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ScienceNews

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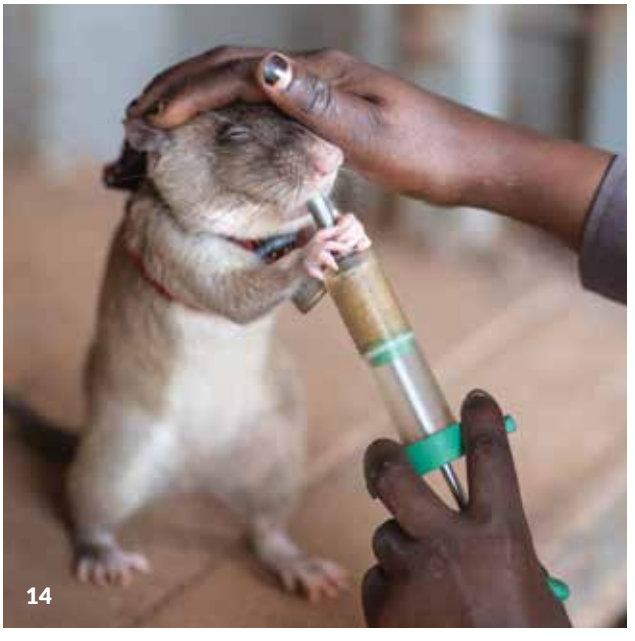
News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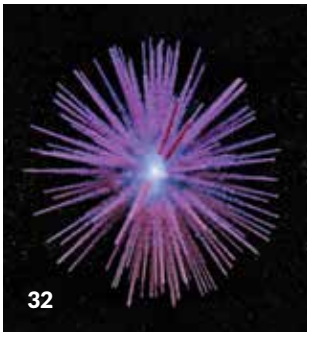
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Departments

COVER Brandon Wall demonstrates a prototype bionic limb developed in the lab of MIT bionicist Hugh Herr. *Jimmy Day/MIT Media Lab*

FROM TOP: MILO MITCHELL/UCLA HEALTH; ADAM MAKARENKO, W.M. KECK OBSERVATORY; APOPO

Re-engineering where body meets machine

The human body is a marvel of engineering, but it's a machine that requires maintenance and repair. At times, that means trying to replace parts lost to injury or illness. The oldest known prosthesis is the "Cairo toe," crafted out of wood and leather and thought to be 2,700 to 3,000 years old. Its flexibility as well as signs that it was repaired multiple times suggest that it wasn't built just for appearance — it helped the person walk.

Many efforts to improve replacement body parts followed, including a leg made from bronze and hollowed wood created in what's now Italy around 300 B.C. Some people in Switzerland and Germany in the fifth to eighth centuries sported wood, iron or bronze feet. In the 15th century, cranks, gears and springs made artificial limbs more functional for those who had at least one hand to manage the hardware. The technology has improved exponentially since then, but one key challenge remains: making the replacement limb easy for the user to control. To solve that major problem, researchers are flipping the script and re-engineering the human body.

In this issue, we explore efforts to restore senses such as proprioception, a person's sense of where their body is in space, after an amputation (Page 22). Such efforts involve engineers who design prostheses in collaboration with surgeons. The surgeons reroute muscles affected by amputation, realigning them so they generate electrical signals more typical of uninjured musculature. Those signals then direct joints in the prosthesis. In a recent study, people with these new muscle-to-prosthesis interfaces increased their top walking speed by 40 percent. Other engineer-surgeon collaborations have rerouted nerves in order to send stronger signals to a prosthesis, or have connected an artificial limb directly to bone to avoid the too-common issue of pain caused by a prosthetic socket. In a paper, one of the scientists termed it "co-engineering the body and machine."

We also delve into a very different form of research: fieldwork. Charles Darwin became famous for developing his theory of evolution by painstakingly gathering specimens of plants, animals and fossils around the world. Most field researchers never become household names, but their work matters.

I didn't know about Margaret S. Collins, who became a global expert on termites, until our life sciences writer Susan Milius proposed a profile of Collins as part of our Unsung Characters series (Page 16). And what a life she led. As a Black woman born in West Virginia in 1922, she was a contemporary of the *Hidden Figures* mathematician Katherine Johnson, and like her peer, Collins contended with both racism and sexism, which impeded her efforts to participate equally in the sciences and in society. Nevertheless, Collins persisted, becoming the first Black female entomologist Ph.D. in the United States, raising two sons and conducting field research in the United States, Central and South America, and the Caribbean.

Collins made fundamental observations about how termites adapt to hostile dry environments and provided a wealth of data for evolutionists investigating how related species become so diverse. The "termite lady" also opened the door for other women who dreamed of a life as a scientist in the field.

— *Nancy Shute, Editor in Chief*

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Excerpt from the November 23, 1974 issue of *Science News*

50 YEARS AGO

A surprising new particle

To add to the present ferment and confusion in particle physics, nature now presents the oddest new particle to turn up in many years.... Theorists are at a loss for the moment about what to do with it.... The new particle is the heaviest yet found ... [and] its lifetime of 10^{-18} seconds ... is long for a particle of that mass. There must be some unheard of kind of structure to keep the particle together for so long.

UPDATE: The newfound subatomic particle, called J/psi, could be explained only as a mash-up of a new type of quark, the charm quark, and its antimatter counterpart. This discovery, known as the November revolution, spurred others that finally confirmed that quarks are fundamental building blocks of matter — a cornerstone of the standard model of particle physics. J/psi still perplexes scientists. For instance, researchers with the ATLAS experiment, a particle detector at CERN's Large Hadron Collider near Geneva, are working to figure out how exactly the particles are produced in high-energy proton smashups.

Male mosquitoes like this *Aedes aegypti* will drink blood when dehydrated, lab experiments show.

RETHINK

Male mosquitoes can suck blood, too

Male mosquitoes may be nearly as bloodthirsty as females under certain conditions, new research suggests.

Male *Culex tarsalis* and *Aedes aegypti* mosquitoes, which are normally disinterested in blood, will take blood meals when they are dehydrated and can't get nectar, entomologist Jason Rasgon of Penn State and colleagues report October 8 in a paper posted to bioRxiv.org.

The finding upends the notion that only female mosquitoes bite, drink blood and spread diseases. Males may not be entirely harmless.

A graduate student in Rasgon's lab noticed that male mosquitoes would sometimes feed on blood in a tray covered by a thin artificial membrane when researchers took away water and their usual nectar meals.

Rasgon wanted to know if parched males would try to get blood from a person, so he stuck his hand in cages containing male mosquitoes. Hydrated males mostly ignored him, but dehydrated males would land and probe his skin. One even bit him.

"It just barely got into the first layer of the skin," Rasgon says. "I was shocked [and] was not expecting that to happen."

Male mosquitoes' long, tubelike mouth parts aren't capable of piercing skin deeply enough to draw blood. But a scratch delivered by Rasgon's cat, Jiji, allowed him to test whether males could get blood another way. Sure enough, a dehydrated male mosquito sipped blood from the open wound.

In another experiment, *A. aegypti* males that were genetically engineered to be unable to sense humidity didn't take blood meals more often when deprived of water. Those findings suggest that males may go for blood to slake their thirst.

One previous research paper indicated that blood is toxic to male *Culex quinquefasciatus* mosquitoes, and scientists thought all male mosquitoes lacked the ability to digest blood. But in Rasgon's experiment, male *C. tarsalis* mosquitoes fed only blood lived as long as those that didn't get blood, and even a smidge longer.

In nature, female *A. aegypti* mosquitoes are the main carriers of yellow fever, but can also spread Zika virus, chikungunya and dengue, while female *C. tarsalis* mosquitoes can spread West Nile virus, St. Louis encephalitis and related diseases (SN: 6/13/15, p. 16). Male *C. tarsalis* mosquitoes can be infected with West Nile and produce infectious virus in their saliva just like females can, the researchers found. So in theory, males could spread disease.

Rasgon doubts males are important spreaders of disease, but scientists need to reconsider the idea that male mosquitoes don't feed on blood and should study whether, in rare instances, they might be able to spread viruses.

— Tina Hesman Saey

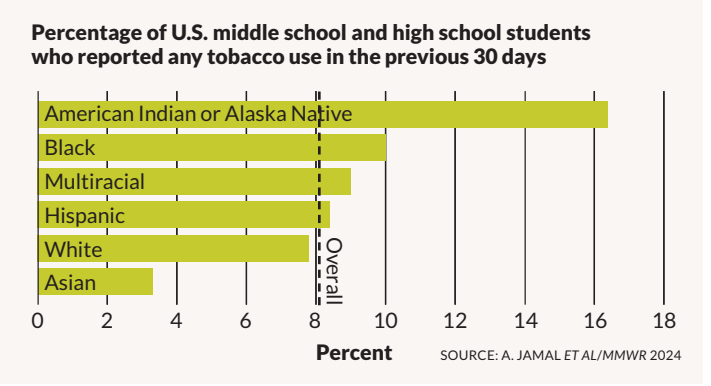
CDC/SCIENCE SOURCE

SCIENCE STATS

Tobacco use tapers among U.S. teens

The lowest number of U.S. teens and tweens in 25 years are using tobacco products.

According to the 2024 National Youth Tobacco Survey, about 8 percent of middle and high school students — or 2.25 million — reported using any tobacco products in the previous 30 days (dashed line in the graph, right). As recently as 2019, 23 percent, or just over 6 million, had reported current tobacco use. Of those students, 20 percent were using e-cigarettes.



E-cigarettes are still the most popular choice, used by 6 percent of students in 2024, researchers report October 17 in *Morbidity and Mortality Weekly Report*. Nicotine pouches — a product that releases nicotine, the addictive substance in tobacco, when placed between the cheek and gum — came in second for the first time at nearly 2 percent, followed by cigarettes, cigars and smokeless tobacco. The National Youth Tobacco Survey was first administered in 1999.

Disparities in tobacco use still exist among tweens and teens from different racial and ethnic groups. Past research has found that the tobacco industry has long targeted certain groups via advertising and marketing, including promoting menthol cigarettes to Black communities and using tribal icons to target American Indian and Alaskan Native people.

Tobacco use most often begins in adolescence, a time when exposure to nicotine can be especially harmful to the developing brain. Nicotine affects memory, attention and learning. Tobacco control programs at the federal, state and local levels have contributed to the drop in use, the researchers write. — *Aimee Cunningham*

The oldest known fossil of a tadpole preserves part of the spine (chain of ridges) and the eyes (two dark spots near the top of the photo).

FROM TOP: C. CROCKETT; M. CHULIVER PEREYRA *ET AL*/*NATURE* 2024

THE –EST

This fossilized tadpole was a big baby

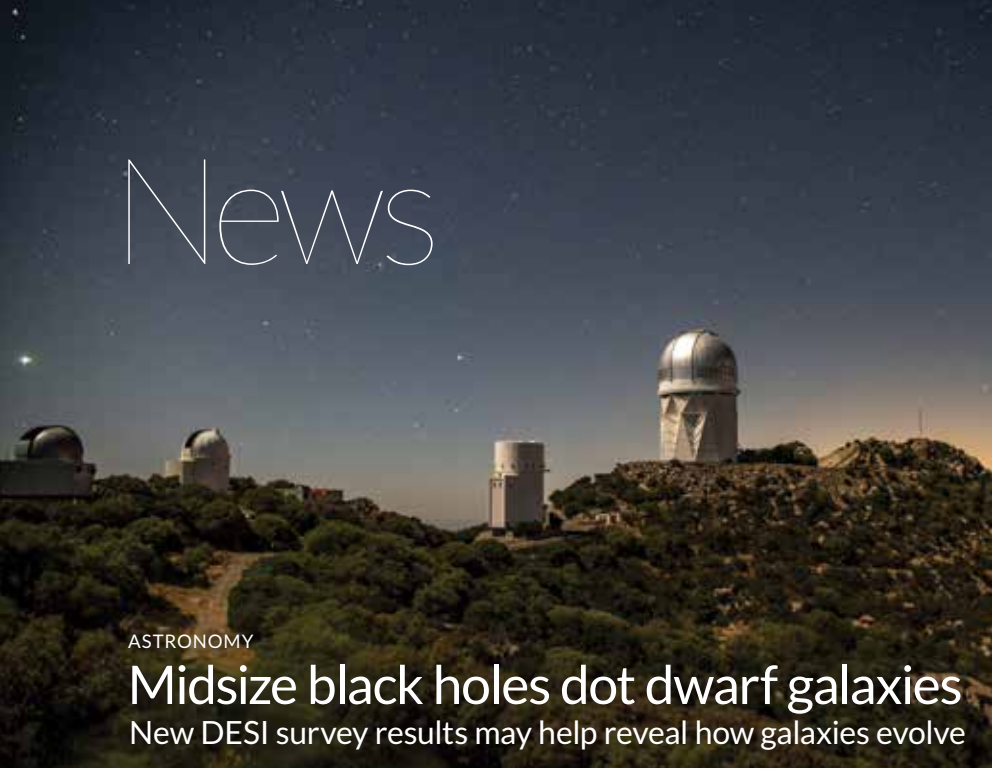
Tadpoles have been wriggling in ponds for at least 161 million years.

A newfound fossil pushes the record for earliest known tadpole back by 30 million years, scientists report October 30 in *Nature*. The petrified pollywog shows that the filter-feeding, puddle-dwelling traits of modern tadpoles had already evolved in some of the earliest frogs.

In 2020, scientists in Argentinian Patagonia found hundreds of fossilized frogs of the extinct species *Notobatrachus degiustoi*. Among them was a tadpole. Evolutionary biologist Mariana Chuliver Pereyra of the Félix de Azara Natural History Foundation in Buenos Aires and colleagues identified the fossil as the same species as the adult frogs thanks to shared features of the vertebrae. The tadpole was far along in its development, and some of its hind legs and forelegs had formed. It was also well-preserved, with soft tissues, including the eyes, set in sandstone.

The tadpole lived between 168 million and 161 million years ago, during the Jurassic Period. While that's about 20 million years after the first frog in the fossil record, the finding represents "the oldest tadpole found to date," Chuliver Pereyra says. The amphibian wasn't just ancient; it was huge, estimated to be about 16 centimeters from snout to tail tip. Modern tadpoles commonly are no more than a couple centimeters long. *N. degiustoi* was big throughout its life, much like the modern American bullfrog (*Lithobates catesbeianus*).

What's more, the ancient tadpole's preserved throat skeleton shows it fed like modern tadpoles do, sucking and straining food particles out of the water. Filter-feeding must have been a winning evolutionary strategy. — *Jake Buehler*



Astronomers are running a vast survey of the cosmos using an instrument on the Mayall telescope (far right) at the Kitt Peak National Observatory in Arizona.

ASTRONOMY

Midsize black holes dot dwarf galaxies

New DESI survey results may help reveal how galaxies evolve

BY LISA GROSSMAN

A colossal census of the cosmos has more than tripled the number of active black holes known to reside in miniature galaxies. It also found the biggest haul of middleweight black holes to date.

The survey turned up about 2,500 dwarf galaxies with actively feeding black holes at their centers, up from about 500 known before, astronomer Ragadeepika Pucha and colleagues report October 31 in a paper posted to arXiv.org. The team also found nearly 300 intermediate-mass black hole candidates, an increase from about 70 previous possible detections.

That's enough to start studying these black holes as a group, rather than in isolation, says Pucha, of the University of Utah in Salt Lake City. Such large-scale studies could solve many mysteries of how black holes and their galaxies evolve together.

Every large galaxy seems to have a supermassive black hole at its center. These behemoths can be over a million times as massive as the sun. But scientists are not sure how the black holes got there.

"It's a bit of a chicken-or-egg question between galaxies and black holes," says study coauthor Stéphanie Juneau, an astronomer at NOIRLab in Tucson. "Which one formed first? Does one control the other?"

Dwarf galaxies and midsize black holes may be the best places to look for answers. These runts are thought to represent the earliest stages of galaxy and black hole growth, objects that have escaped many mergers with other black holes and galaxies over cosmic time.

"To get a complete picture of galaxy formation and evolution, we have to understand how these small galaxies evolve and grow," Pucha says.

Pucha's team turned to data from a project using the Mayall telescope in Arizona to create a 3-D map of the universe. In its first year, the Dark Energy Spectroscopic Instrument, or DESI, survey observed nearly 1.5 million galaxies (SN: 5/4/24 & 5/18/24, *p.* 6). The team searched some of that collection for dwarf galaxies that emit light linked to the hot disk of material swirling around an actively feeding black hole.

Of the nearly 115,000 dwarf galaxies the team found, about 2 percent emit such light. Previous surveys found active black holes in just 0.5 percent of dwarf galaxies.

The researchers also determined the masses of the black holes in more than 4,000 galaxies, dwarf and not. Then the team searched for intermediate-mass black holes, with masses between about 100 and a million times the sun's.

"These are very important because they tell us about how the first black holes were formed in the universe," Pucha says. If black holes start out small and grow through merging with other black holes, then the universe should be littered with these middleweights that represent the in-between stages of growth.

Pucha and colleagues found about 150 confident detections in the DESI data and about the same number of tentative ones, which suggests the first black holes in the universe were relatively lightweight.

But the James Webb Space Telescope, or JWST, has turned up surprisingly massive black holes in the very early universe. That could just mean that JWST hasn't seen the earliest black holes in the universe yet, Pucha says.

This DESI survey probably found just the tip of the iceberg. The full first-year dataset, slated for release in 2025, will contain a lot more galaxies and undoubtedly more black holes. "They've found all the ones that are really bright spotlights," says astronomer Mallory Molina of Vanderbilt University in Nashville. "Even with the most simplistic detection tool we have, [the researchers are] still finding a huge number in this survey. There's a lot more to be explored." ■

Scientists found a bunch of dwarf galaxies, including the ones shown here, that have midsize black holes. They could reveal how galaxies and black holes evolve together.

OBSERVATORY: MARILYN SARGENT/© THE REGENTS OF THE UNIV. OF CALIFORNIA, LAWRENCE BERKELEY NATIONAL LABORATORY; GALAXIES: LEGACY SURVEYS, D. LANG/PERIMETER INSTITUTE, NAOJ, HSC COLLABORATION

ASTRONOMY

Did a fading star fail to explode?

The dramatic dimming might mark the birth of a black hole

BY EMILY CONOVER

Some massive stars may go out with a fizzle, not a bang.

A star that winked out of view could be a failed supernova, a stellar explosion that petered out instead of fully detonating, scientists report. If real, the failed supernova would mark the birth of a black hole.

At the end of their lives, massive stars explode in dazzling outbursts known as supernovas, kicked off when the star's core collapses. But sometimes, scientists suspect, there's not enough oomph for a full explosion, resulting in a star that switches off without fireworks.

No one has ever conclusively detected a failed supernova. But now, there's a new candidate. Visible light from the star, a supergiant in the Andromeda galaxy, faded dramatically beginning in 2016 and fully vanished by 2023, MIT astrophysicist Kishalay De and colleagues report October 18 in a paper posted to arXiv.org.

"It's what you expect [from a failed supernova]. You have something there that's bright and luminous and looks like a massive star, and then it disappears," says astrophysicist Morgan Fraser of University College Dublin.

But the discovery isn't yet confirmed. "There's a lot of other things … that can look a little bit similar and mislead you," Fraser says. For example, clouds of dust can shroud stars, dimming them.

Another puzzle: Scientists expect to see some tumult from a failed supernova, as the star's outer layers should puff off. But De and colleagues saw no visible light show. The star may have previously been stripped of some of its outer envelope of hydrogen. De declined to comment as the study has not yet been peer-reviewed.

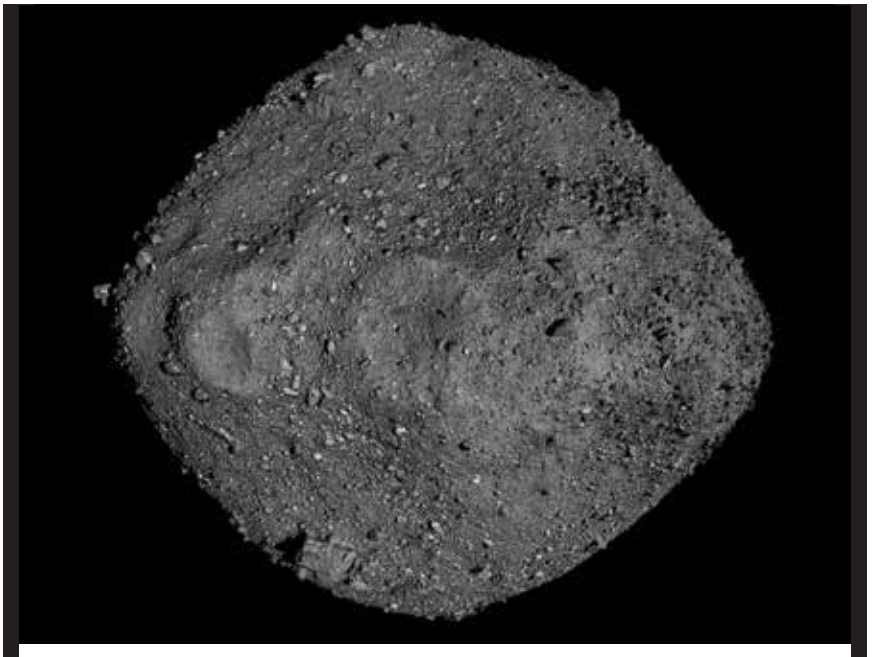
In a failed supernova, when a star collapses, it forms a black hole. So conclusively catching a supernova fail would be an astronomical win. "For the moment, it's the only feasible way of actually seeing a black hole being formed," says astrophysicist Christopher Kochanek of the Ohio State University.

Kochanek and colleagues previously reported a possible failed supernova (*SN: 10/15/16, p. 8*). But scientists are still working to rule out other possible explanations. Follow-up observations with the James Webb Space Telescope, or JWST, showed an infrared glow, Kochanek's team reported in the Feb. 20 *Astrophysical Journal*. That infrared light could be emitted by residual matter falling into a newly formed black hole. Or it could be due to two stars merging and kicking up a cloud of dust.

Likewise, some infrared glow persisted from the newfound vanished star, even though the visible light disappeared. That leaves it in a similar limbo about whether it's a failed supernova. Sparse observations make it "very difficult to tell the difference," says astrophysicist Griffin Hosseinzadeh of the University of California, San Diego.

Additional data from JWST could help nail down the origins of both purported failed supernovas. Scientists could also look for X-rays, which could be produced if there's a black hole swallowing matter.

Understanding the death throes of stars is important for determining how galaxies get their populations of black holes and neutron stars, and how the heavy elements formed in stars get blasted throughout the cosmos. Eventually, scientists hope to be able to predict a star's ultimate fate. ■



GODDARD/NASA, UNIV. OF ARIZONA

PLANETARY SCIENCE

Bennu offers clues to a dark matter theory

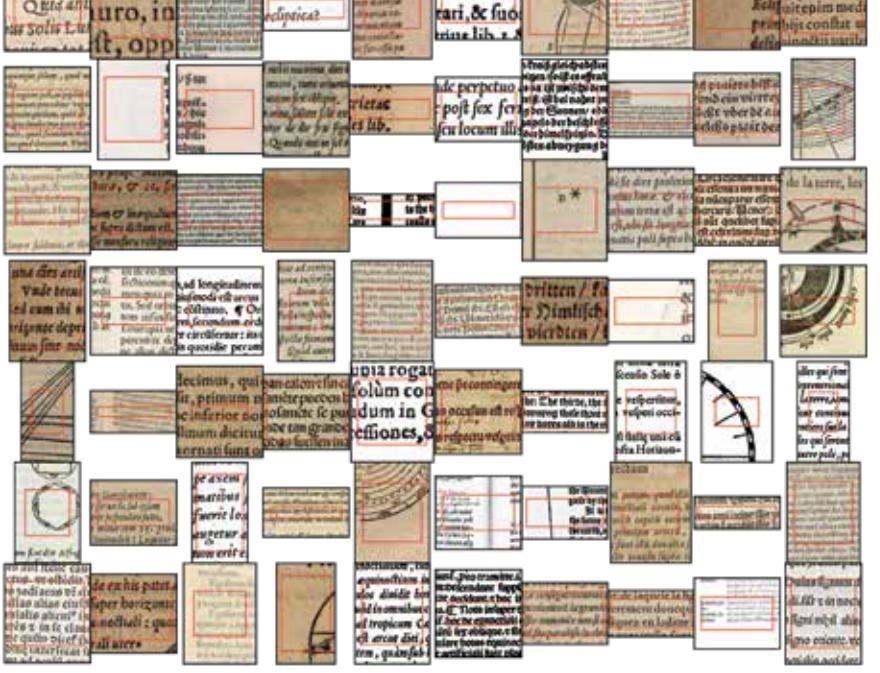
A hypothetical "fifth force" could tug on asteroids. But the asteroid Bennu (shown above) exhibits no signs that its orbit has been tweaked by such a force, setting a ceiling on how strong a potential fifth force could be, scientists report September 20 in *Communications Physics*. The four known forces — electromagnetism, gravity, and the strong and weak nuclear forces — are carried by particles. If a fifth force exists, its particle could play the role of dark matter. Data from NASA's OSIRIS-REx spacecraft on Bennu's trajectory allowed scientists to search for a fifth force associated with particles that are very lightweight, perhaps a trillionth of a trillionth the mass of an electron. Measurements of more asteroids could help scientists broaden the search to cover a range of potential masses. — *Emily Conover*

ARTIFICIAL INTELLIGENCE

AI tracks history of astronomy

Scientists chart the spread of ideas in 16th century Europe

BY LISA GROSSMAN



An AI model trained to recognize varied writings and drawings (a subset shown) in historical textbooks has helped researchers track the spread of astronomy across Europe.

Historians working with an artificial intelligence assistant have begun tracking the spread of astronomical thinking across Europe in the 1500s.

The analysis challenges the "lone genius" idea of scientific revolutions. Instead, it shows that knowledge about the positions of the stars was widespread and used in a variety of disciplines, researchers report in the Oct. 25 *Science Advances*.

"We can see here the first formation of a proto-international scientific community," says computational historian Matteo Valleriani of the Max Planck Institute for the History of Science in Berlin. Valleriani and colleagues used AI to examine a digitized collection of 359 astronomy textbooks published from 1472 to 1650.

These textbooks were used to teach introductory classes on geocentric astronomy—the view of the cosmos that places Earth at the center and moves outward in sequential spheres. Knowledge of the positions of the stars was thought to be important for studying everything from medicine to Latin poetry, so astronomy classes were mandatory for all students. Among other things, students learned to use the position of the sun in the constellations of the zodiac to figure out the date of an event that happened in antiquity, before standardized calendars were common.

Studying these texts can give historians an idea of the knowledge educated people had about the universe and how that understanding changed over time.

The dataset included 76,000 pages of text, images and numerical tables, many with different fonts, formats and layouts. A historian might be able to analyze a handful of books in a career. But Valleriani and colleagues wanted to study all of them.

The team used machine learning to identify 10,000 pages with numerical tables in the textbooks. Next, the group trained an AI model to recognize individual numbers in the tables. Once the AI had extracted the numbers, it compared the different tables one by one and highlighted similarities and differences. For example, some textbooks were basically reprints of an earlier edition and their tables were almost identical. Others introduced new ideas or new ways to use astronomical data.

The AI couldn't tell the researchers what those similarities and differences meant. But it could give them a place to look for trends or moments of change. "It's moving from AI being used as a tool, to help do something I preconceived, to using AI as a team member, suggesting new solutions that I couldn't see," Valleriani says.

A common story about astronomy during this time is that individual heroes of science, like Copernicus, Galileo and Kepler, shook the world by showing that Earth is not the center of the universe.

But historians of science have been moving away from the idea that science is driven by such lone geniuses making big discoveries. Those discoveries had social, political and cultural contexts, and they had to be disseminated into the wider culture somehow. "When you deal with the scientific revolution, the triumph of the Copernican world view, we know the big names," says computational scientist Jürgen Renn of the Max Planck Institute of Geoanthropology in Jena, Germany, who was not involved in the new work. "But in Europe, this was a broad movement. There were many participants."

One of the team's major findings is that textbooks printed in Wittenberg, Germany, in the 1530s were widely imitated elsewhere in Europe. Similar books that were sold in cities with bigger markets, like Paris and Venice, created a new, homogeneous approach to astronomy.

Valleriani finds this ironic. Wittenberg is best known for being the city where Martin Luther kick-started the Protestant Reformation, which split a new branch of Christianity off from the Catholic church.

"It sounds paradoxical," Valleriani says. "While Wittenberg and the Protestant Reformation was dividing Europe … and creating the background against which wars came out, at the same time, Wittenberg was able to develop a scientific approach at the educational level that was in truth taken over everywhere."

There are limitations to this kind of research. Historical data are always incomplete, and historians have to choose a subset of that data to focus on. AI can't account for that bias, so historians must be part of the process, the researchers stress.

This work "shows how historians can in the future deal with artificial intelligence methods," Renn says, "and cleverly use them without this utopian or dystopian illusion that they can do the work for you." ■

O. EBERLE *ET AL*/*SCIENCE ADVANCES* 2024

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HEALTH & MEDICINE

Lizard spit can help detect rare tumors

A protein found in the saliva flags pancreatic growths in scans

BY ROHINI SUBRAHMANYAM

A molecule in lizard saliva could make it easier to find small tumors in the pancreas.

Insulinomas — typically benign tumors that can cause low blood sugar, sudden fainting spells and seizures — are notoriously hard to detect using current scanning methods. But by using a variant of a protein found in Gila monster saliva as a radioactive tracer, a new type of PET scan found the tumors in nearly 95 percent of confirmed cases, nuclear medicine researcher Martin Gotthardt of Radboud University Medical Center in Nijmegen, Netherlands and colleagues report October 17 in the *Journal of Nuclear Medicine*. Standard PET scans had just a 65 percent success rate, the team found.

One of the main functions of the pancreas is to produce insulin, a hormone that keeps blood sugar levels in check. The task of making insulin falls to beta cells, but sometimes these cells malfunction and form insulinomas. These tumors, which affect just 1 to 4 people in a million per year globally, can be cured with surgery.

Enter the Gila monster (*Heloderma suspectum*), a lizard found in the U.S. Southwest. A protein in its saliva, exendin-4, can be made in the lab. The lab-made version is used to treat diabetes, prompting beta cells to make more insulin. Insulinomas contain a high amount of the surface proteins found on beta cells that exendin-4 binds to. That means exendin-4 could be used to locate those surface proteins on tumors.

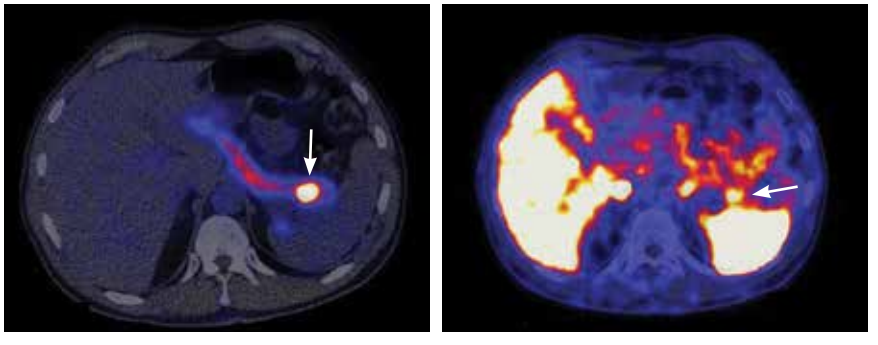
Previous studies had shown that exendin-4 attached to a radioactive molecule could detect insulinomas in PET scans. But successful scans required a high dose, which caused nausea, headaches and low blood sugar in some people.

Gotthardt and colleagues added another molecule to the exendin-4 tracer that lets doctors use a lower dose and still get strong signals in PET scans. Of 53 people who underwent standard imaging tests and a PET scan using the new tracer before having their insulinomas surgically removed, the tumors showed up in 50 of the exendin-4 PET scans and just 35 of the standard scans. In seven cases, the exendin-4 scans detected insulinomas while standard PET, CT and MRI imaging found nothing.

Compared with standard PET scans, the exendin-4 tracer was good at picking up only the insulinomas and not other tissues. It also had fewer side effects on patients compared with previous versions.

The work "is very valuable in showing how exendin-4 could be used in the diagnosis of insulinoma and maybe replace a lot of the imaging techniques that are currently used that aren't as good," says radiologist Peter Choyke of the National Cancer Institute in Bethesda, Md.

Gotthardt's team is now helping labs and hospitals set up this technique. "Everybody should be able to use it, because it really helps the patients," he says. ■



A new type of PET scan (left) detects pancreatic tumors called insulinomas (arrows) more reliably than a standard PET scan (right). It can flag just the tumor and not other tissues.

RADBOUD UNIV. MEDICAL CENTER

HEALTH & MEDICINE

A low-sugar diet in infancy may lower adult diabetes risk

War-era rationing had health benefits later in life, data show

BY SKYLER WARE

The occasional sweet treat probably won't ruin your health. But too much added sugar at a young age could increase the risk of health complications later in life.

Limiting added sugars during the first 1,000 days after conception — so during pregnancy and a baby's first two years — reduces the risk of a child developing diabetes and hypertension in adulthood, researchers report October 31 in *Science*.

"In the first 1,000 days of life, the brain and body are gearing up to finish developing," says Sue-Ellen Anderson-Haynes, a registered dietitian in Boston and a spokesperson for the Academy of Nutrition and Dietetics. Nutrition during that time frame is particularly important, she says, because "everything the mother eats gets transformed into nutrients for the fetus."

Current U.S. nutritional guidelines recommend that adults consume less than 40 grams of added sugars per day and that children under age 2 consume no added sugars. But the average American 2-year-old consumes about 29 grams of added sugars per day; the average adult consumes about 70 grams per day.

To study the effects of excess added sugars early in life, economist Tadeja Gracner of the University of Southern California in Los Angeles and colleagues took advantage of a natural experiment: the end of sugar rationing in the United Kingdom after World War II. While rationing was in effect, each person was allotted about 8 ounces (about 227 grams) of sugar per week. Shortly after sugar rationing ended in September 1953, daily sugar consumption for adults jumped to around 80 grams per day.

Even though other foods were rationed during and after WWII, sugar

intake increased the most after rationing was lifted. Consumption of other rationed foods, such as cheese, milk and fresh fruits remained relatively constant once rationing ended. Similarly, the end of butter rationing caused many families to switch from margarine back to butter, so overall fat consumption did not increase significantly.

Gracner and colleagues collected data from the U.K. Biobank for more than 60,000 participants born from October 1951 to March 1956. They divided participants into two cohorts: individuals born before July 1954, who experienced sugar rationing in utero and in early life, and those born from July 1954 onward, who did not experience any rationing.

People who experienced sugar rationing early in life were less likely to develop type 2 diabetes or high blood pressure in adulthood than people who did not experience sugar rationing, the team found. The risk of developing diabetes among people who experienced rationing was about 62 percent of the risk experienced by those whose sugar intake was not rationed. The risk of developing hypertension among those who experienced rationing was about 79 percent of the risk of those who did not.

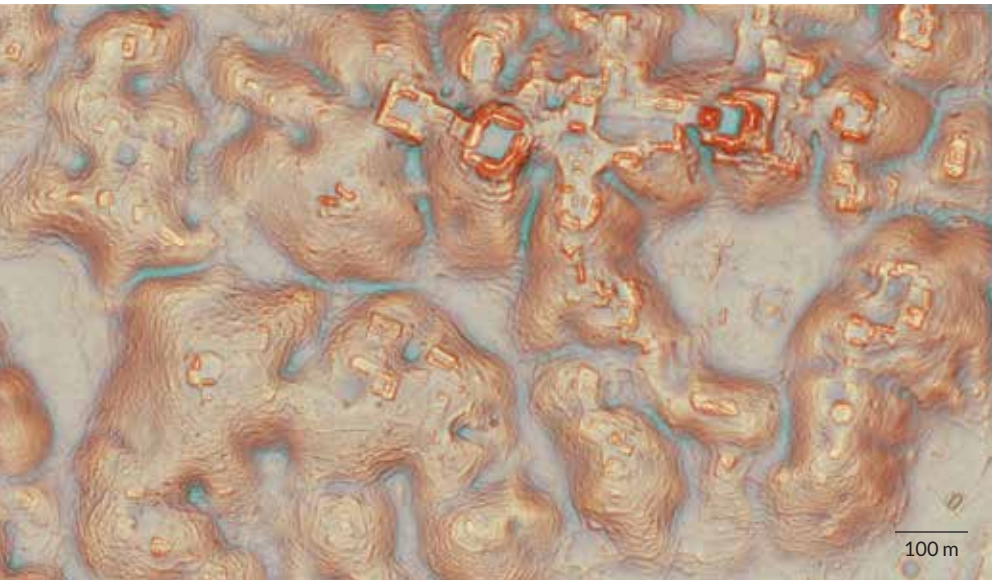
During World War II, the United Kingdom rationed sugar (stamps shown). For people who were children during that time, the rationing may have reduced diabetes risks later in life.

Kids who experienced sugar rationing early weren't immune to developing these chronic conditions, but it tended to happen later in life: four years later on average for diabetes than the nonrationed cohort, and two years later on average for high blood pressure. Participants were also less likely to develop diabetes and hypertension if they experienced sugar rationing in utero, even if the participant did not experience rationing after birth.

Avoiding added sugars can be challenging, Gracner says, especially when so many foods for both adults and young children contain them. "I don't want parents to be feeling guilty for giving their toddlers sugar sometimes," she says. More nutritional education and regulations on the marketing and pricing of sugary foods could help parents choose less-sugar-laden options for their kids and themselves, she says.

"I think we all want to improve our health and give our children the best starting life," Gracner says. "The takeaway is that reducing added sugar early is one of the powerful steps in that direction." ■

LH IMAGES/ALAMY STOCK PHOTO



Data from laser-mapping aircraft helped create a topographical map of a previously unknown ancient city in Mexico's Maya lowlands. Houses, a ball court and other structures made up the center of the city (shown).

L. AULD-THOMAS *ET AL*/*ANTIQUITY* 2024

ARCHAEOLOGY

Ancient Maya megacity revealed

The populous settlement may have been a political capital

BY MEGHIE RODRIGUES

A massive Maya landscape has been hiding under a forested area of southern Mexico.

The newfound city, dubbed Valeriana, spans an area roughly twice the size of Gibraltar and has "all the hallmarks of a Classic Maya political capital," researchers report in the October *Antiquity*. Its temple pyramids, water reservoir and plazas connected by a large passageway might have impressed ancient Maya people over 1,500 years ago.

Archaeologists have long known that the Maya lowlands, in the southernmost region of Mexico, harbor ancient urban settings (SN: 11/20/21, *p.* 14). But the discovery was still surprising.

Archaeologist Luke Auld-Thomas of Tulane University in New Orleans had been looking at random data online when he came across a dataset that Nature Conservancy Mexico was using to study carbon intake and emissions in that region. Auld-Thomas saw that the organization was looking into a place with high archaeological potential and had a hunch there could be structures there.

Further analysis showed his hunch was right. Auld-Thomas "hit the bull's-eye while blindfolded," says study coauthor Marcello Canuto, an anthropologist also at Tulane. "We weren't expecting to find such a big site with such a small dataset."

Nature Conservancy Mexico's environmental analysis had used light detection and ranging, or lidar, technology to estimate tree heights and canopy volumes. With lidar, researchers use lasers from aircraft to map undulations in a landscape. The technology has previously been used to uncover archaeological sites such as high-altitude Silk Road cities in Central Asia, a massive ancient urban complex in Ecuador and long-forgotten urban sprawl in the Amazon (SN: 11/16/24, *p.* 9; SN: 2/10/24, *p.* 7; SN: 7/2/22, *p.* 32).

While lidar beams that reached the forest ground were of little use to Nature Conservancy Mexico, they provided good data for Auld-Thomas and his colleagues to create a topographic map for the newly revealed outlines of archaeological structures.

Reprocessing that data showed that Valeriana could have been quite densely settled. Inhabitants of the many houses surrounded by curved, amphitheater-like residential patios may have enjoyed their time in the nearby lagoon, the researchers speculate, or at the city's ball court, if they were not at the pyramidal temples taking part in rituals.

Valeriana's building density of up to 426 structures per square kilometer was more than seven times that of the surrounding region. Only the massive lowlands city of Calakmul, near the modern Mexico-Guatemala border, was denser, at about 770 buildings per square kilometer.

"It's great to put numbers to the suspicions we had that this might be one of the most densely populated zones of the ancient Maya in the area," says David Stuart, an anthropologist at the University of Texas at Austin who was not involved in the study.

The finding is not just about a site no one knew about before, Stuart says. "It's about the nature of how the Maya settled on their landscape."

Driving around the lowlands today, Stuart says, it is possible to see mounds and pyramids shaping the landscape of the now agricultural fields, and "ancient agricultural terraces [that were] a breadbasket of agricultural activity in ancient times."

The study adds more evidence that the Maya lowlands were, indeed, densely populated beyond just Calakmul, which thrived during the Maya Classic period from 250 A.D. to 900 A.D. and could have had a population of over 50,000. "The fact we found this out with environmental data shows that previous archaeological research suggesting this density was not an overestimation," Stuart says.

Archaeologist Thomas Garrison, also at the University of Texas, agrees. Lidar technology is helping the field of archaeology make large strides, he says. "This study showcases the value that lidar data can have to archaeology even when it is acquired for other purposes." Lidar data from regions that are not extensively known can help archaeologists get a clearer image of the pieces in the Maya civilization puzzle.

But lidar data are not the end of the story, Garrison says. "The next step would be to visit and excavate these settlements to gain a better understanding of them." ■

PSYCHOLOGY

Scientists upend midlife crisis theory

Happiness follows different patterns in various parts of the world

BY SUJATA GUPTA

The notion of the midlife crisis is dead. Or maybe it was always bunk. Now, some scientists want a postmortem for the theory.

The term "midlife crisis" first appeared in the scientific literature in the mid-1960s. But evidence for happiness plummeting in midlife before rebounding was scant. Then in the late 1980s, after crunching data from well-being surveys around the globe, social scientists framed the phenomenon as quantifiable and universal.

But mounting evidence now supports the theory's demise. Recently, researchers found variants of how happiness unfolds among non-industrialized communities in Asia, Latin America and Africa — places often neglected in the scientific literature.

In addition to the classic story, anthropologist Michael Gurven of the University of California, Santa Barbara and colleagues identified examples of midlife dips appearing years earlier than previously reported. They also found happiness peaking in midlife and a steady decline in happiness starting around age 45, the team reports in the Oct. 25 *Science Advances*.

The study is just the latest takedown of what social scientists call the U-curve. The idea is that on a graph of happiness levels by age, the shape of happiness forms a distinctive U. It's been replicated hundreds of times since it first appeared in 2008.

Studies critical of the U-curve have circulated for years but gained little traction until earlier this year, when economist David Blanchflower of Dartmouth College, the theory's cofounder, released papers and a blog post killing it off himself. Mounting despair among teens and twentysomethings, particularly girls and women, has changed the happiness life course, Blanchflower says. "The U-shape curve has now all but disappeared."

Scientists must turn their focus to teens and young adults, he says. "We have a problem.... The question is: What do you do about it? We are behind the game."

Others suggest pausing to reflect. The midlife crisis narrative rose out of people's desire for simple answers to complex problems, says psychologist Nancy Galambos of the University of Alberta in Edmonton, Canada. Researchers now seem to be latching onto an adolescence crisis narrative, she says. "Are we still on the wrong track of trying to find a single trajectory?"

Overly simplistic theories can cause real harm, says psychologist Margie Lachman of Brandeis University in Boston. The U shape tends to focus attention on the bottom-most point in the curve, Lachman says. It "really takes you away from thinking about what is going on at other age groups."

Blanchflower and economist Andrew Oswald of the University of Warwick in England reported in 2008 that happiness plummets in midlife, showing that populations across over 70 countries followed similar U-shaped trends. The idea gained steam after a report in 2012 showed that even great apes get the midlife blues, which hinted at a biological explanation.

Some critics of the U-curve contend it is a statistical artifact. For instance, the shape could stem from efforts to study a "'pure' effect of aging," sociologist David Bartram wrote in February in the *Journal of Happiness Studies*. Researchers tend to control for variables that interfere with happiness, such as divorce or health problems, says Bartram, of the University of Leicester in England. "If you want the results to describe everyone, you have to allow bad things to happen in old age."

Or perhaps findings of a U-curve are unique to the cohort that hit midlife during the Great Recession. Scientists involved with a longitudinal study called Midlife in the United States have interviewed people about their health and well-being since the mid-1990s. Participants who were middle-aged in 2011, just after the recession, were worse off than middle-aged people nearly two decades earlier, says Lachman, a project investigator.

A similar cohort effect seems plausible for those whose teen years coincided with the arrival of smartphones and social media, Lachman says. The pandemic solidified that cohort's shift to an online social world.

Blanchflower counters that the hundreds of papers supporting the U-curve can't all be wrong. Instead, he says, the typical arc of happiness across a life span has shifted, putting the world in uncharted territory.

Despair among adolescents is troubling, Lachman says, but shifting from a midlife to an adolescence crisis narrative doesn't make sense. People in midlife aren't doing better; adolescents are just doing worse, she says. Young people who are suffering "depend on people in middle age. It's their parents and their teachers. Those young people need people in midlife to be in good mental health." ■

Mounting research questions the long-standing idea that happiness plummets around midlife and then rebounds.

WESTEND61/GETTY IMAGES

ANIMALS

Polar bears face a germ onslaught

Exposure to pathogens is rising as the Arctic heats up

BY JAKE BUEHLER

Polar bears are dealing with mounting challenges in a warming world, mostly related to the waning of their wintery wonderland. But the bears may be increasingly infected with bacteria, viruses and parasites, too.

Compared with a few decades ago, polar bears living near Alaska are now more frequently exposed to five different pathogens, researchers report October 23 in *PLOS ONE*.

"With warming, it just allows pathogens to persist in environments they couldn't persist in before," says wildlife biologist Karyn Rode of the U.S. Geological Survey's Alaska Science Center in Anchorage.

But these changes are poorly understood in the Arctic, a region that is morphing rapidly under climate change. Rode and colleagues looked to polar bear immune systems for insights.

The polar bear population native to the Chukchi Sea between Alaska and Russia was a perfect fit. These bears have experienced dramatic losses of sea ice habitat, leading many to spend long periods on land in the summertime (*SN*: 3/16/19, *p.* 20). There, they are exposed to humans and their garbage, possible sources of pathogens. The Chukchi bears also range farther south than many other polar bear populations.

"If there are pathogens moving northward into the range of polar bears, then [the Chukchi Sea population] would be a place we would expect to detect that," Rode says.

She and colleagues screened blood and fecal samples collected from 232 Chukchi bears from 2008 to 2017 for antibodies against a suite of bacteria, viruses and parasites. The presence of antibodies aimed at fighting a specific pathogen suggests the bear's immune system has encountered the pathogen at some point. The team then compared that analysis with a similar one of 115 bears from 1987 to 1994.

The proportion of polar bears exposed to the parasite *Neospora caninum* and to the bacteria that cause the diseases brucellosis and tularemia has at least doubled since the 1990s, the team found. The proportion of bears that had encountered the parasite *Toxoplasma gondii*, which causes toxoplasmosis, increased from about 2 percent to 14 percent. There were also more bears in the recent cohort with antibodies against canine distemper virus.

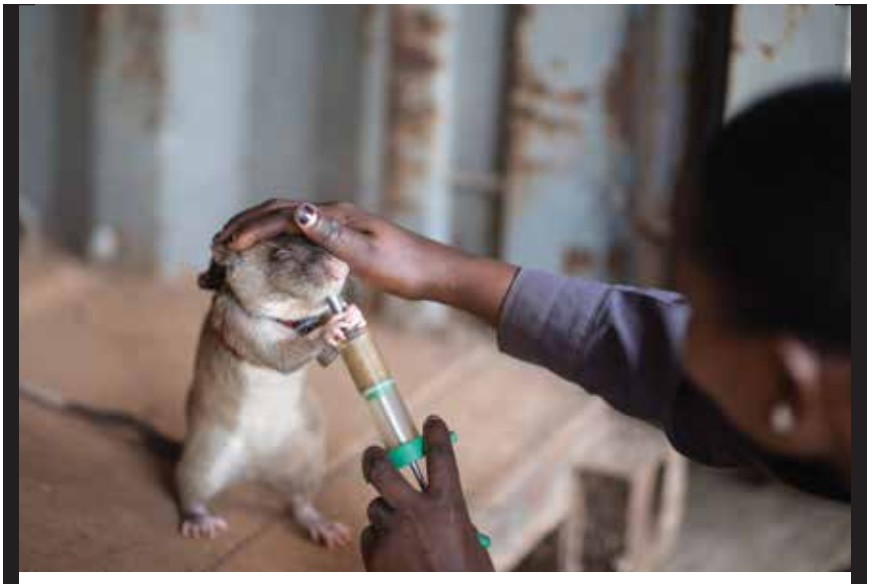
Comparing ratios of diet-related chemical markers in the bears' fur revealed that diet makeup predicted exposure to pathogens. For instance, bears that had been exposed to *N. caninum* ate more bowhead whale than bears that hadn't been exposed.

"[The bears] are probably not the only species that has higher exposure to these pathogens," Rode says. "It's within the food chain that this has increased."

In recent years, ringed seals — a key prey species — have died off in large numbers from an unknown disease, Rode notes. That helped alert researchers to the need to evaluate the polar bears.

While interesting, the findings are inconclusive, says wildlife disease ecologist Andy Dobson of Princeton University. That's because samples were taken from two different geographic locations within the population's domain, he says.

The movement of pathogens affects the whole food chain. Some polar bears are eaten by people through subsistence hunting, Rode says. More work is needed to know whether there's a risk of these pathogens infecting people. ■



APOPO

ANIMALS

Giant rats could sniff out illegal goods

A new kind of border patrol agent could soon start work in African ports, sniffing out smuggled goods. They're rats. And they wear tiny red vests.

African giant pouched rats (*Cricetomys ansorgei*) have been trained to identify pangolin scales, rhino horns, elephant ivory and African blackwood, researchers report October 30 in *Frontiers in Conservation Science*.

The team taught 11 rats how to differentiate between target odors and benign scents. When rats detected a target odor, they signaled with their nose and got a snack (shown above). Eight rats could distinguish the target scents from 146 odors used by smugglers to mask and hide goods, like cardboard, electrical cables and synthetic wigs. Trainees have since ventured into mock warehouses and some have even deployed to real ports. — *Sophie Hartley*

HEALTH & MEDICINE

Virus behind Brazil outbreak can spread from mother to fetus

The Oropouche virus, which has caused a large outbreak in Brazil this year, can spread from a pregnant woman to the womb. A 40-year-old woman's stillbirth this summer was linked to transmission of the virus from the woman to the fetus, researchers report October 30 in the *New England Journal of Medicine*. The Brazilian Ministry of Health in August also confirmed two other deaths due to the spread of the virus to the womb.

As of mid-October, Brazil has reported more than 8,000 cases of Oropouche fever since the beginning of the year. Infections can cause fever, chills, joint pain and severe headaches. There are no medicines to treat it or vaccines to prevent it.

Oropouche virus is mainly spread by biting flies. It's possible it could spread via sexual transmission. A man diagnosed with Oropouche fever had functional virus in his semen 16 days after his symptoms started, researchers report in the December *Emerging Infectious Diseases*. — *Aimee Cunningham*

TECHNOLOGY

Feather-inspired airplane flaps could boost flight performance

Bird wings are contoured with overlapping rows of feathery tufts, spreading out from near the shoulder. These "covert" feathers help birds maneuver through the air. A similar design could boost aircraft performance, too. Lining aircraft wings with rows of flaps can increase lift, reduce drag and prevent stall, researchers report in the Nov. 5 *Proceedings of the National Academy of Sciences*.

The bioinspired flaps would deploy passively when the wings meet oncoming airflow at a high angle, a scenario known as a high angle of attack.

In wind tunnel experiments, engineer Aimy Wissa of Princeton University and colleagues studied how multiple rows of flaps affect the flow of air around airfoils. Flaps placed near the front of an airfoil helped keep the air flowing around it closer to the wing, which improved lift and reduced drag.

A single row of flaps near the rear of an airfoil prevented high-pressure air near the trailing edge from creeping toward the wing front. Low pressure in that area is needed to produce lift, Wissa says. Adding five rows of flaps to airfoils improved lift by up to 45 percent and reduced drag by 31 percent.

Tests with remote-controlled aircraft showed that the flaps can also mitigate stall, which involves a sudden loss of lift at high angles of attack. — *Nikk Ogasa*

ARCHAEOLOGY

A digital exam reels in engraved scenes of Stone Age net fishing

Depictions of Stone Age net fishing have surfaced on engraved stones thanks to an imaging technique that gives magnification a digital boost. Previously unnoticed lines were etched into eight stones found at Gönnersdorf, a roughly 16,000-year-old German site, researchers report November 6 in *PLOS ONE*.

Gönnersdorf is the "only known Upper Paleolithic site in Europe, and possibly worldwide, that visually represents net-fishing practices," says archaeologist Jérôme Robitaille of Monrepos Archaeological Research Center and Museum for Human Behavioral Evolution in Neuwied, Germany.

Robitaille and colleagues examined stones using reflectance transformation imaging. RTI let the researchers manipulate light and shadow on digital versions of engraved surfaces, revealing details that had evaded standard magnification studies. Grids of crosshatched lines, probably portraying a net, surround depictions of fish. — *Bruce Bower*

ARTIFICIAL INTELLIGENCE

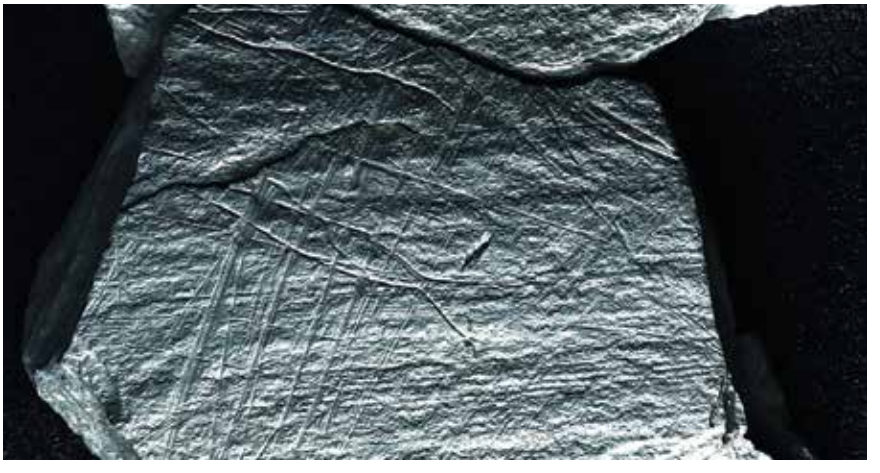
AI-tweaked smiles up attraction

A well-timed smile could be the ultimate speed-dating hack. Smiles enhanced by artificial intelligence during video chats led to higher romantic attraction, researchers report in the Nov. 5 *Proceedings of the National Academy of Sciences*.

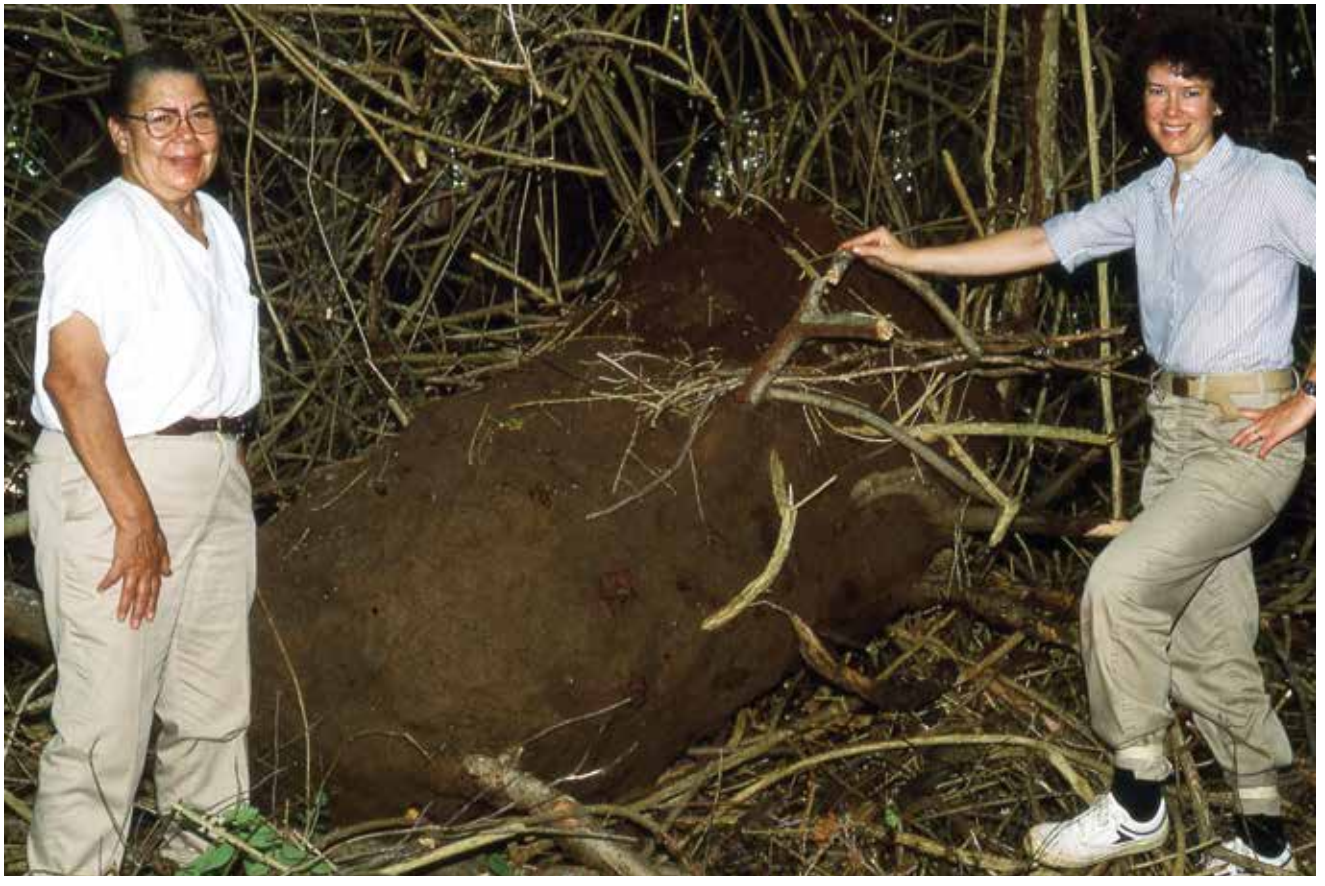
Face filters, available to social media users worldwide, can smooth blemishes, whiten teeth and highlight hair. "The effect of these filters in human psychology remains mostly unknown," says Pablo Arias Sarah, a cognitive scientist at the University of Glasgow in Scotland.

Arias Sarah and colleagues focused on a subtle face-tuning change: a slight tweak to smiles. Across four-minute video chats, 31 participants either had their smiles slightly dialed up or down. In some chats, both people's smiles were similarly enhanced or diminished. In others, smiles were misaligned, with one person's smile turned up and the other down.

Timing was everything. When two chatters both had their smiles boosted, they reported higher levels of attraction than in other conditions. Showing that artificially enhanced smiles can influence romantic feelings raises questions about the ethical use of face-altering technology. — *Laura Sanders*



Scenes engraved on stones found at a nearly 16,000-year-old German site include this depiction of two fish (center and top) surrounded by crosshatched lines likely representing a net.



Termite Pioneer

Margaret S. Collins was the first Black American female entomologist to get a Ph.D. She was also a civil rights activist

By Susan Milius

Entomologist Margaret S. Collins (above, left) stands next to a nest of *Nasutitermes acajutlae* termites on Guana Island in the British Virgin Islands in 1989, along with biologist Barbara Thorne.

On the drive to school, at the first sign of trouble, "she made me get on the floorboard," says the older son of pioneering Black entomologist Margaret S. Collins. He's remembering the tense 1956 civil rights bus boycott in Tallahassee, Fla. As soon as young Herbert had wriggled to a safer spot on the floor of the car, his mom would stomp the gas pedal and hope to outrun the police once again.

Collins, on her morning drives to Herbert's school and then on to her university faculty job, was giving rides to people boycotting the city's racially segregated public buses. Tallahassee's seven-month boycott isn't as famous as the one in Montgomery, Ala., which started in late 1955, but the Tallahassee boycott also stirred fierce white pushback. The legal system made an example of 21 other local activists offering rides, charging them with running a profitable city transportation system without getting a franchise from the city to do so. The targeted activists were each fined $500 and, if caught in illegal activity during the next year, would spend 60 days in jail.

Herbert still remembers crouching in the car, watching his mother's foot on the gas. "I was like, 'You're going to make a hole in the floor if you press

it much harder,'" he says. They never caught her though.

"I think her life would make a great movie," says entomologist Jessica Ware of the American Museum of Natural History in New York City.

In her science, Collins specialized in termites, studying some of the specimens that are now under Ware's care at the museum. Though these insects are perhaps best known for the damage they can do to human-built structures, Collins' interest was not in the service of pest control. Instead, she studied the vast, odd universe of termite diversity, glorying in the variations among the world's 2,000-plus species. Many of these species are not much more likely than a human to eat soggy porch steps.

Though she started by studying termite resistance to dehydration in the lab, Collins in time established herself as a skilled field biologist. She explored in at least 10 countries outside the United States and was recognized as an authority on termites of the Caribbean. Both Collins and Ware, a generation apart, made expeditions into Guyana's rainforests, rich in insects of interest to science but also in snakes, prowling jaguars and other excitements. Field biology is not for the faint-hearted.

Today, Collins also gets recognized for overcoming the many frictions that came with working in the largely white male world of U.S. midcentury biology. Her doctoral dissertation, completed in 1949, made Collins "only the third Black woman zoologist in the country," at least with a Ph.D., writes science historian Wini Warren in *Black Women Scientists in the United States*. And that would make Collins America's first Black female entomologist to earn such an advanced degree.

Hidden figures

Collins' childhood shared some details with the life of mathematician Katherine Johnson, portrayed in the beloved 2016 book and movie *Hidden Figures*, about Black women at NASA who performed key calculations for early space flight (SN: 6/5/21, p. 28; SN: 1/21/17, p. 28). Both Johnson and Margaret James Strickland Collins (her name reflecting two marriages) grew up in West Virginia. Both women skipped grades, went early to the same high school and then the same college.

Born Margaret James in 1922 as the lively, precocious fourth of five children, Collins grew up in the college town of Institute, W.Va., finding plenty of countryside to explore nature. Her superpower was not exotic math but reading. She learned just by sitting on the lap of whichever parent did the nightly story time. At age 6, Collins was allowed to borrow any book she could reach in the library of West Virginia State College, a historically Black institution.

Her father, Rollins James, taught agriculture there. He had worked with crop pioneer George Washington Carver and had a master's degree from Tuskegee Institute. Her mother, Luella, had wanted to become an archaeologist, Collins told Warren during an interview. Luella was a passionate reader, "independent," even "rebellious," Collins said.

Collins could certainly question authority. Herbert, the son who crouched on the car floor, remembers her saying about childhood Christmas merriment: "My parents actually tried to make me think that a reindeer could fly through the air." Having seen a picture of a reindeer, "I knew there's just no way this reindeer could fly."

Both math prodigy Johnson, born in 1918, and reindeer-skeptic Collins went to West Virginia State College, now West Virginia State University.

Collins had planned to major in biology, but lessons she described to Warren as "stereotyped, dull and malodorous" and a "gruff and frightening" teacher sapped her interest. She lost her scholarship. Still, summers working kept her in college long enough to encounter a biology professor who helped her ID a water creature she'd discovered in a stream, thereby renewing her interest. Then came World War II.

These were uncertain times. In July 1942, she married Bernard Strickland, a premed student at Howard University in Washington, D.C. Within months, though, he was drafted for military service.

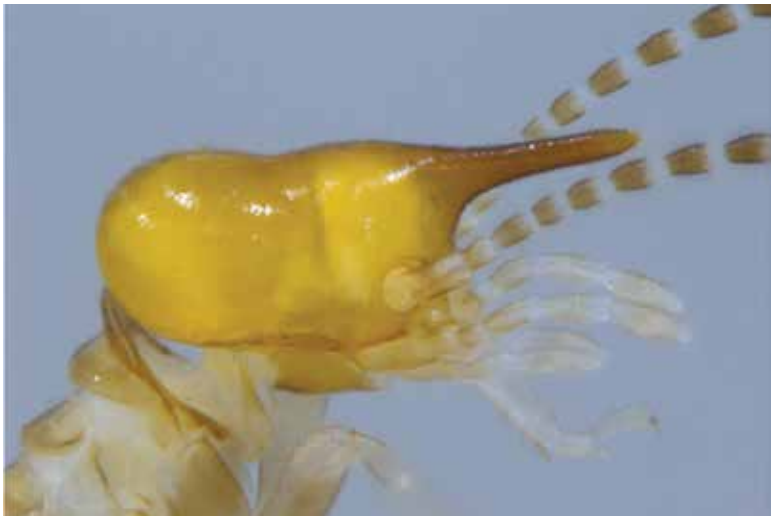
After finishing her undergraduate degree the next year, with a major in biology and minors in physics and German, she headed to the University

HERBERT AND VERONICA COLLINS

Collins and her grandson Herbert Louis Collins III dissect a termite nest at the Smithsonian National Museum of Natural History in Washington, D.C., during the 1990s.

UNSUNG CHARACTERS

This article is part of a *Science News* series highlighting people of science — past and present — who we believe should be better known. Watch for more of these stories, and send your ideas to editors@sciencenews.org



This termite species from the West Indies (a soldier with a "glue-shooting head," shown) was named *Parvitermes collinsae* in 1995 in honor of Collins.

of Chicago. Though the state of West Virginia had a publicly sponsored graduate school, it had only started admitting Black students in 1940 (with the whopping total of three, including Katherine Johnson).

Collins received a $125 stipend from the state, she later told biographer Warren, but it wouldn't go very far. To help fund grad school, she worked a night shift at a ball bearing factory. After rent and other expenses, she could afford only 10 meals a week — and she was often exhausted.

But it was there that her life took on a new direction. In a chance conversation at class registration, she met American biologist and termite maestro Alfred Emerson. Emerson was "a true giant in termite research," says Nan-Yao Su, a specialist in termites and one of Collins' later collaborators, now at the University of Florida's Fort Lauderdale Research and Education Center.

Collins was captivated by the course she took with Emerson. He heard of her financial pinch and offered an assistantship that included looking after the termite collection. This began her lifelong fascination.

Termites rank among nature's star soil engineers in many tropical and subtropical ecosystems. Plus, like bees and ants, they can create complex societies with specialized castes and, in some species, weird body parts. Among the *Nasutitermes* species Collins studied, some termite soldiers defend themselves by squirting sticky glop from their heads through a glue gun structure "like a less-floppy elephant nose," Ware says.

Collins' Ph.D. thesis turned into her first publication on termite tolerance for water loss, which appeared in 1950 in *Ecology*. Of three species collected in the Chicago area, she found that the one that also ranged widely across the more arid West could survive longer in drier air. The thickness of a waxy outer layer played a role but didn't explain all the differences in the species' ranges.

This was one small bit of data for what are giant questions about biodiversity. How can kin eventually become so diverse? And how does evolution create the wild patchwork of species covering the planet? With so many forms around the world, termites are great for exploring these questions.

Though Emerson supported her Ph.D. work, he had his prejudices too. He refused to let Collins join an expedition documenting plants and animals in the Pacific's Marshall Islands after the war. His objections were just "good ole boy stuff," sniffs Vernard Lewis, a termite entomologist at the University of California, Berkeley and a Collins biographer. "The field was supposed to be dangerous and adventurous," and thus not for women back then, Lewis says.

Boycotts and guns

With World War II over, Collins' husband returned to medical school at Howard University. She found an instructor job there in 1947 and joined him. To finish her Ph.D., she would now have to squeeze in remote work and some summers in Chicago. Though her marriage dissolved in 1949, she also finished her Ph.D. that year.

Her new degree won her a promotion to assistant professor at Howard, but she wasn't hopeful

Collins, shown during a 1993 expedition to Guana Island in the British Virgin Islands, was an authority on the termites of the Caribbean.

FROM TOP: RUDOLF SCHEFFRAHN; B.L. THORNE

for future prospects. "They refused to promote me because they said I was too young. But it was also because I was a woman," she later told Warren. Also Collins chafed at the department's majority focus on medically useful research.

In 1951, Collins accepted a teaching position at what became Florida A&M University, like Howard, one of the country's historically Black colleges and universities, or HBCUs. "The white institutions wouldn't hire her, so she went back to the HBCUs," Lewis says. This put her in Tallahassee as civil rights issues were intensifying. Also in 1951, she remarried, taking the name Margaret S. Collins that would be on publications for the rest of her life.

In Florida she could run her own field expeditions looking for termites with help from her husband, Herbert L. Collins. By 1958, she had collected and tested termites' ability for what she called "water relations" in nine of the 13 termite species known in Florida, including those from the Everglades and the Florida Keys. Over years, Collins explored how some termite species — without the extra-hardened outer armor of ants or beetles — avoid drying to a crisp in a desert while others need steaming rainforests. Evolutionary biologist Barbara Thorne of the University of Maryland in College Park points to the long string of papers on water relations as a highlight of Collins' research.

Eventually, there would be research trips that included Herbert Jr. and then his younger brother James as field assistants. Collecting termites is a vigorous business, and a big machete was part of their mom's field gear. "That's a famous machete," Lewis says. Herbert Jr. saved it.

But life was not easy. Moving to Tallahassee in the 1950s era of activism exposed the Collins family to toxic racism. Herbert Jr. remembers his mother planning to give a science talk on termites at a traditionally white school, Florida State University. But a phone caller threatened to blow up the science building if a Black speaker dared to lecture there. According to Warren, Collins then searched the building herself and found no bomb. She also found an alternative location for the talk.

During the Tallahassee bus boycott, Collins ended up doing one special midnight drive that "terrified" her, Warren reports. The civil rights group that had called for the boycott got a tip that the police and FBI were about to raid its headquarters. Collins spirited away the membership records with names, addresses and activities.

The family farmhouse also came under threat from violent racists. As the story goes, Collins, despite her other responsibilities, spent nights on the porch with a shotgun. She guarded the house, Herbert Jr. confirms, but not alone.

Collins stands in 1991 outside the Smithsonian National Museum of Natural History in Washington, D.C., where some of her termite specimens are stored.

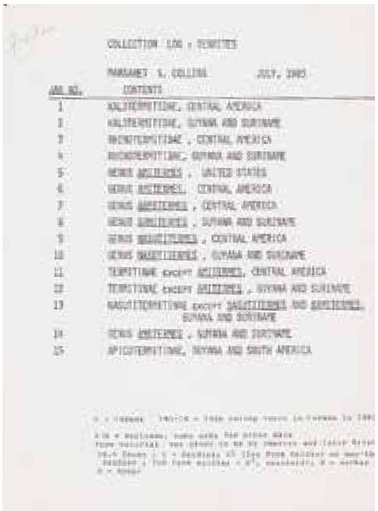
HERBERT AND VERONICA COLLINS

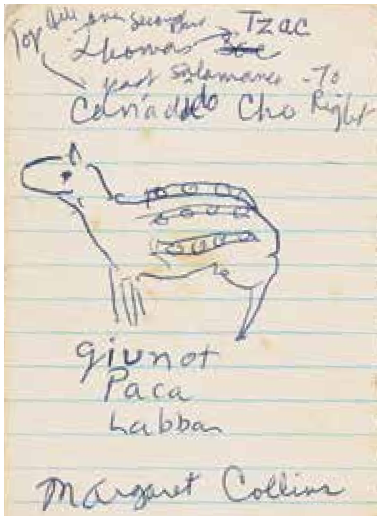
"We had a rocker and a sofa out there, and when the threats were high, we would sleep out there," Herbert Jr. remembers. Each parent had a gun. "For a little kid, it was kind of exciting," he says. The family told jokes, talked about "little things," at least until the children fell asleep. The dangers of the time were real, but only the mailbox got damaged.

Margaret and Herbert Collins divorced in 1963. She left Florida A&M to return to Howard University in 1964 as a full professor. She juggled the needs of her students, her science and her sons while working at Howard and at Federal City College (now the University of the District of Columbia) as well as traveling for research.

The question of how termites got by with very little water, including in the Sonoran Desert, continued to intrigue her. She worked through species after species. Overall, water, scarce or abundant, and heat are the two main factors shaping where particular termites live, Collins wrote in her chapter in the 1969 two-volume, multi-author opus *Biology of Termites*.

An energetic seeker of grants and collaborations, she traveled in the United States, Mexico, the Caribbean, and Central and South America to explore for termites. From the late 1970s, she held (volunteer) research associate status at the





A 1983 log of specimens collected by Collins across the Americas (above left) and field notes from a 1981 trip to Belize (above right) are testaments to Collins' passion for fieldwork.

Smithsonian National Museum of Natural History and worked on its termite collection, which now includes several dozen of her own specimens.

"In many ways, she was just an enthusiastic person," says Thorne, who was a co-adventurer and coauthor with Collins. "The museum stuff, the lectures, the teaching, whatever — she loved all that. But she was at her best in the field."

Getting outdoors

Among the termite marvels that lured Collins into the tropics was that glue-blasting "less-floppy elephant nose" (as Ware described it). This defense mechanism appeared to have evolved twice. Soldiers belonging to species of *Nasutitermes* and *Subulitermes* can do it, yet those species sprouted from rather different branches of the termites' evolutionary tree. "Parallel evolution" is what Emerson and other scientists had called the phenomenon of not-so-related look-alikes.

Collins worked with biochemist Glenn Prestwich to question the notion. Delving into the unusual compounds in the glue convinced them that the cocktails are both so odd and similar that it's too improbable they arose independently. "We were surprised," Prestwich and Collins reported in 1981 in *Biochemical Systematics and Ecology*.

The best sense of what Collins faced as she did all this termite exploring may come from her own words on a pdf of three aged, typewritten pages she had sent colleagues about a mishap in Colombia's Amazon rainforest. Titled "Me and My Maggot or My Duel with *Dermatobia hominis*," the account features a parasitic fly larva that burrows into living flesh and grows spines.

"The whole sorry episode" as Collins puts it, starts one August day as she's sitting outside a small motel in Colombia that served as headquarters for sampling Amazon insect life. A "sharp-stinging sensation" in her ankle prompts "a feeling of foreboding." Sure enough, in coming days, the spot swells into a stabbing-painful, oozing "volcano shaped" lump.

When Collins gets home to the United States, she tries several home remedies, some a bit helpful. She's slammed by work: a U.S. collecting trip, a commitment on a research project, plus she's "deeply involved in catching up on school responsibilities." Then while teaching, she's hit by "pains so severe as to render speech impossible and decorum doubtful."

She excuses herself from "a polite but wondering class" to search for an ice pack. The closest options are cans of frozen orange juice concentrate, which at least let her set up a movie to show her class while she waits for the end. After phoning experts and checking her parasitology references, she goes to an emergency room. A doctor cuts into the inflamed tissue and finds — nothing.

In the end Collins solved the problem herself. She coated the area with thick ointment, and the larva wriggled up to the skin surface. Nabbing it with forceps didn't work, so "I squeezed and squeezed and SQUEEZED until out it popped!" she wrote. She then preserved the larva as a scientific specimen.

Fieldwork is a mix of wonder and alarm in Ware's stories as well. On a recent expedition in Guyana, Ware and her students got a strong reminder of the need for vigilance: a big caiman swimming fast upstream. In another instance, students collecting insects at night heard a jaguarish growl off in the dark. Still dengue-carrying mosquitoes, no bigger than dandelion fluff, might have been the scariest.

Ware never met Collins, who passed away in 1996 on a research trip to the Cayman Islands. The last time Herbert Jr. saw her alive was at an airport near Washington, D.C., where she'd collected an insect she found interesting in an airport ladies' room.

Collins' breakthrough into the largely male club of field biologists, her overpacked years as a single parent, along with her competition for funds amid entrenched sexism and overt racism, make the "termite lady," as she came to be called, an inspiring figure today. Her portrait hangs in Ware's office. ■

Explore more

- Wini Warren. *Black Women Scientists in the United States*. Indiana Univ., 2000.

BOTH: SMITHSONIAN INSTITUTION ARCHIVES

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Centuries ago, Persians, Tibetans and Mayans considered turquoise a gemstone of the heavens, believing the striking blue stones were sacred pieces of sky. Today, the rarest and most valuable turquoise is found in the American Southwest— but the future of the blue beauty is unclear.

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The recipient of a new type of bionic leg prosthesis, which re-engineers muscles to provide better feedback and control, climbs stairs with ease.

Better Bionics

Brain-controlled prosthetic limbs take steps closer to reality

By Simon Makin

The word *bionic* conjures sci-fi visions of people enhanced to superhuman levels. It's true that engineering advances such as better motors and batteries, together with modern computing, mean that the required mechanical and electronic systems are no longer a barrier to advanced prostheses. But the field has struggled to integrate these powerful machines with the human body.

That's starting to change. A recent clinical trial tested one new integration technique, which involves surgically reconstructing muscle pairs that give recipients a sense of the position and movement of a bionic limb. Signals from those muscles control robotic joints, so the prosthesis is fully under control of the user's brain. The system enabled people with below-knee amputations to walk more naturally and better navigate slopes, stairs and obstacles, researchers reported in July in *Nature Medicine*.

Engineers have typically viewed biology as a fixed limitation to be engineered around, says bioengineer Tyler Clites, who helped develop the technique several years ago while at MIT. "But if we look at the body as part of the system to be engineered in parallel with the machine, the two will be able to interact better."

> "If we look at the body as part of the system to be engineered in parallel with the machine, the two will be able to interact better."
>
> TYLER CLITES

That view is driving a wave of techniques that re-engineer the body to better integrate with the machine. Clites, now at UCLA, calls such techniques "anatomics," to distinguish them from traditional bionics. "The issue we were tackling wasn't an engineering problem," he says. "The way the body had been manipulated during the amputation wasn't leaving it in a position to be able to control the limbs we were creating."

In an anatomics approach, bones are exploited to provide stable anchors. Nerves are rerouted to create control signals for robotic limbs or transmit sensory feedback. Muscles are co-opted as biological amplifiers or grafted into place to provide more signal sources. These techniques all improve the connection and communication between a robotic limb and the human nervous system, enhancing what bionic prostheses are capable of (SN: 3/9/24, p. 11).

Anatomics-based devices have been slow to make their way out of labs and into the clinical and commercial worlds, in part due to how difficult it is to forge fruitful partnerships between the engineering and surgical communities. But some experts say the field is edging us closer to that sci-fi vision of seamlessly integrated, brain-controlled bionic limbs, especially as more advances lie around the corner.

Reconstructing muscles

The body's awareness of itself in space — called proprioception — is a tricky sense to restore, but it's important for movement, especially walking. Muscles send signals to the brain about where the body is, how it is moving and what forces it encounters. These signals are generated mainly by coupled muscles called agonist-antagonist pairs, in which one contracts as the other stretches.

In a traditional amputation, this important feedback is discarded. But the technique reported in the July study, known as an agonist-antagonist myoneural interface, or AMI, surgically reconstructs these push-pull pairs and uses the signals they generate to control prosthetic joints. The procedure enables a recipient to "feel" their prosthetic limb.

"When the prosthesis moves, the person actually feels that movement as a natural proprioceptive sensation," says Hugh Herr, a bionicist at MIT. Herr developed the technique alongside Clites and the team's surgeon, Matthew Carty of Brigham and Women's Hospital in Boston.

The recent study, which was part of a clinical trial that Herr and colleagues are conducting, tested the technique in 14 people with below-the-knee amputation. Seven participants had undergone the AMI procedure, while the others had standard amputations. Recipients of the AMI-based system increased their maximum walking speed by about 40 percent, from 1.26 meters per second to 1.78 meters per second, the researchers found, a rate comparable to that of people without amputation.

Extending bones

The most common complaints from prosthetic users involve pain and discomfort. A major source of discomfort is the attachment point.

"Many of the problems with prosthetic usage are related to the socket," says Cindy Chestek, a bioengineer at the University of Michigan in Ann Arbor. Squishy flesh is poorly suited to transferring loads to the part of the body built for that job: bones. The resulting strain can cause tissue damage and, invariably, discomfort, sometimes leading users to abandon their device.

A technique called osseointegration exploits the fact that certain metals bond with bone. Typically, a titanium bolt inserted into the skeleton anchors the prosthesis in place, providing greater strength, stability and comfort. "There's a reason we have skeletons," Chestek says.

The procedure was first carried out in 1990 but didn't become widely accepted and clinically available until the last decade. One implant system, called OPRA, received approval from the U.S. Food and Drug Administration in 2020. The main drawback is that the titanium bolt must go through the skin, creating a permanent hole that carries infection risks. "Other than the infection risk, osseointegration is better in all ways," Chestek says.

Rerouting nerves

Bionicists have long sought to tap into the body's nerves to create prostheses that communicate with the brain. But early efforts were frustrating, mainly because the electrical signals that nerves carry are very weak. "People tried for decades to get meaningful signals from [putting] a wire inside a nerve," Chestek says. "To this day, it's nearly impossible outside of a controlled lab setting."

Instead, modern bionic prostheses communicate mostly with muscles. When activated by a nerve, muscles emit much larger electrical signals, which can be picked up by electrodes on the skin, which then control the prosthetic limb.

But in people with an amputation, nerves that previously operated parts of a missing limb — and could similarly operate the artificial limb — don't usually end in muscles. They go nowhere, which creates neuromas, bulbs at nerve ends whose electrical "sparking" causes pain.

A procedure called targeted muscle reinnervation, or TMR, solves this problem. A surgeon strips muscles of their native nerves and reroutes severed nerves to this freshly cleared ground. Rerouted nerves grow into the muscles over time, which act as amplifiers, creating sources of the required control signals. "You turn a nerve recording problem into a muscle recording problem," Chestek says. "Muscle recording is easy." The procedure also treats neuroma pain — a purpose for which it is often carried out.

A drawback is that TMR cannibalizes existing muscles, limiting the number of signals that can be created. "You run out of real estate pretty quickly," Chestek says. This is especially important for amputations above the knee or elbow, where there are fewer remaining muscles and more prosthetic joints to control.

A new technique, known as a regenerative peripheral nerve interface, or RPNI, surgically inserts small muscle grafts taken from elsewhere and reroutes nerves to these instead. Surgeons can then dissect these nerve bundles into their constituent fibers to capitalize on the newly grafted targets, allowing researchers to create as many signals as they need, Chestek says.

The small size of the muscle grafts makes it difficult to pick up signals from them using surface electrodes, though. "You can't record [electrical signals] from a three-centimeter piece of muscle through the skin very easily," Chestek says. "You have to use implanted electrodes." This is more invasive, and implants face regulatory hurdles, but implanted electrodes produce higher quality signals. They just need to be accessed somehow, as running wires through the skin is not viable outside of laboratory studies.

Some researchers are working on wireless systems, but another solution is to combine RPNIs with

A technique called osseointegration anchors a prosthesis in place using a titanium bolt inserted into the skeleton. Implanted electrodes allow for fine motor control, such as picking up eggs.

INTEGRUM AB

In their lab at UCLA, bioengineer Tyler Clites and Ph.D. candidate Ophelie Herve use a robot arm to manipulate a model knee in a simulation of an experiment to be conducted on cadavers.

MILO MITCHELL/UCLA HEALTH

osseointegration. In this setup, wires between implanted electrodes and the prosthesis simply run through the titanium bolt. A study published in 2023 described an above-the-elbow bionic arm using this approach that enabled the recipient to control every finger of his robotic hand.

Rebuilding bodies

At his UCLA anatomics lab, Clites says, "I've got nine or 10 active collaborations with surgeons on different projects." Here, his team uses cadavers to test ideas and gather data. "We'll mount cadaver limbs to a manipulator arm and evaluate the systems we're developing to make sure they work as intended," Clites says. "It's the backbone of what we do."

One of the projects under development is a new attachment method that avoids the permanent hole that comes with osseointegration. Instead of a titanium bolt, there's a piece of steel in the limb and an electromagnet in the socket of the prosthetic. "That magnet holds [the socket] onto the limb," Clites says, "and then you can control how much attractive force there is by changing the current through that electromagnet." The socket does not have to bear loads; the magnetic force does that job, changing from moment to moment during walking.

At MIT, Herr is also working on a new advance. The recent trial of AMI-based bionic legs used electrodes on the skin to shepherd signals from muscles to the prosthetic joints. But surface electrodes have drawbacks, such as movement causing signal distortions. The new technique, dubbed magnetomicrometry, involves placing magnetic spheres inside muscles and monitoring their movement with magnetometers. "With these magnets," Herr says, "we can measure what we care about and use it to directly control the bionic prosthesis." A commercial product will exist in about five years, he predicts.

For Herr, such advances are personal. Both of his legs were amputated below the knee after a mountain climbing accident 42 years ago. He is thinking of upgrading to AMI-based bionic leg prostheses in the coming years. Once these techniques are perfected, he predicts a leap forward. "When you marry surgical techniques like AMI and RPNI with something like magnetomicrometry, we believe … there's going to be the Hollywood version of brain-controlled robotic limbs."

An added benefit of restoring proprioception, alongside other kinds of sensory feedback such as touch, is that the prosthesis feels more like a part of the recipient. "The goal in the field is when we do robotic reconstruction, the person says, 'Oh my God, you've given me my body back.'" Herr says. "Instead of a robotic tool, we give them a whole limb back. The field is very close to that goal." ■

Explore more

- Hyungeun Song *et al*. "Continuous neural control of a bionic limb restores biomimetic gait after amputation." *Nature Medicine*. July 2024.
- Tyler R. Clites. "Anatomics: Co-engineering body and machine in pursuit of synergistic bionic performance." *Current Opinion in Biomedical Engineering*. December 2023.

Simon Makin is a freelance science journalist based in London.

How to Kill an Asteroid
Robin George Andrews
W.W. NORTON & CO., $29.99

BOOKSHELF

What will it take to defend the world from an asteroid?

The dinosaurs saw a grisly death at the hands of an asteroid, but who's to say that Earth's modern-day inhabitants won't meet the same fate? Fortunately, scientists are already hard at work to prevent that future. *How to Kill an Asteroid* by science journalist Robin George Andrews is a deep dive into the extremely badass business of thwarting a destructive asteroid.

The book's title is a slight misnomer. As Andrews explains, the best strategy to save the planet from an impending asteroid is not to blow it up in space — though that's a reasonable last-ditch option — but instead to deflect it while it's still far beyond Earth's neighborhood. The physics of diversion is tricky: Which spacefaring rocks are harmless and which ones are a real threat? Will scientists be able to detect and intercept one in time? And if we manage to deflect it, will the rock fragment into a gazillion deadly bullets bound for Earth?

Compared with the rest of space exploration, planetary defense has a short history, beginning as a scientific thought exercise in the 1980s and ramping up in earnest in the 1990s. Andrews does an admirable job of packing in details and context about the field. His thorough research brings readers all over the world and across time, from century-past accounts of asteroids striking Earth to recent dress rehearsals of our asteroid preparedness.

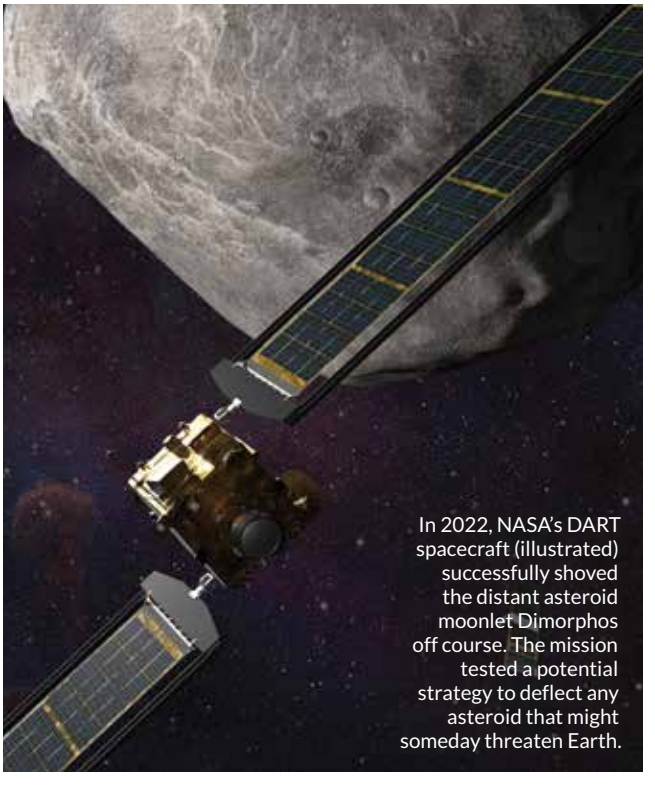
Enter DART, short for the Double Asteroid Redirection Test, which put on trial the world's arguably best concept for a defensive weapon against incoming asteroids. In 2021, the NASA mission hurled a spacecraft toward Dimorphos, a distant asteroid moonlet that poses no threat to Earth, to see whether it could be knocked off course. On September 26, 2022, the spacecraft face-planted onto the moonlet, successfully shoving the space rock off its orbital path (SN: 11/5/22, *p.* 14). Andrews frames DART's tale as a gripping disaster thriller: An asteroid is hypothetically hell-bent on destroying Earth, and it's up to scientist superheroes to save the world. Though full of suspense, the writing is also at times witty and lighthearted.

But for all of DART's success, *How to Kill an Asteroid* presents a somber truth: The DART mission concept is the only tried-and-tested defensive strategy humankind currently has in its anti-asteroid arsenal. The world sorely needs more. And when it comes to developing a planetary security system, we humans may be our own worst enemy.

Indeed, the real challenge isn't in the science, but rather the bureaucratic hurdles to sign off on asteroid-hunting projects, Andrews explains. While humankind has a potential asteroid defensive strategy, we lack an up-to-the-task asteroid detector. Languishing on the drawing board is NASA's NEO Surveyor, a space observatory and asteroid specialist whose fate has become uncertain after a crucial budget cut in 2022. The world has also lost a key space sentinel. Besides being an important instrument for space science, the Arecibo Observatory, which collapsed in 2020, was also one of Earth's best watchdogs for suspicious asteroids (SN: 12/19/20 & 1/2/21, *p.* 8).

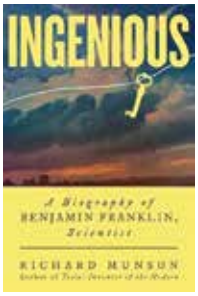
Beyond building the instruments to detect and deter cosmic cannonballs, asteroid preparedness also involves taming the geopolitical, social and economic fallout, Andrews writes. If an asteroid one day hurtles toward Earth, human fears and foibles may complicate matters. Once sky watchers sound the alarm, humankind's collective anxiety could upend everyday life long before the asteroid makes landfall or is successfully diverted. Experts have floated several doomsday scenarios that the world may need to prepare for. For instance, rampant misinformation may trigger insurance scams and crash stock markets. Countries might jump-start their nuclear development programs under the guise of flinging weapons at the asteroid. Other nations might take advantage of the chaos to invade their neighbors. The world might see mass migration out of the predicted ground zero.

Nevertheless, *How to Kill an Asteroid* is overall more hopeful than fear-stoking. It reminds us that the world has no shortage of ideas for how to thwart an asteroid strike. And it is a rallying cry for a reinvestment in planetary defense programs to ensure we're ready for the real thing. Scientists are already more than eager to help. — *Shi En Kim*



In 2022, NASA's DART spacecraft (illustrated) successfully shoved the distant asteroid moonlet Dimorphos off course. The mission tested a potential strategy to deflect any asteroid that might someday threaten Earth.

NASA, JHUAPL, STEVE GRIBBEN



Ingenious
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BOOKSHELF

Exploring a founding father's life of science

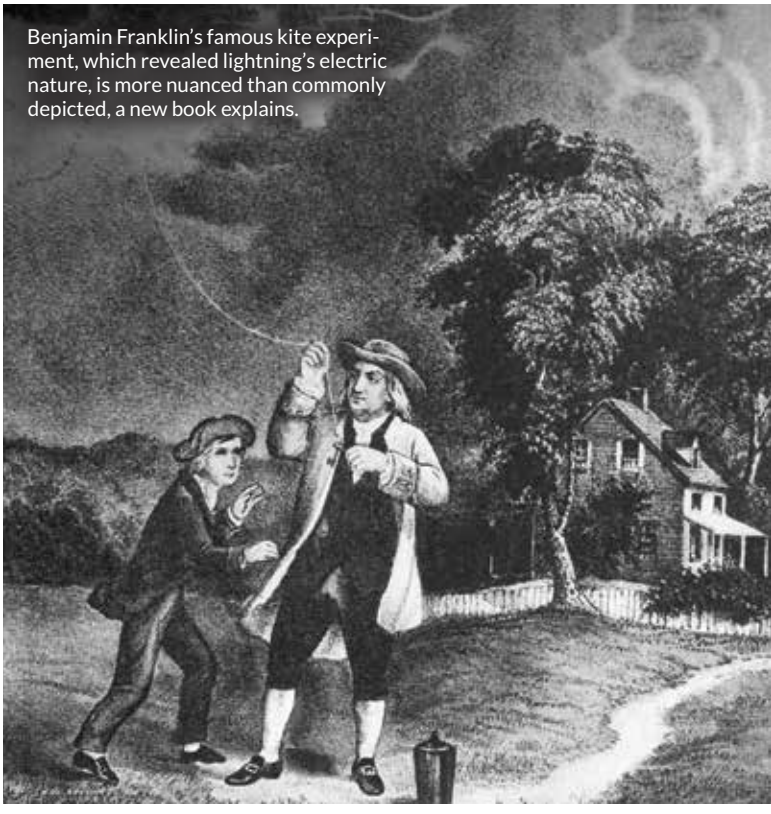
Let's talk about the kite and the lightning storm. In the public's mind, Benjamin Franklin's scientific work has largely been reduced to this one experiment, in which Franklin demonstrated that discharges from thunderstorms are electric in nature (SN: 11/5/11, p. 16). A new biography of Franklin, titled *Ingenious*, dispels some of the misunderstandings about that experiment and about Franklin's science more broadly.

While many accounts of Franklin's life focus on his role as a founding father of the United States, science was central to his life story, author Richard Munson argues. Far from a mere pastime or quirky hobby, scientific research brought Franklin the fame and clout that enabled his diplomacy. "Science, rather than being a sideline, is the through line that integrates Franklin's diverse interests," Munson writes.

The 1752 kite experiment, in which Franklin famously flew a kite during a storm, was more nuanced than sometimes depicted. The kite wasn't struck by lightning. Rather, sparks emitted from the key attached to the kite's string revealed the ambient electric charge produced by the storm. And the experiment wasn't performed on a whim without regard for safety. Franklin was aware of the dangers of electricity and took precautions. "His experiment was neither a lark nor divine revelation," Munson writes. With it, however, he "converted a mystery into a wonder."

Franklin's contributions to the study of electricity went well beyond lightning. He proposed that electricity was a single, fluidlike substance — not two, as others thought. Although Franklin's theory was an oversimplification, it was a predecessor to the modern understanding of electricity. The fluid could be present in excess or in a deficit, which Franklin described with the terminology of "plus" and "minus," or "positive" and "negative," terms that persist today to describe electric charges. Franklin also concluded that the fluid could move or be collected but not created or destroyed, known as the law of conservation of charge. He described the differences between materials that do not transmit electricity and those that do, which he named conductors. Munson notes that J.J. Thomson, discoverer of the electron, said Franklin's contributions to the science of electricity "can hardly be overestimated."

The book follows Franklin's roles in the British colonies in America, the American Revolution and the subsequent nascent period of the new country. As the story unfolds, Munson includes Franklin's concurrent insights into scientific topics ranging from geology to botany and more. Even at times of intense political negotiation, Franklin's thoughts were gripped by wonders of the natural world. He was likewise a prolific inventor, and Munson chronicles his work on printing techniques,



Benjamin Franklin's famous kite experiment, which revealed lightning's electric nature, is more nuanced than commonly depicted, a new book explains.

FPG/THE IMAGE BANK/GETTY IMAGES PLUS

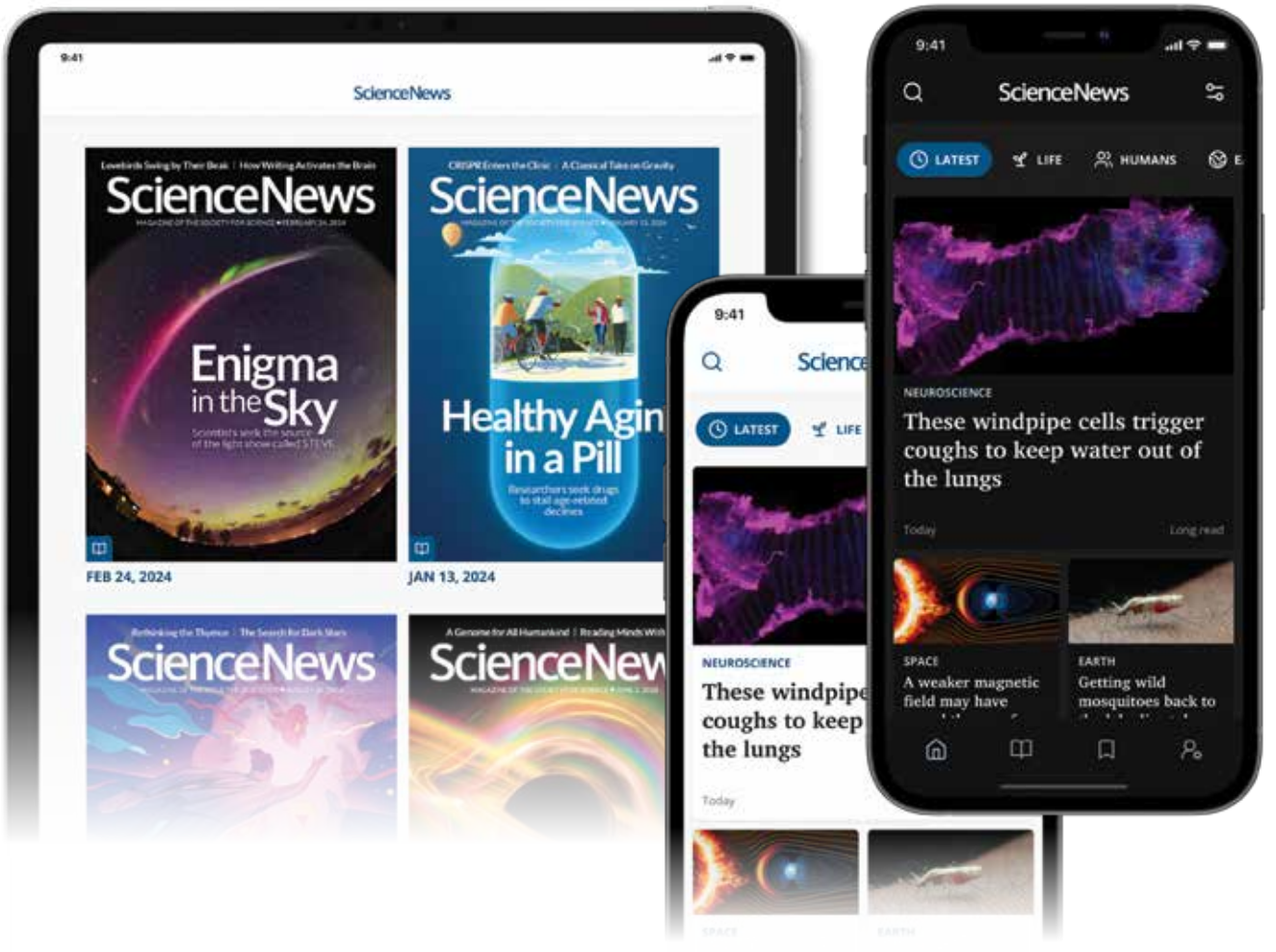
lightning rods and efficient stoves (SN: 8/26/23, p. 5).

The biography largely glosses over Franklin's participation in slavery. Though he eventually became an abolitionist, he was an enslaver for much of his life. Some readers may also wish for more scientific context than the book provides. Franklin's musings on science are often presented without comparison to current understanding. At times, readers may wonder whether his insights were prescient, or intriguing but wrong.

Instead, Munson focuses on Franklin's approach to science, which was full of joy. He played scientific tricks. For instance, he fascinated friends by appearing to smooth the surface of a stream simply with a wave of his cane. Franklin had hidden oil within a hollow cane, which he released to coat the water and smooth out its ripples. He slightly electrified the fence of his home. And he prepared a facetious proposal to study causes and remedies for farts. But Franklin also was humble, altering his theories when presented with new evidence and acknowledging failures and learning from them.

Likewise, Franklin's political views were dynamic — he argued forcefully that the colonies should remain loyal to Britain before embracing the calls for independence. But science, Munson argues, was a cause he fully embraced throughout his life. "He sought out the clever and displayed an almost boundless curiosity, utilizing imagination and investigation to understand the natural and political environments around him."

If we don't understand Franklin's science, Munson says, "we do not appreciate Franklin as well as we believe or as richly as he deserves." — *Emily Conover*



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OCTOBER 19, 2024

Toe-tally mysterious

Hairs on the toes of Mexican free-tailed bats light up under ultraviolet light, but the reason is unknown, ***Jason Bittel*** *reported in "Mexican free-tailed bats' toes glow in the dark"* (SN: 10/19/24, p. 4).

Reader **Eleanor Peterson** asked if the glowing toes might attract prey.

It is unlikely, but it is a logical thought, says biologist **Fernando Gual-Suárez** of the National Autonomous University of Mexico in Mexico City. Many organisms, such as some anglerfish and cave insects, use photoluminescence to lure prey. But unlike those life-forms, which are sit-and-wait predators, bats "are active aerial hunters," **Gual-Suárez** says. What's more, the photoluminescent toe hairs would be difficult for potential prey to see. If these marks were useful for hunting, they would be located near the mouth (think of an anglerfish's lure, for example), and the bats would "use a different hunting strategy," he says.

More studies are needed to know the marks' function, **Gual-Suárez** says. The photoluminescence could serve no function and simply be a byproduct of the hardened structure of the hairs, which are used for grooming or sensing. Or it could be used to communicate with other bats during flights or roosting, he says.

Diving deep on decay

Scientists spotted the rare "golden channel" decay of subatomic particles called kaons. Further studies could break or bolster the standard model of particle physics, ***Emily Conover*** *reported in "Rare particle decay confirmed"* (SN: 10/19/24, p. 16).

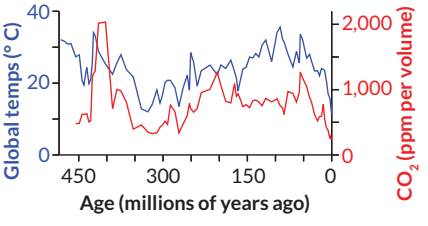
Reader **Derek Lenehan** asked how the decay might stray from the standard model.

If the decay strays from standard model predictions, it would point to new physics that is largely unknown. In this decay, a kaon produces a pion, a neutrino and an antineutrino. But other particles called W and Z bosons mediate the decay, says particle physicist **Cristina Lazzeroni** of the University of Birmingham in England. In new physics scenarios, some physicists have proposed new particles that could act as intermediaries, such as a Z' (pronounced "Z prime") boson. Another is a leptoquark, a particle with properties similar to electrons and their lepton relatives and to quarks—the particles that make up protons, neutrons and other composite particles.

Correction

The graph in "Earth's temperature highs and lows" reversed the labels for curves showing global temperature and atmospheric CO_2 data (SN: 10/19/24, p. 5). Both curves also showed fifth-percentile values rather than the average (50th-percentile) values. The correct version is shown here.

Global mean surface temperature and atmospheric CO_2 levels over time



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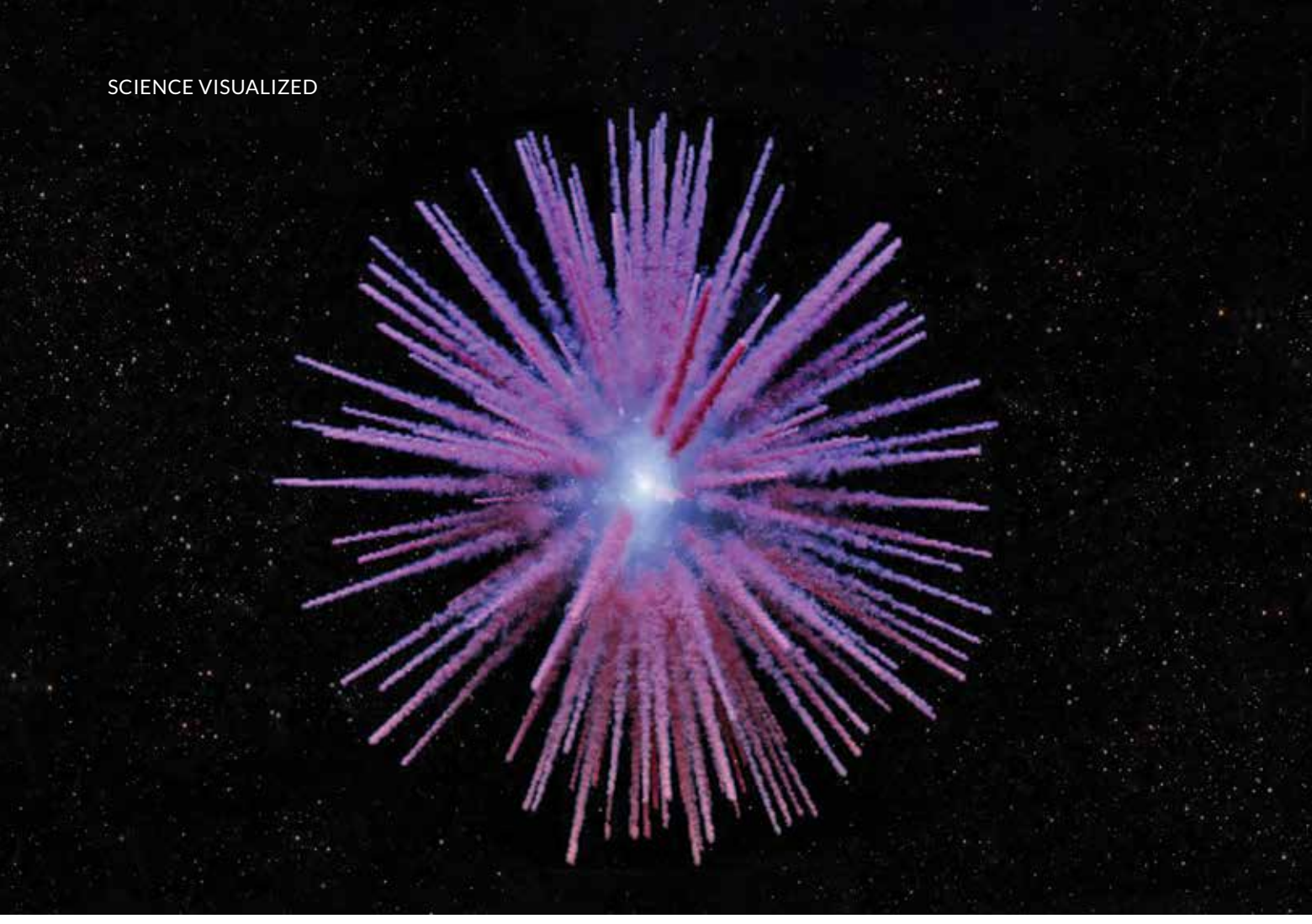

ADAM MAKARENKO, W.M. KECK OBSERVATORY

Behold the spiky vestiges of a 12th century supernova

Some 7,500 light-years from Earth lurks a zombie star cloaked in long tendrils of hot sulfur. Nobody knows how those tendrils formed. But astronomers now know where they're going.

New observations, reported in the Nov. 1 *Astrophysical Journal Letters*, capture the 3-D structure and motion of debris left in the wake of a supernova that was observed detonating more than 800 years ago.

"It's a piece of the puzzle towards understanding this very bizarre [supernova] remnant," says Tim Cunningham, an astronomer at the Harvard & Smithsonian Center for Astrophysics in Cambridge, Mass.

The supernova was recorded in 1181 by astronomers in China and Japan. To them, it looked like a new star appeared then eventually vanished. In 2013, researchers found what seemed to be the remains of that explosion. And it looked weird.

The supernova appeared to be of a kind called type 1a, wherein a white dwarf star blows up, destroying itself in the process. But in this case, part of the star survived.

Stranger still, the star was surrounded by spiky filaments stretching up to about three light-years from the star in all directions. "This is really unique," Cunningham says. "There's no other supernova nebula that shows filaments like this."

He and colleagues used a telescope at the W.M. Keck Observatory in Hawaii to record how fast the filaments are moving relative to Earth. Then the team reconstructed the filaments (illustrated above) and their motions through space.

The system, it turns out, is structured "kind of like a three-layered onion," Cunningham says. The inner layer is the star. Then there's a gap of one or two light-years, which ends in a spherical shell of dust. The final layer is the filaments, which emerge from the dust shell.

Researchers still aren't sure how the filaments formed, or how they've maintained their straight-line shapes for centuries. One possibility is that a shock wave from the explosion ricocheted off the diffuse material that exists between stars and bounced back toward the white dwarf. That wave could have sculpted the material into the spikes astronomers see. Future theoretical studies using the new observations might help solve the puzzle.

While astronomers had been pretty sure that this nebula was the remains of the 1181 supernova, the new study helps confirm it. The speeds and positions of the filaments show they all emanated from the same point around the year 1152, give or take 75 years. — *Lisa Grossman*

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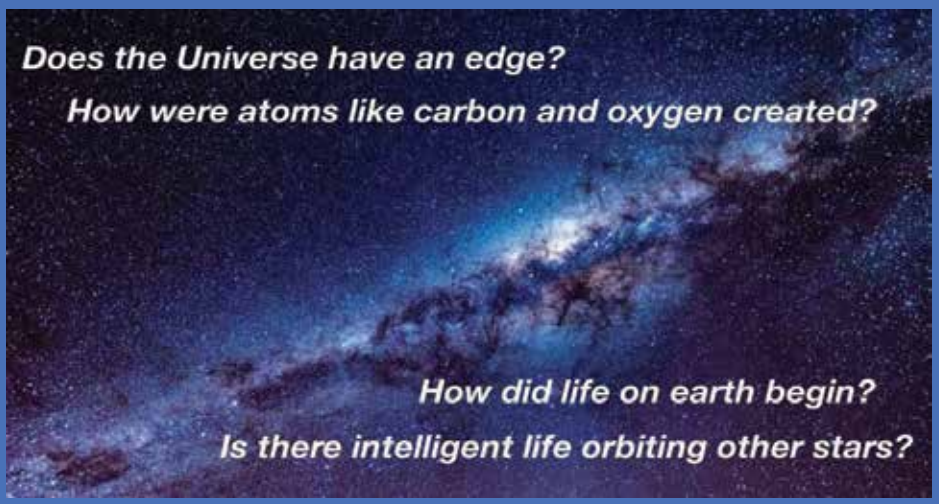

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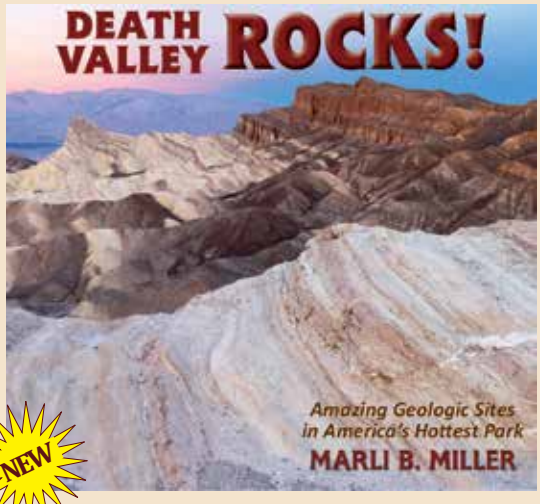

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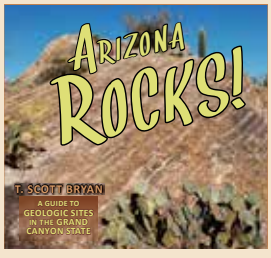

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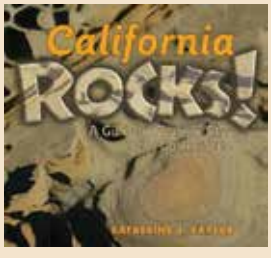

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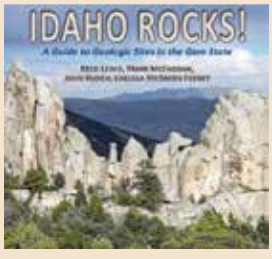

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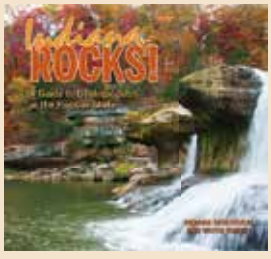

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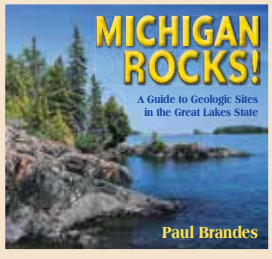

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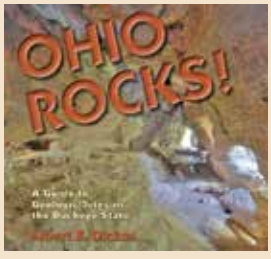

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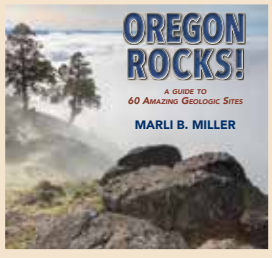

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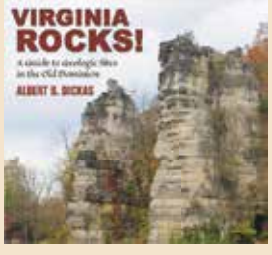

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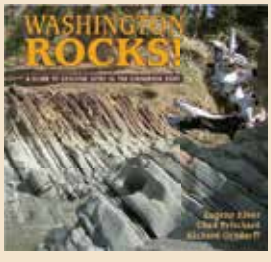

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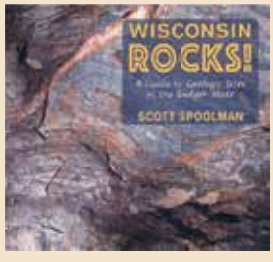

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