

BIONEERS

REvolution from the Heart of Nature

INTELLIGENCE IN NATURE

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How Life from Sea to Sky
Challenges Our Understanding
of Consciousness, Empathy
and Wit



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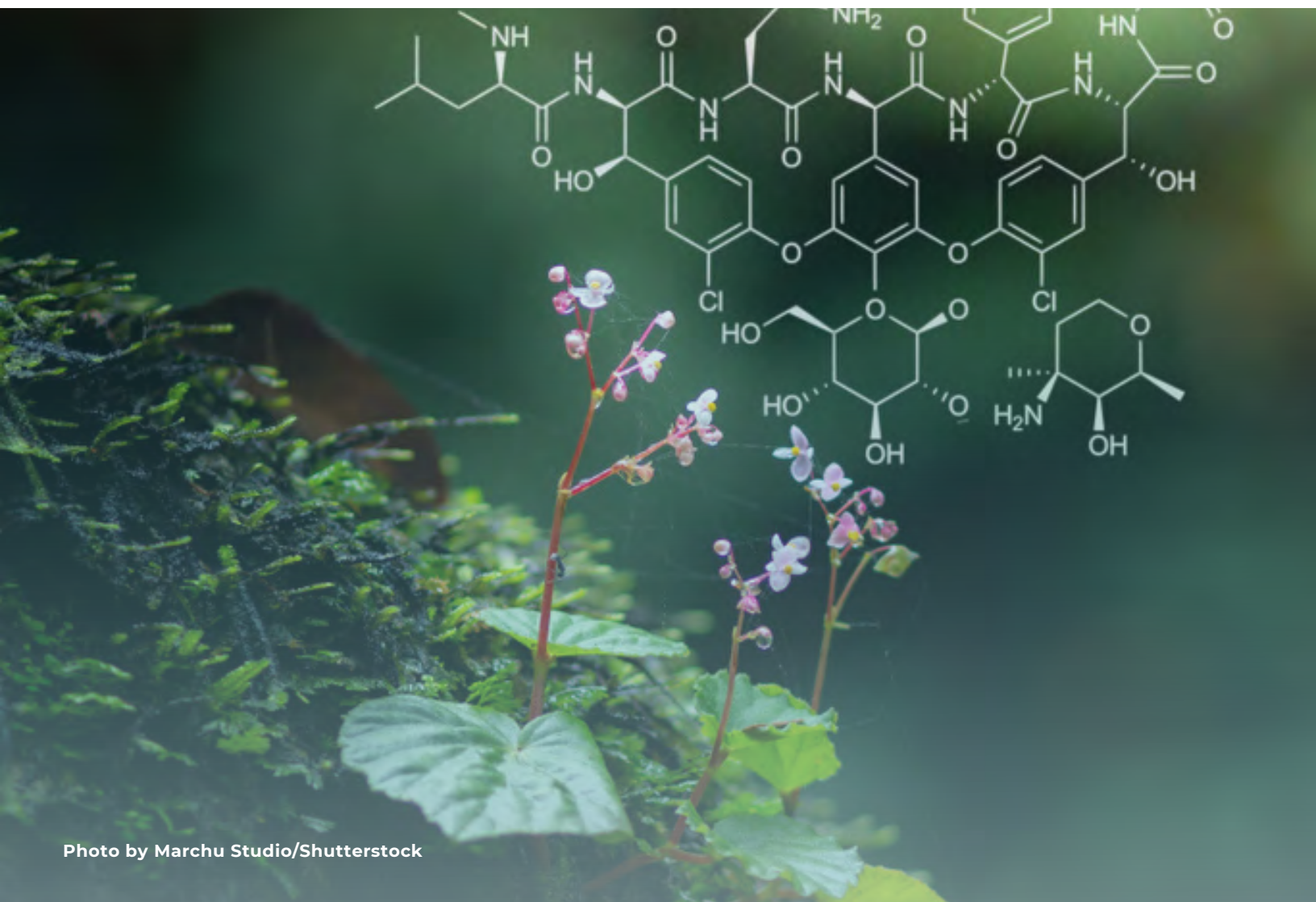
BY PAUL STAMETS

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intelligence.
empathy.
curiosity.
imagination.

These concepts have been largely claimed by humans, both inside and outside the scientific community, for millennia. Examining the natural world with an open mind, however, reveals a different story ... one in which trees warn their neighbors about impending danger, elephants mourn the loss of their family members, pea plants can be conditioned to expect food (just like Pavlov's dog), and all life on Earth is deeply, brilliantly connected.

Bioneers thought leaders have shared research and observations about nature's intelligence for decades. In this reader, we're excited to share a small selection of the groundbreaking concepts buzzed about within our community.





WHAT THE CETACEAN SAYS

James Nestor is a journalist and author who has written in major publications such as *The New York Times*, *Scientific American*, and *Dwell Magazine*. The author of the 2014 book *Deep: Freediving, Renegade Science, and What the Ocean Tells Us About Ourselves*, Nestor is especially fascinated with exploring life underwater — and gave a fascinating keynote address at a recent Bioneers Conference.

To take his fascination to a new level, Nestor teamed up with a marine scientist and professor, David Gruber, and an aerospace engineer, Jean Koster, to establish CETI (Cetacean Echolocation Translation Initiative), an independent research project focused on studying and attempting to comprehend sperm whale clicks. Recognizing that traditional marine biology had limited means and methods for studying these animals,

Nestor hopes his research will lead to important breakthroughs, the likes of which haven't been seen for upwards of 50 years.

"What we found is there's a gap between what's happening in marine biology and interspecies communication in the academic world and the private world and the technology world," says Nestor. "We're trying to bridge the private world and all of these amazing emerging technologies with marine biology and marine science to try to do something big. Will it work? Maybe. Will it fail? Perhaps. But no one else is really trying to do this, which to me is insane."

Bioneers spoke with Nestor about this new venture into animal language, why he's trying to keep it independent, and what he hopes to accomplish if he and his team crack the sperm whale code.



TELL US ABOUT THE TECHNOLOGIES THAT MAKE NOW THE RIGHT TIME FOR THIS TYPE OF RESEARCH.



It's machine learning, especially, and some A.I. technologies that are currently being used to translate and crack into mouse and bat language. That's already happening, so the algorithms are all written, and researchers are discovering incredible things. They're also looking into patterns in birdsong.

We want to use these technologies that exist and are growing and apply them to what could be the most sophisticated form of communication, which is sperm whale clicks. We want to really try to push it and see what happens.

You're not going to find any marine biologists saying these animals aren't communicating in a very sophisticated way.

We've known that for 50 years. We just haven't had the technology or the means to really research it. Traditional marine biologists conducted research in a boat. They dropped a hydrophone over the side of a boat and collected data that has revealed some incredible discoveries. They dropped a hydrophone over the side of a boat and collected data that has revealed some incredible discoveries. But it hasn't been able to crack into these animals' language.

By interacting with these animals face to face, which is what we're going to be doing, you can really spur them to interact in a way that no hydrophone or person on a boat is going to be able to do.

We have video showing that something magical happens when you approach them in peace face-to-face. They want to sit there and interact with you. It's those interactions that we think are going to provide the best data.

MECHANICALLY SPEAKING, HOW DO SPERM WHALES CREATE THESE CLICKS?

They create them in their nose. The sperm whale has the largest nose on the planet. It's technically a "nose" even though it's basically the front of their head.

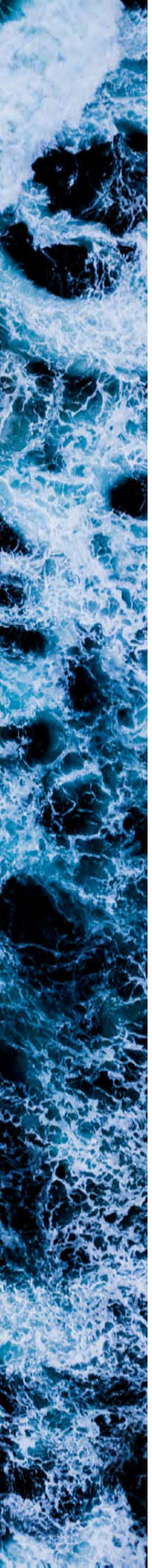
They have a chamber inside of their nose, where they vibrate sounds. They click with these two lips and then vibrate the sounds in this hollow area and shoot them out in the front of their head. They can shoot clicks out and form them in highly directional sound beams.

Someone recorded that there were 1,600 microclicks in a single second sent to one sperm whale from the other. An animal is not doing that by accident. That's not a dog barking. That's a very deliberate signal. We know they're able to pick and choose to which whale they're sending these. If you're diving with these animals, they'll sit there in a circle and crane their heads in just the right way to shoot clicks to one another with a clear signal. It's a pretty mind blowing experience to be in the middle of. To see them conversing. There's obviously something so powerful there.

RELATED RESOURCES



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- [VIDEO: Cracking the Communication of Whales and Dolphins](#)
- [PODCAST: Blue Mind, Ocean Heart](#)



WHAT MAKES SPERM WHALES, IN PARTICULAR, SPECIAL? ARE THERE OTHER SPECIES COMMUNICATING IN THE SAME WAY SPERM WHALES DO?

Yes. Ukrainian scientists at Saint Petersburg Polytechnical University have been collecting data on dolphin clicks and just recently found that they're using these clicks as a form of data transmission. Not the way that humans use language, but still a form of language.

They were able to reveal that the clicking patterns dolphins used were different depending on each dolphin. Inside those clicks are little encoded packs of information. Words. But I think it's more than just words — they're doing more than just communicating a single word. If you think about human language, it's really clunky. If I mispronounce something just slightly, you don't understand me. Transmission of data is a much more evolved way of communicating, which is what we're doing on this phone, and on fax machines, and on email. The study is fascinating. The fact that this is happening right now means to me that when these revelations come out, they're going to come out fast and furiously.

The reason why we're interested in sperm whales is dolphins are a lot easier to study. You can put them in a tank and study them up close. They're small and pretty docile. No one can get near sperm whales. They're 50 feet long, and these are the world's largest predators. But by free diving, we found a way of getting very close to them in ways that no one else really has. Sperm whales have the largest brain ever to have existed on the planet that we know of — about six times the size of ours and many times more complex than our own brains. They've had these brains for tens of millions of years longer than we've had our current-size brains. We know this animal has incredible potential for intelligence. We know they're communicating. We just don't know what they're saying. That's what we hope to find out.

WHAT ELSE DO YOU HOPE TO ACCOMPLISH WITH THIS PROJECT BESIDES JUST UNDERSTANDING LANGUAGE?

If you want to save the animals of the ocean, give them a name, and show their intelligence. I think that will make it a lot harder for idiots to want to continue killing animals off. At least I hope. I think it's going to be easier for resolutions to be passed if we can show the incredible intelligence of these animals. Additionally, tons of whales get hit every year by ship strikes. If there's a way for us to peek into the language, perhaps we can send out some broadcasting language that warns them not to get close — that ships are coming.

But to me, the real fascination is that we're talking about the possibility of communicating with another animal on this planet that is communicating in a way that is so much more sophisticated than human language. There could be industrial applications, but the real interest to me is strictly a scientific and curious pursuit. Just to interact with them on a minimal level, I think, would really get people to realize that there's more happening on this planet than iPhones. There's something bigger going on here.

ANY PLANS TO USE THIS TECH TO STUDY OTHER SPECIES?

Absolutely. We know that orcas use these clicks. We know that dolphins use these clicks. So this could be a lingua franca. Could be. We don't know. No one's really studied it. But if we're able to crack into the communication code of one of these animals, I think it'll be that much easier to replicate the code of others. Then we'll be easily able to determine whether all these cetaceans have been communicating for millions of years. I know that sounds way out and pretty spacey, but it's really not. If you look at the specifics of these clicks and how long these animals have been around to evolve this ability, I think it's completely possible.



DO YOU THINK HUMANS WILL BE ABLE TO MIMIC THEIR CLICKS TO COMMUNICATE WITH THEM?

That's a big challenge. First of all, we have to figure out what they are. We have to understand whether they're like fax transactions, which is possible. If you look at one of these clicks, these animals can repeat the same exact click codes down to the millisecond with the same discrete frequencies. If you look at a fax transmission, it's the same exact thing. So it's a possibility, we just have to capture them. I know that if we're able to capture some really clean signals — and considering how sophisticated machine learning and speaker technologies are now — I'm pretty confident that we'd be able to send them back. That's the ultimate goal: to be able to send them something, and for them to send us some-

thing, and back and forth. It's like ancient sailors going to some distant island in the South Pacific. How did they communicate? They'd draw out a picture in the sand and say this is where I came from, and the indigenous people would draw another picture saying this is where we are, and this is how we understand the world. I have a feeling we'll have to start with that before we really understand each other's languages.

To be clear, there's a big risk involved with this. Maybe we won't find anything for a while. But just the fact we know they're communicating, and we know it's really detailed and complicated and sophisticated, lends me hope that we'll be able to really break into something here. ■





PLANT INTELLIGENCE AND WHY IMAGINATION IS THE KEY TO UNDERSTANDING THE NATURAL WORLD

Monica Gagliano believes she was born to be a scientist. She grew up in the city with parents who thought nature was something to be kept outside. But, Gagliano thought otherwise. She started a journal tracking the growth of her bean plant, and created her first data set at age nine.

Now, Gagliano is a research associate professor in evolutionary ecology at the University of Western Australia, and is a research affiliate at the Sydney Environment Institute at the University of Sydney. Though she began her career by studying animal behavior, she quickly turned her attention to plant behavior. In recent years, Gagliano has blazed the trail for a brand new field called plant bioacoustics, showing that plants do make sounds. Her studies have led her to author numerous groundbreaking scientific articles

and to co-edit *The Green Thread: Dialogues with the Vegetal World*, and *The Language of Plants: Science, Philosophy, and Literature*.

Underlying all of her accomplishments and studies is Gagliano's effort to illuminate the forefront of a new scientific paradigm that dissolves the false separation between people and the natural world. In her book *Thus Spoke the Plant* — which she calls a "phyto-biography," or a collection of stories written with and on behalf of the plants themselves — she describes her experiments that opened the space to begin to understand how to make contact with this other-than-human intelligence.

Here, Gagliano delves into plant intelligence and the importance of imagination in science.



A couple of weeks ago while I was in Brazil at a conference on plant physiology, a colleague of mine — a philosopher — asked a very simple question to a group of us: What killed the dinosaurs?

I'm sure that the first thing that comes to your mind, which is the same thing that comes to everyone's mind, is the asteroid. We know very well that 65 million years ago, an asteroid collapsed onto our planet, put up this big dust of sand and dirt which covered the sun. And then it got really cold and all the dinosaurs died. That's how the story goes. In fact, we also know that at that particular time it seems that many species disappeared. So it kind of corroborated the idea that there was one single cataclysmic event that wiped everyone out — the asteroid. Then in 1978, in the Yucatan peninsula, we found this huge crater that was dated back 65 million years. That was the cherry on top of the cake.

Now, I'm not here to debate whether the asteroid that was charged with the killing of the dinosaurs did a good job — did the job at all — or not.

The reason for asking this question, which was the same reason my colleague asked it at the conference in Brazil, is that when we're asked to think of an alternative explanation that is not the story of the asteroid, we find it really hard to think of something else. It just is the asteroid. What else could it be?

WHAT IS THE ROLE OF IMAGINATION IN SCIENCE?

The point of this is that by the time that you go to school, by the time you turn seven or thereabout, your imagination has already been stifled, and your ability to think of alternative possibilities is reduced dramatically. I'm going to talk about the role of imagination in the context of science, but it's just

an example of what it means in the wider picture.

Imagination, from the root of the word, basically means "creating images of something, or representing something." We all know our imagination touches and deeply moves us, especially when it's expressed through creative approaches that artists and musicians, for example, are really good at. What I find intriguing is that imagination is the creative ability of our mind to literally dream the world and worlds. So it's a bit surprising that such a critical creative endeavor would be dismissed when we talk about science.

When we talk about science and about imagination in science, the word takes on a totally different meaning. Suddenly you're talking about fanciful speculations and empty assumptions. There is a tendency to either downplay the role of imagination in science, or to completely dismiss it from the important role that it has in the construction of knowledge.

I'm not here to lay judgment on science, but it is true that our modern techno-scientific world has subscribed to an arid version of imagination. It's very different from what we know imagination is when we think about it as the creative beings that we are, because we are all artists, we are all musicians in some ways.

When science, which is a strong voice in our culture, describes a world that is deprived of imagination, it is describing humans and the rest of nature as a system of cog wheels. And suddenly those parts are easy to dispose of. They are replaceable. In the worst cases — we see it all the time — they become worthless.

When science, which is a strong voice in our culture, describes a world that is deprived of imagination, it is describing humans and the rest of nature as a system of cog wheels. And suddenly those parts are easy to dispose of. They are replaceable. In the worst cases, and we see this all the time, they become worthless.

I'm interested in how we came to stand in front of this door to imagination, and why we are so scared, especially in science, to open it.

For me, the idea of the imagination brings up this feeling of unruliness and lack of control. In a world where we feel increasingly unsafe, controlling as much as possible might give us the illusion of safety. But maybe it doesn't work that way. Maybe we are standing in front of this door, and we are so concerned that if we open it, we are going to unleash chaos.

But perhaps imagination can release those solutions we are so desperately looking for, and we can't see them without imagination, just as we couldn't see an alternative to the asteroid for the dinosaurs. Because we've been trained and conditioned to think that there's going to be chaos if we open the door.

One of the most impressive scientists in history is of course Charles Darwin, who has guided a revolution of his own. Darwin recognized imagination as a prerogative of the human. It's a faculty that allows us to actually create the brilliant and novel results or opportunities that we are all looking for.

Why is imagination so important? Because it represents a reservoir of meaning. This is a meaning that is embodied. It's in our flesh. It's in our blood. It's in our roots. It's made of a pre-linguistic system that doesn't require us to talk. We can feel it through our emotional system. It's kind of like a birthright.

How lucky is that? We're so desperate for a solution, and the solution is right here, inscribed in the system itself. From a Darwinian perspective or from an evolutionary perspective, the reason this information is so important is because it guides action and adaptive behavior.

These are the types of solutions that we want because these are the solutions to the eco-cultural and political issues that we are having at this moment.

When I opened the door, I found two things: 1.) plants, and 2.) Indigenous Knowledge.

CAN PLANTS THINK? DO THEY HAVE IMAGINATION?

My role, I felt, was to see whether science could actually test my experiences and ideas. Isn't that what science does? It tests ideas. That, in itself, was scary enough. I had a couple of colleagues in my own department who couldn't bear saying hello to me for two years. That is just a small example of how scary it is to actually open that door. But what do we do? We open it anyway.

I moved from just the communication of plants to something that was perceived as even more threatening: the entire area of the cognitive abilities of plants and learning and memory.

Research on learning and memory comes from the domain of psychology, the study of human cognition. Several decades later, we managed to move beyond humans and include some animals — and more recently, even machines. But one thing that this entire field has been insisting on is the fact that neurons and brains are the key.

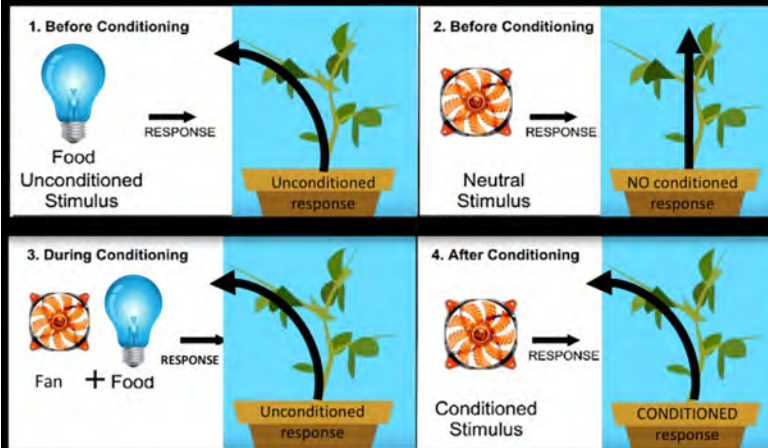
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Plant learning (and memory)

Classical conditioning (associative)



Pavlov's pea experiment

If you don't have them, you are automatically excluded. When you actually explore this assumption, you realize that that's not true.

The first plant that I worked with is *Mimosa pudica*, also known as "the sensitive plant" because it moves really fast. You probably have learned about it from a beautiful article that Michael Pollan wrote a few years ago for the New Yorker. He did a really good job of describing one of the experiments that I did with these plants, which included dropping the plant to see whether the plants could learn to ignore me, basically. And they did. They learned really fast, and they remembered for a very long time.

I'd like to spend some time talking about a kind of higher level of learning, which is from a pea. The nice, humble, green garden pea.

To understand what I did with the peas, we need to go back to the animal kingdom. I'm sure that many of you are familiar with the Pavlovian study of the dog. What is interesting about this experiment is the fact that, first of all, the dog is evaluating what is going on in his environment and he's got his own value system. He's deciding what he wants, what is worthwhile, and what will help him get there.

The next thing is that not all dogs are the same, so this value system is very subjective. There is a subject in there that is making these decisions. The decisions are made based on feelings, depending on how the dog feels about having that dinner and about this bell.

The really interesting thing about this experiment, from my perspective, is that in a way, by salivating to the sound of a bell that has been previously rung to announce the arrival of dinner, the dog is showing us that he is actually extending the amount of information that is in the environment. He's extending the information to something that is not in the environment, because dinner is not actually there. Food, or dinner in this case, is just a concept in the dog's mind. In other words, the dog is imagining dinner.

Now, take this and apply it to a plant. Exactly the same strategy. Dinner for the plant is blue light. In response, the plants don't salivate, but the blue light triggers a phototropic response, which means that the plants will bend toward it. That light is what the plants want just as much as the dog wanted dinner.

I had to find something that would replace the bell, but would play the same role.

I came up with this little tiny fan, which on its own doesn't do anything to the plant. The plant actually doesn't really care that it's there, so it keeps growing straight, hoping for some light somewhere.

Just as Pavlov did with the dog, if you present the fan and the light soon after, eventually the plants learn that, just by the presence of the fan, they can start preparing and turning toward it. The fan tells the plant where the light is going to be. Just like for the dog, there is someone in there who is making the decision, and it's based on a value system. How much do you want that light? What does the fan mean? And just like for the dog, not all plants are the same. Just like for the dog, the plant is actually stretching the field of perception, because dinner – in this case the light – is not even there. Like the dog, the food is a concept, an idea in the plant's mind. In other words, the plant is imagining the food arriving.

This was a great study because apart from the scientific results, it was able to disrupt that linear thinking that if you don't have a brain and neurons, you can't have this ability. We had to relinquish that, or at least expand it.

This study showed me that imagination is everywhere, no matter what kind of mind or what kind of form you are. It says that imagination is at the heart of nature: our own nature as the human form, and any other nature. It's an important bridge between the heart and the mind that dreams the world into being, whether it's the human mind or not.

We are stuck in front of this door to our imaginations, and we are so concerned that if we open it, we are going to unleash chaos. But guess what? By staying behind this door, we are staying stuck inside our minds.

When my mind and my heart were linked together through the bridge of imagination, I discovered a few things: First, it took me over those intellectual gaps that I was so afraid of. Second, it has integrated what would look like discrepancy between what I knew and what new was to come. Then it allowed for the emergence of this new insight, new understanding and inspiring ideas. It changed my life and my world as an individual, but it also showed me that it's absolutely, without a doubt, possible. We can do it. We just need to dare. ■



Photo by studiovin/Shutterstock



WHAT ANIMALS THINK & FEEL

Carl Safina, Ph.D., is an ecologist and the inaugural holder of the Chair for Nature and Humanity at Stony Brook. He is President of The Safina Center and a world-renowned, award-winning author on oceans, animals, and the human relationship with the natural world. A MacArthur, Pew and Guggenheim Fellow, he hosted the PBS series, *Saving the Ocean with Carl Safina*. Below, Safina discusses his research on animal cognition.

Does my dog really love me, or does she just want a treat?

I think that simply by looking at our beloved pets, we can easily see that, yes, of course, they really love us. It's easy to see what's going on in those furry little heads, isn't it? Or maybe not. Maybe you can't really tell what's going on.

But I'll tell you one thing: *something* is going on.

It's a little weird that our question is, "Do you love me?" That's not a question about them, it's a question about me. That's my insecurity talking. "Do you love me?" is not how you get to know somebody better.

So, I needed a different question. My question became: "Who are you?"

We know that the human mind has certain capacities. But are these capacities of *only* the human mind? What else is happening in the brains that share this planet with us?

For a long time many scientists said we can't know. The question of what goes on in other creatures' minds, if they even have minds, is not a scientific question because there's no way in.



"A pattern is emerging. And that pattern says a lot more about us than it says about all of them."

But that is not true, because there are some good ways in. We can look at brains. We can consider evolution, and we can watch what they do.

Jellyfish were the first animals in the world to have nerves, neurons, nerve cells. A nerve cell is a nerve cell, whether it's in a jellyfish or a dog or a human or a crayfish.

Jellyfish gave rise to chordates, chordates gave rise to vertebrates. But our human nerve cells are very much like jellyfish nerve cells, individually.

If we have the same kind of nerve cells, pretty much, and so do dogs and crayfish, what does that say about the emotional and cognitive life of crayfish?

Maybe it says nothing.

It just so happens that if you put crayfish in a laboratory, and every time they try to come out from their hiding place to explore you give them a little electrical shock, they will develop what looks like an anxiety disorder. They will be sort of cringy, and they'll stop coming out. They'll be afraid to come out, it seems. And if you put in the water a drug used to treat human anxiety disorders, they relax and come out.


What do we do to consider the possibility of anxiety among crayfish? We boil them by the thousands.

Octopuses are mollusks, and yet they recognize human faces and use tools, as do most apes. How do we honor the ape-like intelligence of octopuses? Mostly we boil them, too.

On coral reefs, there are fish called groupers. If groupers chase a fish that they'd like to eat into a crevice in the rocks or coral, they'll sometimes go to where they know a moray eel is sleeping. They have a way of signaling to the moray, "Follow me." The moray understands that signal, and often will follow. Then the grouper signals, "It's here," and the moray understands that. The moray will go in — sometimes it will get the fish and sometimes the fish will bolt out and the grouper will get the fish.

Carl Safina speaking at the Bioneers Conference.





This is an ancient, interspecies communication partnership, and people didn't know about it until about a decade ago. When I say "people," I mean the 17 people who read that paper.

How do we honor this ancient partnership? You might think boiled, but no. Fried.

A pattern is emerging. And that pattern says a lot more about us than it says about all of them.

Teaching is when you take time away from what you're doing to show a child or a companion what to do. Chimpanzees do not do that. Little ones learn a lot by watching, but older ones don't stop doing what they're doing to teach. Sea otters, however, teach. Killer whales teach a lot, and they share almost everything that they catch with their family members. That's pretty interesting.

If you look at a mouse brain and a human brain side by side, you'll see that a human brain is basically a very elaborate mouse brain. There's a mammalian brain. Mice have it. Humans have it. Humans have a pretty elaborate one. And this is how evolution works.

Evolution doesn't create something brand new all of a sudden. It takes the parts that are in stock off the shelf and it fabricates a new twist. That's how things evolve, that's how life evolves. Kind of like how cars evolve.

If you look at a human brain and a chimpanzee brain, they don't look too different. Basically, humans have a big chimpanzee brain. It's a good thing ours are bigger, because we're also the most insecure of all the apes. But, uh-oh, dolphins have a bigger, more elaborate brain than ours. Does this tell us that dolphins are more intelligent and think about things more and communicate better? Not necessarily. They might have a brain like that because a lot of it is dedicated to processing sound for their incredible sonar system that we don't have.

You can see brains, but you cannot see minds. That might seem like a dead end.

However, you can see the workings of a mind in the logic of behaviors.

For instance, our mind makes sense of a scene exactly how the minds of elephants make sense of a scene. Elephants find a patch of shade under the palms to let their babies go to sleep. But the big ones don't go to sleep, they stand up dozing. They remain vigilant, resting, facing outward, touching one another. We make sense of that scene exactly how they do, and it is exactly what they're doing.

That's because on the same plains as them, under the arc of the same sun, listening to the whoops and roars of the same enemies, we became who we are and they became who they are. We've been neighbors for a very, very long time. We have a lot in common. Our minds were shaped by common needs.

If you play recordings of people speaking in English and people speaking in Masai through a speaker hidden in the bushes, elephants ignore English because tourists speak English. But they bunch up and run away when they hear Masai because Masai people carry spears, they get into confrontations with elephants at water holes, and elephants often get hurt. They know not only that there are different kinds of animals, and one of them is humans, but they also know there are different kinds of humans, and some of them are fine and others are dangerous. They've been watching us for a much longer time, more carefully than we've been watching them.

We are all mammals, and under the skin we have almost everything in common, and our imperatives are the same. Find food, stay alive, keep our babies alive. Under the skin, we have the same skeleton, the same organs, essentially the same nervous system. The same chemicals that create mood and motivation in human beings create mood and motivation in other mammals. In the flippers of whales are the exact same bones that are in your hand.

Under the skin, we are all kin. We are organically related. We are family.

We see commonalities that we all understand. They understand helping when help is needed, the same way we do. We see curiosity mostly in the young, who are exploring the world for the first time.

We see the deep bonds of family relation. We see the deep bonds of mates to one another. Dancing is dancing. Courtship is courtship. We see it, and we recognize it for exactly what it actually is.

And then we ask a really weird question: "Are they even conscious?"

Why would we ask a question like that? When you get general anesthesia, you become unconscious. That means that you stop experiencing the sensory input from your sense organs. It's like you take your eyes and your ears and your nose and disconnect them from your brain. Then when you come out of it, you regain consciousness. You get your senses connected back to your brain.

That's what consciousness is. It's an awareness of your senses.

Why would we ask whether animals that have eyes and see with them, ears and hear with

them, noses and smell with them, who play with each other, are conscious? Why would we ask that question? Because we have a favorite story, and our favorite story is we're the only ones that matter, and we're the best.


There are various people who try to say that "blank" makes us human, like it's a Mad Lib's line. One of the things they say is that empathy makes us human. Well, it turns out that empathy is one of the oldest emotions because anything that lives in a group needs to have empathy.

Empathy is when your mind matches your mood to the mind of your companions. Every group-living animal needs that kind of empathy, that mood matching, because when it's time to hurry up you better hurry up right away. It doesn't pay if you're with hundreds of companions and they all startle and fly away, it does not pay for you to say, "Geez, that's a lot of work, flying away, I'm going to just stay right here. I wonder why they all just left. That's no good." That's why we all have empathy.

The oldest kind of empathy is contagious fear. Anybody who has money in the stock market knows that humans have that kind of empathy.



Photo by Satya Deep/Unsplash



"Why would we ask whether animals that have eyes and see with them, ears and hear with them, noses and smell with them, who play with each other, are conscious?"

Everything in the living world is on a sliding scale, including empathic abilities. Basic empathy is mood matching. Sympathy is a little bit more distant: "I'm sorry to hear that your great grandmother has passed away." You're not feeling the same grief, but you understand it. If you are moved to act, I call that compassion. We have all of that on a range. Some other species also have that range.

Human empathy is not the thing that makes us human. It's far from perfect. We round up empathic, loyal creatures and we kill them and eat them. We're not too good to each other either.

People who only know one thing about animal behavior know that you're not ever allowed to attribute human thoughts and emotions to other species. This is "against the rules." But science is not supposed to have rules. Science is supposed to have curiosity.

It is unscientific to easily say, "They're hungry when they're hunting and they're ripping food apart, they're exhausted when their tongues are hanging out," and then when they're playing and having fun with their children, to say, "Oh, I don't even know if they're conscious. They're certainly not capable of feeling joy. Joy is a human emotion. We're the only ones."

I was talking to a reporter about this one time, and she said, "But how do I really know? How do you know that other animals can think or feel?"

I was trying to think of the best scientific paper example, and then I realized the answer was right on the rug. My puppy comes over to me and rolls over on her back. Now, she doesn't get up from the rug and go over to the dining room table and roll over on her back. Right? She comes to me. Why does she do that? Because she's just had a thought, and the thought is, 'I would like my belly rubbed, and I'm going to go to him because we are family. I know that if I roll over on my back, I have nothing to fear. I cannot only trust him completely, but he knows what I'm asking for, and he knows how to get the job done and make it feel really good.' She has had a thought, and she has felt, and it's not a lot more complicated than that.

But if you think that's not scientific enough, I can tell you that recently people have trained dogs to go in MRIs. Researchers can watch their brains light up and see that dog love in the dog brain is the same as human love in the human brain.

But that's still not how we see them. We see them by labeling them.

Animals have lives. And when we hurt and kill them, the trajectory of life for the survivors is totally changed. It's different from what it would have been. They're not just numbers. They're individuals in families, with relationships. We are made individuals by our relationships and so are they.

We hurt them so much that I'm often perplexed about why they don't hurt us more than they do.

No free-living killer whale has ever hurt a human being. Why don't they eat us? Why can we trust them around our toddlers? Why is it that two different scientists in two different countries have a very similar story? I'll tell you one of them:

These researchers were traveling, following killer whales to study where they went, and they went into a deep fog bank where they couldn't see anything. The whales were gone, and they started to head home.



Two minutes later, the killer whales appeared in front of the boat. The researchers followed them. After 15 miles following the killer whales, they broke out of the fog bank, and the researcher's house was right there on the shore. And the whales left.

In the Bahamas, there's a researcher named Denise Herzing. She's been studying spotted dolphins for 30 years. When her boat shows up, they recognize it, they know who she is, and they all come over and start bow-riding. One day she arrived and the dolphins wouldn't come near the boat. As she was trying to figure out why, there was an announcement that somebody on board had just died during a nap in his bunk. Now, how can the dolphins know that one of the human hearts has stopped? Why would they care, and why would it spook them?

I don't know the answers to these questions, but I know what it means. It means that there is a lot going on in the other minds that share this planet with us that we never, with our minds that we're so proud of, think about.

In an aquarium in South Africa, there was a nursing-age baby bottlenose dolphin named Dolly. A keeper was on a break smoking, looking through the window at the pool, and the little baby Dolly came over and looked at him while he was smoking. Then she went to her mother and she nursed, and then she came back to the window and she let go of all the milk and it surrounded her head like a cloud of smoke. This was a nursing-age infant dolphin having the idea, 'I'm going to use milk to imitate whatever he's doing.' When humans use one material to represent another, we call that art.

The things that make us human are not the things we keep telling ourselves make us human. Here's what I think... I don't think it's that we do everything totally uniquely. I think it's that we are the extreme animals. We are the most creative and the most destructive, the most compassionate and the cruelest animal that has ever lived. We are all of those things all the time all jumbled up together.

Love and caring is not new with us, and it's not the thing that makes us human. We're not the only ones who care about our mates. We're not the only ones who care about our children.

Albatrosses live in the middle of the ocean on the most remote islands in the world, and they travel for two to four weeks, 8,000 to 10,000 miles, to bring back one gigantic meal for their chicks. That's a lot of devotion.

When we expect new human life, we paint animals on the nursery room walls. We don't paint cell phones. We don't paint desks and work cubicles. We paint animals. We don't even realize why we're doing it.

I think we do it because we have a blessing for our babies that we're not even aware of, and what it says is: Welcome to this beautiful, living world. We're not alone. We have company. And yet every one of those animals, in every painting you see of Noah's Ark, these animals deemed worthy of salvation by the Creator, every one of them is in mortal danger now. And their flood is the rising tide of us.

I started by asking, "Do they love us?" That question needs to be turned around. The question is: "Are we capable, are our human minds capable, of loving them enough to simply let them continue to exist on Earth with us?"

That is a write-your-own-ending kind of story. ■

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TAKE WHAT IS GIVEN TO YOU



What happened to the world I knew?

Robin Kimmerer, Potawatomi Indigenous ecologist, author, and professor, asks this question as she ponders the fleeting existence of our sister species — species such as the passenger pigeon, who became extinct a century ago. She asks this question as she tells the stories of Native American displacement, which forever changed the lives of her ancestors. And she asks this question as she bears witness to global climate change, the disturbance of natural habitats, and the destruction of native lands. Below, Kimmerer brings to life the heartbreak inherent in the commoditization of nature and human development without reverence for Mother Earth.

Photo by Jacob_09/Shutterstock





I want to say at the outset that I will not tell you anything today that you don't already know, but we forget,

we human people ... our elders have told us that our job is to remember. To remember. That's where the stories come in, because once upon a time, the skies over the Potawatomi homelands carried flocks of birds so vast they darkened the sky. They could take days to pass by overhead; flocks so large that their collective weight in roosting broke off the limbs of trees.

It was 100 years ago this fall on September 1, 1914 that the last passenger pigeon passed from this Earth. She was known as Martha, and she lived all alone in the Cincinnati zoo. In this time of accelerating species loss, this centennial commemoration of her death has really weighed very heavily on my shoulders. So I dedicate this piece today to her.

I was surprised to find that while I knew a fair bit about the extinction of the passenger pigeon, I knew relatively little of their lives. So I started reading. I read about their communal nesting, all wing to wing, the way they cherish their single egg, how they shape the forest with their feasting on oaks, and how they came like a distant wind and settled by the thousands to roost, conversing with one another — mothers, children, relatives of all kinds — in the voices which linger in the name that our people bestowed upon them. We called them "omimi."

I was also fascinated to learn about how the lives of omimi intercepted with the lives of my Potawatomi ancestors ... how many of our people understood the great flocks as flocks of departed souls, and how today we wear bird clan regalia of red and blue in their honor. One of the early chroniclers of the abundance of omimi was none other than Simon Pokagon,

a Potawatomi leader, who described them, as it was proverbial among our fathers, that if the great spirit in his wisdom could have created a more elegant bird in plumage, form and movement, he never did. Among Simon Pokagon's people up there on the St. Joseph River was a leader who had a daughter named Shinoda, "the wind blowing through," and she was my great, great, many greats grandmother.

Like omimi, they moved about the landscape together too, making their lives in the oak forest where they, too, feasted on acorns, set their lodges in communal circles, and relatives of all kinds, wing to wing, cherishing their single offspring. They gathered around the fire at night to tell stories.

But someone else wanted those forests for farms, and the birds became a threat to the crops. And so, 1838 was a year in which passenger pigeons were killed by the thousands in traps, with shotguns, in nests, packed in salt and sent by trainloads back to the East. The birds became fewer, and so our people became fewer.

***"Our elders
have told us
that our job is
to remember.
That's where
the stories
come in."***




Our Potawatomi people were canoe people. Our lodges were built on cold, blue lakes under the birches and the pines, lakes that rang with the voices of loons. Our Potawatomi people were canoe people until they made us walk, until someone else wanted that forest, and we were marched away at gunpoint from all that we knew ... marched from Michigan to Kansas in what became known as the Trail of Death. I imagine my grandma, Shinoda's hand just trailing over her beloved medicine plants as she walked away from them, saying a silent farewell to maples.

We should ask them about climate change. In a single season, they lived it.

What is it like to exchange a cool, lush forest for a hot, dusty grassland? Lakes for dry riverbeds? Baskets of wild rice for sacks of weevily flour? Loons for — well, there is no replacement for loons.

When I found a photograph of Martha, I felt in her gaze a lament. How could something so beautiful, so ancient, so prolific simply vanish? What happened to the sound of their wings and where did everybody go? What happened to the world I knew?

And you know what? Every time I looked at that photograph, I felt my great grandmother's voice tugging at my sleeve. Born on the shores of Lake Michigan and buried on the Kansas prairie, she probably said it too. How could something so beautiful, so ancient, so prolific just go away? What happened to the world I used to know?



Climate change is a major driver of species extinction. On average, we lose 200 species every day. Every day. Shouldn't we be looking over our shoulder and saying goodbye as well? Because the stories of our people and the stories of omimi converge, for both were swept away by the same wind, and we know what happens when two winds, two weatherfronts collide—great turbulence and often suffering for the ones below. Two winds, two worldviews, met on this continent.

Worldviews which color our relations with the living land, which shape our answer to the question of: What does land mean? A worldview in which land was understood as sacred, as our sustainer, our pharmacy, our identity, our home, our library, the place where we play out our moral responsibility in return for our very lives, peopled with our non-human relatives.

This is a way of being in which the tar sands are unthinkable. This view of the Earth suddenly encountered another view, a kind of climate change in values. The whole notion of land as a set of relationships and moral responsibilities was replaced by the notion of land as rights, rights to land as property, and what our people called the gifts of the land suddenly became natural resources, ecosystem services and capital. Nature as family became nature as machine, and our non-human relatives, our teachers, became mere objects for consumption. This is a way of being that invites us to the tar sands.

This is the same question that has us teetering on the precipice of unparalleled extinction and climate chaos. Is the land a source of belongings or a source of belonging?

The turbulence of the clash of worldviews spawned the wind that tried to blow away the Potawatomi and propelled the extinction of the most abundant bird on Earth, and we need to remember and name this heartbreak because that same wind still threatens us all, and its temperature is rising.


You should know that the story of Martha and my grandmother, Shinoda, are foretold in the Anishinaabe teachings, the people of the Seventh Fire. It's an ancient teaching which could not be more urgent, for unlike our sister species, omimi, we are still here—with teachings that enable survival and resilience, teachings that the Earth asks for today.

In the teachings of the Seventh Fire are the history of our people, and I'll share just a tiny fragment of it today, each fire refers to an era in the history of our people. It's the story of our origins, our migration, and of our great teachers who warned of the changes that were to come.

The teachings told about a time when the people would become separated from their homelands and from each other, forbidden by law to practice our religions, speak our own languages. A whole way of knowing was threatened with extinction. It was said that there would come a time when you could no longer dip your cup into a stream and drink, when the air would become too thick to breathe, and when even the plants and animals will begin to turn their faces away from us. This, too, we know has come to pass.

But it's a story of hope as well, because the Seventh Fire teachings spoke of a time when all of the world's people would come to a fork in the road and stand there together with a choice to make. In my imagination, one path is soft and green, all grassy and spangled with dew and you want to walk barefoot there. But the other path is burnt, and it's black and it's all cinders; it would cut your feet. Prophecy has become history, for at this time when the world as we know it hangs in the balance, we know we are at that crossroads.

The prophecies of the Seventh Fire tell us that if we want to choose that green path, we first have to turn back along the path that our ancestors left for us and pick up the teachings that they gave us, to retrieve the language, the ceremonies, our spiritual ways.



And only when we have picked those up can we then walk that green path to light the eighth and final fire.

We are the people of the seventh fire, marching toward the lighting of that eighth fire, all of us. It is the people—the wisdom that we reclaim—that will allow us to renew the world. The Indigenous Peoples and the newcomers, we are all part of this story.

If I could choose just a single element of the traditional teachings that we're called to pick up, it would be the teachings of the honorable harvest, which were taught us by the plants who give us everything that we need. We are destined by our biology to take lives in order to sustain our own, aren't we? And that utter dependence upon the lives of others sets up certain responsibilities which are simultaneously practical and spiritual.

This is known as the honorable harvest. They are rules of sorts for our taking. It's a covenant of reciprocity between humans and the living world, a very sophisticated, ethical protocol. One of the first steps of the honorable harvest is to understand that the lives that we are taking are the lives of generous beings, of sovereign beings, and in order to accept their gift, we owe them at least our attention. To care for them we must know what they need. And at the very minimum, we should know their names, especially this one, whose name is "heal all."

It's a sign of respect and connection to learn the name of someone else, a sign of disrespect to ignore it. Yet the average American can name over 100 corporate logos and 10 plants. Is it a surprise that we have accepted a political system that grants personhood to corporations and no status at all for wild rice and redwoods? Learning the names of plants and animals is a powerful act of support for them. When we learn their names and their gifts, it opens the door to reciprocity.

These guidelines of the honorable harvest were taught to me by generous teachers as I was learning to pick medicines and berries.

But it also applies to every single exchange between the people and the Earth, from catching a fish to fossil fuel extraction. The protocols for the honorable harvest are not really written down, but if they were it would look something like this: When you get to the woods, you don't just start grabbing everything in sight. We're taught never to take the first plant that you see, and that means you'll never take the last. This is a prescription with inherent conservation value.

Then, if we encounter another plant, we ask permission. I've always been taught to address that plant, to introduce myself and tell it what it is that I have come for. If you're going to take a life, you have to be personally accountable for it. I know there are places where if you talk to a plant, they'd think you were crazy. But in our way, it's just good manners.

It's a two-way conversation, though. If you're going to ask, you have to listen for the answer. You can listen in different ways—pragmatically, intuitively. Look around. See whether those plants have enough to share. And if the answer is no, you go home, for we remember that they don't belong to us, and taking without permission is also known as stealing. If you are granted permission, then take only what you need and not a bit more. This is a difficult step in our materialist society, where the difference between wants and needs are so blurred.

The honorable harvest counsels that we also take in such a way that does the least harm, and in a way that benefits the growth of the plant. Don't use a shovel when a digging stick will do. Use everything that you take. It's disrespectful of the life that's given to waste it, and we have forgotten that the easiest way to have everything that you need is not to waste what you have.

Be grateful. Give thanks for what you have received. And in an economy which urges us to always want more, the practice of gratitude is truly a radical act. Thankfulness for all that is given makes you feel rich beyond measure.

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It reminds us that we're just one member of the democracy of species; it reminds us that the Earth does not belong to us.

The next tenet of the honorable harvest is to share it with others, human and non. The Earth has shared generously with us, so we have to model that behavior in return. And a culture of sharing, we know, is a culture of resilience.

Reciprocate the gift. We know that in order for balance to occur, we can never take without also giving back. Plant gatherers often leave a spiritual gift behind, but it can also be a material gift—weeding, caretaking, spreading seeds, helping those plants to flourish. We give songs. We give ceremony. We give our respect. We give fertilizer. The ways to reciprocate are many.

What if the precepts of the honorable harvest was the law of the land? What would the world look like if a developer poised to convert a meadow into a shopping mall had to ask the permission first of the goldenrod and the meadowlarks, and had to abide by the answer?

Can we extend the concept of the honorable harvest to address the causes of climate change and extreme energy development? You bet we can.

I'm told that there is a teaching even older than take only what you need, and it is take only that which is given to you. It's a pretty challenging idea to be able to discern what it is that is given as opposed to what we simply take, and I've really wrestled with this idea. I'm not sure I fully understand it yet, but I'm pretty sure that coal from mountaintop removal is not given to us.

Tar sands oil is not given to us. But the sun's energy is given to us everyday. Every day the wind blows. The surf rolls. They're given to us freely and without limit. Had we taken only that which was given to us, perhaps today we would not be afraid of our own atmosphere.

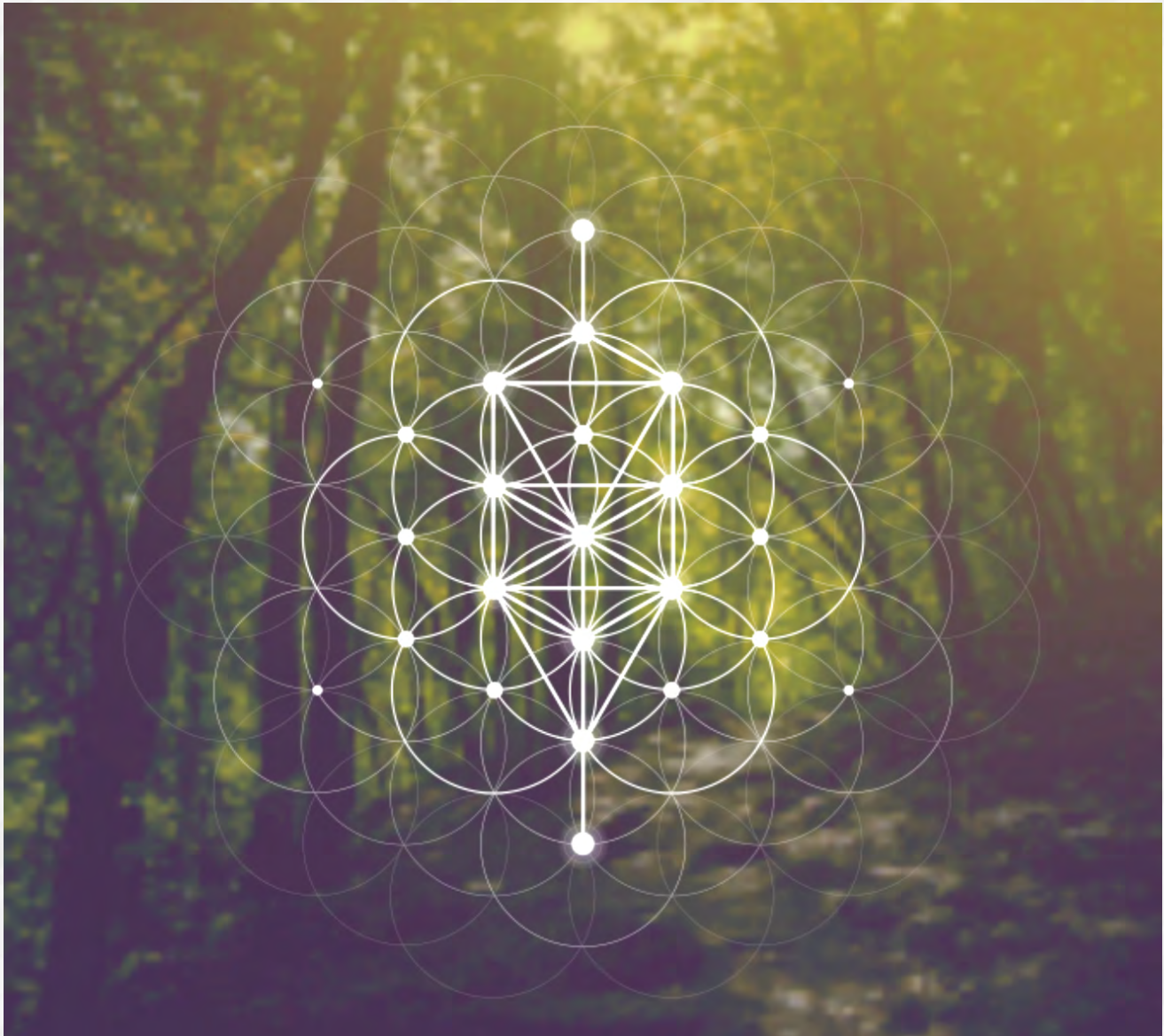
For a time my research as an ecologist was in the field of restoration ecology, but I came to understand that it's not the land which is broken, it's our relationship to land which is broken. Our work must be to heal that relationship. The honorable harvest is a small part of that healing.

We need acts of restoration for polluted lakes, for degraded lands, yes, but we also need a restoration of our own honor, honor in the way that we live, so that when we walk through the world we can hold our heads up high and receive the respectful acknowledgement of our plants and animal relatives. We can look them in the eye in return. And the reward is not just a feel-good sense. It may save us all.

Our challenge as scientists, as citizens, as leaders, as designers, planners and dancers, as students and artists and dreamers in the Bioneers community is to ask how can the effect of the honorable harvest be realized on the land and in our communities? For if we had adopted the wisdom of the honorable harvest instead of marching it away to whither in the dry lands of Kansas, we might this very spring have looked up to see flocks of omimi flying overhead in what Aldo Leopold called a living wind.

If we sustain the ones who sustain us, the Earth will last forever. ■

INTELLIGENCE IN NATURE: OUR FAMILY TREE OF LIFE



Author and anthropologist **Jeremy Narby** started contemplating new ways to think about nature when he lived in the Peruvian Amazon with the Ashaninka people for a few years. This community used the word “ashaninka” to refer not only to themselves, but also to the other species around them, suggesting kinship. In a world dominated by Western ways of thinking, Narby is now using this idea to challenge human-centrism in our relationship with nature.

Narby shows how this growing disconnect between humanity and the Earth we're a part of is an obstacle to living responsibly in the biosphere. His work shows that humans have a lot to learn about consciousness from the unique and innate sense of intelligence in natural life. By recognizing plant intelligence, animal cognition and evolutionary biology, we can honor our place in the Earth's family tree, which is the full tree of life.



A long time ago, I spent a couple of years living with the Ashaninka people in the Peruvian Amazon,

and these are people who know a lot about plants and animals. In fact, they have a name in their language for just about every species living in the forest. But they spoke of plants and animals in a way that I found unusual, as intelligent beings with personalities and intentions, and to have kinship with humans. They even called some species *ashaninka*, which was their word for themselves, meaning our people or our relatives.

So white herons were *ashaninka*. Manioc plants were our sisters. Small birds were our many brothers. Armadillos were brothers-in-law.

The Ashaninka tended to personify other species and to relate to them through kinship.

It turned out this view was fairly common among Amazonian people, but it took me a long time to come to grips with it.


I began working as an activist and fundraiser for Indigenous initiatives in the Amazon, and as an independent anthropologist, I also tried to make sense of the Amazonian point of view. This led me some 25 years ago to start looking into domains like biology, botany, and neurology. And at the time it was already clear that biology confirms human kinship with other species, and that all living beings are genetically related. Scientists were starting to document intelligent behavior in all kinds of living organisms. The more science looked at the intricacies of the natural world, the more intelligence it seemed to find.

This encouraged me to look into intelligence in nature, a subject that concerned both science and Indigenous

knowledge. So in the early 2000s, I interviewed scientists in different countries who were working on this subject, only to find that there was a basic problem with words. So when a Japanese scientist demonstrated that a single-celled slime mold could solve a maze, Western commentators objected to his using the word "intelligence" to describe the slime's behavior. The problem was that Western thinkers tended to consider intelligence as a human exclusivity. They had defined it over the centuries in many different ways, most of which were in exclusively human terms making it difficult for other species to qualify, especially single cells of slime. So the word "intelligence" was human-centered.

But so was the word "nature." The Dictionary defines nature as the phenomena of the physical world — including plants, animals and the landscape — as opposed to humans and human creations. The word "nature" means everything that is not human, and anthropologists have pointed out that this is a concept specific to Western cultures.

"The problem was that Western thinkers tended to consider intelligence as a human exclusivity."



If you go to the Amazon, for example, and ask people there about their word for nature, for everything that is not human, they say they have no such concept. And on the contrary, they tend to view most other species as people like us.

Meanwhile, modern Western thinkers have tended to put human beings in a category of their own, above all other species, arguing that, for example, animals are incapable of thinking because they lack language. But recent scientific research has just proved the contrary, and that even small invertebrates like bees think and handle abstract concepts. And numerous other species have systems of communication, some of which are close to human language.

Take prairie dogs. They have a sophisticated form of verbal communication involving high-pitched chirps that they use to describe the world around them. They can describe intruders according to species, size, shape, speed, and color. A prairie dog may chirp: "Here comes a small, thin human wearing blue moving slowly," or "here comes a tall, yellow coyote moving fast." Prairie dogs have brains the size of grapes, but they chirp away all day long, and scientists have just begun to understand them.

Now, there is strong evidence that numerous species think, feel, remember, and plan, and have language-like abilities and systems of communication. This has led some Western thinkers to move away from constantly affirming the centrality of human beings. But here I'd like to mention a new concept that would keep humans at center stage - the Anthropocene, a supposedly new geological era ushered in by human impacts on the biosphere. The word comes from the Greek *anthropos* (human being) and *kainos* (new), and roughly means "the age of humans." It's not an official scientific concept yet but it seeks to draw attention to human activities like driving species out of existence, poisoning ecosystems, deforestation, warming the climate, and leaving radioactive contamination and garbage all over.

But naming today's geological age after humanity hides the importance of other species like bacteria and plants in the functioning of the biosphere. It also dilutes responsibility for ecological damage among humans. Indigenous people who oppose oil extraction in the rainforest are surely less responsible for degrading the biosphere than most people living in industrialized societies. The problem is not humanity in general but certain humans in particular. And naming today's geological age after our species has narcissistic overtones, if only because no previous geological age bears the name of a single species.

So instead of affirming the centrality of humans for the umpteenth time, it would be interesting to move beyond the anthropo-centered frame that has enclosed Western minds for centuries and build a new, less destructive relationship with the other species living on this planet.

The human-centered concepts of Western cultures have disparaged the other species of this world for so long that most existing legal systems consider plants and animals like objects. The only subjects being humans, of course. But this is starting to change. In divorce cases, some judges are starting to consider the family dog as a member of the family rather than as a possession. If the dog is a possession, the answer to the question, "Who gets the dog?" is the person who paid for it. But if the dog is like a person or a child, the question becomes, "What is in the best interests of this person?" So dogs are starting to get a paw in the door of personhood in some places.

But "person" is one of those human-centered words. Its first definition is a human being regarded as an individual. And this is one of the reasons why critics argue that attributing personhood to other species doesn't make sense. So it seems that it will be difficult for other species to be granted personhood. Yet at the same time, it's increasingly clear that considering them as mere objects is inexact.

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And here I'd like to point out that considering other species as persons is the definition that anthropologists currently give of animism. And when Amazonian people and other animists say that they consider a plant or an animal as a person, I take them to mean that there's someone home, a self rather than a thing, a sentient being with its own point of view. And even plants qualify.

Now, scientists have demonstrated that plants perceive the world in their own way. A plant may not have eyes, but it perceives light through photoreceptor proteins that cover its entire body and that are nearly identical to the ones inside our own retinas. It's as if the plant had tiny eyes all over its body. A plant knows if you're standing next to it and if you're dressed in red or blue. Plants learn and remember and make decisions. They make plans. Even a blade of grass perceives the world around it, makes decisions and acts on them. This has led some philosophers to start granting personhood to plants, and other philosophers to disagree fundamentally.

And here I think Indigenous people can help philosophers think things through, regardless of whether sisters manioc and brother-in-law armadillo are bona fide persons or not, at the end of the day you still have to eat something,

or rather somebody. And the animist take on this question seems to be that eating other species means knowing them, identifying with them, and trying to see the world from their perspective.

Among Amazonian people, the shortcut to seeing the perspective of other species is to ingest plant teachers. These are plants like tobacco and ayahuasca, and they tend to teach that other species have their points of view which humans gain from taking into consideration. In this view, plant-induced trances give other species the opportunity to voice their complaints and demands, which humans can then take into consideration or else risk retribution. But working with plant teachers is tricky business as we'll be discussing this afternoon.

In animist societies, considering other species like persons often means treating them like relatives or allies. In the Ashaninka case, beneficent plants like manioc, corn, or peach palm are called brothers or sisters because they are so good and generous, whereas species that are hunted are treated with more distance, like brothers-in-law, and plants like ayahuasca and tobacco are considered powerful and therefore potentially dangerous allies. But in all cases, using plants and animals involves recognizing the relationship one has with them.

It turns out that Ashaninka people integrate into their kinship system not only plants and animals, but also visiting anthropologists. So I can give you an example of this kind of creative kinship based on personal experience.

Back in the day I was living in an Ashaninka community. Men would introduce themselves to me and say, "So how should we treat each other, as brothers or brothers-in-law?"

And I'd say, "Well, I don't know." They'd say, "Well, brothers, if we want to be close and share things, and brothers-in-law, if we want to be more distant like trading partners."



So I ended up with a couple of brothers and a whole slew of brothers-in-law, but the point is that this kind of kinship can be practiced creatively on an individual basis and in real time.

Last but not least, the Ashaninka considered some species as harmful, in which case they refer to them as having once been “human”, atziri, but not as ashaninka, “our relatives”. So poisonous snakes were not even brothers-in-law, which is not to say the contrary, of course.

People who want to move away from the anthropo-centered scene that Western cultures have upheld for centuries can start by moving away from treating plants and animals like objects, and humans too for that matter.

Human kinship with other species is real and confirmed by science, but after centuries of treating other species like objects and refusing to have relations with them, people in Western cultures will need time to think this through. Here, animist societies provide a template. They may treat other species like relatives, but just like with relatives: some are close, others are more distant. Some are beneficent. Others are problematic. The nature of the relationship depends on both parties, and prudence and flexibility is required.

That's how you treat your in-laws, right?

I don't mean to say that people who speak in Western tongues should become animists but rather that we can learn from animist cultures. Animists use kinship categories to think about other species but in a Western context — other concepts like friend, neighbor, doctor, colleague, may be more appropriate. People will need to think about this creatively and according to their own convictions.

I initially thought to end with a consideration of respectful living in the biosphere, but now I think that “responsible” is a better word than respectful because it's more concrete. It comes from the verb “to respond.” I think that living responsibly means living in a way that responds to the situation we're in, and to what we now know. I think that responsible living in the biosphere means learning to see other species as beings like us, in that they have intentions, make decisions, and they know what they're doing. They have points of view. I think that responsible living in the biosphere means learning to take the interests of other species into consideration and allowing them room to live. And I think it means learning to relate to them and to think through the kinship we have with them.

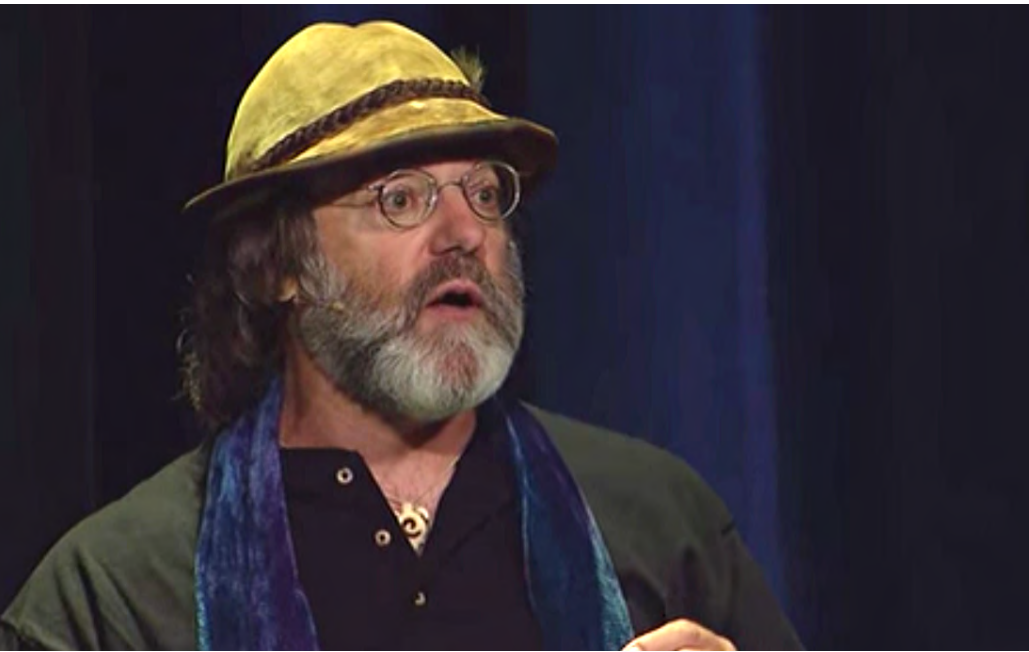
So now to get started, I call birds amigos. I consider some mushrooms as my friends. And I think of the blades of grass as sisters as I mow the lawn. ■

SOLUTIONS UNDERFOOT: HOW MUSHROOMS CAN SAVE THE BEES

Old-growth forests are libraries of ancestral knowledge, with fungi being the biological network that connects it all. Visionary researcher **Paul Stamets** has spent more than 40 years studying mycelium, its ability to recycle nutrients, and its role in sustaining life from the ground up. He's now using those restorative properties to save the bees from extinction.

Bee populations are declining as they face viruses precipitated by climate change. But Stamets' groundbreaking invention of MycoHoney, made by bees that sip mycelium droplets, provides nutrients to safeguard bee survival. MycoHoney is the first step to saving the world's most important pollinators from the growing threat of extinction, and ensuring the survival of humanity in the process. It doesn't get much sweeter than this.





My favorite hat is a very cool hat, made from the amadou mushroom, which is a birch polypore

mushroom. This hat is actually made by some ladies in Transylvania. It allowed for the portability of fire, as you can hollow this mushroom out, put embers of fire inside — and carry fire for days.

There's no doubt that we all are Africans. We migrated north into Europe and we discovered something new called winter. This mushroom allowed for the portability of fire.

This mushroom goes back thousands of years medicinally also.

In 450 BCE, Hippocrates first described it as an anti-inflammatory. This mushroom in the 1960s was the first to contain an antiviral substance that was known to medicine. And beekeepers throughout Europe, still to this day, use it for smoking bees.

Well, this mushroom is an example of the thread of knowledge going back to our ancestors, when we were once forest people. Not long ago we were so dependent on the forests, and deforestation is the greatest threat to human survival today.

Another friend of mine is agarikon. Agarikon was first described by Dioscorides in 65 AD as *elixirium ad longam vitam*, or “the elixir of long life.” It is a resident exclusively of the old growth forests in Washington, Oregon, British Columbia, Northern California, and now thought to be extinct throughout most of Europe because of deforestation. I believe that agarikon, like amadu, will be extremely significant for human survival.

We have now entered into the sixth greatest extinction event known in the history of life on this planet. But this extinction event is not caused by an asteroid impact,

or volcanoes, or earthquakes — it's caused by an organism, by us. Not only are we the cause of this extinction event, but we're likely to be its victim.

Deforestation is causing zoonotic diseases to spread. The emergence of Ebola is directly related to deforestation and a clash between bats and humans. This is something that I think is emblematic of the times. When an organism exceeds the carrying capacity of its ecosystem, then disease vectors emanate. This is the way of nature.

I spend a lot of time in the old growth forests, and in these forests are libraries of knowledge. Ancestrally it goes back not only millennia, but multi-dimensionally in ways that we can barely imagine.

The largest organism in the world is a fungus in Eastern Oregon. It is a honey mushroom called armillaria. It covers 2,200 acres. It's a contiguous mycelial mat, and it's only one cell wall thick. Think of that: The forests are being governed and controlled by these large fungal mats, and I think we should respect things that are larger than us, especially the largest organism in the world.

"We have now entered into the sixth greatest extinction event in the history of life on this planet."



The mycelium of these fungi in particular are the grand molecular disassemblers of nature. They're soil magicians. They're tenacious. They can hold tens of thousands times their weight. They can hold the soil together, preventing erosion. And then when they stream out and grow coarse habitats, they control the dissension of subsequent microorganisms that populate the downstream communities that give rise to the plants in the forest that create the debris fields that then feed the fungal descendants.

They're purposeful in their choosing of microbial allies. They're commensal.

The mycelium is an extended stomach. They're externalized lungs, and I believe that these are externalized neurological networks and part of the Earth's natural Internet that's in constant biomolecular communication, governing the ecosystem.

The mycelium expresses these little extracellular droplets — in which are acids, enzymes, all sorts of messaging molecules — many compounds that scientists are still discovering that are unique (at least they're unique to us) and the mycelium transports thousands of nuclide. These bundles of nuclei stream across the networks. And in the hundreds of millions of tips of mycelium in a swath the size of the stretch of my arms is a new insect, a new toxin, a new food source. There's a reassortment of nuclei in an expression of a new enzyme, a new acid, a new solution to digesting that toxin. What happens?

The mycelium becomes educated. It then captures that new nutrition, and that information genetically becomes resident within the entire mycelial mat. These are self-learning membranes.

More than 90% of plants have mycorrhizal fungi, which extend the root zones hundreds of times, giving them the essential nutrients. But the use of fertilizers now on factory farms defeats the mycorrhizal networks and make a plant become addicted like a drug addict. Depending upon these natural ecological systems is far better.

A resource study came out just a few months ago — and it's surprising that this study just recently came out — in which six bean plants were individually put into different pots. The first bean plant was exposed to aphids; the plant then produced alkaloids that are anti-aphid. The first plant was the only one exposed; the five other plants did not produce anti-aphids. But when the six plants were joined together in common soil connected by the mycelial networks, when the first plant was exposed to aphids, all the other five plants also produced the anti-aphid alkaloids, thus proving that the root system had a communication pathway to help alert and defend the community from potential pathogens.

Not long ago, our forests of the world had enormous amounts of wood debris. Unfortunately now, the wood debris has been taken out of the forests, and with our current practices, we have a small fraction of the resident wood debris in nature, which organisms depended upon and through which we've evolved through the thread of evolution to where we are today. Now we are removing that menu of wood debris from the ecosystem. Organisms have been dependent upon it for millions of years. What do they do?

I want to bring to you to an epiphany that I've had that I think is just truly revolutionary. Bee populations are facing stressors that lead to colony collapse disorders, loss of poor bee nutrition, loss of forage lands, parasites from mites that are carrying viruses, and exposure to pesticides. My good friend Louie Schwartzberg has made a short movie about how bees forage several miles away from their habitat. The bees leave these hives and then they don't come back. And worker bees are at the end of their life when they're foraging, so when you see bees on flowers, that's the last week or so of their life. But upon hatching, young bees then quickly become nurse bees and they take care of the brood. Well, when there is a loss of foraging bees, the nurse bees then are prematurely recruited, and as a result, the nurse bees' population declines and the brood is not taken care of.

Mites and other diseases then begin to spiral out of control, and suddenly the whole colony collapses.

So, follow me on this path of a very bizarre set of circumstances. My friend Dusty and I are hiking in the old growth forest in the Olympic National Forest, the south fork of the Hoh. Dusty sees this incredible bear scratch — bears scratch trees for the resin — which had become an entry wound for polypore mushrooms when we came back two years later. So the forest service and the lumber industry hired hunters to kill thousands of bears because they were scratching the trees and hurting their timber interests.

But David Suzuki and others then found out the bears were actually pulling salmon from the stream and bringing sea phosphorus back into the forest ecosystem, thus allowing the trees to grow larger. Humans are so adept at choosing exactly opposite of their best interest.

So, when we went returned to this tree and the red-belted polypore mushroom was popping out, this was exactly the species that the timber industry and the lumber industry was trying to prevent

from growing.


But this fungus is very active in breaking down a wide assortment of toxins, including pesticides, herbicides, and fungicides.

Meanwhile I had a garden, and in 1984 I had two bee hives. I was growing a giant mushroom in my garden, and one day was astonished to see the bees had moved wood chips away, exposing its mycelium. I looked really carefully and they were sucking on my mycelium. Now, in my garden we have many flowering plants, but a continuous stream of bees — from morning to dusk for 40 days — went to my patch of mycelium and sucked it down.

I thought this was very interesting. I looked at it carefully. I could see the little sweat droplets on the mycelium that they exposed, and they were sipping on them. I thought that was really interesting, so I published this in *Harrowsmith Magazine* and in one of my books, "Growing Gourmet and Medicinal Mushrooms." Virtually everybody ignored me except for one bee keeper in Ottawa. I said, "Well, maybe that's why bees are attracted to sawdust piles in the summertime."



Photo by Andrea Ferrario/Unsplash



But later, an article came out saying that all plants are part fungi and that fungicide use reduces beneficial fungi that are important for bees. Then a series of other articles comes out about a Polyphenol called P. coumaric acid, which controls your detoxification pathways. We use it, bees use it, and all animals use it. So basically without fungi, you don't have P. coumaric acid, and the bees are dependent upon these fungal compounds that are in decomposing wood for their detoxification pathways. When you remove the wood, their detoxification pathways are turned off, and there is a hyper-accumulation of toxins — fungicides, herbicides, insecticides, and more. The bees develop malaise and are not able to take care of themselves.

So, Louie Schwartzberg knew of my work with insects and fungi and asked, "Paul, can you help the bees?" I told him about the strange experience with bees in my garden, and I started thinking and thinking. I love the brain space between sleep and awakening, and I lay in that state of semi-consciousness and I had this Gestalt-ic experience of connecting the dots. Then I had this epiphany that took me 30 years.

We have now created MycoHoney, coming from mycelium.

The MycoHoney is extremely sweet — a wide assortment of sugars and polysaccharides. Beekeepers typically use 50% sucrose solutions to feed the honey bees. The honey bees are not native to North America, but we have 4,000 native bees, and they also are dependent upon these complex sugars. So we approached several universities with this MycoHoney. When I contacted Washington State University, they said, "Please, don't go to anyone else. This is too cool of an idea."

So we started running experiments with bees. First we do a stress test. A hundred bees in a cage are given extracts of the mycelium (the MycoHoney) of different species. We have 500 strains of species in our cultural library, but I focused in on a particular group of polypore mushrooms because I knew from agarikon and from amadu that they had anti-viral properties.

When we started doing this research, it dawned on me that many of these polypores grow on birch trees, and so we have the amadu at the very top, we have chaga, and we have reishi. Now, bees go to scratched trees, only of willows and birch trees and young firs, which the bears also scratch. The red-belted polypore grows on firs, and these three other species grow on birch trees, but that's specifically the trees the bees go to sip on the sap and to collect their resins for population — for propolis.

Our preliminary results of a stress test show the effects of the red-belted polypore and the amadu mushroom in being able to increase longevity, which is extraordinarily significant. It means that more of the bees are living and that worker bees can do their job. The nurse bees are not prematurely recruited.

So with Dr. Steve Shepherd and Dr. Brandon Taylor, who I'm working with and as entomologists with 39 years of experience studying bees, I'm unaware of any reports that extend the life of worker bees more than this.

Then we decided to look at the viruses being vectored by the mites. The bees in captivity only live for about four weeks before they succumb to the viruses vectored by the mites. With the absence of access to these fungal constituents that help the detoxification pathway, the viral counts skyrocket. But when feeding them our extracts compared to their sugar control, the viral counts plummet.

A massive amount of viruses will reproduce within the bees without the exposure of the myco-honey.



But as the myco-honey increases, there's a radical decline in the viral pathogen payload.

How weird is this? The same mushrooms that can limit bird flu, H5N1, and herpes, can also positively affect bees by controlling the viral burden and reduce them. I think this points to a larger picture. And looking now at the bees in captivity and the survival rate, the red reishi also—and this is significant here in this part of the life span—again, the worker bees were able to do their job, the nurse bees, they don't have to be prematurely recruited, the colony then is better able to survive.

We have confirmed that we can increase longevity, we can confirm that we reduce the viral payloads, and we know that the varroa mites can be controlled by *Metarhizium* fungi. Now, we are going to go into thousands of bee hives next fall to try to demonstrate this across many states in the United States and hopefully in many countries.

I really believe the solutions are literally underfoot, and they're also endemic to our culture. How many of us who read Winnie the Pooh to our children, or some of you young people here, knew about Winnie the Pooh going to rotted logs to go after the bees? I'm thrilled that I made this discovery, and I'm also frightened. How is it today that I'm the first one to have made this discovery? We scoured the scientific literature. We had mycologists, entomologists that have gone to hundreds of conferences, but no one's ever mentioned this — even a whisper of it. Bees are attracted to rotting logs, specifically for their immunological benefit and ability to up-regulate their immune system, allow them to detoxify toxins, and they allow them to be better pollinators.

30% of our food is directly pollinated by bees. 70% of our food is controlled by pollinators. We are suffering a collapse of our ecosystems, but we can do something about this. I'm proposing we be mushroomed. I'm calling out to all of you as citizen scientists to join in a mycological revolution — to go out and be able to help wild bees as well as the honey bee, and to be able to engage in permaculture practices to return carbon back into the soil, and to build the mycelial networks... *because we are far more interconnected with mycelium in nature than we even have a glimpse of being possible.* ■

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