

NATIONAL  
GEOGRAPHIC



# Explorer

TRAILBLAZER

SPECIAL ISSUE:

## WOMEN IN SCIENCE



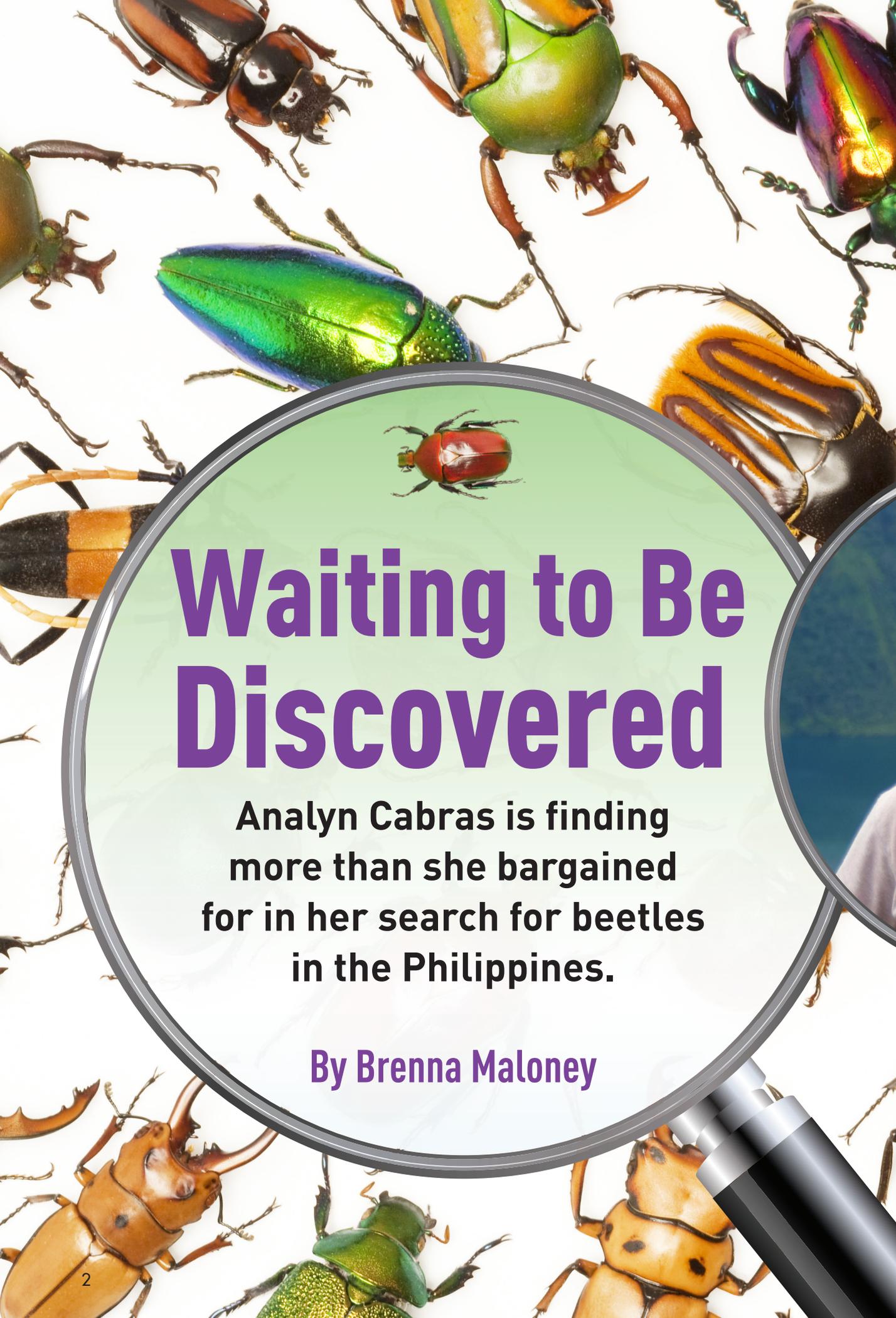
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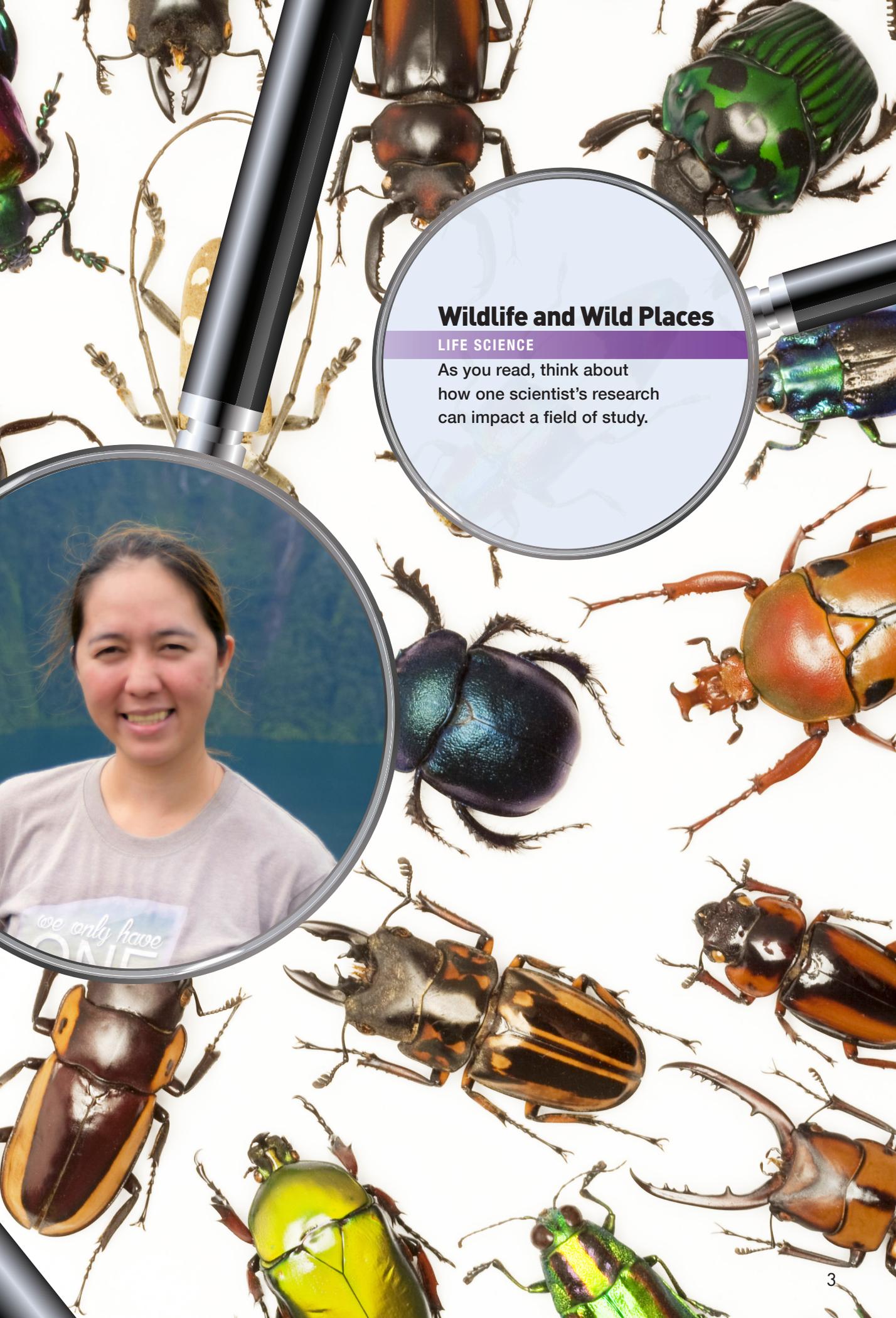
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# Waiting to Be Discovered

**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.

**A**nalyn Cabras is a biologist. She studies living things. She's also a taxonomist. She puts living things into categories. Cabras is a conservationist who works to protect living things. And she's a coleopterist. That means, she studies beetles.

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

Cabras looks for beetles on Mindanao. It is an island in the Philippines. In the rainforests, she sneaks up on small shiny beetles from the weevil family.

"You have to be very, very careful," Cabras says. "If they sense you coming, they fall to the ground." Then, they're difficult to find.

## Island Surprises

The island keeps her busy. 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. She looks 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," she says. Cabras and her team found four new species in one small stretch.

It sounds simple, but you have to know what to look for. And you have to be patient. At first, Cabras didn't find much. But, the more she went into the field, the more she found.



## Know Your Scientist

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

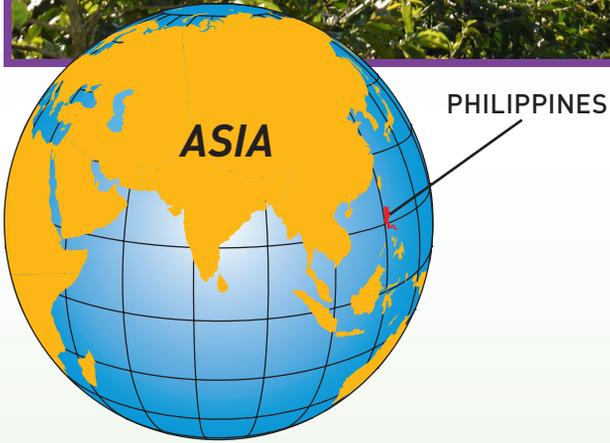
**Biologist:** an expert on living organisms

**Coleopterist:** a person who studies or collects beetles

**Conservationist:** a person who 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 natural 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. If possible, Cabras collects a beetle as a sample. Then it can be looked at in the lab.

This work requires special skills. "You have to train your eyes to look into the microscope. But you also have to train your hands," Cabras says. Beetles must be cut apart to see what is inside them. That means good eyes and steady hands. But, Cabras can't always trust what she sees.

## Weevil Wonders

Jewel weevils, for example, sparkle like gems. Their elytra, or wing covers, shimmer with colors from turquoise and gold to orange and pink. This makes them easy targets for predators. But weevils want to be seen. Color is a warning: *Don't eat me. I taste bad.*

This is called **aposematism**. The animal lets its predator know that it is not worth eating. Bright colors, sounds, and odors can warn predators. Cabras didn't realize how much this was going to affect her 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 closely at beetles.

## Mindanao Mimics

There's a species of jewel weevil called *Pachyrhynchus reicherti*. It has a black and spotted body. Its elytra are joined together. It's too tough to bite through. Its strong colors and markings tell predators to stay away.

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

It's called **Müllerian mimicry**. That's when two equally harmful things have developed to look like each other. They send clear signals to predators to stay away.

A third beetle, *Doliops daugavpilsis*, looks a lot like the other two. But it's a longhorn beetle. It has a soft shell that predators could bite through. By having colors and patterns similar to the weevils, the longhorn stays safe. It keeps predators away by looking dangerous. This is **Batesian mimicry**.

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.

## Testing a Theory

Cabras wondered if she was the only one being fooled by these mimics. She tried an experiment. She made fake beetles from modeling clay. They looked like *Pachyrhynchus reicherti*. She set them out in places where the beetles were common. She set them out in places where they were not common. Then she set up cameras.

Where the beetles were common, predators stayed away from the clay beetles. They knew what the colors and patterns meant. In the places where the beetles were not common, predators tried to attack. They had not yet learned to stay away.

Cabras still has many questions. But land on Mindanao is being cleared away for farming and houses. In a few years, she might not be able to find these beetles in their natural habitat. So for now, her eyes are trained on them.



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. They also want to learn how [people] affect it. The first kind just study and observe. The second kind try to fix the damage people do.

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

## Our Changing Planet

### HUMAN IMPACT ON EARTH

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 solve?

**A:** Most of 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.

**Wastewater** from farms has 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. Like all plants, microalgae give off oxygen. Microalgae also absorb the nutrients from wastewater. Then they grow into a biomass called an **algae bloom**.

When microalgae die, bacteria decompose these plants. The bacteria also absorb oxygen from the water. This causes a dead zone.

**Q:** How will you tackle this?

**A:** I found a way to **upcycle** wastewater and make it reusable. I learned that microalgae could clean water polluted by this 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.

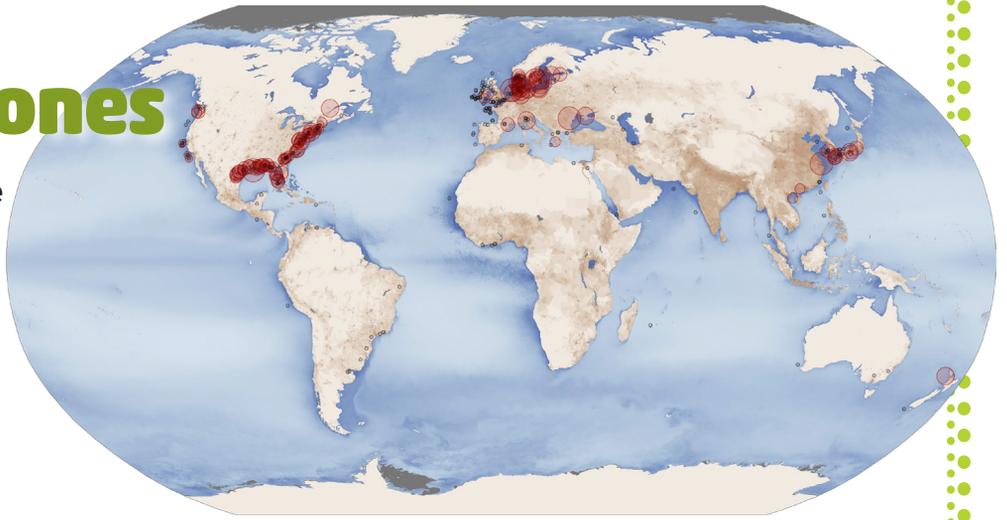


# Dead Zones

## Location and Size

(in square kilometers)

- size unknown
- 1 km<sup>2</sup>
- 10 km<sup>2</sup>
- 100 km<sup>2</sup>
- 1,000 km<sup>2</sup>
- 10,000 km<sup>2</sup>



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 water animals. This 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 produce so much poop that the water must be changed every day. The wastewater drains into rivers and oceans.

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

**A:** We learned that feeding their fish is very expensive.

So, you had two big problems—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 microTERRA do?

**A:** We take fish farm wastewater and give it to our microalgae.

They clean the water so it can be reused. This also helps stop downstream pollution. That can destroy ecosystems.

Our company uses special microalgae. Through **photosynthesis**, they produce protein. We process the protein from the microalgae into food for the fish.

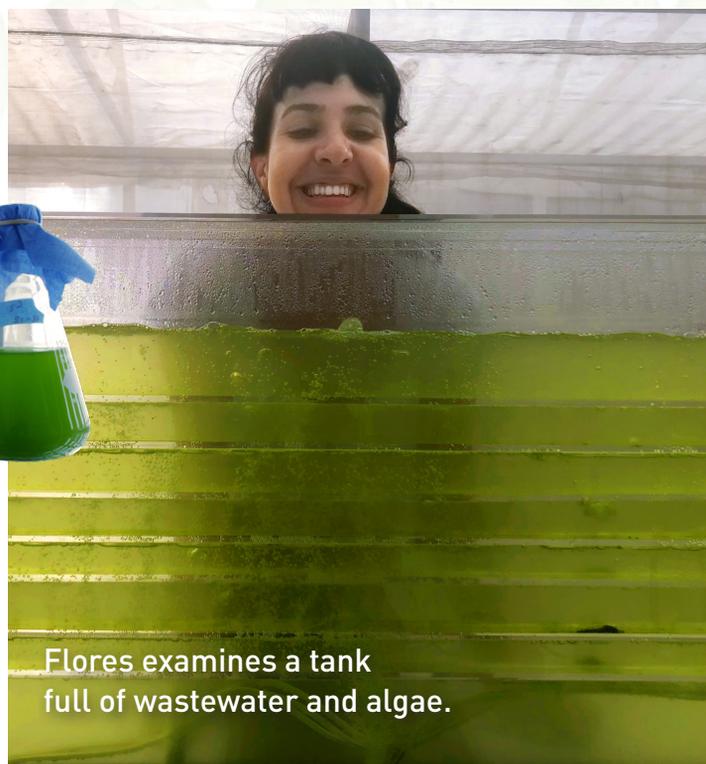
**Q:** How do you grow the microalgae?

**A:** We start in the lab on a small scale.

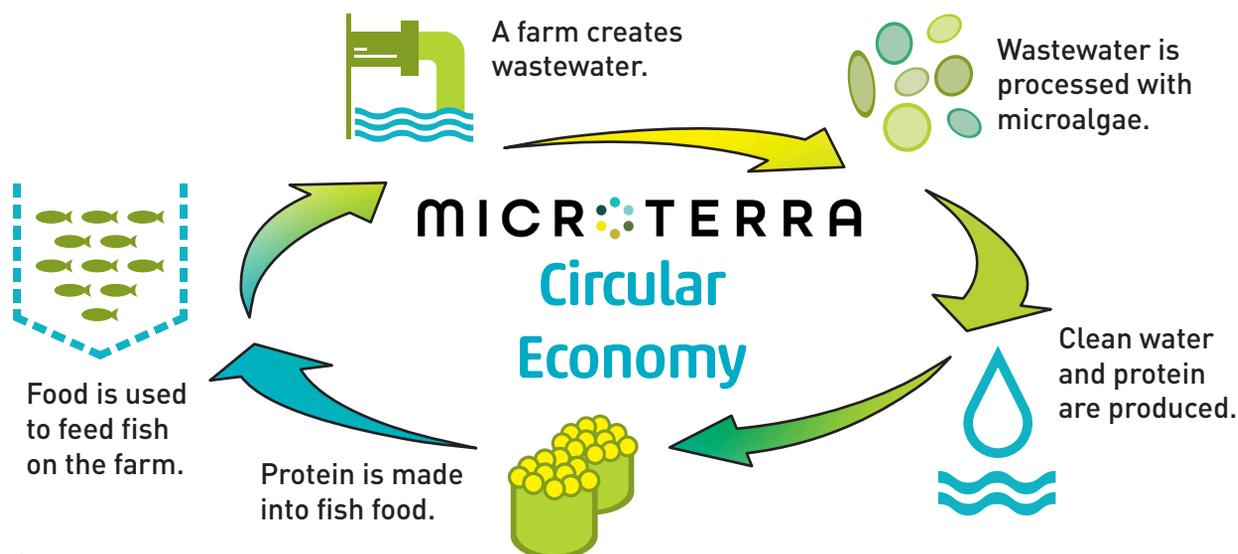
We know what the microalgae like. We know what they need to grow. And we know where they thrive in general. But, we have to scale up because agriculture is huge.

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

**A:** Yes. We have bioreactors where the microalgae grow. We also built a harvester to collect the biomass. The harvester 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. Everything [in the lab] has to be disinfected a couple of times.

**Q:** Do you have any advice for future environmental scientists?

**A:** I would say to start on small projects. Think of different ways to reduce waste or pollutants. How about a tiny water treatment pond? Every experiment counts! Tell others about what you are doing. 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

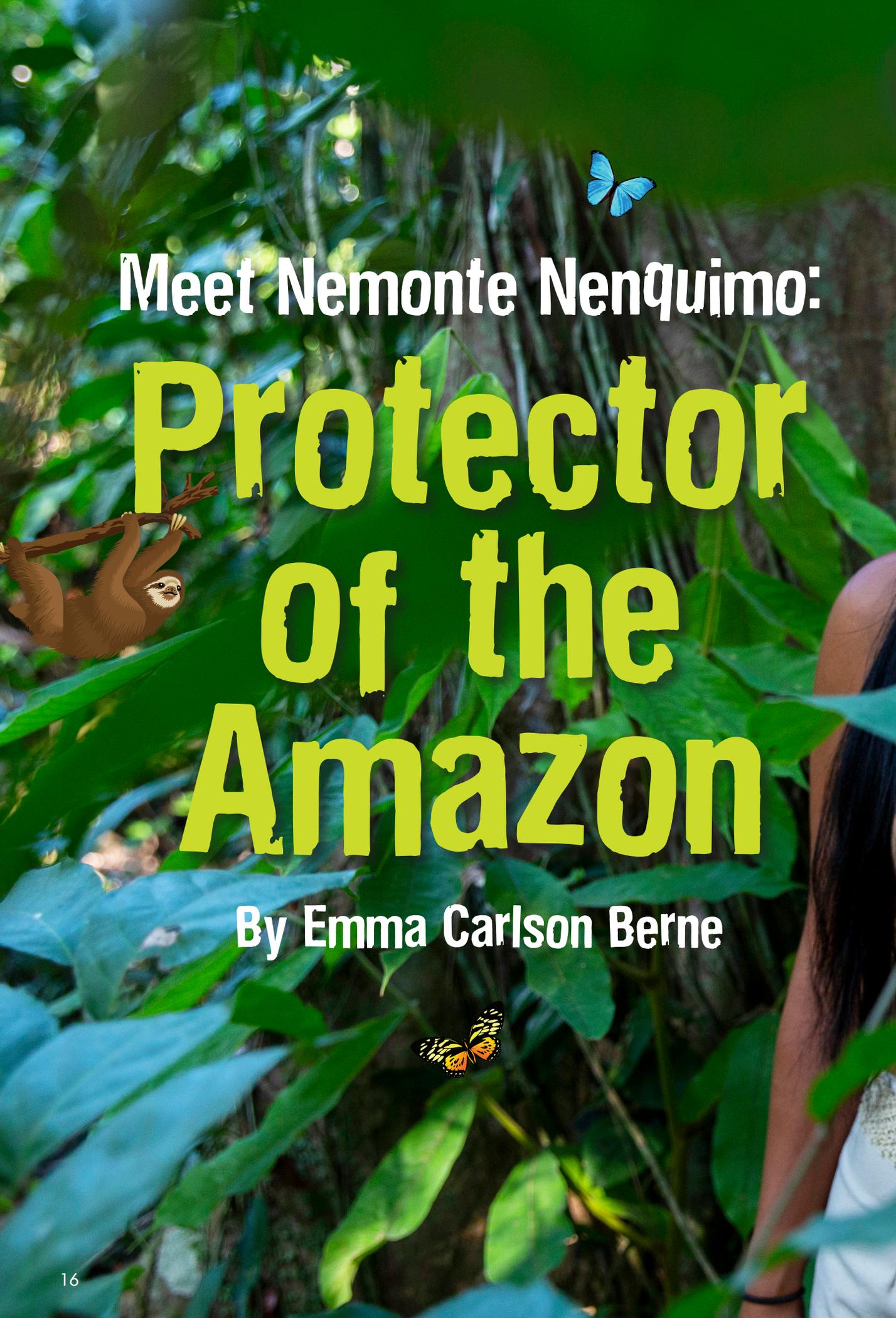
**microalgae:** microscopic organisms typically found in lakes, rivers, or oceans

**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.



**T**he courtroom was crowded in Puyo, Ecuador. Nemonte Nenquimo stood under harsh lights. She was wearing red face paint and a crown of feathers. Three judges sat in front.

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**. The government had divided up their land. They wanted to auction it off to oil companies.

Nenquimo had helped her tribe file a **lawsuit** against the government. The Waorani had presented their case. Now, the judges would decide!

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

Nemonte Nenquimo is a leader of the Waorani nation.



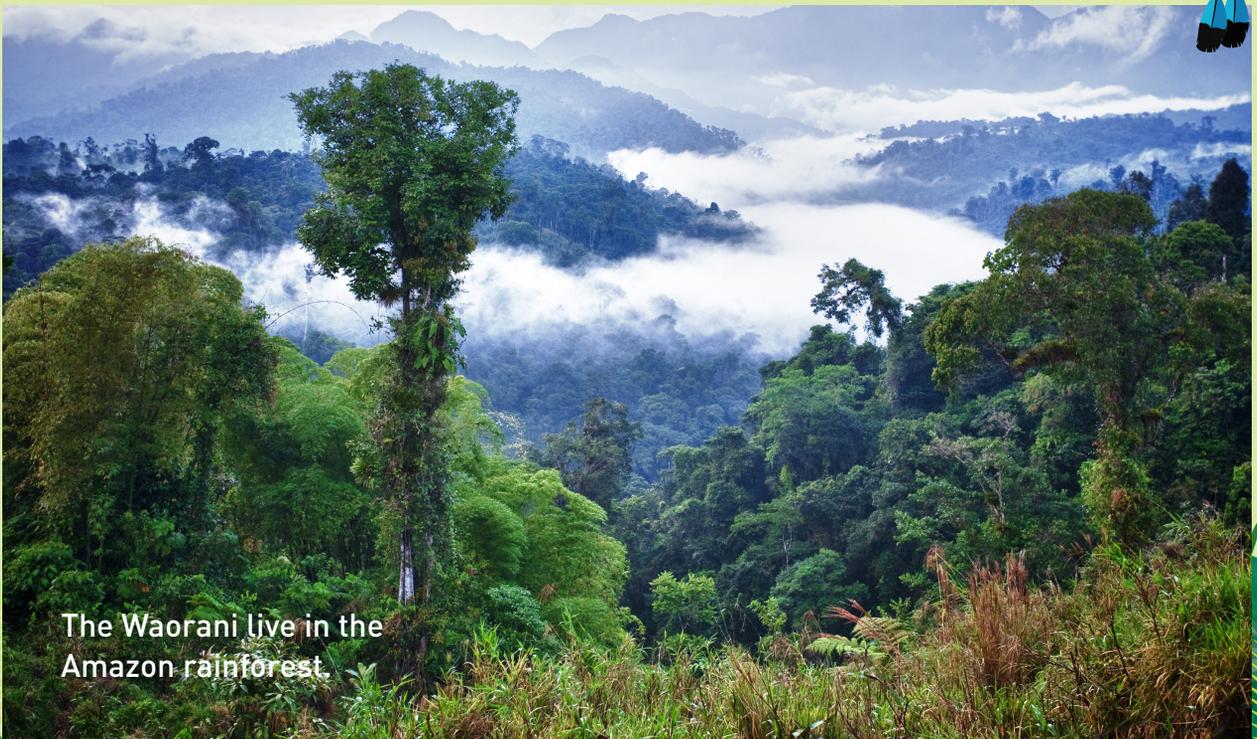
## A Rainforest Home



The Waorani nation is made up of about 5,000 **indigenous people**. They live on 2.5 million acres of rainforest. Most of the land is in Ecuador. Here, more than 1,500 species of bird, 300 species of mammal, and more than 840 species of reptile make their home. As hunter-gatherers, the Waorani's lives are connected to the rainforest. Weapons for hunting are made from peach palm wood. Traditional huts are made of palm leaves and tree trunks.

The Waorani have always fought off invaders. But they did not have much contact with the outside world until an American missionary came in 1958.

Once contact was made, something was discovered. Oil. The oil was valuable. To get at it, oil companies ran roads and pipelines into Waorani land. For the most part, this was done without the Waorani's permission.



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. By law, the government had to explain this to the Waorani.

Government representatives flew into the rainforest. They held short, rushed meetings. Many Waorani did not have enough time to get there. Few understood the language being used.

Later, the Waorani learned that the government had divided up a large section of the Amazon for drilling. The Waorani section was number 22. They needed to defend their land.

## A Leader for Her People

Nemonte Nenquimo was born and raised in the Waorani culture. Early in her childhood, her family moved to a community deep in the rainforest.

Nenquimo's grandfather, Piyemo, was a respected warrior. He believed that the rainforest should be protected. From him, Nenquimo learned that the land must be defended against threats.

Nenquimo also learned from Waorani women. They have always been the caretakers of the forest. They watch over the plants and animals and tell the men where to hunt and for which animals.



In 2015, Nenquimo 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, and fruit tree groves. They used traditional drawings as well as GPS and cameras.

Later, these maps would be used to show the deep relationship the Waorani have to their land.

Nenquimo and four other women were elected to lead the lawsuit. It argued that the government had not gotten the free agreement of the Waorani. This was required by law.

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



## In Court

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.

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

As they walked, they sang their traditional songs. They wanted people to see their pride in their culture.

Nenquimo felt like a warrior that day, she recalled. Inside the courtroom, the Waorani and their lawyers presented their case. Their maps showed the judges the Waorani's bond to their land.

## The Ruling

On April 26, one judge spoke. He said that the government had not tried to understand the Waorani and their culture. The Waorani had not given consent. 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. It celebrated their origins in the rainforest. She also sang of a healthy future for their children.

Outside, rain began to pour down. For the Waorani, rain has always been a sign of victory. Now, other indigenous people could bring lawsuits of their own, if needed.

As for Nenquimo, her work goes on. Her focus is the education of young people. She wants to create jobs, so they will stay on the land.

She wants to protect and teach the Waorani language. But Nenquimo knows young people must also learn the tools of the outside world. Then, they can carry on the fight to protect the Waorani lands.

## WORDWISE

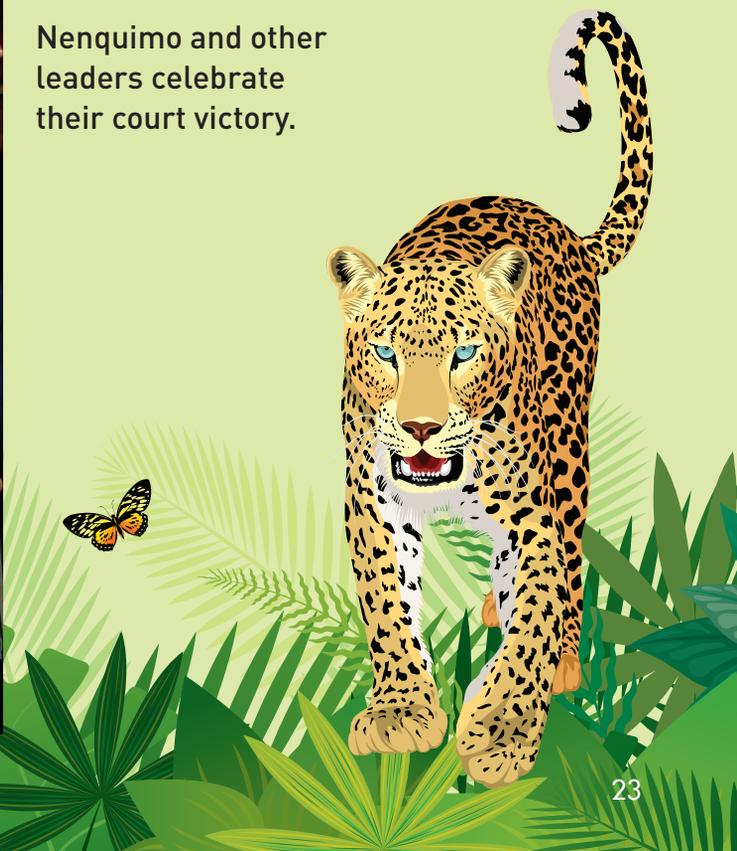
**culture:** a pattern of behavior shared by a society or group of people; many different things make up a society's culture. These things include food, language, clothing, tools, music, arts, customs, beliefs, and religion.

**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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