

RATS REVEAL OUR HISTORY

Weallimagine being friends with celebrities.

Sthatabalthing?



SHARETHE LOVE (OF SCIENCE)

Give the young science fans in your life a full year of amazing discoveries with a subscription to Science News Explores — the new magazine for families from the trusted team at Science News.

The perfect gift for your explorer.

snexplores.org/magazine





# **Table Of Contents**



LEV RADIN/SHUTTERSTOCK



JULIA FILIPENKO/SHUTTERSTOCK

Science News Explores | February 2023 | Vol. 2, No. 2



YOUR QUESTIONS **ANSWERED** 

Ask us a question, any (science) question



SCIENCE IN ACTION Space smash and easier reading



STRANGE BUT TRUE How water can create some quirky icicles



WHAT'S THIS?! Hint: This 'sad potato' isn't a plant



TRY THIS! An egg-y experiment and a word puzzler



INNOVATIONS New cloth keeps you cool — or warm



TECHNICALLY FICTION Baby Yoda may be an alien, but slow aging is not



**EXPLAINER** Solid, liquid, gas — matter is more than that



TEST YOUR KNOWLEDGE Wildfires get bigger, and air pollution gets worse

## Department



A magazine by the Society for Science

#### **SCIENCE NEWS MEDIA GROUP**

EXECUTIVE PUBLISHER Maya Ajmera PUBLISHER Michael Gordon Voss EDITOR IN CHIEF Nancy Shute

#### **SCIENCE NEWS EXPLORES**

EDITOR, DIGITAL Janet Raloff **FDITOR PRINT Sarah 7ielinski** ASSISTANT MANAGING EDITOR Jill Sakai ASSISTANT EDITOR Maria Temming ASSISTANT DIGITAL EDITOR Lillian Steenblik Hwang **EDITORIAL ASSISTANT Aaron Tremper** 

#### **SCIENCE NEWS**

EDITOR, SPECIAL PROJECTS Elizabeth Quill NEWS DIRECTOR Macon Morehouse MANAGING EDITOR, MAGAZINE Erin Wayman

#### **CONSULT DESIGN AND MARKETING**

**Team of Creatives** 

#### SOCIETY FOR SCIENCE

PRESIDENT AND CEO Maya Ajmera CHIEF OF STAFF Rachel Goldman Alper CHIEF DESIGN OFFICER Stephen Egts CHIEF PROGRAM OFFICER Michele Glidden CHIEF, EVENTS AND OPERATIONS Cait Goldberg CHIEF COMMUNICATIONS OFFICER Gayle Kansagor CHIEF ADVANCEMENT OFFICER Bruce B. Makous CHIEF TECHNOLOGY OFFICER James C. Moore CHIEF FINANCIAL OFFICER Dan Reznikov

#### **BOARD OF TRUSTEES**

CHAIR Mary Sue Coleman VICE CHAIR Martin Chalfie TREASURER Hayley Bay Barna SECRETARY Christine Burton AT LARGE Thomas F. Rosenbaum MEMBERS Craig R. Barrett, Adam Bly, Lance R. Collins, Mariette DiChristina, Tessa M. Hill, Charles McCabe, W.E. Moerner, Dianne K. Newman, Roderic Ivan Pettigrew, Afton Vechery, Gideon Yu, Feng Zhang

#### Science News Explores

1719 N Street NW, Washington, DC 20036 202-785-2255

#### SUBSCRIBER SERVICES

E-mail: subscriptions@snexplores.org Phone: 1-855-478-5081

Web: www.snexplores.org

Mail: Science News Explores, P.O. Box 292933, Kettering, OH 45429-0255

Subscriptions include 10 issues per year published monthly except in January and July and cost \$19.95 (international rate \$44.95 includes extra shipping charges). Single copies are \$4.50 plus \$1 shipping and handling (or for international, \$2.50 shipping and handling). Periodicals Rate Pending, Permit Acct Number: 3410866. Periodicals postage is pending at Washington DC and additional mailing offices. POSTMASTER: send address changes to Science News Explores, PO Box 292933, Kettering, OH 45429-9985

Society for Science is a 501(c)(3) nonprofit membership organization founded in 1921. The Society seeks to provide understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate and inspire (learn more at societyforscience.org).

Copyright © 2023 by Society for Science. Republication of any portion of Science News Explores without written permission of the publisher is prohibited. For permission, contact permissions@snexplores.org.

#### $\mathbf{Q}$ Why do leaves fall off trees but pine needles don't?

— Cora B.

Trees have two major strategies for survival, says Mason Heberling. He is a plant ecologist studying how plants function and a curator at the Carnegie Museum of Natural History in Pittsburgh, Penn. Each strategy has pluses and minuses, depending on the tree's environment. You can figure out the strategy from the leaves. Deciduous trees, such as sugar maples or oaks, drop their leaves in the fall and grow new ones in spring. They do this annually because their leaves can't survive a harsh winter. Evergreen trees have some green foliage year-round. Some evergreens, such as pines, have needles. These are specialized leaves that can withstand the cold, snow and wind of winter. Pine needles do fall off their tree (a pine forest usually has a carpet of scented pine needles), but they don't drop every year. Needles often last two years or more before they fall off and are replaced.



#### **Q** Why do we dream?

— Jiajing Z.



A Scientists still aren't sure! Some researchers suggest dreams help our brains sort through our daily experiences. Others have proposed that dreams let our ancestors practice important survival skills. Dreams may not have a purpose at all, says Luigi De

Gennaro of the Sapienza University of Rome in Italy. He studies how the sleeping brain works. "The mind can't stop working for a third of our lives," says De Gennaro. And scientists have used special equipment to show that our brains continue to be active when we're asleep. The brain works differently when we sleep, though. Certain areas become engaged in ways unlike when we are awake. De Gennaro says that dreams may be the wacky byproducts of these changes.

#### **Q** What is the universe made of?

— Elise G.



A The observable universe, all the energy and matter that can be detected from Earth, can be split into two things: what we can see and what we can't. Less than 5 percent of the universe is "normal" matter that's visible to us. (Matter is anything that takes up space

and has mass.) This includes everything from planets and stars to basketballs and video games. But most of this normal matter is hydrogen found in the form of plasma. The rest of the universe is more mysterious, made of dark matter and dark energy. They are called "dark" because they don't produce or reflect light. We can't see these substances. Scientists can only detect dark matter by observing how its gravity pulls on visible matter and bends light. Dark matter, they estimate, makes up roughly a quarter of the observable universe. Dark energy makes up the remaining 70 percent of the universe. We know it exists because this unseeable force is causing the universe to expand faster and faster.

#### CORRECTION

In the November issue, we mixed up the positions of Neptune and Uranus on page 29. Neptune is actually the 8th planet from the sun, and Uranus is the 7th. Thanks to the eagle-eyed readers who pointed this out. We try hard not to make mistakes but promise to let you know when we do.

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

#### NASA's DART spacecraft bumped an asteroid off course

#### This was the world's first test of a strategy to ward off killer asteroids

umans have, for the first time. purposely moved a celestial object.

This past September, NASA's

DART spacecraft rammed into an asteroid named Dimorphos. It struck the space rock at about 22,500 kilometers per hour (nearly 14,000 miles per hour). Its goal? To bump Dimorphos slightly closer to the larger asteroid it orbits, Didymos.

The experiment was a smashing success. Before the impact, Dimorphos orbited Didymos every 11 hours and 55 minutes. After, its orbit was 11 hours and 23 minutes. NASA announced these results in a news briefing.

Neither Dimorphos nor Didymos comes close to Earth. But the DART mission's outcome suggests that a similar impact may be able to divert a killer asteroid if one is ever found headed toward Earth.

Four telescopes in Chile and South Africa watched Dimorphos and Didymos every night after DART's impact. The telescopes can't see the asteroids separately. But they can see the asteroids' combined brightness. That brightness changes as Dimorphos passes in front of and or passes behind Didymos. The pace of those changes reveals how fast Dimorphos orbits Didymos.

All four telescopes saw brightness changes consistent with an 11-hour, 23-minute orbit. The result was confirmed by two planetary-radar facilities. Those instruments bounced radio waves off the asteroids to measure their orbits directly.

"This is a very exciting and promising result for planetary defense," said Nancy Chabot. This planetary scientist works at Johns Hopkins Applied Physics Laboratory in Laurel, Md. That's the lab in charge of the DART mission.

Nudging a real killer asteroid out of the way would require smashing a spacecraft into it years before it could reach Earth, Chabot says. An upcoming space telescope called Near-Earth Object Surveyor could help provide such an early warning of asteroids on collision courses with Earth.

— Lisa Grossman



NASA's DART spacecraft (illustrated) slammed into the asteroid Dimorphos in the world's first test of a strategy to defend the Earth from killer asteroids.





One World Trade Center



Didymos 780 meters Burj Khalifa



Statue of Liberty

**Dimorphos** 163 meters

**Great Pyramid** of Giza 139 meters

#### Easier reading might be as simple as more space

#### Students with and without dyslexia read better when letters have extra spacing

ave you ever tried to pick out the face of a friend in a group photo? It can be hard, especially when everyone is crowded together. It can also be hard to read a passage of text when the letters are crowded together. In fact, a new study shows that spacing the letters farther apart can help anyone read faster, and potentially with better comprehension.

Dyslexia is a common condition that can cause a person to have difficulty reading. It traces to a language-processing problem in which the brain has trouble connecting the letters on the page to sounds. People with dyslexia can confuse the order of numbers, letters and other images. Past research had shown that crowded text was especially difficult for people with dyslexia to read. So researchers at Anglia Ruskin University in Cambridge, England, wanted to see how much help an increase in the spacing between letters would provide.

Steven Stagg and his team recruited 59 students between 11 and 15 years old. The kids came from schools in three places in England. Thirty-two had dyslexia; 27 did not. As the researchers recorded, each student read two passages out loud. One passage was printed in its original format. In the other, the spacing between the letters was increased by 2.5 points. That extra space equals

about 0.88 millimeters (0.03 inch). The recording allowed the scientists to measure someone's reading speed and count any errors, such as skipped words.

People with dyslexia often employ aids to help them read, such as colored overlays. So the researchers offered those to the students here. These plastic sheets are tinted with one of several colors. Readers place the plastic on top of the text and then read through it.

Those colored overlays didn't help either group of kids. But the extra spacing did. Kids with dyslexia read the wider-spaced text 13 percent faster than the text with original spacing. These kids also made fewer mistakes. Students without dyslexia read faster, too, although only by 5 percent.

Stagg studies how the mind processes language. He wasn't surprised that the colored overlays weren't helpful. Stagg has dyslexia and says colored overlays never helped him much, either. What did surprise this cognitive scientist was

that wider-spaced letters helped even kids without dyslexia.

This is very good news. It means teachers and publishers can print material with extra spacing between letters knowing it will help everyone. Readers with dyslexia won't feel singled out by having to use special reading materials.

Jenae Cohn, who heads the Center for Teaching and Learning at the University of California, Berkeley, agrees. "This will," she says, "level the playing field."

It's a simple fix, too. Certain textwriting and document-processing software (such as Microsoft Word) can easily add extra spacing between letters. Web designers can add space to the text on their pages, too.

Cohn suspects it may take some time for techniques like these to become widely used. But Stagg is optimistic that wider spacing between letters will catch on. "Some methods to help people read better have shown mixed results," he says, "but letter spacing seems to be the one thing that everyone is finding works."

— Avery Elizabeth Hurt

the letters farther apart can help anyone read

faster, and potentially with better comprehension.

Adding a bit more space between letters helped kids both with and without dyslexia read text faster.

Have you ever tried to pick out the face of a friend in a group photo? It can be hard, especially when everyone is crowded together. It can also be hard to read a passage of text when the letters are crowded together. In fact, a new study shows that spacing

#### Why some icicles have ripples

#### Quirky shapes are carved by water with different densities

ater is weird. Typically, liquids get denser as they cool down. But freshwater only gets denser until it reaches about 4° Celsius (39.2° Fahrenheit). At lower temps, it gets less dense — until it freezes at 0° C (32° F). Now, scientists have found that strange trend in density can carve ice into unexpected shapes.

Researchers dipped rods of ice in liquid water between 2° C and 10° C (35.6° F and 50° F). The water closest to each ice rod was cooler than the surrounding liquid.

When ice was dipped in water cooler than about 5° C (41° F), the extra-cold water near the ice was less dense than the surrounding water. That made it more buoyant. So, the extra-cold water rose. This drew warmer water closer to the bottom of the ice rod. As a result, ice near the bottom melted faster, creating a downward-pointed spike.

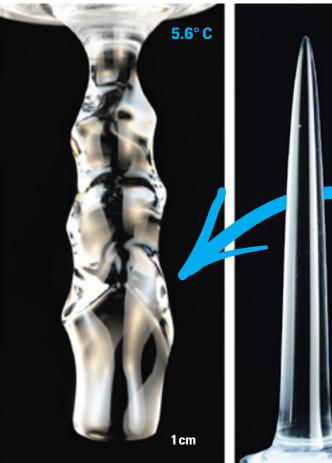
The opposite occurred when ice was dipped in water warmer than about 7° C (44.6° F). In this case, the colder water near the ice was denser than the water around it. That colder, denser water sank. This pulled warmer water near the top of the ice, making it melt faster and forming an upwardpointing spike.

Between about 5° C and 7° C, "basically, the water is confused," says Leif Ristroph. This mathematician works at New York University in New York, N.Y. Water at these temperatures formed layers of different densities. Some layers tended to rise as others sank, swirling up the fluid. This carved "weird ripples into the ice," Ristroph says. His team shared these findings in Physical Review Letters.

— Rachel Crowell

8°C





Fun fact: Swirls and vortices of mixing layers of water between 5° C and 7° C carve ice into complex, rippled shapes.

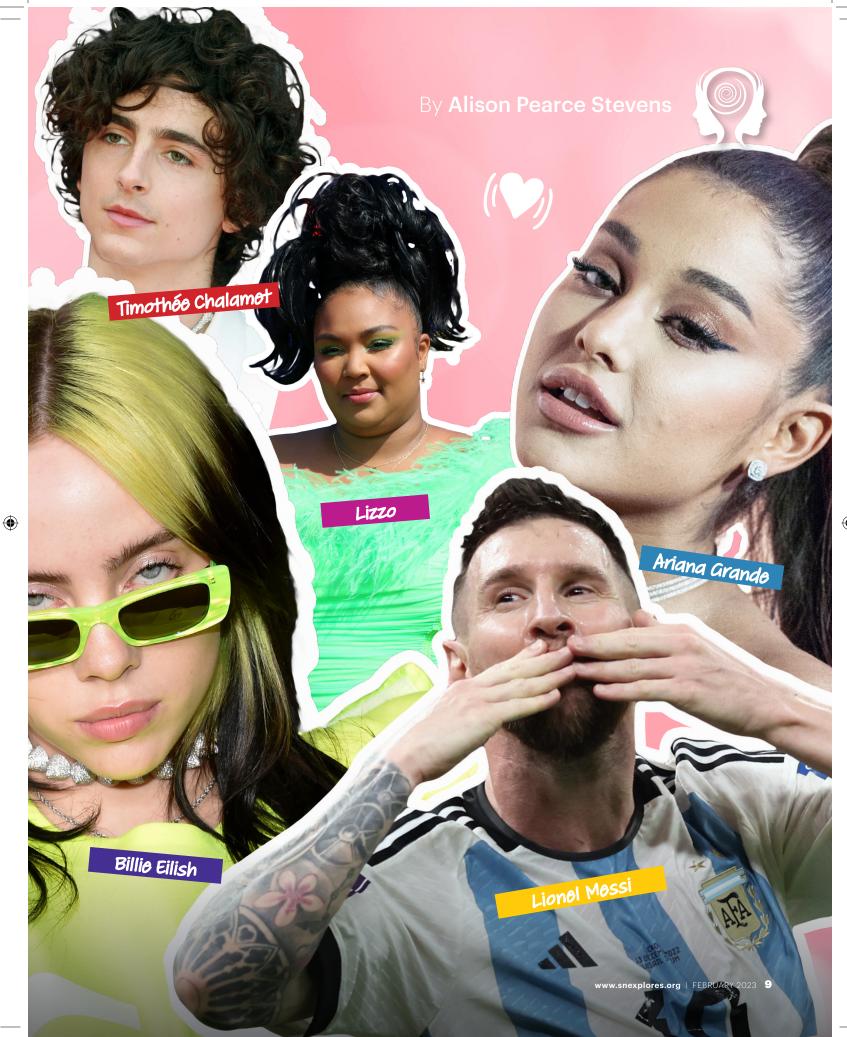
Leif Ristroph calls this study his lab's "first little dip into ice." Next he wants to explore other factors in nature - such as saltiness that shape ice as it melts.













o you find yourself waiting for the next MrBeast video to drop so you can see his latest challenge? Or perhaps the newest experiment from Mark Rober? Maybe you're wild about Harry Styles, Billie Eilish or Timothée Chalamet. You follow them on social media, connect with other fans online and maybe even message them now and again. Even though these people are celebrities, you feel like you know them. Now, research shows our attachments to them can be healthy.

Most of us form relationships of some sort with celebrities and fictional characters. We imagine having a conversation with that person or asking for advice. Sometimes we develop a more romantic crush. Embarrassing as it may sometimes feel, this is perfectly normal. Scientists call these faux friendships "parasocial relationships." Social relationships involve two or more people. Parasocial ones, on the other hand, are completely one-sided.

They develop as we begin to feel we know someone famous — or fictional — at a deep level. We may revel in that emotional attachment to the celebrity or character. They, however, don't even know we exist.

As discouraging as that may sound, parasocial relationships can be a good thing. They can help us figure out who we are. They can boost self-esteem. Beware, however: In some cases, they also can influence us to believe or appreciate things about which we might otherwise have been skeptical.

Even one-sided relationships can boost self-esteem and foster acceptance of others.

#### **Powerful relationships**

Decades ago, parasocial relationships happened between TV viewers and the people on screen. This was especially true for talk-show hosts and newscasters who spoke directly to the camera. People watching felt as though these TV personalities were talking directly to them. Over time, they felt a close connection with them.

It wasn't just people on TV. Beatles fans went wild for the band, just as Harry Styles fans do today. More recently, parasocial relationships have shifted to other types of screens. Many people, from children to adults, have some form of screen that they use for entertainment. Even young children form parasocial



SAB ARCHIVE/GETTY

10 FEBRUARY 2023 | SCIENCE NEWS EXPLORES





relationships with on-screen personalities. Big Bird and Elmo from Sesame Street can seem like friends. So can animated characters or superheroes.

"We root for them," says Kristin Drogos. "We want them to do well." Drogos is a communication researcher at the University of Michigan in Ann Arbor. It's that positive feeling toward these on-screen personalities that causes us to form a parasocial bond with them. And that connection can be powerful.

We learn from our friends, Drogos says. And it doesn't really matter whether they exist in real life or on-screen. That's one reason Sesame Street is an effective way to help kids learn, she notes.

Children and teens learn more than just information from these "friendships." They also learn important social skills. Girls are drawn to physically attractive, smart characters, Drogos has found in her research. Boys, on the other hand, prefer smart characters that are physically active. Drogos and a colleague shared these findings in Frontiers in Psychology. Starting at a very young age, we look for cues about how to act in our gender roles, she explains. We start to imitate how our favorite characters act and dress.

For the most part, that's healthy, she notes. But it can go too far. Boys watching violent YouTubers may, for instance, become too accepting of violence. Or teen girls may go to great lengths to look more like their favorite person.

"These are powerful relationships," Drogos says. And they can have a big impact on our own choices. "Think about who your favorite TV characters are. Are they good people?" she asks. "They are going to potentially shape how you think about the world around you."

#### **Confidence boost**

Parasocial relationships form without thought. We don't start watching a show thinking, I'm going to watch this because I want to become friends with this character. Yet a bond may still develop.

One reason: Our brains treat on-screen faces the same as in-person faces, explains Bradley Bond. He is a communication researcher at the University of San Diego in California. "We assign personhood to people we see in-person and on screens," he explains. And we "process them in a similar fashion." We are a social species. So we crave connections with other people. "It's human instinct," he says, and parasocial bonds help fill that need.

For some people, these relationships play an important role in our lives. In one study, Bond studied LGBTQ+ teens. Kids with few real-life LGBTQ+ friends were more likely to form parasocial relationships with those characters, he found. He concluded that these bonds provided a "sense of belonging that might be absent ... in their real-life social networks." Such a sense of belonging is essential to self-esteem and a sense of well-being, Bond says. He shared the findings in the journal Media Psychology.

Parasocial bonds can also help reduce prejudice against groups of people. For instance, he recently surveyed young adults who watched a show featuring a cast of gay characters. Over the course of the season, Bond measured attitudes toward gay people among the straight participants. As they got to know characters in the show, he found, their attitudes shifted. They became more accepting as the strength of their parasocial bonds with them grew. He described those findings in Communication Research.

**Fans of the Beatles** (left) went wild for the British band and formed parasocial relationships with the musicians in the 1960s. People today do the same but not just for musicians, actors and other celebrities. They now also connect with influencers (above) who have gained fame on social media sites like YouTube, Instagram and TikTok.





#### The stronger our feelings toward the celebrity or influencer, the more likely we are to listen and adopt their views.

Participants didn't identify with the characters over their sexual orientation. But they did connect over other aspects of their lives. Having an overbearing mother, for example. Or being teased for liking comics. Bond suspects that similar changes in prejudice would be found for other groups of people, such as people of different races or cultures. But to date, those studies haven't been done.

#### **Breaking down defenses**

The strength of a parasocial bond can get a big boost when a celebrity interacts with a fan on social media. This might happen if the celeb responds to a direct message, for example. Does such an interaction change the relationship from parasocial to social? No, Bond argues. He still considers it a parasocial relationship — just one with a brief interaction. The fan feels more strongly connected. The celebrity doesn't experience that sense of connection. "The emotional bond — that feeling they're your friend — is still one-sided," Bond says.

Nicole Liebers agrees. She is a mediacommunications researcher at the University of Würzburg in Germany. Parasocial relationships grow over time, she explains. They "develop in stages, just as [real-life] social relationships do." The occasional response from a celebrity to a direct message or comment from a fan increases the fan's positive feelings toward that person. Such interactions also increase trust. And that's where things can get complicated.

In Germany, the United States and elsewhere, advertisements must be labeled. Seeing the label changes how we view information, Liebers says. We know an ad is not so much a fact as someone's favorable view about something. When we see the label, she says, we think: "I have to be careful not to fall in the trap." This helps us resist an ad that's trying to persuade us.

But when we feel like the person in the ad is a friend, we tend to view it differently, Liebers says.

12 FEBRUARY 2023 | SCIENCE NEWS EXPLORES



008-013 Feature 1\_CelebritiesRev.indd 12 10/15/24 11:48 AM

PALOFF/STRINGER/GETTY IMAGES





Many people in the United States may never meet someone from South Korea. But being a fan of the South Korean boy band BTS (above) can give a person a window into a world they might otherwise never experience.

We like the person. So if they like the product, we are more likely to buy it. This is how parasocial relationships can change behavior. The stronger our feelings toward the celebrity or influencer (an influencer is a type of social media celebrity), the more likely we are to listen and adopt their views.

Liebers was part of a team that investigated how much of an impact influencers have. The researchers showed 157 people two sets of Instagram posts of an influencer selling a product. For some participants, the influencer was someone they followed. They had a stronger parasocial bond with the individual. For others, the influencer was someone they were seeing for the first time. In some cases, the posts were labeled as ads. Other times they were not. The participants then answered a series of questions about whether they would buy the advertised product.

People viewing a new influencer were less likely to buy the product when posts were labeled as

ads, compared with when posts were unlabeled. But followers with a strong parasocial bond to the influencer didn't become more critical of ads. When ads were labeled, they actually became more likely to want the product. They "perceive the disclosed advertisement as more honest," she found. Being aware of this shift can caution us to work harder to recognize and avoid tricky ad campaigns. Liebers and her colleagues described their findings in the *International Journal of Advertising*.

Despite the potential pitfalls, parasocial bonds are generally a good thing. They provide us with a window into the world. "Representation matters," Bond says. The more we are able to learn about people who are different from us, the more understanding we can have for others. Sharing of stories "can alter our social consciousness," he says. Parasocial relationships are a logical way for that to happen.

www.snexplores.org | FEBRUARY 2023 13

## RATS REVEAL THE



By **Bethany Brookshire** 



## HISTORY OF US



uttons. Old nails. Ancient fishing nets. Sandals, silver spoons, football tickets and old hair pins. It's quite a collection. But it wasn't assembled by people. These items were all brought together by rats.

Lots of people dislike rats. They slide around in sewers. They get in the garbage. They can spread disease. It can be difficult to see their value — other than as an animal model for studying human illness.

But rats have more to share. The contents of their nests can teach archaeologists, historians and the rest of us not only about those rats but also about the people they live among. After all, where people go, rats tend to follow.

#### Home, rat-infested home

Colonial Williamsburg is a popular tourist destination in Virginia. This living-history museum recreates life from the time of the American Revolution in the late 1700s. Many of its buildings were built around then.

When the first Europeans came to Virginia, black rats (Rattus rattus) hitched a ride in their ships. They went on to live with the Europeans and often built nests in the walls of people's homes. Those nests are full of information about early settlers.





One good example comes from Orrell House. A family of rats built a nest behind a staircase. They lined their nest with objects from Orrell House's human residents, notes Matthew Webster. He helps preserve buildings in Williamsburg for the Colonial Williamsburg Foundation. That rat nest remained hidden from everyone until January 2021. That's when Webster and his team opened the staircase and found what it was hiding.

"There were buttons, there were pins — lots of thread," Webster says. "The Orrell family were tailors." But the nest's objects say more about the family than just their occupation. They show what specific materials these people used. That's important, Webster says, because it helps historians find out what the early settlers could make and produce for themselves — and what they had to import from across the ocean.

The best part about rats, Webster says, is that they are homebodies. "These rats tend to range only about 150 feet from their nest," he explains. That's a little more than 45 meters. "So you're getting a snapshot of items that that are fairly close by."

Another building, known as the Bray School, had even more rats. Rats in the walls, rats by the chimney, rats in the roof beams. In 1760, this building became a school for Black children. Most of the students were enslaved. The Bray School was supposed to teach them about Christianity. Maureen Elgersman Lee is a historian of African American history at William & Mary, a university Not all past occupants of historic buildings are gone. When Matthew Webster and his team broke open a wall at Orrell **House at Colonial** Williamsburg (above, a piece of wall with horsehair still visible in the plaster), they found the remains of the tiny body of a rat (left).

Rattus norvegious

The brown rat, sometimes called the Norway rat, originally hailed from Eastern China and Mongolia. Now the rat can be found on every continent except Antarotica.

in Williamsburg. She explains that the school's founders "were working to, in fact, strengthen slavery by giving children access first to the Anglican faith."

Eventually the school moved on to a bigger building. But the rats remained. They stayed as the house became a women's dormitory for William & Mary. And they stayed as it became a place to study military science. The rats stayed and stole — until the historians found their nests in November 2021.

The rats were "collecting the personal items," Webster says. There were combs and pins, maybe even hand-written letters. People might have thrown out old football tickets or shoes. But once rats found them, they kept the bounty. Historians are studying the nests now to find out more about the many people who lived in Bray School over the centuries.

These nests have given Elgersman Lee a new appreciation for rodents. "It was fascinating to think that these little creatures are stealing things, and ... safeguarding them for us to find later," she says.

#### World-traveling rats

Rats have been hitching rides on ships for probably as long as people have set sail. Now, by studying modern rat genes, scientists can find out where people went, and when.

This is especially important for periods when people didn't keep diaries, explains Emily Puckett. She works at the University of Memphis in Tennessee. She studies how a species' DNA differs across its range. One good example comes from islands in the South Pacific known as Polynesia. People first arrived in this area some 3,000 years ago.

Reaching these islands took long trips by boat. And any long trip needs snacks. Since there were no handy gas stations along the way to grab some goodies, ancient seafarers brought live rats to munch on. This was the Pacific rat, or Rattus exulans. As people spread and populated island after island, they brought many plants and animals with them — including the rats.

By analyzing the rat's genetics, scientists have been able to figure out when people arrived where. Rats — and people — first showed up in Tonga, then Samoa. Afterward, they spread to the Society Islands, and finally to Easter Island and Hawaii.

Here's how scientists learned that. In rats, DNA the instruction manual of their cells — "really tells a story about the people," says Puckett. As a species reproduces, successive groups of its offspring will get new and different tiny, random changes to their DNA. Most of these changes won't change anything for the rat. But Puckett can find and track these DNA changes to show where populations of rats descended from over time.

Another species — the brown rat, or *Rattus* norvegicus — can help tell a larger story about how people spread around the globe, Puckett finds.

Brown rats are the standard New York City sewer rat. But they're not native New Yorkers. Today they're found around the world. They originally hailed from Eastern China and Mongolia. From there, Puckett's DNA samples have shown that the brown rat spread south and east, to India. Another group spread through China and Russia. Still other rats spread west, eventually hitting Europe and Africa. From Europe, colonists took them to North and South America — and almost everywhere else.

Rats could even tell historians about how big a city was, says David Orton. At the University of York in England, he studies animals that lived with ancient humans. Usually, when historians find remains of an ancient city, they want to dig and find more. "The trouble is that most of the time, the ancient cities tend to be underneath modern cities," Orton says. "And you can't just go and dig the whole thing up."

But you can follow the rats. Rats are "very dependent on humans for their food supplies and for their shelter," he explains. To move from place to place, rats need people transporting food and other goods. Only ancient cities big enough to have many connections to other sites would have been able to support populations of rats. So finding ancient rat bones in the ruins of a town offers a clue to how big the city must have been to support them. The DNA in rat bones also could help determine where the rats came from — and which cities might have been linked.



The Paisley 5 Mile Point Caves (left) are in a desert region of **Oregon. Scientists** (inset, top) have studied nests built by pack rats (inset, bottom) to determine that humans have used the caves for thousands of years.





#### **Hoarding history**

In central Oregon, desert surrounds the Paisley 5 Mile Point Caves. Between 14,000 and 7,000 years ago, some of the earliest Americans made their home here. How do we know? The pack rats.

Also called woodrats, pack rats — in the genus Neotoma — are true to their name. They'll steal anything, says Dennis Jenkins. He's an archaeologist at the University of Oregon in Eugene. "We have to pick up all of our tools

each day and take them out of the cave." If they don't, foraging pack rats will make off with them during the night.

Pack rats store their loot in middens. These are large nests the rats build out of wood, leaves, dirt, rat poop and pee. A group of pack rats can inhabit the same cave — and the same midden — for thousands of years. Over time, all the materials added to the midden give scientists a picture of how the area around the cave has changed with time.

A midden (far left) is a large rat nest built out of wood, leaves and dirt and bodily wastes. Rats pee and poop constantly. Their feces are sticky and the urine can dry in a desert environment to form a hard, almost amber-like substance. If the air gets humid, though, the stinky pee melts back down (near left), sometimes running into a rat's midden and gluing everything together. Jenkins is part of a team that analyzed poop in the Paisley rat middens. The scientists found

evidence of Ponderosa pine shells in the poo. Ponderosa pines don't grow around the caves. Nor did the midden have any pine needles. That might mean that people were bringing pine nuts to the caves - and the rats stole some.

"By making off with some of the food that the Native Americans were eating, [the rats] have given us a good idea

of what the [human] diet was like at that particular time," Jenkins explains.

The rats also stole bits of woven baskets, cord, sandals and fishing nets. These items might normally break down over time. But they remained well preserved inside the dry cave middens. As a result, Jenkins says, "Those nests are treasures."

#### Tar pit treasures

Rancho La Brea, in Los Angeles, Calif., hosts another of these treasures. This site is full of asphalt seeps. "It's just sticky dirt," says Alexis Mychajliw of Middlebury College in Vermont. That sticky dirt trapped animals long ago, leaving their bones in the pits. Because it's so thick, asphalt moves slowly. It mixes up the bones of animals into giant skeleton puzzles. It should also squish anything softer than this tarry substance. Rat poop, for example, shouldn't be there. Yet scientists kept finding rat poop.

"They assumed that it was like a brown rat, or black rat going in there and pooping," says Mychajliw. But when she saw the feces, she recognized they were special.

"I have my own rats," Mychajliw explains. Hers are modern brown rats. And she knows what their poop looks like. The La Brea poop was the wrong size. It had to belong to a different species — a pack rat.

Mychajliw, who studies the relationships between ancient organisms, had the poop radiocarbon dated. This method compares two different forms of carbon in material from something that was once living. The balance between the two forms of carbon can tell scientists the age of the object. This poop wasn't new, Mychajliw learned. It was 50,000 years old!

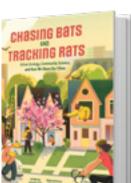
In one area of Rancho La Brea, her team showed that the asphalt was seeping up and into a pack rat midden. The sticky stuff perfectly preserved the midden's contents — rat poop and all. With a scanning electron microscope, she says, "you can literally see the plants inside the poop." Those plants offer clues to the Los Angeles environment 50,000 years ago. And they suggest Los Angeles was about 4 degrees Celsius (7.2 degrees Fahrenheit) colder back then than scientists had thought.

The pack rat midden that sank into the asphalt seep obviously doesn't have current tenants. The midden inside the Paisley 5 Mile Point Caves, though, still has plenty of rats. And they're still stealing, Jenkins says.

In 2003, one of his students was eating an apple. That student was in a pit dug down almost a meter (three feet) into the floor of the cave. He would take notes and then reach up to the edge of his pit to grab his fruit for another bite. The last time he reached up for the apple, it was gone. The student quickly hauled himself out of the pit to see a pack rat making off toward the back of the cave with his snack.

A few thousand years from now, archaeologists of the future may find the last of that apple. Using it and other stolen snacks, they might be able to

learn what scientists such as Jenkins and his students were up to. And the scientists of the future will know who to thank. The rats.



#### **Chasing Bats and Tracking Rats**

— by Cylita Guy, PhD, illustrated by Cornelia Li

Cities are no place for wild animals, right? But some animals actually do better in the Big City! Hit the pavement with DIY challenges in this guide to urban ecology.

## A love of small mammals drives this scientist

#### Alexis Mychajliw looks to tar pits and fossilized poop to understand ancient ecosystems

lexis Mychajliw credits her pet rats, hedgehog and dog for some of her best ideas. "They really inspire me," says Mychajliw. "Just looking at their behaviors and asking questions like, 'Why do they do these things?' and 'Do their wild relatives do these things?'"

Her pet rats' droppings helped her recognize fossilized pack rat feces, or coprolites, found in the La Brea Tar Pits of Los Angeles, Calif. (see page 19). And her passion for mammals has led to research work all around the world, from Japan to the Gulf of Maine to Trinidad and Tobago. Mychajliw now studies extinctions and paleoecology, or ancient ecosystems, at Middlebury College in Vermont. She uses Pleistocene fossils trapped in tar pits roughly 50,000 years ago to better understand past environments. In this interview, she shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper* 



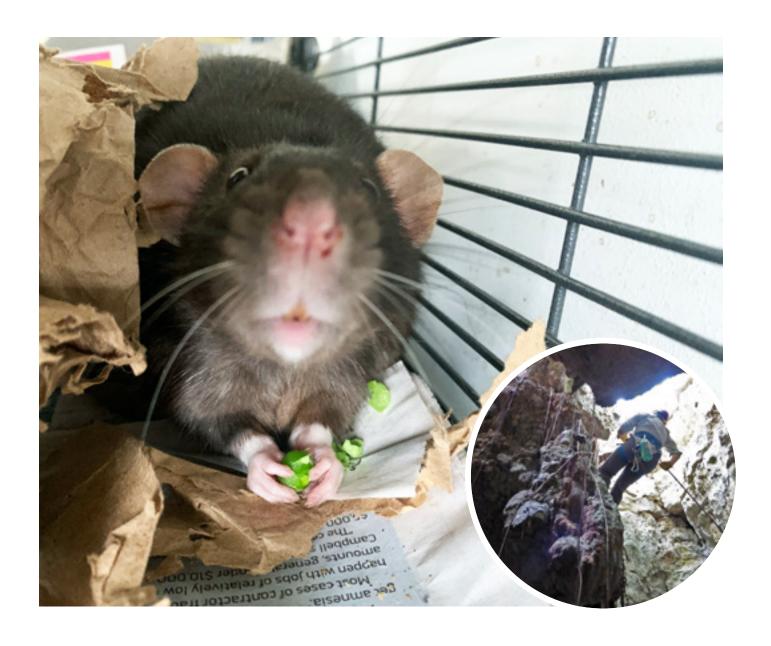
#### • How do you get your best ideas?

A The best questions come from the people who live alongside these animals. To give you an example, when I started my graduate work, I wanted to work on solenodon conservation. Solenodons look like giant shrews. They're venomous, and they're pretty threatened by human activities. And there are only two species left. They represent nearly 70 million years of evolutionary history. So losing them would be

a big blow to global conservation efforts and to protecting the mammal tree of life.

I really wanted to study how their venom evolved and look at ancient DNA. So I traveled to the Caribbean, where solenodons live. When I got there, I talked to local people who lived alongside this animal. They wanted to know what this animal ate. No one had ever studied that using molecular tools. And this was a problem because to conserve something, you need





to know what resources it uses. But it was also a question of whether solenodons were conflicting with domestic chickens and roosters. So I switched my research question to focus on solenodon diet.

What's one of your biggest successes?

A I love doing science that is meaningful to people. It's not just about a publication. I like making people feel excited or appreciate something they never thought about. I loved the work I did figuring out what solenodons were eating. I could go back to people and give them an answer to a question they had.

Q What do you like to do in your spare time?

A I really love exploring new places. I do a lot of hiking with my dog. I love looking for mammals in the wild, so I do a lot of tracking. And I also enjoy looking for fossils.

#### What would you recommend someone do if they're interested in possibly pursuing a career in science?

A Explore your interests and find something that you just can't stop asking questions about. At the end of the day, being a scientist is knowing how to ask questions. Then you have to develop the right set of tools to get those answers.

Alexis Mychajliw (above, left and inset, right) credits some of her best ideas to her pets (above, her rat Mink) as well as people who live alongside the animals she studies.

#### How salty does the sea have to be for an egg to float?

An eggs-periment teaches why some objects float in the ocean while others sink

By Science Buddies

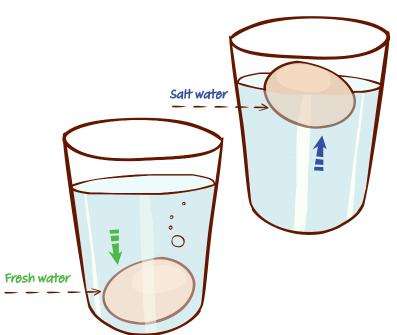
id you know that if you put an egg in a cup of tap water, it will sink to the bottom? But, if you add enough salt, the egg will float back up to the surface! Why? Because the density of the egg is higher than the density of tap water. But adding salt to water increases the density of the water. With enough added salt, the saltwater solution's density is higher than the egg's, and the egg will then float. But just how much salt is needed to make an egg float?

#### **OBJECTIVE**

Determine what salt concentration will float an egg.

#### **EXPERIMENTAL PROCEDURE**

- 1. Take five eggs out of the refrigerator, use a permanent marker to label them 1-5, and allow them to warm to room temperature.
- 2. Make a solution of 1 cup of salt dissolved in 5 cups of water.
- **3.** Pour that solution into four glasses, labeled Cups 1-4, diluting some glasses with tap water



following the directions in the link below. Fill Cup 5 with tap water.

- **4.** Now, starting with Cup 5 and working your way up to Cup 1, place the first egg in each solution to see if it will float. Repeat with the other four eggs.
- 5. In which cup did the eggs first float? If the eggs floated in more than one cup, did you notice any difference in how they floated? Record your observations.
- **6.** To get an even more exact idea how much salt is needed to make an egg float, repeat steps 2 through 5, starting with the water in which the eggs first floated.
- **7.** When you are done handling the eggs, wash your hands with soap and warm water.



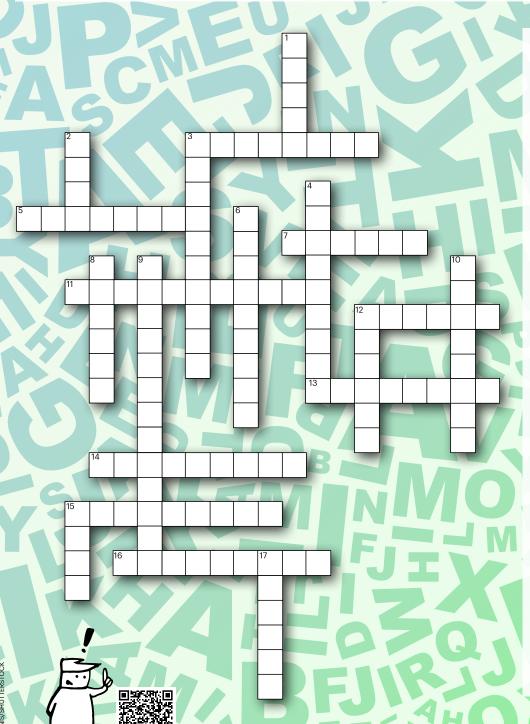
Find the full activity, including how to dilute your water and analyze your data, at snexplores.org/eggs. This activity is brought to you in partnership with Science Buddies.



### EIGR5

#### Crossword

If you're having trouble figuring out the answers to the clues below, make sure you read all the stories in this issue. Check your work by following the QR code at the bottom of the page.



#### **ACROSS**

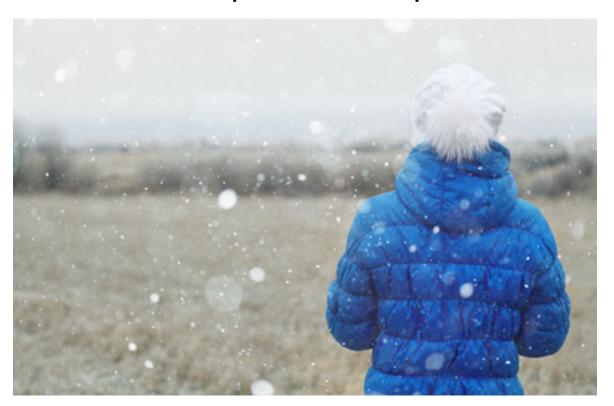
- 3 Furry thieves that will steal anything
- 5 Common reading disorder
- 7 Fourth state of matter, found in stars
- 11 Radioactive material used for dating
- 12 Insect that lives for a day
- 13 DART spacecraft target
- **14** Takes images from above Earth
- **15** Maples and oaks are both this type of tree
- 16 Vomits out food waste

#### **DOWN**

- 1 Gas form of water
- 2 One fossil critter doesn't have this
- 3 Describes faux friendships with celebrities
- 4 South Pacific islands first reached by boat
- 6 A pine tree is one example
- 8 Rat genus
- **9** Reptile that lives for more than a century
- 10 Creator of tiny particles in smoke
- 12 Takes up space and has mass
- **15** Describes stuff that doesn't produce or reflect light
- 17 Dangling frozen water

#### This cloth warms when you're cold, cools when you're hot

The fabric has a couple more tricks up its sleeve



magine if the same jacket that warms you up on chilly days would also cool you down on hot ones. Fabrics with "phase-change" properties can do that. And a research team from China has shown that 3-D printing techniques can yield a strong phase-change cloth — one that hides some more tricks up its sleeve.

This new fabric not only helps regulate temperatures but also conducts electricity. It even resists the radio waves used in Wi-Fi.

"The combination of those properties is what's very intriguing," says Sergio Granados-Focil. He did not take part in the cloth's development.

But this polymer chemist at Clark University in Worcester, Mass., is familiar with phasechange materials.

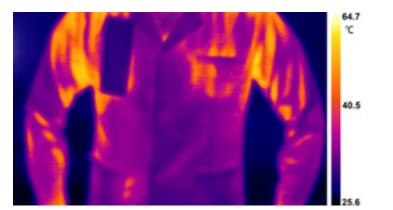
Water is a great example. It goes through a phase-change when it freezes or evaporates. In each case, it's the same molecule, just in different chemical phases. The removal or addition of heat triggers the change between phases. Ice cubes melt into a glass of water, for instance, when they absorb the water's heat. That warms up the ice but cools down the water.

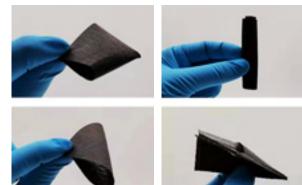
Phase-change cloth also works by moving heat around. The Chinese team trapped a phasechanging polymer inside the fabric. The polymer alternates between

crystal and non-crystal forms. Becoming a crystal absorbs — or removes — body heat. That will cool you down. But this heat isn't gone. The fabric stores it. The polymer releases that heat when it shifts back into a non-crystal. This now warms you up.

The fabric's polymer changes its shape at different temperatures. That's the phase-change part. In the non-crystal phase, "the polymer chains can move around each other," notes Emily Pentzer, who did not take part in the new work. This polymer re-crystallizes again as it cools, the polymer scientist explains. She works at Texas A&M University in College Station.

Shape-shifting polymers could help make a coat that would keep you cozy on cold days but cool you off on hot ones.





An infrared image (left) shows a volunteer wearing a jacket lined with the phase-change fabric. Lighter colors indicate warmer areas. Darker colors are cooler. The fabric kept its unique properties even after being crumpled, stretched or folded 2,000 times (right).

The Chinese team 3-D printed its fabric using an "ink" made from a mix of the new polymer and carbon nanotubes. As their name implies, each of those tubes was only a few billionths of a meter in length. The phase changes occur between 40° and 55° Celsius (104° and 131° Fahrenheit).

The new fabric performed well, better than the research team expected, says Yongyi Zhang. Even after being folded 2,000 times, it worked as it was designed to do, he notes. Zhang studies nanotechnology at the Chinese Academy of Sciences in Suzhou. His team described its innovative fabric in ACS Applied Materials & Interfaces.

The Chinese team added nanotubes to the fabric to help it conduct electricity. Nanotubes also speed up the cloth's ability to move heat around, Zhang explains. An added benefit, he notes: The tiny tubes add "radiation resistance."

Here, Granados-Focil explains, "They're talking about radio waves ... Wi-Fi connections, that kind of radiation." If used to encase a smartphone, he says, others "can't access the information." This attribute might add appeal for military or defensetype applications.

Byron Jones believes ordinary fashion designers would have little need or interest in such applications. A mechanical

engineer, Jones works at Kansas State University in Manhattan. But years ago, he worked with companies that tried developing phase-change fabrics for everyday use. "My personal opinion," he says, "is that phase-change materials in everyday clothing is more about marketing hype than it is about useful impact."

Here's the problem, Jones says. Your phase-change jacket absorbs heat as you get hot, then releases it as you cool off. You hope it will keep you comfortable. But it can't absorb all your heat. Still, absorbing even 10 percent should keep you modestly comfy.

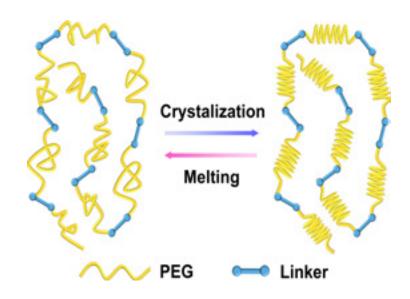
Jones does see some possible uses, however. It might prove useful in a situation where you

only need "a few minutes" of heating or cooling capacity. "Then you go back into an environment where the phase-change material is recharged" - returned to its heatabsorbing or heat-shedding state.

Granados-Focil agrees. "This electrical conductivity business — it's interesting," he says. For example, in gloves, it should mean you can operate touchscreens. And it might let you touch something really hot or cold for 30 seconds without needing clunky gloves.

This technology "isn't going to change all of our sweaters tomorrow," Granados-Focil concludes. But for niche-type applications, he says "it could be interesting."

— Katie Grace Carpenter 🕨



The fabric's phase change is driven by the polymer PEG (short for polyethylene glycol) as it shifts between non-crystal (left) and crystalline (right) forms.

Animals that can protect themselves tend to live longer

rogu, also known as "Baby Yoda," is very much a toddler. He coos adorably. He

rides around in a floating stroller. He sticks random objects in his mouth. But this wide-eyed child of Star Wars' The Mandalorian is a whopping 50 years old. This makes sense, given that one of the only other known members of his species — Yoda — lived to the ripe old age of 900.

Such slow-aging, long-living creatures are not unique to the galaxy far, far away where Star Wars is set. Earth has its own champions of longevity. Giant tortoises live more than a century. And Greenland sharks survive hundreds of years. Meanwhile, mice live a couple of years and adult mayflies survive for a single day. Why does one animal — be it Grogu or a Greenland shark outlive others?

In general, animals that can't protect themselves age faster, says Richard Miller. He studies animal aging at the University of Michigan in Ann Arbor.

"Let's say you're a mouse. Most mice die within six months of age. They freeze to death. Or they starve to death. Or they get eaten," Miller says. "There's almost no pressure for building a creature that will be long-lasting ... when you're going to get eaten in six months." As a result, mice are best suited for short lifespans where they grow up and have a bunch of babies within a couple of months.

"Now, let's say you teach the mouse to fly, and you've got a bat," Miller says. "Because they can fly, almost nothing can catch them and eat them." Bats aren't pressured to rush reproduction the way that mice are. They can stretch out their aging process, growing up more slowly and having babies over a longer stretch of time.

Animals that wait to have babies until they are more mature may make better parents, says

Steven Austad. This biologist from the University of Alabama at Birmingham is an expert on aging. Having fewer babies at once over a longer period of time, he adds, could boost the odds that some young will be born in good environmental conditions that help them survive.

So, for bats — which stand a much better chance of avoiding death than mice — it's useful to have a body that can last decades. The result: Some bats have evolved to live more than 30 years.

Another feature that can lead to slow-aging species is being big. Think of elephants, Miller says.



predation."This has allowed elephants in the wild to live up to about 60 years.

The protective nature of the ocean can also lead to long lifespans. "The longest-lived animals are all in the ocean. And I don't think that's an accident," Austad says. "The ocean is very, very constant. Particularly the deep ocean."

None of these protections, though, seems to apply to Grogu. He can't fly. He's not a sea creature. He's not even very big. But he probably has a big brain.

for a mammal of that size," Austad says. Humans have especially big brains for primates and live about 4.5 times as long as expected. "Bigger brains make better decisions, see more possibilities, are more finely tuned to changes in the environment," Austad says. Those insights help quick-witted animals evade death. That, in turn, could have opened up the opportunity for us to develop long lifespans. The same may be true for Grogu's species.

For slow-aging animals like Grogu to last so long, their bodies

Miller's team has found that long-lived birds, primates and rodents all have more of this enzyme in their mitochondria than do their shorter-lived relatives. This hints that the enzyme may help slow-aging animals live a long time. The group has also identified other cell parts that seem to be connected with long lifespans. If future drugs can give humans more of this cellular machinery, we may someday boast the long lifespans of Grogu and Yoda.

- Maria Temming 🕨

#### The many states of matter

#### Solid, liquid and gas are just the beginning

ce, water and vapor are three distinctly different forms — or states — of water. They are all the same chemical, H<sub>2</sub>O, only in different states. Solid (the ice), liquid (the water) and gas (the vapor) are the three most common states of matter on Earth. But they're not the only states. And the most common state in the universe is none of those three; it's plasma. Here are the differences between them:



The atoms and molecules that make up a solid are tightly packed together. Materials in this state have a definite volume and shape that is maintained without the help of a container. A desk, phone and tree are all examples of matter in its solid form.

#### **LIQUID**

A liquid's atoms and molecules are less tightly packed. Materials in this state have a definite volume but no defined shape, and squeezing will not compress them into a smaller volume. A liquid will take the shape of any

container into which it's poured but will not expand to fill the entire container. Water, shampoo and milk are all liquids.

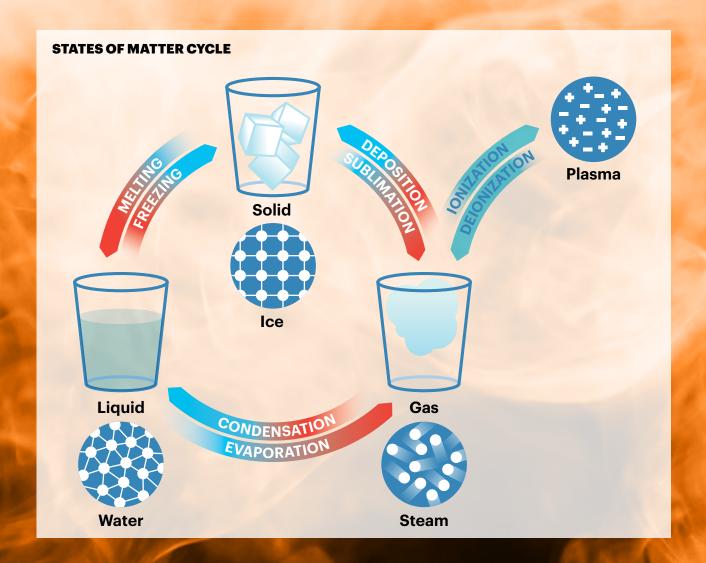
#### **GAS**

The atoms and molecules of a gas move more rapidly and freely than those in a solid or liquid. Materials in this phase have no definite volume nor shape. A gas will both take the shape of its container and expand to fill that container. Examples of common gases include helium (used to make balloons float) and the oxygen in the air we breathe.

#### **PLASMA**

Like a gas, this state of matter has no definite shape nor volume. Unlike gases, however, plasmas can both conduct an electric current and create magnetic fields. What makes plasmas special is that they contain ions — atoms with an electric charge. A plasma can be created by heating a gas to extremely high temperatures. A plasma may also form when a jolt of high voltage moves across a space of air between two points. Lightning and neon signs are examples of partially ionized plasmas. Plasmas are often found in stars, including our sun. — Allison Gasparini 🕨

A geyser in Iceland exhibits the three main states of matter of H<sub>2</sub>O. Liquid H<sub>2</sub>O is known as water. The steam coming off the geyser is the gas form of H<sub>2</sub>O, and the surrounding snow shows H2O in its solid state.



#### **THREE LESSER-KNOWN STATES OF MATTER**

Bose-Einstein condensate: Very-low-density atomic matter that has been cooled to near absolute zero. This state forms only under carefully controlled, extreme laboratory conditions.

Degenerate matter: This state of matter develops when a gas is super-compressed. It now begins to act more like a solid, even though it remains a gas.

Quark-gluon plasma: As its name suggests, this is made up of the elementary particles known as quarks and gluons. A quark-gluon plasma was the first form of matter to fill the universe following the Big Bang.

#### Wildfires are lofting more pollution into U.S. skies

#### New maps estimate people's exposure to harmful airborne particles

n parts of the western United States, sometimes the sky looks gray, and the sun is hidden from view. Not because of clouds but because of wildfire smoke. That smoke contains tiny particles that are harmful to health. Now, researchers have found that exposure to such pollution has grown in the United States over the past decade as wildfires have gotten bigger and more common.

"There's so many health effects from particulate matter," or PM, says Marissa Childs. An environmental health researcher, she works at Harvard University in Cambridge, Mass. Especially concerning are really small particles, called PM<sub>25</sub>. These are smaller than 2.5 micrometers. That's about one-twenty-fourth the width of a strand of hair.

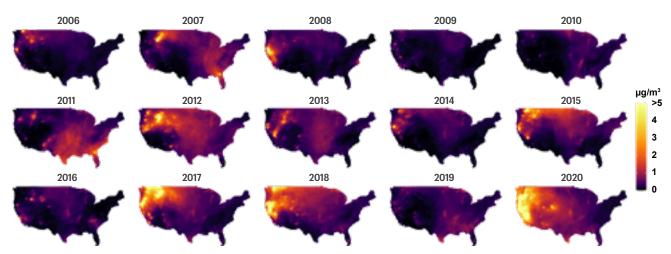
Health risks from such particles include asthma and shorter lifespans. To find out how much smoke PM<sub>25</sub> that people are exposed to in different places, Childs' team made maps of the pollution. They did this using data from about 2,000 air monitoring stations across the United States, as well as satellite images of wildfire smoke.

The resulting maps, published in Environmental Science & Technology, show estimates for the daily smoke PM<sub>2.5</sub> that people across the continental United States were exposed to from 2006 to 2020. (The maps did not include Alaska or Hawaii.)

"We especially see a really large increase in the number of extreme days with high pollution levels," says Childs. In 2020 alone, 25 million people experienced at least one day where PM<sub>2.5</sub> levels were over 100 micrograms per cubic meter. On days with such high pollution, people in affected areas shouldn't be spending a lot of time outside. — Carolyn Wilke

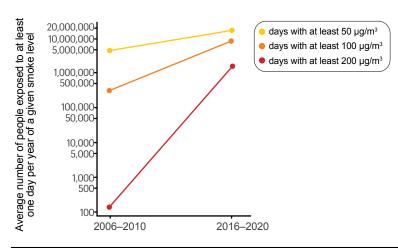


#### WILDFIRE SMOKE ACROSS THE UNITED STATES



These maps show the average daily smoke  $PM_{2.5}$  concentrations for the United States from 2006 to 2020. Those concentrations are measured in micrograms per cubic meter (µg/m³).

#### **INCREASING SMOKE EXPOSURE**



This graph shows the change in exposure to extreme levels of PM25 from smoke over the last decade. Days with PM<sub>2.5</sub> levels above 50 micrograms per cubic meter (µg/m³; yellow line) are considered extreme days. The orange line shows days with greater than 100 µg/m3. The red line shows days above 200 µg/m3. The y-axis is on a logarithmic scale. That scale more easily shows the huge range of smoke exposure.

Researchers calculated the number of people exposed to at least one day a year at these levels. They averaged those results from 2006 to 2010. They also averaged the results for 2016 to 2020. The change across the last decade is the later years' value minus the earlier years' value.

#### **DATA DIVE**

- Look at the maps of the United States. From 2006 to 2020, which years have the highest concentrations of smoke PM<sub>25</sub>?
- **2.** What parts of the country have the highest levels of smoke PM<sub>25</sub> in those years? What parts have the lowest levels?
- Look at the graph. What is the value for days greater than 50 micrograms per cubic meter (µg/m³) for 2006 to 2010? What is it for 2016 to 2020?
- 4. What is the value for days greater than 200 μg/m³ for 2006 to 2010? What is it for 2016 to 2020?
- **5.** Which exposure level of PM<sub>2.5</sub> increased the most drastically? Why do you think that is?
- **6.** Why do you think the researchers chose to average across five years of data to calculate differences that happened in the last decade? What would happen if they instead used only a single year where there were more wildfires, such as 2020?

#### This ancient critter had spines but no anus

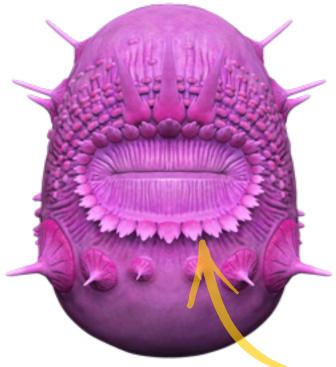
#### The 'angry minion' was about a millimeter long

o ifs, ands or butts about it. A teeny critter that lived several hundred million years ago did not have an anus. It had been thought to be an early member of a group of animals that includes humans. But no more. New 3-D imaging of holes on its body suggests it was more closely related to insects.

Most fossils of this animal had been flattened. It made the Saccorhytus coronarius fossils look "like a very sad balloon that's collapsed in on itself," says Philip Donoghue. He's a paleontologist at the University of Bristol in England. His team's new 3-D pictures, shared in the journal Nature, bring S. coronarius to life. It appears a bit like a wrinkly potato — or perhaps an angry minion. But a very small one. It's just about a millimeter (four-hundredths of an inch) long.

Why this critter had no anus is a puzzle. Some other animals lack one. Jellyfish are one example. To get around the problem, they vomit out their food wastes. But members of the group that contain insects (and the group that contains us) usually do have anuses. That makes S. coronarius an uncomfortable fit in either group.

Still, "if you haven't got an anus," Donoghue jokes, "you're not going to be very comfortable anywhere." — Anna Gibbs



This 3-D reconstruction shows what the extinct animal Saccorhytus coronarius may have looked like. The views of the front (left) and back (right) helped scientists reclassify this critter.



Fun fact: Holes left behind by spines were once mistaken for early gill slits.

#### INSIDE THE MIND OF A SCIENCE AWARD WINNER

A winner of Regeneron Science Talent Search — Society for Science's most prestigious competition — answers three questions about science

Cience competitions can be fun and rewarding.
But what goes on in the mind of a winner? Regeneron Science Talent Search (STS) 2022 champion
Christine Ye shares some of her science inspiration and gives advice for young scientists.

#### Q Which scientist — alive or deceased — would you want to solve scientific mysteries and why?

A I'd love to work with Kip Thorne! Thorne received the 2017 Nobel Prize in Physics for his pioneering work in building the Laser Interferometer Gravitational-Wave Observatory (LIGO), which was the focus of my STS project. Funnily enough, Thorne himself was in the 1958 STS class, back when it was the Westinghouse Science Talent Search! I truly admire Thorne's combination of brilliance and range.

#### Q What would you like to be renowned for?

A I'd like to be renowned for using a creative, interdisciplinary and technical approach to making a difference in humanity's knowledge. No matter where I end up, I'll keep chasing the multifaceted thrill of solving hard problems and hopefully help crack open our universe's mysteries.

#### Q What would you say to inspire the next generation of scientists?

A Just give things a try! If there's anything I've learned through my scientific research, it's that you can't expect anything to go according to plan. But those moments of aimlessness are often where one experiences the beauty of discovery. Being openminded and willing to ask interesting questions can take you a long way in science, even if you don't necessarily have the most expertise or experience in a given field. So don't overthink things, and don't expect to have everything planned out — just go build that prototype, explore that dataset, test out that experiment and proceed from there!



#### 1st Place Winner **Christine Ye**

Christine, now 18, studied gravitational waves emitted in powerful collisions between neutron stars (collapsed super-dense stars) and black holes. She analyzed data collected by LIGO to model rapidly rotating neutron stars and showed that a fast-spinning neutron star could be super massive yet would still be smaller than a black hole. Since winning, Christine has moved from her hometown of Sammamish, Wash., to Palo Alto, Calif., to attend Stanford University.





REGENERON

SCIENCE TALENT SEARCH

A program of SOCIETY FOR SCIENCE
Since 1942

#### REGENERON SCIENCE TALENT SEARCH

recognizes and empowers our nation's most promising young scientists.

Learn more at societyforscience.org





