

NATIONAL GEOGRAPHIC



Building a Dinosaur

An inside look at the dramatic reconstruction of a sauropod

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The Deep Frontier

How technology is expanding our understanding of the ocean

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Where Bears Roam

A journey to Alaska's extraordinary Katmai National Park

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A Saharan Graveyard

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FROM *the* EDITOR

NATHAN LUMP

IT'S NOT A SURPRISE that here at National Geographic, we are all in on discovery. One of our organization's founding principles was the value of exploring and learning more about our world and sharing those discoveries with you, something that is as important today as it was in the late 19th century. For even as our understanding of the planet has increased exponentially, there is still so much that we don't know.

A case in point? The ocean. Only 25 percent of the world's seabed is mapped in high resolution, and by one estimate, more than 90 percent of the ocean's species are still unclassified. The subject of this month's cover story—and a new National Geographic series streaming now on Disney+—is a group of scientists who are seeking to greatly expand our knowledge of the undersea environment.

They're making use of advanced technology, such as a state-of-the-art "floating laboratory" designed specifically for this purpose.

Elsewhere in these pages, we're sharing other discoveries: The fruits of an incredible trove of dinosaur bones uncovered in the western United States, including a dramatic reconstruction of a *Diplodocus*-like specimen slated to go on display later this year at a museum in California. What National Geographic Explorer Paul Salopek learned about China during his ongoing walk across the world. A journey through one of America's greatest, but not particularly well known, national parks—Katmai in Alaska, where you can see brown bears and gain insights into their lives.

I hope you enjoy the issue.

A handwritten signature in black ink, appearing to read 'Nathan Lump'.



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See astonishing ways these larvae fool would-be predators, from mimicking foliage to giving the stink eye.

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On the high-tech *OceanXplorer* research vessel, scientists seek out sixgill sharks and other mysteries far below the sea's surface.

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FINDING MY WAY

At age 39, a writer finally found out why she's unable to recognize and remember people. The cause? A neurological disorder called face blindness.

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WELCOME TO BROWN BEAR PARADISE

Fishing, grazing, playing, nursing. As the shaggy omnivores go about their daily lives in Alaska's Katmai National Park, visitors can look on and learn.

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Deer antlers, essential to the species, are the fastest growing bone in all vertebrates. They also hold surprising potential for human medicine.

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DOUBLE THE TROUBLE

The planet's heaviest snake, known for its stealth and death grip, is now classified as two separate species.

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SECRETS FROM A SAHARAN GRAVEYARD

For two decades, a paleontologist has been returning to Africa's largest Stone Age burial ground and uncovering more about the enigmatic deaths.

130 *NEW FROM NATIONAL GEOGRAPHIC*

ON THE COVER The customized *OceanXplorer* vessel is investigating the sea, from its surface to its depths, using sonar, submersibles, a helicopter, and on-site labs.

Photo illustration by NEIL JAMIESON

She has five rules.

GREY'S ANATOMY



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IN FOCUS

JUST IN FROM OUR PHOTOGRAPHERS



OCEAN

“After observing the animal’s behavior, I positioned myself and CAPTURED THE CLOWNFISH in a moment of what appeared to be a *kissing or whispering* gesture.”

DENNIS CORPUZ, *Photographer*

In Anilao, in the Philippine province of Batangas, a clownfish tends to its offspring. The fish “mouths” the eggs to clean them and remove any that have not survived.

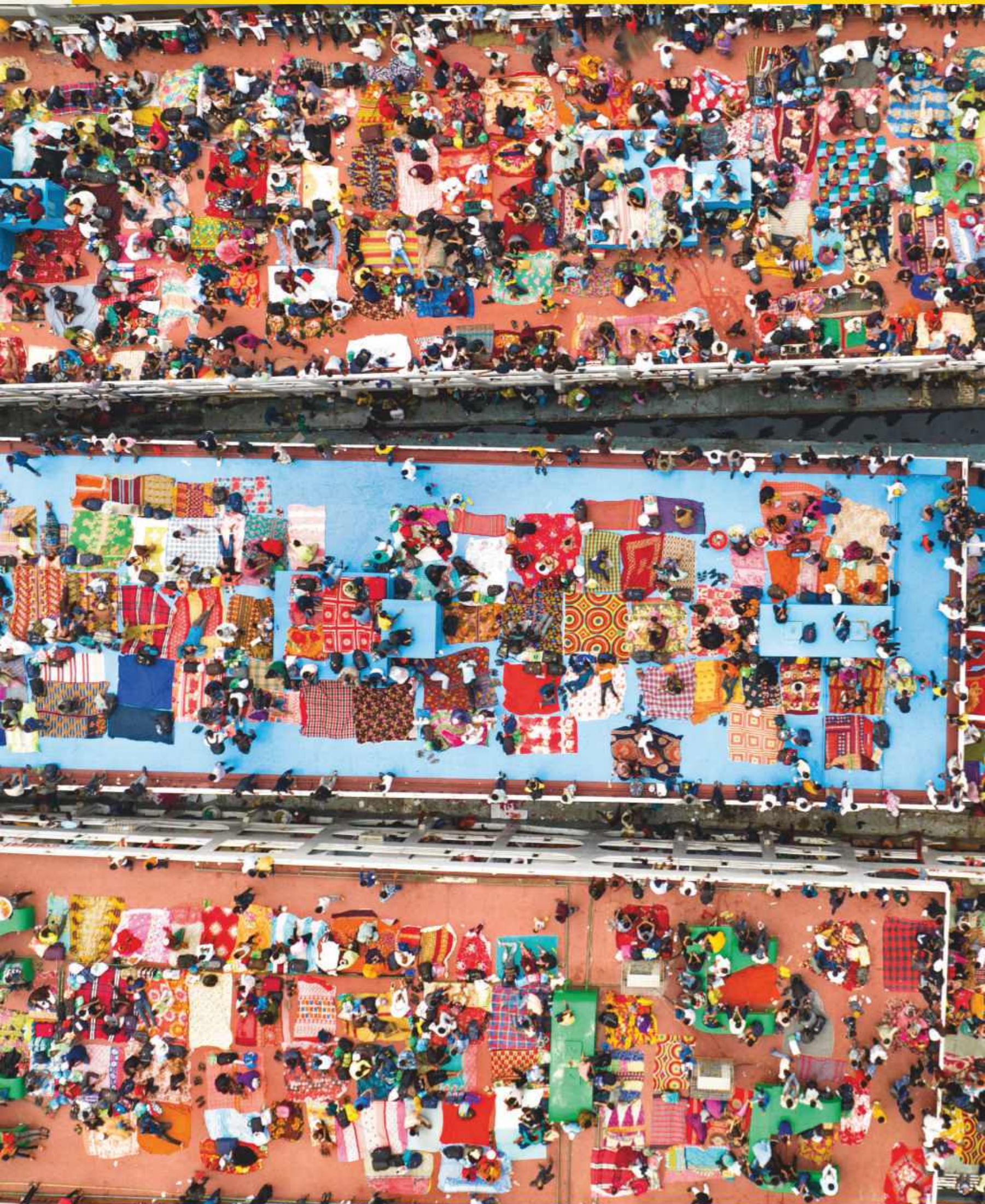
WILDLIFE

“The purple color *attracted my attention*,
and when I kneeled to take a photo,
I found the supertiny white fungi standing
next to them and making them
LOOK LIKE GIANTS in comparison.”

JAVIER AZNAR, *Photographer*

Purple pinwheels tower over *Hemimycena* fungi in
Ecuador’s Yasuní National Park. The UNESCO biosphere reserve
is home to an astonishing array of species.





SEPTEMBER



IN FOCUS

TRAVEL

“Usually 500 to 1,000 people travel in each launch, but during ANY VACATION, the number doubles or triples. People take *positions on the top deck* and make an hours-long journey.”

MOSTAFIJUR
RAHMAN NASIM,
Photographer

During the Eid al-Adha holiday in densely populated Bangladesh, travelers board large river vessels at the Sadarghat terminal in Dhaka, preparing to head toward districts in the country's south.





IN FOCUS

CULTURE

“It was magical to capture the UNEXPECTED, a moment of balance and delicate rest in the Dionysian frenzy of the *traditional celebrations* of the Vesuvian countryside.”

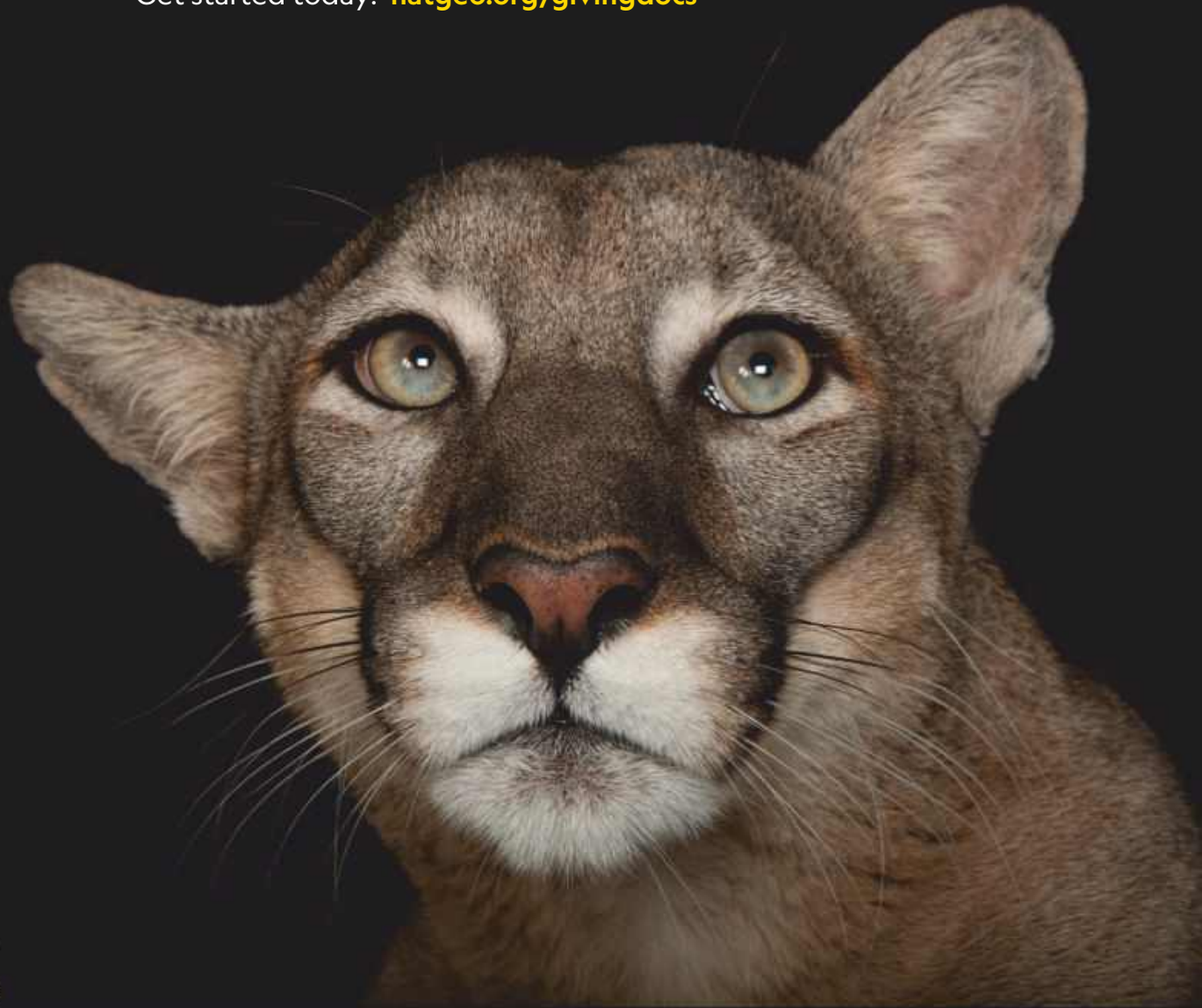
ELENI ALBAROSA,
Photographer

On an estate near the southern Italian town of Somma Vesuviana, revelers take a break from Easter-time festivities of dancing, playing music, and feasting by napping in a vineyard.

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CONTRIBUTORS

NATIONAL GEOGRAPHIC EXPLORERS

These contributors have received funding from the National Geographic Society, which is committed to illuminating and protecting the wonder of our world.



Acacia Johnson,
p.76

Curiosity and a camera led the Alaska-born photographer to spend seven years chronicling life in the Arctic and Antarctica. An Explorer since 2023, she returned home, to the heart of Alaska's brown bear country, for this issue.



John Stanmeyer,
p.94

His 21st feature for the magazine took him back to China, where he lived from 1996 to 2003. An Explorer since 2017, he now resides in Massachusetts with two Great Danes. His next photography project will focus on soil extinction.



Paul Salopek,
p.94

An Explorer since 2012, this two-time Pulitzer Prize-winning writer set out in 2013 on a slow storytelling journey, tracing our ancestors' migration from Africa to South America. To date, the footsore journalist has covered more than 15,000 miles.



Paolo Verzone,
p.110

Having photographed a Moroccan dinosaur dig, Egyptian pyramids, and the search for scrolls in West Bank caves, Verzone was right at home in a Stone Age graveyard in the Sahara. He became an Explorer earlier this year.



Peter Gwin, p.110

Over two decades of writing for *National Geographic*, his assignments have included modern pirates, kung fu masters, Tuareg rebels, and snow leopards. For this feature, he revisited a Saharan archaeological site, the subject of one of his first stories for the magazine.



Richard Conniff, p.16

The National Magazine Award winner writes often about the natural world. His recent *National Geographic* articles cover pterosaurs, privately owned dinosaurs, and, this month, how dino bones go from dig to display. He's the author of *House of Lost Worlds*.



Craig Cutler, p.16

For this issue, the photographer spent almost five years documenting the reconstruction of a dinosaur. The top challenge? How to capture a beast twice as long as a bus. "The specimen was bigger than the space," he says. "Both ends stuck out of the room."



Annie Roth, p.46

The filmmaker, journalist, and author tells stories about animals and those who study them. While reporting the ocean exploration feature, she found herself in a submersible 650 feet below the surface. Next time she hopes to go even deeper.

From excavation to exhibition, years of painstaking work and millions of dollars bring a dinosaur back to life.

D I N O

HOW TO BUILD

A man with glasses and a blue button-down shirt is working in a workshop. He is holding a long, white, segmented dinosaur skeleton, likely a Diplodocus, which is mounted on a metal frame. The workshop is cluttered with various tools, equipment, and materials, including a workbench, a blue tool bag, and a red metal frame. The lighting is warm and focused on the man and his work.

Paleontologists Luis Chiappe (at right) and Pedro Mocho study a model of a *Diplodocus* at Research Casting International, where real dinosaurs are reconstructed.

S A U R

Words by
RICHARD
CONNIFF

Photographs by
CRAIG
CUTLER

W

WHAT A STRANGE thing it must be to become a fossil. Say you live a full life for a *Diplodocus* dinosaur, swinging your enormously long tail across your Jurassic world for 70 or so years. Then you die—but in such extraordinary circumstances that, against all odds, your bones are buried and transformed over time into stone. Mountains rise and wear away around you. Rivers come and go. Glaciers rumble overhead. Your bones endure.

Even stranger, a hundred or more million years later, volcanic activity comes to dominate the area. When the superheated fluids eventually cool and drain away, your stony bones have become green, highlighted here and there with red patches like roasted meat.

And then the strangest turn of all: You return to the surface after an absence of 150 million years, and there you're discovered, extricated, and reassembled by some unimaginable new species in a bizarre new world.

STEP 1: **DISCOVER AND DIG**

A TEAM FROM THE NATURAL HISTORY MUSEUM of Los Angeles County (NHMLAC) first spotted the sauropod dinosaur they call Gnatalie in 2007 after erosion revealed a single leg bone beside a bluff in southeastern Utah. What they found underneath brought them back to the dig site for nine more summers. The jumble of bones—*Diplodocus*, *Camarasaurus*, *Allosaurus*, *Stegosaurus*, and others—had been swept together by the rivers of their day into a dinosaur logjam. Even the reconstructed specimen slated to go on display at the museum this fall is not



A team spent 10 years unearthing a dinosaur from its rocky resting place in southern Utah. Tormented by gnats during the first year of excavation, the workers nicknamed the dinosaur Gnatalie.

PHOTO: STEPHANIE ABRAMOWICZ



a single dinosaur but combines parts from two or more individuals of the same species found at the site. The identity of that species, which may be new to science, has yet to be determined. But with its long neck and tail and four sturdy legs, it shares many of the characteristics of the genus *Diplodocus*.

The nickname Gnatalie came unromantically from the tiny gnats that maddened team members the first year of excavation. They scheduled later digs for high summer, preferring the risk of dehydration and heat-stroke to gnat bites.

Among other routine hazards at the dig site, mountain lions left their tracks in the dirt, and rattlesnakes sometimes sheltered under tarps. On one occasion a lightning bolt hit the top of a nearby bluff, and a lone juniper tree burst into flame. People scattered for shelter.

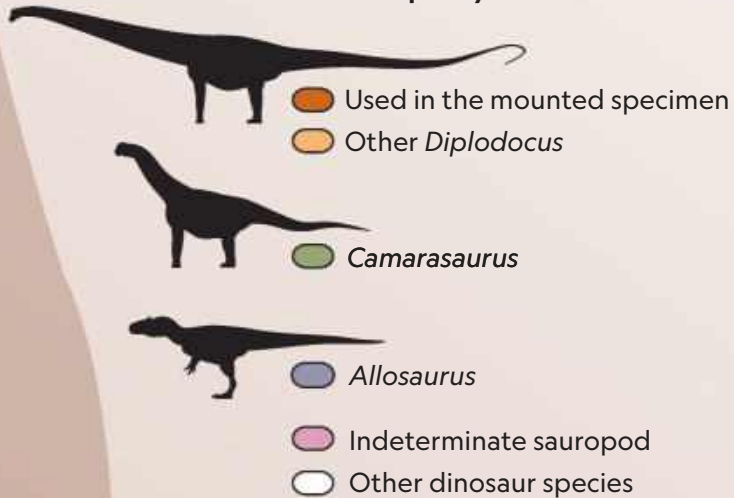
Because the site was accessible, a long day's drive from Los Angeles, the museum team saw it as a chance to show people how dinosaur science gets done, with volunteers, donors, and students doing hammer-and-chisel work. Planning dinner one night, team members conducted a head count and realized they had

JURASSIC QUARRY

Since 2007, paleontologists have been working to expose and catalog a concentrated collection of fossils discovered in a remote corner of Utah. The rock there is part of the sprawling Morrison formation, a stratum of sandstone from the end of the Jurassic period—over 150 million years old. From the bone bed, the team has been able to combine the well-preserved bones of several dinosaurs to assemble one complete skeleton.



Dinosaur bones in the quarry



Morrison formation outcrops (fossil-rich rock)

3 ft
1 m

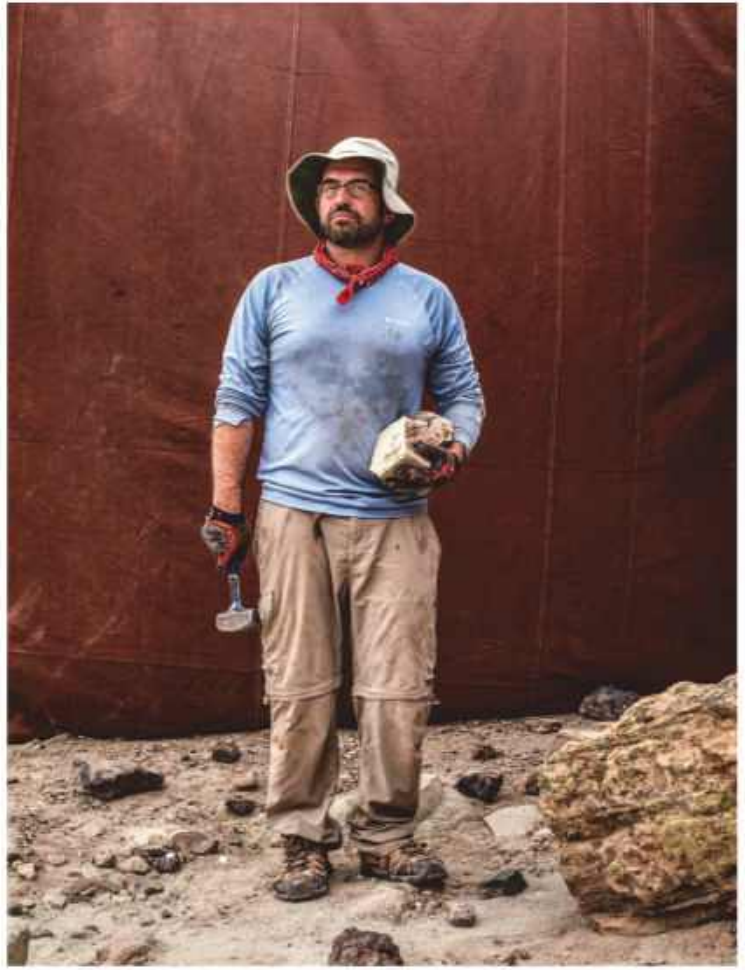
G N A T A L I E
Q U A R R Y



B U T T E

The L.A. museum's scientific illustrator at the dig, Stephanie Abramowicz, devoted days to making a detailed map (re-created, opposite page) of the "dinosaur logjam" buried at the bottom of an ancient river.





Clockwise from top left: Team members Jonatan Kaluza, Domenic D'Amore, Pedro Mocho, and Alyssa Bell used concrete saws, rock hammers, chisels, and other tools to excavate the dinosaur bones still encased in rock, or matrix. They then wrapped the fossils in a heavy plaster coating to form a protective jacket. Some jackets, such as this section of vertebrae (right), weighed more than a ton.



50 people in camp. For some, it was the first time they'd slept in a tent.

The abundance of specimens also complicated the dig. "You're playing pick-up sticks with a bunch of dinosaur bones," says NHMLAC paleontologist Alyssa Bell. "They're all tangled and locked together." In 2014 the team discovered what turned out to be an entire neck, back, and pelvis still fused together in stone. "I remember us just standing there scratching our heads and trying to figure out how on earth we're gonna get all these apart," says Bell.

The excavation process entails trenching around blocks of stone containing the fossils and digging under them, leaving temporary pedestals for support. Jackets of burlap and plaster are placed around the fossils to protect them. At the start, the crew managed to keep the jackets at a weight the workers could lift out by hand. But they soon progressed to jackets weighing a ton or more, requiring heavy machinery for the lifting.

When the time came to extract a giant pelvis, "they had ropes on either side and teams of people rocking it back and forth," says Stephanie Abramowicz, the museum illustrator at the dig. The moment it broke free, there was a crack of thunder. "It was very clear Gnatalie was speaking to us, released from the ground, ready to live another life," says Abramowicz.

STEP 2: PREP BONES

THE NEXT STOP FOR BONES coming out of the dig was the museum's prep lab in Los Angeles. The fossils were challenging, says Doug Goodreau, who runs the lab, because the surrounding material was like cement. Preparators used an angle grinder to chunk away excess stone, with sparks and stone chips flying, as well as hammers, chisels, and dental tools for more delicate work. Another essential tool: an eye for the unexpected.

"Each jacket can be a quarry unto itself," says Goodreau. Bones, teeth, and other bits must be patiently mined from the matrix. Work on one pelvis, and on bones discovered alongside it, took the better part of a year. As many as six preparators at a time worked to expose fine details, using miniature jackhammers called zip scribes and micro-sandblasters called air abraders. It sounded, says Goodreau, like a

beehive buzzing. The last bit of prepping was to fill flaws and gaps with an epoxy putty close to the color of the bone but different enough to distinguish restored from original material.

STEP 3: RECONSTRUCT SKELETON

IN THE SUMMER OF 2023, in a small Canadian town on the north shore of Lake Ontario, 2,600 miles from the Los Angeles museum, Gnatalie's bones lay in shallow wooden boxes in a back room at Research Casting International (RCI), a firm specializing in rebuilding dinosaurs for museums. Some bones rested on beds of foam, others on sand, each with a manila card detailing its place in the coming reconstruction.

In a meeting room upstairs, staff from the museum and from RCI were working through details of the mount. It would measure about 75 feet long, on display in the grand entry hall of a new wing of the museum. But at the moment, it appeared that six feet of the head and neck would poke through a wall into the next room. They debated alternative positioning, but every move seemed to be constrained by architecture. Too far one way and the head might miss key ceiling anchor points. Too far the other and the tail would intrude on an emergency exit.

Despite what architects and designers imagined, the skeleton was "not just a model you can make go any way you want," says paleontologist Luis Chiappe, director of the museum's Dinosaur Institute, who served from the start as leader (and head chef) at the dig. But the

'IT WAS
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STEPHANIE ABRAMOWICZ,
MUSEUM ILLUSTRATOR

challenge did not seem to leave anyone flustered, insuperable obstacles being standard in paleontology. Then someone announced, a little meekly, that different design software programs had been miscommunicating: The dinosaur's head wouldn't poke through the wall after all.

But there were plenty of real, rather than imagined, problems to solve. A large section of spine crushed and twisted during those 150 million years underground presented a major issue, for instance. Installed as is, it threatened to bend the spine in a way that would distort the entire mount. In the end, Chiappe opted to have RCI scan those vertebrae and produce uncrushed, 3D-printed substitutes for a more natural look. The real bones would be displayed below, as part of the exhibit's message about the challenges of getting from dig to exhibition hall.

STEP 4: MOUNT FOR DISPLAY

THOUSANDS OF DECISIONS and many months later, the RCI team set to work mapping parts and building corresponding steel structures to support them. A thick-walled steel post for the pelvis and the back legs went up first. Then came a horizontal steel armature following the natural curve of the spine. The reconstruction took months of painstaking labor, and none of it was permanent. Instead, the sections of armature slid together, or apart, in a neat stub-and-socket system. Steel holders attached each bone to the larger structure more firmly than in the living animal—but in such a way that any bone, or all of them, could be removed for repair or research. It would take just a few turns with an Allen wrench, as if it were all an elaborate piece of ready-to-assemble household furniture.

When everything was complete, the bones and steel were disassembled, packed in shipping crates, and trucked back across the continent to Los Angeles. There, on a plinth specially designed for this moment, the parts are coming together, more quickly this time. Going on two decades since their first sighting, the dinosaurs blended in this mount are rising up into the exhibition space they will henceforth dominate. Gnatalie's new life, as terror and teacher to our upstart species, is beginning at last. □

Still cradled in half its plaster jacket, an enormous sacrum formed part of the dinosaur's pelvis. Minerals from hydrothermal activity at the site gave many of the fossils an unusual green hue (right).

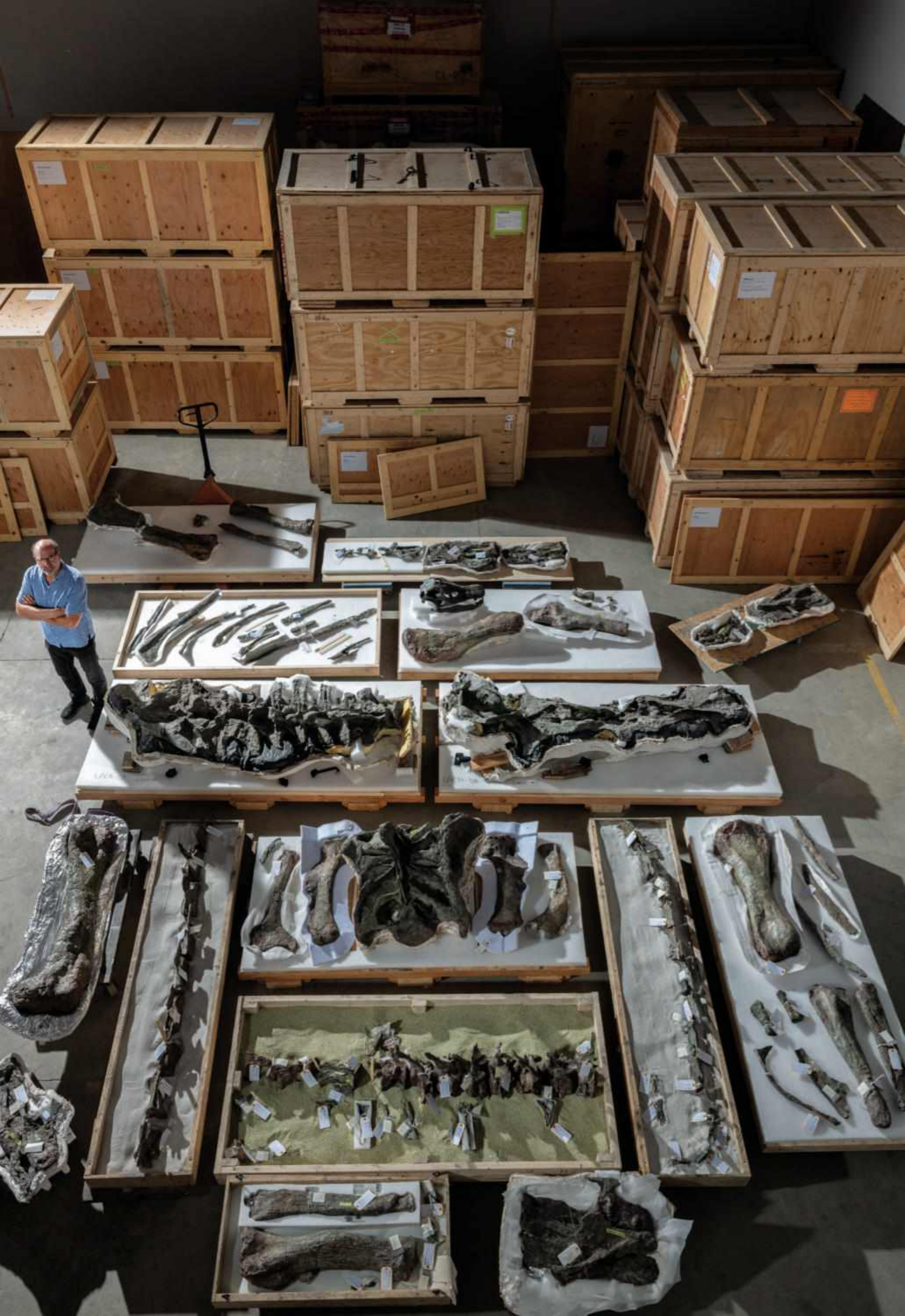








At the museum's lab in L.A., preparators cut open the jackets and spent years removing the concrete-hard matrix. Here, preparator Erika Durazo reveals the details in a section of the dinosaur's spine.





Trucked from L.A. to Research Casting International (RCI) in Trenton, Ontario (opposite), the bones were form-fitted with metal armatures (above right) handcrafted by Carm Espinal (above left) and colleagues. Bones distorted by eons underground were scanned and 3D printed to make accurate substitutes (top left). Patricia Aitkenhead (top right) paints the replicas to match the dinosaur's bones.



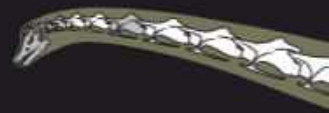
RCI blacksmith Jeff Haffner uses a forming tool called a swage block to fashion parts that will hold each bone in place. Gnatalie sparks back to life (opposite) as blacksmiths Nevin Dallman and Brian Ross (at right) assemble a steel framework to support its massive skeleton.





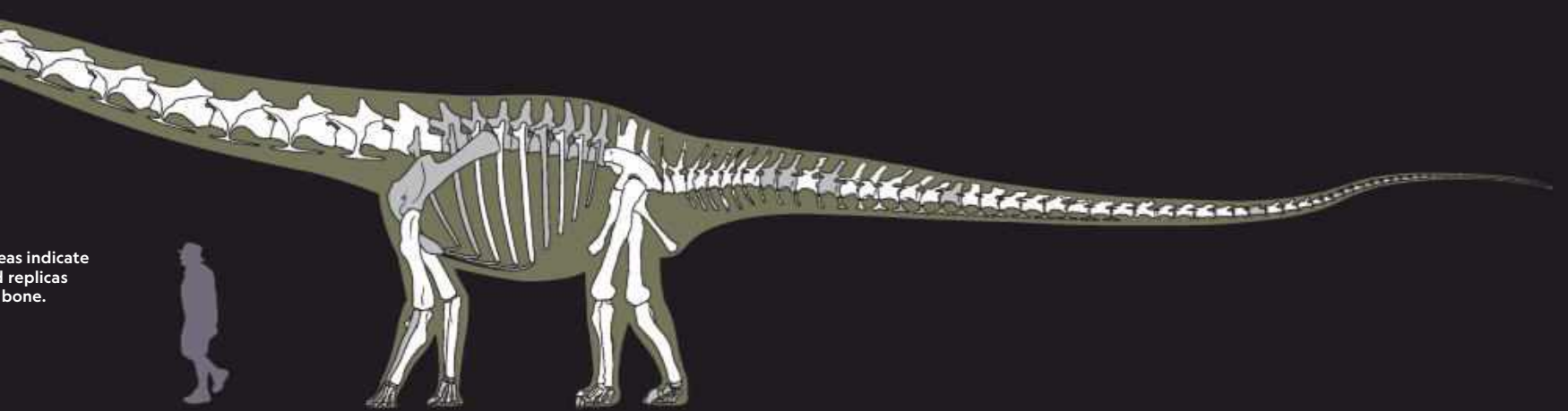
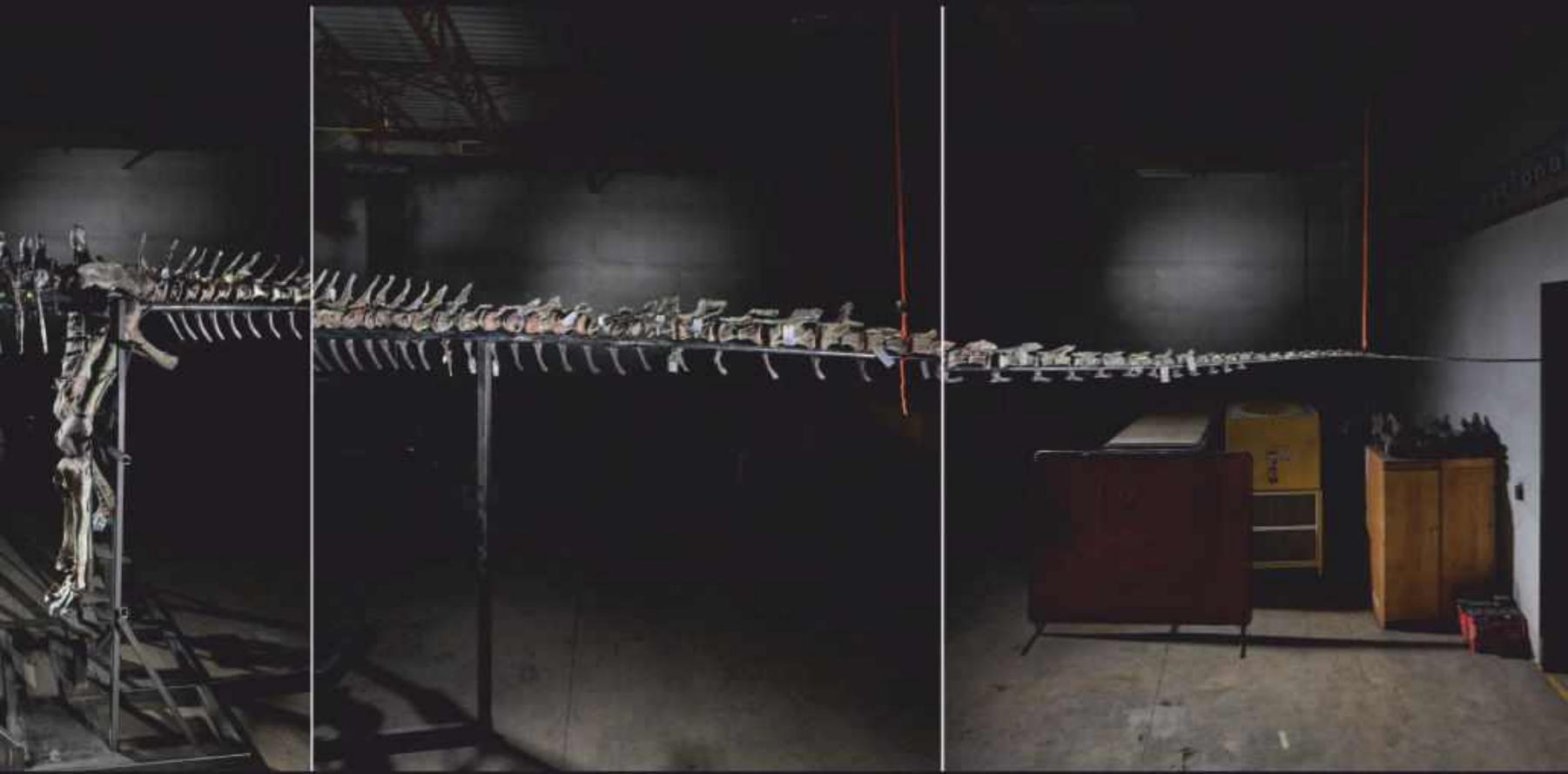
FROM EXTINCTION TO EXHIBITION

The crowning moment comes as RCI technician Kevin Krudwig positions the skull on the nearly completed skeleton, which measures 75 feet long—almost twice the length of the average city bus—and weighs around five tons, as much as some RVs. In life, the dinosaur (illustration, right) may have weighed two times as much. Later this fall the multimillion-dollar reconstruction will be the star attraction of a new wing of the Natural History Museum of Los Angeles County.



ART: STEPHANIE ABRAMOWICZ

Shaded and
3D-printed
of missing

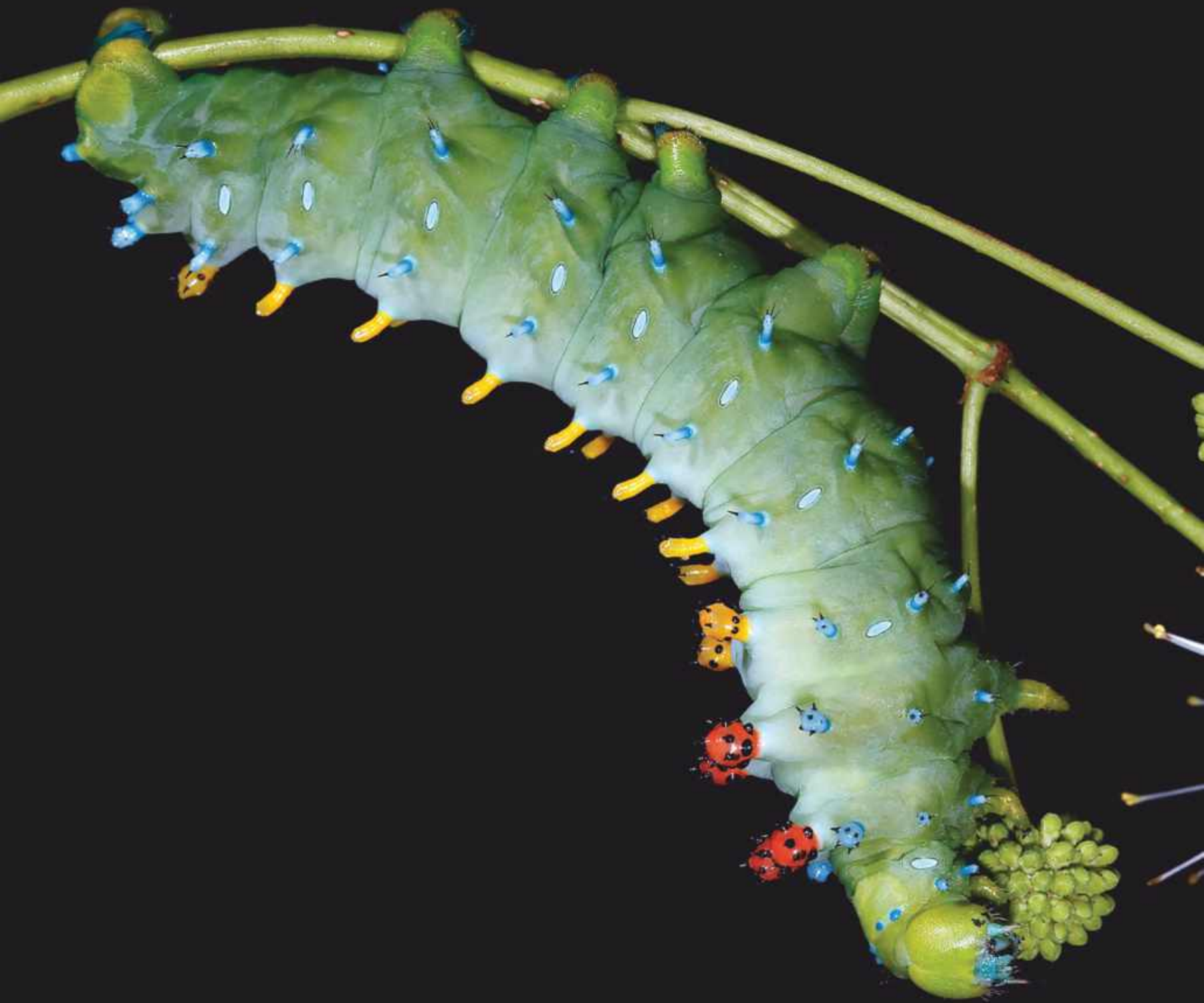


Areas indicate
replicas
bone.



Gnathale's vertebrae include a mix of fossils and 3D-printed replicas. Some 150 million years after its burial, the dinosaur will soon tower above awestruck museumgoers, as if alive again in a strange new world.





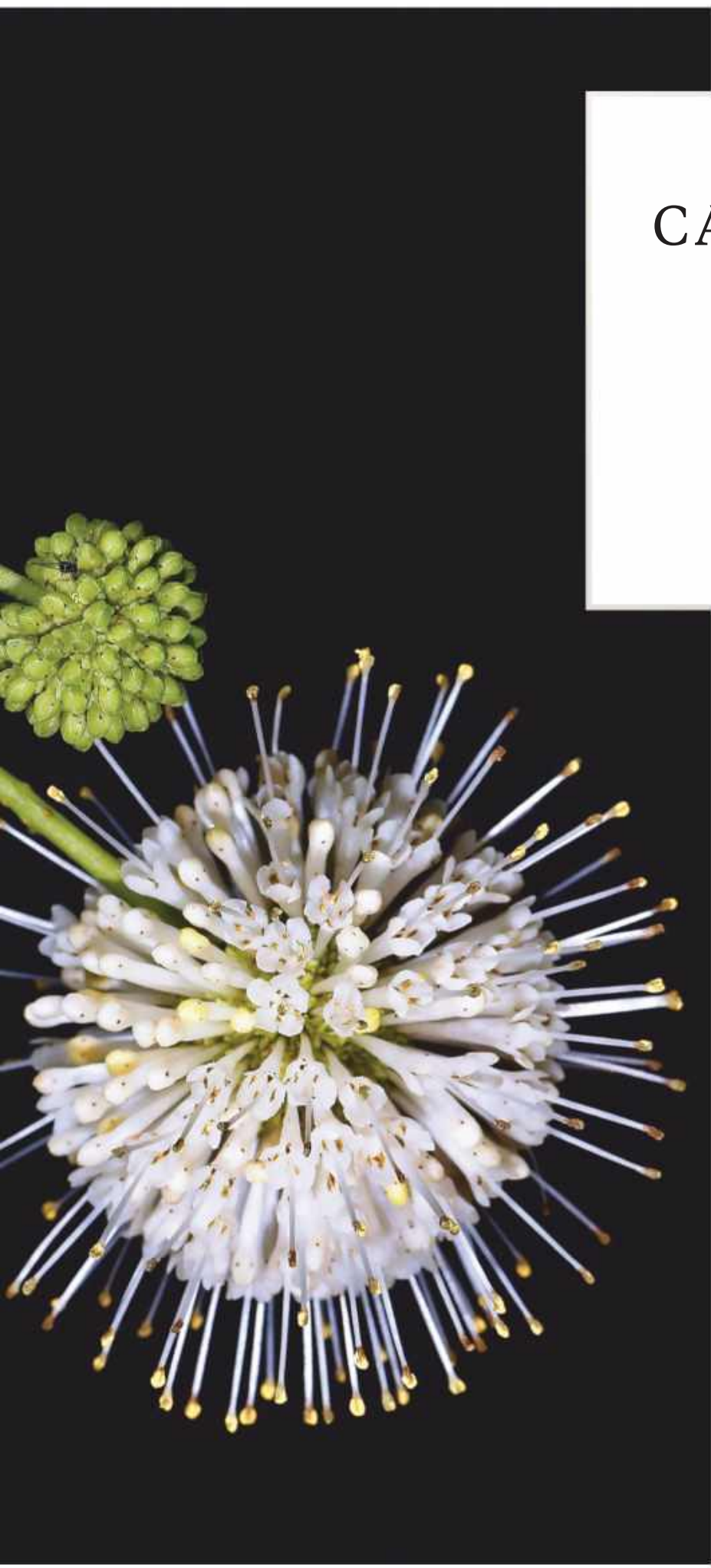
TRICKSTER CATERPILLARS

A nature enthusiast and
educator reveals the amazing
ways these insects can
fool their predators—and us.

Photographs by
SAM JAFFE

→ **BEFORE THEY TRANSFORM** into moths and butterflies, caterpillars must outwit, outplay, outlast. Sam Jaffe's images of the tubular creatures show just how: through mimicry, defensive adaptations, and partnerships with plants. The naturalist-photographer has been enamored with the insects since age four. "I used to bring them into my parents' house," he says. "They'd find them crawling up the walls." While working at Harvard University, Jaffe began taking pictures of native caterpillars during his free time, then displaying the results at local galleries. The exhibitions sparked so much interest that he launched an educational nonprofit, the Caterpillar Lab, in 2013, to open our eyes to these masters of metamorphosis and inspire their protection. —JASON BITTEL

Photographer Sam Jaffe captures the delight and deceit of his subjects, such as this cecropia caterpillar. Despite its fierce appearance, the breakfast-sausage-size creature is harmless.







Top row, left to right

After eating a leaf, big poplar sphinx caterpillars clip the stalk and let it fall, perhaps to hide from predators.

The lace-capped caterpillar is a leaf-edge mimic, using its own body to fill in the foliage space it just devoured.

“It’s a general trend that if a caterpillar is hairy or spiny, it’s a good one not to touch,” says Jaffe. The cherry dagger variety can cause slight skin irritation.

Pug caterpillars come in a rainbow of hues, depending on their host plant. These raised on blue vervain aren’t a perfect match but can fool from afar.



Bottom row, left to right

While some may view the common looper caterpillar as nothing more than a pest of lettuce and tomatoes, Jaffe sees “character and form and color.”

Elm sphinx caterpillars eat elm leaves, of which they’re a near-perfect copy. Even their scratchy, ridged texture is a dead ringer for their host plant’s, says Jaffe.

Blackberry looper caterpillars pretend to be simple twigs or other plant parts. Jaffe notes that as adult moths, they are “absolutely beautiful little green things.”

The eight-spotted forester that Jaffe found on a fox grape tendril vomits when threatened, a common caterpillar defense.

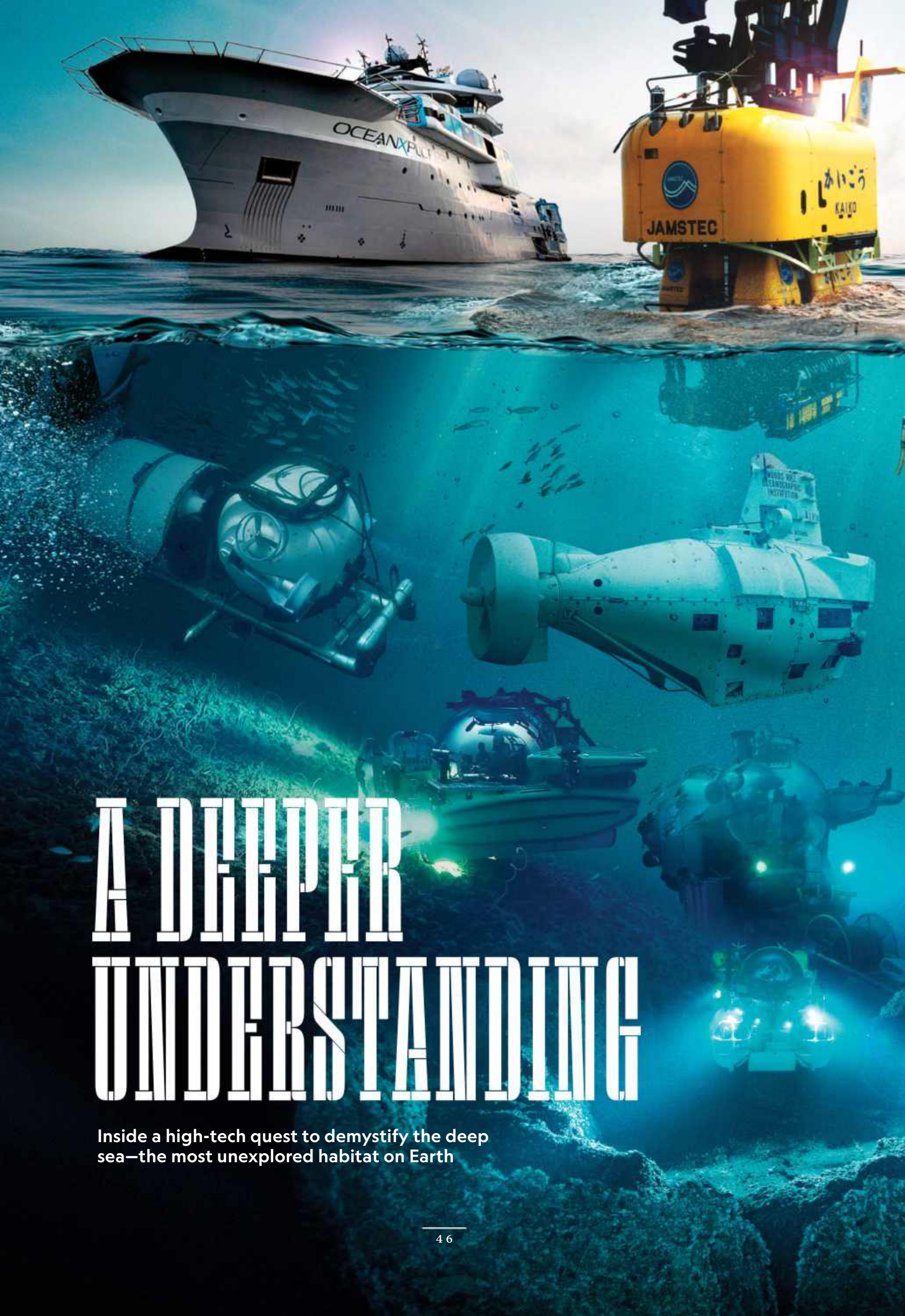
Left to right

Not all caterpillars consume leaves. The goldenrod flower species, for instance, are “clearly perfectly adapted to hide within the flowers that they eat,” Jaffe says.

The ultimate trickster? It’s the Abbott’s sphinx, according to Jaffe. Not only does it look like a snake, but when irritated, it makes a warning sound while raising a fake eye into the air.



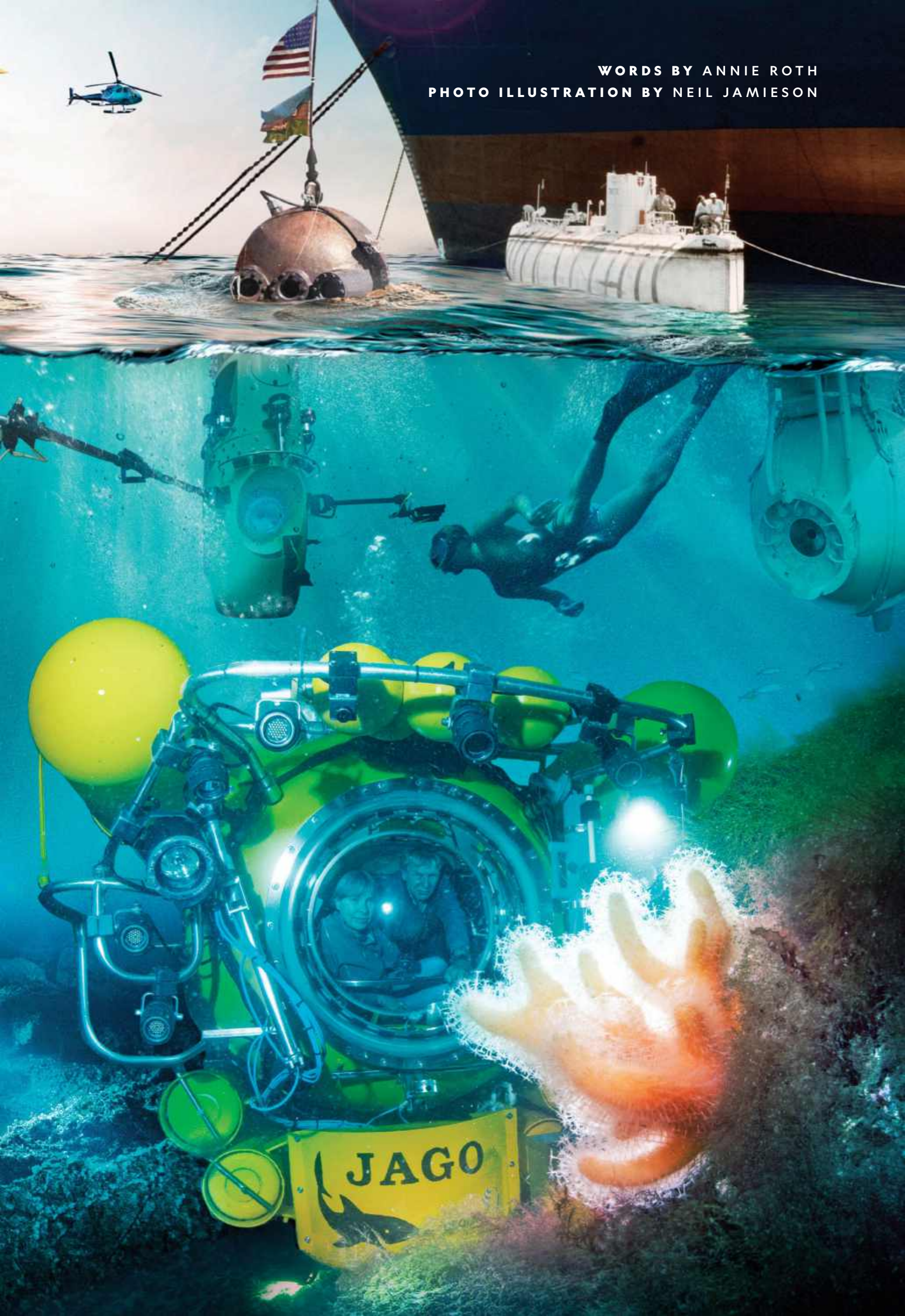




A DEEPER UNDERSTANDING

Inside a high-tech quest to demystify the deep sea—the most unexplored habitat on Earth

WORDS BY ANNIE ROTH
PHOTO ILLUSTRATION BY NEIL JAMIESON



OceanXplorer is a vessel with a helicopter, submersibles, and small boats for research missions. Here, deck safety officer Derek McQuigg operates a small craft in Sognefjorden, Norway's longest and deepest fjord.



ON A WARM JUNE MORNING, A 286-FOOT private research vessel set off from the green and rocky sea cliffs of the Azores, a chain of islands jutting upward from the North Atlantic Ocean, about a thousand miles west of mainland Portugal. The gleaming white *OceanXplorer*, rising high above the water, resembled a modified superyacht, with a helicopter pad on the bow and a pair of yellow submersibles near the stern.

PHOTO: MARIO TADINAC, OCEANX



Below the surface, the ship's hull featured a high-resolution sonar array to map underwater terrain.

The *OceanExplorer* had embarked on a unique mission: to tag and retrieve data from bluntnose sixgill sharks in their natural environment, an area so deep that much of their behavior remains a mystery. These prehistoric predators, whose ancestors first appeared 200 million years ago, can grow

up to 18 feet long. They're concealed within the ocean's mesopelagic layer, or "twilight zone"—a frigid region reaching 3,000 feet down that's nearly devoid of light. Still, each evening, the slow-moving yet buoyant sixgills here make a three-hour journey up to shallower waters to feed at a known hunting spot on the ledge of an undersea mountain near the Azores.

On board were nearly 70 crew members,

including shark biologist Melissa Márquez, who grew up in Mexico; deep-sea researcher Zoleka Filander, a South African ecologist who has discovered several new species of invertebrates; ocean technology inventor Eric Stackpole, a NASA veteran who co-founded an underwater robotics company; and two guest scientists from Portugal's University of the Azores, Jorge Fontes and Pedro Afonso, who had developed a tag that tracks sharks and provides video.

The team hoped to locate at least one six-gill, attach a camera tag to it, and then retrieve the tag later—something never accomplished before in the deep sea. It would require a series of dives in one of the onboard “bubble subs”—so called because of the acrylic globe that houses passengers. Even then, they would get only a glimpse into this hidden world; the tag would automatically release after 12 hours and float to the surface for recovery. Recovering the data, however, would mark a scientific first, yet another in a series for the team, which works with the nonprofit initiative OceanX. Over the past few years, its researchers have taken dramatic footage of orcas hunting humpback whales and separately made audio recordings of how male humpbacks might use undersea terrain to amplify their mating songs. They have also captured rare footage of the Dana octopus squid in its natural habitat.

If such moments sound particularly entertaining—sharks! whales!—that was by design. The *OceanXplorer* is the flagship of OceanX, an exploration and media venture co-founded by Ray Dalio, the billionaire founder of the hedge fund Bridgewater Associates, and his son Mark, who has previously co-produced shows for National Geographic. The group launched in 2018 with the stated goal to “explore the ocean and bring it back to the world.” This has involved converting a former Norwegian support vessel for oil rigs into a mobile scientific research center and film set. OceanX advisers include James Cameron, the Hollywood director of *Avatar* and *Titanic*.

Beyond the helicopter and the bubble

subs, which can take explorers to 3,280 feet underwater, the vessel also carries a remotely operated vehicle (ROV) for filming far deeper, plus its own wet and dry laboratories and a holographic viewing table for researchers to generate seemingly made-for-TV models of the data they collect from the deep ocean. There are more than 3,000 film-quality light fixtures throughout the boat. And starting in August, viewers around the world can tune in to see the result of the sixgill expedition, which is part of the National Geographic series *OceanXplorers*. “There’s never been a more urgent need to understand our ocean and the animals that call it home,” Cameron narrates in the series. “Because their lives, and ours, depend on it.”

OceanXplorers is inspired by the work of Jacques-Yves Cousteau and Louis Malle, who together released the film version of Cousteau’s best-selling book *The Silent World* nearly 70 years ago. The documentary was among the first underwater films shot in color and sparked worldwide interest in the ocean. That included Ray Dalio, who was entranced by Cousteau’s work and has shared that enthusiasm with his son. “How do you create a Cousteau moment for the modern age?” says Mark Dalio.

The modern age could use an updated *Silent World*. New technologies are on the cusp of unlocking scientific breakthroughs, but only if they’re funded—which means people need to care and demand action. Spurring that through a series of six 30-minute-plus episodes might sound a bit far-fetched, but as the footage reveals, each journey can lead to even more surprising discoveries.



AT AROUND 10:30 P.M., CAMERAS ROLLED from all angles as the *Neptune*, one of the *OceanXplorer*'s three-person bubble subs, dangled from a large crane, suspended over the dark ocean. Inside, Márquez, the shark biologist, sat near Afonso, a marine ecologist, and a submarine pilot. Márquez and Afonso had never had the chance to

GOING UNDER, A HISTORY

ADVANCEMENTS IN OCEAN EXPLORATION THROUGH THE AGES



1934

Engineer Otis Barton and naturalist William Beebe dive below 3,000 feet, a human first, in a vessel called a bathysphere off the coast of Bermuda.



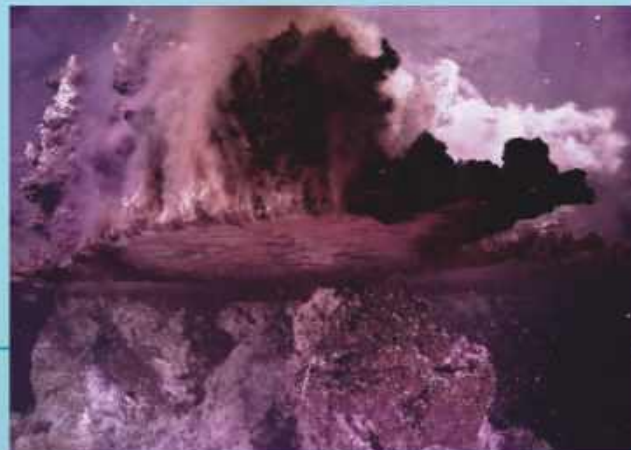
1960

Jacques Piccard and Don Walsh are the first to visit Challenger Deep, the lowest region of Earth's oceans.



1970

Scuba gear allows scientists like National Geographic Explorer at Large Sylvia Earle to spend hours underwater.



1977

U.S. scientists discover hydrothermal vents via an underwater camera and temperature sensor. To their surprise, life thrived in this sunless environment.



2012

Filmmaker and Explorer James Cameron exceeds the 1960 depth record at Challenger Deep, which was then surpassed by Victor Vescovo in 2019.

2024

Caltech engineers test the potential of bionic jellyfish—live jellies equipped with sensors to record information as they swim.



PHOTOS: WILLIAM BEEBE; BATES LITTLEHALES; DAVID LIITTSCHWAGER (NATIONAL GEOGRAPHIC IMAGE COLLECTION, THREE PREVIOUS FOR 1934, 1970, AND 2024, RESPECTIVELY); AFP/GETTY IMAGES (1960); ROY SUBASTIAN/SCHMIDT OCEAN INSTITUTE (1977); MARK THIESSEN, NGM STAFF (2012)



A mother humpback whale will stay with her calf for about a year. The nonprofit OceanX filmed one pair being hunted by orcas and investigated whether the shape of the sea-floor amplifies the humpback whale's song.

BRIAN SKERRY, NATIONAL GEOGRAPHIC IMAGE COLLECTION



A submersible launched from the *OceanXplorer* illuminates seafloor terrain in the Red Sea. Underwater geologic features are difficult to explore, but submersible and ROV technology allows scientists to study them up close.

scout for sixgills directly from a sub. Multiple cameras captured the researchers' wide-eyed expressions as the submersible dropped into the ocean and quickly disappeared below the surface.

Step one in tagging a sixgill: Conduct a population survey in the area, where the sharks are known to convene at night after spending their days deeper in the ocean.

After Márquez and Afonso descended to a ledge more than 800 feet down, they saw something large moving past their submersible's headlights.

"Shark, shark, shark!" Márquez called out, looking both excited and a little startled. "That's huge. Adult. Definitely an adult. About 15 feet long."

She could see right away that the animal was female because of the lack of claspers, or sexual organs, under its pelvic fin.

Over the course of eight hours underwater, the team spotted 11 sixgills, which had traveled an estimated 1,800 feet upward to look for food. Each shark seemed to have a different temperament, with some keeping their distance and others swimming directly at, or even right below, the sub.

They were also all female, except for one juvenile male, supporting the idea that the animals may travel in single-sex groups outside of mating season.

None of the potential targets moved quickly. "She's so sluggish," Márquez said as one of the sharks passed by, illuminated by the light of the sub. "I guess she's conserving her energy. And it's cold out there; it's only 39 degrees."



THE DEEP SEA STILL HAS PLENTY OF mysteries to reveal. It is the largest habitat on Earth, comprising more than 95 percent of the ocean, yet remains the least explored. At the first ever United Nations Ocean Conference, in 2017, an international coalition of scientists announced its intention of using multibeam sonar to generate a detailed map of the seafloor in its entirety by 2030.

When the initiative was first introduced, only 6 percent of the seabed was mapped with an adequate resolution; that figure is now 25 percent mapped in high resolution, with more terrain being added every day.

That effort may reveal a better understanding of the seafloor, but when it comes to ocean conservation, researchers face an additional challenge of trying to protect an ecosystem that's still not well surveyed.



VIDEO STILL: OCEANX

roduced, mapped to the now is ion, with y. r under- it comes s face the protect an eyed. The

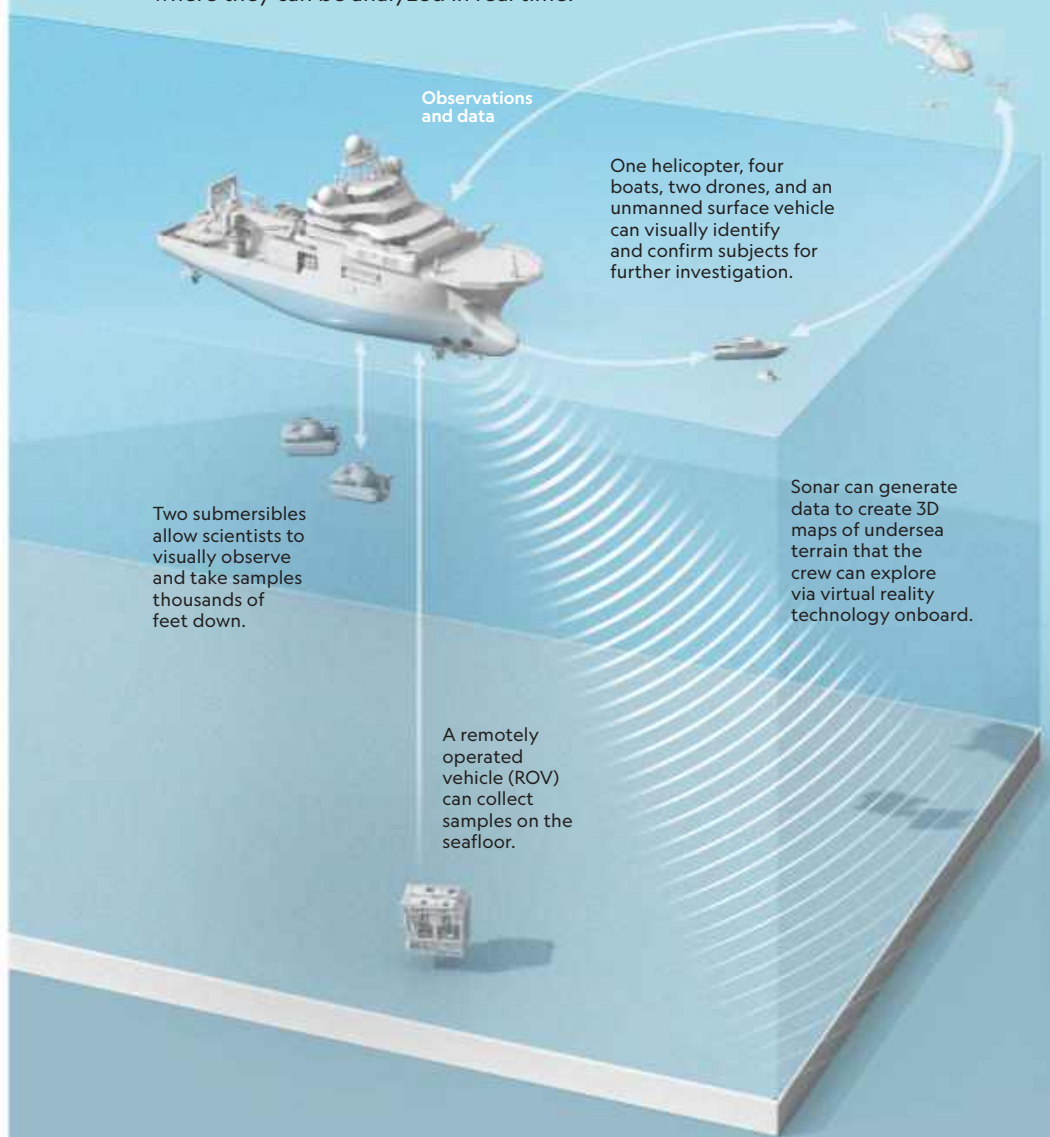
vast majority of species in the ocean—by one estimate, more than 90 percent—have yet to be classified. Rather than just cataloging discoveries, ocean-exploration entities have also put effort into better relaying the wonder of the unknown. By 2019, private equity investor Victor Vescovo piloted a submersible to the lowest point of all five ocean basins, setting a record for the deepest crewed dive in history when he reached the

LABORATORY AT SEA

OceanXplorer is custom-built to explore the ocean from the surface to its darkest depths and share that information with the world. With sonar, submersibles, multiple labs, and even a helicopter, the nearly 70-person crew can work in the field and in the lab simultaneously, going where the currents of science take them.

A NIMBLE FLEET

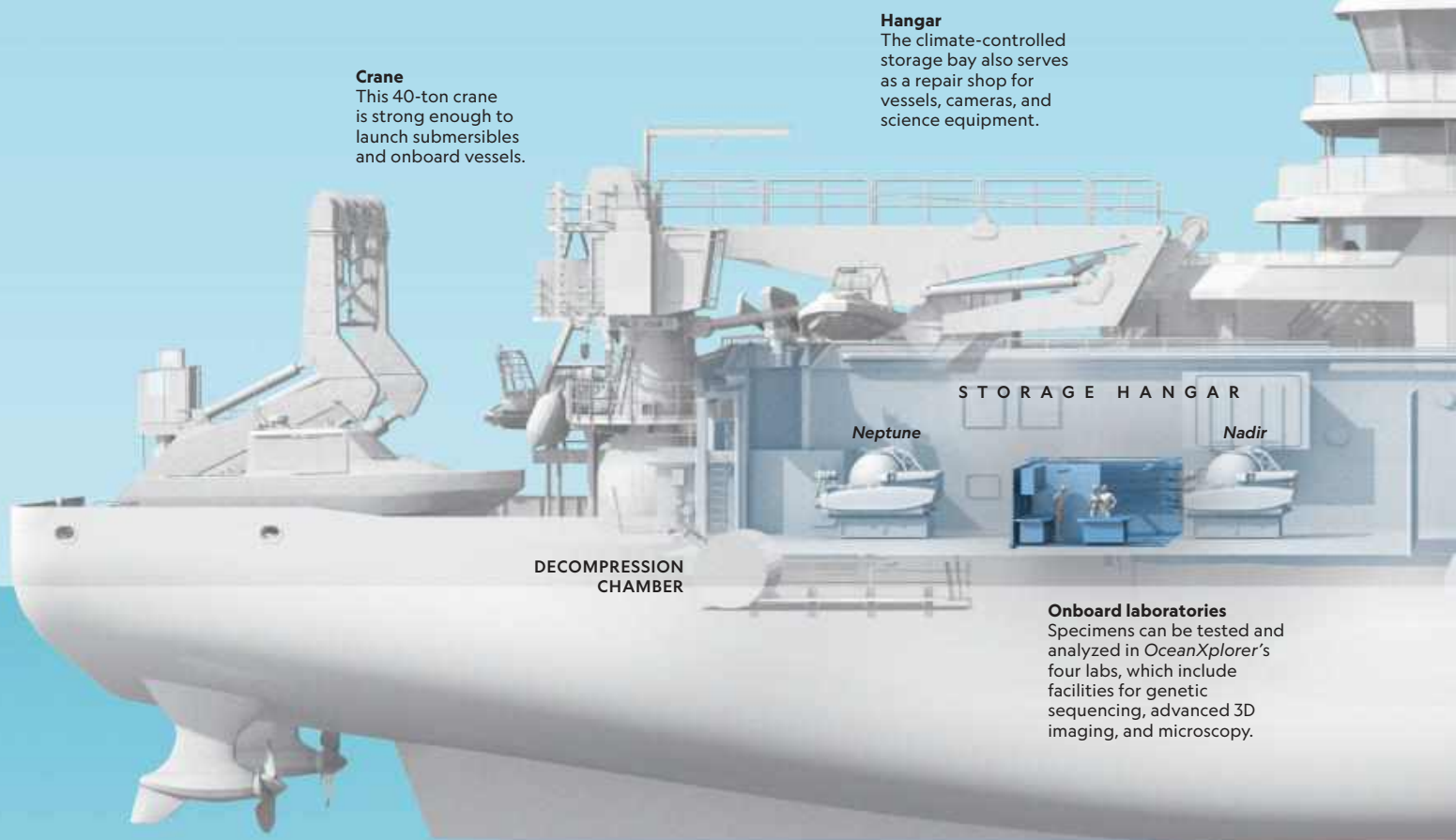
Multiple research vehicles can be launched from *OceanXplorer* for specific missions. Each one relays observations and data back to the ship, where they can be analyzed in real time.



REFITTED FOR RESEARCH

The 286-foot *OceanXplorer* was once a support and survey ship that serviced offshore oil rigs. The vessel was completely redesigned in 2020 for scientific exploration and sharing discoveries with the public.

ILLUSTRATIONS BY VIOLET FRANCES



Crane
This 40-ton crane is strong enough to launch submersibles and onboard vessels.

Hangar
The climate-controlled storage bay also serves as a repair shop for vessels, cameras, and science equipment.

STORAGE HANGAR

Neptune

Nadir

DECOMPRESSION CHAMBER

Onboard laboratories
Specimens can be tested and analyzed in *OceanXplorer's* four labs, which include facilities for genetic sequencing, advanced 3D imaging, and microscopy.

SUBMERSIBLES

OceanXplorer carries a fleet of three small vessels that can operate at depths as far as 19,685 feet, opening up almost 98 percent of the world's seafloor for exploration.



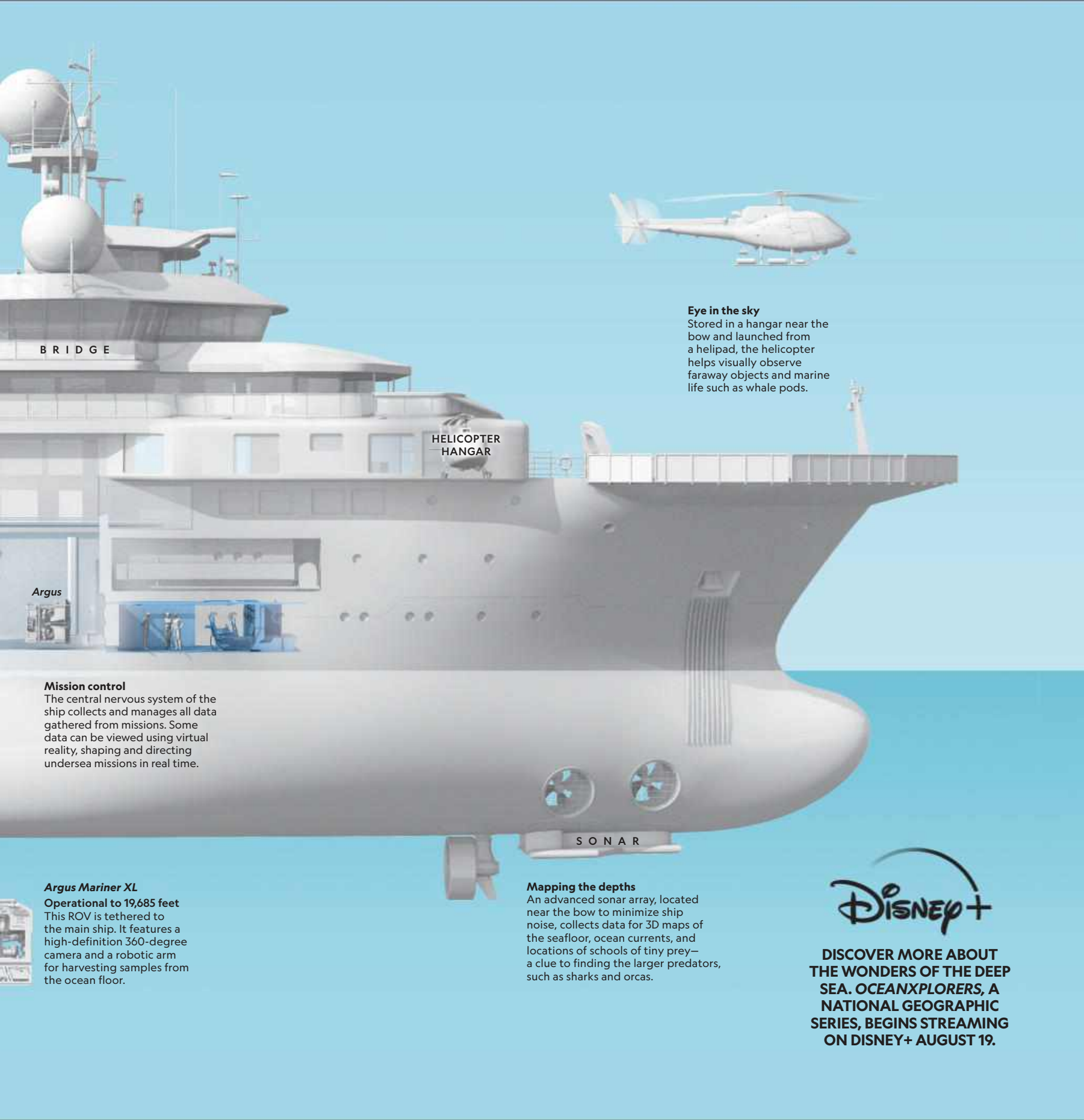
Neptune
Operational to 3,280 feet
One of two crewed "bubble subs," *Neptune* is optimized for collecting scientific samples and tagging species.



Nadir
Operational to 3,280 feet
Nadir is designed for filming and broadcasting the discoveries of its underwater partner, *Neptune*.



GRAPHIC: JASON TREAT AND EVE CONANT, NGM STAFF
SOURCES: NOAA; OCEANX



BRIDGE

HELICOPTER HANGAR

Argus

Mission control

The central nervous system of the ship collects and manages all data gathered from missions. Some data can be viewed using virtual reality, shaping and directing undersea missions in real time.

Argus Mariner XL

Operational to 19,685 feet
This ROV is tethered to the main ship. It features a high-definition 360-degree camera and a robotic arm for harvesting samples from the ocean floor.

SONAR

Mapping the depths

An advanced sonar array, located near the bow to minimize ship noise, collects data for 3D maps of the seafloor, ocean currents, and locations of schools of tiny prey—a clue to finding the larger predators, such as sharks and orcas.

Eye in the sky

Stored in a hangar near the bow and launched from a helipad, the helicopter helps visually observe faraway objects and marine life such as whale pods.



DISCOVER MORE ABOUT THE WONDERS OF THE DEEP SEA. OCEANXPLORES, A NATIONAL GEOGRAPHIC SERIES, BEGINS STREAMING ON DISNEY+ AUGUST 19.



bottom of the Mariana Trench in the Pacific Ocean, at a depth of nearly 36,000 feet.

“We have an ability to see, hear, and sample [the ocean] in ways that we just never had before,” says Chris Scholin, the president and CEO of the Monterey Bay Aquarium Research Institute, a nonprofit oceanographic organization based on California’s central coast.

Submersibles, satellites, drones, ROVs,

autonomous underwater vehicles, and undersea observatories are giving scientists and explorers unprecedented access to the ocean. As a result, scientists are discovering an average of 2,000 new marine species each year.

“It’s amazing what’s happened in the last few years,” says Jyotika Virmani, executive director of the Schmidt Ocean Institute, a nonprofit dedicated to science

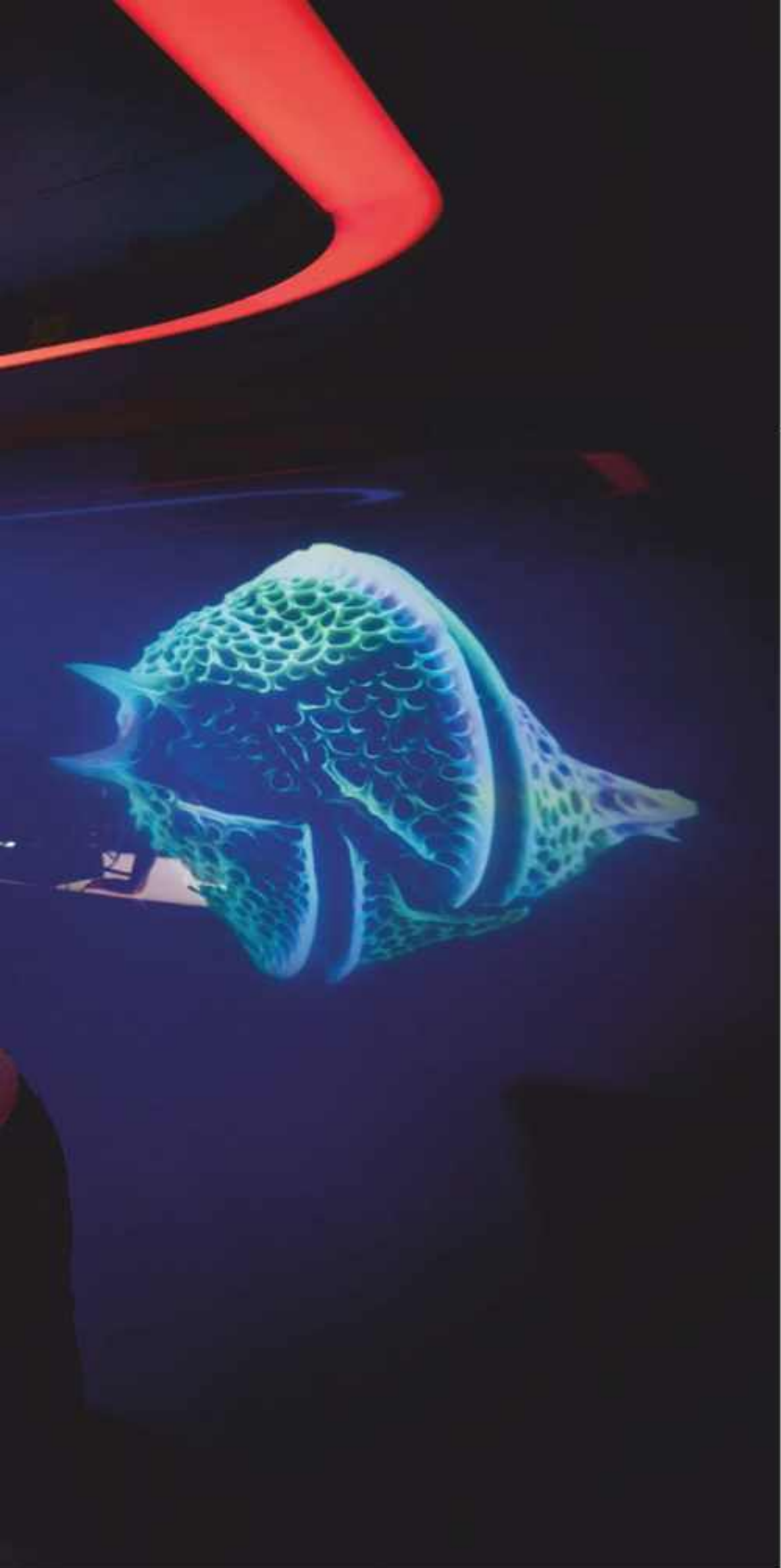


PHOTO: ANDY MANIN, OCEANX

OceanX science program director Mattie Rodrigue examines a sample on one of the ship's high-power microscopes. State-of-the-art labs like this one seek to narrow vast knowledge gaps in marine science.

and exploration that recently aided discovery of more than a hundred species believed to be new to science during expeditions to a seamount chain off the coast of Chile. “Things are happening, and they’re happening faster and faster. There’s been an almost exponential increase in information that we’re getting about the ocean.”

One of OceanX’s goals is to telegraph the vast human health and innovation

losses that may occur if important species disappear before we can learn more about them. “The ocean is just a huge library of DNA that can be exploited by humans for medical purposes, manufacturing—all kinds of things,” says Vincent Pieribone, OceanX’s co-CEO and a professor at the Yale School of Medicine. Compounds from marine life are actively being investigated for their potential as antibiotic and antiviral medications and even for components of artificial bone.

The majority of the narrative being shared right now is “the obituary of the ocean,” says Philippe Cousteau, Jr., a filmmaker, explorer, and grandson of Jacques-Yves Cousteau. “I think that has held back capturing the public’s imagination.”

AFTER CONFIRMING THE UNDERWATER ledge was a feeding spot for sixgills, the team decided it was ready to tag a shark. Around midnight on another evening, the *Neptune* shuttled Márquez and marine ecologist Fontes back to the ledge, passing through a shoal of boarfish so dense it temporarily obstructed the bubble sub’s view.

This time, decaying fish had been secured to an extended metal rod, which projected several feet in front of the submersible to entice a sixgill.

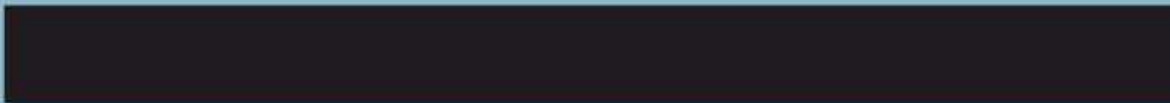
“Come on, Big Mama,” Márquez said, as if willing a shark to appear.

When the first sixgill arrived, it ignored the bait, focusing instead on a morsel that had become detached and floated to the



BELOW THE SURFACE

FOR RESEARCHER MELISSA MÁRQUEZ, THE JOURNEY TO STUDY SIXGILL SHARKS AT DEPTH WAS BOTH THRILLING AND PERSONAL.





VIDEO STILL: NATIONAL GEOGRAPHIC. PHOTO: MARIO TADINAC, NATIONAL GEOGRAPHIC (MÁRQUEZ)

Getting into an OceanX submersible was the kind of moment I had dreamed about since childhood. I grew up shuttling between Puerto Rico, where I was born, and Mexico, where I moved when I was two years old, always exploring the tide pools and beaches of the Caribbean Sea and the Gulf of Mexico. When I joined the OceanX crew, I finally had the chance to go really deep, heading for an undersea shelf on the edge of a seamount.



OceanX scientists, including Melissa Márquez (above), attempt to attach a camera tag to a six-gill shark from a submersible (left) at a depth of more than 800 feet. They journeyed so deep hoping to capture the shark's natural behavior.

For me, this journey was more than just a scientific expedition. It was a statement—a declaration of my presence in a world where people like me, people of color, were often overlooked and underestimated.

I've made the sea my life. Mostly, I focus on sharks: their ecology, behavior, and conservation. I've been surrounded by scientists and have been lucky enough to share my knowledge on TV and radio shows and at major conferences. But I was often the sole woman in these spaces, and usually the only Latina.

As we slipped beneath the surface, the world was a liquid blue, but with each passing meter, the light dimmed and the vibrant blues shifted to the monochromatic palette of the deep. Eventually, it was pitch-black. Our lights had been turned off to avoid attracting any baitfish, which would clog up the underwater sonar.

"Want to see something cool?" the submarine pilot asked. "Close your eyes, and don't open them until I say so."

After a few minutes, he gave me the OK and I opened my eyes. The sea had transformed into a kaleidoscope of blues and greens. Bioluminescence is common in the deep-sea zone, and it was gorgeous. Despite the darkness and the cold and the knowledge of the crushing weight of sea above, I felt a sense of peace. I was exactly where I was meant to be. —Melissa Márquez



bottom, and stayed out of range. Some time later, two more sharks appeared, with the larger one chasing off the smaller, probably to protect the new food source. At a certain point, one creature's large, trapezoidal tail knocked the sub with an audible thump, startling everyone behind the six-and-a-half-inch acrylic hull.

The *Neptune* was outfitted with a laser-sighted spear gun that could fire a kind of

arrow into the skin of the sixgill. Connected to the arrow was the tracker—a small, red, hard-foam package that housed a camera and other sensors capable of monitoring the animal's speed, depth, and movements for up to 12 hours.

When the larger of the two sharks came into view, Fontes pressed a button to fire the arrow, but it shot wide, narrowly missing the moving target.



PHOTO: MARIO TADINAC, NATIONAL GEOGRAPHIC

Mystery lurks beneath the waves. Greenland sharks can live for centuries, but little is known about how they hunt and survive in deep, cold Arctic waters. The OceanX crew tagged one to measure its movements.

SIXGILLS LIKELY HAVEN'T CHANGED MUCH in 200 million years and retain features from the Jurassic age. When the tagged shark reapproached *Neptune* to finish its meal, cameras captured its eyes rolling back into its head as it shook the bait. Unlike many sharks, sixgills

don't have a retractable membrane to protect the eye while hunting; instead their eyes just... roll back. For the crew, it was a visceral reminder of how different these animals are.

Because sixgills are especially buoyant, one working hypothesis for how these sharks hunt has been that they may float upward along ridgelines in the ocean, seeking silhouettes from potential prey that they can ambush.

While the show focused on the red camera tag, it was accompanied by another, more basic satellite tag that could transmit movement data for an additional nine months, allowing the researchers to continue to learn more about the species' vertical migrations. Such underwater monitoring is important: Although scientists can catch deep-sea sharks with nets or hooks and pull them to the surface, being dragged from the deep can cause potentially fatal pressurization injuries for the creatures. Stressed animals don't make great study subjects either, which is why scientists at OceanX want to tag them in their environment.

Once reviewed at the mission control room, the data retrieved from the tracker appeared to support the thesis about the sixgill's hunting method. The shark would travel slowly, with short upward bursts of speed that might signal it was ambushing prey from below.

"Damn it," he said.

Márquez grabbed her head. "I can't believe it," she said, before signaling that another shark was approaching. With only one arrow left, the pressure was on. This time, Fontes was able to hit the animal's large torso. Up in the *OceanXplorer's* mission control room, Stackpole, the underwater robotics technician, and Afonso watched with excitement and gave each other a high five.



PHOTO: BRIAN SKERRY

Sperm whales can hold their breath for up to an hour and dive more than a mile below the surface. OceanX scientists are interested in how these marine mammals hunt in such deep waters.

A LARGER MISSION

ZOLEKA FILANDER IS A SCIENTIST DOCUMENTING SEAFLOOR LIFE AND INSPIRING A NEW GENERATION OF RESEARCHERS ON LAND.



PHOTO: PAIGE MCGARVIN, NATIONAL GEOGRAPHIC

National Geographic Explorer Zoleka Filander is a deep-sea researcher with South Africa's Department of Forestry, Fisheries, and the Environment.

More specifically, she's a benthic ecologist, which means she scouts the seafloor for new or rarely seen forms of life, making her an integral part of the OceanX team.

Over the course of her career, Filander has discovered three new species of bottom-dwelling invertebrates, including *Heterocyathus monileseptatum*, a type of stony coral that looks like a Cronut pastry. Her work helped lay the groundwork for a network of deep-sea marine protected areas off the coast of South Africa.

"The ocean is still that one force that

joins us all together," says Filander, because of its role in generating oxygen for the atmosphere and sequestering carbon.

"I see it as a space where I am most fulfilled, not just on a professional level but also on a personal level. When I'm going through tough times, that's where I go."

Today Filander considers sharing her knowledge of marine science to be a huge part of her work, often visiting schools, orphanages, libraries, and hospitals in South Africa to spur future deep-sea researchers.

"The deep is a very complicated system, out of sight and out of mind for most people," Filander says. If we are to explore it in its entirety, we need everyone on board. —AR

OceanX missions aren't all focused on thrashing sharks and whales. Often they pursue the more prosaic business of mapping. While the *OceanXplorer* tracks sharks and films whales, the vessel is also using its own sonar array to add to the growing body of data about the seafloor. In 2019 OceanX conducted an end-to-end survey of the largest coral reef system alongside the continental United States. It also conducted yet another voyage off the Azores, in 2023, producing yet more findings on underwater seamounts and ridges to support the designation of 30 percent of the region's economic zone waters as marine protected areas. Scientists working with OceanX have contributed to nearly a hundred research papers, on topics ranging from coral-dwelling crabs to microbial life around hydrothermal vents.

"The sea, once it casts its spell, holds one in its net of wonder forever," Jacques-Yves Cousteau wrote. At a time when the public's increasingly short attention span may make it harder to digest complicated information, OceanX is trying to perpetuate that spell.

Dalio, the nonprofit's co-founder, says he wants *OceanXplorers* "to be a launch, not just of a series but of a new awareness and excitement about the ocean," adding he wants to "create a wave" that gets others involved and working together. If that can happen, he says, "we really are on the brink of a golden age for ocean exploration."

What its scientists share with the public seems to be getting attention: OceanX has more than four million followers on TikTok.

DURING ANOTHER DIVE IN THE SUB, Márquez and Afonso witnessed a large sixgill skim close to the floor of the ledge. This might be attributed to the animal's use of highly attuned electrical sensors in its head to detect movements of other creatures in the murk. But instead of seeing the feeding method their data suggested, what

Great hammerhead sharks (at left and bottom) cruise along the seafloor in the Bahamas. Scientists are scrambling to learn more about these critically endangered creatures. The OceanX helicopter crew followed one on a stingray hunt.

happened next was different. The creature quickly inverted, swinging its tail vertically above its head before swinging it back and forth to seemingly pin something against the seafloor. It could have been a ray hiding under the sand.

Back on the *OceanXplorer*, Márquez and the team talked over just how much that moment defied their expectations. Rather than proving one version right or wrong, the truth is more exciting: The sixgill may have different hunting tactics it can deploy.

"The data from the tag was telling us one thing," said Márquez, "but our own eyes are telling us something completely different." It's an unexpected finding and a reminder of just how much remains unknown.

AT DUSK ONE DAY, THE SUN LIT UP THE rocky cliffs of the Azores, and the *OceanXplorer* steered onward, the large vessel backlit by the dimming light that reflected across the vast ocean around it. Eventually, the ship would head back to port to refuel and start another mission, bringing on another group of local scientists to study the deep.

As the ship moved ahead, it looked small against the backdrop of the ocean, which stretched so far that it blended into the glittering horizon line. Almost every day at sea features a moment like this, when, with the right perspective, the enormous vessel suddenly looks small. When you zoom out, there's always more ocean. □



SECRETS OF THE DEEP

OCEANX IS NOT ALONE IN EXPLORING THE ABYSS.

The deep sea—defined as the area between where light begins to dwindle and the seafloor—makes up nearly all of the ocean. But because of extreme pressure, frigid temperatures, and lack of sunlight, it remains the least explored. Much of modern ocean research is focused on mapping its geographic features and cataloging its eclectic collection of life. For the past 15 years, scientists working with the Schmidt Ocean Institute have explored its depths with urgency. In 2024 alone, SOI expeditions discovered around 150 species believed to be new to science, including deep-sea corals and squat lobsters. Their fastidious exploration stands to not only demystify the deep sea but also improve the way we manage and conserve it. —AR





PHOTOS: ROV SUBASTIAN/SCHMIDT OCEAN INSTITUTE



Seamounts, the mysterious mountains of the ocean, are hot spots for life, as seen in recent scientific surveys supported by the Schmidt Ocean Institute. Marine creatures observed include (clockwise from top) green feather stars living on deep-sea coral at 3,000 feet, the rarely seen whiplash squid at 3,625 feet, and a bright red member of the sea toad family that can walk on the seafloor at 4,556 feet.

FINDING
My
WAY

A writer with
face blindness reflects
on moving through a
world filled with
friendly strangers.

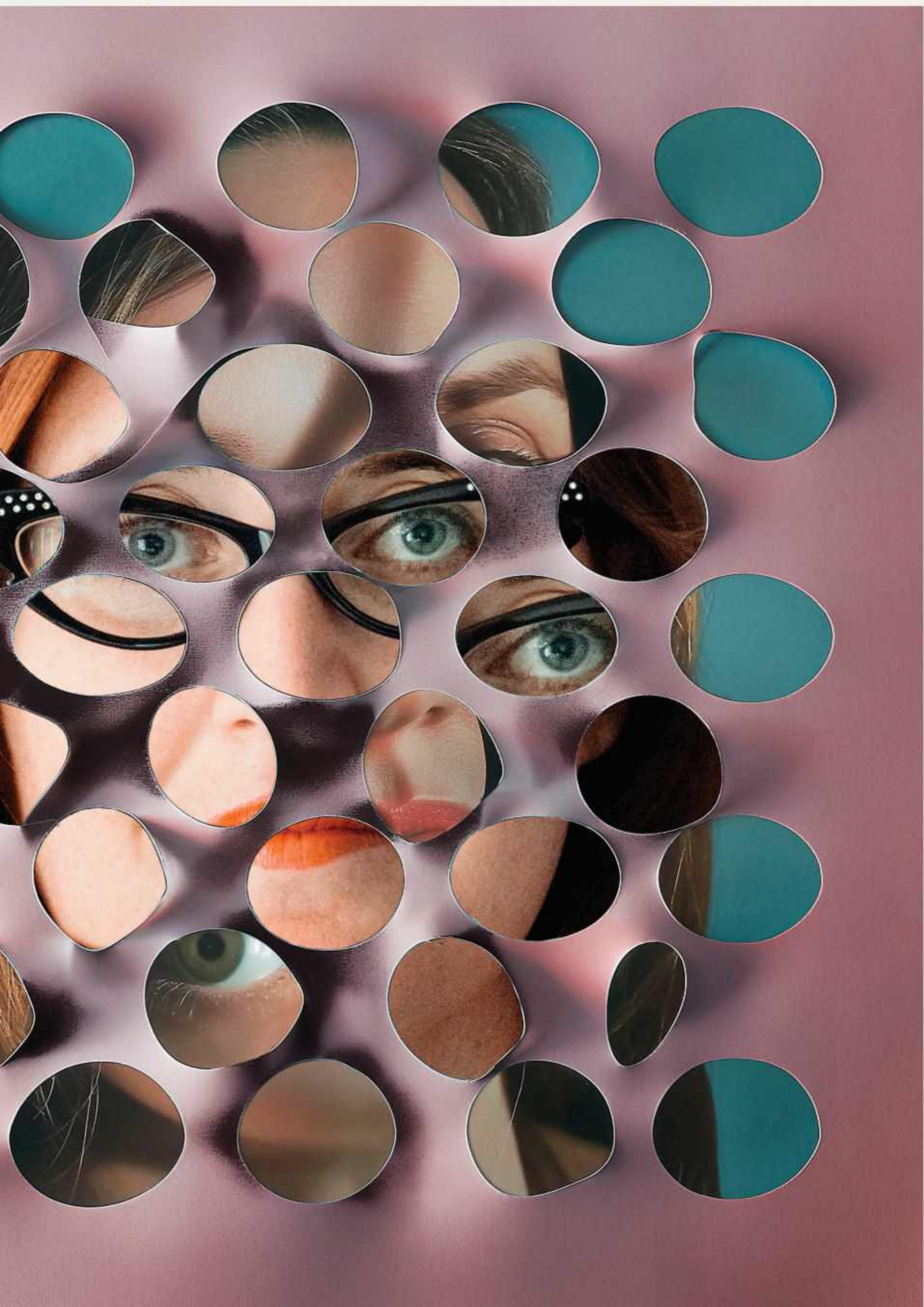
Words by
SADIE DINGFELDER

Illustration by
MATTHIEU BOUREL

→ **FIFTEEN PAIRS OF EYES STARED** into the gloaming. An hour passed before someone spied the faintest wisp of smoke on the horizon. The wisp drew closer, becoming something larger, winged, and muscular: sandhill cranes the color of storm clouds, save for their smart red caps. They swirled around our bird blind, a converted shipping container set into the riverbank to hide us from the cranes, and dropped out of the sky in groups of two or three or five, landing gently in the Platte River in central Nebraska.

“It looks like one big mass of birds,” explained our guide from a conservation group called the Crane Trust. “But they actually stay in family groups for their entire migration.”





“How do they keep track of their mates?” I asked.

“They look alike to us, but I bet they look different to each other,” replied a woman in a green coat. I turned away from the birds to study her face. She had wide-set eyes, a ski jump nose, and short gray hair. Was she the same woman I was chatting with on the van ride here, the one who showed me pictures of her dogs?

She was flanked by two similar looking women, and all three were traveling with their own mates—men who were, to me, interchangeably outdoorsy, middle-age, and white. After the cranes melted into the inky darkness, we humans filed silently out of the blind and trekked across a muddy field, our careful footfalls drowned out by a choir of chirping frogs.

Back in the dining hall, we sat speechless, some of us near tears at the beauty we’d seen. As we began to put our collective wonderment into words, I noticed many of my fellow “craniacs” (our term for crane enthusiasts) were calling me by name. It wasn’t strange by any means. After all, we’d spent the past six hours together, chatting over drinks, getting settled in our cabins, and then packing ourselves tightly into vans. But, hard as I tried, I couldn’t draw forth any of their faces or names.

To my eye, humans are nearly as interchangeable as cranes, and I only recently discovered why. I have a neurological disorder known as prosopagnosia, or face blindness. Some people end up with this condition through brain injury, but most cases are genetic in origin—and this version, known as developmental prosopagnosia, affects 2 to 2.5 percent of the population. It touches nearly every aspect of our lives, from dating to networking to making friends, and yet it goes largely undiagnosed. This is because, like most people, folks with face blindness

assume that everyone else sees the world the same way as we do. We don’t realize that other people perceive faces as distinctive and highly memorable. A case in point: Bill Choisser, who coined the term “face blind” in the late ’90s, once asked his partner, “Why do TV shows have so many close-ups of actors’ faces? How are we supposed to tell them apart if we can’t see their clothes?”

As a kid, all I knew was that I couldn’t seem to make any friends. I’d hit it off with someone one day and then treat them like a stranger the next. I later found out that my classmates, quite reasonably, thought that I was aloof, or weirdly hot and cold. To fend off loneliness, I would read constantly, usually series like *The Baby-Sitters Club* or *Sleepover Friends*. I dreamed of having not just one pal but many. I yearned for the safety of a flock.

In college I abruptly switched strategies—from treating everyone like a stranger to treating everyone like a friend. Walking to class, I’d stop and chat with anyone who so much as glanced my way. It was, I thought, a major improvement. So it went for another 20 years. I knew everyone without really knowing anyone, save a handful of best friends and a boyfriend, all of whom tended to be visually distinctive, or at least very loud. It never occurred to me that this might be a strange way to live.

Not long after I turned 39, I began writing down funny stories from my life, pushing to meet a personal deadline to write a book by 40. Since I was working at the *Washington Post* at the time, I sent drafts to friends who also happened to be award-winning journalists. They had questions: Why are you always lost? Why do you regularly have no idea who you are talking to? Why is your life shot through with so much ambiguity and confusion?

Other people might have consulted a neurologist, but as a science writer,

my first instinct was to sign up for studies. One, run by researchers at Harvard, involved brain scans followed by nearly 30 hours of intensive face-recognition training. My scores in the program improved, but whatever skills I learned during the exercises did not translate to real life. Somehow, I figured out a work-around for tests that were all but impossible given my unusual brain—and this is how I (and most face-blind people) get through life. We figure it out. We adapt.

This is also true for the sandhill cranes. When humans replaced wetlands with farmlands, the birds adapted their diet to include crops like corn. The sandhills, however, are uncompromising in at least one regard: They need wide, shallow waterways to roost in—and that’s why, during much of the year, Crane Trust staff mow down saplings and prevent shrubbery from rooting along the riverbanks. As a result of this adaptability and assistance, sandhill crane populations have been steadily increasing every year.

While I don’t require much accommodation these days, except for the occasional name tag, I do worry about all the lonely face-blind kids out there—as well as people who have other neurological differences. What could we as a society do to make the world more hospitable to the largely unacknowledged diversity of human brains and minds? Where should we be clearing riverbanks?

It was late when we got back to our cabins, but I was still curious about the cranes. I skimmed a few papers before going to bed, and I discovered that cranes probably do look alike, even to each other. But their calls are distinctive. Each bird has its own signature sound, and their voices can carry for miles. This is how cranes keep track of their family members throughout their migration—not with their eyes but their ears.

I should have known. While the cranes

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without really
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SAVE A HANDFUL
of best friends
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It never occurred
to me that this
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way to live.

looked the same to me, I noticed one particular bird that stretched its neck long and made a sound like an angry clarinet. “It looks like he doesn’t like where his family has roosted,” my friend in the green jacket observed. It was impossible to know, but I suspected she was right. The world is a cacophony of consciousnesses, all so different from your own. But sometimes, if you’re quiet, perceptive, and lucky, you can hear another singular voice piping through the din. I drifted to sleep that night feeling a deep kinship with the cranes, comforted by the knowledge that while my vision may sometimes fail me, my curiosity never will. □

Sadie Dingfelder’s first book is *Do I Know You? A Faceblind Reporter’s Journey Into the Science of Sight, Memory, and Imagination.*

A close-up, side-profile view of a brown bear's head and shoulder, showing its thick, shaggy fur. The bear is positioned on the right side of the frame. The background is a soft-focus landscape of green grass and distant mountains under a clear blue sky.

Welcome to BROWN BEAR PARADISE

ON THE REMOTE KATMAI COAST OF
ALASKA, VISITORS GET TO KNOW THESE
APEX PREDATORS AS INDIVIDUALS.

A brown bear
searches for salmon
along a creek in
Alaska's Katmai
National Park. The
park supports one
of the densest
brown bear popula-
tions in the world.

Words and photographs by
ACACIA JOHNSON



A mother bear and her cub

amble toward us across the grassland. The cub—a shaggier, blonder miniature of the mother—is in its second summer here in Hallo Bay on the coast of Alaska’s Katmai National Park. It mirrors mom’s adult behavior but is still playful, affectionate. Now the cub snuggles against her, and they sit down facing away from us and curl up for a nap. They’re completely, almost radically, at peace with our presence.

And the feeling is mutual. Within half an hour, my fiancé—who, like many first-time visitors to Katmai, had been concerned about coming close to such large predators—is so at ease around the bears that he too falls asleep in the grass.

Around 2,200 brown bears live in Katmai National Park and Preserve’s four million acres, and its Pacific coast, separated from the rest of the park by the Aleutian Range, is home to some of the highest densities of brown bears ever recorded. Abundant coastal food sources like sedges, salmon, and razor clams mean that bears can gather in large numbers and still have plenty to share. That makes food-rich areas like Hallo Bay, accessible by bush plane or boat, some of the best brown bear viewing in the park.

DAVE BACHRACH HAS led brown bear trips in Katmai for over 20 years. Now 67, he is steady and relaxed, and speaks with calm authority, dressed in the same muddy gray as the glacial silt that forms this coast. Following his example allows tourists to fit, for a few hours, into the bears’ world.

“I want people to see bears in their natural environment,” he says, “not reacting to us.”

Brown bears have been part of my life for as long as I can remember. In their 20s, my parents spent their summers running one of Alaska’s first brown bear viewing camps on the rugged coast just north of the Katmai border. Brown bears were revered in our household, and we regarded them as individuals, with—as research now shows—their own personalities. “Living with bears demands respect,” my mother told me. “We were honored to be visitors in their world.” Bear photos are still tacked up among family pictures in my parents’ kitchen.

Their five years as bear guides, in the mid-1980s, took place during a pivotal shift in thought in Alaska, where brown bear tourism had previously been synonymous with trophy hunting. Biologists and field staff at the nearby McNeil River State Game Sanctuary were learning to read brown bear behavior, challenging longtime assumptions that bears were unpredictable.

They discovered that if humans behaved equally predictably—by limiting visitors to small guided



Shaped by volcanic and glacial activity, Cape Douglas is part of Katmai's 497 miles of rugged coastline along the Shelikof Strait—all of it home to brown bears.

A tour group watches a mother bear nurse her cub in Hallo Bay, where meadows of protein-rich sedge grass provide ample food before the summer's salmon runs begin.





groups, respecting the bears' behavior and space, and never exposing the animals to human food—the bears could grow tolerant of a human presence over time. I grew up regularly visiting McNeil River and assumed that gazing out at a landscape of 40 bears at a time was normal.

Nearly 50 years ago, McNeil River's most influential manager, Larry Aumiller, started a successful program bringing visitors to watch brown bears from the same spot, every day of every summer. The program continues today. Field staff give each bear a name as an identifier, like Braveheart or Solstice or Ears, and add each day's observations to decades of compiled research.

At McNeil, I learned to notice how bears honed unique fishing tactics: snatching airborne fish from waterfalls, "snorkeling" after fish in eddies, or waiting downstream for larger bears' scraps. Mother bears can be hovering and attentive parents that discipline their cubs—or they can be comparatively lax, letting them run wild.

The memories that stand out most involved the bears' incredible displays of vulnerability and trust: a female called T-Bear that chose to nurse her cubs in front of my camera lens; a blond bear with a radial halo of a face that approached my father and me so she could take a nap beside us in the shade. What I didn't realize as a child was that these moments could take place only because of how the land was protected and managed.

To Aumiller, spending time with bears in the wild is, in its broadest sense, about learning to share space with wild animals. In Katmai, this act of sharing land with bears is not new. Traces of human habitation, dating back 9,000 years, have been found along

salmon-laden rivers where bears still fish today.

"It's always seemed to me that people who don't learn to share don't thrive," Aumiller once told me. "And those who share, do. If you can learn to do that with an apex predator, I think you can do that with almost anything."

One of the biggest threats to brown bears is irreversible habitat loss. Globally, brown bears occupy only 2 percent of their former range. Nearly all the brown bears left in the United States live here in Alaska. Katmai's expansive, unbroken terrain is precious: A single bear in Katmai may roam more than 50 miles each summer to find enough food to survive the winter.

The urgent need for conservation of this land can feel abstract—until you see a mother bear and her cub in person.

BROWN BEARS are *Ursus arctos*, the same species as grizzlies. Standing seven to nine feet tall and weighing up to 1,500 pounds, they grow famously plump on fish and vegetation each summer. Some of Katmai's brown bears have even become internet famous, thanks to

Brown bears were revered in our household, and we regarded them as individuals, with—as research now shows—their own personalities.



WHERE THE BEARS ROAM

Katmai National Park's four million acres are home to some 2,200 brown bears, the highest density on Earth. Over four summer months, visitors to the park have the chance to see bears as they move from the coast to inland streams following the salmon migration.

Bear-viewing likelihood



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From the air, the green sedge of the Katmai coast appears etched with brown bear trails, illuminating a web of passages that have been followed for generations.





Explore more of Katmai in the new series *National Parks: USA*, premiering September 8 on National Geographic Channel. Stream the series the next day on Hulu.

the phenomenon of Fat Bear Week. This annual online competition run by the park and *Explore.org* lets viewers of a webcam set up at Brooks Falls vote on their well-fed favorite.

About half of all visitors to Katmai arrive at inland Brooks Falls to watch bears fish for salmon. Floatplanes line the beach, arriving guests are briefed with a safety video in a small theater, and two gift shops and a restaurant do a brisk trade. The last time I visited the falls' crowded viewing platform, I was given a 45-minute wait time and a restaurant pager with a picture of a bear on it. It's a great place to reliably see bears—but it's an entirely different experience from being out in the coastal wilds, in a small group, surrounded by bears in every direction.

The Katmai coast is accessible only by air or sea, and its remoteness, coupled with its plentiful natural food sources, helps make bear viewing here as safe as it is. Far from roads or settlements, Katmai's brown bears have never learned to associate humans with food or harm. In areas like Hallo Bay, tourists have been coming to watch bears for decades, following the same protocols developed by Aumiller and other bear biologists.

Each time we spot a bear, Bachrach reads its behavior. If the bear appears

relaxed, we can watch for a while to see what it does. If it shows any signs of anxiety—moving away from us, yawning, or, in extreme cases, huffing—we give it space and leave it alone. We must never provoke behavior, let bears get too close, and most important, never let even a crumb of our food fall to the ground. The bear guides who took over from my parents learned this the hard way when a door once blew open to a cabin where a bowl of fruit had been left out on a counter. After a bear got in, it sat on their porch for days, wanting more.

By midafternoon, Bachrach leads us up a ridge of driftwood separating the meadows and the ocean. In a wide field, a pair of fluffy blond cubs tumble in the grass while seven or eight more bears graze in the far distance. On the other side, below a gravel beach, an amber bear wanders the glacial mudflats. It's searching for razor clams, which it will either crush or pry open with its jaws and dexterous claws.

The image of a bear as a ferocious carnivore shows only one facet of an intelligent and highly complex animal. In the wild, brown bears rarely fight. They spend their days searching for food, resting, playing, traveling, and caring for their young.

And they're omnivores, much like humans. A 2022 study found that bears are less carnivorous than previously thought.

When bears emerge from their dens in the spring in Katmai, they feast on sedges and dig for razor clams at low tide. As the salmon run from late June through September, the bears move to the mouths of salmon-filled rivers, but they'll also continue eating grass and berries. By the time they return to hibernation, they can have increased their body weight by 50 percent.

To be in tune with what bears are doing is to be in tune with what foods are in season—and by extension, what's happening in their environment. A healthy bear is a sign of a healthy ecosystem.

A

T THE END OF AUGUST, I join Bachrach and six guests on a liveaboard boat for a weeklong trip down the Katmai coast. It's salmon season, the beginning of summer's turn toward fall. When we return to Hallo Bay, the grass has yellowed and the bears have largely dispersed, but we spot a female with a rare group of four tiny first-year

cubs. Farther south, we watch bears fish in small, remote coves where thousands of salmon hang suspended in ribbons of green water.

Each time a new brown bear arrives at the edge of a river, the bears shift positions to allow space according to a hierarchy of size. We too move carefully around the bears—and around other tour groups visiting by boat and floatplane. This time is vital to the bears' winter survival. Ensuring that we don't disturb their feeding is one of the most important parts of being a responsible visitor.

Finally, we sail toward Geographic Harbor (named in honor of National Geographic in 1919 by an explorer whose expedition was funded by the Society). It's a maze of islands, where waterfalls rush from basaltic cliffs and alders blanket the land down to the waterline. When the weather clears, we're driven ashore in Zodiacs to a tidal plain where a river fans out to the sea. Life here moves to the rhythm of Katmai's 20-foot tides, and as the water rises, the rivers begin to jostle with salmon.

A dark chocolate-colored bear with two cubs appears out of the alders, then a lanky adolescent, then a big male with a shaggy copper coat. Gulls cry out overhead. Soon the bears are everywhere, fat and glossy, lunging into the rivers to catch the most calorie-rich food of the year. Five species of salmon migrate through Katmai's rivers, each one at a different time, and the bears know exactly when the time is right.

In a few hours, the whole landscape will be underwater. Soon the bears will retreat to their dens to sleep through the winter. New mothers will bear their young in the dark.

"What do you think people get out of seeing bears?" I ask Bachrach.

During our days together aboard the boat, I've watched his guests go from hesitant to awe-struck, then comfortable, and then observant and thoughtful.

"Hopefully they're experiencing something that is both inspirational and humbling, that creates a reconnection to something wild that lives within them," Bachrach says. "But they're also getting a wilderness experience that will help them better understand the value of having wildlife and wilderness in our lives." □

HOW TO GO

Getting there: Most bear-watchers stay in Homer or Kodiak, Alaska, and take day trips to Katmai by bush plane or overnight trips by boat.

Recommended outfitters: Beluga Air runs day trips out of Homer, Kodiak Island Expeditions does day trips out of Kodiak, and AK Adventures has multiday boat trips.

Where to stay: Several wilderness lodges, such as Alaska Grizzly Safaris and Katmai Wilderness Lodge, also offer bear viewing in Katmai. For backcountry camping, check out Curious Nature Guided Adventures and Expeditions Alaska.

Best times to go: Plan your trip around the type of bear behavior you would most like to witness, keeping in mind that behavior and distribution change constantly throughout the summer season (map, page 83). Visit from June through early July to see bears grazing on vegetation, and from August through September to see bears fishing for salmon.

Good to know: Whether you choose a day trip, wilderness lodge stay, boat trip, or camping, look for a transport operator who is as experienced as the guide. Expect to walk a few miles each day in hip or chest waders. Prepare for the rapidly shifting weather with layered clothing and quality rain gear.

Cubs tussle playfully in a meadow in Hallo Bay. Adult brown bears rarely fight if they can help it, preferring to manage most conflicts by displays of body language.





Brown bears gather each fall along the tidal flats and creeks near Geographic Harbor to fish for salmon, creating a perfect spectacle for visitors.





ALL ABOUT ANTLERS

Deer shed and regrow their antlers annually, a regeneration that's shaped by their environment and could have applications in modern medicine.

Graphic by
DIANA MARQUES

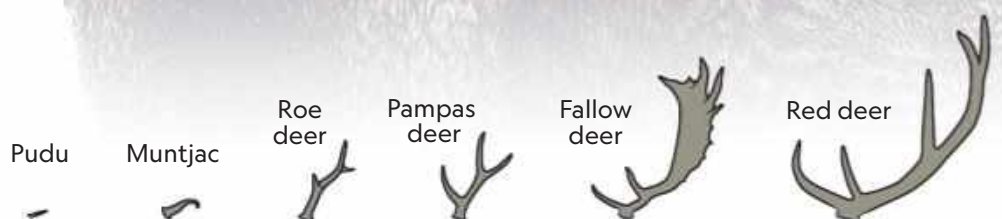


Bigger and heavier
Antler complexity and size increase as a deer matures. Influenced by genetics and food supply, growth can be stunted when resources are scarce.

White-tailed deer
Odocoileus virginianus

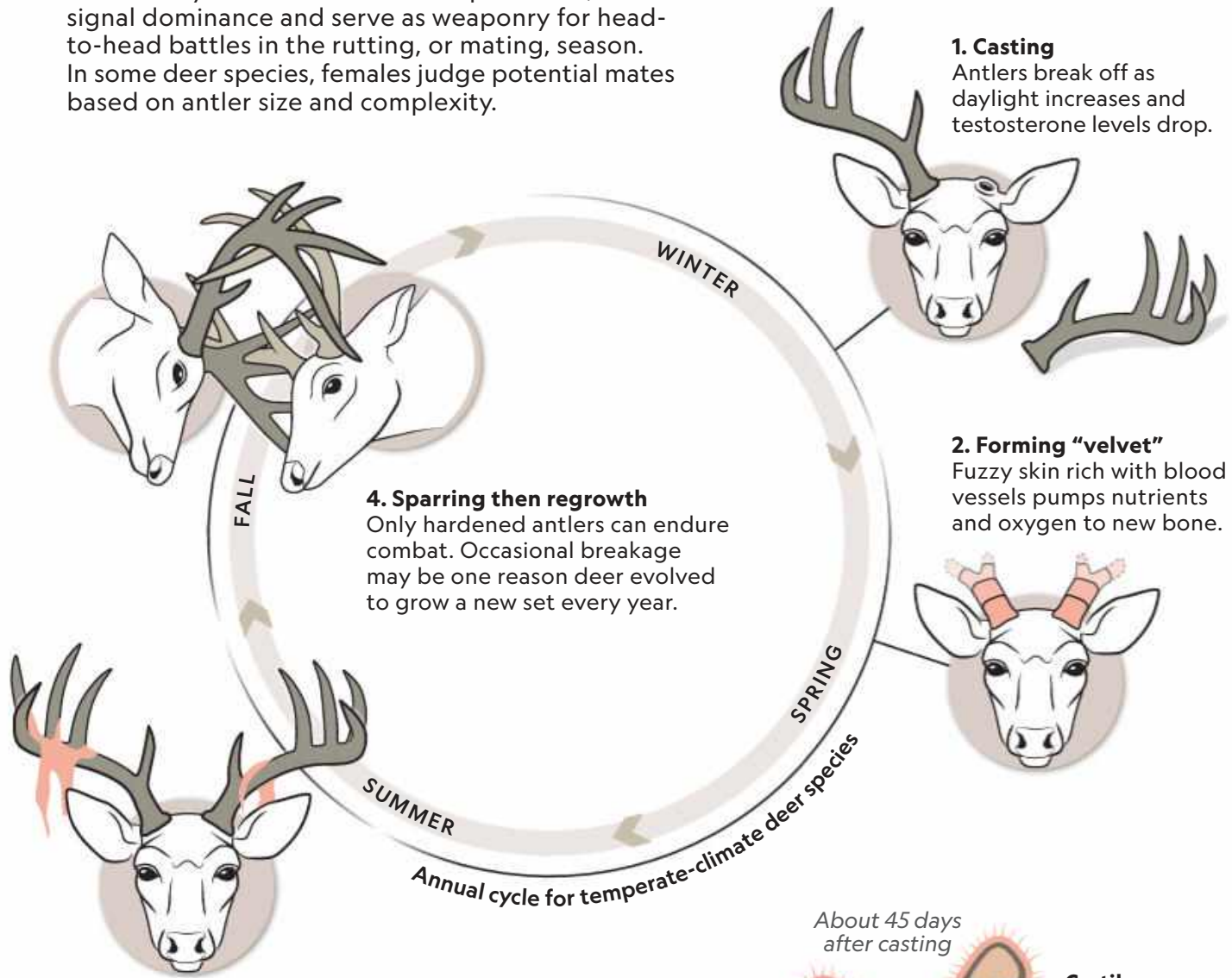
Range of racks
Antler shapes of more than 50 deer species around the world range from simple spikes—also called points or tines—to forked, or branched, racks.

ILLUSTRATIONS IN APPROXIMATE,
RELATIVE SCALE

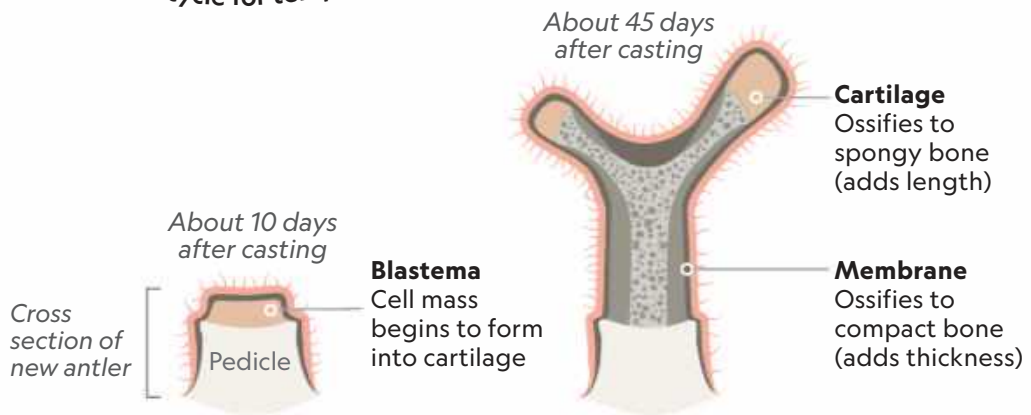


Tools of fight and display

A male-only feature in all deer except caribou, antlers signal dominance and serve as weaponry for head-to-head battles in the rutting, or mating, season. In some deer species, females judge potential mates based on antler size and complexity.

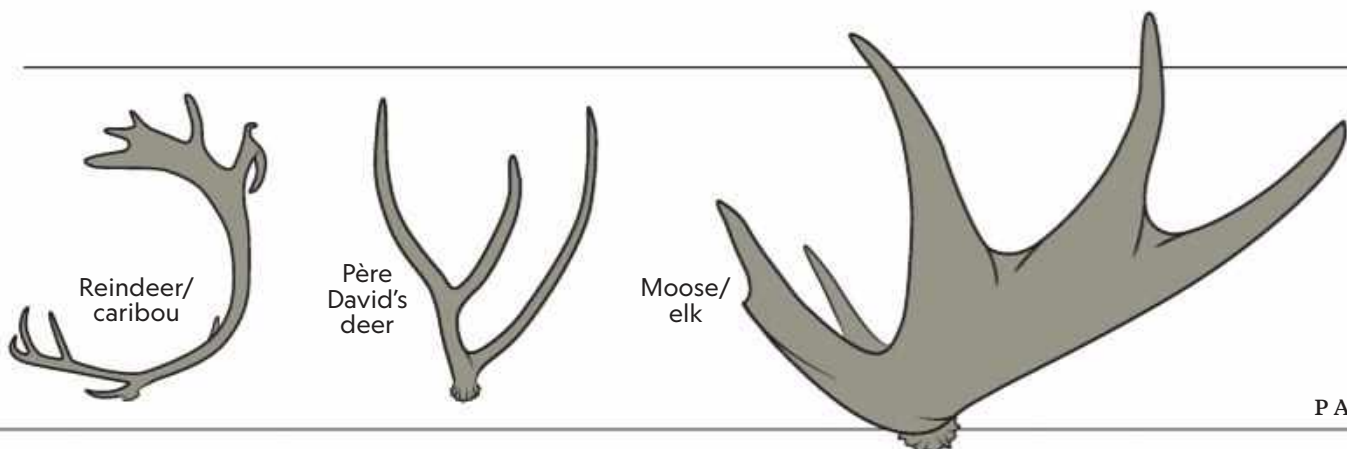


3. Shedding velvet
Days shorten and testosterone levels rise. Without velvet, the bone dies and hardens.



The promise of regeneration

Recently identified stem cells, similar to those that regenerate lost limbs in amphibians, direct antler regrowth. Antlers are the fastest growing bone in all vertebrates—in some species averaging 0.7 inch a day, or 47 inches and 33 pounds in three months—with potential applications for human tissue and organ repair.



Mao Zedong, whose leadership of China's Communist Party was cemented during the Long March, keeps watch over elderly patrons at a teahouse in Pengzhen. As the country's population rapidly ages, a demographic revolution is brewing.



Continuing his storytelling walk across the world, journalist Paul Salopek recalls the harrowing journey of China's Red Army 90 years ago—and encounters the forces reshaping China today.



TRAILING THE GHOSTS OF THE LONG MARCH

Words by PAUL SALOPEK

Photographs by JOHN STANMEYER



Pursued by Nationalist armies in 1935, Mao's rag-tag troops had to secure Luding Bridge over the Dadu River to make good their escape. They succeeded, and today the footbridge is a popular tourist destination along the Long March trail.



FOR GOING ON THREE
YEARS NOW, I'VE BEEN
WALKING ACROSS
CHINA. WHEN DONE,
I'LL HAVE LOGGED
SOME 4,200 MILES.

STARTING IN THE SOUTHWEST in October 2021 and rambling northeast, I've roughly followed an imaginary geographical divide called the Hu Line, which separates China's lush, densely populated east from its more arid and roomier west. I haven't spotted too many motorized Chinese out stomping my trails. In a nation of 1.4 billion, this felt odd sometimes, to claim horizons for myself. Which isn't to say I'm not meeting ghosts.

When you walk the world—and I've been trekking from Africa to South America for almost a dozen straight years, following the pathways blazed by our prehistoric ancestors out of Africa—you begin to read terrain like a palimpsest. Some places barely offer up a passing word. Others are layered with the whispers of feet and time. China is like this, a densely narrated landscape.


In Yunnan Province I walked the Burma Road, sluiced with the sweat and blood of 200,000 village laborers in World War II. Later, I hunted the cobbled remnants of

the thousand-year-old Silk Roads in Sichuan Province. And in Shaanxi Province, my boots raised puffs of dust on the Qin highway, built more than two millennia ago to speed galloping imperial cavalry to the frontiers of Mongolia—a distance of 450 hilly miles—in just three days. Or so legend goes. But the one phantom trail in China that resurfaced often to mind, particularly in the hinterlands, was the Chang Zheng—the Long March.

Every Chinese schoolchild knows the tale: Ninety years ago this October, in 1934, as China lurched through a terrible civil war, the fledgling Communist Party and its peasant Red Army fled their bases in southern China, routed by the Nationalist government of Chiang Kai-shek. To escape total destruction, the Communists walked. They embarked on a 6,000-mile retreat over the eastern Himalaya, across rivers defended by artillery, and through swamps where men and pack animals vanished whole. More than 80,000 troops and camp followers—men, women, children—began this exodus. A year later, only 8,000 still stood. After holing up in the caves of Shaanxi, the survivors rebuilt their revolutionary movement, and by 1949 they'd swept across China, changing the country and the world forever.

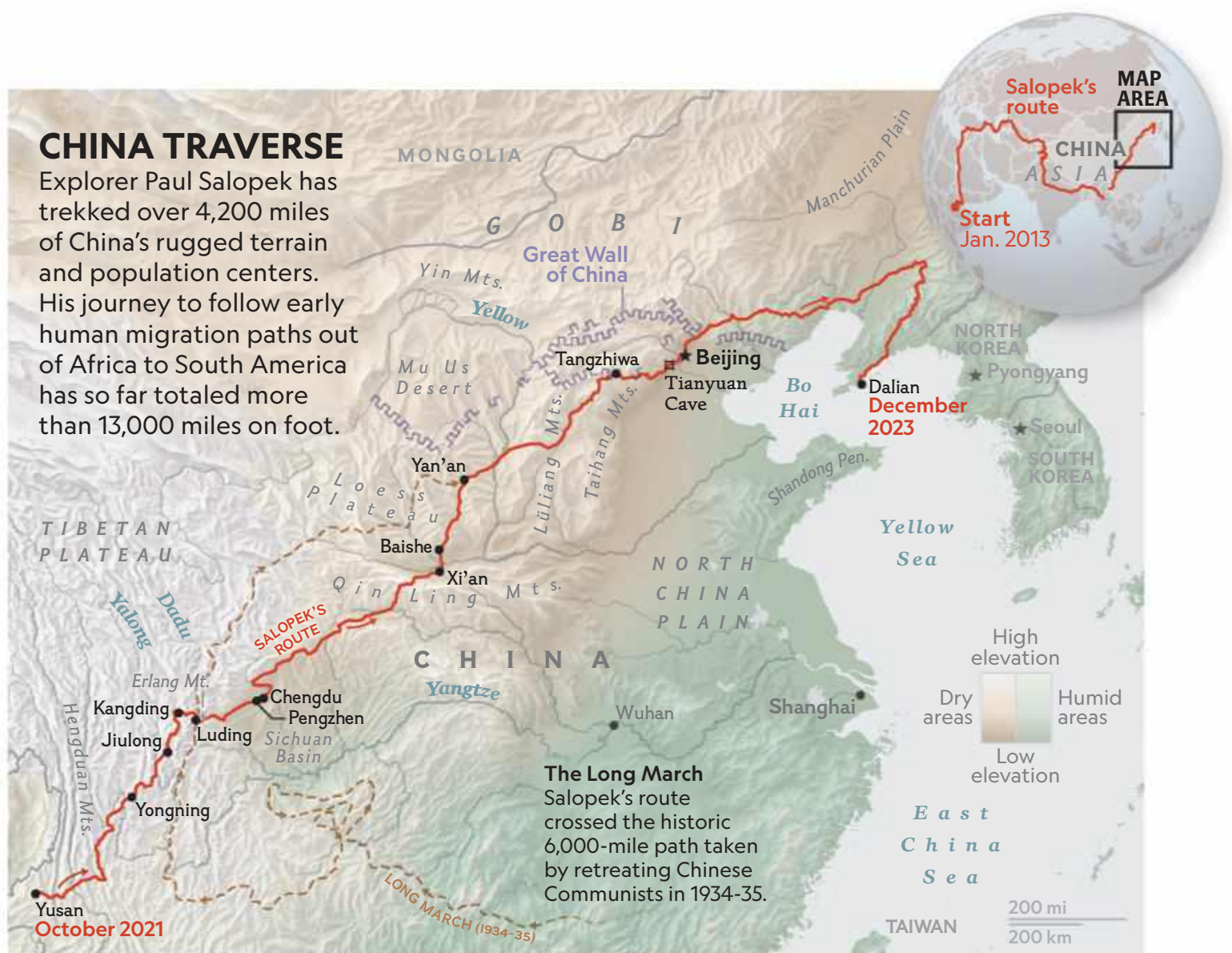
“Has history ever known a long march to equal ours? No, never,” crowed Mao Zedong, who, Moses-like, recast his comrades' retreat as a glorious tale of rebirth. “The Long March has proclaimed to the world that the Red Army is an army of heroes.”

Walking through China today, almost nobody talks of the Long March. It's a patriotic school lesson: a historical cliché, like Washington crossing the Delaware or Hannibal crossing the Alps. But when I sit on curbs in half-empty Sichuanese villages, guzzling yet

 The nonprofit National Geographic Society has funded Explorer Paul Salopek and his Out of Eden Walk for 11 years. Follow the walk at OutofEdenWalk.org.

CHINA TRAVERSE

Explorer Paul Salopek has trekked over 4,200 miles of China's rugged terrain and population centers. His journey to follow early human migration paths out of Africa to South America has so far totaled more than 13,000 miles on foot.



another bottle of Nongfu Spring lemonade, or while tottering over the frozen cornfields of Shaanxi, I can almost hear, if I cock my ears, the *whisk whisk whisk* of thousands of grass sandals shuffling by, footfalls from a spectral column that once stretched 50 miles.

And again I ask myself: Where is China marching now?

I LEAVE YUNNAN in the first days of 2022 through the ice peaks of the Hengduan range. The lowest passes scrape 14,000 feet and are shin-deep in snow. Below spreads all of Sichuan. I ricochet down rocks to a monastery called Muli, where ethnic Tibetan monks shoot hoops. They wear saffron and American basketball shoes. "PRACTICE BUDDHISM WITH CHINESE CHARACTERISTICS" urges a giant red placard slung across the temple.

Mao and his Long Marchers met fierce resistance in this hypoxic frontier. The Communists hailed from China's sweltering lowlands. To them, the mountains hard by Tibet were an alien barrier populated by non-Han minorities: a mix of ethnic pastoralists, inhabitants of a so-called tribal corridor. The Red Army's standard goodwill gesture of redistributing feudal property made little impression among the seminomads.

"Passing into the Mantzu and Tibetan territories, the Reds for the first time faced a populace united in its hostility to them, and their sufferings on this part of the trek exceeded anything of the past," writes Edgar Snow in *Red Star Over China*, the seminal book immortalizing the Long March for Western audiences. "They had money but could buy

no food. They had guns but their enemies were invisible.” The famished army raided turnip patches. They starved.

Fortunately, I don’t. People are kind. There is always food. One day I skid through a frozen highway tunnel two miles long. Its hermit caretaker, an ethnic Yi handyman named Shen Hao, lives alone in the generator building with a wood-fed stove. “I have everything I need. Things with price tags? You cannot take them with you when you die,” Shen reminds me, filling his dim lodgings with woodsmoke as he prepares us yak butter tea and steaming noodles. “Things without price tags, like love and friendship, maybe those you can take.”

I think about Shen’s words as I stumble, giddy with altitude, into villages of brand-new mansions built of stone. These extraordinary manors, facilitated by easy rural loans, are mostly occupied by wizened couples whose ancestors defied the Red Army. The local roads are impeccable, made of poured concrete. There is decent internet signal. I wonder if such amenities are yet another goodwill effort, this time launched after the 2008 Tibetan uprisings. It seems an old bargain is being struck: prosperity for calm.

On a whim, two spirited teenagers decide to guide me along the road to Jiulong.

One girl is ethnic Yi, the other Tibetan. They don’t speak their minority languages. They don’t need to, they shrug. Classroom instruction is delivered solely in Mandarin. They have marched ahead, leaving their parents marooned in a traditional world.

“Why should we even learn English?” winks one girl. “Soon Chinese will be the language spoken everywhere.”

IN THE SPRING I WALK a looping highway. Road workers share their lunch of tangerines. I reach Luding Bridge, the scene of the iconic battle of the Long March. It was fought in 1935. At issue was a strategic, iron-chain span across the Dadu River. As Edgar Snow describes it with zeal: “One by one Red soldiers stepped forward to risk their lives, and, of those who

offered themselves, thirty were chosen. Hand grenades and Mausers were strapped to their backs, and soon they were swinging out above the boiling river, moving hand over hand, clinging to the iron chains.”

Today the bridge is a Red tourism site. Elderly Tibetans square-dance next to it, their boom box throbbing out Chinese folk-pop.

Mao and I temporarily part ways in the river canyon of the Dadu. His ghostly revolutionaries file north, eluding Nationalist armies, to disappear into the wild grasslands and swamps of Gansu. I pivot east, toward big-city Chengdu, the capital of Sichuan. But first, I must scale 11,000-foot Erlang Mountain to meet a man who may be the world’s last living *beifu*.

Beifu are fabled tea porters. For 250 years, they hauled back-cracking burdens of tea





Chinese wedding-day traditions include games and pranks, and here groom Zhai Rui proposes to bride Zhang Chenxin before family and friends. (She said yes.) Like millions of China's young adults, the couple left their rural hometown for jobs in a distant city. The trend reaches even to the remote mountain home of Ma Dujilamu (above) and her husband, Bian Duji. The fourth-generation Tibetan herders make enough producing yak cheese and butter to send their two children to college. The students' post-graduation plans? Move to a city.





“None can claim greatness without surmounting the Great Wall’s majestic heights,” wrote Mao near the end of the Long March in 1935. Today wind turbines march across a ridge opposite the wall’s crumbling Guangwu section.

PANORAMA OF FOUR IMAGES

from Sichuan into the Tibetan highlands. (Even children undertook these incredible journeys of woe.) The porters' grit was legendary. Often traveling barefoot, the beifu traversed 150 miles of snowy crags, lugging bamboo containers of tea weighing up to 400 pounds. Some collapsed of hunger or exposure on frozen mountain trails. Others fell to their death. The corpses were rolled into anonymous graves. Their loads were carried on.

"There used to be many robbers between Kangding and Luding," Wang Shikang, 89, rasps loudly, in the way of people hard of hearing. "The bandits couldn't care less about our tea. They always attacked us on the return trip, after we'd been paid. We walked in groups of 20 for protection." The pay for each Olympian three-week circuit: a handful of coins that would buy a sackful of corn.

"I can still feel the pain," admits Wang, a stoic, red-faced grandpa who may be the final porter still alive after the foot caravans began to fade 80 years ago. "I have rheumatism in my knees and back."

I climb Wang's austere trails of heavy fogs, ice, snow, and strong winds. Pausing to catch my breath, I spot curious holes drilled into flat bedrock. These were worn by the action of hundreds of thousands of wooden *guaizi*, the indispensable walking sticks of vanished legions of tea porters. Here lay a monument to China's true superpower, I think: the incomprehensibly vast, unrecorded tenacity of its so-called ordinary people.

I TRAMP ONWARD through pages of Edgar Snow, whose 1937 book is both praised as a classic of revolutionary China and condemned as too naive regarding the Communists. A correspondent for the *Saturday Evening Post*, he traveled secretly to meet Mao in his Shaanxi redoubt, vaccinated "with smallpox, typhoid, cholera, typhus, and plague germs. All five diseases were prevalent in the Northwest." An outbreak of bubonic plague especially worried him.

Nearly a century later, I wade through the sticky Sichuan summer, zigzagging around COVID-19 lockdown zones.

Chengdu is my first megacity. Population 16 million. A garden city. A cultural city. But unpredictable quarantines erupting across its neighborhoods force me to keep going. I must power stride through the colossal metropolis in three days.

Six months later in Xi'an, my next urban center, China's draconian COVID lockdowns are abruptly canceled. I discover this by startling awake to a silent December dawn. There is no 6 a.m. loudspeaker urging citizens to fall out for PCR tests administered by *da bai*, the "big whites" in hazmat suits. I blink sleepily out my window: In the courtyard of my cheap hotel, guests with bed head are dancing. Protests against relentless quarantine



policies had been erupting across Chinese cities for days. In the age of Mao Zedong as in the era of China's current leader, Xi Jinping, an addiction to centralizing power still works—until it spectacularly doesn't.

CHINA MANUFACTURES 13 billion pairs of shoes each year. This is enough to shoe 60 percent of humankind. China also assembles 60 percent of the world's mobile phones, 70 percent of our toys, and nearly 80 percent of our solar panels. Soon it will be selling us most of our electric cars. In addition, more people inhabit caves in China—tens of millions—than anywhere else on Earth. The latter factoid you learn by walking.

Second winter in China. I leave Xi'an and walk into a cosmos of dry gullies and hills. Everywhere, there is a coating of macaron

yellow dust: on roads, on my eyelashes, in my bowls of tofu fried in chili sauce. Dust colors the very sunlight that drips from a wax sun. At night, dust settles into my dreams. Blown loess: a steady rain of particulates falling over millions of years from Mongolian steppes. This is the famous Loess, or Yellow Earth, Plateau.

Here, I begin to spot hundreds—thousands—of cave houses called *yaodong*.

"Warm in the winter, cool in the summer," Tong Yue, a jolly apple farmer from Baishe village, proclaims, using a sales pitch that must date from the Pleistocene. "Cheap to build too."

Tong's shelter is invisible from the surface. I nearly walk past it. Hand-dug 20 feet straight down, it looks like a sunken courtyard, or a drained swimming pool with doors bored



The mirrored surface of a reservoir near Beijing reflects soaring peaks and a sinking water toy. Water from distant mountain springs has been channeled to Beijing for centuries; today faraway rivers are being tapped to slake the megacity's thirst.

into the bottom of each vertical wall. Such structures are the clever brainchildren of poverty and innovation. Many yaodong today sit empty. Their former residents have migrated up and out to cities. Optimistically, Tong has converted her cave into a rural motel. I am her first foreigner.

Her underground rooms are clean, bunker-like, chilly. A geological silence steeps my whitewashed chamber. At dawn, after a breakfast of Tong's buckwheat noodles, I shrug on my parka and pack, and step outside. The sky above is square and brightening to the hue of shining steel.

One hundred and sixty miles to the north, hunched at a desk in his own cave house, Mao spent years inventing Marxism-Leninism with Chinese characteristics. A tough American foreign correspondent named Agnes Smedley once visited Mao there, in the '30s, and punched his wife in an argument.

I read this particular anecdote on my laptop in a Kentucky Fried Chicken while being watched by secret police. All of this occurs in the remote plateau city of Yan'an. It is a redoubt procured by the Red Army after 368 days of walking. After 18 mountain ranges were crossed. After 24 rivers were forded. After fighting 10 warlord armies and the national army of Chiang Kai-shek. The terminus of the Long March.

ON THE TRAFFICLESS byways in Shanxi Province, I ramble into a village called Tangzhiwa. It is the spring of 2023. Two elderly women sit against a house, deftly hand-stripping poplar branches of young leaves. I ask them if it is edible. "Boil it five times to get the bitterness out," says Li Qin, explaining the recipe for a famine food eaten today only by the very aged, out of a hard nostalgia.

Li and her friend are among the last people in the village. This is not new. China's rural spaces have been emptying for generations. Maybe 500 million people have made the shift already. What is new: Rural or urban, they're all getting older. China is aging. This



is the next huge sociological revolution rattling the nation. Many Chinese women today can't be persuaded to bear even one baby, per the country's extinct "one child" policy. The rapid graying of China soon will trigger colossal economic impacts globally. Over the next decade, a staggering 300 million people will age out of the Chinese workforce: nearly the population of the United States. Who then will staff the "factory of the world"?

I walk across the green scrub hills of Hebei Province. I am nearing Beijing. Fourteen years after the Long March, Mao occupied the city and declared the birth of the People's Republic of China from Tiananmen Square. He's still there, sealed inside a crystal sarcophagus. You can visit him starting at 8 a.m. daily except on Mondays.



At his home in a Tibetan village in Sichuan Province, Grandfather Gao cradles his granddaughter before the family's mid-day meal. As China's birth rate plunges and its workforce shrinks, its people walk an uncertain path into the future.

“A genius,” a young artist from Yunnan once told me of Mao. “He knew how to inspire men’s hearts.”

“He killed my grandfather,” muttered a middle-age farmer in Sichuan. It wasn’t the right moment to ask whether he meant in battle or likelier through policies that swept away multitudes. (The Great Leap Forward, Mao’s misbegotten stab at industrialization, ended up starving some 30 million Chinese.) Officially, the Chairman’s reputation appears to be ascendant. President Xi has revived the cult of personality, seeking to emulate the Great Helmsman’s grip on power.

Twenty-five miles west of Beijing I visit Tianyuan Cave. The shallow cave is among the oldest *Homo sapiens* sites in Asia. The ancient man whose bones were found there died 40,000 years ago. This makes him among

the earliest anatomically modern humans to tread what is today China. Scientists, studying his toe bones, even hypothesize he may have worn shoes—if true, another first in our long prehistory of settling of the globe.

What did Tianyuan Man dream of? What was his main complaint? That he was not loved enough? That his life’s path seemed a maddening circle? That he was driven cruelly on by his heart or belly? I stand squinting at the cave’s mouth, looking down over the hills toward the unseen metropolis. Cicadas trumpet the broiling June day. The hills are fuzzed with apricot and oak. We have come so far. And we have so long yet to march. And my heart turns over. And I can feel it already, as I begin my descent to the old capital that Marco Polo called Cambaluc. I will miss China. □

DOUBLE THE TROUBLE

Researchers have split the green anaconda, a formidable predator, into two separate species.

Photograph by
JOEL SARTORE

→ **UNTIL RECENTLY**, scientists thought South America was home to just one kind of green anaconda, the world's heaviest snake. But a study has revealed there are two species of the reptile: *Eunectes murinus*, the southern green anaconda that lives in Brazil, Peru, and Bolivia, and the newly named *Eunectes akayima*, or northern green anaconda. The latter is found in Ecuador, Venezuela, Trinidad, Guyana, Suriname, and Colombia. Nearly identical in appearance but with distinct genetics, both snakes also dwell in French Guiana, sometimes on opposite banks of the same river. Yet they never interbreed. According to study co-author Bryan Fry, a National Geographic Explorer and biologist at the University of Queensland in Australia, they're more than 5 percent different genetically. To put that into context, we're less than 3 percent different from chimps, he adds. —JASON BITTEL



PHOTOARK
JOEL SARTORE

The National Geographic Society funds Explorer Joel Sartore's Photo Ark project, which aims to document every species living in the world's zoos, aquariums, and wildlife sanctuaries.



JUNGLE CAMO

The anaconda's dusky, mottled skin allows the snake to disappear in the murky water of swamps, marshes, and slow-moving streams.



SCIENTIFIC NAMES
Eunectes murinus (pictured),
Eunectes akayima

TYPE
Reptile

DIET
Carnivore

AVERAGE LIFESPAN
About 10 years

SIZE
Up to 30 feet long
and 550 pounds

UNDERWATER SURVEILLANCE
Eyes and nostrils high atop its head enable the snake to see and sniff while almost fully submerged.



GREEN ANACONDA RANGES



DEATH GRIP

Anacondas coil around wild pigs, deer, caimans, and even jaguars, restricting the blood flow and rapidly arresting the heartbeat of prey.



MAP: ANNIKA HOERNER, NGM STAFF
SOURCE: JESÚS A. RIVAS, NEW MEXICO HIGHLANDS UNIVERSITY
PHOTOGRAPHED AT HUACHIPA ZOO, LIMA, PERU



**A dinosaur hunter
stumbled upon
Africa's largest
Stone Age burial
ground. More
than two decades
later, he can't
stop going back.**

SECRETS FROM A



SAHARAN GRAVEYARD

Words by
PETER GWIN

On-location photographs by
PAOLO VERZONE

Studio photographs by
REBECCA HALE

Skulls unearthed at Gobero, a remote site in Niger, date back to when the Sahara was green.

Archaeologist Boubé Adamou examines bones exposed by powerful seasonal winds during a 2022 expedition to Gobero. Each year they strip away layers of sand, revealing more bones and artifacts. "There's always new surprises," he says.







**STANDING ATOP A
SMALL DUNE DEEP IN THE
SAHARA DESERT,
A TEAM OF SCIENTISTS
STARED AT A FRESHLY
OPENED GRAVE.**



Agadez, the closest city to Gobero, arose thousands of years after the grasslands disappeared and the Sahara became a desert. By the 1400s, it was a hub for camel caravans trading between Central Africa and the Mediterranean.

Three human skeletons lay on their sides, as though they'd drifted off to sleep in the loose brown sand and never awakened.

It was just before dusk during the last days of an expedition to a place called Gobero, located in Niger's Ténéré desert. Often described as a desert within a desert, the Ténéré is almost completely devoid of rain and defined by monumental seas of shifting sand known as ergs. Here the temperature regularly exceeds 120°F, blinding sandstorms can blow in without warning, and Nigerien authorities require a platoon of soldiers to accompany visitors to

guard against bandits. But this barren landscape also holds one of the world's rarest archaeological sites, a graveyard dating back almost 10,000 years.

That morning a college student named Hannah Moots, using a small wooden pick and brush, had begun excavating a skull, its crown barely peeking out of the ground. Working carefully, she'd exposed the eye sockets and jaw and continued down the neck to find the shoulder, then followed the arm to a cluster of finger bones. But there she stopped: There were too many finger bones for just one body. Paul Sereno, the expedition's leader, joined Moots, and soon they'd uncovered more bones—many more.

Oumarou Idé, a Nigerien archaeologist working nearby, came over to see the progress. Throughout the afternoon, other members of the team, their skin sunburned and clothes grimed with salt stains, gravitated to the dune. Even some of the soldiers, cradling their rifles, came over to see what was going on. Finally, as the light softened and the desert air cooled, a startling picture came fully into view.

The pelvis of one skeleton indicated it was a woman. Facing her were two children. Their teeth gave their ages to be about five and seven years old. The five-year-old was clinging to the older child, holding on with a tiny arm draped across the seven-year-old's neck. The woman's right arm curled under the older child's head. Her left arm reached out and connected with the left hand of the five-year-old in the jumbled mass of finger bones.

"They're holding hands," someone murmured.

The scene raised many questions: Was this a mother and her children? Who buried them in this tender embrace? And how did they die? To have been arranged so precisely, the three would have had to perish at nearly the same time and been posed in these positions before rigor mortis set in. Was it a sudden tragedy or some sort of ritual sacrifice? No cause of death was apparent—their teeth and bones signaled good health and betrayed no signs

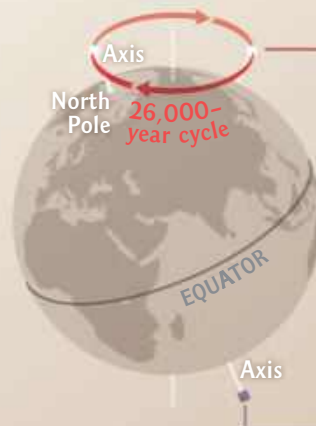
WHEN THE SAHARA WAS GREEN

Thousands of years ago, the Sahara was humid and lush—and someday could be again. Thanks to gravity, Earth's axis wobbles, periodically increasing a region's exposure to the sun for thousands of years at a time. More heat leads to more evaporation from the ocean, intensifying monsoons that make grasses flourish.

Biomes of Africa

- Mediterranean
- Desert
- Grassland
- Wooded grassland
- Woodland
- Forest

Jupiter's gravity and Saturn's also cyclically change the shape of Earth's orbit, amplifying the humidifying effect of precession.



Precession (wobble)

The gravitational pulls of the sun and moon create a tidal bulge at the Equator. Earth wobbles, turning the direction of its axis toward different points in space.

Obliquity (tilt angle)

22.1° — 23.4° — 24.2° — 24.5°
Present day Humid period

A one-degree change in tilt can drive extreme changes in climate.

PRESENT DAY



AFRICAN HUMID PERIOD circa 11,000–4,500 years ago



of trauma. But without soft tissue to examine, it was impossible to say how three seemingly healthy people died simultaneously.

“Maybe,” Sereno said, “they drowned.”

I was among those gathered on that dune in 2006, on assignment for *National Geographic*. Nearly two decades later, now with two children of my own, I’m still enthralled by the mystery of that scene. But it’s just one of many mysteries that have emerged from that place since then. Just as the Ténéré is a desert within a desert, Gobero is a scientific enigma within an enigma, one that has obsessed Sereno, Idé, and many others who continue to glean clues, teasing out a rich picture of a lost world.

So when Sereno called in 2022, soon after the pandemic lockdown had lifted, and offered me the chance to go back to Gobero, I said yes.

THE IDEA OF THREE PEOPLE drowning in the Sahara seems ludicrous until you consider that the Sahara hasn’t always been a desert. In fact, it transforms from desert to lush savanna about every 21,000 years. A quirk in Earth’s planetary mechanics periodically causes its axis to tilt slightly, increasing the amount of radiation directed to the Northern Hemisphere, which in turn pulls Africa’s seasonal rains northward. For millions of years, this cycle of monsoon shifts has created numerous wet periods in the Sahara. The most recent one began at the end of the last ice age, roughly 12,000 years ago, and persisted until about 4,500 years ago.

Technology has helped scholars see what this Green Sahara looked like. Satellites have identified ancient riverbeds and the shorelines of lakes, including the original perimeter of Lake Chad, which at its peak was bigger than all the North American Great Lakes combined.

But even more obvious clues about the Green Sahara have been staring scholars in the face.

Thousands of engravings and paintings discovered on rock formations throughout the Sahara document thriving hunter-gatherer communities. The artists portrayed figures wearing elaborate headdresses and throwing spears and shooting arrows. But their main subjects were the animals they saw, including hippos, giraffes, elephants, rhinos,

It was impossible to say how three seemingly healthy people died simultaneously. ‘Maybe,’ Sereno said, ‘they drowned.’

and antelope—species now more closely associated with wetter parts of Africa.

Despite such vivid depictions, we know very little about these people. During the 20th century, a handful of significant archaeological sites were found in the Sahara. Excavations yielded samplings of pottery and stone tools—isolated glimpses of Green Sahara cultures. But for the most part, the desert’s intense radiation, high winds, and shifting sands have scattered, buried, and scoured away much of the evidence of their existence.

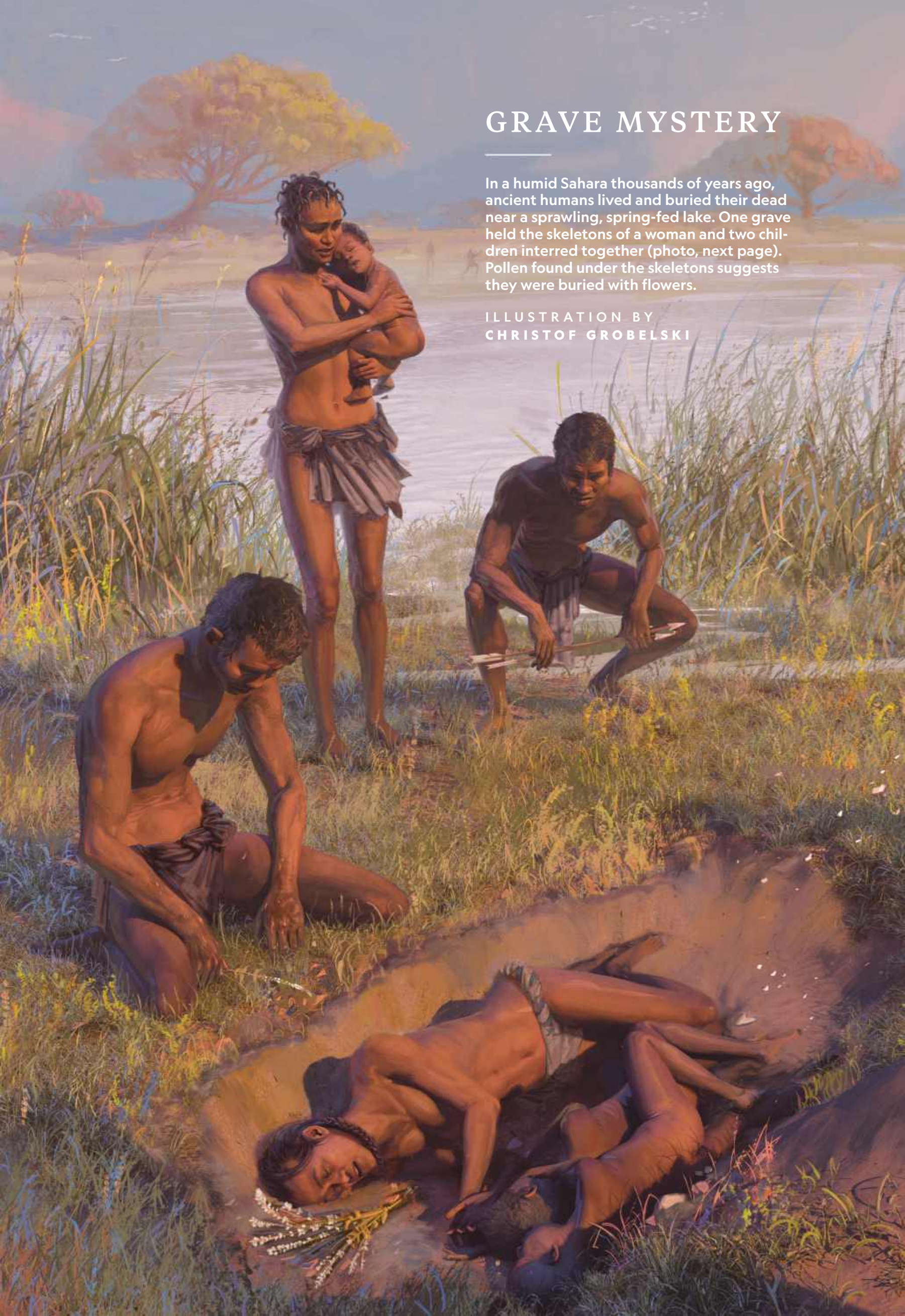
So it was practically a miracle when Paul Sereno stumbled upon Gobero. He’s an unlikely scientist to find a human burial ground, as his primary subjects lived millions of years before humans. Since the early 1990s, the University of Chicago paleontologist and National Geographic Explorer has made headlines for his discoveries of new dinosaur species in the Sahara, including *Afrovenator*, a fast-running meat-eater; *Suchomimus*, a creature the length of a school bus, with a crocodile-like head; and *Jobaria*, a 70-foot-long plant-eater with an elongated neck.

In 2000, Sereno was looking for more of their kind as he led a scouting expedition in the Ténéré. The team spent one morning driving in a convoy of (Continued on page 124)

GRAVE MYSTERY

In a humid Sahara thousands of years ago, ancient humans lived and buried their dead near a sprawling, spring-fed lake. One grave held the skeletons of a woman and two children interred together (photo, next page). Pollen found under the skeletons suggests they were buried with flowers.

ILLUSTRATION BY
CHRISTOF GROBELSKI





GRAPHIC: MONICA
SERRANO, PATRICIA
HEALY, NGM STAFF
SOURCES: PAUL SERENO,
U. OF CHICAGO;
CHRISTOPHER
STOJANOWSKI, ASU





TRIPLE EMBRACE

One of the most enigmatic burials found at Góberro is a woman and two children posed holding each other. The children's teeth reveal their ages to be five and seven. Four perfectly shaped arrowheads in the grave

are believed to have been added at the time of burial. Scientists think the three died at roughly the same time, but the cause is unknown. Their bones and teeth suggest good health and show no signs of violence.

BRACELET GIRL

Excavated during a 2005 expedition, a 10-year-old girl laid to rest around 4,900 years ago appears to be the most recent burial at Gobero. On her arm she wears a bracelet made from a hippo tusk. "It's rare to find children in Neolithic burials with jewelry like

this," says expedition leader Paul Sereno. Also unusual, she was buried just a few yards from a man interred almost 5,000 years earlier. "That's about the length of time from the first Egyptian pharaoh to my grandfather," Sereno says.





A necklace found elsewhere at Gobero includes one stone bead and nine beads and a pendant made from hippo ivory.



(Continued from page 117) Land Rovers near a rocky ridgeline. Periodically, they'd stop to search on foot for fossils. Just as the convoy was about to return to camp, Mike Hettwer, the expedition's photographer, wandered toward three small dunes. He found them covered with human bones, potsherds, beads, arrowheads, and other stone artifacts. "It was all there just lying on the sand," he told me, "everywhere you looked."

Bido Dindine, one of the expedition's Tuareg guides, said local camel herders referred to the area as Gobero.

There were also lots of animal bones. Paleontologists study modern species to understand dinosaur physiology, and Sereno has a near-encyclopedic memory for animal skeletons. He quickly recognized the bones of hippos, giraffes, fish, crocodiles, and turtles. "All the animals we find in the Serengeti were there," he said.

Next to the dunes they found a dry lake bed, which helped explain the large concentration of aquatic animals. "There was so much to take in," Sereno said. "It was overwhelming." They made a quick survey, estimating that the area contained upwards of 200 burials.

Eventually, Sereno came to understand that the three dunes were protected by a doughnut-like rim of rhizoconcretions, a type of rock formed around the roots of reeds and other plants. This created a protective crust that kept the dunes intact. When the rhizoconcretions finally started to break apart, the skeletons had begun to emerge. There were half-buried skulls, hands reaching out of the sand, ribs scattered.

"The rhizoconcretions are why those burials survived thousands of years," Sereno said, noting the seasonal Harmattan winds, which carry Saharan dust across West Africa to the Atlantic. "Any exposed bones won't last long."

He showed me a photo of a skull from the 2000 trip and another photo of it in the same spot five years later. Much of the bone had been ground away—literally sandblasted. "That's what the desert does," Sereno said.

MOUNTING AN archaeological dig in Niger is complicated. The country is larger than France, Germany, and Italy combined, and most of it is barren stretches of desert with little or no road access. Since gaining independence from France in 1960, Niger has endured a series of military coups and ethnic conflicts, has struggled to diversify its agriculture-based economy, and suffers from chronic food and medicine shortages. As a result, requests by foreign scientists to explore its remote eastern deserts—which border Libya and Chad, nations wrestling with their own internal conflicts—must wind their way through a lengthy government approval process.

"It's difficult for many people in Niger to realize the value of the dinosaur fossils and the artifacts we have," Sidi Amar Taoua, a tour guide from the desert city of Agadez, told me. "Most people are worried about access to clean water, schools for their children, job opportunities, and security."

In the north, the country's colonial past and the large uranium mines run by French companies have colored some Nigeriens' views about outsiders coming to dig in their deserts. "Some people think we're looking for oil or gold," Dindine told me. Further suspicions were raised when the U.S. military built a large drone base in Agadez to run surveillance missions across the region.

After the initial discovery of Gobero, Sereno was able to organize four full expeditions to the site and carve out time from five other dinosaur excavations to revisit it. Some years he wasn't able to travel because of security issues—a Tuareg rebellion and threats from terrorist groups that had moved into parts of Niger and neighboring Mali.

Each time the expeditions returned and set up their tents near the ancient lake bed, the scientists wondered what they'd find. Had the desert winds finally carried away the small dunes? Had curious nomads rummaged the site? Or had it been ransacked by looters? But each time, new discoveries were exposed.

There were ceramic pots inscribed with various designs, a warthog's tusk, the skeletons of a toad and a python. There were large fishhooks and harpoon points, including one made from a crocodile jawbone. There were finely worked arrowheads made from green felsite, red jasper, milky white quartz, even petrified wood; ostrich eggshell beads; and pendants made from hippo ivory and amazonite.

Several prehistoric middens, or garbage dumps, overflowed with bones from Nile perch and catfish and included a stack of mussel shells. Even the sand contained evidence—pollen from palm and fig trees, cattails, and other plants associated with wet areas.

But the finds that left team members speechless were the burials. “We find every age—old people, middle age, teenagers, children, infants,” Sereno said. Radiocarbon dating puts the oldest burial, a six-foot-two man posed in a tight crouch, at around 9,500 years ago, near the beginning of the Green Sahara. The most recent burial, a 10-year-old girl wearing a large hippo ivory bracelet, occurred about 4,900 years ago—a span of roughly five millennia. “That’s about the length of time from the first Egyptian pharaoh to my grandfather,” Sereno said, “all in this one small area.”

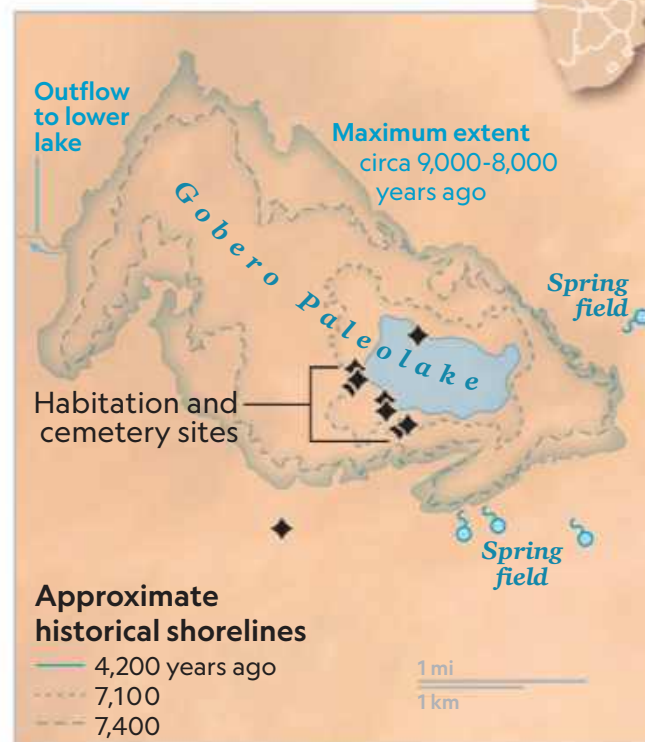
The burials tended to fall into two broad categories. In the older ones, the bodies were buried in the same manner as the six-foot-two man, with arms held close to the torso and knees pulled up tightly to the ribs and spine, so that the skeletons resemble collapsed accordions. One theory holds that some of these had been interred tightly bundled, possibly in animal hides.

Idé, head of archaeology for Niger’s Research Institute in Human Sciences, explained that the dates of these burials suggest these people were part of what archaeologists have named the Kiffian, a fisher-forager culture that ended about 8,000 years ago. Around that time, the burials at Gobero were flooded and remained submerged for several centuries.

The younger burials, he said, belong to the Tenerean people, who arrived about a

BYGONE LAKE

Over millennia, the shallow lake at Gobero waxed and waned. At one point it covered more than five square miles, flooding some of the burials. But as water resources declined, it shrank to about a tenth of its peak area.



thousand years after the Kiffian burials ceased. Based on evidence found at other sites, some scholars believe the Tenereans were among early herding cultures that started to appear in the latter part of the Green Sahara period.

At Gobero, almost all the Tenereans were positioned on their sides, as though asleep. In one burial, a woman holds a newborn, the pair possibly succumbing during childbirth. A 12-year-old boy lies with his hands clasped under his head like a pillow, a tiny bird skeleton clutched in his right hand. Nearby, a man appears to have two teeth filed into fanglike points. Elsewhere, a man sits on a large turtle shell; another wears a ceramic pot on his head.

These burials seem to be communicating something about the deceased. When excavating a grave, archaeologists usually disarticulate skeletons if they plan to take them to a lab. Sereno wanted to preserve the most important

A team begins brushing the sand away from a partially uncovered human skeleton at Gobero. Once bones are exposed to the Sahara's powerful sandblasting winds, there's limited time to collect them before they're ground to nothing.



and unusual Gobero figures in their striking poses, so he employed a technique paleontologists use to preserve dinosaur fossils. He dug trenches around some of the most interesting burials and encased them in plaster, allowing the team to remove them in situ for transportation back to his lab.

Excavating human remains is a highly sensitive subject, but there's a compelling case to be made for studying the Gobero burials in a modern lab. The bones contain volumes of information, says Chris Stojanowski, a professor at Arizona State University who was part

of the 2006 expedition. He's been studying skeletons collected on that trip ever since. "You see all this?" he said to me recently on Zoom, tilting his camera to reveal stacks of books and papers. "It's all Gobero research."

Stojanowski analyzes skeletal remains to understand how humans interacted with their environment, what diseases they suffered, telltale signs of their lifestyle left on their bones and teeth. One of the most surprising things was how few injuries he found. One person had a skull fracture but had survived, because it had fully healed. Then there

Surrounded by expedition members, Paul Sereno examines a hippo fossil at Gobero in 2022. Two decades earlier, he was hunting for dinosaur bones when he stumbled onto the site. Since then, he's returned eight times to study its ancient burials.



was a woman who'd suffered a wound to her fibula that also had healed. Embedded in the bone were rock fragments consistent with what an arrowhead would leave.

"Otherwise," Stojanowski said, "there's no real signs of violence that I can see."

They also don't seem to have been under significant stress from starvation, drought, or chronic illness. As teeth form, they accumulate microscopic layers of enamel—like how trees add new growth rings—and periods of high stress, including trauma, are recorded by disruptions in the layers. Hoping to shed

light on the triple burial, Stojanowski had molars from the two children thin-sliced and reviewed microscopically; the results revealed no evidence of significant stress.

Another revelation was the people didn't seem to move from place to place. With nomadic individuals, you can trace their movements by matching the signature of the strontium isotopes in their teeth—accrued from the plants and animals they ate and the water they drank—with the strontium in the bedrock at the places they visited. But the people Stojanowski has studied at Gobero

show primarily one signature. “They didn’t really move much.”

Sereno has found other evidence that implies people lived year-round at Gobero. His teams have collected otoliths, the bony structures from the inner ears of fish. Like layers of enamel in teeth, otoliths grow in tiny rings, adding a new one each season. The outermost

I couldn’t stop wondering what secrets Gobero still held and how many might never be known.

ring suggests when a fish was caught. The otoliths found in Gobero’s middens indicate the fish were caught throughout the year.

One of the biggest surprises was that out of the thousands of animal bones found at the site, only a single cow bone has been identified. Why would a herding culture like the Tenereans not show more evidence of cows? Sereno believes the answer may simply be that the people who lived at Gobero weren’t herders or nomads. “Practically everything they needed was at Gobero, and they adapted their lifestyle specifically to this place.”

WHEN SERENO ARRIVED in Niger in 2022 after being away for three years, the usual difficulties awaited him. A West African air traffic controllers’ strike suspended flights to Agadez. Meanwhile, the Niger military was called on to provide security for a traditional festival, so the expedition’s escort of soldiers was delayed. Sereno was trying to squeeze a lot into this expedition—there were several dinosaur sites to excavate—but he’d saved four days for Gobero. Yet, as the delays mounted, the four days were cut to one.

When the convoy of Land Rovers and military vehicles finally rolled up to Gobero,

I hardly recognized the place. A line of large sand dunes east of the site that I’d used to get my bearings in 2006 had shrunk and retreated into the distance. A few sparse stands of acacia trees near the lake bed had grown into a small forest filled with insects and chattering birds. I even startled a large desert hare that bolted from behind a tuft of bunch grass.

Sereno hurried up one of the dunes to check on a burial he’d planned to excavate, and other members of his team spread out to look for fossils and artifacts. I followed a Nigerien archaeologist named Boubé Adamou out onto the dry lake bed. Known as a keen-eyed bone finder, he always seems to spot what others miss. “He’s relentless,” Sereno said.

Adamou moved at a slow, deliberate pace, scanning the sandy hard pan. The sun beat down on our backs. After all these expeditions and the harsh conditions, what could be left? Suddenly he pointed, and there was a bone harpoon point with its unmistakable serrated tip lying on top of the lake bed where thousands of years ago it had been hurled by a hunter aiming at prey in shallow water.

By midafternoon, a camp table was covered with the finds, including several bone harpoon points, large grindstones, arrowheads, hippo and fish bones, and crocodile scutes. The grave Sereno wanted to excavate, it turned out, was of a woman buried with a large turtle shell, like one previously found with a man. Were they somehow connected? Why were turtle shells so important? Some kind of marker of the Gobero people’s identity? An item needed for the after-life? Another clue, another mystery.

But there wasn’t time to remove the skeleton in plaster. The commander of the soldiers said it was time to leave—we had to be back at camp before nightfall. Sereno argued, but the officer wouldn’t budge. The burial was covered and the convoy loaded up. As we bounced across the desert, I couldn’t stop wondering what secrets Gobero still held and how many might never be known.

LAST WINTER, Sereno invited me to Chicago to visit his laboratory, which holds a menagerie of ancient creatures worthy of a museum. A *Sarcosuchus* skull—large enough for me to fit inside its gaping jaws—guards the door. A model of *Nigersaurus* with its wide, flat mouth stares out from atop a cabinet alongside a full skeleton of an *Eoraptor* perching on two legs with a long, curving tail. There are feathered theropods, an armored dinosaur that hasn't been formally named, and a *Jobaria* skull the size of a truck engine—all discoveries that Sereno and his colleagues have unearthed and described.

Gobero is there too. Endless rows of drawers contain thousands of artifacts and animal bones. I recognized a giant tortoiseshell found in the lake bed and a large Tenerean pot. Sereno, who is 66, plans to return all the material, including the burials and dinosaur bones, to Niger in stages over the next 15 years. To that end, he's busy working with Idé and others to build two museums to house it all. He showed me architectural plans for one to be built in the capital, Niamey, and a smaller one for Agadez, the nearest city to Gobero.

But the fieldwork isn't finished. Sereno hopes to collect at least one more skeleton. At the end of the 2022 expedition, he and the team briefly returned to Gobero to retrieve the woman with the turtle shell. As they dug, Adamou, the bone finder, noticed the skull of a child, and while they were excavating that burial, they uncovered the foot of another skeleton they dubbed "DNA Man."

According to Sereno, no one has been able to get ancient human DNA from the central Sahara. But if you could obtain a sample and match it to the DNA of a modern African population, it would pull back the curtain on the descendants of Gobero and where they went when the Green Sahara period ended—the beginning of the next epic chapter in the story of Africa.

But because the burials aren't deep and have been subjected to desert sun and heat

for millennia, the collagen in the bones and the dentin in the teeth, good sources for DNA samples, are too degraded. "I always thought if I could find a burial that was deeper than the others, we might get a viable sample," Sereno said. DNA Man, who is about a foot below the surface, might've been protected just enough.

Lack of time once more prevented Sereno from collecting a skeleton. He covered the burial and marked the spot, hoping someday to come back. Again. "Gobero just won't let go of me," he said, laughing.

Now things are even more difficult in Niger. Last July, a military coup deposed the democratically elected president. In March, its leaders ordered the U.S. military to close the drone base and leave the country. It seems unlikely Sereno will return to the desert for some time.

In the lab I found the thing I'd come to see—the burial of the woman and two children. Sereno was able to remove it intact, and paleoartist Tyler Keillor had made casts of all the bones and created an exact replica, which is what I was looking at. He'd mounted it standing up, so a viewer could walk around it and examine the underside of the burial. Seeing it from this angle reminded me of my wife in bed cuddling our children.

Over the years the team has culled new details. The three were buried around 3400 B.C. The woman, between 25 and 35 years old, had been laid in the grave first, followed by the seven-year-old and then the five-year-old. Four perfectly shaped arrowheads had been added, and pollen found beneath the bones revealed they'd been interred with cockscomb flowers.

There's no evidence to prove this was a mother and her children, but that's how my imagination fills in the story. There's no way of knowing who buried them, but I can't help but look on this scene as a husband and father. And I can't help but read the message that their burial seems to convey as one of love and profound loss. It's the first time I've felt an emotional connection to prehistoric people. But 5,400 years later, I feel their sorrow. □



FROM OUR INSTAGRAM ACCOUNTS

PHOTOGRAPHER
Chris Burkard

LIKES
12,430+

WHERE
Hampi, India

→ **HUMAN-POWERED**, slow travel—that’s what photographer Chris Burkard treasures. For this shot, he crawled up a ledge, mindful of snakes, to capture his friend bouldering. With padding below him in case of a fall, the friend is just a dot in the surrounding

grandeur. The World Heritage site and onetime capital of the Vijayanagara Empire is a popular area for outdoor adventure. Burkard loved being able to show his subject as a detail in the landscape, “almost like a period at the end of a sentence.”

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