The Home Forum®

Life at the extremes

CREATURES THRIVING IN HARSH ENVIRONMENTS MIGHT OFFER A GLIMPSE AT EARTH'S PAST – OR AT LIFE ON OTHER PLANETS.

kid space

IMAGINE IT'S 2030, and your ground crew has just strapped you into a spacecraft headed for Mars. Your assignment: Look for life on the Red Planet.

Astronomers think that Mars and Earth were very similar when they were young. Other scientists point to fossils on Earth that show life was thriving on our planet when it was "only" a billion years old (it's about 4.5 billion years old now). Maybe life emerged on Mars, too.

But where do you look for Martians? What do they look like? Are fossils all that remain on Mars – now a frigid planet with a wisp of an atmosphere? Or might life still exist beneath the planet's dry, rocky, windswept surface? If life never existed on Mars, are there other places in the solar system besides Earth where life exists?

Those questions are driving scientists to travel to some of the coldest, hottest, and otherwise most inhospitable spots on Earth to look for living organisms. And they're finding them by the billions: colonies of single-celled creatures living in Antarctic lakes; bacteria deep in the Earth's crust; tube worms that cling in silent darkness to the sides of volcanic vents on the ocean floor.

Call it X-life: life in extreme environments.

"Studies of life elsewhere in the solar system really aren't about what we used to call LGMs – little green men," says Matthew Kane, a biologist working with the National Science Foundation. Instead, the studies focus on microbes: tiny one-celled organisms with a remarkable ability to boldly thrive where no human could.

"When you think about life in extreme environments or elsewhere in the solar system, you think about microbes," he says, "because as organisms grow more complex, they have a more limited range" of habitats.

Scientists say microbes are the most widespread form of life on Earth. By some estimates, if you could weigh every living thing on Earth – from microbes and monkeys to giant Sequoias and blue whales – microbes would account for more than half the total weight. In soils, microbes help turn minerals into chemicals that plants can use. In the ocean, microbes are food for larger creatures. Inside mammals' stomachs, microbes help digest food.

Microbes also can change the chemical makeup of their surroundings. Vast mats (communities) of microbes that existed when the Earth was young probably gave our atmosphere its initial supply of oxygen, which allowed other life forms to emerge and thrive.

In fact, researchers say, early microbes "taught" plants about photosynthesis – the process by which green plants make food using carbon dioxide, water, and light.

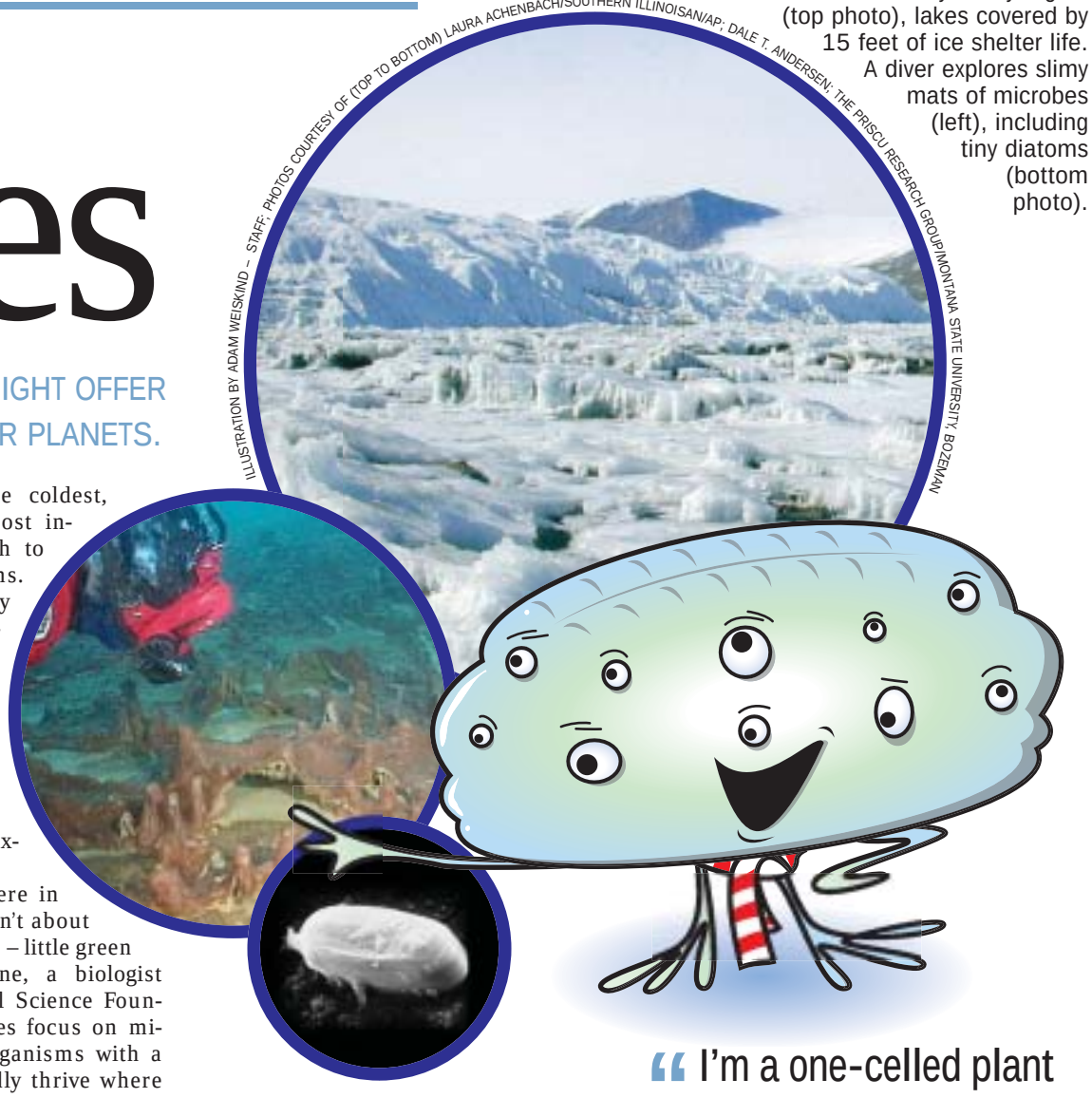
An easy place to look for the hardiest of these microbes is in Yellowstone National Park. The park is on a geological lid atop a hotspot in the Earth's crust where hot magma has pushed its way near the surface. It bubbles with hot springs, foul-smelling fumaroles, and its famous geysers.

Many of the microbes found around hot springs rely on photosynthesis and form large slimy mats. "There is a huge diversity of life there," says Anna-Louise Reysenbach, a scientist at Portland State University in Oregon. She studies relationships among microbes and between microbes and their surroundings. "You can find more diversity in one square centimeter" of these mats "than you'll find in a square mile of tropical rainforest," she says.

Comparing these slimy mats to forests is pretty accurate, says David Ward, a scientist from Montana State University in Bozeman. Visitors to Yellowstone see hot springs (the water is far too hot to touch) and "lots of green stuff" along the channels flowing from them. Under a microscope, the green stuff – not much thicker than a few sheets of notebook paper – resembles a forest. Smaller organisms that require less light (the understory) live beneath taller ones that require more light (the canopy). "It's equivalent in the microbial world to what you would see in a forest. The difference is only a matter of scale," Professor Ward says.

DR. REYSENBACH adds that Yellowstone is an amazing place to study X-life because it offers such a broad variety of microbial environments – from water that is almost pure acid to water that is extremely alkaline. The closer you get to either end of this range, the more corrosive the liquid is – except to the microbes thriving in it. Many of these microbes are thought to be descendants of the earliest forms of bacteria that inhabited the young, volcanically active Earth.

But do all microbes need light to live?



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In Antarctica's Dry Valley region (top photo), lakes covered by 15 feet of ice shelter life. A diver explores slimy mats of microbes (left), including tiny diatoms (bottom photo).

"I'm a one-celled plant called a diatom. I'm built like an M&M, with a hard silica shell. I live in ice-covered lakes in Antarctica, and I love to eat phosphorus."

"I'm a cyanobacterium. I'm no plant, but I make oxygen the way plants do. I thrive in water that's so hot it can stew a tomato!"

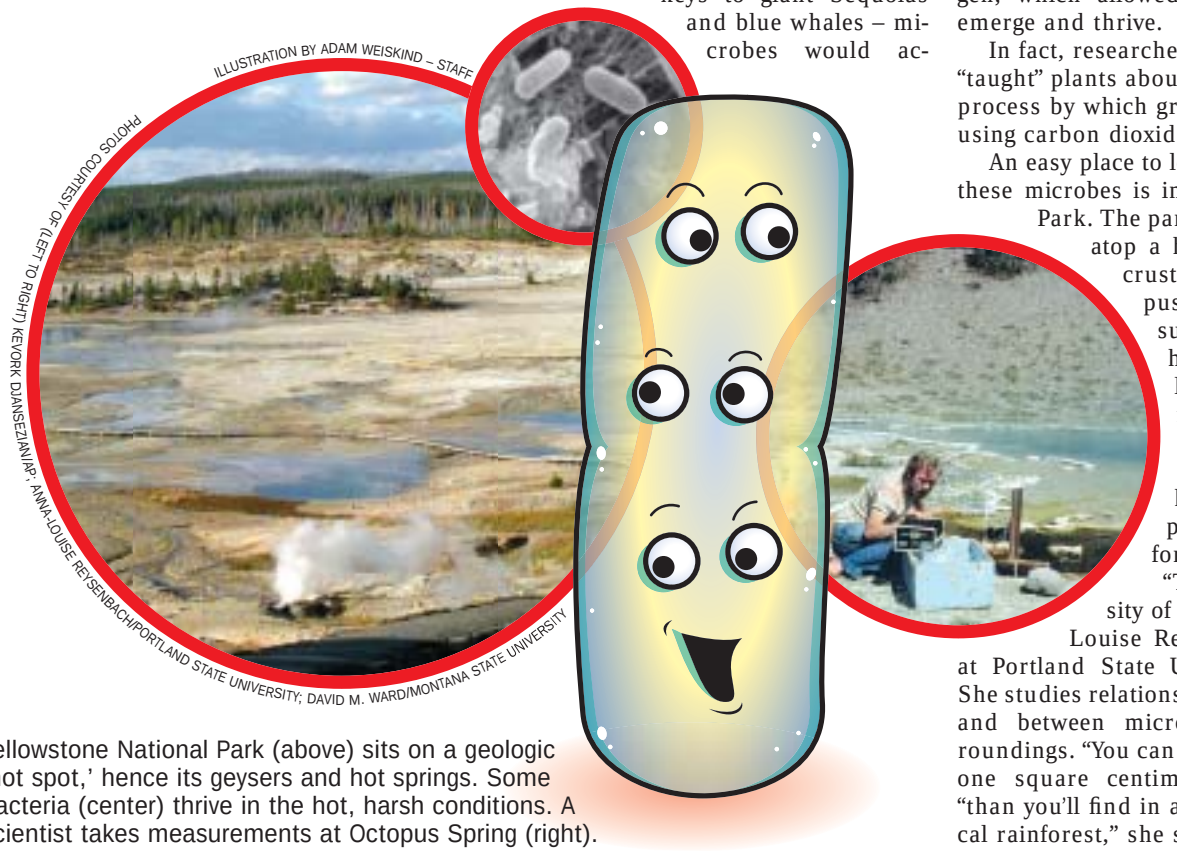

ILLUSTRATION BY ADAM WEISKIND – STAFF; PHOTOS COURTESY OF (LEFT TO RIGHT) KEVORK DJANSEZIAN/AP; ANNA-LOUISE REYSENBACH/PORTLAND STATE UNIVERSITY; DAVID M. WARD/MONTANA STATE UNIVERSITY

Yellowstone National Park (above) sits on a geologic 'hot spot,' hence its geysers and hot springs. Some bacteria (center) thrive in the hot, harsh conditions. A scientist takes measurements at Octopus Spring (right).

Nope. Take undersea volcanic vents. They burble up from the sea floor at depths sunlight can't reach. In 1977, scientists visited one of these vents in the Pacific and were stunned to find it teeming with life – tube worms, blind shrimp, crabs, and other creatures. And – surprise, surprise, – microbes that have never seen the light of day sat at the bottom of that food chain. In fact, a tube worm couldn't live without microbes living inside it. The worm has no mouth, stomach, or other digestive organs. Instead, chemicals from the surrounding water seep into it and bacteria convert them to food the worm can use. The bacteria feed off the minerals dissolved in the water emerging from the vents, called "black smokers."

Paul Johnson, a marine geologist at the University of Washington at Seattle, had another question: If you can find microbial life around vents – which appear in places where magma is welling up from deep inside the Earth to form new crust – could microbes be found in old crust as well?

Yes. He has found microbes living more than 100 feet deep in crust that's about 3.5 billion years old. And while new crust quickly cools from 2,190 degrees F. to just above freezing, the temperature under old crust is about 140 degrees F. It's kept warm by a blanket of sediment that sits on top the crust, trapping heat rising from inside the Earth. The upper crust has lots of small spaces into which water can flow.

So undersea microbes appear to live just about anywhere you'd care to poke a hole and look deep in the undersea crust. And that undersea crust makes up 70 percent of the Earth's "surface."

Finally, let's chill a bit and look at life in the slow lane down in Antarctica's Dry Valleys. Except they're not exactly dry. They contain ice-covered lakes. In the summer, it gets warm enough for water to flow into them from nearby snowfields and glaciers.

Here, too, life thrives, says Peter Doran, a scientist at the University of Illinois at Chicago. He studies the bacterial mats that form on the lake bottoms.

Here, the variety of microbial critters is pretty small, he says, because the habitat appears to change very little. The water at the bottom is salty and stable, with little mixing between it and the layers above. But it's cozy. Despite the wide swings in air temperature from winter to summer (minus-50 to 32 degrees F.), the water in the lakes stays at room temperature year-round. It's warmed by the sun in summer and insulated by its icy cover in winter.

As they learn about how life survives in these relatively shallow lakes, scientists are setting their sights on the hunt for life in the continent's granddaddy, Lake Vostok. It's about the size of Lake Ontario, is some 3,280 feet deep, and it's trapped under a layer of ice 2-1/2 miles thick.

John Priscu, another Montana State University scientist, is helping to plan a search for life in Lake Vostok. He notes that columns of ice brought back from drilling expeditions there show ample evidence of microbial life. But the deepest sample penetrated only partway into a 650-foot layer of ice that marks a boundary between the ice above and the surface of the lake below. He hopes to lead a team to drill deep enough to bring up water samples. His dream: Send down a remotely piloted underwater vehicle.

> "Scientists were surprised to see us tube worms living in pitch-darkness near deep-sea vents. The vents spew out hot (750 degrees F.) mineral-rich water from deep inside the Earth."

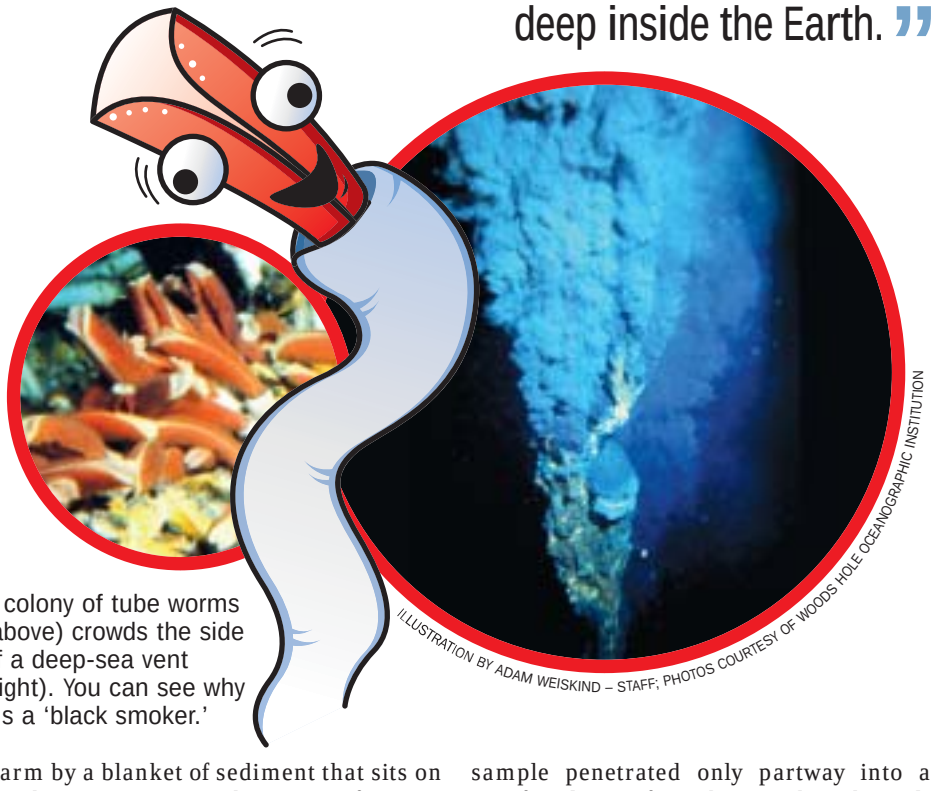

ILLUSTRATION BY ADAM WEISKIND – STAFF; PHOTOS COURTESY OF WOODS HOLE OCEANOGRAPHIC INSTITUTION

A colony of tube worms (above) crowds the side of a deep-sea vent (right). You can see why it's a 'black smoker.'

Russian and French scientists' research suggests there may be hydrothermal activity at one end of the lake, just as there is on the sea floor and at Yellowstone.

If that's true, Dr. Priscu says, "then you have an energy source. You could have these unique organisms there. You could have an environment that supports multicellular organisms," as black smokers do.

"Wouldn't that be great to put down a submarine and see tube worms meters long under 2-1/2 miles of ice?" he wonders. "It gives me goosebumps...."

Peter N. Spotts

■ ***Next Week:*** *If life is in such odd places on Earth, what about life in outer space? Watch for our 'Design an Alien' contest!*

TODAY'S ARTICLE ON CHRISTIAN SCIENCE

For kids

Getting the right message

HAVE YOU EVER PLAYED a game called "telephone"? The way you play is this: You and a group of friends sit around in a circle. One person thinks of something to say. Then, that person whispers the sentence in the ear of the person sitting next to him or her. The sentence is whispered from ear to ear until the sentence has gone around the whole circle. The last person in the circle has to say the sentence aloud.

That's when things can get pretty crazy. Maybe the first person said, "My sister has polka-dot pants." But the last person might say, "My sister has a hippopotamus for an aunt!" Or maybe the first person whispered, "I like spaghetti with meatballs for dinner." But the last person might say, "I hiked with confetti in my overalls last winter."

Even when there are just a few people in your circle, the sentence never comes out sounding the same. But everyone knows that what the last person says is going to be different (and a whole lot sillier) than what the first person said. That's what makes the game so funny.

Of course, getting the wrong message isn't always funny. A wrong message could mean missing the beginning of soccer practice or not knowing about an invitation to a friend's party. These are mixed-up messages that could certainly cause a lot of problems!

Believe it or not, thoughts of sickness or loneliness or fear are mixed-up messages, too. They might seem real and true, but they actually aren't. Why not? Because they aren't the thoughts that God thinks about us. They aren't the good things He tells us about ourselves.

God sees each of us as perfect. He sees us the way He made us, as healthy and helpful and loving. He sees only what is true – that we are actually spiritual, not material.

What does it mean to say we're spiritual and not material? It means that who we are isn't based on the color of our eyes or whether we're short or tall. Even twins, who look the same, are two different people. You can tell this by the way they act. One might love music, while the other may like sports.

In other words, it's our qualities that make us individuals. The special way we each express creativity and strength (and everything in between) is our spiritual selfhood. It's what makes you, you, and me, me.

When we think about ourselves this way, we're actually listening to what God is saying. We're trusting His messages, and only His messages, to understand who we really are. We're trusting what's called spiritual sense. When we do this, we can't go wrong.

I discovered this when my gums were really swollen. At first, I was worried. But I knew there was one thing I could do, and that was to listen to God and only to God. As I listened, I remembered a Bible verse that says, "Trust in the Lord with all thine heart; and lean not unto thine own understanding" (Prov. 3:5).

This verse was a reminder to stay true to what God knows about me. So, I stopped looking at my gums and started listening to spiritual sense. I wanted to understand myself as perfect – just the way God made and sees me. Soon, I began to feel peaceful, and I fell asleep.

> In listening to God's messages, I could see and feel what was true about me. I was healed.

Around 5 o'clock in the morning, I woke up with my gums hurting worse than ever. For a moment, I was scared. But then I remembered the second half of that Bible verse: "Lean not unto thine own understanding." What that verse said to me was that I could and should continue to listen to spiritual sense. It was telling me what was true – that I was already perfect. And so, trusting that, I went back to sleep.

When I woke up again later, I found that my gums were no longer swollen. In listening to God's messages, I was able to see and feel what was true about me, even when my body was trying to tell me otherwise. I was healed.

In that game of "telephone," no matter how silly or crazy the last person's sentence may be, the first person always knows what was said at the beginning. What the last person says doesn't really change the first person's sentence. In just the same way, God always knows what's true about each one of us. And, trusting spiritual sense, we can find this out at any moment. We can understand that we're spiritual and perfect, no matter what. All we have to do is listen to the right message.