Science News Explores
November 2022

IS THE SKY BLUE?

PLANETS AND MOONS FOLLOW RULES

COULD WE MAKE VIBRANIUM?
P26

THE PLUTO PLANET PUZZLE

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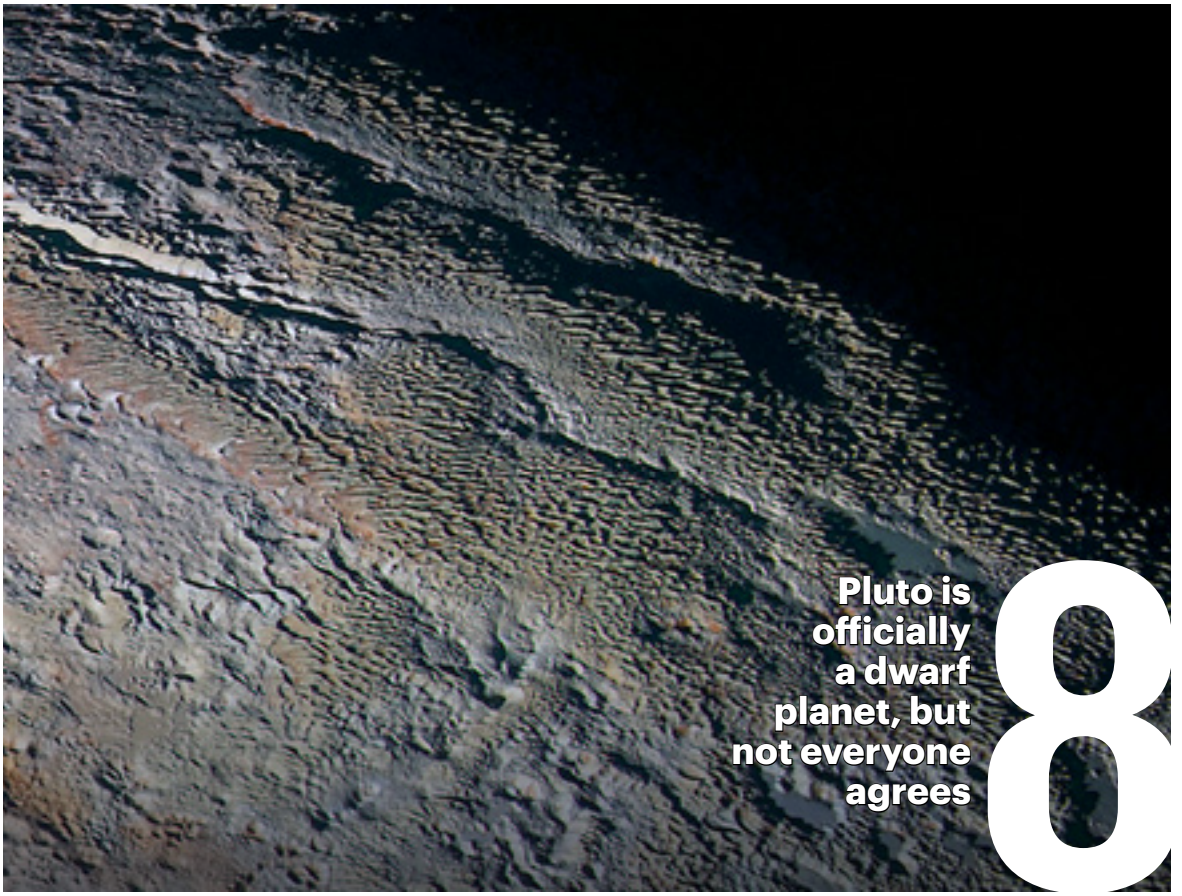

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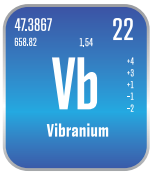

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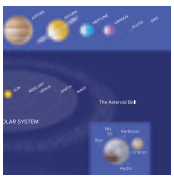

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COVER: NASA IMAGES/SHUTTERSTOCK

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Q Do you think Planet Nine exists?

— Matthew H.

Some scientists think that a distant Planet Nine (illustrated) may orbit the sun beyond Neptune — but nothing has been found yet.

A It's too soon to say. No one has ever observed this supposed ninth planet in the solar system, which would orbit the sun far beyond Pluto. Some computer models suggest that Planet Nine's gravity would explain the weird orbits of other objects in the distant solar system. But other computer models do not agree. Proving whether Planet Nine exists would require getting a better look at the edge of the solar system. The Vera Rubin Observatory in Chile could help with this when it starts observing the sky within the next couple of years.

Q Why are flies attracted to dead animals?

— Emily Z.

Decomposing animals offer a valuable food source for adult flies and their young. Blowflies are one of the first and most frequent types of flies to arrive on the scene, says Lauren Weidner. Weidner is forensic scientist at Arizona State University in Phoenix. She studies how the insects found on dead bodies can help criminal investigations. The antennae of blowflies pick up chemical cues released by rotting bodies. Weidner says that more female blowflies tend to be found on a corpse than males. These female blowflies feed on the rotting corpse to help their eggs develop. They will then lay these eggs on moist areas of the corpse. The fly larvae, or maggots, will soon hatch and begin feasting.

Q If salt is a mineral, how is it edible?

— Izzie B.

Many types of salt exist around us. Sodium chloride, or table salt, is the type we eat. In fact, table salt is essential to most living things. Mike Gordon is a neuroscientist at the University of British Columbia in Vancouver. His lab uses fruit flies to study how the brain responds to the foods we taste. The sodium in salt keeps our bodies working, he says. Sodium helps nerve cells talk to each other and allows muscles to contract. This need for salt can be seen across the animal kingdom, including in Gordon's fruit flies. Like us, fruit flies seek out only small amounts of salt. But eating too much of it can be harmful. "Balancing sodium levels in your body is just a really important task for animals in general," says Gordon.

Do you have a science question you want answered? Reach out to us on Instagram (@SN.explores), or email us at explores@sciencenews.org.

Sarah Zielinski
Editor, *Science News Explores*

CALTECH/R. HURT (IPAC)

BRAIN

Why teens can't help tuning out mom's voice

As kids become teenagers, unfamiliar voices suddenly become more interesting than mom's

Do you sometimes ignore your mom while chatting with friends? If you're a teen, that's fairly common. And new research may explain why so many adolescents tune out their mom's voice.

Young kids' brains are very tuned in to their mothers' voices, science has shown. But as kids morph into teens, everything changes. "Adolescents have this whole other class of sounds and voices that they need to tune into," explains Daniel Abrams. He's a neuroscientist at Stanford University School of Medicine in California.

Teenagers' brains are more tuned in to strangers' voices than their own moms, the new research shows. Abrams and his team shared their findings in the *Journal of Neuroscience*.

The researchers scanned the brains of 7- to 16-year-olds as they listened to things said by their mothers or by unfamiliar women. The words were pure gibberish: teebudieshawlt, keebudieshawlt and peebudieshawlt. Using such nonsense words allowed the scientists to study voices on their own, not what was being said. As the kids listened, certain parts of their brains became active. This was especially true in brain regions that help us to detect rewards and pay attention.

Abrams and his colleagues already knew that younger kids' brains respond more strongly to their mom's voice than to a stranger's. "In adolescence, we show the exact opposite of that," Abrams says. For teens, these brain regions respond more to unfamiliar voices than to their mom's. This shift in what voice piques interest most seems to happen between ages 13 and 14. That's when teenagers are in the midst of puberty, a roughly decade-long transition into adulthood.

These areas in the adolescent brain don't stop responding to mom, Abrams says. It's just that unfamiliar voices become more rewarding and worthy of attention. Here's why: As kids grow up, they expand their social connections way beyond their family. So their brains need to begin paying more attention to that wider world.

That's exactly as it should be, Abrams adds. "What we're seeing here is just purely a reflection of this."

But mothers' voices still have special power, especially in times of stress, one 2011 study in girls showed. Levels of stress hormones dropped when these stressed-out girls heard their moms' voices on the phone. The same wasn't true for texts from the moms.

The brain seems to adapt to new needs that come with adolescence. "As we mature, our survival depends less and less on maternal support," says Leslie Seltzer. She's a biological anthropologist at the University of Wisconsin–Madison. She was part of the team that carried out that 2011 study. Instead, she says, we rely more and more on our peers — friends and others closer to our own age.

So while both teens and their parents may sometimes feel frustrated by missed messages, that's okay, Abrams says. "This is the way the brain is wired, and there's a good reason for it."

— *Laura Sanders*

FEDERICO MARSICANO/SHUTTERSTOCK

FOSSILS

This big dinosaur had tiny arms before *T. rex* made them cool

Short, burly forelimbs may have helped *Meraxes gigas* with mating

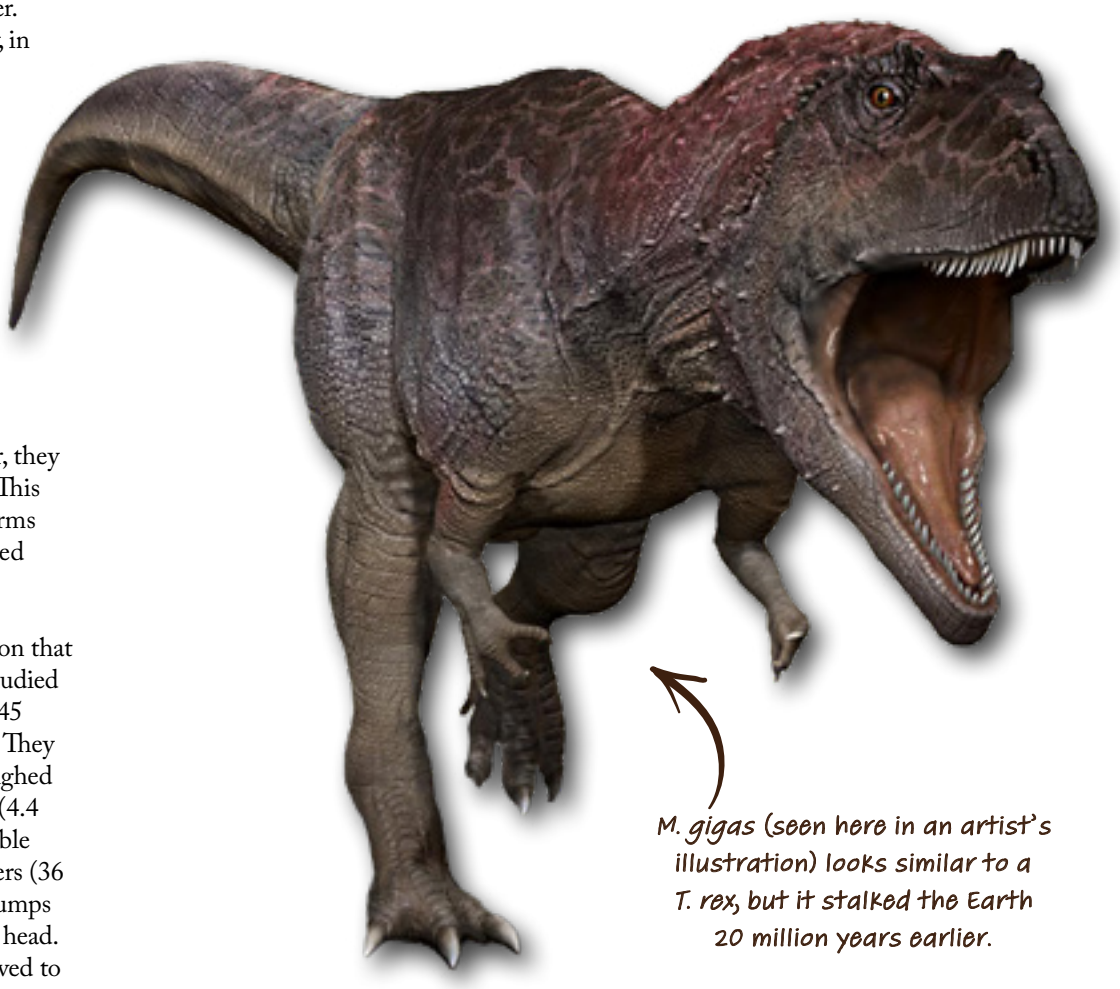
Tyrannosaurus rex's tiny arms have launched a thousand sarcastic memes. I love you this much, goes one of them. But *T. rex* wasn't the only dino to have such strangely short upper limbs. It wasn't even the first. Another big-headed, short-armed carnivore stalked Earth 20 million years earlier. It was also a continent away, in what's now Argentina.

Meet *Meraxes gigas*. This earlier dino rose to dominate its landscape between 100 million and 90 million years ago, notes Juan Canale. He's a paleontologist in Buenos Aires. He works as part of Argentina's CONICET research network. And though *M. gigas* and *T. rex* look similar, they were only distant relatives. This new dino shows that tiny arms alongside giant heads evolved independently in different dinosaur lines.

The *M. gigas* fossil skeleton that Canale and his colleagues studied appears to have been about 45 years old at the time it died. They estimate the animal had weighed more than four metric tons (4.4 U.S. short tons). Its formidable body spanned some 11 meters (36 feet). A host of crests and bumps and tiny hornlets topped its head. These ornaments likely evolved to help attract mates, Canale's team suspects. They described the beast in *Current Biology*.

Why these dinosaurs had such tiny arms remains a mystery. They weren't for hunting: Both *T. rex* and *M. gigas* used their massive heads to hunt prey. The arms may have shrunk so they were out of the way during group feeding frenzies.

But, Canale notes, *M. gigas*' arms were surprisingly muscular. That suggests to him that they were more than just an inconvenience. One possibility is that the arms helped lift the animal up from a reclining position. Another is that they aided in mating — perhaps showing a mate some love.
— *Carolyn Gramling*



M. gigas (seen here in an artist's illustration) looks similar to a *T. rex*, but it stalked the Earth 20 million years earlier.

CARLOS PAPOLIO

ANIMALS

A sea slug's head can crawl around and grow a whole new body

Why? Parasites might be the reason

Losing your body from the neck down can be just another of life's annoying — if temporary — setbacks. That is, if you're one of two kinds of rippling, green-tinged sea slugs.

Heads of *Elysia* cf. *marginata* sea slugs sometimes pull themselves free from their bodies. The heads just keep crawling around. Within a few hours, some heads start nibbling algae again. Within about 20 days, heads from young slugs can have regrown those missing body parts, heart and all.

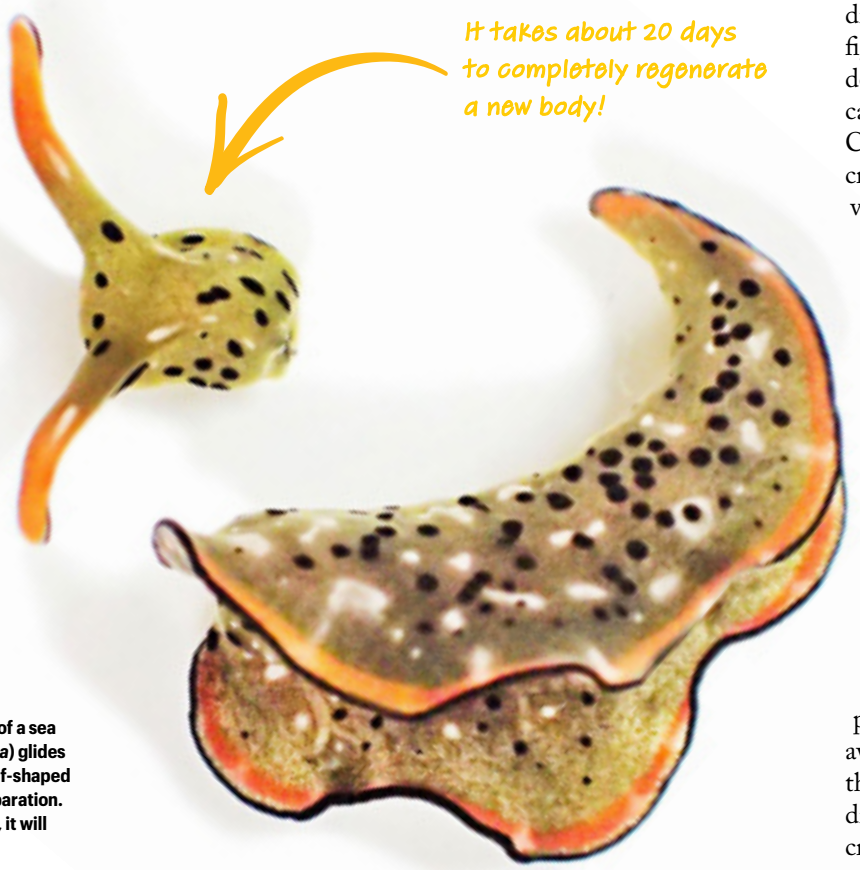
Sayaka Mitoh and Yoichi Yusa are ecologists at Nara Women's University in Japan. They described the regrowth of slug bodies in *Current Biology*. "As far as we know," Yusa says, this is the first report of such a dramatic "whole-body" regeneration in any sea slug.

Mitoh first noticed the sea slugs' extreme regeneration by chance. It showed up in some *Elysia* slugs in the lab. "We were really surprised to see the head crawling," Yusa says. The head of a sea slug can take several hours to rip itself loose from its body. That's so slow that Mitoh and Yusa don't think the move helps slugs escape predators.

Instead, a detachable body could give the sea slug a drastic, but effective, way of fighting parasites. A bit like dogs getting fleas, sea slugs can be plagued by copepods. Copepods are tiny cousins of crabs and shrimp. Lifestyles vary, but some copepods attach themselves to sea slugs.

Mitoh monitored 82 *E. atroviridis* slugs infested with copepods. Three of the slugs ditched their bodies along with a lot of those copepods. Two of the three managed to grow a new body. Another 39 of the parasitized slugs let parts of their bodies slowly fall away. In contrast, 64 sea slugs that had been collected at the same time had no pests. And none of them threw away its body. That supports the idea that parasites could drive slug heads to detach and crawl away from their bodies.

— *Susan Milius*



The detached head of a sea slug (*E.* cf. *marginata*) glides by its still-living, leaf-shaped body a day after separation. If the head survives, it will grow a new body.

S. MITOH

Think you know what you're seeing? Find out on page 32

PLUTO PRESENTS A PLANETARY PUZZLE

Even astronomers can't agree what to call this distant orb >>

By **Lisa Grossman**

MARK GARLICK/SCIENCE PHOTO LIBRARY/ALAMY STOCK PHOTO

For 76 years, Pluto was the beloved ninth planet. No one cared that it was the runt of the solar system, with a moon half its size. No one minded that it had a tilted, oval-shaped orbit. Pluto was a weirdo, but it was our weirdo.

"Children identify with its smallness," wrote science writer Dava Sobel in her 2005 book *The Planets*. "Adults relate to its … existence as a misfit." People felt protective of Pluto.

So it was perhaps not surprising that there was public uproar when Pluto was relabeled a dwarf planet more than a decade ago. The International Astronomical Union, or IAU, redefined "planet." And Pluto no longer fit the bill.

This new definition required a planet to do three things. First, it must orbit the sun. Second, it must have enough mass for its own gravity to mold it into a sphere (or close). Third, it must have cleared the space around its orbit of other objects. Pluto didn't pass the third test. Hence: dwarf planet.

"I believe that the decision taken was the correct one," says Catherine Cesarsky. She was president of the IAU in 2006. She's currently an astronomer at CEA Saclay in France. "Pluto is very different from the eight solar-system planets," she says. Plus, in the years leading up to Pluto's reclassification, astronomers had discovered more objects beyond Neptune that were similar to Pluto. Scientists either had to add many new planets to their list or remove Pluto. It was simpler to just give Pluto the boot.

"The intention was not at all to demote Pluto," Cesarsky says. Instead, she and others wanted to promote Pluto as one of an important new class of objects — those dwarf planets.

Some planetary scientists agreed with that. Among them was Jean-Luc Margot at the University of California, Los Angeles. Making it a dwarf planet was "a triumph of science over emotion. Science is all about recognizing that earlier ideas may have been wrong," he said at the time. "Pluto is finally where it belongs."

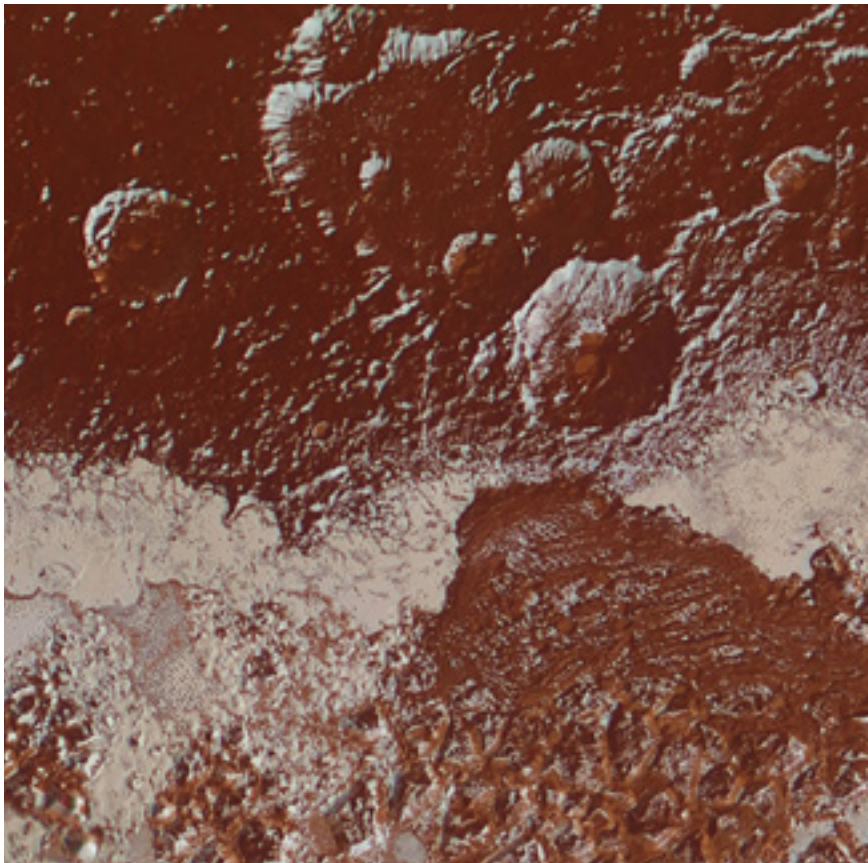
Others have disagreed. Planets should not have to clear their orbits of other debris, argues Jim Bell. He's a planetary scientist at Arizona State University in Tempe. An object's ability to cast out debris does not just depend on the body itself, Bell says. So that shouldn't disqualify Pluto. Everything with interesting geology should be a planet, he says. That way, "it doesn't matter where you are, it matters what you are."

Pluto certainly has interesting geology. Since 2006, we've learned that Pluto has an atmosphere and maybe even clouds. It has mountains made of water ice, fields of frozen nitrogen and methane snow-capped peaks. It even sports dunes and volcanos. That fascinating and active geology rivals any rocky world in the inner solar system. To Philip Metzger, this confirmed that Pluto should count as a planet.

"There was an immediate reaction against the dumb [IAU] definition," says Metzger. He's a planetary scientist at the University of Central Florida in Orlando. But science runs on evidence, not instinct. So Metzger and colleagues have been gathering evidence for why IAU's definition of "planet" feels so wrong.

In 2015, NASA's New Horizons spacecraft offered the first close-up views of Pluto's surface, including this landscape (below), which includes blocky mountains (upper right), craters (lower right) and the gray-white frosting of methane ice.

BELOW: NASA/JHUAPL/SWRI



TOMBAUGH: GL ARCHIVE/ALAMY; TOP: ARI GEA/SAYOSTUDIO

The Kuiper Belt (above) can be found on the outskirts of our solar system. Pluto is one of more than 3,000 objects that astronomers have spotted there.

The rise and fall of Pluto

For centuries, the word "planet" was much more inclusive. When Galileo turned his telescope on Jupiter in the 1600s, any large moving body in the sky was considered a planet. That included moons. In the 1800s, when astronomers discovered the rocky bodies now called asteroids, they called those planets, too.

Pluto was seen as a planet from the very beginning. Amateur astronomer Clyde Tombaugh first spotted it in telescope photos taken in January 1930. At the time, he was working at the Lowell Observatory in Flagstaff, Ariz. Upon his discovery, Tombaugh rushed to the observatory director. "I have found your Planet X," he declared. Tombaugh was referring to a ninth planet that had been predicted to orbit the sun beyond Neptune.

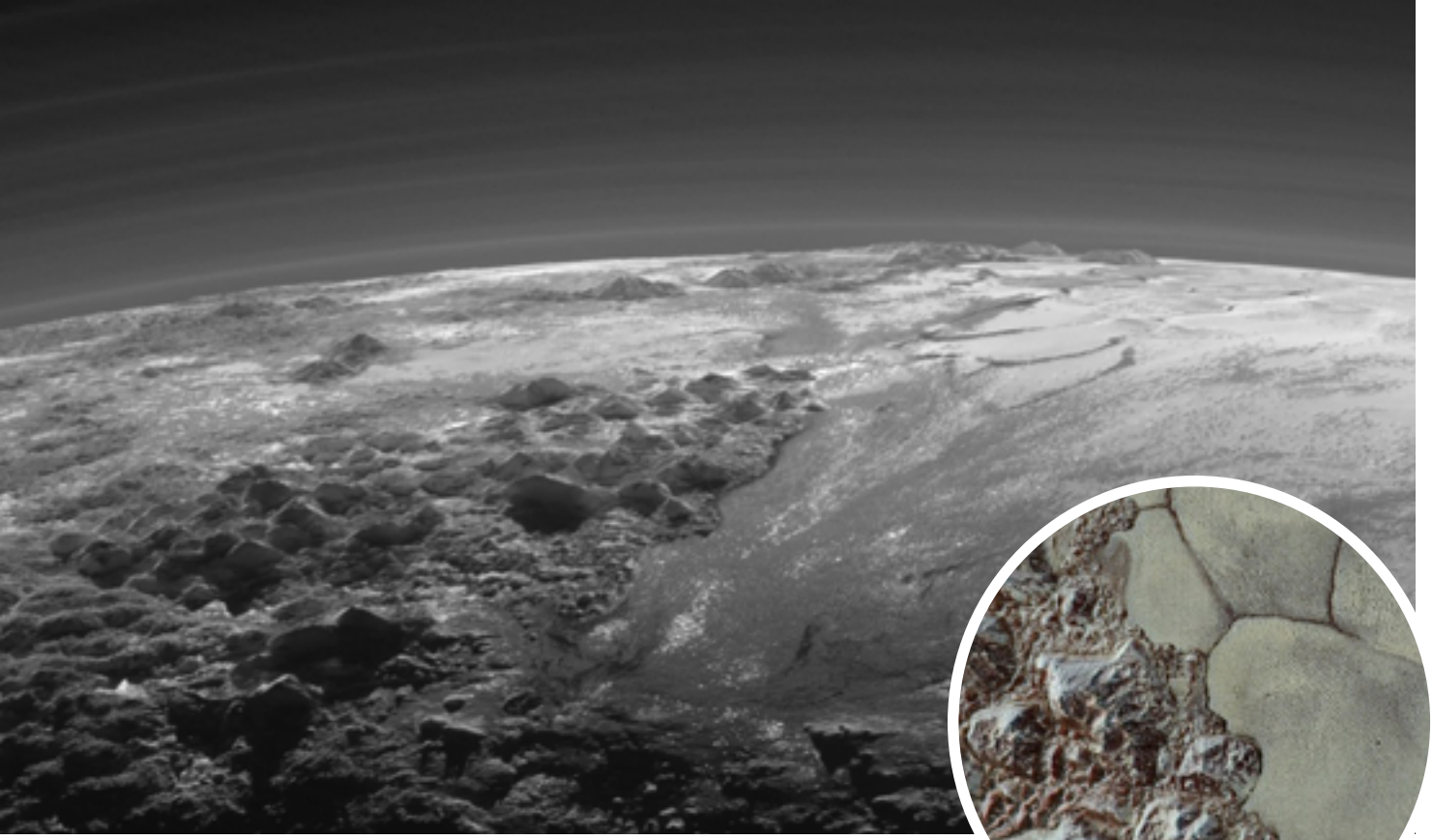
But things got weird when scientists realized Pluto wasn't alone out there. In 1992, an object about a tenth as wide as Pluto was seen orbiting out beyond it. More than 2,000 icy bodies have since been found hiding in this frigid outskirt of the solar system known as the Kuiper Belt. And there may be many more still.

Finding that Pluto had so many neighbors raised questions. What did these strange new worlds have in common with more familiar ones? What set them apart? Suddenly, astronomers weren't sure what truly qualified as a planet.

Mike Brown is a planetary scientist at the California Institute of Technology in Pasadena. In 2005, he spotted the first Kuiper Belt body that appeared larger than Pluto. It was nicknamed Xena, in honor of the TV show *Xena: Warrior Princess*. This icy body was left over from the formation of the solar system. If Pluto was the ninth planet, Brown argued, then surely Xena should be the 10th. But if Xena didn't deserve the title of "planet," Pluto shouldn't either.

Tensions over how to categorize Pluto and Xena came to a head in 2006. The drama peaked at an IAU meeting held in Prague, the capital of the Czech Republic. On the final day of the August meeting, and after much heated debate, a new definition of "planet" was put to a vote. Pluto and Xena were deemed dwarf planets. Xena was renamed Eris, the Greek goddess of discord. A fitting title, given its role in upsetting our concept of the solar system. On Twitter, Brown goes by @plutokiller, since his research helped knock Pluto off its planetary pedestal.

Amateur astronomer Clyde Tombaugh poses with a homemade telescope. He discovered Pluto in 1930 when he was 24 years old.



Close views of Pluto show the rugged water-ice mountains that border cells of nitrogen ice.

NASA's New Horizons spacecraft revealed that Pluto has an icy landscape (above), covered in rugged mountains (left) and smooth plains (right).

BOTH: NASA/JHUAPL/SWRI

Messy definitions

Right away, textbooks were revised and posters reprinted. But many planetary scientists — especially those who study Pluto — never bothered to change. "Planetary scientists don't use the IAU's definition in publishing papers," Metzger says. "We pretty much just ignore it."

In part, that might be sass or spite. But Metzger and others think there's also good reason to reject IAU's definition of "planet." For a pair of research papers, the scientists examined hundreds of scientific papers, textbooks and letters. Some of the documents dated back centuries. They show that how scientists and the public have used the word "planet" has changed many times. And why was often not straightforward.

Consider Ceres. This object sits in the asteroid belt between Mars and Jupiter. Like Pluto, Ceres was considered a planet after its 1801 discovery. It's often said Ceres lost its planethood after astronomers found other bodies in the asteroid belt. By the end of the 1800s, scientists knew Ceres had hundreds of neighbors. Since Ceres no longer appeared special, the story goes, it lost its planetary title.

In that sense, Ceres and Pluto suffered the same fate. Right?

That's not the real story, Metzger's team reported. Ceres and other asteroids were considered planets — albeit "minor" planets — well into the 20th century. The term "minor planets" only fell out of fashion in the 1960s. That's when spacecraft got a closer look at them. The largest asteroids still looked like planets. Most small ones, however, turned out to be weird lumps. This provided evidence that they were fundamentally different than the bigger, rounder planets. The fact that asteroids didn't clear their orbits had nothing to do with their name change.

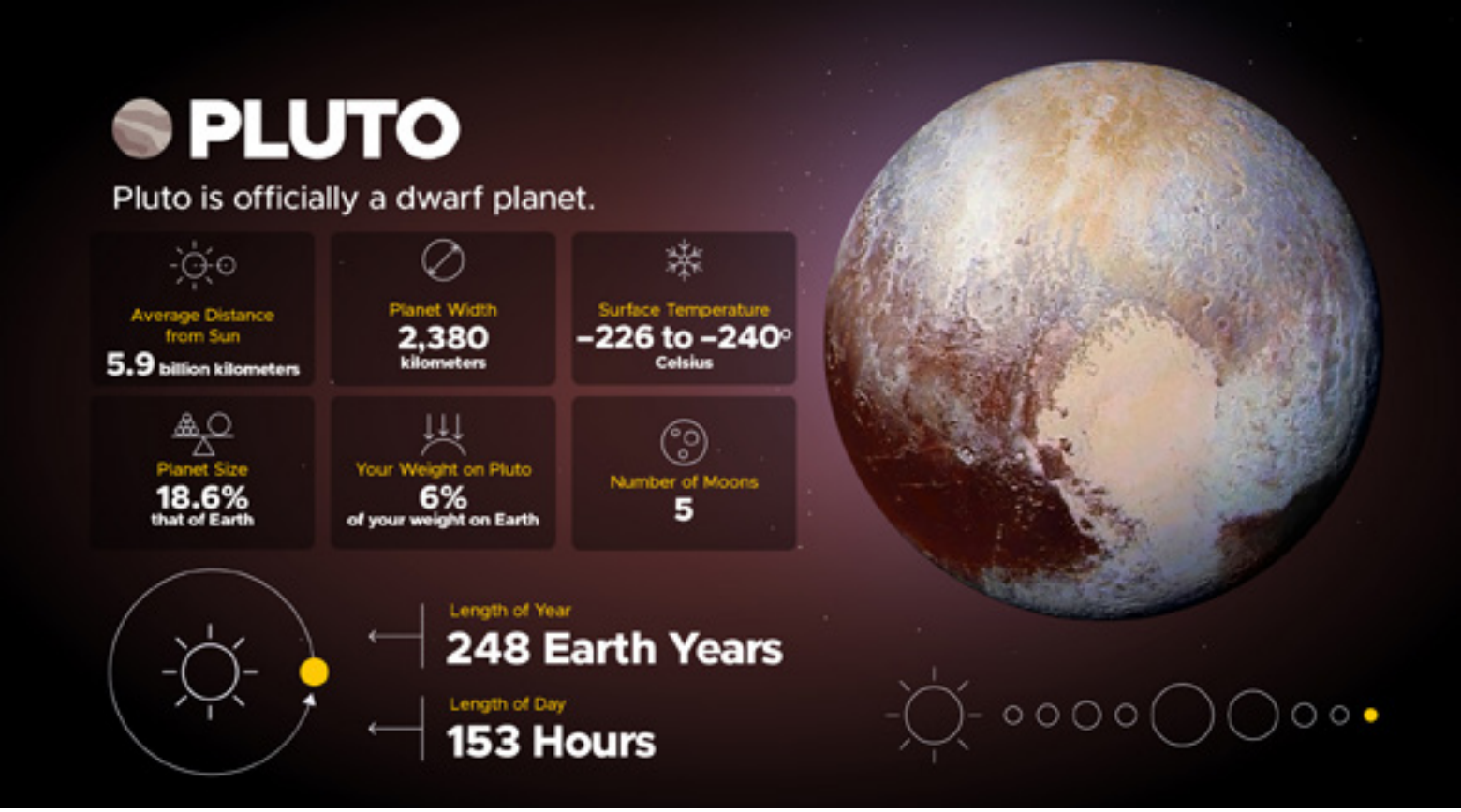
And what about moons? Scientists called them "planets" or "secondary planets" until the 1920s. Surprisingly, people didn't stop calling moons "planets" for scientific reasons. The change was driven by nonscientific publications, such as astrological almanacs. These books use the positions of celestial bodies for horoscopes. Astrologers insisted on the simplicity of a limited number of planets in the sky.

But new data from space travel later brought moons back into the planetary fold. Starting in the 1960s, some scientific papers again used the word "planet" for objects orbiting other solar system bodies — at least for some large round ones, including moons.

In short, the IAU definition of "planet" is just the latest in a long line. The word has changed meanings many times, for many different reasons. So there's no reason why it couldn't be changed once more.

Real-world usage

Defining "planets" to include certain moons, asteroids and Kuiper Belt objects is useful, Metzger argues. Planetary science includes places like Mars (a planet), Titan (one of Saturn's moons) and Pluto (a dwarf planet). All these places have extra



Read More

The Planets Are Very, Very, Very Far Away

A Journey Through the Amazing Scale of the Solar System

—by Mike Vago

Did you know that it takes about three days for a spacecraft to reach our moon? That's about 80,000 miles a day! Learn more about the size of our solar system in this guide packed with expandable diagrams and a few laughs.

INFOGRAPHIC: PK DESIGNS/SHUTTERSTOCK; PLUTO: NASA

complexity that arises when rocky worlds get big enough to become spherical. Examples of that complexity span from mountains and atmospheres to oceans and rivers. It's scientifically useful to have an umbrella term for such complex worlds, Metzger says.

"We're not claiming that we have the perfect definition of a planet," he adds. Nor does Metzger think everyone need adopt his. That's the mistake the IAU made, he says. "We're saying this is something that ought to be debated."

A more inclusive definition of "planet" might also give a more accurate concept of the solar system. Emphasizing eight major planets suggests they dominate the solar system. In fact, the smaller stuff greatly outnumbers those worlds. The major planets don't even stay in fixed orbits over long time scales. Gas giants, for instance, have shuffled around in the past. Viewing the solar system as just eight unchanging bodies may not do that complexity justice.

Brown (@plutokiller) disagrees. Having the gravitational oomph to nudge other bodies around is an important feature of a planet, he argues. Plus, the eight planets clearly dominate our solar system. "If you dropped me in the solar system for the first time, and I looked around … nobody would say anything other than, 'Wow, there are these eight — choose your word — and a lot of other little things.'"

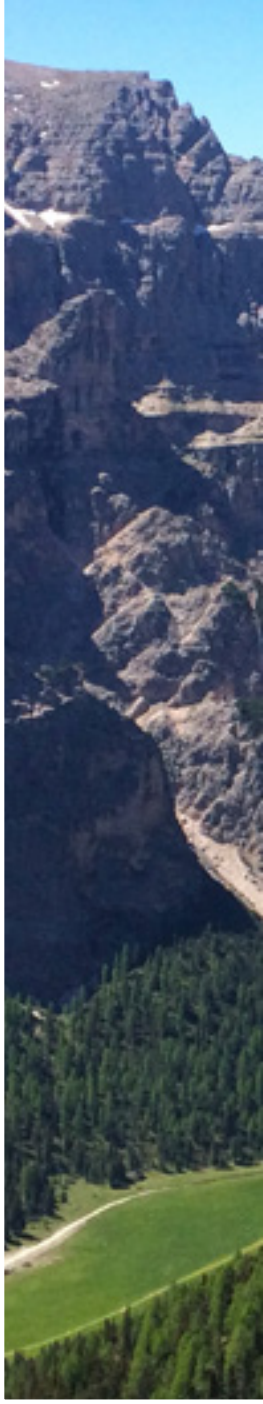
One common argument for the IAU definition is that it keeps the number of planets manageable. Can you imagine if there were hundreds or thousands of planets? How would the average person keep track of them all? What would we print on lunch boxes?

But Metzger thinks counting just eight planets risks turning people off to the rest of space. "Back in the early 2000s, there was a lot of excitement when astronomers were discovering new planets in our solar system," he says. "All that excitement ended in 2006."

Yet many of those smaller objects are still interesting. Already, there are at least 150 known dwarf planets. Most people, however, are unaware, Metzger says. Indeed, why do we need to limit the number of planets? People can memorize the names and traits of hundreds of dinosaurs or Pokémon. Why not planets? Why not inspire people to rediscover and explore the space objects that most appeal to them? Maybe, in the end, what makes a planet is in the eye of the beholder.

This physicist hopes to shake up our understanding of space

Adeene Denton studies asteroid impacts to better understand the planets in our solar system



Simulating an asteroid impact on distant Pluto is all part of a typical day for Adeene Denton. The PhD student studies planetary geoscience at Purdue University in West Lafayette, Ind. As an impact physicist, Denton wants to know what these cosmic smashups can reveal about planets.

NASA's New Horizons spacecraft flew by Pluto in 2015, about the same time that Denton started her PhD program. The mission offered scientists the first close-up views of the dwarf planet — and sparked a lot of questions. Denton was hooked. And ever since, she has been using a mix of geology, astrophysics and coding to learn even more about this mysterious dwarf planet. In this interview, she shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper*

Q What inspired you to pursue this particular career?

A I think a lot of scientists will say that they were really interested in astronomy or STEM from a young age. That they loved math and science. And I, actually, really didn't. When I went to college, I entered as a history major. I took an introductory geophysics class just out of curiosity. And I realized geology is really just history but on a vastly different timescale.

Q What's one of your biggest successes in your career?

A I published a paper last year that was quite symbolic of what I like about science, which is people coming together to answer a question and bringing their own expertise. I just happened to run into the head of the New Horizons mission. He had been revisiting photos of the far side of Pluto taken by New Horizons. He was interested in how what he was seeing in the photos could be related to the giant

Right: Adeene Denton (above, in the Dolomite Mountains of Italy) was motivated to study geology after an inspiring course in college. That led to a career studying the geology of faraway Pluto.

crater that's on the other side of Pluto. If you hit a planet on one side, you could maybe make something happen on the other side. I thought it was a wild idea. But I found that that is actually what happens: You can hit Pluto on one side and make a massive canyon on the other.

Q What do you like to do in your spare time?
A I am a dancer and a choreographer. How I approach physics is very much the way I approach dance. To dance, you have to have a very clear understanding of how your body moves in space. But also how your body creates negative space. The shapes that you can make with your bodies — like making a hole with your arm. So it's a way to be physically creative that lets me go back to my work and think about it differently.

Q What piece of advice do you wish you had when you were younger?
A I wish that someone had told me that there is so much more to science than what's shown to us in the media. If you find something interesting, there will always be a way to try to answer those questions. There will be a way to use the skills that you have and develop new ones to explore in a way that is interesting and useful.

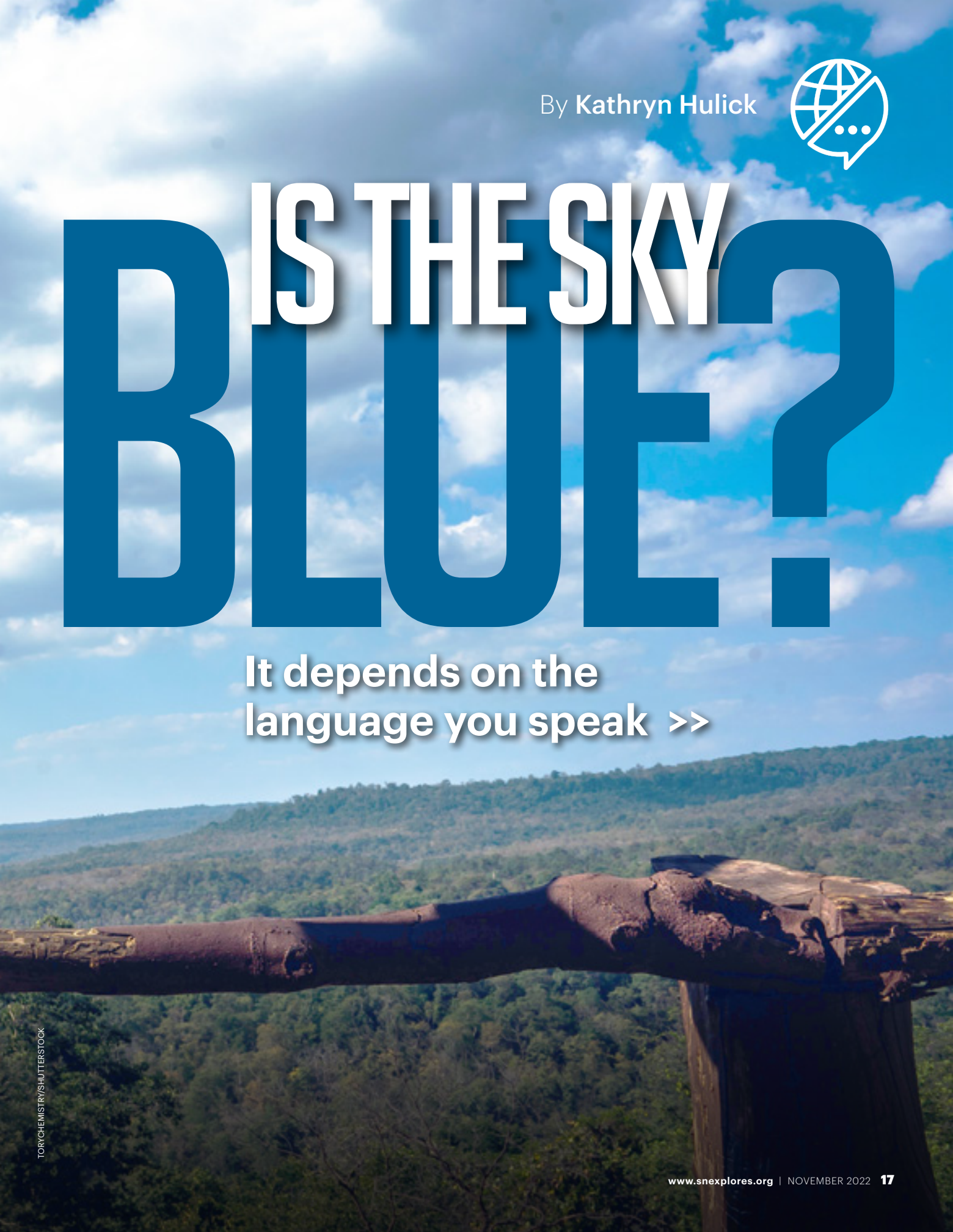
ALL: A. DENTON

TK

By **Kathryn Hulick**

IS THE SKY BLUE?

It depends on the language you speak >>



TORYCHEMISTRY/SHUTTERSTOCK

BUGHAW (Tagalog)

AZRAQ (Arabic)

GOLUBOY (Russian)

ACHA ANỤNỤ ANỤNỤ (Igbo)

What color is the sky? What about the ocean, grass or bananas? These may seem like simple questions with easy answers. The sky is blue. So is the ocean. Grass is green. Bananas are yellow.

If you speak English, this is all obvious. But what if you speak a different language? Your answers to these kinds of questions may change in surprising ways — and not just because the words you use sound different.

In Kyrgyzstan, a country in Central Asia, a traditional song opens with a line about mountains touching the blue sky. The Kyrgyz word *kok* (pronounced like cook) means blue. Yet people also walk through *kok* grass. "We use *kok* for green color," says Albina Ibraimova, a former English teacher in Bishkek, Kyrgyzstan. Kyrgyz has another word for green, but it's not as common.

Like many Kyrgyz people, Ibraimova also speaks Russian. In Russian, the sky is *goluboy* (GOL-uh-boy). That means "blue." However, Russians would not call the ocean *goluboy*. That color is *siniy* (SEE-nee). *Goluboy* and *siniy* are usually translated as light blue and dark blue. But to a Russian speaker they are as different as pink and red are to someone who speaks English.

Most people share the same type of brain with senses that work the same way. The human eye contains light-detecting cells called rods and cones. Three types of cones capture a vast rainbow of around 1 million different hues. In rare cases, a person may have fewer types of cones than usual. That causes color-blindness. There are also reports of an even rarer condition that adds a fourth type of cone. These people may see many more colors than the rest of us.

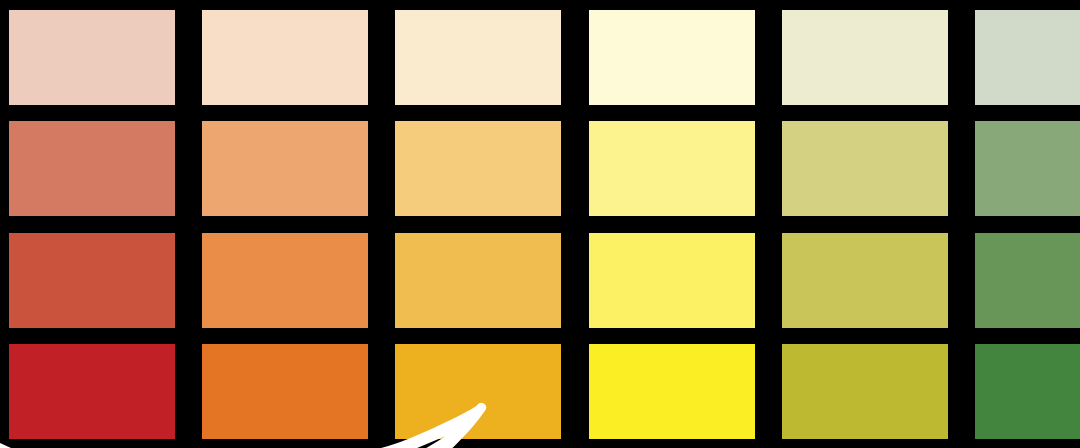
Unless you have one of these rare conditions, it doesn't matter if you speak Kyrgyz or English. You'll see the same shade of sky. You just might name and categorize that color differently than someone who speaks another language. You may similarly name and categorize smells, sounds, directions, family relationships and other experiences differently. Why? And what's going on in the brain when it encounters familiar or unfamiliar categories? Researchers who study languages, psychology and the brain are on the case.

BLUE (English)

KOK (Kyrgyz)

TRY THIS!

Pick any color on this chart. Tell a friend the color's name only, such as "blue" or "orange." How many guesses does it take for your friend to point to the shade you have in mind?



Fun Fact: warm colors should take fewer guesses than cool colors.

Edward Gibson spent time in Bolivia studying how the Tsimane' name colors. They only use words for black, white and red consistently. "They see exactly the same colors we see," says Gibson. They simply don't talk about color very much.

E. GIBSON

Filling in the rainbow

If you look through a box of 64 crayons, you may find creative names for all the colors. But most of them belong to just a few color categories. In English, those basic categories include red, blue and so on. English speakers use these color words for a wide range of shades. A color term like "scarlet" is not basic because it's part of the red category.

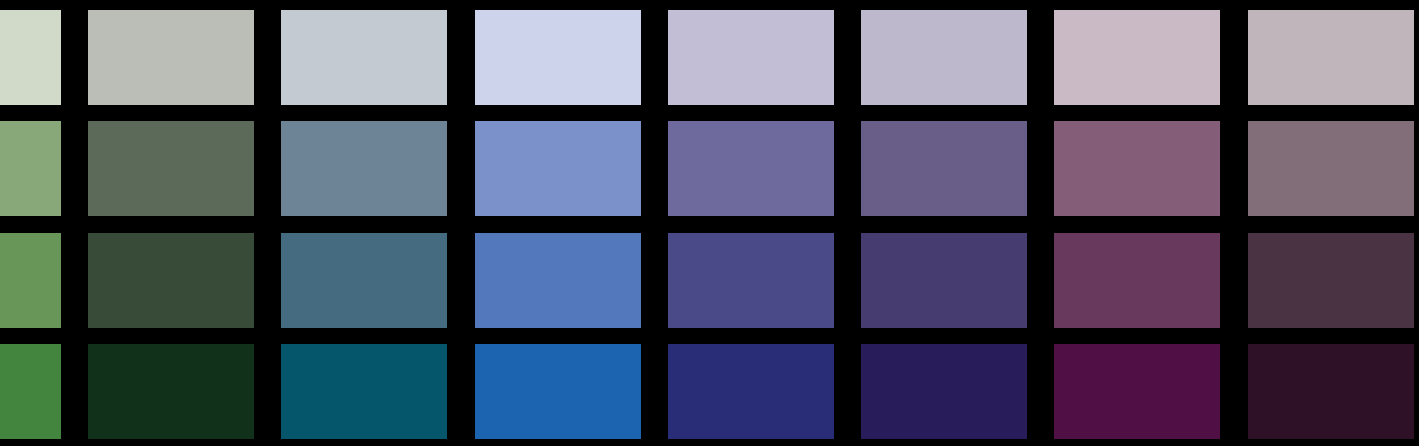
Not all languages have the same set of basic colors, though. Ancient Greek had very few color categories while modern Greek has many. Some languages group colors. An especially common grouping is green with blue, which linguists call "grue." Is there any common trend in the way different cultures talk about color?

In 2017, Bevil Conway and Edward Gibson measured how easy it is for people to communicate colors. Easy color communication, they say, means that when someone says a color name to you, you're both likely to imagine a very similar shade. Conway is a neuroscientist at the National Institutes of Health in Bethesda, Md. Gibson is a cognitive scientist at the Massachusetts Institute of Technology in Cambridge.

"All languages have the same basic structure," says Gibson. "Warm colors are easier to communicate, and cool colors are harder." It didn't matter if a language had two color categories or 10. Names of warm colors, such as pink, red, orange and yellow, tend to cover fewer shades in the color spectrum. People also tend to agree more on which shades should get these names.

Fun Fact: The Berinmo people on the island nation of Papua New Guinea, in the southwestern Pacific, have one word for blue, green and dark colors. But they have two separate words — nol and wor — for shades that English speakers would group together as yellow.

Fun Fact: In 2015, researchers found that British English speakers are using lilac and turquoise as basic colors.



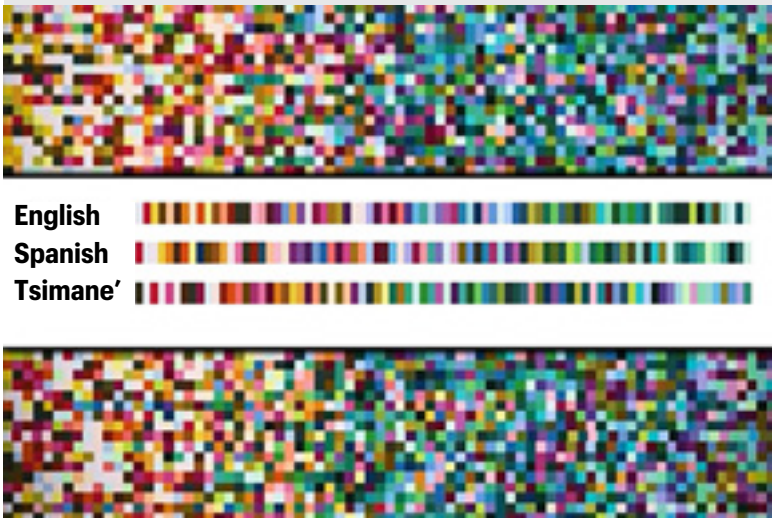
Why? Conway thinks the answer has to do with why people name colors in the first place. Think about bananas. "Bananas aren't yellow," he says. They start out green. The peel eventually turns yellow, but the fruit is white. When they go bad, they turn brown and black. Yellow, he says with excitement, "is the color of bananas that you care about." People name colors, he says, in order to categorize things that are meaningful to them. And people tend to care most about things that they can touch and interact with. That's why warmer colors get a larger number of categories.

The team analyzed 20,000 photographs of natural and artificial objects. The objects tended to be warm-colored. Backgrounds tended to be cool-colored. Blue animals, fruits and flowers are especially rare. "There's lots of blue in the world," says Conway. "But you [often] can't touch it. The sky can't be grasped."

Gibson has spent time with the Tsimane' (Chi-MAH-nay) people, who live in the Amazon rainforest in Bolivia. "They all know black, white and red," he says. They have some words for other colors, but they tend not to agree on what they mean. "They just don't talk about the other colors," says Gibson. For instance, he notes, "What color is the sky?" That's a question they would never ask.

What do you notice about the colors in this chart?

The left side is mostly warm and the right side is mostly cool. Each horizontal line of colors in the chart is a different language. Researchers Bevil Conway and Edward Gibson sorted the shades from left to right based on how easy it is to communicate each one in that language. Around the world, warm colors are easier to talk about than cool colors.



ADAPTED FROM E. GIBSON *ET AL.* COLOR NAMING ACROSS LANGUAGES REFLECTS COLOR USE, *PNAS*

The hidden world of smell

If it seems odd to have no word for the color of the sky, here's a question for you: What does soap smell like?

You may say something like "soapy" or "clean-smelling." You might compare the scent to a place or thing, like "my grandmother's house" or "vanilla." The nose can detect an astonishing 1 trillion different odors. That's way more scents than there are colors! Yet English-speakers rarely talk about them. And when we do, we describe them in very roundabout ways.

For a long time, Western researchers thought the lack of categories for smells was biological. Perhaps the nose wasn't as important as the eyes. Or maybe odor-recognizing parts of the brain couldn't link to the language parts. Many scholars have claimed that "it's impossible to have [a] vocabulary for smells," says Asifa Majid. She is a psychologist at the University of Oxford in England.

Majid conducted a survey of how people who speak different languages talk about the senses with her colleague Niclas Burenhult. He's a linguistics researcher at Lund University in Sweden. They have both spent time in the Southeast Asian nation of Malaysia working with the Jahai. It's a group of hunter-gatherers. "I brought a smell kit to the field," says Burenhult. It was a simple scratch-and-sniff test. Jahai volunteers named all the different scents.

When Majid and Burenhult looked at the results, they were astonished. "The Jahai have got smell language," Majid realized.

The pair reported that the Jahai have at least 12 abstract words for categories of smells. To the Jahai, soap smells *harim* (Ha-RRUM). So do some types of flowers and perfumes. Gasoline, smoke and bat poop all smell *chnges* (Chung-ES). Roasted food smells *chrngir* (Chung-EARR). Many other cooked foods and sweets smell *chngus* (Chung-US). There's even a word for bloody scents that attract tigers, *pl-eng* (Pull-EG-ng). Burenhult says, "They group smells like we group colors." This makes scents much easier to discuss.

Majid and Burenhult tested how people with and without a robust smell language might name the same odors. Groups of 30 Jahai speakers and 30 Dutch speakers sniffed and describe each of 37 scents. Like English speakers, the Dutch have very few abstract words for smells. The Jahai speakers took an average of two seconds to name each smell and used just 22 different names in their responses. The Dutch speakers provided a whopping 707 different names, and their responses took an average of 13 seconds each.

Asifa Majid visited Malaysia to study the smell language of the Jahai. Here, she's sniffing wild ginger.

In one of Majid's Malaysian studies, Jahai people named different scents contained inside smelly markers, nicknamed "Sniffin' sticks."

However, both groups made very similar expressions when sniffing the same scent. There was nothing wrong with the Dutch speakers' noses. They just didn't have categories they could use to describe what they had smelled to others.

Why do some cultures develop a dedicated smell or color vocabulary while others don't? "We don't know," says Burenhult. Most likely, he says, there are multiple reasons. The environment, genetics and cultural or religious practices may all play a role.

Developing an ear for language

Not all languages use the same set of sounds. And sign languages don't use any sounds, just hand movements. Do you know how to say the word for dog in Spanish? It's *perro*. You have to roll the "r" sound. It sounds like the rumble of a cat's purr. That sound doesn't exist in English. Similarly, English has a sound, "l" as in lip, that does not exist in Japanese. There are 44 different sounds in English but a whopping 800 distinct sounds in all the world's languages.

A newborn baby's brain pays equal attention to all language sounds. Over the first few months of life, the brain changes. It learns to pay special attention to sounds common in your native tongue, says Nina Kraus. She is a neuroscientist at Northwestern University in Evanston, Ill. By the time you're walking and talking, your brain is no longer paying attention to unfamiliar language sounds. In a sense, says Kraus, "you're deaf to these sounds." As a result, a Japanese speaker may mix up the English words lip and rip. Similarly, an English speaker may have trouble hearing any difference between the two Hindi letters, "ਡ" (dah) and "ਢ" (dha), because English has just one dah sound.

Anyone can learn to speak any language. That means anyone can learn new categories for smells or colors or sounds, just as Burenhult learned the Jahai smell vocabulary. Learning or studying new languages "opens up a world of possibility," adds Majid. "We think the world is one way," she says, but maybe it's only that way because that's how we tend to talk about it. Other cultures could be talking about things totally differently. Instead of using words for left and right, some cultures use only north, south, east and west. So someone might say, "your east shoe is untied." Other cultures use one word for both older sister and aunt, and another word for both younger sister and niece.

So is the sky blue? The answer depends on what "blue" means to you — in your culture and in your language.

BOTH: N. BURENHULT

CHEMISTRY

Build ice towers with bottled water and ice

Add cold water and salt to create your own mini ice castle

By Bethany Brookshire

If you pour extremely cold, purified water (less than 0° Celsius or 32° Fahrenheit) onto an ice cube, that cube acts as a nucleation point. That's a place where ice crystals can self-assemble. The water will freeze when it hits the cube and then stack up — forming a tower of ice. If the water isn't cold enough, though, you just get a lonely ice cube in a puddle of water. How do you get supercold water? The secret is salt.

HYPOTHESIS

Water chilled in ice with salt will be colder and form taller ice towers than water chilled in water without salt.

METHOD

1. Fill two smaller coolers with ice. Add 700 grams of salt (24.7 ounces, or about 2.5 cups) to one cooler and mix well.
2. Sink eight bottles of purified water into each cooler. Wait 25 minutes.
3. Gently rotate the bottles without shaking them. Wait another 20 minutes.
4. Take the temperature of the ice mixtures in each cooler.
5. Place an ice cube on a plate. Measure the height of the cube with a ruler.
6. Carefully remove a bottle of water and open it. Gently and slowly pour a small, steady stream of water onto the ice cube. After a second or two, the water will begin to freeze on top of the cube, producing an ice tower.
7. Quickly whip out a ruler and get the height of the ice tower before it melts.
8. Repeat for all 16 bottles.

DID YOUR DATA SUPPORT YOUR HYPOTHESIS?

Find out how to analyze your data and more, at snexplores.org/ice-tower

BOTTOM: KOYA979/SHUTTERSTOCK; TOP: JULIA-ART/SHUTTERSTOCK

Double Puzzle

The words in this puzzle all come from this issue's many space stories. Unscramble the letters to fill in the words on the right. Then transfer the numbered letters to the corresponding boxes below to decode the secret message.

AGYLAX						16				
OSOERNAMTR					7	8		17		
IYWLAKMY	14	23							18	
SASRT			10							
LUPTO				9						
JMBSWAEBE					1					
WRFDA			15							
EPLNAT				12	5					
SERCE	4	21	22	24	13					
RBOIT				11	20					
LPEOESETC					25	6		2		
IGATVRY			3							
ESLLIEP						19				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8	16

17	18	19	20	21	22	23	24	25

SVEKLOID/SHUTTERSTOCK

COMPUTERS

Facial expressions could be used to interact in virtual reality

This technology would allow people who can't use handheld controllers to play virtual games

When someone pulls on a virtual reality headset, they're ready to dive into a simulated world. They might be hanging out in VRChat or slashing beats in Beat Saber. Regardless, interacting with that world usually involves hand controllers. But new virtual reality — or VR — technology out of Australia is hands-free. Facial expressions allow users to interact with the virtual environment.

This setup could make virtual worlds more accessible to people who can't use their hands, says Arindam Dey. He studies human-computer interaction at the University of Queensland in Brisbane. Other hands-free VR tech has let people move through virtual worlds by using treadmills and eye-trackers. But not all people can walk on a treadmill. And most people find it a challenge to stare at one spot long enough for the VR system to register the action. Simply making faces may be an easier way for those who are disabled to navigate VR.

Facial expressions could enhance the VR experience for people who can use hand controllers, too, Dey adds. They can allow "special interactions that we do with our faces, such as smiling, kissing and blowing bubbles."

Dey's team shared its findings in the *International Journal of Human – Computer Studies*.

FACING OFF WITH NEW TECHNOLOGY

In the researchers' new system, VR users wear a cap studded with sensors. Those sensors record brain activity. The sensors can also pick

PHOTOCREO MICHAL BEDNAREK/SHUTTERSTOCK

A. DEY/UNIVERSITY OF QUEENSLAND

Participants used three facial expressions (above) — a smile, a frown and clenched teeth — to interact with their virtual environment.

up facial movements that signal certain expressions. Facial data can then be used to control the user's movement through a virtual world.

Dey's team designed three virtual environments for users to explore. One required participants to catch butterflies with a virtual net. Another had them picking up items in a workshop. In a third, they had to shoot zombies.

Eighteen young adults tested out the technology. Half of them learned to use three facial expressions to move through the virtual worlds. A smile walked them forward. A frown brought them to a stop. And to perform a task — swooping a butterfly net, picking up an item or shooting a zombie — they clenched their teeth. The other half of participants interacted with the virtual worlds using hand controllers.

After some training, participants spent four minutes in each of the virtual worlds. After visiting each world, participants answered questions about their experience: How easy was their controller to use? How "present" did they feel in that world? How real did it seem? And so on.

Using facial expressions made participants feel more present inside the virtual worlds. But expressions were more challenging to use than hand controllers. Recordings from the sensor-laden cap showed that the brains of people using facial expressions were working harder than those who used hand controllers. But that could just be because these people were learning a new way to interact in VR. Perhaps the facial expression method would get easier with time.

WORK TO BE DONE

"This research pushes the boundary of hands-free interaction in VR," says Wenge Xu. He studies human-computer interactions at Birmingham City University in England. He was not involved with the study. But "further research is needed to improve the usability of facial expression–based input."

Dey does plan to explore ways to make interacting through facial expressions easier. That may involve swapping out the sensor-laden caps for some other face-reading technology. One idea: "Use cameras that capture face movements or facial gestures," he says. Or sensors could be embedded in the foam cushion of a VR headset. Dey imagines one day people will train VR systems using their own sets of expressions.

"Technology has helped me along the way [in a] world that wasn't necessarily made for me," says Tylia Flores. As a person with cerebral palsy, standard methods of interaction aren't always available to her. She feels the new technology could make VR more accessible for people whose physical movements are limited.
— *Alison Pearce Stevens*

CHEMISTRY

Could we make vibranium?

The 'perfect' metal may be fictitious, but scientists hope we can mimic some of its key characteristics

In the fictional Marvel universe, an element called vibranium can do many things. The fantastical metal makes up Captain America's near-impenetrable shield. It gives Black Panther superpowers. It also helps the futuristic African society of Wakanda run. There are shiny, metallic skyscrapers with blue neon lights. Flying vehicles that can shoot lasers. Video calls with 3-D holograms.

And all of this is due to that near-magical substance. A meteorite brought it to Wakanda long ago.

No one has discovered vibranium on Earth, of course. And scientists say that finding something similar is a long shot. However, mimicking some of the fabulous substance's superpowers might be a possibility.

WHAT IS VIBRANIUM?

Vibranium's key traits line up with our definition of metals, says Darryl Boyd. He's a chemist at the U.S. Naval Research Laboratory in Washington, D.C. And as a Black Panther fan, Boyd has thought a lot about vibranium. Metals, he notes, should be able to conduct heat and electricity. They also should be shiny and something that can be molded into sheets or pulled into wires.

"You can argue that you see all five [of those traits] throughout the various Marvel representations of vibranium," Boyd says. But the three that stick out to him are vibranium's strength, conductivity and luster.

In Wakanda, people use vibranium in medicine, electrical circuitry, fabrics, jewelry, communications and more. "The city transportation system runs by vibranium. And that implies pretty heavily that there's some kind of conductive nature," Boyd says. "So this again, is consistent with what we know about the properties of metals."

It also looks shiny, bright and very regal. This is similar to other metals that can shine in brilliant colors, such as gold and silver.

WHAT IS THE CLOSEST THING WE HAVE TO VIBRANIUM?

"There's no perfect element" — at least on Earth, notes Sibrina Collins. She's a chemist at the Marburger STEM Center at Lawrence Technological University in Southfield, Mich. But Wakanda's vibranium "seems to be the perfect element," she says. In that land, it "can be used for absolutely everything." In fact, she notes, it "has aspects of various elements on a periodic table." In other words, there may not be one substitute for vibranium. But many elements, combined, might fit the bill.

For instance, Boyd says, like titanium, vibranium is strong. It's also got the shine of silver or platinum and electrical conductivity similar to copper. He concludes that vibranium "represents [a mashup] of the best properties of the metals that we know of."

Collins also compares vibranium to platinum because of its use as medicine in *Black Panther*. Platinum may not be the cure-all that vibranium is. But it is a part of some drugs used to treat cancer, such as cisplatin.

IF VIBRANIUM WERE REAL, WHERE WOULD IT GO ON THE PERIODIC TABLE?

Having traits of so many metals makes it difficult to pin down where vibranium could go on the periodic table of elements. Collins suggests it would be in what's known as the D or F blocks. These elements appear in the table's middle and very bottom. Collins notes this is also where many of the metals are that go into computers and other tech.

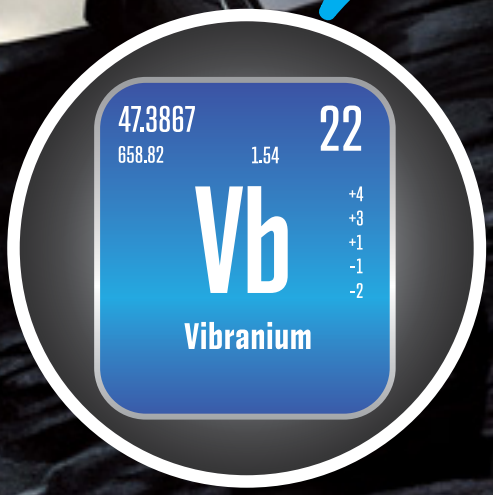
The periodic table typically groups elements with similar properties. If Boyd were to add vibranium to the table, he'd create another row and place it under uranium and neodymium.

"Neodymium is used in magnets," he points out. "It's in almost all your computers." In fact, he argues, "It's an incredibly important element that people don't talk enough about."

The movies also suggest vibranium is radioactive. That would make it similar to uranium. It's an element used to generate

The Black Panther gets their superpowers from a mystical herb, but they get help from a supersuit woven with vibranium.

Chemists have dreamt up what vibranium might look like on the periodic table.



nuclear power. "If [Black Panther or Killmonger] were too close to the train tracks, then their suits became ineffective. And that suggests to me that there's some characteristics there — within the vibranium — that can alter behavior in a way that might be similar to radioactivity."

COULD WE EVER MAKE VIBRANIUM?

It's unlikely any one material could perfectly mimic vibranium. But scientists could use other metals to do some of what vibranium can. Collins is interested in how vibranium was used to heal a gunshot wound. And she wonders if other metals, too, might be used in the hospital or in different drugs.

Boyd agrees that making vibranium or something similar is unlikely. "But do I think there are some aspects that may exist that we could explore in the future — and maybe make it a reality? I do think so."

It might just take some imagination to get there.
— *Anil Oza*

BLACK PANTHER: 7E ART/MARVEL STUDIOS/WALT DISNEY PICTURES/PHOTO 12/ALAMY STOCK PHOTO; VIBRANIUM ILLUSTRATION: STEVE MCCRACKEN

SPACE

Even orbits have laws

The paths of planets, moons and other objects in the sky follow rules

Even in ancient times, stargazers knew that planets differed from stars. While stars always appeared in the same general place in the night sky, planets shifted their positions from night to night. They appeared to move across the backdrop of stars. Sometimes, planets even appeared to move backward. (This behavior is known as retrograde motion.) Such strange movements across the sky were hard to explain.

Then, in the 1600s, Johannes Kepler identified mathematical patterns in the planets' movements. Astronomers before him had known that the planets orbited, or moved around the sun. But Kepler was the first to describe those orbits — correctly — with math. As if putting together a jigsaw puzzle, Kepler saw how the pieces of data fit together. He summed up the math of orbital motion with three laws:

1. The path a planet takes around the sun is an ellipse, not a circle. An ellipse is an oval shape. This means that sometimes a planet is closer to the sun than at other times.

2. A planet's speed changes as it moves along this path. The planet speeds up when passing closest to the sun and slows as it gets farther away from the sun.

3. Each planet orbits the sun at a different speed. The more distant ones move more slowly than those closer to the star.

Kepler still couldn't explain why planets follow elliptical paths and not circular ones. But his laws could predict planets' positions with incredible accuracy. Then, about 50 years later, physicist Isaac Newton explained the mechanism for why Kepler's laws worked: gravity. The force of gravity attracts objects in space to each other — causing the motion of one object to continually bend toward another.

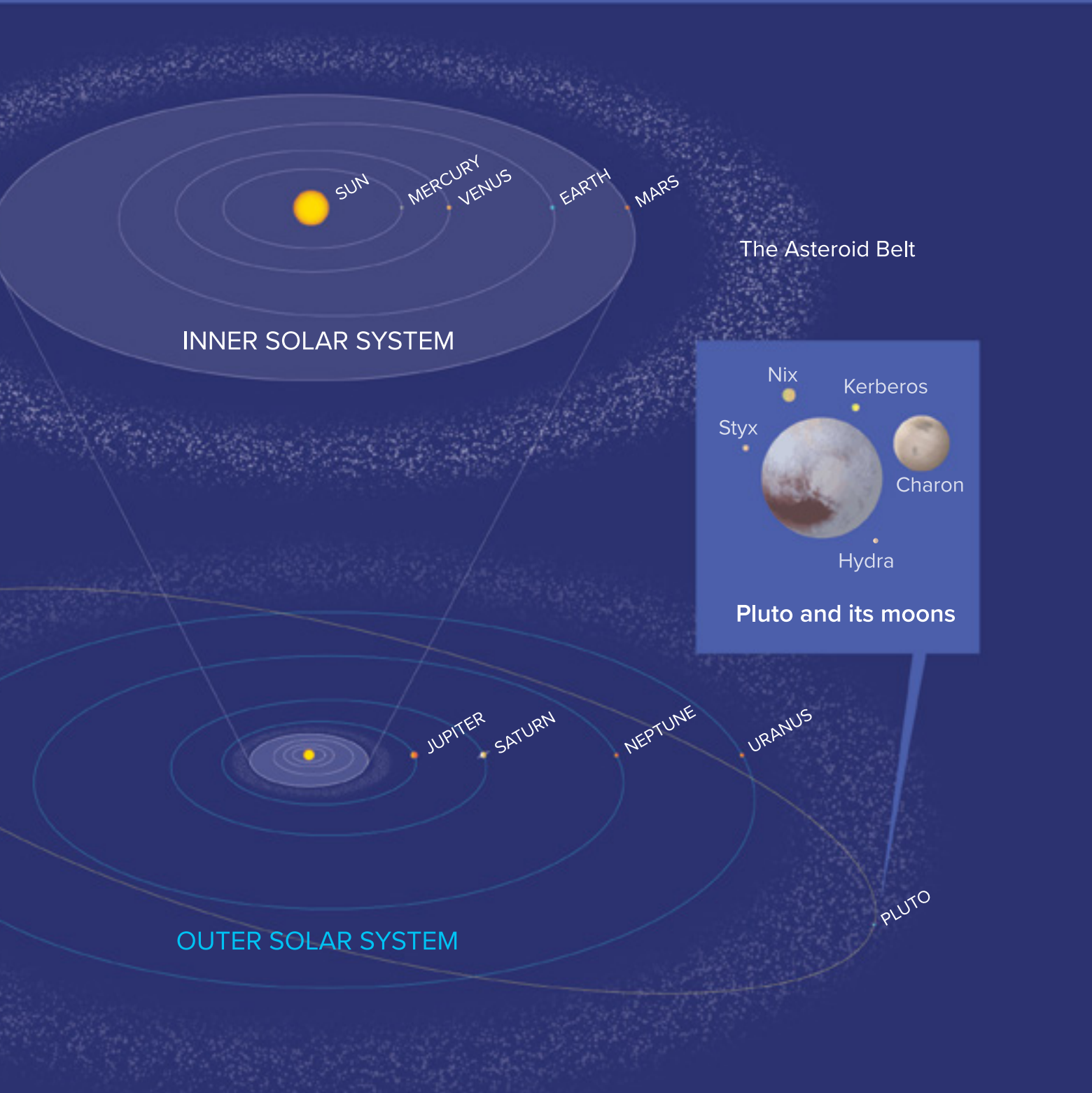
Throughout the cosmos, all sorts of celestial objects orbit each other. Moons and spacecraft orbit planets. Comets and asteroids orbit the sun — even other planets. Our sun orbits the center of our galaxy, the Milky Way. Galaxies orbit each other, too. Kepler's laws describing orbits hold true for all these objects across the universe.

— *Trisha Muro*

While all eight planets orbit the sun on the same plane (planets and orbits not drawn to scale), the dwarf planet Pluto's orbit is inclined by 17 degrees and more oval-shaped. But Pluto and its moons all follow the same rules of orbits that other celestial bodies do.

ILLUSTRATION: STEVE MCCRACKEN

MERCURY
VENUS
EARTH
MARS
CERES
JUPITER
SATURN
NEPTUNE
URANUS
PLUTO
ERIS


SUN
MERCURY
VENUS
EARTH
MARS
The Asteroid Belt
INNER SOLAR SYSTEM
Nix
Kerberos
Styx
Charon
Hydra
Pluto and its moons
JUPITER
SATURN
NEPTUNE
URANUS
PLUTO
OUTER SOLAR SYSTEM

OCEANS

Corals stash microplastics in their skeletons

Worldwide, corals may store millions of kilograms of plastic

Plastic pollution is piling up all over Earth and entering the oceans. That includes tiny bits called microplastics. These are pieces about the size of a grain of rice or smaller. Now, researchers have found that corals stash a surprising amount of those tiny plastic shreds in their tissues and skeletons.

Researchers had seen some corals munching on plastics before. But it wasn't clear if that's the only way plastics get into corals and whether corals hang onto plastic for a long time. The new finding could help explain why less plastic is seen floating in seawater than the millions of metric tons thought to pollute the ocean each year.

Jessica Reichert is an ecologist at Justus Liebig University Giessen in Germany. In the lab, Reichert's team grew four species of coral that build reefs. For 18 months, the researchers exposed these creatures to pieces of black polyethylene. Polyethylene is one of the most common plastics in the ocean. It's used in bags and bottles. The black color made the plastic easy to see when corals gobbled it up or grew their skeletons over it.

At the end of the experiment, the researchers tallied up how much plastic the corals took in. Most plastic debris inside corals was in their skeletons rather than tissues. The researchers shared these results in *Global Change Biology*.

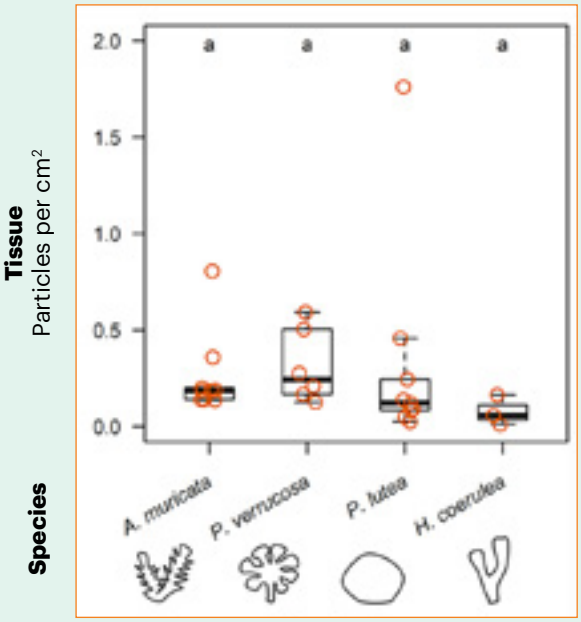
The researchers then estimated how much plastic corals might be accumulating worldwide. Their calculations suggest that corals may cache between almost 6 billion and 7 quadrillion microplastic pieces each year. That could be up to 20 million kilograms (44 million pounds) of plastic — the weight of 10,000 cars. But it's not clear yet how those plastic fragments impact reefs.

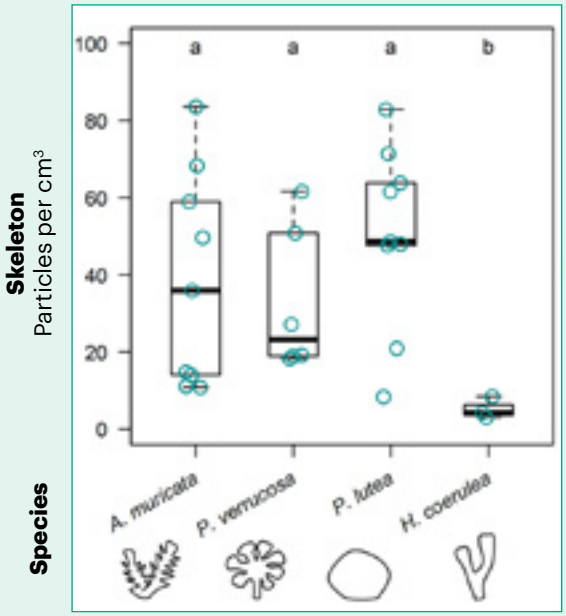
— *Carolyn Wilke*

REEF: CHONLASUB WORAVICHAN/SHUTTERSTOCK; MICROPLASTICS: NOAA/SCIENCE SOURCE

A PLASTIC TALLY

These graphs show how much plastic corals took into their tissue (left graph) or their skeletons (right graph). These "box and whisker plots" show how data is distributed over a range. Each orange or aqua circle represents a data point collected from an individual coral. The thick line in the middle of the box is the middle value (the median) if all the observations were lined up smallest to largest. The box contains the half of the data that falls in the middle when the values are lined up. So the highest quarter of values and lowest quarter of values fall outside the box. The "whiskers" represent the values that most of the data is likely to lie between. Data points outside of the whiskers are called "outliers."





Researchers grew corals in the lab and watched to see how many tiny pieces of plastic the animals took up over 18 months. Corals can hang onto a lot of plastic, they found.

REICHERT *ET AL/GLOBAL CHANGE BIOLOGY* 2021 (CC BY-NC 4.0); ADAPTED BY L. STEENBLIK HWANG

DATA DIVE

1. What are the highest and lowest values for how much plastic each of the four corals took into their tissue? What are the median values (marked by the dark black lines)?

2. What are the highest and lowest values for how much plastic each of the four corals held in their skeletons? What are the median values?

3. How would you go about finding the average of values for either the tissue or skeleton for any given species? Can you do that from these graphs?

4. For each species, roughly how much more plastic was in the skeletons than the tissue?

5. In the two graphs, which values are outliers? How far are these values away from the median?

6. What's another way you could show these data?

7. In this experiment, all the corals were exposed to the same type and amount of microplastic. How might the experiment's setup be changed to more closely reflect what happens in the ocean?

ANSWER

The Cartwheel Galaxy shines bright

This image from the James Webb Space Telescope dazzles

Astronomers have been looking forward to this for decades. NASA is now releasing images from the new James Webb Space Telescope, or JWST. The pictures are allowing humanity to see farther into space — and more clearly — than ever before.

This image shows sites of intense star formation throughout the Cartwheel Galaxy. About 500 million light-years from Earth, it gets that name from its bright inner ring and colorful outer ring. Astronomers think it used to be a large spiral like our Milky Way — until a smaller galaxy smashed through it.

In images from other telescopes, the space between those rings appeared shrouded in dust. But JWST's image shows new stars forming. Some are emerging in spoke-like patterns between the central and outer rings. These star births are likely aftereffects of that earlier galaxy collision.

Ring galaxies are rare. Galaxies with two rings are even more unusual. The Cartwheel's strange shape means that the long-ago collision set up multiple waves of gas rippling back and forth. It's likely that this galaxy has a long road to recovery. Even astronomers don't know what it will look like in the end.

— *Lisa Grossman*

Bright and dusty spokes connect the inner and outer rings of the Cartwheel Galaxy in this image from the James Webb Space Telescope. Two neighboring galaxies appear prominently to its left.

NASA, ESA, CSA, STScI

Inside the mind of a science award winner

A winner of Broadcom MASTERS — Society for Science's middle school competition — answers three questions about science

Science competitions can be fun and rewarding. But what goes on in the mind of a winner? Broadcom MASTERS 2021 champion Camellia Sharma shares some of her science inspiration and what she liked best about the competition.

Q What would you invent if you had all the resources in the world?
A I would like to find a vaccine for cancer. A vaccine is developed against an antigen. An antigen is the part of a pathogen that our immune system recognizes, [but] cancer cells often do not have such markers because they are a part of our body. Further, they are adept at hiding from the immune system and defeating its mechanisms of attack. Therefore, developing a cancer vaccine is challenging.

Q Which scientist — alive or deceased — would you want to solve scientific mysteries with?
A Marie Curie is my hero. She is one of the only four scientists who have won two Nobel Prizes. I would like to explore what time is with her. [For instance], why does time only move forward while we can move back and forth in the other three dimensions?

Q What was your most favorite or memorable experience from Broadcom MASTERS?
A One of my favorite parts of the virtual experience was getting to know the 29 other like-minded finalists. I enjoyed being able to discuss current STEM topics with people who understand and care about it.

Winner of the 2021 DoD STEM Talent Award

Camellia Sharma

Camellia Sharma, 15, from Henrico, Va., was concerned about a declining fish population impacted by climate change and overfishing. In response, she created a 3-D-printed, GPS-enabled AI AquaDrone that can help in fish studies, search and rescue, and defense. The special drone can fly, land on water, transform into a boat and then dive under the water to take photos of fish. The software that Camellia created to complement her invention uses computer vision to count the fish and can even categorize fish types.

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