird which is the Citizen Science Initiative run by the Cornell Lab of Ornithology. So it's very scientifically sound thing and it's fun. There's actually a new expansion that was just released, that adds 81 new European birds to the mix.

39:17 SC: Wow! So this would be a very good present for the game/science/bird lover, in your...

[laughter]

39:17 VT: Yeah, I mean like...

39:17 SC: Which is like my niche and...

[laughter]

39:17 VT: No, I think any of those, any of those people. The game, it won this very prestigious board game award this year, called "The Kennerspiel des Jahres." It's respected in the board game community, and then there's also these very strong scientific elements. Some of the abilities that you can activate in the birds mimic things that the birds do in real life. So the Kuku for example, it lays eggs on other bull-nest laying birds just as it does in real life. So the game is really interesting and fun as a game and then it is also you are learning a little bit.

40:26 SC: Okay, Valerie, you really gave people a lot of options for their own enjoyment over perhaps the holiday break, or for presents. Thank you so much.

40:35 VT: You're welcome Sarah.

40:37 SC: Valerie Thompson is the Books Editor for science. You can find a link to the books, films and games that we talked about today, on the books blog, Books, Et Al, which is at blogs.sciencemag.org/books. And that concludes this edition of the Science Podcast. If you have any comments or suggestions for the show, write to us at Science Podcast at AAAS.org. You can listen to the show on the Science website. That's sciencemag.org/podcast. There you'll find links to the research and news discussed in the episode. You can also subscribe on iTunes, Stitcher, Spotify, Pandora, and many other places. The show was produced by Sarah Crespi and edited by Podigy. Special thanks to Megan Cantwell, and Joel Goldberg. Jeffrey Cook composed the music. Don't forget we're skipping next week, but we'll be back on January 2nd. See you in 2020. On behalf of Science Magazine and it's publisher, AAAS, thanks for joining us.