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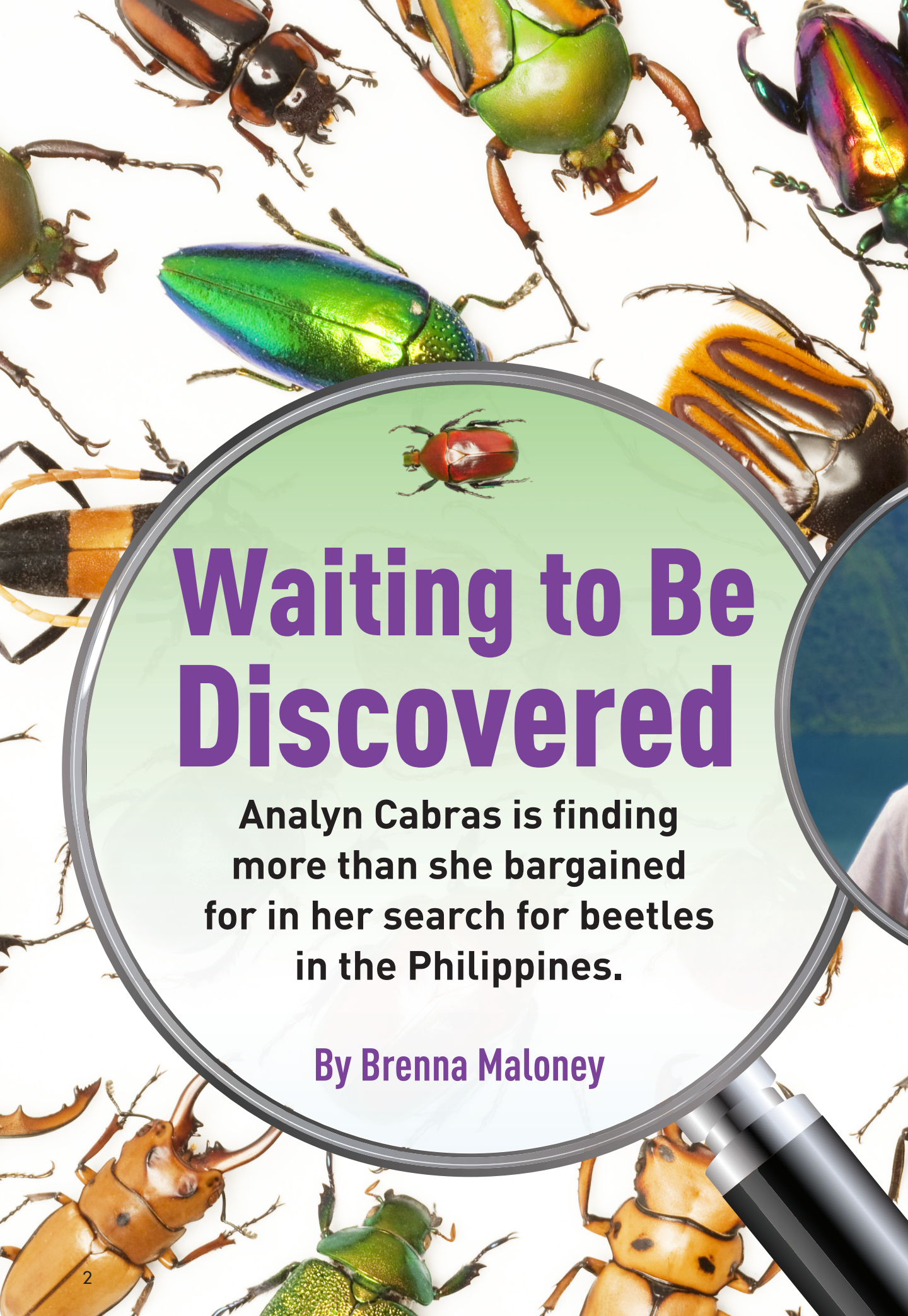
Explorer

PATHFINDER

SPECIAL ISSUE:

WOMEN IN SCIENCE



Waiting to Be Discovered

Analyn Cabras is finding more than she bargained for in her search for beetles in the Philippines.

By Brenna Maloney

Wildlife and Wild Places

LIFE SCIENCE

As you read, think about how one scientist's research can impact a field of study.

Analyn Cabras is a biologist. She studies living things. She's also a taxonomist. She puts living things into categories. Cabras is a conservationist. She works to protect living things. And she's a coleopterist. The living things she studies are beetles.

Studying beetles is a pretty big field. Earth is home to more than 400,000 species of beetles. They are the largest group of animals on the planet. Beetles can be found on every continent but Antarctica. They can live where it's hot or where it's cold, where it's dry or where it's wet. Some are barely visible. Others are almost too big to hold in one hand.

Cabras spends her days looking for beetles on Mindanao, an island in the Philippines. In the rainforests, she sneaks up on tiny, iridescent beetles from the weevil family.

"You have to be very, very careful," Cabras says. Many beetles are sensitive to vibrations. "If they sense you coming, they fall to the ground." Then, they're almost impossible to see. This is just one lesson Cabras has learned from her fieldwork.

Island Surprises

This island keeps her busy because so little is known about what lives there. "Here in Mindanao, we have so many mountains, which are still unexplored," she says. Cabras sees her job as recording what is there and looking at how the beetles relate to each other and the world.

So far, her work has been full of surprises. "It feels like every time we go into the field, we discover at least one new species. It's kind of mind-blowing. In one area of eastern Mindanao, we found four new species in a 1.5-kilometer (less-than-a-mile) stretch," she says.

It sounds simple, but you have to know what to look for. And you have to be patient. "When you first start field research, you will not find [anything]," Cabras says. "But as you go more often into the field, you will find so much, you won't know where to begin!"

Know Your Scientist

In her work studying beetles, Analyn Cabras plays many roles:

Biologist: an expert on living organisms

Coleopterist: a person who studies or collects beetles

Conservationist: a person who supports or acts for the protection of the environment and wildlife

Cabras does her research in mountainous regions on the Philippine island Mindanao.

Cabras uses a magnifying glass to get a closer look at a beetle.

Ecologist: an expert in the relations of organisms to one another and to their physical surroundings

Taxonomist: a biologist that names and groups organisms into categories

Finding Something New

Cabras takes great care when she thinks she's found something new. She signals to her teammates to stop moving. She doesn't want any sudden movements to scare off a beetle. Then she tries to take a photograph of the scene. "I usually take photos of their food plant and habitat," she says. This gives information to taxonomists as well as ecologists and conservationists.

Many jewel weevils, for example, have ranges as tiny as one patch of forest. They eat only certain plants. It is vital, then, to conserve the plant if you hope to conserve the beetle.

A Fuller Picture

There's another reason why Cabras tries to record the scene: "For some of my colleagues, this is the first time they are seeing the species alive," she says. They have never seen their habitats or host plants.

If possible, Cabras then collects a beetle as a sample so that it can be looked at more closely in the lab. "When you are in the laboratory, it's the same thing—you have to photograph them and examine [their anatomy]," she says. But the beetles may be as small as 5 millimeters (less than a quarter of an inch). It requires a lot of patience.

That's not all. "It also requires special skills and years of training to do the lab work. You have to train your eyes to look into the microscope, but you also have to train your hands," Cabras says. Beetles must be dissected, or cut apart, to see their internal structures. That requires good eyes and steady hands. Still, Cabras can't always trust what she sees.

Weevil Wonders

Jewel weevils are so named because they sparkle like gems. Their elytra, or wing covers, shimmer with colors from brilliant turquoise and shiny gold to pale orange and pink. The colors make them easy targets for predators like frogs, lizards, and birds. But weevils want to be seen. Their colors act as a warning: *Don't eat me. I taste bad.*

This is called **aposematism.** The animal advertises to its predators that it is not worth eating. Aposematism can take the form of bright colors, sounds, odors, or other characteristics.

Cabras knew all about aposematism, but she didn't realize how much it was going to affect her weevil research.

This leaf beetle looks like some jewel weevils.

This beetle would become important to Cabras' research. She discovered a new species that looked similar.

Cabras uses a microscope to look at beetle specimens.

Mindanao Mimics

There's a species of jewel weevil called *Pachyrhynchus reicherti.* Its black and spotted body has a unique pattern. Its elytra are fused together. It cannot fly. It's too tough to bite through. And its strong colors and markings tell predators to stay away.

When Cabras first spotted a new species, *Metapocyrtus willietorresi,* she mistook it for *Pachyrhynchus reicherti.* It has similar colors and markings. It has tough, fused elytra. Neither beetle would make a good meal. So, why was one copying the other?

The phenomenon is called **Müllerian mimicry.** That's when two equally harmful things have evolved to resemble each other. When beetles have similar colors and patterns, predators learn that they represent dangerous, foul-tasting, or even poisonous beetles. And predators stay away.

It doesn't end there. A third beetle, *Doliops daugavpilsi,* looks a lot like the other two. It's a longhorn beetle. It has a soft shell—one that predators could easily bite through.

By having colors and patterns similar to the weevils, the longhorn stays safe. This is **Batesian mimicry.** An edible insect with few defenses keeps predators away by looking dangerous.

Testing a Theory

Cabras wondered if she was the only one being fooled by these look-alikes. She tried an experiment. She and her team made fake beetles from modeling clay. They looked like *Pachyrhynchus reicherti.* She set them out in places where these beetles were common and in places where they were not. Then she set up cameras to see what would happen.

Where the beetles were common, predators avoided the clay beetles. They had learned what those colors and patterns mean. In the places where the beetles were less common, more predators tried to attack. They had not yet learned to stay away.

Cabras still has many questions she wants answers to. But a lot of land on Mindanao is being cleared away for farming and houses. In five to 10 years, she might not be able to find these beetles in their natural habitat.

With the clock ticking, Cabras is doing her best to discover, observe, and record the biodiversity that she sees in Mindanao. For now, her eyes are trained on weevils.

To test a hypothesis, Cabras used fake beetles made of modeling clay, like the one shown here. She wanted to see if predators would react to the beetle's warning colors.

Here are a few examples of the beetles Cabras saw during her fieldwork on Mindanao. The mimics strongly resemble their models.

MODEL

Metapocyrtus kitangladensis

MIMIC

Coptorhynchus sp.

Pachyrhynchus tikoi

Metapocyrtus sp.

WORDWISE

aposematism: the advertising by an animal to potential predators that it is not worth attacking or eating; it may use colors, sounds, smells, or other characteristics.

Batesian mimicry: a form of mimicry wherein a harmless species is protected by its resemblance to a species that is harmful to predators

Müllerian mimicry: a form of mimicry wherein two species that are harmful to predators share similar appearances as a shared protected device; if a predator learns to avoid one of the noxious species, it will avoid the mimic species as well.

Seeking Solut

Marissa Cuevas Flores worried about water pollution. She decided to do something about it.

As told to Simone T. Ribke

Q: Let's start by talking about environmental scientists. Why did you choose to become one?

A: There are two kinds of environmental scientists. Both kinds study the environment to learn how it behaves and how [people] affect it. The first kind just study and observe. The second kind try to reverse the damage people do. They use the tools of biology, chemistry, and engineering.

I am the second kind. I needed to have a purpose. I try to fix the problems I see. That keeps me motivated. For me, science has always been the greatest tool that human beings have.

As you read, think about how people are working to find new ways to protect Earth's resources and environments.

tions

Marissa Cuevas Flores is the founder and CEO of microTERRA based in Mexico.

Q: What environmental problem did you want to focus on?

A: About 70 percent our freshwater goes to agriculture. Water runoff from farms causes pollution. Yet, we need farms to provide the food we eat. That problem bothered me. We're not only talking about clean water. We're also talking about feeding people.

The **wastewater** from farms has a lot of nitrogen and phosphorus. These **nutrients** are found in fertilizer. They can cause **dead zones** in lakes and oceans.

Q: What is a dead zone? How can agricultural wastewater cause it?

A: A dead zone is a low oxygen zone in a river, lake, or ocean. Nothing can live in it. The nutrients from the wastewater cause **microalgae** to grow quickly. These tiny plants absorb sunlight and carbon dioxide and turn it into oxygen.

When you add nitrogen and phosphorus to the water, microalgae absorb them. They grow into a biomass known as an **algae bloom.**

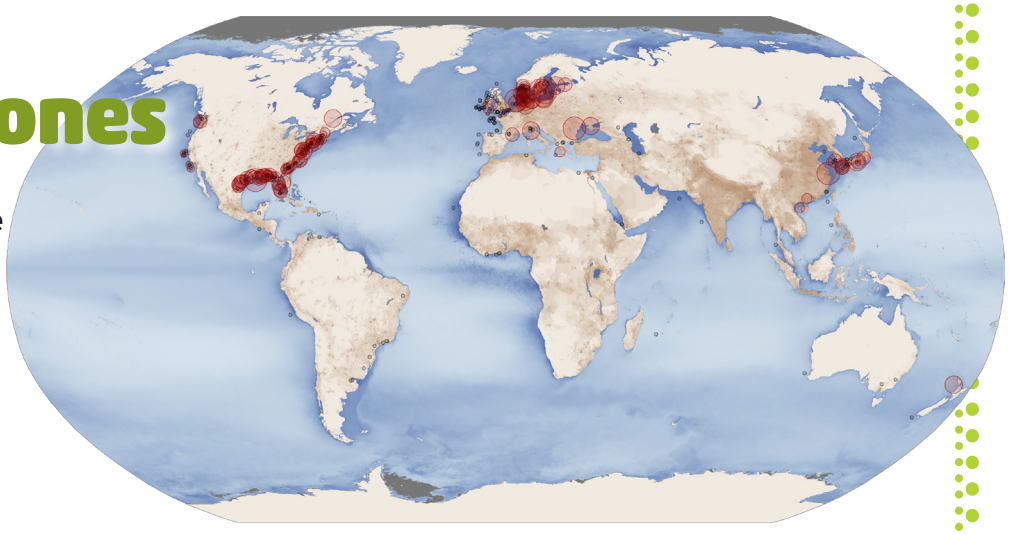
Microalgae itself is not harmful. The problem starts when these microalgae die. The bacteria that decomposes the plant absorbs a lot of the oxygen from the water. This causes a dead zone.

Q: How did you decide to tackle this problem?

A: I decided to find a way to **upcycle** wastewater and make it reusable. I realized that microalgae could clean water polluted by agricultural waste.

FAST FACT:
Each year, 200 million tons of fertilizer are used worldwide on our crops. Yet, there is more than crops can absorb, and it is washed away by rain or irrigation.

Dead Zones



Location and Size
(in square kilometers)
- size unknown
- 1 km²
- 10 km²
- 100 km²
- 1,000 km²
- 10,000 km²

Excess nutrients can lead to too much algae. Algae can block light that other plants need to grow. When algae die, they decay. Then oxygen in the water gets used up. Low oxygen levels kill aquatic animals. This cycle can lead to the creation of dead zones. There are **more than 500 dead zones worldwide**.

algae, as seen under a microscope

Q: You started looking at fish farms. What did you learn?

A: Most fish farmers grow fish in human-made ponds. The fish in these ponds produce so much poop that farmers need to replace the water every day. The wastewater drains into tributaries and rivers and oceans.

Q: What else did you learn from the fish farmers?

A: We learned that 70 percent of their expenses go into feeding their fish.

And that was your aha! moment. You had two environmental problems—aquacultural waste and fish farmers needing cheaper fish food. That's when you created your company, microTERRA.

Fish farms must manage their waste problems as well as keep their fish fed.

Q: What does your microTERRA do?

A: We take fish farm wastewater and give it to our microalgae. This cleans the water so the water can be reused. It saves a lot of water, too. It also helps stop downstream pollution that will destroy ecosystems.

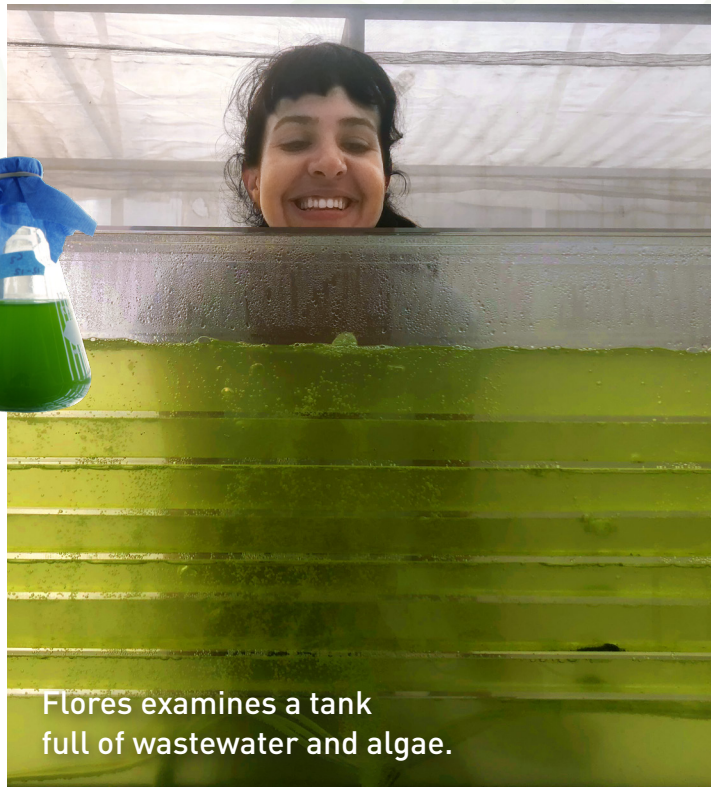
Our company uses a special strain of microalgae. When it goes through **photosynthesis,** it produces protein. We then process the protein from the microalgae into food for the fish.

Q: How do you grow the microalgae?

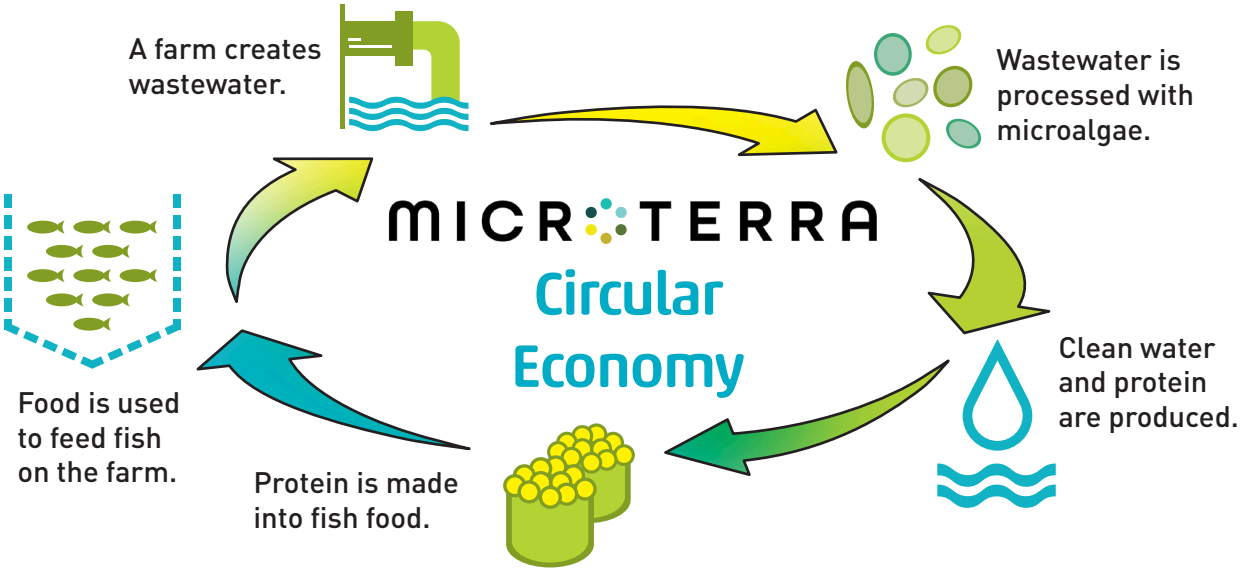
A: Microalgae are microscopic. So, we start in the lab on a small scale. We know what the microalgae like. We know what they need to grow. And we know where they thrive in general. But we have to scale up because agriculture is huge.

Q: So, to scale it up, you have to grow massive amounts of microalgae?

A: We use a bioreactor. We have pretreatment [in the lab]. We have bioreactors where the microalgae grow and a harvester to collect the biomass. Building the harvester was a challenge. It had to hold large quantities of wastewater. It had to be cheap and easy to manage, too.



Flores examines a tank full of wastewater and algae.



Microalgae convert excess nutrients in water into protein. They also release oxygen.

Q: Is it dangerous to work with wastewater?

A: Wastewater is full of harmful bacteria. We use gloves and wear masks and gowns for protection.

Q: Do you have any advice for people who might want to become environmental scientists?

A: I would say to start on small projects. Think of different ways you can reduce waste or pollutants. It could be something like a tiny water treatment pond. Every tiny experiment counts! Tell everyone about what you are doing. Maybe you can share ideas and solve problems together.

WORDWISE

algae bloom: a large, harmful amount of algae that suddenly grows in a body of water

dead zone: a low-oxygen area in one of the world's oceans, lakes, or rivers where few organisms can survive

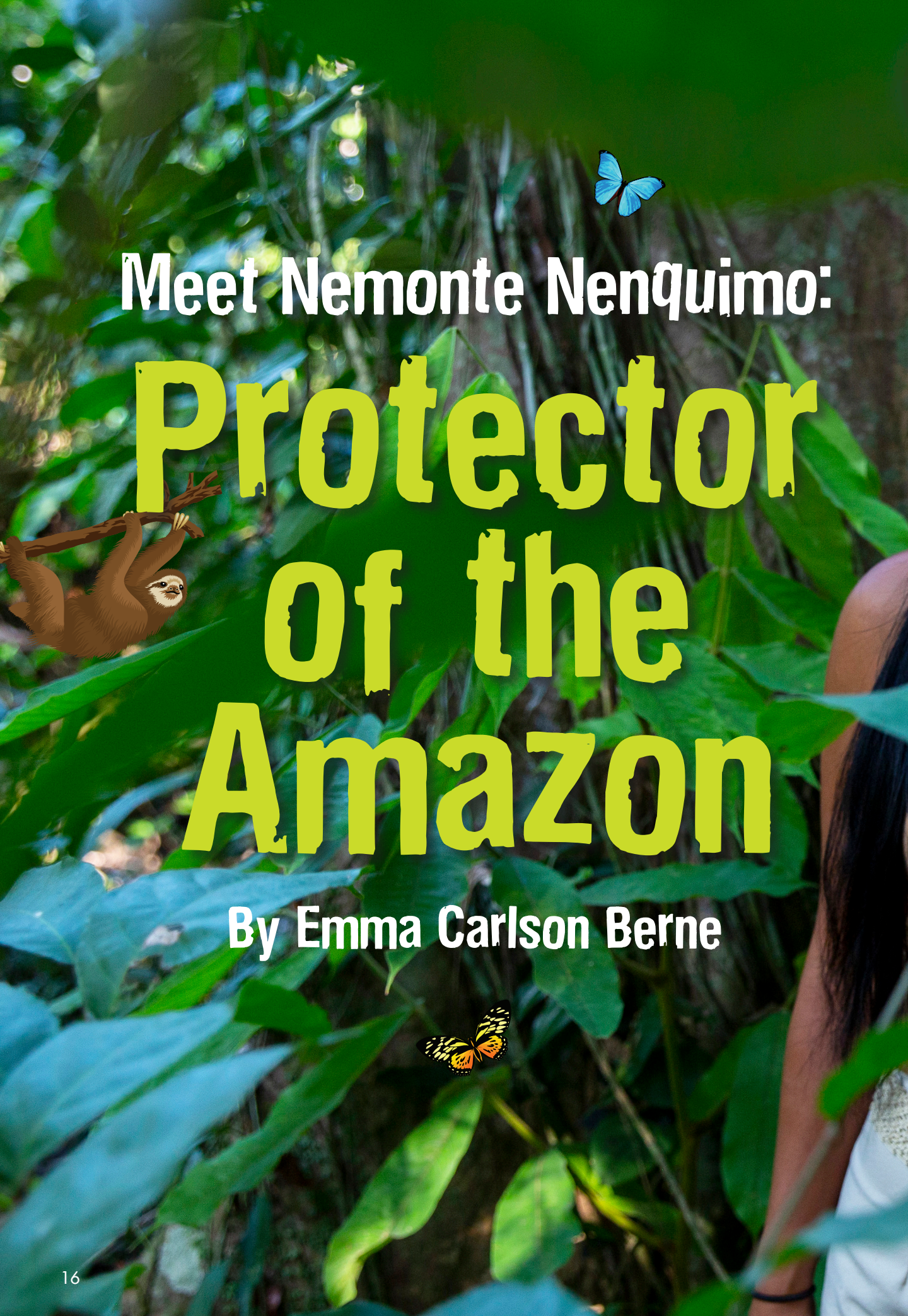
microalgae: microscopic organisms typically found in lakes, rivers, and oceans

nutrient: a substance that living things need for healthy growth, development, and functioning

photosynthesis: the process by which green plants use sunlight to make their own food

upcycle: to recycle a material to make a product that is more valuable than the original

wastewater: any water that has been contaminated by human use



Meet Nemonte Nenquimo: Protector of the Amazon

By Emma Carlson Berne

Human Journey

HUMAN-ENVIRONMENT INTERACTION

As you read, think about the connections the Waorani people have to their land.

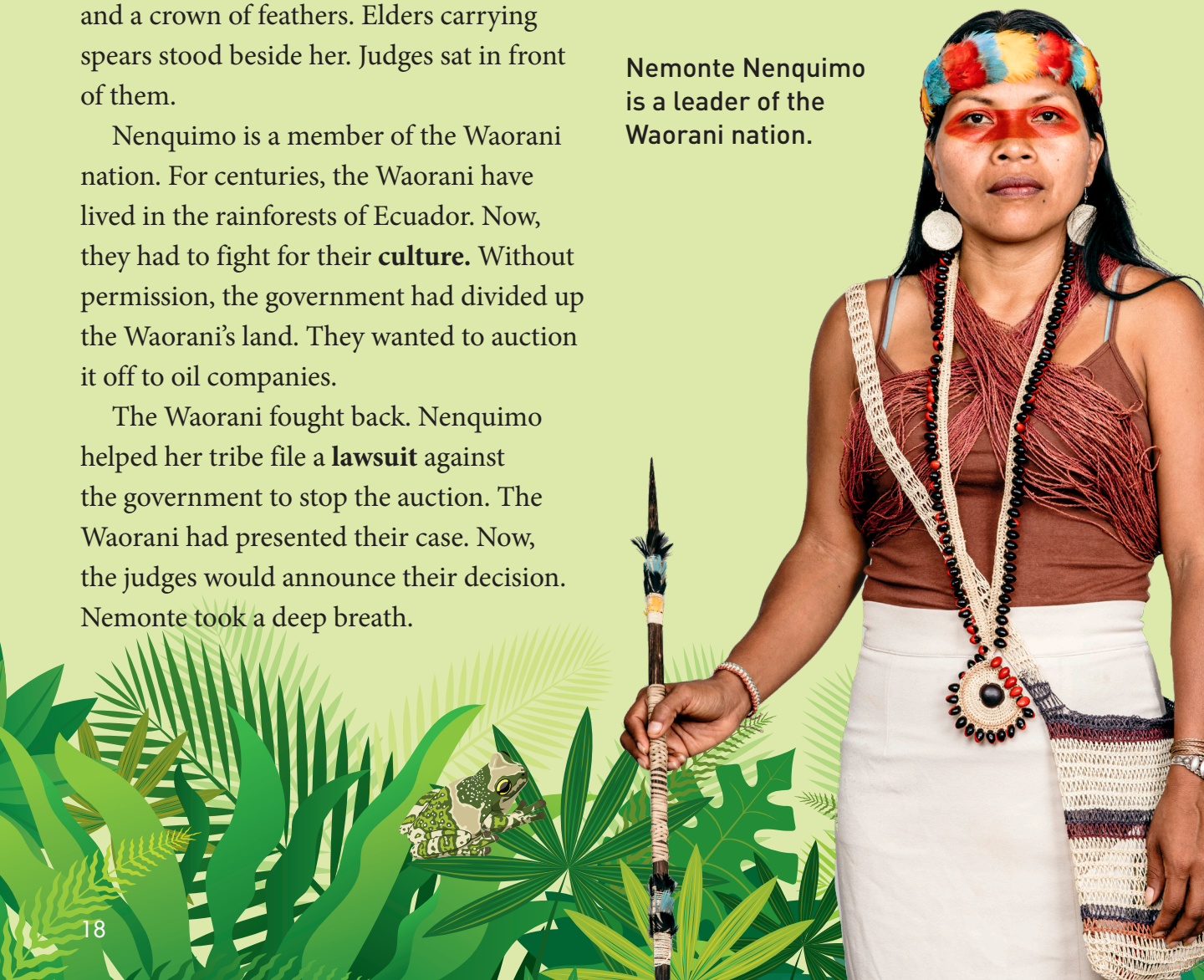
Nemonte Nenquimo raises her fist in a sign of defiance at the start of the court hearing in Ecuador.

Nemonte Nenquimo stood under harsh lights in a crowded courtroom in Puyo, Ecuador. She was wearing red face paint and a crown of feathers. Elders carrying spears stood beside her. Judges sat in front of them.

Nenquimo is a member of the Waorani nation. For centuries, the Waorani have lived in the rainforests of Ecuador. Now, they had to fight for their **culture.** Without permission, the government had divided up the Waorani's land. They wanted to auction it off to oil companies.

The Waorani fought back. Nenquimo helped her tribe file a **lawsuit** against the government to stop the auction. The Waorani had presented their case. Now, the judges would announce their decision. Nemonte took a deep breath.

Nemonte Nenquimo is a leader of the Waorani nation.



A Rainforest Home

The Waorani nation is made up of about 5,000 **indigenous people** who live on 2.5 million acres of rainforest land. Most of the land is in Ecuador. More than 1,500 species of bird, 300 species of mammal, and more than 840 species of reptile make their home here.

"Our culture comes from the forest," Nenquimo says. As hunter-gatherers, the Waorani's lives are entwined with the rainforest. Weapons for hunting are made from wood. Traditional huts are made of palm leaves and tree trunks. Palm fibers are woven into baskets.

The Waorani have always fought off invaders, as far back as the Inca empire. They did not have significant contact with the outside world until 1958 when American missionary Rachel Saint made contact with them.

Once contact was established, something was discovered: oil. The oil was valuable. To get at it, oil companies ran roads and pipelines into Waorani land. Trees were cut down, destroying ecosystems and animal habitats. Mostly, this was done without the permission of the Waoroni.

The Waorani live in the Amazon rainforest.

Drilling Down

In 2012, the government of Ecuador wanted to offer new drilling rights to oil companies. The drilling area included Waorani lands. The government was required to explain the pros and cons of oil drilling to the Waorani and other communities.

So, government representatives flew into the rainforest and held short, rushed meetings. Many Waorani did not have time to travel by foot or canoe. Few understood the language that was used. And only the benefits were presented.

Afterward, the Waorani learned that the government had divided up a large section of the Amazon. These sections would be auctioned off for drilling. The Waorani section was number 22.

They needed to defend their land. But first, the Waoroni needed a leader.

A Leader for Her People

Nemonte Nenquimo is a 35-year-old mother. She was born and raised in the Waorani culture. Early in her childhood, her family moved to a community deep in the rainforest.

Nenquimo's childhood was filled with swimming in the rivers, picking wild fruit, and listening to traditional songs.

Nenquimo's grandfather, Piyemo, was a respected warrior and defender of Waorani territory. Piyemo believed that the rainforest should be protected. From him, Nenquimo learned that the land must be defended against those who do not make their homes there.

Nenquimo learned from her grandmother, too. Women in the Waorani nation have traditionally been the caretakers of the forest. They watch over the plants and animals and tell the men where to hunt and for which animals.

Nenquimo was already a community leader. In 2015, she helped lead the Waorani in a project to map their ancestral lands. Elders and young people worked together. They mapped the sacred waterways, animal breeding sites, burial spots, and fruit tree groves. They used traditional drawing methods as well as GPS and cameras. These maps would be invaluable to show the deep relationship the Waorani have to their land.

Twelve communities elected Nenquimo and four other women to lead the lawsuit. The case argued that the government had not gotten the free agreement of the Waorani. And this was required by law. The planned auctioning of the lands was illegal.

On February 27, 2019, the Waorani officially sued the government of Ecuador. They did not know if they would succeed. But, they knew they had to try.

Surrounded by her people, Nenquimo speaks to reporters about the court case.

In Court

On April 11, 2019, hundreds of Waorani people marched through the streets of Puyo to the courthouse. They wore traditional clothes made of palm leaves. Their faces and arms were adorned with paint used for battle and special occasions.

As they walked, they sang their traditional songs. They wanted people to see their pride in their culture. Nenquimo walked at the front, her arms linked with other women. She felt like a warrior that day, she remembered later. Her face paint, her crown, and papers were her weapons.

Inside the courtroom, the Waorani and their lawyers presented their case to three judges.

Their maps would help the judges grasp the Waorani's bond to their land. Elders would give testimony. Proof of oil pollution would be presented.

The Ruling

On April 26, the judges were ready to announce their decision. Nenquimo held her grandmother's hand tightly. The judge spoke. The government had not tried to understand the Waorani and their culture. One meeting was not enough for the Waorani to give their free consent to the auctioning of their lands. The judge gave the verdict: The land was to be protected. The Waorani had won.

Nenquimo remembers that the room was filled with emotion and music. Her grandmother began to sing a song celebrating their origins in the rainforest. She sang of a healthy future for their children.

Outside, they paraded through the streets. Rain began to pour down. For the Waorani, rain has always been a sign of nature celebrating a victory.

The ruling created a precedent. Other indigenous Amazonian people could use this case as an example for lawsuits of their own. It was a great victory, but Nenquimo's work is not done. She is now focusing on the education of the Waorani children.

Nenquimo wants to create jobs, so young people will stay on the land. She wants to protect and teach the Waorani language. But she knows young people must also learn the tools of the outside world. Then, they can carry on the fight!

WORDWISE

culture: a pattern of behavior shared by a society or group of people; many different things make up a society's culture. These things include food, language, clothing, tools, music, arts, customs, beliefs, and religion.

indigenous people: the first people who lived in any region, before later immigrants

lawsuit: a process during which a disagreement between people or organizations is decided in court

Nenquimo and other leaders celebrate their court victory.

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