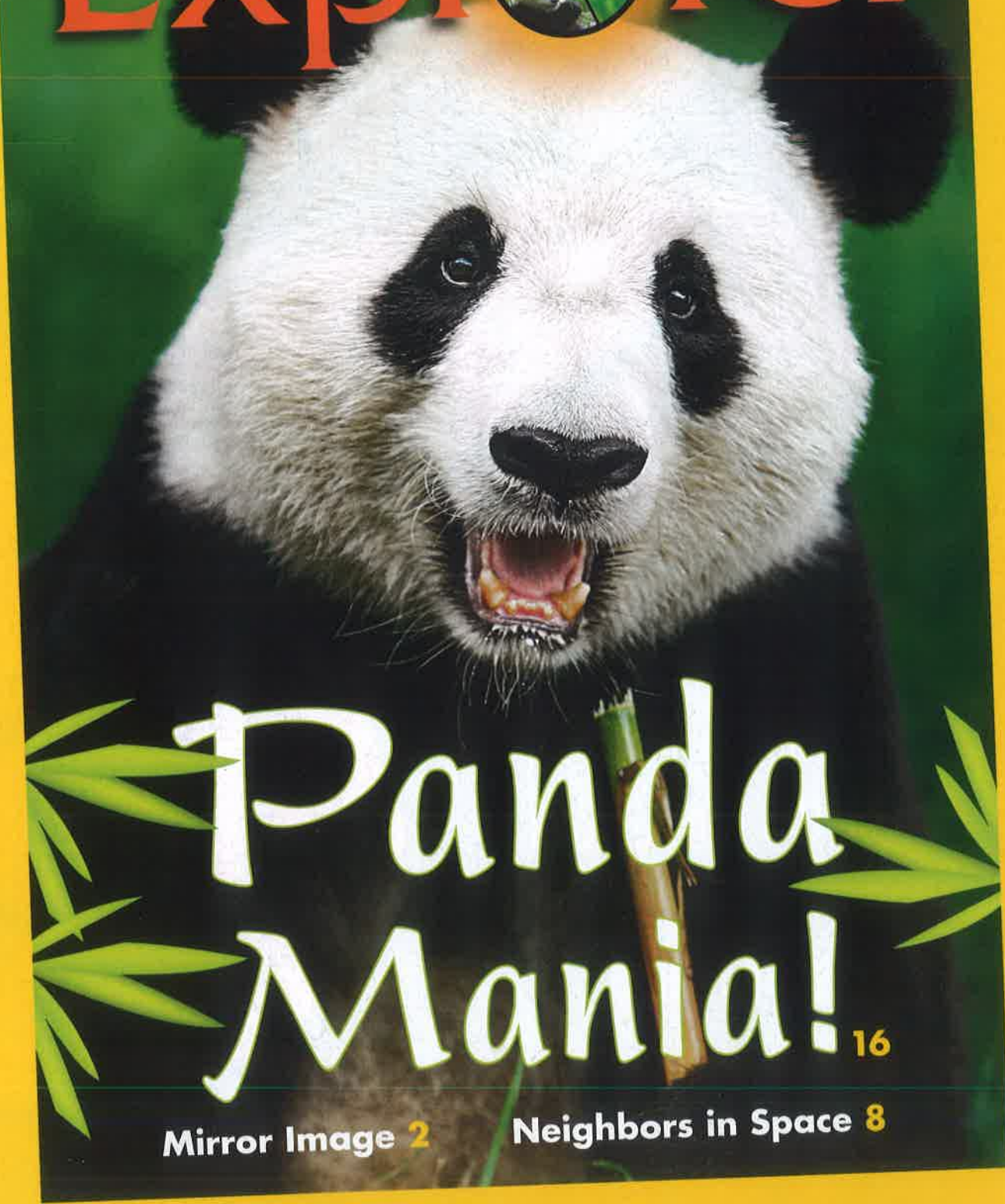
PATHFINDER EDITION NGPATHFINDER.ORG NOVEMBER–DECEMBER 2012

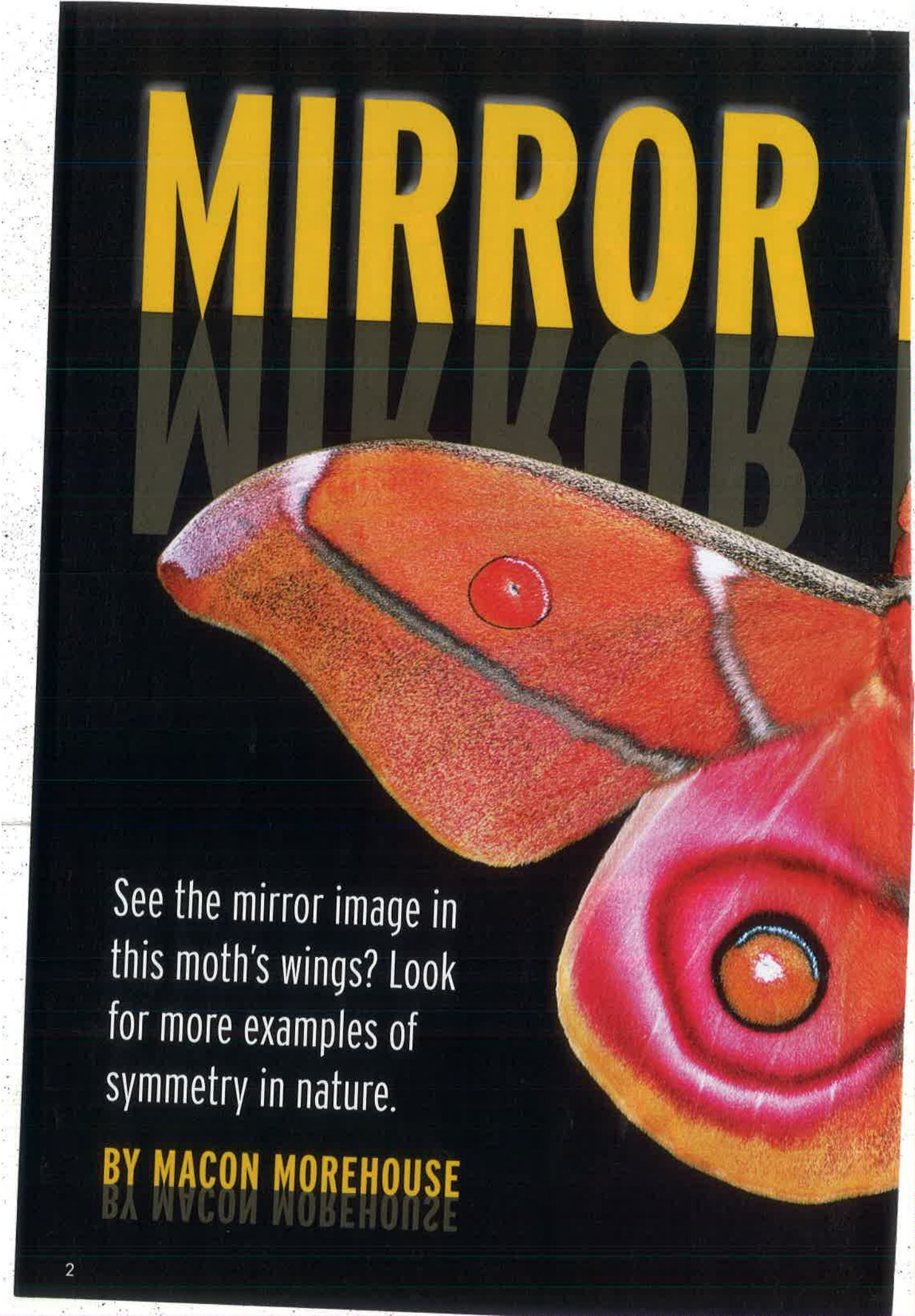
NATIONAL GEOGRAPHIC

Explorer



Panda Mania! 16

MIRROR



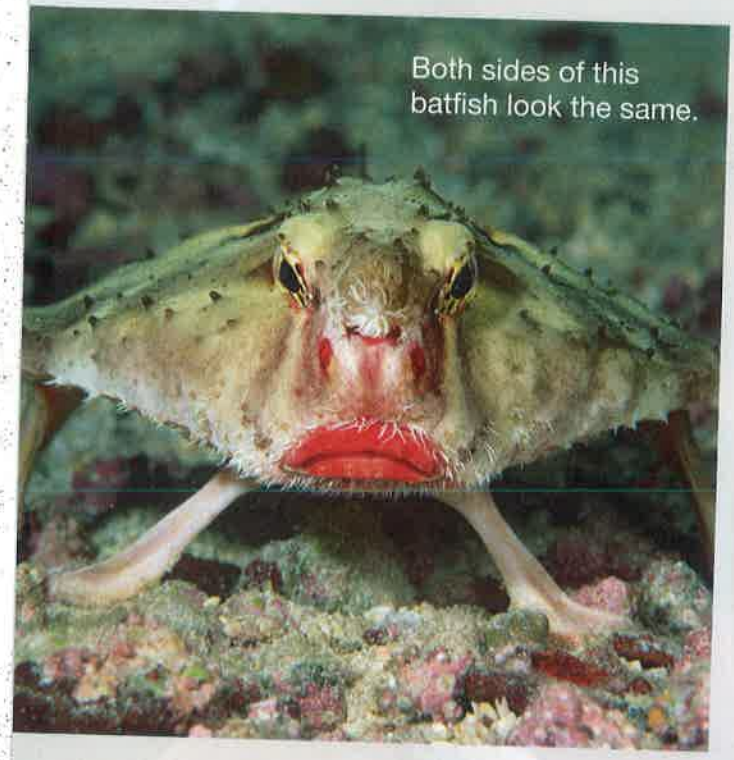
See the mirror image in this moth's wings? Look for more examples of symmetry in nature.

BY MACON MOREHOUSE

MAGE

Mathematics

COMPREHENSION STRATEGY:
As you read, ask: Does this make sense? Mark parts that are confusing. Revisit them after reading.



Both sides of this batfish look the same.

Look at this funny fish. Its bright red lips frown. Its eyes glare. It even has a tiny fishing rod hidden in its head. It sticks this body part out to catch its dinner.

If this isn't odd enough, check out the fish's four fins. It's standing on them like they are feet! This fish can swim. Yet it spends much of its time walking across the seafloor on its fins. Meet the rosy-lipped batfish.

This batfish may be one of the weirder looking animals in the sea. Yet in one way, it's not odd at all. Like most animals, both sides of its body look the same. This whacky fish is a great example of **symmetry.**

Symmetry occurs when at least two sides of something match. That means it has parts that are similar in size and shape. Sometimes, these parts are evenly placed along a dividing line. Sometimes, they're evenly spaced around a central point. Either way, it's symmetry.

Here's how you can tell with the batfish. Draw an imaginary line down the middle of the fish's face. Each side has a bulging eye. Each side has two fins. The line also divides the fishy frown in half. Both sides look the same. That's symmetry.

Seeing Double

The batfish has a kind of symmetry called **bilateral symmetry.** It's also called mirror symmetry. That's because it's like looking in a mirror and seeing your reflection. An exact copy of you looks back. Now imagine that the line you drew down the middle of the batfish is a mirror. The fish's right side looks like a reflection of its left side.

In nature, though, both sides aren't always exactly the same. You can see that if you draw a line of symmetry down the middle of your face. You might notice that one eyebrow is slightly higher than the other. Maybe when you smile, you've got only one dimple instead of two. Both sides of your face have an eye, an ear, and half a smile. Both are almost alike. So your face is still symmetrical.

Making Matches

It's even easier to see bilateral symmetry in a luna moth. Find one resting with its wings open. Then you can really see how its two sides look the same.

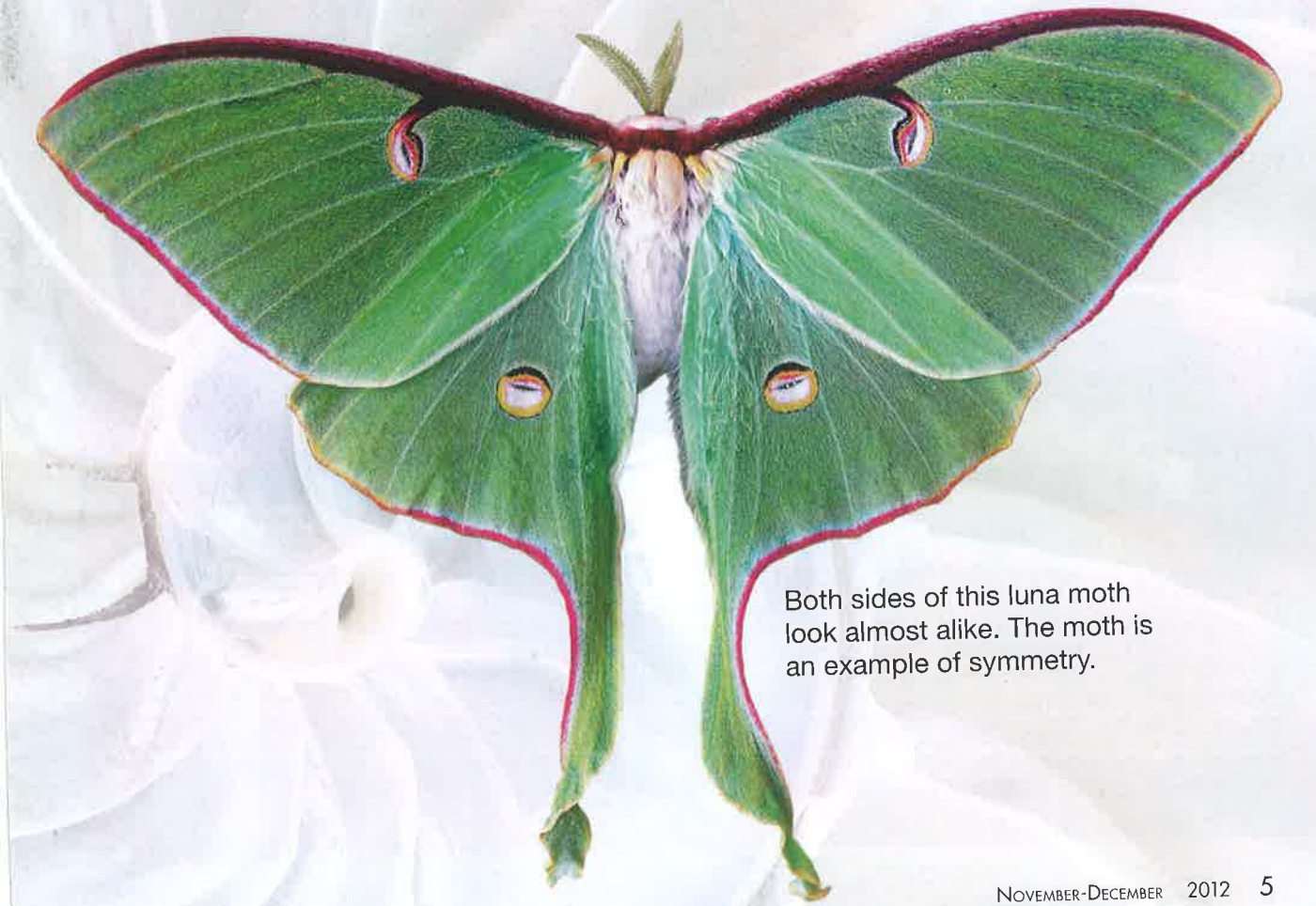
A pair of pale green wings grows from each side of the moth's body. Two feathery antennae stick up from its head. Its body parts are about the same size and shape. They are evenly arranged along its white furry body.

Now look at the pretty patterns on its green and purple wings. You can see symmetry there, too. A ribbon of purple runs along the edges of its wings. The matching spots on its wings look just like a pair of eyes staring at you. The patterns are made by thousands of tiny overlapping, matching scales.

Bilateral symmetry is all around you. Most animals have it. Camels, beetles, pigeons, and frogs have it. You can even look at your pet for signs of symmetry.

You can find symmetry other places in nature, too. Look at a leaf. A vein runs down the middle and divides the leaf in half. It's the same with some types of flowers. Take a look at a bleeding heart flower. Its curvy petals form the shape of a heart. Both sides look the same.

Divide each bleeding heart flower in half. Both sides match.



Both sides of this luna moth look almost alike. The moth is an example of symmetry.

Star Turn

Bilateral symmetry is one kind of symmetry. It's not the only kind. In fact, some things have two different kinds of symmetry.

To see how that works, dive into the sea. You're looking for a pretty sea star with five pointy arms. There's one. It's crawling across the seafloor.

Now look for the matching halves. It's not quite as easy to find with a sea star. You can, though. The line goes right down the middle of one arm. So each half of the sea star has two whole arms and one half arm.

Look at the sea star again. See how its five arms stick out from its center. That means the sea star has a second kind of symmetry, too. It's called **rotational symmetry.** You can turn, or rotate, the sea star and it looks just like it did before you moved it.

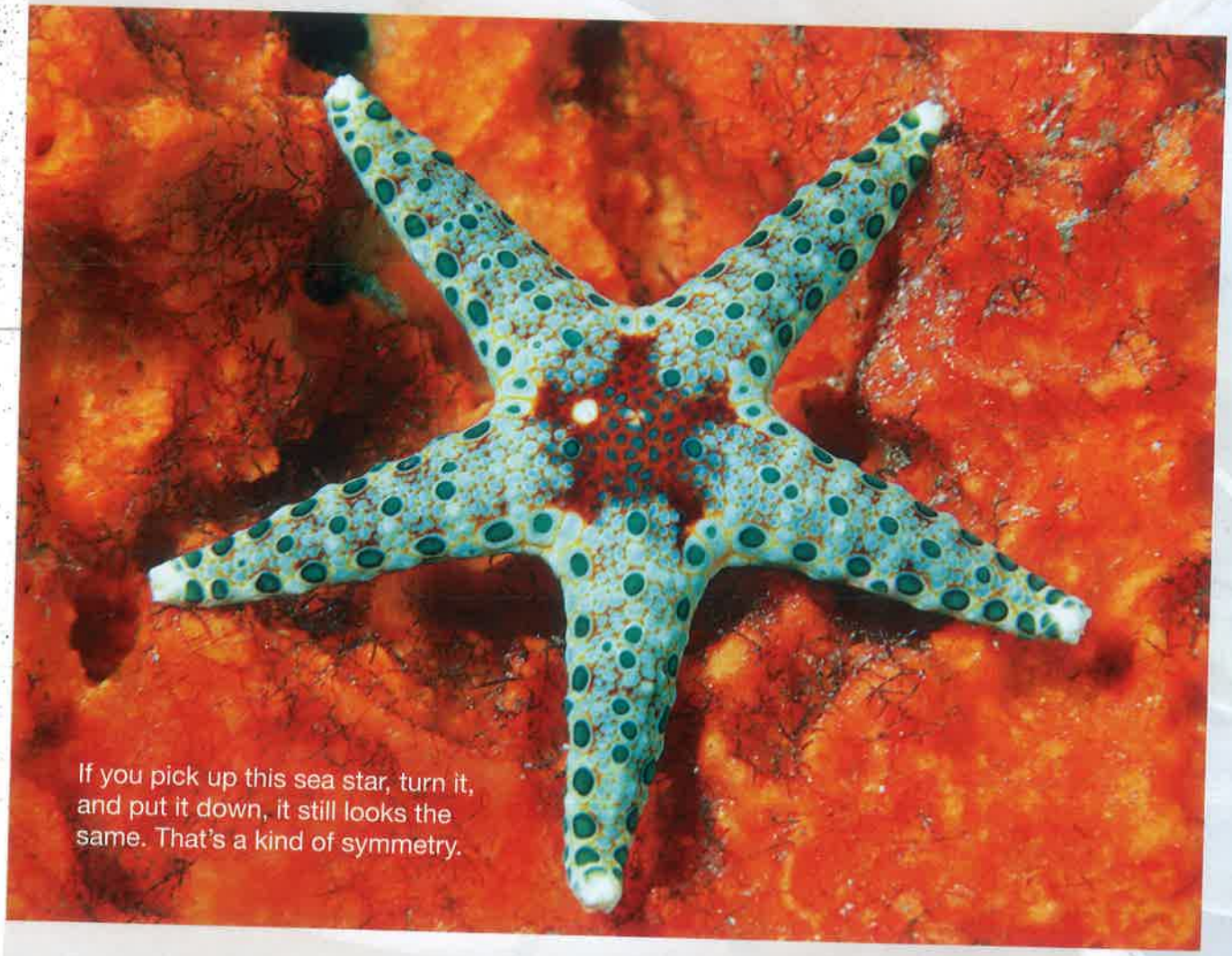
Heads or Tails

The sea star looks the same after you turn it because it doesn't have a head or a tail. Instead, it has a mouth in the middle of its body. Its arms stick out from that central point.

Only a few kinds of animals have rotational symmetry. They all live in the water. Yet you can find plenty of other examples of this kind of symmetry in nature.

A passion flower is a good example. Look at the photo of it. Its yellow petals fan out in a circle from its center. So do the spiky purple and white parts. Now rotate the photo a little bit. You're looking at the image from a different angle. Yet it still looks almost the same. That's rotational symmetry.

If passion flowers don't grow near you, look for daisies or dandelions. No matter how you turn these flowers, they look the same.



If you pick up this sea star, turn it, and put it down, it still looks the same. That's a kind of symmetry.

Turn the photos of this passion flower and snowflake upside down. Do they still look the same?

Symmetry in Snow

You can find rotational symmetry in nonliving things, too. Bundle up and go out in the snow. Whirling and twirling snowflakes blow in every direction. It's a blizzard. There's no order within this chaos. Or is there?

Zoom in on an individual snowflake. One lands on your sleeve. Quick, take a look before it melts. You've just seen one of the most beautiful examples of symmetry in nature. To really see a snowflake's patterns, though, you may need to look at it through a special microscope.

A snowflake forms when water vapor freezes. The vapor turns into an ice crystal. Its center is a hexagon, with six sides and six points. Six matching branches grow from each point. The branches have matching ridges and grooves. In some snowflakes, the branches look like feathers. In others, they look like spears or other geometric shapes.

You may have to look at a lot of snowflakes before you find what you're looking for. Most start out perfectly symmetrical. Then as they fall, they slam into each other.

That can damage these fragile crystals. Branches break. Snowflakes melt. Just like that, their symmetry vanishes.

Seeing Symmetry

From deep in the sea to high in the clouds, symmetry is all around you. Now it's your turn to find it.

Find a caterpillar with bilateral symmetry. Look for a flower with rotational symmetry. See how many examples you can find. Once you start looking, you'll see nature's symmetry all around you.

WORDWISE

bilateral symmetry: when a line can divide an object into matching halves (also called mirror symmetry)

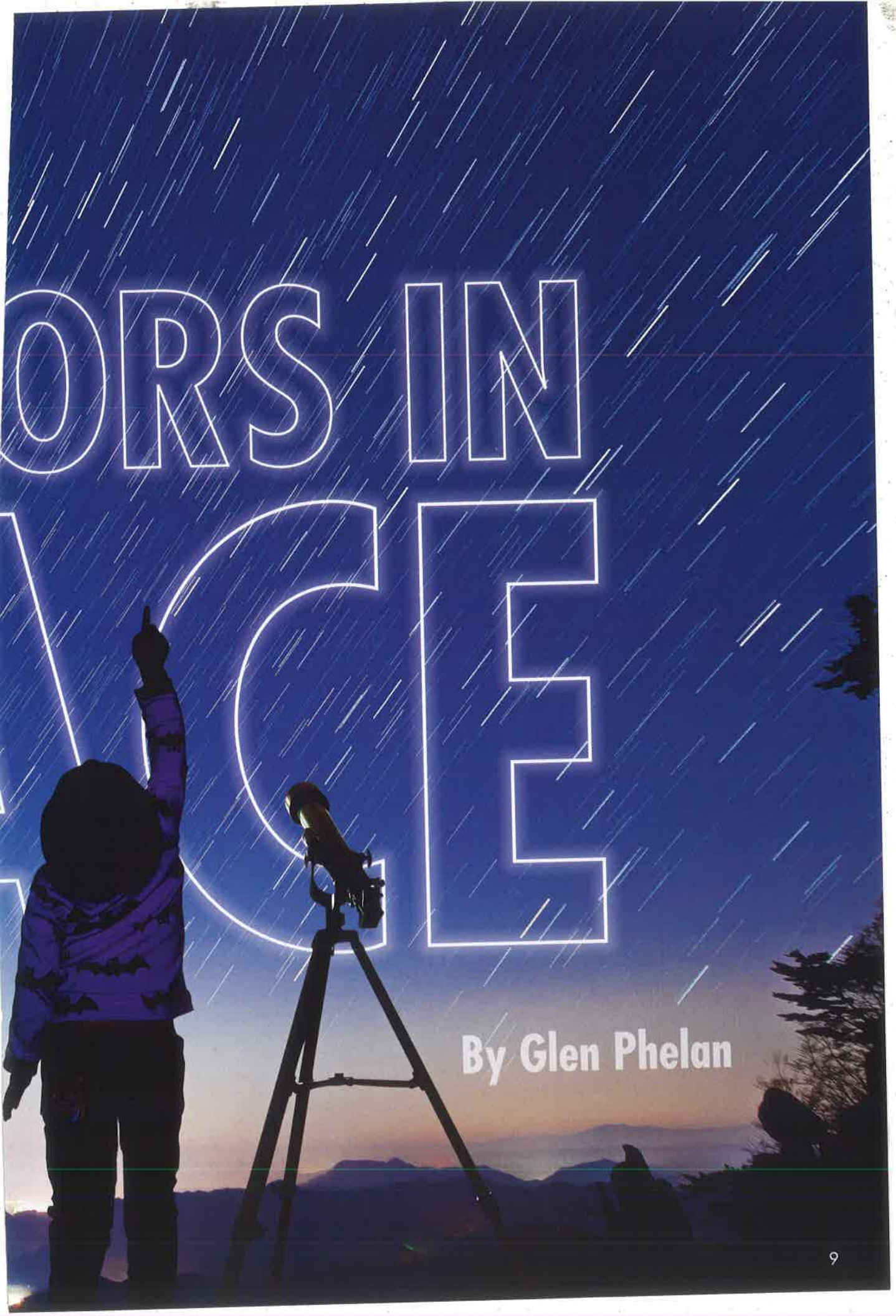
rotational symmetry: when similar parts are arranged around a central point (also called radial symmetry)

symmetry: a matching of parts on each side of a dividing line or around a central point

Space Science

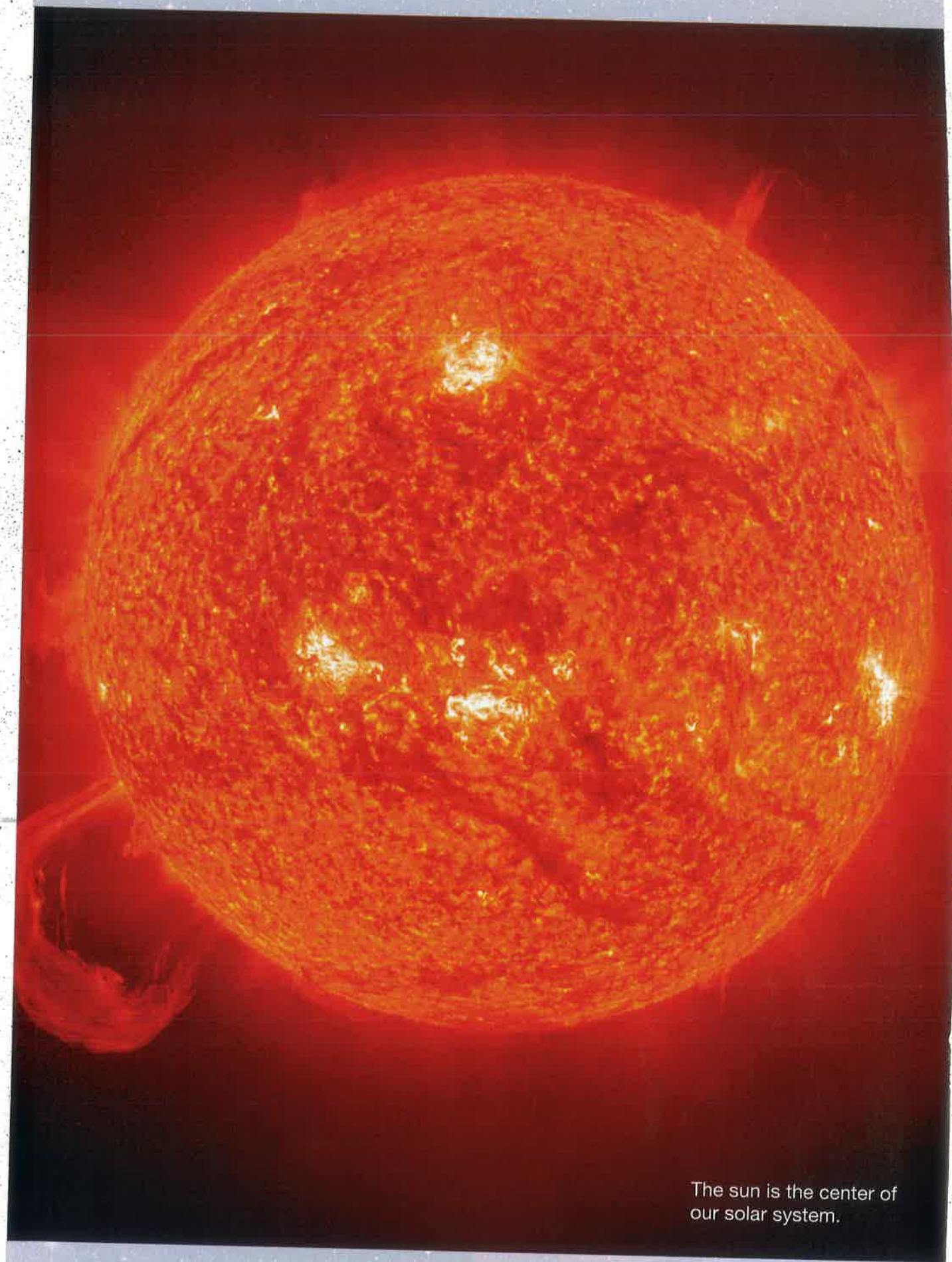
COMPREHENSION STRATEGY:
As you read each section, use the subhead to help you find the main idea.

Blast off to meet our NEIGHB SPA



ORS IN VCE

By Glen Phelan



The sun is the center of our solar system.

Your rocket is on the launch pad, and you're strapped into your seat. With six seconds before liftoff, the main rocket engines fire. They roar. They rumble. Everything starts to shake.

The countdown winds down—5, 4, 3, 2, 1. Liftoff. The rocket shoots up, pressing you into your seat. Hang on!

You're on a tour of our **solar system.** Your super-fast rocket will blast off to the sun. Then you'll pick up speed and tour the eight **planets** that **orbit** the sun. They make up our neighborhood in space.

Our Star

You head to the center of our solar system. Your destination is a yellow **star,** our sun. Like all stars, the sun is a ball of hot, glowing gases. These gases churn, sizzle, and pop.

You can't land on the sun, though. The surface of the sun isn't solid. This is a place of bubbling gases and raging heat.

All this activity is important. The sun's light and heat spread throughout the solar system. A tiny amount of this energy falls on each planet. Without the sun, life on Earth couldn't exist.

The sun is the biggest and hottest object in our solar system. If the sun were hollow, a million Earths could fit inside it. Temperatures in the core soar to 15 million degrees Celsius (27 million degrees Fahrenheit).

That's not all. The sun also holds our solar system together. Without its powerful gravity, our planetary neighborhood would fall apart. The sun's gravity is a natural force that pulls the planets toward the sun. It keeps the planets from spinning off into space.

The first four planets from the sun are called the inner planets. Mercury, Venus, Earth, and Mars are all small and rocky worlds.

The next four planets are called the outer planets. Jupiter, Saturn, Uranus, and Neptune are huge, cold balls of gases. Because of their large size, they are called gas giants. As you make your tour of our solar system, take a closer look at each planet.

The First Planet

The sun's nearest neighbor is Mercury. It's the smallest planet. If you look out your rocket window, you'll see that Mercury is pitted and scarred. Craters dot its surface.

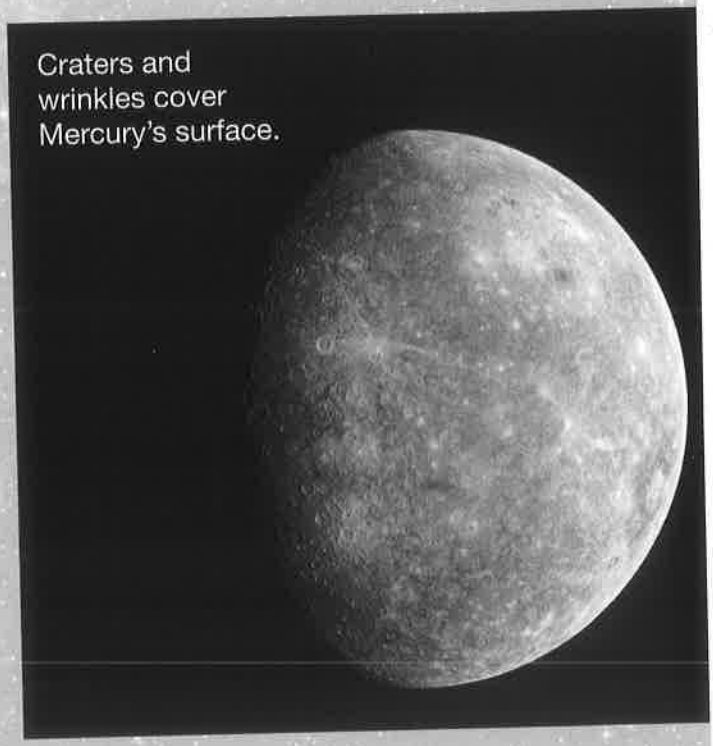
Mercury's surface is also wrinkled. That's because the planet used to be bigger. Then its core cooled a little and shrank. This made its crust fold in places, forming ridges or wrinkles.

If you're feeling a little warm on Mercury, it's because the temperature can get hot. It can also get really cold. Mercury has the greatest temperature change between day and night of any planet.

The side of Mercury facing the sun bakes in the heat. It gets 11 times hotter than Earth's average temperature. The side of Mercury that faces away from the sun gets very cold. Temperatures there drop hundreds of degrees below freezing. Ice may even form in some of Mercury's craters.

Mercury spins slowly, so the side facing the sun is bathed in light for about 59 Earth days. A lot of heat builds up during that time.

Yet the heat doesn't last. Mercury has almost no atmosphere to trap the heat. As the planet rotates, the dark side cools quickly.



Craters and wrinkles cover Mercury's surface.

Venus's atmosphere traps the sun's heat.

The Hottest Planet

Mercury may be closer to the sun, but Venus is hotter. It isn't a very welcoming neighbor. Venus's thick atmosphere traps the sun's heat. It's made up mostly of carbon dioxide. Its clouds are coated with acid.

Beneath the clouds, Venus's rocky surface floats on melted rock. This magma bursts through to the surface often, forming huge volcanoes. Venus has more volcanoes than any other planet in the solar system.

You'd better not try to land. Not only would you have to dodge spewing volcanoes, you'd also get squashed. The air on Venus is thicker than Earth's. It would crush your spacecraft like a soda pop can. So keep flying.

The Living Planet

Of course we know the third planet from the sun. It's our planet, Earth. From up here, it looks like a blue marble. That's because oceans cover nearly three-fourths of our planet. Earth is the only planet known to have liquid water.

Earth also has just the right temperatures for life. Our atmosphere is just right, too. It has enough oxygen for us to breathe and gases that protect us from the sun's harmful rays.

Neither Mercury nor Venus has a **moon,** but Earth does. A moon is a natural object that orbits a planet. Now it's time to head to the fourth planet.

The Red Planet

On Mars, wispy clouds and patches of pink mist form in the thin atmosphere. In many ways, Mars is most like our own planet. Even the length of its day is similar. A Martian day is just 41 minutes longer than a day on Earth.

People haven't walked on Mars yet, but today, you're going to land there. As you touch down in a rocky valley, you see a spinning orange dust devil. These dust storms form when warm air rises. Like tiny tornadoes, they scatter dust across the planet. The rocks and soil in this valley are rich in iron minerals. They have a reddish color to them.

You might like to get out and walk around, but you'd better not. It's very cold here. You also can't breathe here. Too much carbon dioxide makes Mars's air poisonous. You need to take off and keep moving. You're about to see the largest planet in the solar system.

The Largest Planet

Jupiter is larger than all the other planets in the solar system put together. Don't let its size fool you, though. This planet can really move. It spins once every 10 hours. That's the shortest day in the solar system.

Jupiter's rapid spin creates rough weather. Whipping winds race across the planet. One swirling storm, called the Great Red Spot, has raged for hundreds of years.

A mighty volcano towers over the surface of Mars.

Jupiter's Great Red Spot is a giant storm.

The Ringed Planet

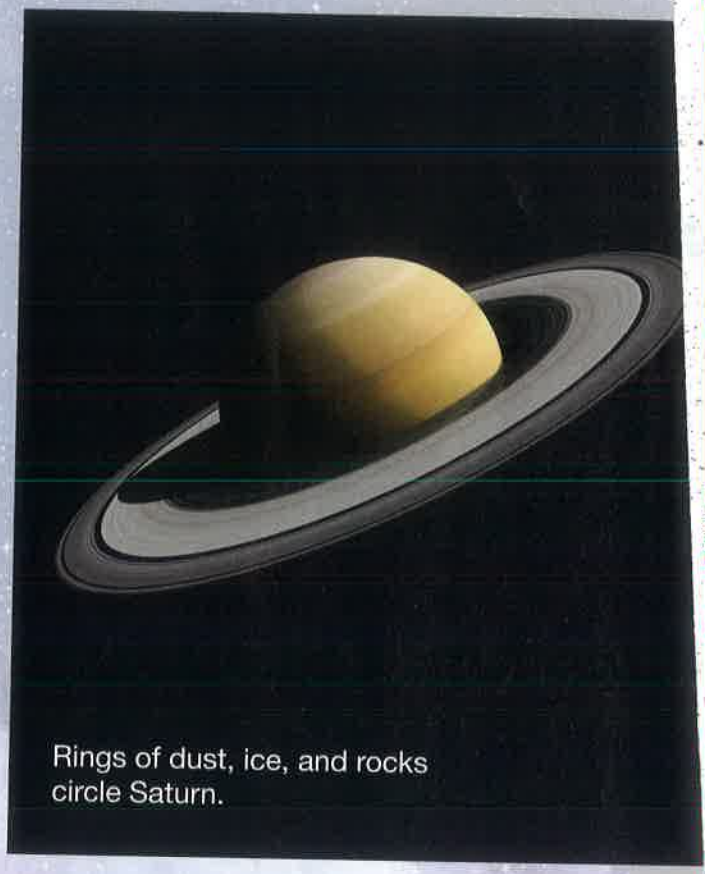
All of the gas giants have rings, but none are as spectacular as Saturn's. You can see them clearly as you come closer to the planet.

Bits of rock and ice make up the rings that orbit the planet. Some are as small as grains of dust. Others are as large as boulders. Scientists think they are leftover pieces of moons. The moons may have collided with rocks in space.

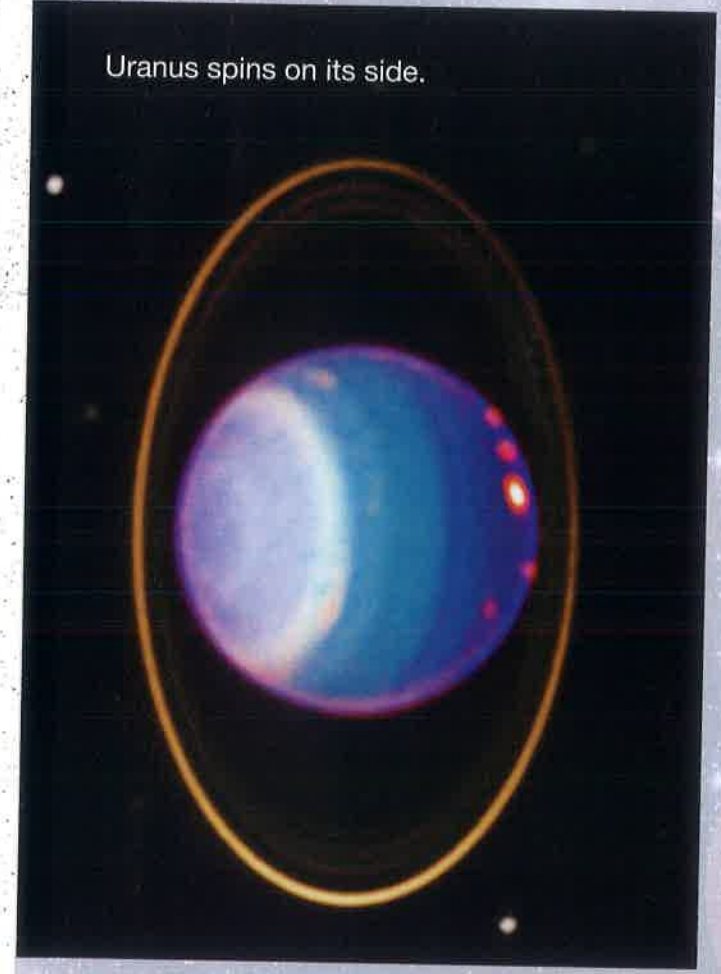
Saturn has plenty of moons left. It may have more than 60. They vary in size and shape. Some of them have remarkable features. One has geysers that shoot ice into space.

Beneath the rings and moons, Saturn is a lot like Jupiter. It is a world of wicked winds and banded clouds. Giant hurricanes spin across the planet's surface. Some grow larger than the U.S. state of Texas.

Saturn is also the only planet that could float. If you could find a container big enough, Saturn would bob on top of the water.



Rings of dust, ice, and rocks circle Saturn.



Uranus spins on its side.

The Sideways Planet

Once you move past Saturn, you'll blast over to Uranus. Uranus is blue, but it doesn't have water. Its color comes from methane gas in its atmosphere.

Uranus is a cold, dark world. Here's a way to think of how dark it really is. Imagine that the amount of sunlight that hits Earth is equal to four dollars. Only a penny's worth of sunlight reaches Uranus.

Like Saturn, Uranus has rings. These rings are darker and thinner than Saturn's—only a few kilometers thick. This planet also has brightly colored outer rings.

The similarities with Saturn stop here, though. Uranus is a real oddball in the solar system. It does something strange. It spins on its side.

It seems to roll like a ball instead of spinning like a tilted top, like the other planets do. Scientists think something must have knocked Uranus on its side. One or more large objects may have crashed into the planet long ago. The impact could have turned the planet sideways.

The Frozen Planet

You're almost at the end of your tour. Neptune is the last planet in our solar system. Neptune was discovered through math.

Some astronomers noticed that Uranus's orbit didn't seem quite right. Two math experts thought that another planet's gravity was pulling on Uranus. These experts used math to predict where the other planet was. Astronomers looked where the planet was supposed to be and found it.

Neptune lies 30 times farther away from the sun than Earth. It takes this planet almost 165 Earth years to orbit the sun. Neptune gets little heat or light from the sun. It's cold here. This planet is mostly made of ice.

Neptune is known for its powerful storms. Winds here are the fastest in the solar system. These winds can blow up to 2,575 kilometers (1,600 miles) per hour. That's nine times faster than winds on Earth.

Good Neighbors

It's pretty chilly this far from the sun. You should probably head back to Earth. Fire the rockets and settle in for the ride.

You live in an interesting neighborhood. Eight planets and one star make up our solar system. From the smallest planet nearest the sun to the dark and icy gas giants, each planet has a story to tell. Each world is unique.

WORDWISE

moon: a natural object that orbits a planet

orbit: to move around a star, planet, or other object in space

planet: a nearly round object that orbits a star

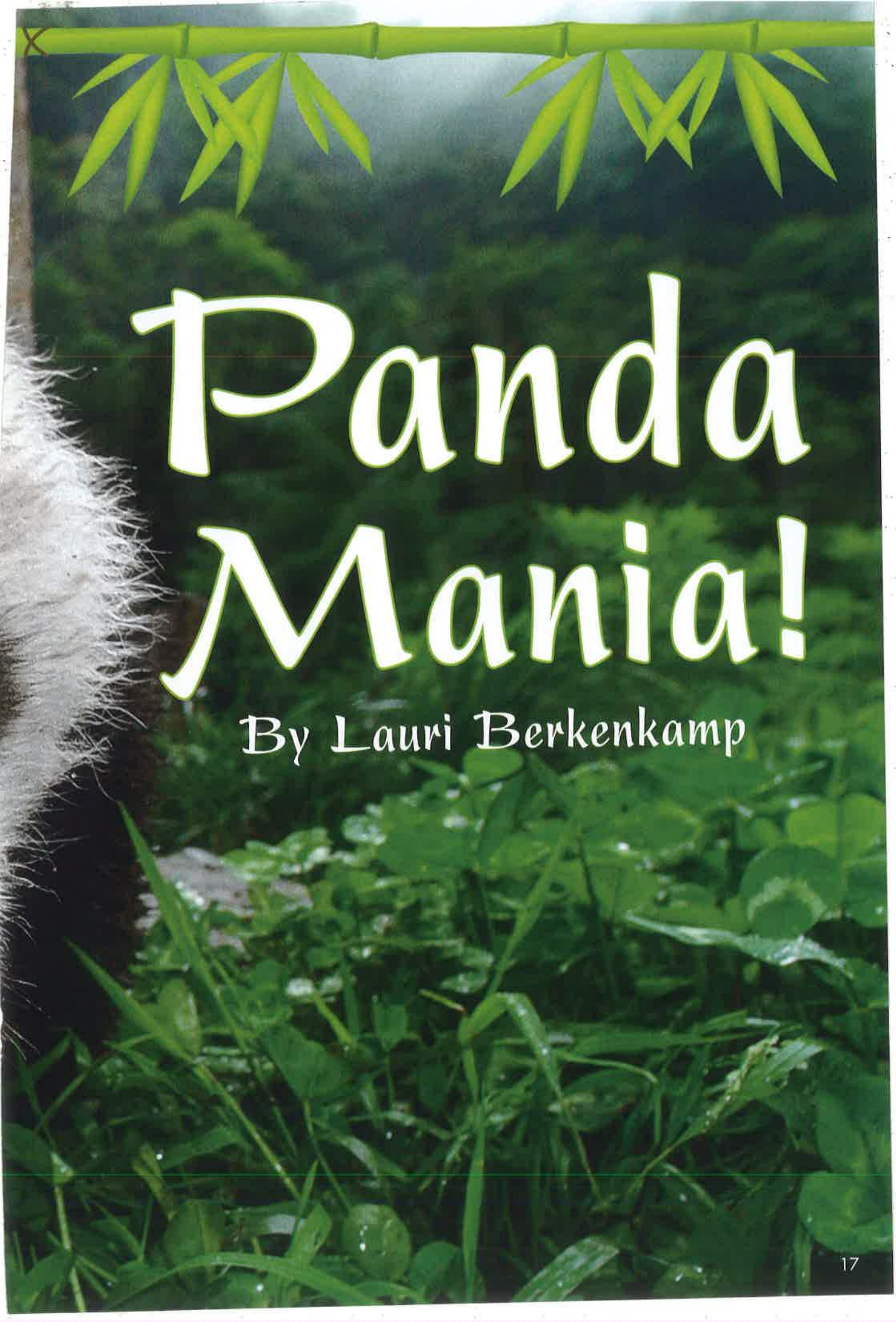
solar system: the sun and everything that orbits around it

star: a body of hot gases that makes energy

Storms swirl across Neptune.

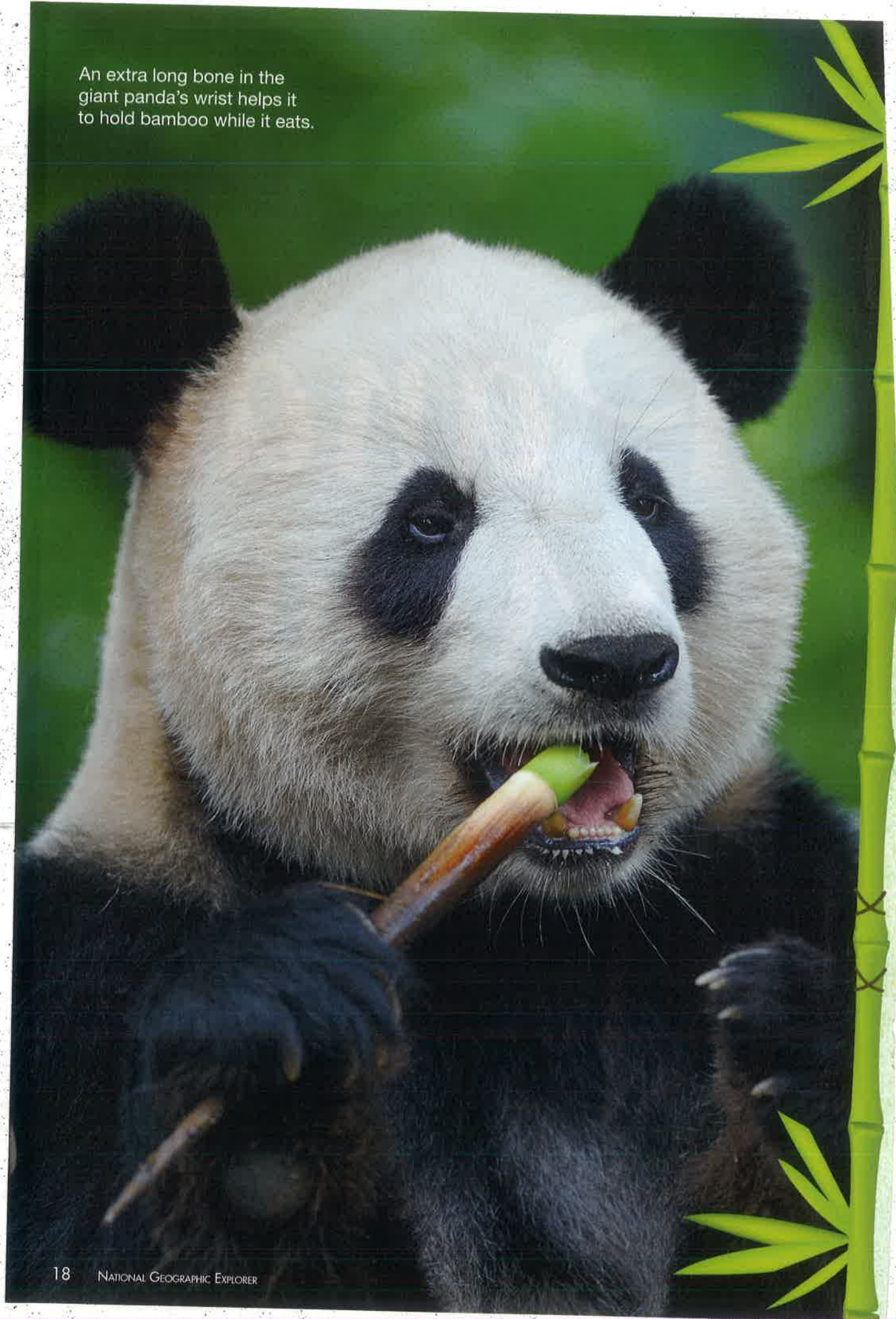
Life Science

COMPREHENSION STRATEGY:
As you read, make inferences about the adaptations giant pandas need to survive.



Panda Mania!

By Lauri Berkenkamp



An extra long bone in the giant panda's wrist helps it to hold bamboo while it eats.