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**00:06 Sarah Crespi:** Welcome to the SciencePodcast for February 28, 2020. I'm Sarah Crespi. First off this week, I talk with contributing correspondent Lizzie Wade about contradictory evidence for a hidden ancient empire in Mexico. Next, we hear from Rashid Sumaila about calculating the billions of dollars illegal fishing costs the global economy every year. Finally, in this month's book segment, Kiki Sanford interviews Gaia Vince about her book, "Transcendence: How Humans Evolved Through Fire, Language, Beauty, and Time." Now we have contributing correspondent Lizzie Wade. She wrote a feature this week about an ancient empire hiding in plain sight. Hi, Lizzie.

**00:47 Lizzie Wade:** Hi, Sarah.

**00:48 SC:** I got a little mystery there in my intro. Let's keep it going for another half minute. Okay. This all started in 378 CE.

**00:57 LW:** Yes.

**00:58 SC:** According to some monuments in the Maya City of Tikal, there was a visitor from a strange place. Who is this visitor?

**01:07 LW:** The strange visitor is named Siyaj K'ak, which means roughly fire is born in Mayan language. The inscriptions that record his arrival don't really say who he was beyond his name or what he was doing or what happened, why he came. Like motivations you want if you're writing a novel or a feature story about him are not there. But the key mysterious element here, is that on the same day that he arrives, that Siyaj K'ak arrives, the king of Tikal dies. The implication there is that Siyaj K'ak is somehow involved in that death and these two events are probably related in some way.

**01:47 SC:** What kind of clues do we have about the identity of this visitor?

**01:51 LW:** Yeah, so he's probably a warrior, but the monuments also say that he's working for this guy called Spearthrower Owl, and Spearthrower Owl is a king of a far away land that Siyaj K'ak presumably, debatably, maybe comes from. [laughter] And eventually Spearthrower Owl's son becomes the new king of Tikal after Siyaj K'ak comes in, Siyaj K'ak makes Spearthrower Owl's son the new king of Tikal. So like some relationship is happening between all of these people. And Spearthrower Owl and his son are both depicted in this style of dress. And actually, the sale of art that's related to the central Mexican city of Teotihuacan.

**02:34 SC:** Tikal is somewhere else?

**02:36 LW:** Tikal is about 1000 kilometers to the southeast. It's an important Maya city, and

Teotihuacan is in the mountains of Central Mexico. It's a huge metropolis of about 100000 people. The cities are two cultures interacting in some way. And the question is, is whether this event recorded in Maya writing is an invasion or a conquest of Tikal by Teotihuacan.

**03:01 SC:** These are very different places, Tikal and Teotihuacan.

**03:05 LW:** The Maya sites are in these tropical jungles and Teotihuacan's in these snowy volcanic mountains, and so a lot of things are very different about these cultures.

**03:14 SC:** Can you describe what it's like to visit Teotihuacan?

**03:17 LW:** What really always strikes me is just the scale of this city. And you're only seeing a tiny part of it, as a visitor, like a tiny part of the downtown. It went on for miles and miles in every direction. Thousands and thousands of people from all over Mesoamerica lived there. It must have been really a stunning place.

**03:35 SC:** Do you think it's surprising that most people have heard of the Maya world, but not Teotihuacan?

**03:40 LW:** I think the Maya world is... It's bigger. There are more sites you could go to. Teotihuacan's just this one place. So if you're not in Mexico City, you probably won't go to Teotihuacan or have heard of it. The way that Maya cities were "discovered and publicized" in the 19th century really left such an impression on the US and Europe and particularly, that I think that their fame comes from that they're these mysterious esoteric places. And Teotihuacan was... It just doesn't have that piece of it.

**04:11 SC:** Going back to this meeting, this transition of leadership in the Maya City of Tikal, this has been known about since the 1970s. What is going on now that makes. That's making people ask even more questions about what happened back in this place in 378 CE?

**04:28 LW:** I think the most interesting new stuff that we know about is coming from Teotihuacan, which is interesting, because this writing about this event comes from Tikal. So Teotihuacan in the past couple of years, archaeologists have been excavating this site called The Plaza of the Columns. Well, they found one thing that was a feast deposit. So after feasts in Mesoamerica, like a common offering to do after this important event would do like break all these ceramics that you used during the event.

**04:54 SC:** Oh, poor archeologists.

**04:56 LW:** Yeah, yeah. The breaking part isn't that great, but the leaving them there is perfect. So archeologists found this huge deposit of ceramics that include both Teotihuacan and Maya style ceramics, and the art styles of these two cultures much like the cities, are just really different. The Maya art, it's very naturalistic. When they depict people, it has a lot of detail. They're very ornate. And Teotihuacan style art is much flatter, it's more geometric, more kind of abstract and almost cubist. So it's really easy to tell the difference between the art styles.

**05:28 SC:** But you can have both of them in...

**05:30 LW:** Both of them in the same place at Teotihuacan. So the thinking is, they had a feast together. And very close to this deposit, is this very fancy building that people could have worked or lived in that was once decorated with these really intricate Maya murals, which look again, very different from the other art at Teotihuacan. So the idea is maybe this was some kind of diplomatic residence, the Maya Embassy in Teotihuacan maybe. Fairly fancy Maya people are living there. And they lived there for about 50 to 100 years around 300 to 350 this feast happens, but when they find these murals, they're smashed to bits. They're right next to this building, so they know that they were once on the walls. They've been completely destroyed.

**06:16 SC:** And not for fun, like with the plates?

**06:18 LW:** Yeah, it doesn't seem like it's for fun with the plates. These faces are scratched out. This isn't a very common thing to do, unlike with breaking ceramics after a feast.

**06:27 SC:** And the timing is...

**06:29 LW:** 350 to 400. So that's right around the time that Siyaj K'ak is getting to Tikal in 378.

**06:38 SC:** That's what's going on at Teotihuacan? We have plates, we have murals we have some radiocarbon dates but we don't have any written records we don't have any artistic depictions of these events, like we do at Tikal if we go there we see the monuments and the writing what's being investigated there today.

**06:56 LW:** There's a reanalysis of the writing, which from the 1970s when this outline of these events was first suggested Maya writing wasn't fully deciphered yet. They're getting a better idea of who all these major players were and what their relationship was precisely between them and stuff like where Siyaj K'ak' might have gone after Tikal. Was he involved in founding new dynasties, at other Maya cities? There's also new excavations at Tikal that's looking at this early period of the city the stuff you see at Tikal now, it's actually built a little bit later, than when most of the stuff's happening, so it's been a little bit hard to excavate 'cause it's underneath. And there's also just lots of excavations in lots of different Maya cities and this big LIDAR project, which is this sort of radar-like thing that you shoot down at the ground from a plane and it allows you to make these maps where you can sort of take off the tree cover, and see the Archeological Sites underneath, and so that's also adding a lot of information to what Archeologists know about what's going on in the Maya world at this time.

**08:00 SC:** So how is LIDAR contributing to a better understanding of these regions?

**08:04 LW:** In this case One of the questions is, How did Teotihuacan's presence change anything for Maya commoners? If it did at all? You need a larger regional view of that. You can't just excavate a palace. The LIDAR gives you a much broader view. One thing that seems to be emerging is that, a lot of land around Tikal there seems to be these ditches and watchtowers built on

top of hills and some defensive...

**08:29 SC:** Fortification.

**08:30 LW:** Infrastructure. Yeah, fortifications that archeologists had only had a tiny glimpse of before and now they can see that it really probably extends quite far is that to defend against Teotihuacan, is that Teotihuacan coming in and building this stuff.

**08:43 SC:** Cause more mysteries.

**08:44 LW:** More mysteries. It's all only more mysteries.

**08:47 SC:** Is there any evidence that other cities besides Tikal came under the domain of this new leadership?

**08:54 LW:** Yeah, so there's a couple of inscriptions saying, that Siyaj K'ak' shows up in other cities and is referred to as an Overlord or a leader. There's a place called Calakmul which is very close to Tikal where a year after Siyaj K'ak's arrival in Tikal they commemorate a building about that event, and there's these mural paintings of Teotihuacan warriors accompanying a new king to the throne of Calakmul this is very suggestive. But not everyone thinks this is exactly as easy to interpret as it might seem.

**09:28 SC:** We're raising the idea, how invisible empire that we didn't know about before. Or there's this other theory. What is the other theory that Maybe this isn't necessarily Teotihuacan taking over a big part of Maya territory.

**09:42 LW:** Yeah, so Teotihuacan, does have a pretty extensive geographic reach. I think the debate is whether and how intensely that extends into this, Maya world. Some people see these inscriptions at Tikal and think, there's not really any great evidence, that these people were actually from Teotihuacan. Siyaj K'ak' is a Maya name no description of where he's from is given Tikal doesn't really become a colony, it stays a Maya city, its culture doesn't change, that much it doesn't seem like it's subjugated by this ferocious empire and really interesting, some of the key people that are associated with these Teotihuacan kings in the Maya region. Like Spearthrower Owl's son who becomes the king of Tikal and also there is the king of Copán which is a Maya city in Honduras that has some connections to Teotihuacan in the writing they've found both of their bodies and neither of these people are from Teotihuacan neither of them grew up in Teotihuacan.

**10:44 SC:** Neither of them are from this 1,000 kilometer away Metropolis.

**10:48 LW:** Yeah they're both Maya... You can study the isotopes in their teeth to see where they grew up. So basically, the isotopes from the water in each region, are slightly different, and so you can sort of track the isotopes that are preserved in their teeth to different parts.

**11:03 SC:** Okay, so they aren't from Teotihuacan. Why then are there so many markers of Teotihuacan associated with their rule?

**11:12 LW:** I think the people who are skeptical that Teotihuacan the city is literally involved in this think that Maya were appropriating this imagery of this far away foreign power that's known for its great military might. So these Maya people are dressing up as Teotihuacanos to beat rebellions against the dynasties in their cities and so Siyaj K'ak' he could have taken over a bunch of Maya sites, but he might not have been working for a king of Teotihuacan he might have been working for just another Maya ruler. This idea of a faraway power would have been very potent, for the Maya and especially Teotihuacan which was such a unique city it was so big its military force was so strong. They might have just been sort of tapping into that symbolically, rather than being literal people from that place.

**12:01 SC:** Yeah, I think there's some really interesting tensions that you pull out in your story. And one is you have these two cities these two sites, they seem to be talking about each other, but they have different kinds of evidence those different pieces of evidence point to different things.

**12:16 LW:** Yeah, totally, it's very confusing. And this is why it's such a fruitful and exciting debate as well because there are all these different lines of evidence that seem to be saying slightly different things. So you have the Maya writing besides the dates down to the day, year month with people's names. Sometimes people's relationships like their family relationships and you can sort of track these people through time. It's much like working with an archive as we know from all other forms of history, especially Maya history which was carved into these monuments, and palaces. Like there's some feeling that this writing is essentially, propaganda done for the benefit of the elites in other cities.

**13:01 LW:** So it's not necessarily really reflecting what is happening for everyone. Maybe it wasn't really a conquest in the way that we would think of it, that it would change everybody who lived in Tikal's life. Maybe it was just sort of a new king and nobody else really cared. And at Teotihuacan, you have these radiocarbon dates that vaguely coincide with the written dates that the Maya record. You can say, "Okay. These Maya murals were destroyed some time between 350 and 400, were they destroyed before Siyaj K'ak' got to Tikal, after were these completely unrelated events. You can't really tell that from the dates alone. And then you have these isotopes data which is considered the gold standard in archaeology about the individual lives of people, saying these people who are depicted as Teotihuacan warriors in Maya art have nothing to do with Teotihuacan [laughter] in their biology. They don't necessarily fully contradict each other all the time. They also don't really line up into a neat for sure story.

**14:03 SC:** So what happened after, after the change in leadership in Tikal? What happened to Tikal, and what happened to Teotihuacan over the centuries?

**14:11 LW:** Tikal actually really expands after this invasion conquest, whatever happens in 378. There's a lot of Maya cities. Tikal is like a big... Relatively big one, but it's not particularly special before this event. And after this event, it becomes a really major power in this region with lots of other cities allied with it. And they sort of continue using this Teotihuacan imagery for a long time in their history, even after Teotihuacan itself collapses, which happens around 550, and that's another kind of mysterious event. It seems like maybe there was some kind of rebellion of the citizens in the city. It doesn't seem to have been attacked from outside. But Teotihuacan stops being

sort of a political force in Mesoamerica around 550, less than 200 years after this stuff happens. But Tikal, even centuries later, is still using this Teotihuacan imagery, and clearly remembering this important event that changed the course of their history. And whether that means just that this left a huge imprint on them like they could remember beyond the actual existence of Teotihuacan, or it could mean that Teotihuacan never really had anything to do with this at all, and it really was all about the imagery to begin with [chuckle] So even that it's a little bit up for debate.

**15:27 SC:** What would be a really good thing to find? What is a piece of evidence that would kinda show everybody what actually happened?

**15:35 LW:** I think this debate would be really hard to resolve, and you're gonna need evidence from a lot of different places. But one exciting thing that's going on right now is that there are new excavations at Tikal looking specifically at the part of the city that was active during this time period. And the archaeologist there is looking for people from Teotihuacan living in Tikal. We know that there are immigrant communities in Teotihuacan, including this Maya community. But that hasn't really been a focus in Maya cities. Finding a colony of Teotihuacanos in Tikal wouldn't necessarily definitively prove conquest, or invasion, or what exactly was the political drama that was going on. But it would at least show that people from Teotihuacan are in the Maya world and that this isn't just an inter-Maya story, like there is some kind of foreign involvement. But again, that's ongoing, and those results are gonna be announced this summer.

**16:32 SC:** Thank you so much, Lizzie.

**16:33 LW:** Thanks, Sarah.

**16:34 SC:** Lizzie Wade is a contributing correspondent based in Mexico City. You can find a link to the article at [sciencemag.org/podcast](http://sciencemag.org/podcast). Stay tuned for an interview with Rashid Sumaila about the staggering cost of the illegal fish trade.

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**16:54 SC:** You may have heard of illegal fishing being bad for the environment, bad for sustainable fishing. But as Rashid Sumaila and colleagues report this week in Science Advances, the illegal fishing trade is also incredibly costly. Hi, Rashid.

**17:09 Rashid Sumaila:** Hi. How are you, Sarah?

**17:11 SC:** Good. So I glossed over this in my intro. What exactly is legal and illegal fishing?

**17:16 RS:** Essentially, you are fishing illegally if you are fishing where according to the laws of the country in whose waters you are fishing. You are not supposed to fish. You don't have a license. You are not authorized to catch fish in the area, and you do so. Then it is illegal.

**17:35 SC:** What you tend to care about is large-scale illegal fishing. So not just a person who didn't get a fishing license and went and caught a couple of fish.

**17:43 RS:** Exactly, yes. Because for subsistence fishers, people who catch the fish to feed themselves and their families, that cannot be classified as illegal. In most cases, there's no reporting system. There is even no rule saying you shouldn't catch a fish and feed your family. So that is not our issue here. The issue is the large industrial fishing fleets. Most of the time, they are international, actually, who come in and take the fish from domestic waters without the authorization to do so.

**18:16 SC:** So what you wanted to know in this study, how much fish was being taken out of the oceans. And then on top of that, how much that costs local economy. So how did you try to get a handle on these numbers?

**18:29 RS:** We were able to do this here, now, in 2020, because we started putting together databases way back in the early 2000s. We have databases of catches, the amount of fish we take out to eat, and also fish that we take out and throw back in, fish we don't like. They come in as bakasi. So we have a comprehensive database of how much fish we remove from the ocean. So that's database number one. The second thing we have which is the economics part of it, that's the beauty. In our group, we have ecologists and economists and other scientists, it's interdisciplinary. So we the economists we also put together databases on the fish price, the amount you pay at the dock, and also fish prices along the fish chain. So we are able to know what a wholesaler will pay at the dock for fish, how that goes to the retailer, and up to the point you eat the fish in the restaurant. So we have data on this.

**19:31 RS:** Now when you bring these things together then you are able to do this kind of study and a part of the total catch will also have unreported catches and reported catches and from the unreported, the large scale part, a portion of that ends up in what we call illicit trade in fish. Because they are traded outside of the formal economy and therefore they're illegal and illicit in fact.

**19:57 SC:** Right so you think of it as fish laundering, right?

**20:00 RS:** Absolutely. It's just like somebody stealing hats and laundering it or all the other illegal and illicit activities unethical activities that people do. So that's how we see, this is part of it. And the reason why it's a huge thing economically is that, especially for small countries, developing countries, the fish never touch their coast and the big boats on the ocean, they steal these fish, they process it, and ship it out. So it doesn't get processed. People don't get jobs and incomes, and their food.

**20:35 SC:** Absolutely, and the scale, is really staggering, what you found out. First let's talk about how many fish that you calculated were illicitly traded or illegally fished.

**20:48 RS:** This is a lot, actually, we're looking at eight to 14 million tons of fish taken out of the ocean...

**20:56 SC:** In a year.

**20:56 RS:** In the year. And I usually, what I do is I convert this to the number of mature cows just to let people understand, right? That is the equivalent of at least about 14 million, 15 million mature cows being pulled out. I call them fish cows.

**21:13 SC:** So how do you know when people are not reporting that they've taken fish, and that the fish are taken?

**21:18 RS:** Yeah. So this is almost detective work. And thanks to really motivated students. A lot of credit goes to them. So we do a lot of digging to find out what is the true take and they discuss... So for example, we had a student, Nicole, she's from Bahamas, and we look at the national data and it just doesn't make sense. The total amount they report, if you go to Bahamas, during the holiday season, every restaurant, they're serving fish, if you just make a quick back of the envelope calculation there's no way the national number will just make it. So she goes out there and checks the number of restaurants, the average number of eaters and how much they eat, and then we work it out. We have a beautiful saying, we say, "If you take fish, somehow that fish will cast a shadow on society because it's going to be processed, it's going to be eaten, it's gonna show up somewhere in the system."

**22:19 SC:** And then you also convert it to the money, how much this takes out of the global economy. Can you talk about how much that is?

**22:29 RS:** When you look at the the basic dollars, we talk about tons of fish and missing mature cows, you've added value to this conversation. When you just look at a value at that point, we're talking about \$17 billion there about.

**22:42 SC:** Wow. That's a year.

**22:42 RS:** It's a year. A year. And in places where this is real money. If we converted this to the purchasing power parity of say people in West Africa or South East Asia this is multiples more because the dollars to somebody in Senegal or in Papua it's much more valuable than a dollar to you and me in Vancouver and New York or DC, right? So that's it. Now that is the raw amount at the door. If you take this through the value chain, which is really important because this is where the jobs are, the people who process the fish, the people who do the cooking and serving in the restaurants right? That takes us to about \$50 billion a year going into the illegal system.

**23:29 SC:** What about the taxes, how does that fit into this?

**23:32 RS:** If you take out an economic activity, you make it informal, you make it illicit and illegal, what that means is that the activities are not reported to the authorities formally, and that means tax revenues are lost. Here too the main losers are really African, Asian and Latin... Some of Asian not all of them, and Latin American countries, we estimate about \$4 billion of taxes, and this is really very minimal estimate, we underestimated just because we don't have hard facts there. We use forestry numbers to try to help us that you will agree with me that it's easier to tax a tree than a fish.

**24:17 SC:** It's easier to hide a fish, right?

**24:19 RS:** Exactly and the fish move and all those... So this is very conservative but that's still a lot of money for the countries most hit by this activity.

**24:29 SC:** Are those places that you mentioned Southeast Asia, West Africa, are those the places that are particularly hard hit by this trafficking?

**24:36 RS:** Absolutely, if you take Asia, Africa and Latin America together, that is 85% of the 14 million tons of fish we talked about. So that's a lot. Over 80% of the total dollar amounts we're talking here. And the large industrial boats are not their boats, you know? This is, European boats or whatever Chinese boats coming in to parts of the world and doing this, and it really saps the economies of countries that need to move their economies forward.

**25:11 SC:** Is that their primary route, then? So it's the fish are taken out of the sea, and they never touch land and they're processed on a boat and then they basically join, they join the fish market from there.

**25:21 RS:** Yeah laundering, right? They're laundered into the big markets of the world which is Europe, America and Japan, China, of course, is big and getting bigger and this local domestic fishes are deprived of their fish, jobs and incomes.

**25:37 SC:** So this type of fishing, this large-scale industrial fishing that isn't permitted, does it impact how people manage their fisheries? Does it basically deprive the local people of the kind of fish they need to eat?

**25:50 RS:** Yeah, absolutely, yeah, you see a good example is, is Senegal, they have this grouper, it's so central to the culture. They make Jollof rice, I don't know whether you've heard of Jollof rice.

[chuckle]

**26:04 SC:** I do know.

**26:04 RS:** The West African thing, right? And you have this grouper, a family will just have one big grouper on top of their Jollof rice everybody eats on the big bowl and this fish is virtually gone. Where you find them these days is in the big hotels where the locals cannot patronize. So this has real consequences on the people, this is tough when you follow the fishing story. About 260 million people around the world earn some income and livelihood from ocean fisheries, from those catching it through to the food system, right?

**26:45 SC:** Yeah.

**26:45 RS:** So it's a global issue really.

**26:48 SC:** We know this is illegal because there are laws, there are rules in place that say you must report what fish you've caught in the waters to whoever locally controls those waters and then

sometimes you have to pay money, who writes those laws? Are those international law, are they varying country by country?

**27:06 RS:** Essentially country by country. So countries do this but this is done under the auspices of the UN Convention of the Law of the Sea which is the big umbrella law globally that says, within 200 nautical miles of the coast of a maritime country is the country's waters essentially and the fish is theirs, citizens of the country own these fish.

**27:30 SC:** Yeah, that's a good way to start talking about how you recommend that this be addressed. This is something that you have in your paper as a bunch of different options. So what kinds of approaches can be taken to cut back on this illegal trade?

**27:48 RS:** The paper has a table where we actually itemize what various groups or levels whether it's government or private sector what we need to do to deal with this. One of the big things we need to do is collaboration across national borders because the fish do not respect all our divisions and lines they go where they go. There is one species of bluefin tuna that we found out goes through, if it stays alive goes through the country waters of at least 53 countries around the world in its lifetime so you need solid international collaboration. And actually there's a nice example where we saw that where the US and South Africa worked together to nail down a big illegal fishing company in South Africa. This business guy, he's South African he's also American, he has American passport and the lobster I believe, South African lobster he did, were illegally catching more than 50% of the national quota and shipping it out. So one diligent scientist managed to track them and proved this.

**29:04 RS:** You know what this guy did, when the South Africans went after him he just flew into the US, he is a US citizen he has a passport and that kept the South Africans they couldn't get him but fortunately in this case US and South Africa have a nice agreement to deal with this kind of thing. So he was actually arrested in the US, they went through the court system and the company was fined about \$60 million I remember. I think \$60 million for all the illegal stuff, they did harm in the environment and the economy of South Africa and that of the US because he was shipping into the US and lobsters fishes in the US were being harmed because it pushes the price artificially because he's an illegal and that was such a good example how international collaboration can help nail down these big ones.

**29:55 SC:** Yeah, if you think about it as the way people share a river if anybody decides to put a dam in or to start taking a bunch of water out it affects of all these other places.

**30:05 RS:** That's it.

**30:06 SC:** Alright, Rashid thank you so much for talking with me.

**30:08 RS:** You're most welcome, thank you.

**30:10 SC:** Rashid Sumaila is a professor and Canada Research Chair in Interdisciplinary Ocean and Fisheries Economics at the University Of British Columbia's Institute for the Oceans and Fisheries. You can find a link to his science advances article at [sciencemag.org/podcast](http://sciencemag.org/podcast). Don't touch that dial

our book segment is still to come. Kiki Stanford and author Gaia Vince discuss her new book *Transcendence: How Humans Evolved Through Fire, Language, Beauty and Time*.

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**30:46 Kiki Sanford:** Welcome to the book segment of the Science Podcast, I'm Dr. Kiki Sanford and this week we are going to delve into a brilliant and a hopeful story of humanity and our interconnectedness with science writer and broadcaster Gaia Vince whose latest book is called *Transcendence: How Humans Evolved Through Fire, Language, Beauty and Time*. Thank you for joining me today Gaia.

**31:07 Gaia Vince:** Great to be here.

**31:08 KS:** Your last book was about the Anthropocene. In the new book you focus much more on humanity, what was the logical leap between the two books?

**31:18 GV:** Well, in a sense this is almost the prequel. For my Anthropocene book I was traveling for two and a half years around the globe exploring this new age and this extraordinary effect that one species is having on the planet, on our biodiversity, on even the temperature, the atmosphere, the acidity of the oceans. I was looking at this incredible planetary change that we're undergoing at the moment which is driven by us and I started wondering how did a small psyche become this planet dominating force. And to me this is the greatest question, "Who are we? What makes us so special? Why are we not seemingly reined in by all the limitations that seem to affect all the rest of life?"

**32:04 KS:** In your view what has allowed us to transcend?

**32:09 GV:** Humans are the product of the coevolution of our genes but also our environment and our culture so this triad, this human evolutionary triads and I'm making the case in *Transcendence* that the biggest evolutionary driver in the success of the human age is not our slow-burning biology but our fast-moving culture.

**32:33 KS:** How does culture make the difference?

**32:35 GV:** So my central thesis is that all humans have the same biology. There is more genetic diversity between two chimpanzees either side of the Congo River than there is between two humans from different continents. And yet we don't see that because we have this enormous cultural variation. We've basically culturally speciated. And this diversity, it gives us our resilience, it's our strength. We are all the product of our particular cultural developing birth. So the cultural developing birth that we are born into and that's of our locality our culture our social norms, and that's what makes us different, and it even affects our life chances. And this cultural speciation is very different from our genetic speciation, because people of different cultures, of course, can move across, and learn, and take part, and integrate and assimilate, and become a part and change the culture that they move to in a way that we can't with our genes. So we are actually incredibly flexible, and we make our culture. We make, we invent ourselves. And that has a massive influence

on our biology, on our genes, on our environment. And so we get these feedback loops, and that's really what I'm talking about when I talk about human evolutionary triad.

**33:56 KS:** Does this mean that culture is going to influence the biology and the genetics and potentially also the environment that we live in? All of it working together as we move forward through time.

**34:10 GV:** Our culture is a part of what it means to be human. It's a very fundamental part of who we are. Cultural evolution affects our biology. The way our bodies and minds work. For instance, people whose cultural developing birth involves literacy. People who can read well are less good at recognizing faces, because our brains have specialized in words recognition instead of facial recognition. The words we use also affect our perception. For example, colors. People who don't have a separate word for a color like blue can't distinguish the color as well as people who do have that. We have those words in our language, which means we actually see them. Now, there's nothing different about the biology of our eyes or our brains at birth. But what's happened is our culture has changed the way we see things.

**35:02 KS:** How has the tonality of language been influenced?

**35:05 GV:** That is really interesting. Just as our biology is affected by our culture and our environment, so our culture is affected by our biology and our environment. So people who live in different environments, say warm wooded environment speak with a different number of consonants in their language than people who live in dry, more desert environments. Languages spoken in warm, wet, heavily wooded areas such as in Southeast Asia tend to use more vowels and fewer consonants, mostly in simple syllables. But English and Georgian languages, which didn't evolve in rainforests have lots and lots of consonants. The languages of those who live in altitude contain more words with a strong expulsion of air in the consonants, whereas arid desert like places are less likely to have tonal languages. And that's partly because of the harmful effects of the dryness, so the environmental effect on the vocal cord movement. So that's an anatomical, environmental, cultural adaptation of... I don't think the environmental effects on our biology and our culture have really been acknowledged to the extent that they actually play out in the human evolutionary story.

**36:25 KS:** We've been talking about language, but you have broken your book down into four sections. Fire, language, beauty and time. Can you expand a bit on why fire was important beyond simply the ability to cook our food?

**36:40 GV:** A central theme of this book is that our great success as a species is down to our ability to harness energy better than any other life form. So all of life is limited by the amount of energy it can control, it can harness. And that depends on how much you can eat or in the case of a plant how much photosynthesis it can do. However, we have managed to exceed that, and that's really the secret to our success. We control energy better than any other life form.

**37:16 KS:** But what gave us this advantage?

**37:19 GV:** Let me take you back to what makes us distinctive compared to other species. So there is a lot of belief perhaps that it's our brains, it's our big brains. But it's not our individual intelligence that's made us so successful, but our collective intelligence. And that's because we do something that no other species does, and that is that we cooperate in large numbers with unrelated individuals, with strangers even. And this is a central theme to our species, collaboration. And it's so important that we've developed rituals and practices to encourage it and make it pleasurable. So we seek more of it and part of that is through language, it's through storytelling. We dance, we sing. We do all sorts of things together to make it pleasurable. But at the root of this, collaboration makes us better, more efficient hunters, because we can outsource the physical and mental costs of hunting to our group and to our technologies.

**38:21 GV:** And what I mean by this is the energy costs of the physical or mental work. We don't just rely on our individual brains. We outsource our thinking energy to the group. We have the efficiency of scale in terms of outsourcing our physical and our mental energy costs, but we also have in this toolbox of all these human minds, this collective brain. And if you think about where we are now, it's seven-and a half billion of us many of whom are on the internet. So the more people and the more interconnected, the more chances there are of these people and these ideas to meet. Then you get this explosion of cultural complexity, and that's really what we are seeing now.

**39:02 KS:** You proposed calling humans no longer Homo sapiens, but Homo omnis. Where did that come from? And why is Homo omnis special and important in your view?

**39:15 GV:** I think what's happening is we're reaching a tipping point in the way that we operate on this planet. Up until now, we've had these local effects and we've acted fairly locally, even regionally within our societies. But I think what's happening now really truly is planetary. We're changing the environment in a planetary way. But we're also operating in a lot of ways, planetarily, which means we're not operating as a family or a tribe or even a society. We're really operating as humanity, as this super organism of humans.

**39:48 GV:** So I call this creature Homni, Homo omnis. It's kind of the combination of all of our effects, and I compare it a bit to the slime mold. I sort of see it as this hyper-connected massive population which all acts together and sort of blunders along where we're all a little bit of parts of this and so effects are systemic. So there's not a lot we can do to change some of these huge outcomes. But we can act together to do things so we can influence this super organism, this Homni super organism. But also our fate is very much interlinked with a Homni's fate because we are also a part of Homni.

**40:29 KS:** Is every human equally a part of Homni?

**40:32 GV:** We are not equally a part of Homni. So some of us are on the outside, where we're less protected when some of us are nice and secure. So at the moment, we do have these huge inequalities where some people have no power and no influence over the way that Homni goes and the way Homni affects them. And others do have a lot of power. This is not given by our genes, it's to do with our social inheritance. It's entirely socially orchestrated. So we have many choices about how this works and how we can move it. But we have to act in a way that we try and align our

interests and to be as inclusive as possible. That's the way I think that this could have a very positive outcome.

**41:14 KS:** Science goes against so many of our innate ways of thinking and perhaps therein lies one of the difficulties of moving forward culturally.

**41:25 GV:** Yes, exactly. It's a different way of thinking about the world and it's not necessarily a better way, it's just a different way. Scientific understanding is very different. This rational way of understanding is very different from the sort of subjective way of understanding and we have both. So in the book, I talk about the different ways that we have of understanding. One of which is subjective, this idea that we decide something is worth something more if we beautify it. And as a result, we like things like gold or diamonds, we think they're worth a lot.

**41:55 GV:** Whereas, you know, actually, what are they worth? We can't eat them. They don't keep us warm. So they have a subjective value which we've agreed as a society is important. But then there is this other way of thinking about the world, this other way of experiencing and understanding the world, which is not based on culturally learned, handed-down knowledge. But it's based on objective testing and experimentation. And this goes way back. It's not something that was just invented. It's something that we understand in a very different way from our subjective knowledge about the world. And that's something that humans can do really well. I can't understand a quantum world at all, but I can work it out mathematically and I can follow equations explaining it. But I don't have the same knowledge of it. And I think that's really interesting and I wonder if our brains will evolve to start having a sort of more experiential understanding of these things in time. Who knows?

**42:53 KS:** I think that would be so exciting. [chuckle] To be able to go... To change our story to the point that we don't just think of ourselves wherever you're located on Earth, looking out into the heavens. But to place yourself mentally within our Solar System in an arm of the Milky Way.

**43:11 GV:** Yeah, this is how we understand our world scientifically. And I think perhaps some people do have more of an experiential understanding of it. Perhaps there are geniuses whose brains are wired in a way that they can understand this more intuitively than I can. And this is why we need this great diversity of minds and these great diversity of mindsets to help the rest of us take the next step on our culturally evolutionary journey.

**43:36 KS:** Well, thank you for helping us take a step along that journey, by writing your books and sharing these new perspectives with everyone, sharing this knowledge.

**43:47 GV:** Thank you so much, it's been such a pleasure.

**43:49 KS:** And thank you for joining me for this interview with Gaia Vince about her book *Transcendence: How Humans Evolved through Fire, Language, Beauty and Time*. I'm Dr. Kiki Sanford and I hope that you'll join us again next month for a peak between the pages of another science book.

[music]

**44:06 SC:** 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/podcasts. There, you're gonna find links to the research and news discussed in the episode. You can also subscribe on iTunes, Stitcher, Spotify, Pandora, and many other podcasty places. This show was edited and produced by Sarah Crespi with production help from Podigy, Megan Cantwell, and Joel Goldberg. Jeffrey Cook composed the music. On behalf of Science magazine and its publisher, AAAS, thanks for joining us.