# NATIONAL GEOGRAPHIC EXPLORING ISLANDS A tepui in SOUTH AMERICA may hold clues to the MYSTERIES of evolution. DISNEP+ WATCH 'EXPLORER: THE LAST TEPUI' STREAMING APRIL 22



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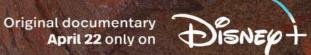
Climb into the unknown.



EXPLORER

# THE LAST TEPUI

EARTH DAY PREMIERE



# Telling Stories That Matter

#### BY SUSAN GOLDBERG

#### DEAR READER.

For as long as I can remember, I've wanted to make a difference, to help make the world a better place. It's why I became a journalist 42 years ago and why I came to *National Geographic*.

This is my last letter to you as editor in chief. I'm deeply grateful to have spent eight years working with some of the world's best journalists—dedicated professionals who've received 10 National Magazine Awards, three Pulitzer Prize finalist nominations, two Webby Media Company of the Year honors, and hundreds of other accolades during my time as editor.

I'm leaving *National Geographic* for the world of higher education. At Arizona State University I'll do what I can to strengthen journalism during a challenging time for the free press. And I'll be working with the next generation of storytellers, who must communicate ever more powerfully about daunting issues like climate change.

As I've learned through our work here, there's a conundrum to covering these issues: How can honest reporting on existential threats keep readers engaged without leaving them feeling hopeless? How can journalism on these complex topics ignite audiences' curiosity, foster deeper understanding, and excite people about solutions? Trying always to achieve that balance—while creating visually rich, reportorially deep, global journalism—has been both as gratifying and as vexing as anything in my professional life.

Every day at *National Geographic* we track the latest in science, the environment, and the human journey in all its marvelous complexity. The covers above reflect some of the most consequential topics of the past eight years (and some are also personal favorites).







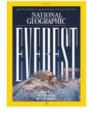


















As I look back, I'm proud that we've explored issues such as gender and race—and in doing so were willing to examine publicly our own troubled history. I'm proud that we make it our business to celebrate the world's wonders and report on what's going right. And I'm proud of our progress—though far from complete—in assembling a diverse, global corps of writers, photographers, and other journalists. Who better to cover a fast-changing, multitextured world?

It's been a true honor to work with my gifted colleagues here. It's been a privilege to work on *National Geographic*, with its enduring legacy, and a singular opportunity to help reinvent it for today's audiences. Thank you for taking that journey with me.

And thank you for reading *National Geographic*.  $\square$ 

A dozen covers, in order of publication during my eight years here, from top row to bottom and left to right: June 2015, December 2015, May 2016, January 2017, April 2018, June 2018, September 2018, September 2019, July 2020, November 2020, January 2021, and December 2021.



### **Introducing ATEM Mini Pro**

#### The compact television studio that lets you create presentation videos and live streams!

Blackmagic Design is a leader in video for the television industry, and now you can create your own streaming videos with ATEM Mini. Simply connect HDMI cameras, computers or even microphones. Then push the buttons on the panel to switch video sources just like a professional broadcaster! You can even add titles, picture in picture overlays and mix audio! Then live stream to Zoom, Skype or YouTube!

#### **Create Training and Educational Videos**

ATEM Mini's includes everything you need. All the buttons are positioned on the front panel so it's very easy to learn. There are 4 HDMI video inputs for connecting cameras and computers, plus a USB output that looks like a webcam so you can connect to Zoom or Skype. ATEM Software Control for Mac and PC is also included, which allows access to more advanced "broadcast" features!

#### **Use Professional Video Effects**

ATEM Mini is really a professional broadcast switcher used by television stations. This means it has professional effects such as a DVE for picture in picture effects commonly used for commentating over a computer slide show. There are titles for presenter names, wipe effects for transitioning between sources and a green screen keyer for replacing backgrounds with graphics.

#### **Live Stream Training and Conferences**

The ATEM Mini Pro model has a built in hardware streaming engine for live streaming via its ethernet connection. This means you can live stream to YouTube, Facebook and Teams in much better quality and with perfectly smooth motion. You can even connect a hard disk or flash storage to the USB connection and record your stream for upload later!

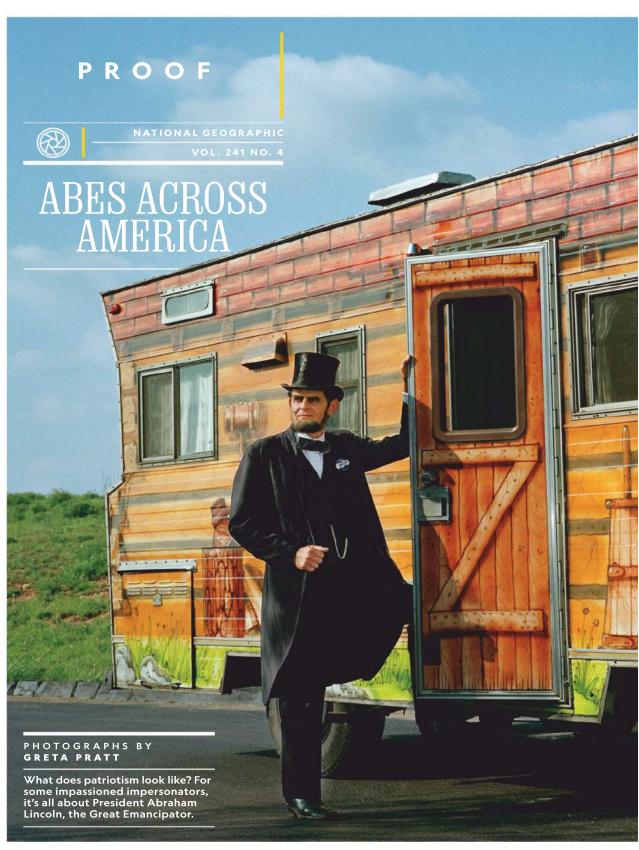
#### Monitor all Video Inputs!

With so many cameras, computers and effects, things can get busy fast! The ATEM Mini Pro model features a "multiview" that lets you see all cameras, titles and program, plus streaming and recording status all on a single TV or monitor. There are even tally indicators to show when a camera is on air! Only ATEM Mini is a true professional television studio in a small compact design!









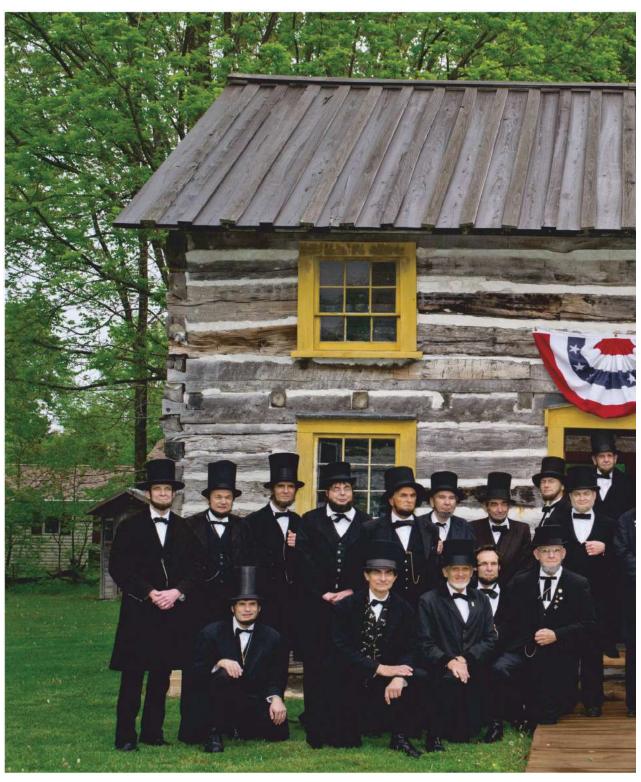




Greta Pratt wrote of her portrait series Nineteen Lincolns, "My intention is to comment on the way a society, composed of individuals, is held together through the creation of its history and heroic figures." Pictured here, clockwise from top left, are Robert Taylor and Mike Reiser (seated), Randy Duncan, Chester Damron, and Stan Wernz.



For these Lincoln devotees, black suits, bow ties, stovepipe hats, and beards (real or not) are standard. Though some of Pratt's subjects are now retired or deceased, she thinks their stories "still speak to the enduring appeal of America's 16th president." Pictured on this page, clockwise from top left, are Vernon Risty, Whit McMahan, Gerald Bestrom, and Jim Sayre.



Members of the Association of Lincoln Presenters (ALP) gather at an annual conference, in 2012, in Decatur, Illinois. The organization's membership now numbers 95 Lincolns from 32 states, including several that were part of the Confederacy.



The ALP promotes its reenactors' availability for appearances with the tagline, "We are ready, willing, and Abe L." Also on the membership roster: 40 Mary Todd Lincolns, three Ulysses S. Grants, and one Harriet Beecher Stowe.



### THE BACKSTORY

AS LINCOLN REENACTORS, THESE AMERICANS DRESS THEMSELVES IN THE PAST TO CONVEY VALUES FOR TODAY.

WHY LINCOLN? That's the question Greta Pratt asked the costumed men before her camera, all of whom committed a portion of their lives to a president now gone for more than 150 years. For these fans, Pratt learned, Abraham Lincoln "embodies one of America's most cherished tenets: that the common man, through sheer hard work and determination, can elevate his status in society."

At four annual conventions of the Association of Lincoln Presenters, Pratt met men and women who perform as the president and first lady at schools, senior centers, and other venues. For the portraits in her project, she framed the men in softly focused, pastoral backgrounds reminiscent of historical paintings, and she challenged them to "summon up your inner Lincoln."

They did so gladly. "Lincoln brings out the best in me," says Illinois reenactor Randy Duncan (page 8). "He probes the patriotism of each of us." Though her subjects began portraying Lincoln for varied personal reasons, Pratt says, they continue because he helps them feel part of something larger: a nation. —HICKS WOGAN

The real Abraham Lincoln, above, sits for a portrait by Alexander Gardner in 1863.

#### EXPLORE

IN THIS SECTION

**Surfing Mountains** Sea Glass Doubles Walruses' Songs Footprints of Foods



ILLUMINATING THE MYSTERIES-AND WONDERS-ALL AROUND US EVERY DAY

NATIONAL GEOGRAPHIC

**VOL. 241 NO. 4** 

# A Way for Nature to Rest in Peace

CONSERVATIONISTS SEE CEMETERIES AS A TOOL TO PRESERVE LAND, NATURALLY—AND DETER RUNAWAY DEVELOPMENT.

BY XANDER PETERS



AT ITS MOST PEACEFUL, the Indiangrass Preserve in southeast Texas is hushed and still. Its springtime canvas is lush with prairie grass; monarch butterflies cling to yellow tickseed flowers as eastern bluebirds circle overhead. Come summer, rains will douse its shallow wetlands, where bobcats pause to drink as they prowl for cottontails.

An agrochemical research facility occupied part of the site as recently as 2001. Then the Katy Prairie Conservancy restored the land into a nature preserve.

Since 1992 the conservancy has protected more than 18,000 acres of Texas land that otherwise might have been developed, says Elisa Donovan, its vice president and general counsel. The conservancy has championed tallgrass prairie and wetlands, plentiful species, and rare ones, such as the crawfish frog and the western chicken turtle. Its latest project aims to restore and preserve the natural state of land that will welcome the living—and also the dead.

For several years Donovan and colleagues have been planning a conservation cemetery here. Nationwide, only about a dozen of these operations exist: single properties with areas in simultaneous use as nature preserves, parklands, and environmentally conscious burial grounds. This would be Texas's first.

The current conservancy plan includes 50 acres of space for so-called green burials. No caskets or concrete liners will be used. The dead won't be embalmed, to eliminate synthetic, potentially harmful chemicals. Each body lowered into the ground will wear only biodegradable clothing and a shroud.

A conservation cemetery takes green burial grounds one step further. Its landscape protects the dead as they naturally decompose—and in return, the dead help protect the land (with the customary laws that discourage disturbing cemeteries). That's the plan for property near the Indiangrass Preserve site and a conservancy field office, a nondescript white building on the edge of Waller, a small town 42 miles northwest of Houston.

Beyond Waller, development continues chewing away at nature as the region echoes the Houston suburbs' insatiable growth. Greater Katy grew from 81,000 residents to a sprawling suburb of more than 309,000 between 1990 and 2020, according to the Katy Area Economic Development Council. It's a trend that has barely shown signs of slowing down, forcing conservationists like Donovan and her colleagues to get creative in response.

Look to the north from the conservancy's field office: That's a ranch of more than a thousand acres, which was acquired by developers and soon will be a residential area. Neighboring landowners already are creating a municipal utility district, the first step in the birth of a new subdivision. To the south, a dusty two-lane highway soon will be four lanes so it can meet the projected flow of future traffic.

"It really feels like a race," Donovan says of the effort to conserve land. "Can we protect the land before someone comes in, subdivides it, and builds hundreds of thousands of homes on it?"

**THE CONSERVATION CEMETERY** idea came to the Katy Prairie Conservancy folks from the Kate Braestrup memoir *Here If You Need Me*. Donovan remembers Braestrup writing of a missing person's remains found in the forest. The body gradually decomposed, and a nearby shrub sprouted into a tree, intertwining with the remains.

The sense of peace Donovan took from Braestrup's description grew within her like the tree through the skeleton. She buried the thought until her father died years later, when she found herself reflecting on the connections between nature and death. The family honored her father's wish to be cremated. He would be stored in a niche in perpetuity. Thousands of dollars were spent.

"It was smaller than a filing cabinet," Donovan says. It didn't sit right with her—and a growing

# Environmental impact at the end

When a human life's end raises the question of what to do with the mortal remains, are some solutions greener than others? Parties to the debate give different answers. Conservation cemetery advocates point to the environmental impact of conventional burials, in which a person is laid to rest in a casket, with a concrete liner, underground. Such interments typically involve headstones and other end-of-life products that may travel thousands of miles, creating emissions along the way. Cremation is an alternative but not a climate-friendly option, experts say: Similar to how carbon stored in roots is released when a tree is cut down, carbon that makes up part of the human body is released into the atmosphere when the remains are incinerated at 1,400 to 1,800 degrees Fahrenheit for multiple hours. One cremation produces on average more than 534 pounds of carbon dioxide, according to an estimate by cremation technology manufacturer Matthews Environmental Solutions. By comparison, the green burials practiced in conservation cemeteries allow root systems to trap the carbon released from human bodies during decomposition. -xp

number of individuals seem to feel the same. They're rethinking what it means to die and whether there's a purpose to be had when it happens. They're shunning the multibillion-dollar business of managing death, with hope that their remains will give back to the earth.

But the concept of a conservation cemetery is not new. It's retrofitted for a new era.

In 1825, as farmland evolved into industrial acreage, conservationist George Brimmer bought land in Massachusetts to preserve its valleys and wetlands from development. Brimmer later partnered with others to turn the land into a cemetery, effectively skirting developers' wandering eyes.

The result was Mount Auburn Cemetery, which borders Cambridge and Watertown, Massachusetts. Today it still resembles the land Brimmer sought to preserve, albeit with a fleet of gravestones poking out of the green turf. "I like to think of Mount Auburn Cemetery as not just the first rural cemetery, but in fact, it was a form of land conservation," says Candace Currie, director of Green Burial Massachusetts, a nonprofit group working to create the state's first legally recognized conservation cemetery. "To this day, people go there to get away from the city."

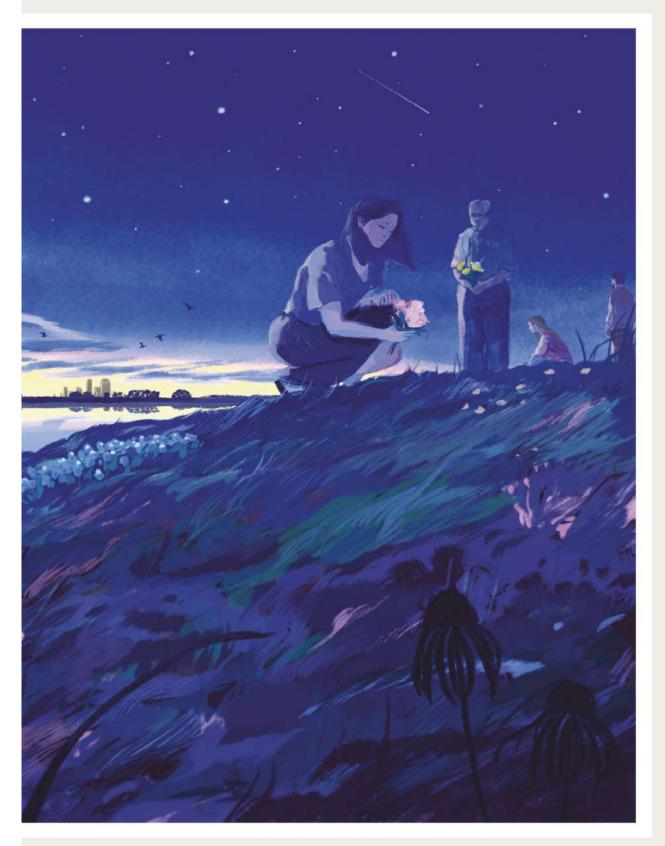


ILLUSTRATION: XIAO HUA YANG A PRI L 2022 17

In the decades after Brimmer established Mount Auburn Cemetery, new technologies changed the way the living interacted with the dead.

The profession of undertaker emerged in the United States during the Civil War. Preserving bodies became common practice for morticians seeking a way for families to say goodbye to fallen soldiers; the war dead were embalmed, laid in wooden boxes, and sent home by the thousands. President Abraham Lincoln's funeral procession raised embalming's public profile. For 19 days after his assassination in 1865, the president's casket was left unsealed; embalmers kept the body fresh to accommodate public viewings.

Like most of the systems, customs, and industries that touch our lives, the management of death has radically changed since the time of Lincoln. Today the modern deathcare industry generates more than \$20.5 billion annually.

Conservation cemetery and green burial advocates responded with their own movement. In 1996 in Westminster, South Carolina, the nation's first natural burial ground was established by family physician Billy Campbell and his wife, Kimberly. Called Ramsey Creek Preserve, the property has more than doubled from its original 33 acres.

Facilities like these are "way more than just greener versions of contemporary cemeteries," Billy Campbell has said. He considers them "multidimensional social and ecological spaces where the burials don't overwhelm the naturalness of what is there."

Currie sees another important trait. For green burials, loved ones help "take care of our own dead," she says. "It's a right, I think, that people want back."

Speaking with Currie, Green Burial Massachusetts president and co-founder Judith Lorei describes the push for natural burials and conservation cemeteries as a new school of thought.

"People are really beginning to think outside the box," Lorei says.

She catches herself, and laughs.

IT'S A MATTER OF Stripping away the unnecessary. Of getting back to basics. With conservation cemeteries, "we're trying to help people come back to the concept that nature is enough," says Heidi Hannapel, a consultant with the preservation group Landmatters and a co-founder of Bluestem Conservation Cemetery.

At the same time, the cemeteries are a modern-

#### WE'RE TRYING TO COME BACK TO THE CONCEPT THAT NATURE IS ENOUGH.'

—Heidi Hannapel, co-founder of Bluestem Conservation Cemetery

even entrepreneurial—approach to land preservation, says Bluestem's other co-founder, Jeff Masten. "It's a different land use, it's a different tool, it's a different strategy," says Masten, also a Landmatters consultant. "Conservation burial grounds, for some people, are like a business that helps land stay in use."

Donovan knows the Katy Prairie cemetery won't be the David felling Houston development's Goliath. Rather, the aim is just to hold off the giant. In the end, it's about the bigger picture, Donovan stresses. All profit from selling natural burial plots (tentatively, for around \$4,500 apiece) would be used to restore 250 more acres to a natural state.

Donovan hopes the conservation cemetery project prompts visitors to reflect on their ultimate fate. At some point, each of us will die. But until then, we have choices. What do you want your legacy to be?

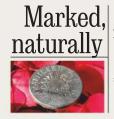
"Let's be thoughtful about our end of life and what we want to see happen," she says.

Someday, I ask, is this where you'll be buried? She laughs nervously. "If we had the cemetery out there today and I passed away, yes, put me on the Katy Prairie." Donovan replies.

Should the project go according to plan, Donovan wouldn't be alone on the Katy Prairie landscape. Neither would anyone else who chose to be laid to rest there. Each springtime, the prairie grasses above them would burst to life, and flowers would bloom into the cusp of summer.

Late in the afternoon, I drive back from the preserve. The landscape bolts from green and brown to gray and grayer as Houston's skyline comes into view. Rush hour churns the city, where it's anything but hushed and still.  $\ \square$ 

**Xander Peters** resides, writes, and is often found tending his garden in New Orleans. His work has appeared in publications including the *Christian Science Monitor*, the *Bitter Southerner*, and *Audubon*.



In a conservation cemetery, if markers like gravestones aren't used, how will visitors know if a grave is nearby? Planners at the Katy Prairie Conservancy intend to use metal survey spikes with small medallions on top. They will be inserted into the ground near graves yet will be

subtle enough to not interrupt the appearance of the preserve's landscape. As Donovan says, though, the group wants a clear way to tell where everyone is buried. That's why GPS coordinates will also be used as part of the grave markings, allowing friends and families of the dead

to locate a grave on their smartphones if, say, the prairie grass is too tall to recognize it. The conservancy also hopes to create digital remembrances for each person buried at the preserve—online obituaries so that each visitor, family, or friend can honor those there. –xp







NUBEQA is a prescription medicine for men with prostate cancer that has not spread to other parts of the body and no longer responds to hormone therapy\*

\*Hormone therapy includes drug treatments or surgery that lowers testosterone.

#### Ask your doctor about NUBEQA

#### **NUBEQA.com**

#### **INDICATION**

NUBEQA® (darolutamide) is a prescription medicine used to treat men with prostate cancer that has not spread to other parts of the body and no longer responds to a medical or surgical treatment that lowers testosterone.

It is not known if NUBEQA is safe and effective in women and children.

## IMPORTANT SAFETY INFORMATION

NUBEQA can harm unborn babies and cause loss of pregnancy. Men with female partners who may become pregnant should use effective birth control (contraception) during treatment and for 1 week after the last dose of NUBEQA.

# Before taking NUBEQA, tell your healthcare provider about all your medical conditions, including if you:

- Have kidney or liver problems.
- Have a partner who may become pregnant.
   Males who have female partners who may
   become pregnant should use effective birth
   control (contraception) during treatment and
   for 1 week after the last dose of NUBEQA.
   Talk with your healthcare provider about birth
   control methods.
- For women, tell your healthcare provider if you are:
  - pregnant or plan to become pregnant.
     NUBEQA can cause harm to your unborn baby and loss of pregnancy (miscarriage)
  - breastfeeding or plan to breastfeed. It is not known if NUBEQA passes into breast milk.

#### **Even with rising PSA on hormone therapy\***

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without their prostate cancer spreading to other parts of the body when they added NUBEQA to hormone therapy (median<sup>†</sup> 3.4 years for NUBEQA + hormone therapy compared with 1.5 years for hormone therapy alone)

Adding NUBEQA also extended overall survival<sup>‡</sup> by lowering the risk of death by 31% compared with hormone therapy alone

**Tell your healthcare provider about all the medicines you take,** including prescription and over-the-counter medicines, vitamins, and herbal supplements. NUBEQA may affect the way other medicines work and other medicines may affect how NUBEQA works. You should not start or stop any medicine without talking to your healthcare provider.

#### Most common side effects of NUBEQA include:

• Feeling more tired than usual • Arm, leg, hand, or foot pain • Rash • Decreased white blood cells (neutropenia) • Changes in tests that determine how your liver works (liver function tests)

NUBEQA may cause fertility problems in males, which may affect the ability to father children. Talk to your healthcare provider if you have concerns about fertility.

These are not all the possible side effects of NUBEQA. Call your doctor for medical advice about side effects. You may report side effects to the FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

<sup>†</sup>Median is the middle value in a set of numbers, not the average. <sup>‡</sup>How long a person may live after diagnosis or starting a therapy.

Please see additional Important Safety Information on adjacent page and Important Facts About NUBEQA on next page.



# IMPORTANT FACTS ABOUT NUBEQA® (darolutamide) tablets (new-BEH-Kah)

#### What is NUBEQA?

NUBEQA is a prescription medicine used to treat men with prostate cancer that has not spread to other parts of the body and no longer responds to a medical or surgical treatment that lowers testosterone. It is not known if NUBEQA is safe and effective in women and children.

#### What should I tell my healthcare provider before taking NUBEQA?

Tell your healthcare provider about all your medical conditions, including if you:

- Have kidney or liver problems
- Have a partner who may become pregnant.
   Males who have female partners who may become pregnant should use effective birth control (contraception) during treatment and for 1 week after the last dose of NUBEQA.
   Talk with your healthcare provider about birth control methods
- For women: tell your healthcare provider if you:

   are pregnant or plan to become pregnant.
   NUBEQA can cause harm to your unborn baby and loss of pregnancy (miscarriage)
- are breastfeeding or plan to breastfeed. It is not known if NUBEQA passes into breast milk

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

NUBEQA may affect the way other medicines work and other medicines may affect how NUBEQA works.

You should not start or stop any medicine before you talk with the healthcare provider that prescribed NUBEQA.

#### How should I take NUBEQA?

- Take NUBEQA exactly as your healthcare provider tells you.
- Your healthcare provider may change your dose if needed.
- Take your prescribed dose of NUBEQA 2 times a day with food.

- Swallow NUBEQA tablets whole.
- If you are receiving gonadotropin-releasing hormone (GnRH) analog therapy, you should continue with this treatment during your treatment with NUBEQA unless you have had a surgery to lower the amount of testosterone in your body (surgical castration).
- If you miss a dose of NUBEQA, take your normal dose as soon as possible before your next scheduled dose. Do not take 2 doses together to make up for a missed dose.
- If you take more NUBEQA than prescribed, call your healthcare provider right away.

#### What are the possible side effects of NUBEQA?

- Feeling more tired than usual
- Arm, leg, hand, or foot pain
- Rash
- Decreased white blood cells (neutropenia)
- Changes in tests that determine how your liver works (liver function tests)

NUBEQA may cause fertility problems in males, which may affect the ability to father children. Talk to your healthcare provider if you have concerns about fertility.

Tell your healthcare provider if you have any side effect that bothers you or that does not go away.

These are not all the possible side effects of NUBEQA. Call your doctor for medical advice about side effects.

#### How should I store NUBEQA?

- Store NUBEQA at room temperature between 68°F to 77°F (20°C to 25°C).
- Keep the bottle tightly closed after you first open it.

Keep NUBEQA and all medicines out of the reach of children.

The information provided here is not comprehensive.

#### To learn more about NUBEQA:

- Talk to your healthcare provider or pharmacist
- Visit www.nubeqa.com to obtain the FDA-approved product labeling
- Call 1-888-842-2937

You may report side effects or quality complaints of products to the FDA by visiting www.fda.gov/medwatch, or call 1-800-FDA-1088.

DISPATCHES FROM THE FRONT LINES OF SCIENCE AND INNOVATION



NEUROSCIENCI

#### MICE AND HUMAN IMAGINE ALL THE

HAVE YOU EVER had a dream so vivid that for real life? What if you actually did ope you'd envisioned with them closed? Accord study, you may have—at birth. Researche newborn mice and found that, in the few deyes open, their still developing retinas si patch informational waves. Previously ran waves start flowing from a mouse's templ same direction visual stimuli flow wher forward. As lab director Michael Crair ex state "allows a mouse to anticipate what opening its eyes," preparing the animal to its surroundings. Human babies also exh at birth—discerning objects, detecting m Crair says, "we are born capable of many least in rudimentary form."—HICKS WOG

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PHOTOS (FROM TOP): EOSTA/NATURE AND MORE; TIM WINTER, ALA MINT IMAGES LIMITED/ALAMY STOCK PHOTO

#### EXPLORE BREAKTHROUGHS

#### Produce sans plastic labels

A Dutch produce distributor has devised an eco-friendly way of labeling fruits and veggies as organic: Harmless markings are lasered into foods' skins with a method called natural branding. It reduces plastic packaging and food waste, since marked pieces can be sold individually. -нw





#### NS, JUST EY'LL SEE

t you nearly mistook it n your eyes to a world ling to a Yale University rs imaged the brains of lays before the animals' mulate vision and disdom in direction, these e toward its nose—the a mouse is scurrying plains, this dreamlike it will experience after perceive and navigate ibit some visual ability otion. This suggests, as of these behaviors, at

VMY STOCK PHOTO;

PRESSING NEWS

#### **Hugs really** do make us feel better

Hugs, a casualty of the pandemic, have measurable effects, judging from two research studies. In Japan, researchers monitoring infants four to 12 months old found their hearts beat less rapidly during hugs from parents, but not from other people. And in London an experiment with blindfolded subjects found that longer hugs are considered more pleasant. Ranking hugs by strangers, subjects liked five- or 10-second embraces better than one-second squeezes. -нw





24 NATIONAL GEOGRAPHIC

small coastal community of Nazaré for centuries. No one successfully surfed the giant waves of winter—at least not until American Garrett McNamara, at the urging of dedicated locals, came to investigate in 2010. "As soon as I walked up to the lighthouse, I saw the biggest waves I'd ever seen," he says, but conditions were terrible. "It was like, OK, this is going to be amazing as soon as we get the right wind." He studied the waves and then rode a record-breaking, 78-foot-tall monster in 2011. Now it's common to hear this once quiet fishing village described as surfing's Everest, or its big-wave holy grail.

Surfing here means coming close to the force

of nature and respecting it as nonnegotiable. Underwater features supercharge the unforgiving wave volume, speed, and unpredictability. There's also a beach break—waves crash on shifting sands, not rock or coral. "Because of snitting sands, not rock or coral. "Because of the big waves, the sands are always moving," says Portuguese surfer Tony Laureano, at 19 among the youngest in the big-wave community here. The waves are often "bumpy," making for jagged rides that magnify the challenge. One can try to outsmart them; the first wave of a set of several

rides that magnify the challenge. One can try to outsmart them; the first wave of a set of several "kinda cleans the bumps," he explains.

But there are no hard-and-fast rules—except that one cannot tackle the biggest waves alone.

Surfers are motored toward these moving mountains by a tow-in partner on a Jet Ski. That Jet Ski often is backed up by a second one in case things really go wrong. Up at the nearby lighthouse, spotters with walkie-talkies scan for good sets of incoming waves. Gathered on the cliff and the beach below; a mix of townspeople, maritime officials, rescue teams, medics, families, with watchful eves. "Here you can yell to

maritime officials, rescue teams, medics, families, with watchful eyes. "Here you can yell to the surfers, and they can hear you," McNamara says. "You can feel the ground shaking, and you actually get misted by the waves."

If watching these rides is a mixture of hope and dread, measuring them is a mixture of science and headache. There's no end line etched in chalk, no easy reference point. "We're talking about a dynamic situation, so we're talking about a dynamic situation, so we're talking about a dynamic situation, so we're talking about marticles [that] are moving all the time." water particles [that] are moving all the time," says Miguel Moreira, an assistant professor in the Faculty of Human Kinetics at the University of Lisbon, one of a few experts puzzling out

better ways to measure surfing records.

Even surfers can't really tell a wave's exact size. "You know if it's big, but you don't know how big," Laureano says. Gabeira knew her record wave was "the most radical" she'd ever surfed ware was the institution and the sound of it exploding behind her. After his record breaker, McNamara wondered, What are you guys excited about? He says he was "just surfing with my heart and just enjoying

#### **ALL GEARED UP**

Before getting towed in by Jet Ski, surfers must put on special equipment to survive the cold, the falls, and getting pinned under wave

CREATING GIANTS

submarine canyon, more than 120 miles long and three times as deep as the Grand Canyon in some areas. Each winter, the swell from North Atlantic storms is focused and amplified by the canyon, shaping some of the largest waves on the planet.

Surfers can race up to 45 miles an hour, similar to speeds in fast downhill skiing.

the ride—but always focusing on the exit."

Surfers have long hunted for such giant waves. "That's always been the chat: Where is the 100foot wave?" says British surfer Andrew Cotton.
'And Nazaré is a village, and the waves break
right in front of the lighthouse." He's still incredulous. "How was the biggest wave in the world
hiding, all this time, in plain sight?"
One thing is certain. The waves by

One thing is certain. The waves have changed the town—and those who ride them. For Gabeira, pulled unconscious from a harrowing wipeout in 2013, her brush with death made her more humble, "more human." Laureano can't explain how he or other surfers survive at all: "Sometimes." I just feel I have some superpowers."
Perhaps, by some unearthly osmosis, these

"The energy and the power that the waves have is something from another world," Laureano says. "It's magic." And mystical. And unruly.  $\ \square$ 

The challenge of measuring big waves To determine wave height, experts analyze videos for ever changing reference points, including a surfer position over the board, and wave crest and trough.



Even small changes in food and shopping habits can reduce your diet's carbon footprint and boost health.

BY ANNIE ROTH

Going vegan or vegetarian is one way to decrease your diet's impact on greenhouse gas emissions—but it isn't the only way. A recent Purdue University study suggests that smaller tweaks can make a difference too, while improving your health.

After analyzing the 2010 grocery purchases of more than 57,000 U.S. households, Purdue researchers found 71 percent could shrink their food carbon footprint by making three changes:

Skip the unhealthy snacks

Avoiding foods with high calorie counts and low nutritional value can reduce the total carbon footprint of U.S. household food consumption by nearly 10 percent. Items like candy, soda, and packaged snacks take more ingredients and more processing, which translates to higher environmental impacts.

#### Watch bulk buys

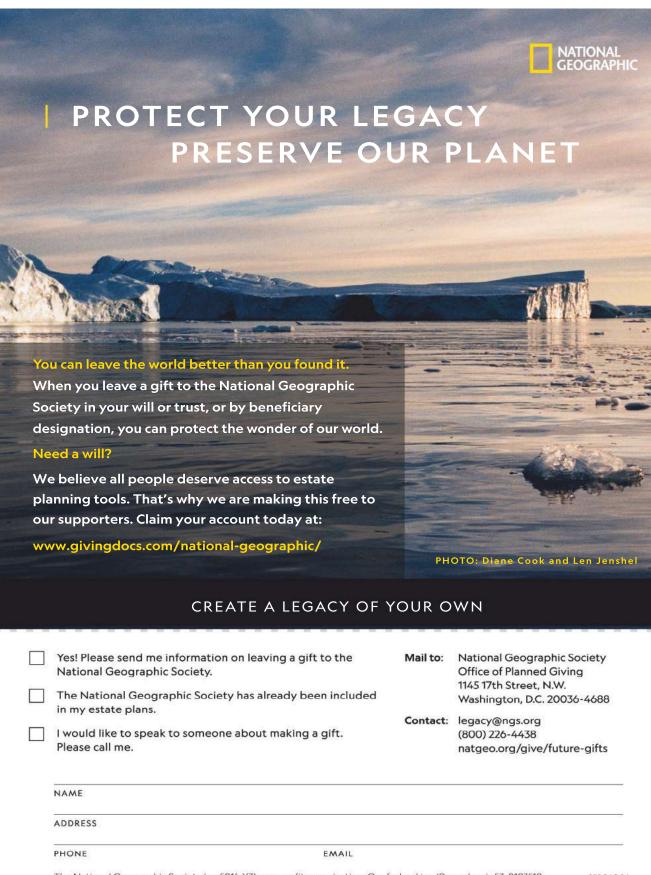
Households of one or two people may end up with food waste when they try to save money with bulk buys. Before you buy supersize, consider whether a three-pound jar of peanut butter will go bad before it's used up.

Trim ready-made foods

One average microwave meal may not have a very large carbon footprint. But buying them regularly can add up to significant emissions because ready-made foods' large sales volume amplifies their carbon emissions, the study found.

Seemingly small shopping shifts can add up: By making the above changes, the U.S. could cut more than a quarter of emissions from household food consumption, the researchers say. That's about 36 million metric tons—about what 6.6 million households generate in a year of electricity use. "Collective action can make a huge impact," says study co-author Hua Cai.





# WHERETHE WALRUSES SING

ON A REMOTE ALASKA ISLAND, UNFORGETTABLE MELODIES COME FROM A SURPRISING SOURCE.

STORY AND PHOTOGRAPHS BY **ACACIA JOHNSON** 

THE FIRST RAYS OF SUN are breaking over the tundra cliffs, and from the open sea, walruses are approaching the

shore below. Their breath rises in golden



puffs, and they're chiming: a haunting, metallic song like a softly ringing bell. You hear it with your whole body, as if you're underwater.

This is Round Island, one of seven craggy isles in Bristol Bay that make up Alaska's Walrus Islands State Game Sanctuary. For millennia it's been an important resting place—known as a haul-out—for male Pacific walruses, which gather on its shores by the thousands every summer to recuperate after mating season. The Indigenous Yupik people, who have long hunted walruses sustainably on Round Island, call it Qayassiq: "place to go in a kayak."

In the early 1900s, commercial hunting decimated the walrus population. By the time the sanctuary was created and all hunting banned, in 1960, Round Island was one of North America's last Pacific walrus haul-outs. Despite weighing in at over a ton each, walruses are quite sensitive to disturbance. Boat traffic and loud noises can cause them to stampede into the water, sometimes leading to injury or death for animals in the frenzy. If a site is disturbed frequently enough, the walruses may abandon it completely.

Pacific walruses wallow in the shallows off Round Island, which is open to adventurous travelers for a few months each year.

WHEN PEOPLE WHO LOVE THE PLANET

COME TOGETHER,

#### ANYTHING IS POSSIBLE.



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Thanks to the sanctuary, Round Island remains a seasonal home for walruses. Today the sanctuary is co-managed by the Qayassiq Walrus Commission, with representatives from nine Yupik communities who ensure that traditional knowledge is considered. As the walrus population recovered, tribal leaders successfully petitioned to reinstitute subsistence harvest. Since 1985 a state-run program has allowed visitors to the island from May to August. But they are few, partly because getting there requires a boat ride across at least 20 miles of the Bering Sea.

I've come to Round Island with my brother, a wildlife biologist, to see walruses. As we approach by boat,

the island appears enchanted: a dome of green rising from the sea, its summit shrouded in mist. Margaret Archibald, one of two Alaska Department of Fish and Game technicians who staff the island each summer, greets us. "I apologize in advance if I'm a chatterbox," she says. "You two are the first visitors we've had in weeks."

The landing beach is packed with sleeping walruses. To avoid disturbing them, we unload a short distance away, keeping our voices low. After pitching our tent in the campground, we join Archibald on her daily rounds. It's her job to maintain the trails, oversee the visitors program, and enforce the three-mile exclusion zone protecting the island from boat traffic and commercial fishing. But she considers her most important task to be the daily counts of walruses, seabirds, and Steller sea lions. Bristol Bay and its fisheries are a vital ecosystem for Alaska's economy, and data collected about Round Island's residents are

some of the region's most consistent. As temperatures rise, Archibald says, effects on the island provide valuable insight into the broader marine ecosystem.

Archibald leads us up to a viewpoint for First Beach. When we peer over the edge, we see hundreds of walruses below. We smell them too: salty, marine, and fecund. For hours each day, my brother and I wander among the overlooks, watching the walruses. They're social animals, piling onshore in a mosaic of blubber and tusks. In the water, they're graceful swimmers. As we chat with Archibald one afternoon, she explains that walruses are a keystone species, helping to shape their entire biotic community. Despite this, and their

vulnerability to melting sea ice, they're often a low priority for conservation. Walruses are hard to track, and existing data have been deemed insufficient to classify them as endangered.

Archibald says that experiencing walruses in person is a great way to encourage their conservation. "Once

people come here and see them, they're going to forever be more aware of walrus habitat—and the fact that walrus are real animals," she says, "not a sticker or an emoji." Observing them—their different colors, their battle scars, their antics—reminds me that they are individuals, with personalities and emotions.

On our last morning, I climb to a craggy peninsula where seabirds nest. The beach below is full of walruses glinting amber in the sunrise, and more wallow offshore, chiming softly as they wait for space to join the crowd. As I scan the coastline, I realize that I am now seeing walruses with fresh eyes.  $\square$ 

Acacia Johnson is an Alaska-based photographer and writer.



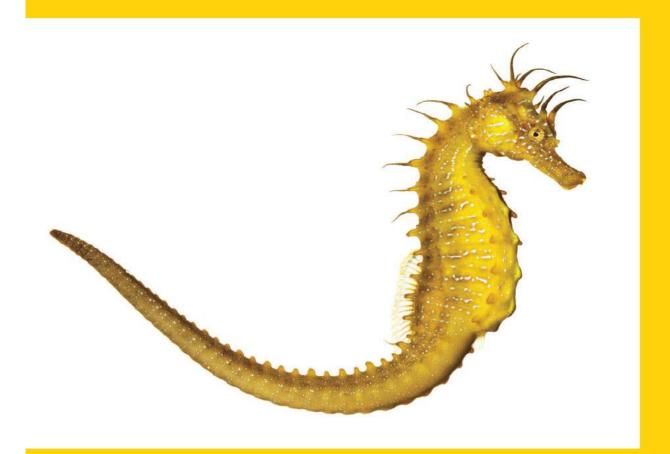
Margaret Archibald (at right) and Matthew Lohrstorfer, Alaska Department of Fish and Game technicians, monitor the island's wildlife, including the walruses that rest on its shores.

NATIONAL GEOGRAPHIC

#### **APRIL 2022**

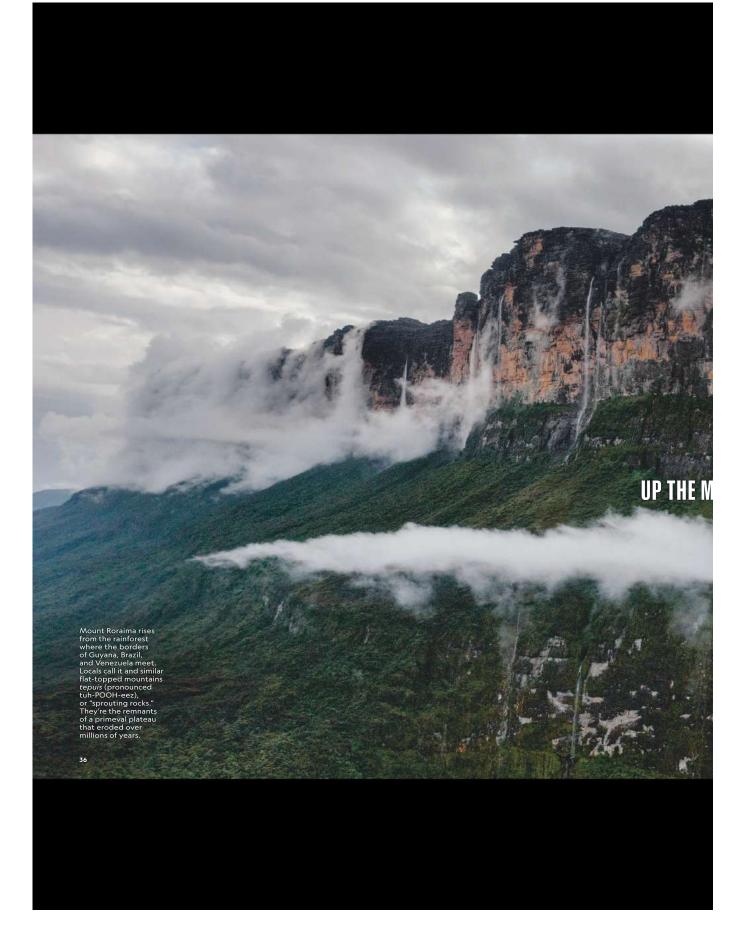
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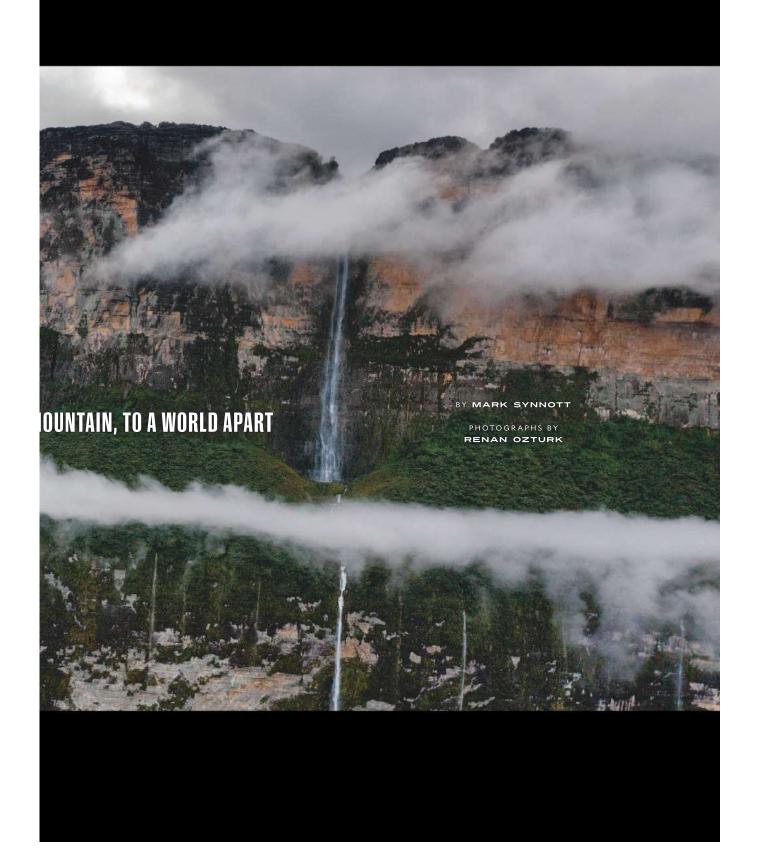
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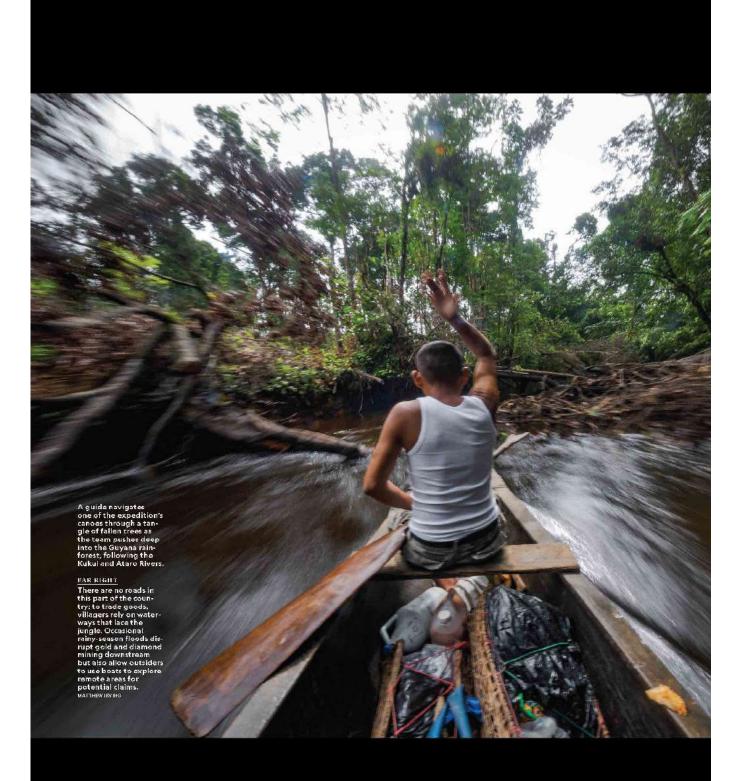


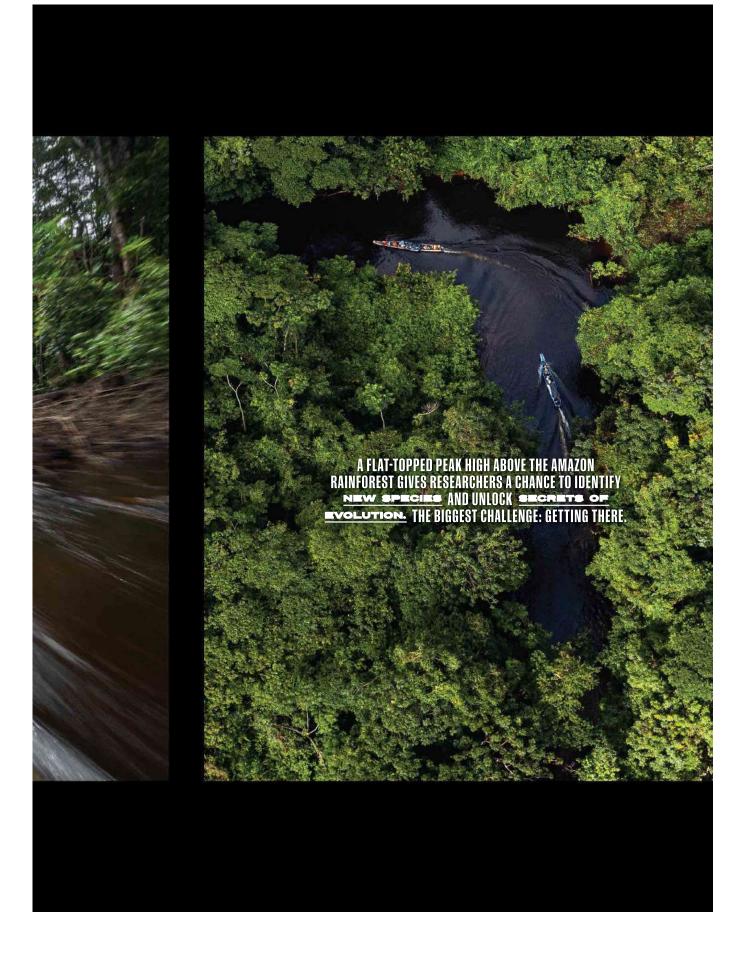
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'IT'S EASY TO SEE THE SEAHORSE'S
ALLURE, WITH ITS FANCIFUL BLEND
OF TRAITS THAT SEEM BORROWED
FROM OTHER ANIMALS: A HORSE'S
HEAD, A KANGAROO'S POUCH,
A MONKEY'S PREHENSILE TAIL.'











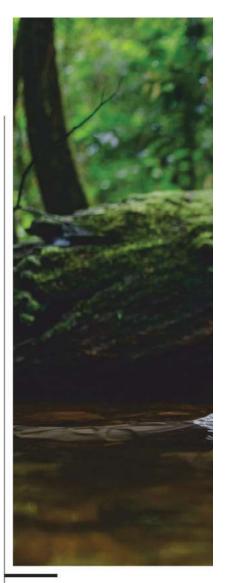
#### ON A PITCH-BLACK FEBRUARY NIGHT,

Bruce Means stood alone, deep in the Pakaraima Mountains in northwestern Guyana. Scanning the cloud forest with his headlamp, he peered through his foggy glasses at a sea of ancient trees cloaked in beards of verdant moss. The humid air, ripe with the smell of decaying plants and wood, trilled with a melodious symphony of frogs, drawing him like a siren song so deep into the jungle that he wondered if he would ever make it back out.

Grasping a sapling in one hand for balance, Bruce took a shaky step forward. His legs quivered as they sank into the boggy leaf litter, and he cursed his 79-year-old body. At the beginning of this expedition, Bruce had told me that he planned to start slowly but would grow stronger each day as he acclimated to life in the bush.

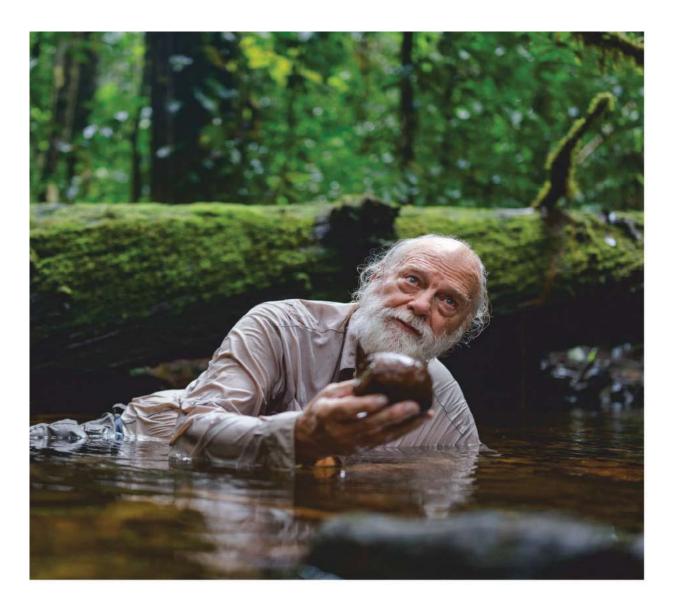
After all, during his career as a conservation biologist, he'd made 32 previous expeditions to this region. I'd seen a photo of him in his younger days—a six-foot-four, broad-shouldered backwoodsman, with his long hair pulled into a ponytail and a huge snake draped over his neck.

He'd told me stories about riding rickety buses in the 1980s across the plains of Venezuela's Gran Sabana and then setting off into the mountains, where he hunted for new species of amphibians and reptiles. Once, he'd spent days alone on the summit of an obscure peak, sometimes naked, living as close



Bruce Means looks under rocks for frogs and other species unknown to science. During the expedition, the 79-year-old biologist explored many watery habitats. Even a pond can be a tiny universe of life, he says, likely to contain species that exist nowhere else.

The National Geographic Society, committed to illuminating and protecting the wonder of our world, has funded Explorers Bruce Means and Mark Synnott's expeditions in South America.



to the natural world as he could. These were all an extension of the explorations he'd made as a kid in Southern California, tramping through the Santa Monica hills looking for alligator lizards and tarantulas, or, as he likes to say, "small experiences of the magnificence of nature."

It was that philosophy that had led him here, now. Sure, the ponytail was gray and thin, and at 285 pounds, he was well over his fighting weight, but he assured me he still had the fire. Soon, he would find his rhythm.

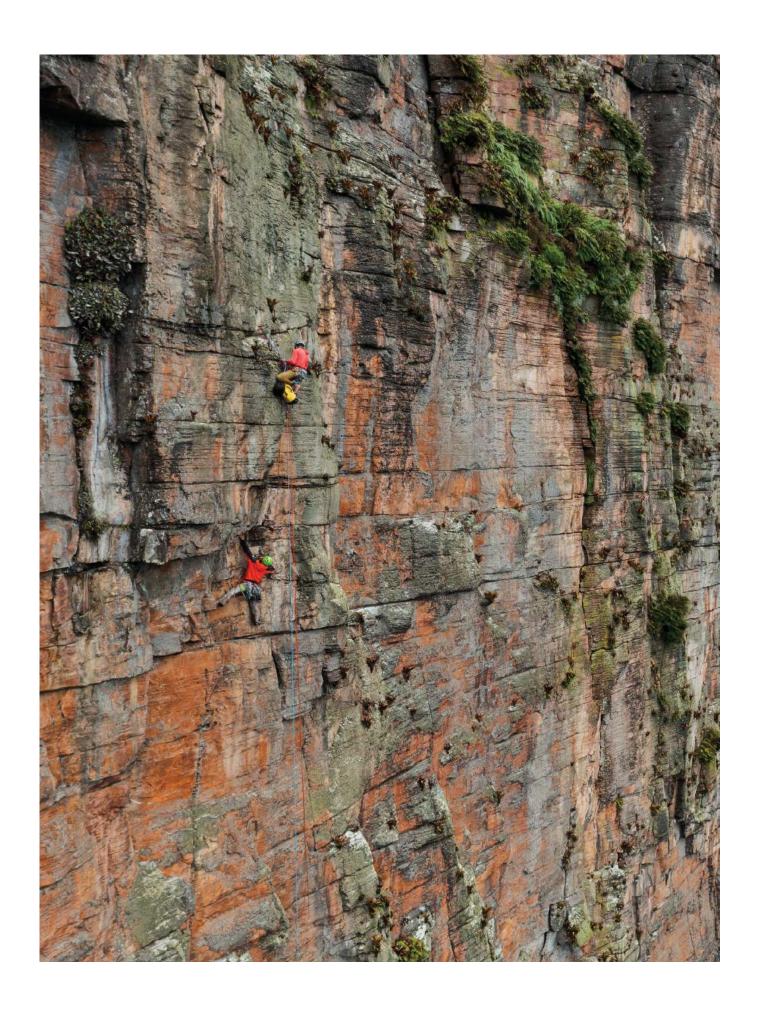
But the jungle—with its swarming insects, incessant rain, and sucking bogs that threaten to swallow a person whole—has a way of wearing one down, and after a week of rugged bushwhacking and endless river crossings, it was obvious to everyone on our expedition that he was growing weaker each day. At night, a rattly cough kept him awake, and as he lay in his hammock, he thought about home back in Tallahassee, Florida, where his wife and two grown sons had practically begged him not to go on this trip. The wilds of the Guiana Highlands are no place for an out-of-shape septuagenarian.

And yet, I'd seen Bruce rally before. We'd made three previous trips to this region, a remote hot spot of biodiversity called the Paikwa River Basin, that lies on the northern edge of the Amazon rainforest. Bruce's main interest here was frogs, and if the planet held a frog paradise, this was surely it.

Frogs play a critical role in ecosystems around the world, but nowhere have they existed for









longer than in equatorial rainforests like this one. For millions of years, the frogs here have followed an array of evolutionary pathways, resulting in a profusion of species in all shapes, sizes, and colors, and with astonishing adaptations.

More than a thousand amphibian species have been described in the Amazon Basin alone—from jewel-like poison dart frogs (named for their primary use among Indigenous people), to glass frogs (with skin so thin it reveals their beating hearts), to milk frogs (which live high in the canopy inside water-filled tree holes), to the recently discovered zombie frogs (that spend most of their lives underground). Many of these have yielded breakthroughs in medicine, including new types of antibiotics and painkillers and potential cancer and Alzheimer's treatments.

Scientists believe they've identified only a fraction of the world's frog species. Meanwhile, the ones we do know of are disappearing at an alarming rate. By some estimates, up to 200 frog species may have gone extinct since the 1970s, and Bruce and other biologists fear that many others will die out before we even know they exist. What secrets about evolution, medicine, or other mysteries would be lost with them?

Bruce refused to dwell on such gloomy ruminations. He focused instead on the wealth of biological treasures these rainforests still held. "The potential for future discoveries in the Paikwa is virtually limitless," he told me, his voice filled with his trademark enthusiasm. But he also knew that time was running out—not just for the frogs but for him too.

an oddity as the only English-speaking nation in South America, a legacy of its history as Britain's only long-term colony on the continent. Most of the country is covered in untracked rainforest, but in the

far northwestern corner, the Pakaraima Mountains run along Guyana's border with Brazil and Venezuela. Here, several table-topped mountains, which resemble the monumental mesas in the deserts of the American Southwest, rise sharply above the dark green canopy of the Paikwa River Basin. To the local Pemon people who've lived in their shadows for centuries, these otherworldly peaks are known as *tepuis* (pronounced tuh-POOH-eez)—or "sprouting

Akawaio team member Franklin George rests after a day of hacking through the jungle and hauling supplies, often under a steady rain. During the trek to Weiassipu, the team set up shelter each evening and wrung out their clothes. "The jungle just swallows you down day after day," says writer Mark Synnott. "We were constantly soaked and slathered in mud. We called it living in mud world."

rocks"-sometimes called "houses of the gods."

Unlike typical mountain ranges that often form in linked chains, tepuis tend to stand alone, emerging from the rainforest like islands poking out of a foggy ocean. A few of their summits can be reached by hiking routes, but most are ringed with sheer cliffs—some up to 3,000 feet tall—and often are festooned with spectacular waterfalls.

Geologists tell us that tepuis are the remnants of an ancient plateau, called the Guiana Shield, that once formed the heart of the supercontinent known as Gondwana. Hundreds of millions of years ago, when this part of South America was connected to Africa, the Guiana Shield stretched across parts of what is modern-day Guyana,



French Guiana, Colombia, Brazil, Venezuela, and Suriname. This mass of ancient sandstone and quartzite gradually fractured and eroded until roughly 30 million years ago, when the hundred or so tepuis that exist today took on something resembling their present form.

Gondwana split apart eons ago, but this part of South America still holds many clues to its shared past with Africa. Today some of the species endemic to tepuis are closely related to plants and animals found in West Africa, and the types of diamonds mined in Sierra Leone and Guinea are the same as those that erode from tepui cliffs and are carried downstream in the Paikwa and other rivers.

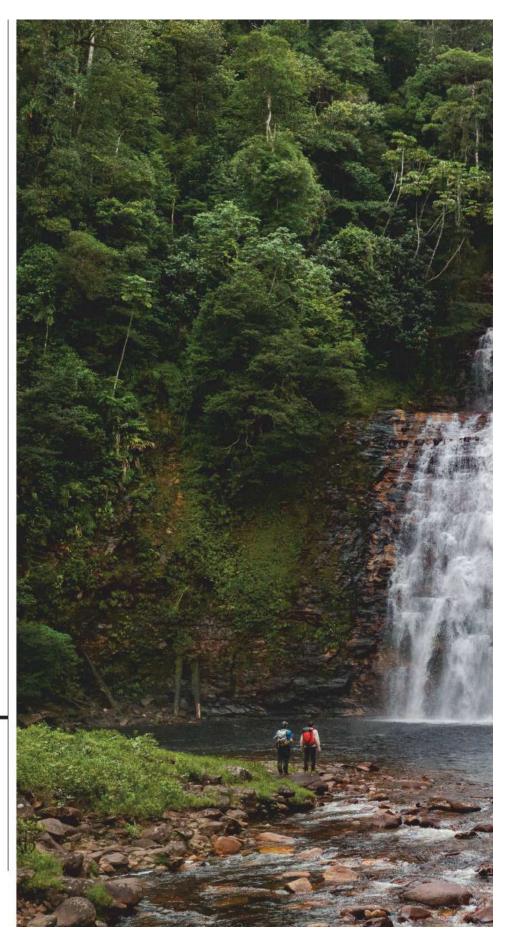
The first European to see a tepui was probably

the English explorer Sir Walter Raleigh, who led an expedition up the Orinoco in 1595 while searching for El Dorado, the fabled lost city of gold. Raleigh wrote about seeing a crystal mountain in the distance, which might have been Mount Roraima: "It appeared like a white church-tower of an exceeding height. There falleth over it a mighty river which toucheth no part of the side of the mountain, but rusheth over the top of it, and falleth to the ground with so terrible a noise and clamour, as if a thousand

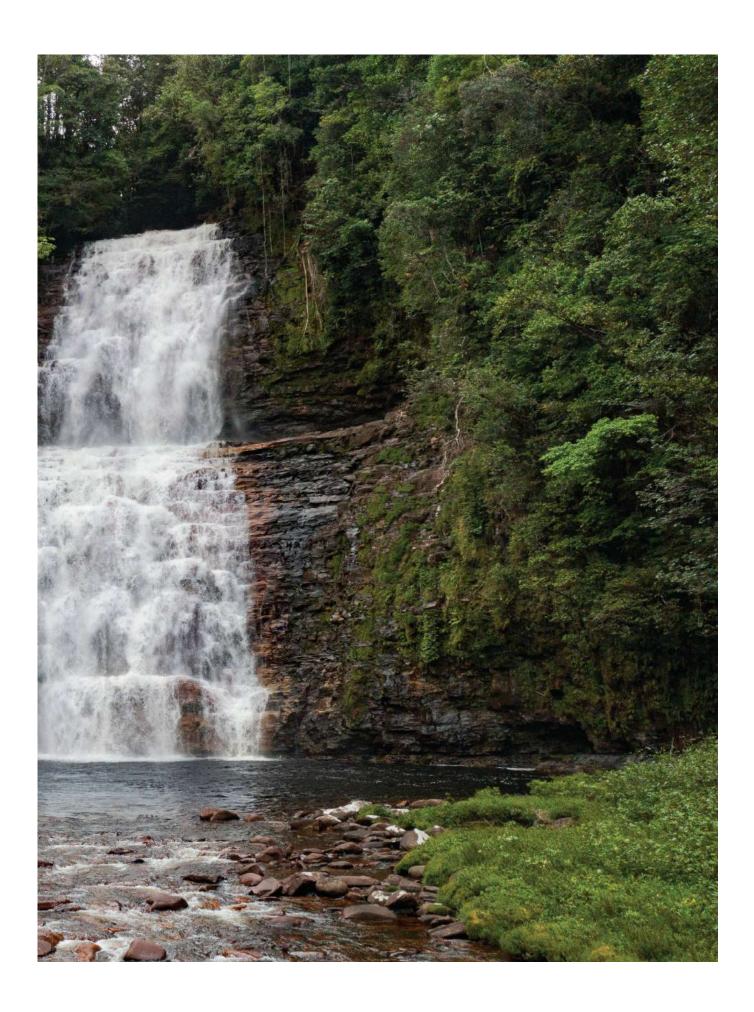
### **EXPLORER: THE LAST TEPUI**

Follow as the team searches for new species on South America's sky islands, available to stream on Disney+ starting April 22.





Synnott and Honnold stand below a cascade called Double Drop Falls, where they established a base camp. From there, the team cut a five-mile trail through pristine rainforest to the base of Weiassipu. Then they climbed the tepui, searching for frogs and other species.



great bells were knocked one against another."

I first learned of these otherworldly rock formations as a boy, when I read Sir Arthur Conan Doyle's 1912 classic, *The Lost World*. In this science-fiction tale, a scientist discovers dinosaurs and protohumans living on an isolated plateau hidden deep in the Amazon jungle. That book and its protagonist, the ebullient Professor Challenger, jumped to mind when I first met Bruce in 2001 through mutual friends at

or its relationship to others in the genus known as pebble toads.

The "Oreo," as Bruce called it, was chocolate brown, about the size of his thumbnail, with four-toed feet that reminded me of Mickey Mouse's cartoon hands—an evolutionary adaptation that enables these frogs to climb like no other. It was the seventh known species from the *Oreophrynella* genus. Each of these species lives separately from the others; six are found only on

## 'TEPUIS ARE LIKE THE GALÁPAGOS ISLANDS,' BRUCE ONCE TOLD ME,

the National Geographic Society. He recounted some of his explorations of tepuis, describing them as individual laboratories for evolution—islands in the sky—that have been completely isolated for so long that some frog species exist on the summit of a single tepui and nowhere else on Earth.

"Tepuis are like the Galápagos Islands," he once told me, "but so much older and more difficult to study."

He had been looking for someone to help him access the most inaccessible terrain on and around the tepuis. With my background as a professional climber, I could do just that. So in 2003 and 2006, we spent weeks searching for new frog species in the jungle below Roraima. While flying home in a helicopter after the second trip, we passed over a small tepui that wasn't on our map. Its summit was incised by a 600-foot-deep sinkhole with a thick forest at its bottom. Bruce grabbed me by the shirt and shouted in my face, over the sound of the rotors, "Mark, I *need* to be in that hole!"

Six years later, in 2012, a helicopter dropped Bruce and me on top of that tepui, called Mount Weiassipu (pronounced why-OSS-i-pooh), and I helped him rappel into the sinkhole. After five days of camping at the bottom and crawling around at night through what Bruce described as "a lost world within a lost world," he found a tiny frog he described as a "missing link" in tepui evolutionary biology. A single specimen of this species, named *Oreophrynella weiassipuensis*, had been collected by a team of spelunkers in 2000, but it hadn't been properly preserved, and as a result, very little was known about it

their own tepui summits and one in the cloud forests of the Paikwa River Basin.

They've each followed distinct evolutionary paths, but at least two share a remarkable adaptation that allows them to escape predators. When a tarantula or scorpion attacks, these frogs curl into tight, pebble-size balls and roll and bounce down tree branches, vines, leaves, or rocky surfaces until they're out of harm's way. By the end of that trip with Bruce, I wasn't sure who was more charming, these minuscule frogs or the man who had dedicated his life to studying them.

There was another frog on top of Weiassipu that Bruce had photographed and captured but wanted to study more. This one had classic treefrog hind feet designed for climbing. Based on its size, brown color, and white-speckled belly, Bruce was confident that it was a new species of the genus *Stefania*.

For years, he and his collaborator, Belgian biologist Philippe Kok, had been building *Stefania*'s evolutionary tree. By charting the DNA from other *Stefania* frogs, they concluded there were missing species. If Bruce could collect this elusive frog on top of Weiassipu and prove through DNA analysis that its ancestors evolved for millions of years to suit that ecosystem, cut off from the rest of the world, he'd be a step closer to a more complete understanding of how life evolves on tepuis.

So Bruce had proposed one final expedition to the Guiana Highlands to find this *Stefania* and to sample the species richness of other amphibians and reptiles in the Paikwa River Basin. We'd travel by bush plane and dugout

canoe along the Kukui and Ataro Rivers, then trek 40 miles through untracked jungle to Weiassipu, which we would attempt to climb via its sheer north face. "This is probably the last one I've got in me," Bruce said. "But I'll get there. Even if I have to crawl."

My challenge was to devise a way to help Bruce look for new species in the one tepui environment that no scientist had ever studied: the cliff faces. But safely hauling a man who would

riverbank, landing facedown in a creek. After it was clear he wasn't hurt, someone broke the tension with a joke about the jungle being guilty of "elder abuse."

Everyone laughed—including Bruce. But as he continued to struggle over the next several days and as the trail grew more treacherous, the humor died off. Bruce's safety became an ever present worry for our team.

After a week of this, we finally set up a base

## 'BUT SO MUCH OLDER AND MORE DIFFICULT TO STUDY.'

turn 80 on this expedition up a big-wall rock climb would take skills well beyond my own. So I recruited two ringers: climbing superstar Alex Honnold, 35, whose ropeless ascent of El Capitan in Yosemite National Park was documented in the film Free Solo, and Federico "Fuco" Pisani, 46, a Venezuelan-Italian and one of the world's most experienced tepui climbers.

RUCE SUMMONED his reserves and pushed on through the jungle in search of frogs. For days we'd been trudging across a swampy floodplain

through ankle-deep mud that

almost sucked our boots right off

our feet. It rained incessantly, and even when the sun poked through the low clouds, it never penetrated the dense canopy overhead. Down in the steamy understory, mosquitoes and biting flies reigned, and our sweat-soaked clothes, slick with mud and ripped by thorns, stuck to our rashy skin. Every day we crossed countless tea-colored rivers and creeks via precarious log bridges. The slow-moving water, which was also our drinking source, was stained from decaying vegetation—something that no amount of purifying could remove.

Even Alex found the conditions challenging. But for Bruce, the trek had devolved into a harrowing ordeal. He fell often and hard. Lacking the balance and confidence to cross the many log bridges, he opted instead to slide down the steep embankments and wade or swim across the water. Once, he'd somersaulted down a steep

camp of sorts downstream from a roaring 200foot cascade that Bruce called Double Drop Falls. It looked like a gargantuan two-hump waterslide and hammered into a pool with such force it filled the air with a fine mist that drifted over the camp.

The team gathered under a tarp, sitting on a bench around a crude table made from fallen logs, to take stock of our situation. Bruce spread a map across the table, and with a wrinkled finger, he traced the route that still lay between us and Weiassipu. To the south lay a valley that was unexplored, according to our team's Akawaio guides, members of the small Indigenous group that lives in the area where Guyana, Venezuela, and Brazil converge around Roraima. Above the roaring falls rose the massive tepui, Weiassipu, which remained hidden behind thick forest canopy and swirling clouds.

Sitting across from me at the table, Alex was practically vibrating, so eager was he to get to the mountain where he could climb his way up and out of what he called "mud world." Fuco, bespectacled and with thick curly brown hair flecked with gray, sat quietly next to me. He'd led more than 20 expeditions to the tepuis over the past 27 years, but he'd never been involved in a scientific expedition on a tepui. He'd always wanted to be a scientist, even pursuing a Ph.D. in biology at one point, and I noticed that Bruce often called on Fuco when trying to identify the flora and fauna that surrounded us.

Standing behind Alex were the leaders of the 70-strong team of local Akawaio people who were supporting our expedition as guides and porters. Edward Jameson and Troy Henry were legendary

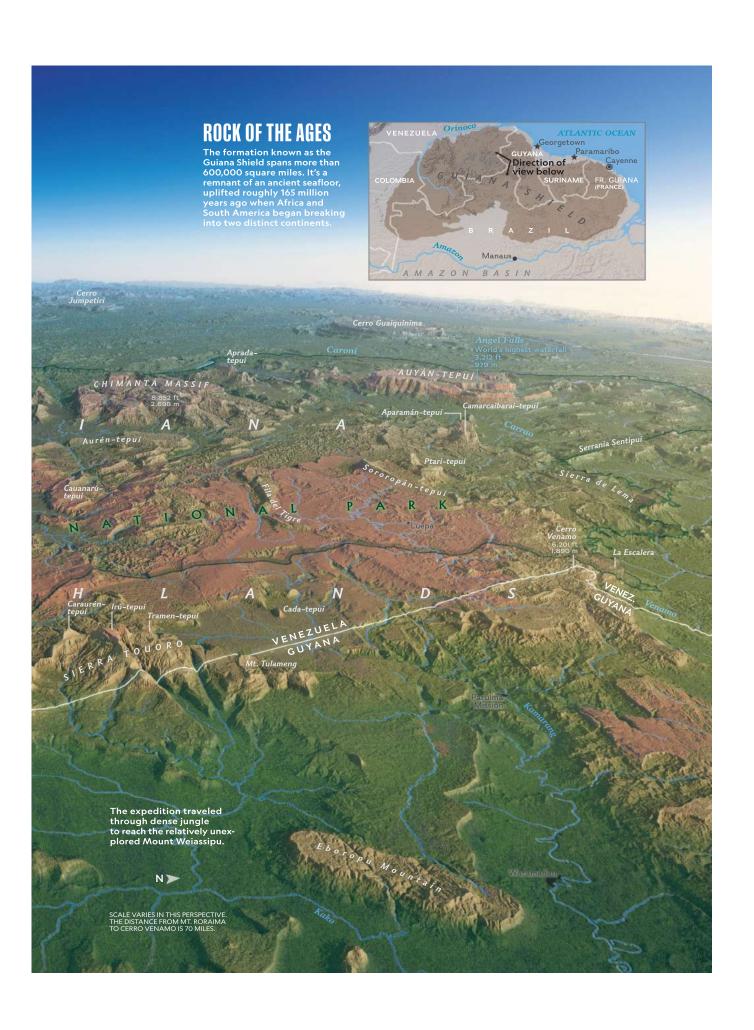
# **SKY-HIGH ARCHIPELAGO**

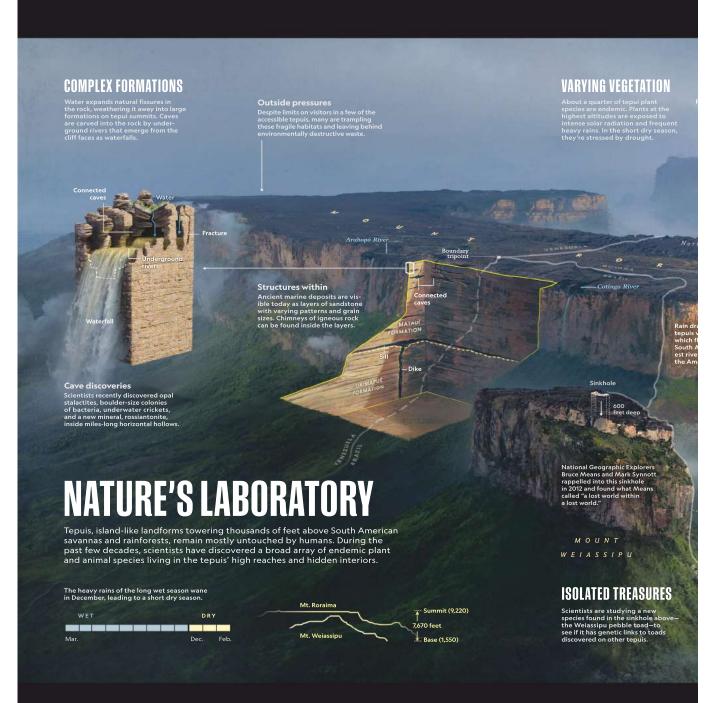
Just as flora and fauna evolved on remote islands across the oceans, so too did plants and animals isolated on the summits of tepuis, rock plateaus rising out of South American rainforests. Slow weathering honed their sheer cliffs and hollowed valleys between them. Scientists believe these sky islands each fostered unique life-forms, separated by oceans of tropical lowlands.



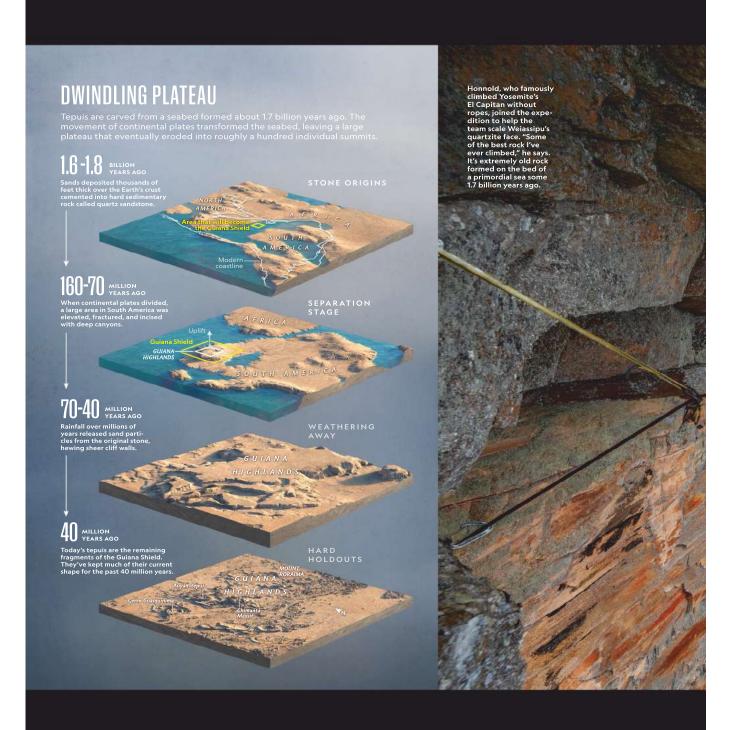
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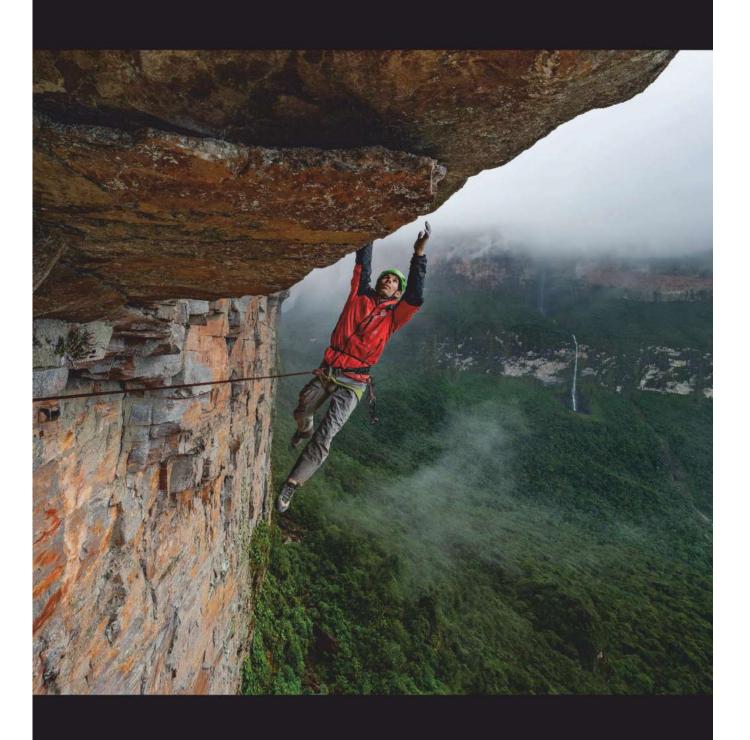
AMAZON BASIN erro el Abismo G U More than 65 percent of Canaima National Park consists of tepuis. The park was made a UNESCO World Heritage site in 1994. The Gran Sabana is a grass-land region on the Guiana Highlands. Forested valleys weave through the plains. MOUNT WEIASSIPU h Camp VENEZUE next page: Double Drop Falls MONTERORAIM Route of expedition MONTE RORAIMA NATIONAL PARK



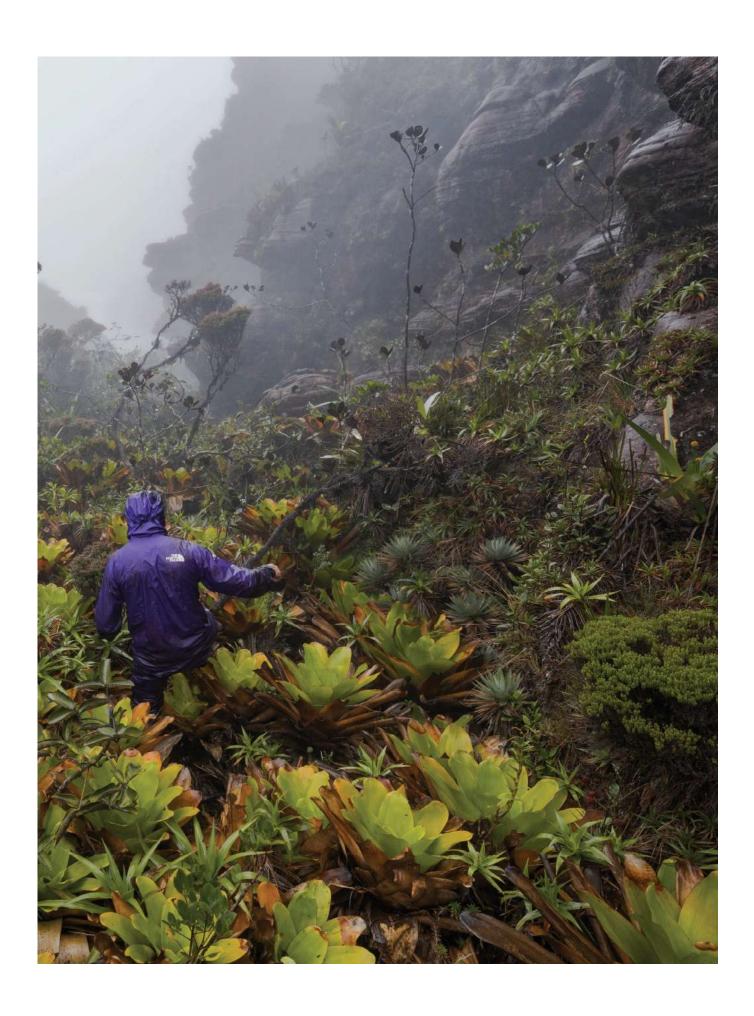












among the Akawaio for having climbed the 1,500-foot Prow route of Roraima with a British expedition in 2019. They didn't know it yet, but we had brought medals from Guyana's newly elected president, Mohamed Irfaan Ali, to present to them in honor of their feat.

Short, rippling with muscle, and constantly smiling, Edward, 55, had accompanied Bruce and me on our previous expeditions to the region. He'd grown up in this forest and could survive out here more or less indefinitely with little more than his trusty machete, which he kept razor sharp with a file he wore on a string around his neck. He told me that since our last expedition, he'd been working off and on as a mining prospector, or "pork-knocker," a Guyanese term that refers to the miners' backcountry practice of living on pickled wild bush hog.

Since I'd last seen Edward in 2006, Guyana had been gripped by a gold rush. A few thousand artisanal mines had been dug throughout the country's interior. Like most Akawaio, Edward had spent much of his life farming and hunting. But the lure of earning cash, maybe even finding life-changing treasure deep in the jungle, was impossible to resist. He described how the miners would dig down to a layer of clay, then inject high-powered jets of water to blast the clay into a slurry, which then was pumped to the surface, sluiced and rinsed, and then mixed with mercury, which binds to the gold. The chemical process especially worried Bruce.

"A teaspoonful of mercury can contaminate an entire river system," he told me.

An Akawaio named Denver Henry showed me a map detailing the location of dozens of mining claims scattered across the rainforest surrounding the Paikwa River. So far, the pork-knockers had been held off by the inaccessibility of the terrain and the Akawaio's resistance to building an airstrip in their villages. But Edward told me that during the last rainy season, when the lowlands flooded, outside prospectors had come in with boats from Kamarang, one of the biggest villages in the region, to explore claims. Every year these mines get a little closer to the Paikwa River Basin.

Around the table, we agreed Bruce needed time to recover, so we decided to split up. The climbing team would move ahead to cut a trail to the base of Weiassipu's north face, about five miles away, while Bruce and a team of Akawaio collected specimens at Double Drop Falls.

Some of the frog species encountered on the expedition:

#### TOP LEFT

MacConnell's pebble toad (Oreophrynella macconnelli) inhabits the forest near Double Drop Falls and is one of two known species of pebble toad that don't live on a tepui summit.

#### TOP RIGHT

An unnamed species of Stefania was found in the cloud forest below Weiassipu.

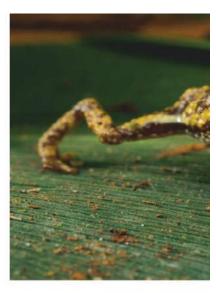
#### BOTTOM LEFT

The Roraima tree frog (Boana roraima) lives between the leaves of arboreal bromeliads.

#### BOTTOM RIGHT

The Kanaima tree frog (Nesorohyla kanaima) has unusually dark eyes. "Few other frogs have irises so black that you cannot see their pupils," Bruce Means says. It's unclear what advantage black irises may have over colorful ones.

RYAN VALASEK (TOP LEFT AND BOTTOM LEFT)





RUCE EMERGED from his hammock the next morning wearing only muddy briefs and was met by a group of Akawaio holding gallon-size Ziploc bags. At the beginning of the trip, he'd announced that in order to sample the biodiversity, he would pay for specimens. The

payout was 100 Guyanese dollars (about 50 cents) per creature, with a premium bonus for a Stefania frog, which immediately created a thriving microeconomy in a land where there is little opportunity for Indigenous people to earn hard currency.

Bruce opened his journal to a blank page and started taking notes. Edward was first in line. His









baggie held four frogs. Salio Chiwakeng was next, with five lizards and six frogs. Markenson James confidently delivered a large black scorpion, Tityus obscurus, and his friend presented a spider fit for a Stephen King movie. Bruce pulled it out of the bag with his bare hand, pinching its hairy body between his fingers as one might hold a crab. "Theraphosa blondi," he said, "aka the Goliath birdeater." A member of the tarantula family that happens to be the world's largest spider by mass (and yes, it eats birds), this one tipped the scales at half a pound and was six inches across. It stared at us with beady eyes and bared curved black fangs that looked like a vampire's. After jotting down a few notes, Bruce put it onto his balding pate and let it walk around.

Meanwhile, Alex, Fuco, and I loaded up with food and gear for the climb, including a thousand feet of rope and three hanging cots, called portaledges, for camping on the side of the cliff. Two Akawaio guides, Harris Aaron and Franklin George, led us up a narrow ridge and over a hump into a thick forest. Wielding machetes, they slashed a path through a carpet of giant ferns and between old-growth trees held fast in the thin, sandy soil with colossal buttress roots that extended, pyramid-like, 20 feet across their bases.

Spiky bromeliads of every conceivable size and color covered the ground and grew up the sides of the trees, sprouting from clumps of moss. Orchids with delicate white flowers emerged from rotten stumps. White bellbirds, rainbow-colored macaws, and tiny iridescent hummingbirds darted through the leaves, filling the air with their warbles and whistles. For brief moments the clouds would lift, letting the sun filter through holes in the canopy, illuminating patches of the steamy forest floor where luminous blue morpho butterflies flitted in shafts of light.

On the second day of fighting our way to the base of Weiassipu, we began to catch glimpses of its towering north face through occasional ARLY THE NEXT MORNING, We started to climb Weiassipu. Our plan was to ascend the wall via whatever seemed to be the best route, laying a trail of ropes anchored to the mountain along the way. When the entire cliff was rigged, we'd strap Bruce into one of the portaledges and haul him up behind us. From the comfort of this hanging platform, Bruce would look for new species on the vertical

## THIS WAS THE DIAMOND WATERFALL, WHERE LEGEND HAS IT THE PLUNGE POOL

openings in the forest. Soon we entered a maze of jumbled, slippery boulders cloaked in a spongy blanket of electric-green moss. Gradually, the firm ground gave way to an elevated lattice of deadfall that occasionally would break out from under our feet like a trapdoor.

Late in the day I heard a loud *oof* behind me. I looked back to see Alex hanging by his armpits. One of his legs had broken through the rotten trellis of dead wood and augered into a jagged void between two rocks. After extricating himself, he pulled up his pant leg. His shin was covered in a paste of blood and muck. Fuco caught my eye. He didn't say anything, but I knew what he was thinking: How in the world are we going to get Bruce through this section?

When we finally walked out of the forest at the base of Weiassipu just before sunset, it felt like being reborn. The clouds had lifted, and the wall glowed in the dusk. Across the valley, we stared at the nine-mile-long east face of Roraima, where a dozen waterfalls, each as tall as the Empire State Building, poured out of the mountain like flowing ribbons of golden silk.

Franklin directed our attention to the most spectacular cataract, which burst from a hole in the side of the cliff about 200 feet below the rim. This, he said, was the Diamond Waterfall, where legend has it the plunge pool at its base sparkles with diamonds the size of one's fist. It's a tale that dates back to Sir Walter Raleigh, who wrote that some of his Native guides promised to bring him to a mountain that had "very large pieces growing diamond-wise; whether it be crystal of the mountain, Bristol diamond, or sapphire, I do not yet know, but I hope the best."

walls that guard Weiassipu's summit.

Progress was painstakingly slow, and by late afternoon, Fuco and I found ourselves huddling on a small ledge about 150 feet up the wall. Above us, a mud-stained rope snaked up and across a 25-foot horizontal section of rock—known in climber parlance as a roof—to where it was tied to Alex, who hung like a bat with his left leg hooked over a spike of rock.

"What do you think?" he called down. "Should I go for it?" The last section of the roof followed a flake of rock that stuck out from the wall like a diving board. There was no way to say for sure how solid it was. Earlier that day I had taken the first whack at this pitch, getting to where Alex was now, before chickening out and handing over the lead to Mr. Free Solo.

"Better to leave it for tomorrow," yelled Fuco. "It will be dark in a few minutes."

Without saying anything else, Alex reached out to the edge of the flake with his right hand, cut his feet loose, and swung out over the void. Then he proceeded to go hand over hand across the flake, completely trusting that it would stay attached to the mountain. After 15 feet or so, he let go with one hand to chalk up his fingers.

Watching him dangle casually by one arm, 200 feet above the jungle, I was struck by the uncanny resemblance he bore to a pebble toad I'd seen clinging to Bruce's finger a few days prior. Seconds later, Alex reached for another crack above his head, and the last thing I saw as darkness enveloped the mountain was his legs slithering over the lip.

That night, back down in our makeshift hammock camp at the base of the wall, Alex, Fuco, and I were arguing about the feasibility of our plan. In setting the route, it had become clear to me that hauling Bruce up the cliff like a piece of baggage was going to be a lot more dangerous than any of us had expected. My biggest concern was that Bruce was on blood thinners for a heart condition—something he had failed to disclose until we were well into the trek. What if he got hurt somehow and we couldn't stop the bleeding?

Right then, a light flashed in an opening in

the sun pulsed in a deep blue sky. Below, an ocean of clouds blanketed the valley. To the west, I could see dozens of waterfalls pouring from Roraima's 1,500-foot-tall east face, forming halos of rainbows around the plunge pools at the base.

After downing a cup of coffee and some energy bars, we set off across the ledge, hoping it might lead to the summit. After half a mile of tunneling upward through thick bushes covered in spiderwebs, we turned a corner and found ourselves at

## AT ITS BASE SPARKLES WITH DIAMONDS THE SIZE OF ONE'S FIST.

the jungle far below, a signal from base camp. I turned on our radio and heard Bruce's voice. With a heaviness in his speech, he told us that Brian Irwin, our expedition doctor, had just persuaded him to pull the plug on our harebrained plan.

"I can't tell you how much this grieves me," Bruce said. "Fuco, especially, knows the herpetofauna well. I'll send up the picture that I've drawn of the *Stefania* that I'm pretty sure is new to science up there."

"OK, Bruce," Fuco said. "I'm going to do my best to find the lucky *Stefania*."

The next morning, the entire valley below Weiassipu was enveloped in the same gray mist that we had been living in for days. I now understood why Bruce called this zone a cloud forest. This basin seemed to create its own weather, and it was a rare moment when we could see more than a hundred feet in any direction. It rained for hours, but luckily the wall was overhung just enough that we usually avoided getting wet.

While Alex led the way, Fuco and I followed, looking for frogs inside cracks and digging into any patches of soil we found. At the end of each pitch, we used pulleys to haul up heavy bags that held everything we needed to survive on the wall for a few days. It was an exhausting day, during which the only creatures we found were a centipede with an orange stripe on its back and a big, possibly carnivorous, cricket. It wasn't until well after sunset that we crawled into our portaledges, anchored to the wall next to a narrow ledge 700 feet above the jungle. We fell asleep to the sound of rain pattering against our nylon rainflies.

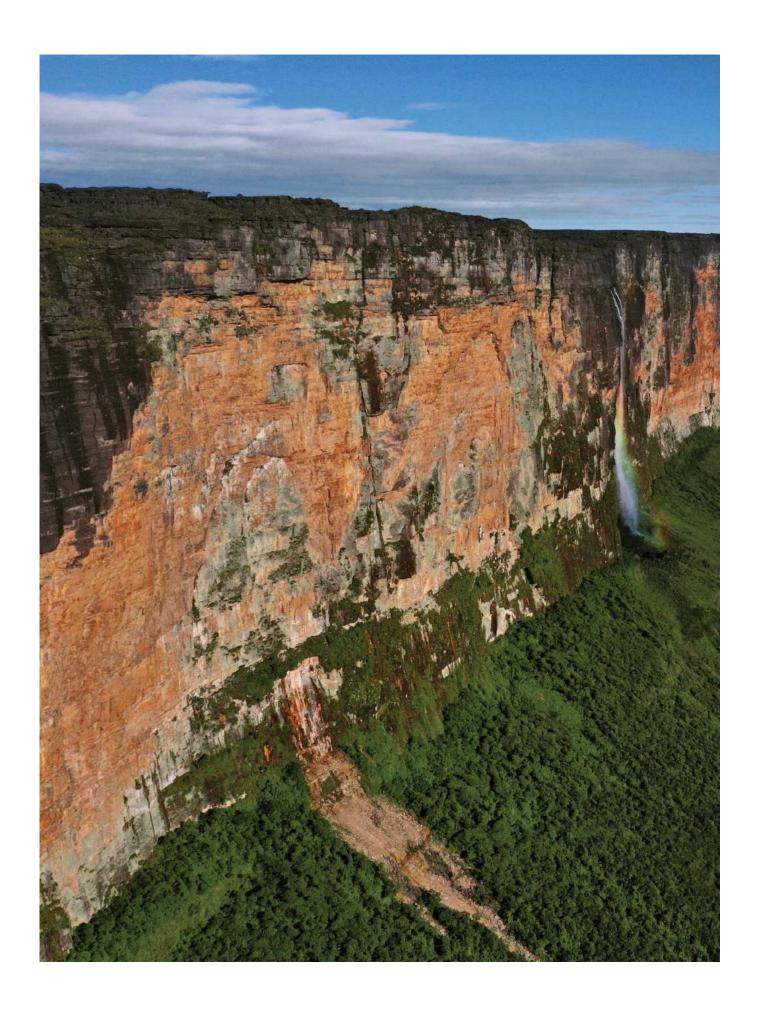
When the sun rose the next morning, I unzipped the door. The clouds were gone, and

the top of the tepui, staring across the plateau. In the span of a few feet, we stepped from a hanging cloud forest onto a bog covered in pitcher plants, yucca, and sundews, glistening carnivorous flora that resembled Venus flytraps. Off in the distance, twin rock pinnacles rose above the sinkhole that Bruce and I had explored in 2012.

It started to rain, and the clouds that had blanketed the valley began curling over the summit rim and enveloping us. Fuco and I found shelter under a mushroom-shaped rock, where we huddled, soaked and shivering, with my poncho draped over us like a tarp. Alex, meanwhile, had disappeared, presumably to go climb something.

Fuco called Bruce on the radio. "Where is the best place to find that lucky *Stefania*?" he asked. I felt bad for Fuco because I knew that he carried the weight of everyone's expectations. Bruce told him to look on the branches of small trees and shrubbery. But he also mentioned that *Stefania* like to hide inside clumps of moss during the day and that he usually finds them at night when their eyes catch the beam of his headlamp.

Fuco and I spent the afternoon wandering in the fog and rain, poking through thick moss and combing branches and leaves, hoping to spot one of the minute frogs, or any kind of vertebrate, but all we found were some tadpoles from a known species of frog. Fuco went out again that night in yet another rainstorm but found nothing. It felt like a major defeat. Although the expedition had been designed to sample a broad range of fauna, the focus had been to find frogs on this tepui, especially the new species of *Stefania*. That this was probably Bruce's last expedition made our failure especially crushing.





of supplies and were forced to head down the mountain. Bruce had relocated to a new spot, "Sloth Camp," a day's hike above Double Drop Falls. We found him sitting at a workbench sketching a rubbery brown frog, its body laid out on a metal tray next to his notebook. His field lab was covered with several glass jars of formaldehyde, filled with frogs, lizards, and snakes. He lit up when he saw us, but his eyes were puffy and red rimmed. His safari shirt was ripped and splotched with mud. As he gripped the edge of the table and tried to stand, he grimaced, and I realized that he was in a great deal of pain.

"I'm so sorry we didn't find the *Stefania*," Fuco said, handing Bruce a baggie that contained the centipede and cricket.

"It's OK," said Bruce. "The fact that you didn't find any frogs up there is actually a scientific result in its own right." I could see that a devilish grin was spreading across his face. He led us over to the workbench, where he picked up the brown frog and held it up for us to see. A small white tag with some numbers was attached to its foot.

"Is that ...?" I said, recognizing it from the sketch of the *Stefania* that Bruce had sent us.

"I won't know for sure until I've been able to do the DNA analysis," Bruce said, "but I'm about 95 percent sure that this is a new species of *Stefania*." He explained that it was different from the one he'd seen all those years ago on top of Weiassipu—the one Fuco, Alex, and I had just been killing ourselves to find—but it was almost definitely another missing link in the *Stefania* evolutionary tree that he and Philippe Kok had been working on for years.

Bruce put the frog back down and started pulling out other specimens to show us. "It's funny how it worked out," he said. "Me not going up the wall turned out to be a blessing in disguise, because it gave me time to thoroughly explore this cloud forest, which no scientists have ever investigated before."

In all, Bruce was confident he'd found six species new to science, including a nonvenomous colubrid snake and a spectacled lizard, which had a transparent lower eyelid that allowed it to see when its eyes were closed.

That evening, over a dinner of watery noodles, we discussed what had long been the elephant in the room. Bruce's condition had deteriorated to the point that there was simply no way he could

Means pauses for a moment by Double Drop Falls before leaving the rainforest he's studied for 35 years. The 2021 expedition was his 33rd and final scientific mission to the Upper Paikwa, yet much remains to be discovered. Only about half of the region's frog species have been scientifically identified, Means says. "It's up to someone else to pick up where I've left off."



make the trek out. The only option was to call in an emergency helicopter rescue.

The canopy was so thick that our satellite phone didn't work, but after several hours we finally managed to text our coordinates to our outfitter back in Guyana's capital, Georgetown.

The next day a helicopter descended into the small opening at the base of Double Drop Falls. After a round of hugs, Bruce headed for the chopper, only to trip and fall one last time. As the helicopter climbed out over the jungle, I saw Bruce in the passenger seat looking out the window. I knew he could see Weiassipu and Roraima to the south and west, rising from the cloud forest, their waterfalls casting rainbows and diamonds into the rivers far below. Ahead, the veiny path



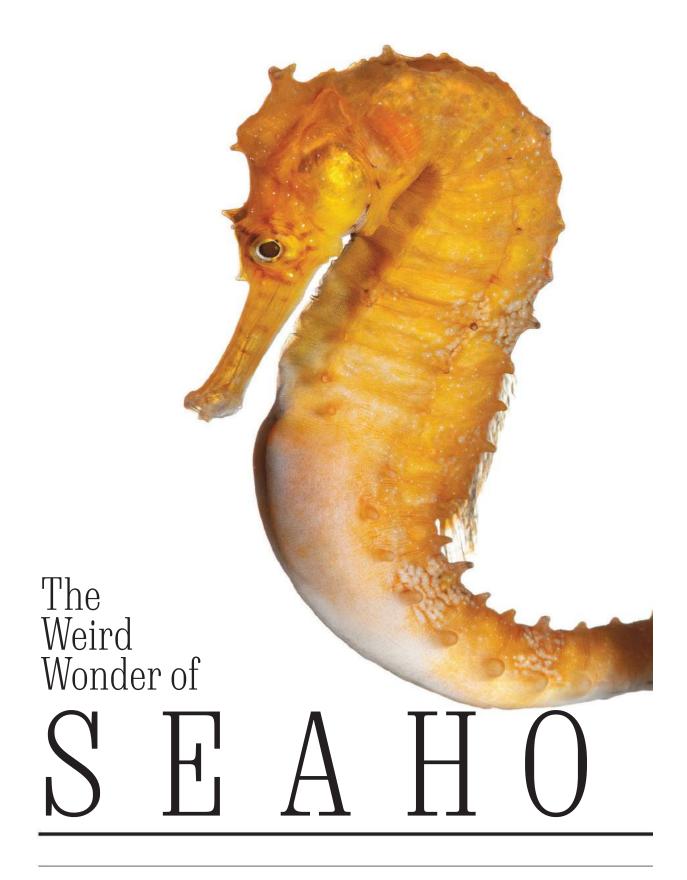
of the sparkling Paikwa River twisted northward, growing turbid as it passed through the scars of the encroaching mines, which every year draw a little bit closer to this Shangri-la of biodiversity.

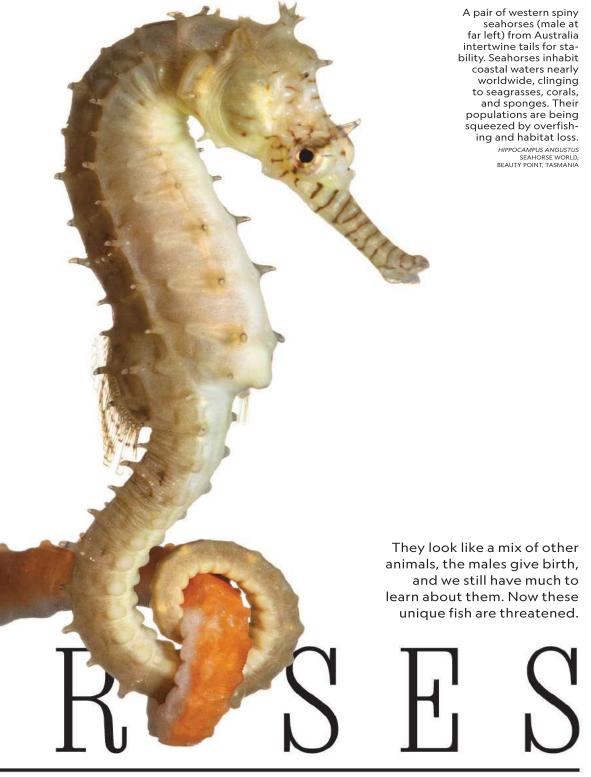
As I turned to begin packing up for the long trek back out of the jungle, Edward pulled me aside. From an inside pocket he produced a small plastic vial holding a pea-size raw diamond. Now that our expedition was over, he was hoping I might buy it from him. Holding that tiny stone between my fingers, I thought about all the pork-knockers who wanted to dig mines to pull these out of the ground and all the money they could provide to their families. I marveled at how such a small rock could threaten something as ancient and primordial as the Paikwa

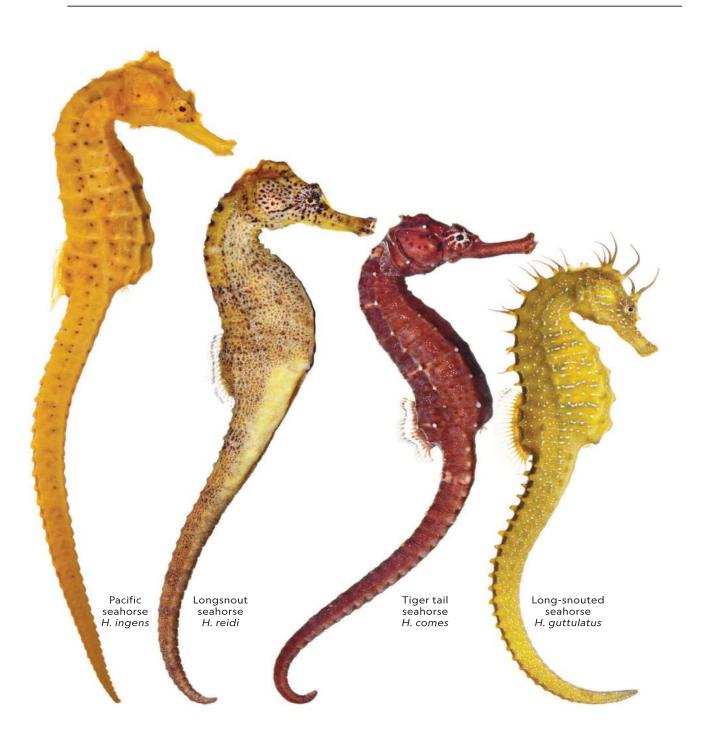
River Basin and the tepuis that surround it. And I thought about how my old friend would probably never see this place again—and about the new species that he now carried in the waterproof bag between his feet.

If the tepui gods were smiling, maybe one of these creatures might prove so rare and singular that the world would finally realize what Bruce Means has known all along: The real treasures of El Dorado aren't gold and diamonds-they're the plants and animals that call this magical place home. □

Writer Mark Synnott and photographer Renan Ozturk last teamed up to search for George Mallory's lost camera on Mount Everest. Their story appeared in the July 2020 issue.







The seahorses in this sample are shown almost life-size. All seahorse species belong to the genus

A sampling of the world's 46 identified seahorse species reveals their array of sizes, colors, crowns, fins, and frills.

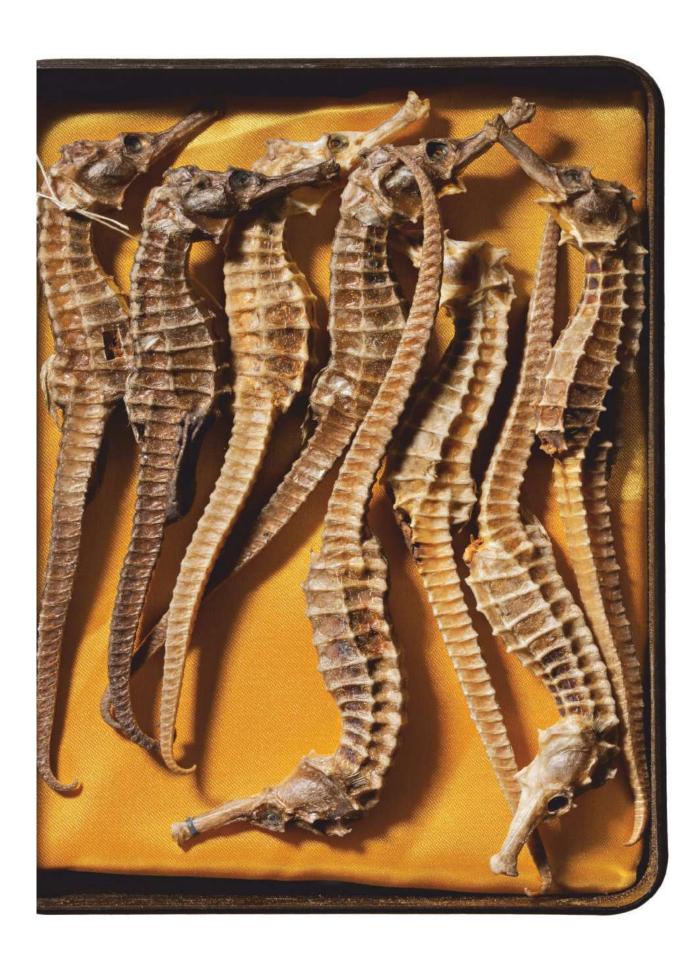


Hippocampus, from the ancient Greek for "horse" and "sea monster."

Miguel Correia pointed at the seafloor. I stared and shook my head. He jabbed a gloved finger at the spot. I swam closer and stared harder. Sand. Algae. Rocks. A spiral of sea cucumber poop. I exhaled a swarm of bubbles in frustration. And then, suddenly, there it was, tucked into the seaweed right where I'd been looking: a three-inch-tall, long-snouted seahorse, Hippocampus guttulatus, muddied yellow with a smattering of dark freckles and a mane of skin filaments. Later that dive I spotted (also with help) its short-snouted cousin, *Hippocampus hippocam*pus, the other seahorse native to this coastal lagoon in Portugal called Ria Formosa. ¶ Every continent but Antarctica has varieties of these fabled fish in its coastal waters. Worldwide, scientists recognize 46 species, the smallest no bigger than a lima bean, the largest the size of a baseball glove. And that number is likely to rise: Four new species were named in just the past decade.

Dried seahorses confiscated at San Francisco International Airport were shipped from Asia, where each year millions are ground up for traditional medicines. Biologists worry about illegal trade and other threats depleting wild populations.

HIPPOCAMPUS KELLOGGI CALIFORNIA ACADEMY OF SCIENCES, SAN FRANCISCO







Stripped from the seabed as bycatch, the fish are sold around the world for traditional Chinese medicine and for trinkets.

A male pot-bellied seahorse displays a crown of skin filaments as individual as a human fingerprint.



It wasn't long ago that Ria Formosa, in the Algarve region of Portugal, was home to as many as two million seahorses, says Correia, a biologist at the University of the Algarve's Center for Marine Sciences. He and colleagues breed and study the animals in a small waterfront facility, and they've seen populations of both species decline dramatically. "We've lost up to 90 percent in less than 20 years," he says.

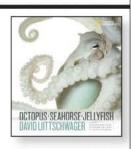
Such falloff appears widespread, in part because seahorses live in the most hammered marine habitats in the world—including estuaries, mangroves, seagrass beds, and coral reefs. In Ria Formosa, for example, human activity from farming of clams to illegal bottom trawling—buries or rips up the seagrass beds that seahorses prefer.

The hardest hitter globally is unregulated fishing, which fuels a wide-reaching trade in dried seahorses. Stripped from the seabed as bycatch—the incidental capture in bottom trawlers and other catchall gear—the fish are sold around the world for traditional Chinese medicine and for trinkets. A much smaller number are sold live for the aquarium trade, mostly to U.S. consumers.

It's easy to see the seahorse's allure, with its fanciful blend of traits that seem borrowed from other animals: a horse's head, a chameleon's independent eyes and camo skills, a kangaroo's pouch, a monkey's prehensile tail. Hippocampus comes in colors rivaling Crayola's Big Box and in a multitude of bumps and blotches, stripes and speckles, spikes and lacy skin extensions. A seahorse has bony plates instead of scales, and, with no stomach to store food, it almost constantly sucks up copepods, shrimp, fish larvae, and other tiny edibles.

These sit-and-wait predators are dancers of a sort. During courtship, a pair rises and falls faceto-face in the water, communicating with color

Photographing his subjects in research labs and public aquariums, David Liittschwager captures the singular beauty of three groups of mysterious sea creatures in a new book, Octopus, Seahorse, Jellyfish, from National Geographic.



The female impregnates the male rather than the reverse. an evolutionary quirk unique to seahorses.

changes and tail embraces. They may tango for days and stay together for an entire season.

And here's the twist: The female impregnates the male rather than the reverse, an evolutionary quirk unique to seahorses and their close relatives. She deposits her yolk-rich eggs into his belly pouch through a port on her trunk called an ovipositor. Several weeks later the distended male goes into body-spasming labor, ejecting dozens to thousands of young-depending on the species' size—into the current. Offspring drift awhile before settling down, and only a scant few avoid being eaten by predators in those early days.

When a seahorse needs to move from here to there, it swims upright with the frantic flutter of its dorsal fin at up to 70 beats per second and steers with its pair of pectoral fins. To stay put, it uses its flexible tail to grab onto seagrass, coral, or other fixed items on the seafloor. The seahorse's excellent camouflage then makes it all but invisible.

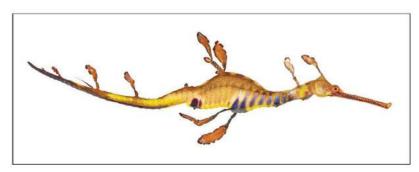
For all their notoriety—who wouldn't recognize a seahorse?—much about the fish remains little known, including where they live and precisely how their populations are faring. The IUCN Red List of Threatened Species includes all *Hippocampus* species, and many are listed as data deficient.

"For the vast majority of species," says marine biologist Amanda Vincent of the University of British Columbia (UBC), "beyond taxonomy and a basic description, we know almost nothing." Vincent is the director of Project Seahorse, a conservation alliance between UBC, where Vincent

# **Meet the Cousins**

Seahorses, pipefish, and sea dragons belong to a family of fish known as Syngnathidae, a taxonomic group that includes 295 species. Among the family traits are long snouts, fused jaws, and bony body armor. After fertilizing the eggs, males carry them during incubation. Many species, such as the weedy sea dragon (inset below) and the ribboned pipefish (right), are masters of disguise.

HALIICHTHYS TAENIOPHORUS (RIGHT) BIRCH AQUARIUM



PHYLLOPTERYX TAENIOLATUS (ABOVE), AQUARIUM OF THE PACIFIC, LONG BEACH, CALIFORNIA





Commercial fishing operations scoop up at least 76 million seahorses a year. Some 80 countries are involved in trading them.

is a professor at its Institute for the Oceans and Fisheries, and the Zoological Society of London.

Such a knowledge gap, blamed in part on the dearth of scientists who study seahorses, is especially problematic for a fish that's so exploited. Project Seahorse estimates that commercial fishing operations scoop up at least 76 million seahorses a year; some 80 countries are involved in trading them. "Fishermen used to throw them back," notes Healy Hamilton, chief scientist of NatureServe, a Virginia-based conservation group, "but now in many places you'll see a [buyer] on the dock just waiting to take them."

While some fishermen target seahorses, it's bycatch that's devastating seahorse populations, says Project Seahorse's program manager, Sarah Foster. Global exports should have edged toward sustainability after 2004, when worries about extensive international trade prompted new regulations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). "Unfortunately, it seems that most trade in dried seahorses has just moved underground," Vincent says. The good news is that the live trade is relying more on captive breeding, reducing pressure on wild populations, she says.

Field surveys and CITES records have exposed Southeast Asia, especially Thailand, as the main supplier of seahorses, and indicate that two West African countries, Guinea and Senegal, have increased their exports. Hong Kong is by far the top importer, with heavy shipments also to Taiwan and mainland China. Most of the demand for seahorses reflects their use in traditional medicines. Vendors promise, for

example, that dried seahorses boost virility, have anti-inflammatory properties, and can treat everything from asthma to incontinence.

TO GET A SENSE of the pressures on seahorses, I visited a warehouse at the California Academy of Sciences, where Hamilton rummaged through one of many boxes of plastic bags bulging with brittle skeletons that had been confiscated at San Francisco International Airport. There were hundreds, maybe thousands, of fish, "representing just a year's worth of what was stopped at a single port," she told me.

Occasionally officials seize a supersize haul: In 2019 in Lima, Peru, more than 12 million dried seahorses were confiscated from a single Asia-bound ship—a load worth some six million dollars on the black market. But more often, seahorse shipments escape detection, Hamilton said, with incalculable losses to each exploited species.

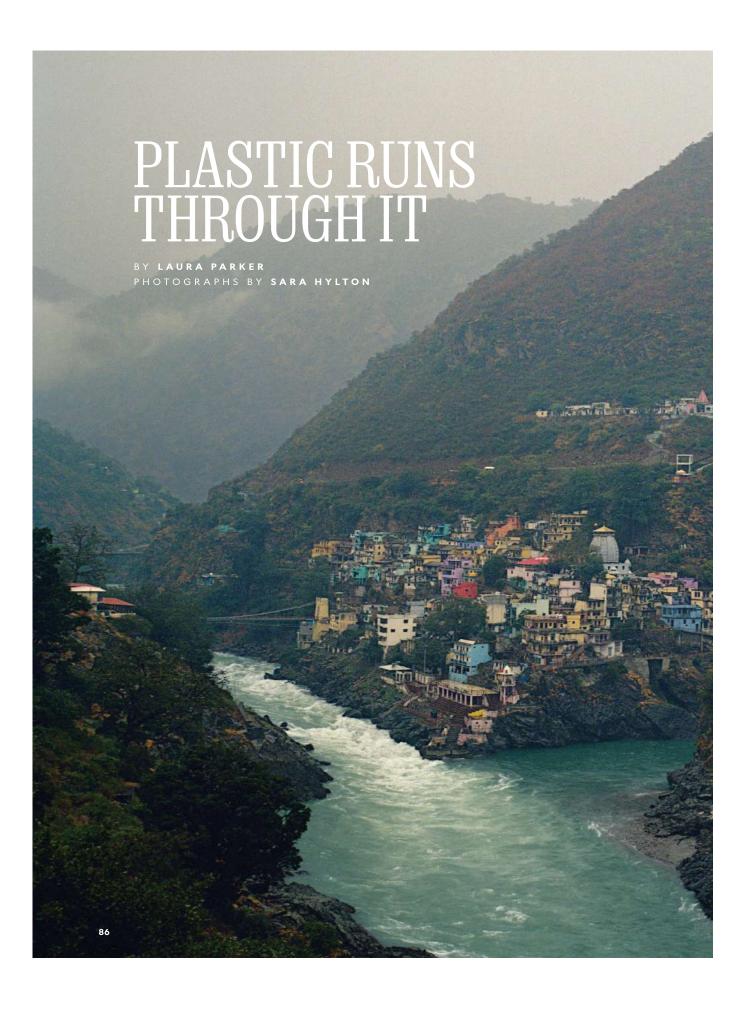
On a positive note, in 2020 the Portuguese government created two small marine protected areas within Ria Formosa to act as seahorse sanctuaries. It's good news, but experts say the key to maintaining seahorse numbers is better fisheries management, with severe limits and even bans on trawling. Market demand doesn't have to be a death sentence for *Hippocampus*, Foster says—"if we can get CITES rules to work as intended to support sustainable legal trade."

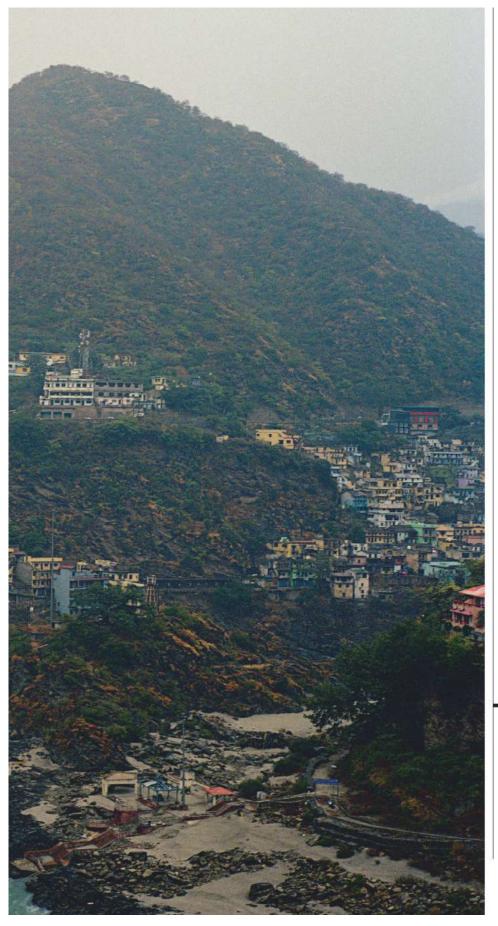
Meanwhile, Asia's consumption of seahorse products could shrink on its own "as younger, more progressive-minded people move away from using wildlife in traditional ways," Foster says. The traditional-medicine community ultimately shares a goal with conservationists, she says. Traders and users often are vilified, "but in the end we all have incentives to keep seahorses from disappearing."

Acting on those incentives matters because "there is absolutely no way seahorses can sustain today's level of exploitation," Hamilton said from her perch overlooking the warehouse shelves. "And people need to know: We are headed towards a world bereft of too many of these extraordinary fishes."

Longtime contributor **Jennifer S. Holland** is writing a book about dog intelligence, due out in 2023. **David Liittschwager** has published seven books, including *A World in One Cubic Foot*.

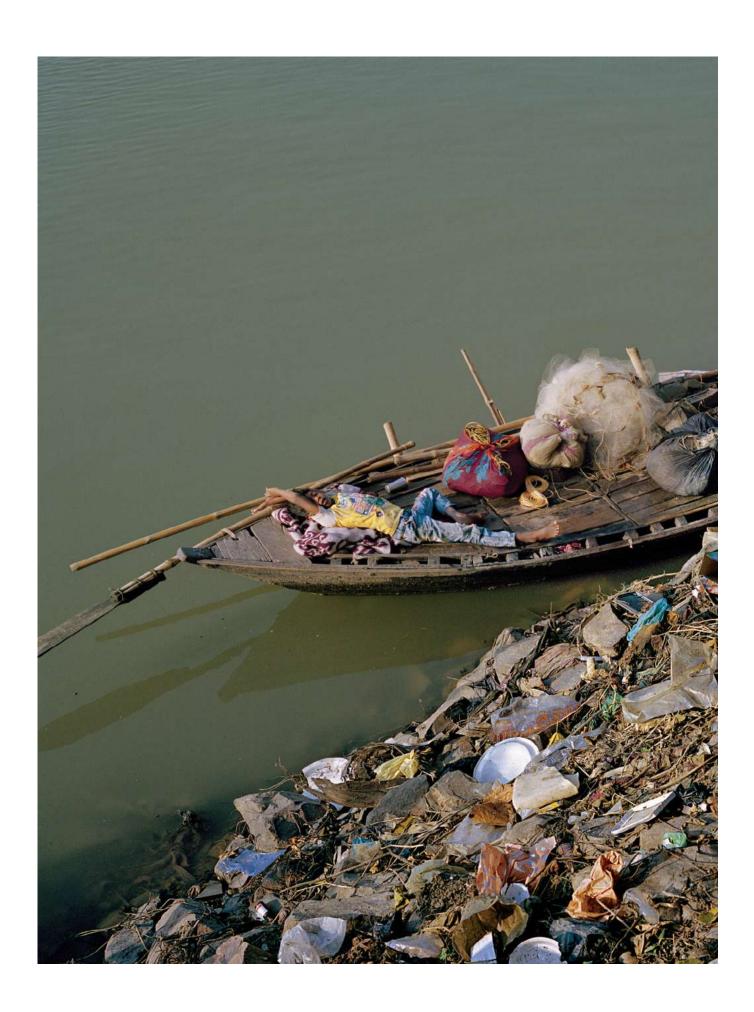






The Ganges River is a sacred waterway in India. It's also a major source of the manufactured waste that fouls the ocean.

Two rivers, the Bhagirathi and the Alaknanda, converge in the western Himalaya to form the Ganges, at the Indian town of Devaprayag—Sanskrit for "holy confluence." The amount of plastic waste flowing out of the Ganges is estimated at more than 6,000 tons a year.





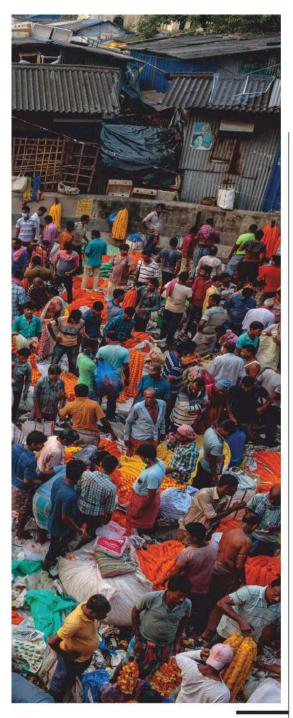
A National Geographic expedition set out to document the extent of plastic pollution in the river—and its sources on land.

Fisherman Babu
Sahni, 30, and his son
Himanshu Kumar
Sahni, eight, approach
a bank on the Punpun
River, a Ganges tributary. Throughout rural
India, trash collection is
rare, and ad hoc dump
sites like this one are
common. Most plastic
waste in the ocean
gets there by washing
off the land.





The National Geographic Society, committed to illuminating and protecting the wonder of our world, funded Explorer Sara Hylton's reporting along the Ganges River.



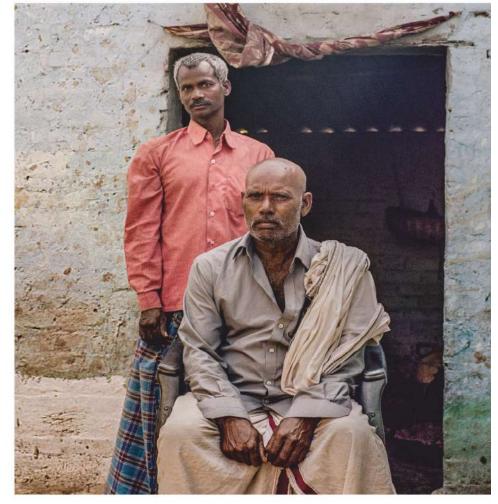
Kolkata's Mullick Ghat flower market is jammed before the Durga Puja festival. In operation since the 1850s near the Hooghly River, a branch of the Ganges, the market now features plastic flowers as well as real ones. Both are sometimes scattered on the river as offerings.



IN THE PAST DECADE, as the world has awakened to the growing accumulation of plastic debris in our oceans, the efforts to solve the mounting crisis have been numerous, imaginative—and insufficient. By 2040, the amount of plastic flowing annually into the sea is forecast nearly to triple, to 32 million tons a year. That means by the time a baby born this year graduates from high school, there will be, on average, a hundred pounds of plastic trash for every yard of coast-line around the globe.

The message from scientists is, it's not too late to fix it. But it's past time for small steps.

Most of the research about plastic waste has focused on plastic already in the oceans and its potential for harm—it poses a lethal threat to a wide range of wildlife, from plankton on up to fish, turtles, and whales. Less is known about how the waste gets to the ocean. But it's clear that rivers,



Sita Ram Sahni (seated), 70, and his nephew Vinod Sahni. 50, pose in front of their home on the Ganges's north bank in Bihar. The Sahni family has fished the river for more than 50 years. Their nets, once made of cotton, are now made of blue nylon, a kind of plastic.

## OPPOSITE

Nylon nets are commonly used-and frequently replacedon the Ganges, one of the world's largest inland fisheries. When lost or discarded in the river, the nets can entangle turtles, otters, and endangered river dolphins. Over time, they break down into microplastics.

especially rivers in Asia, are major arteries.

In 2019 the National Geographic Society sponsored a research expedition to one of those rivers: the Ganges, which flows across northern India and Bangladesh, through one of the largest and most heavily populated river basins in the world. A team of 40 scientists, engineers, and support staff from India, Bangladesh, the United States, and the United Kingdom traveled the full length of the river twice, before and after the monsoon rains that dramatically swell it. Sampling the river and the land and air around it, and interviewing more than 1,400 residents, the team sought to find out where, why, and what kind of plastic was getting into the Ganges-and from there into the Indian Ocean.

"The problem can't be solved if you don't

know what it is," said Jenna Jambeck, a University of Georgia environmental engineering professor who was one of the leaders of the expedition. It was her groundbreaking research in 2015, including her calculation that an average of 8.8 million tons of plastic end up in the oceans every year, that captured the world's attention and helped transform marine plastics into a top environmental concern. Like most experts, Jambeck believes the solution lies not in cleaning up the oceans but in reducing and containing plastic waste on land, where most of it originates.

On a balmy November afternoon, I met Jambeck in the ancient Indian city of Patna, which sprawls along the south bank of the Ganges, some 500 miles inland from the mouth of the



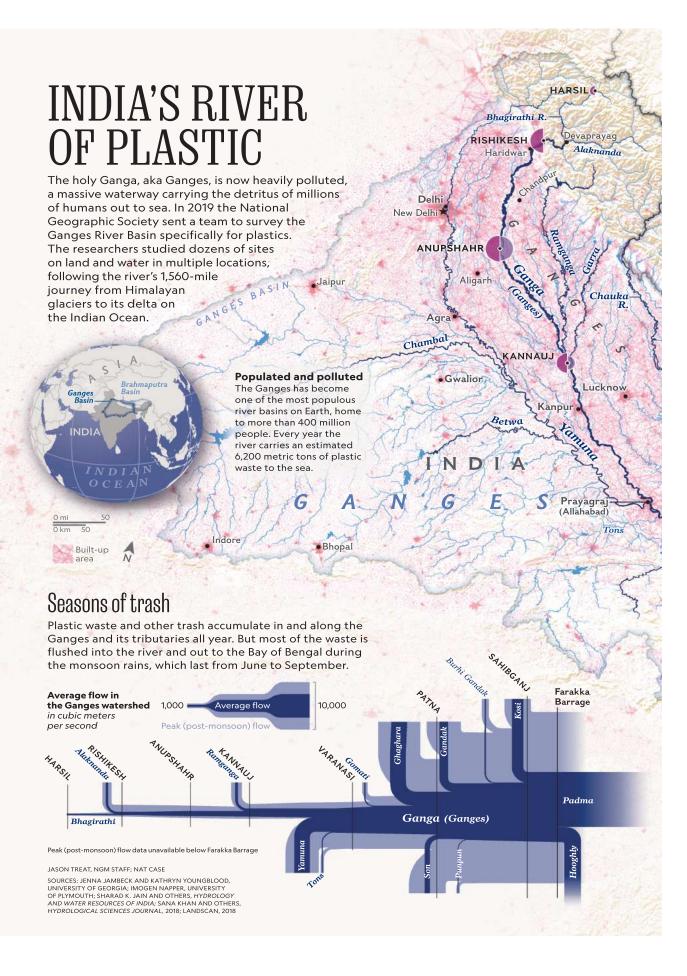


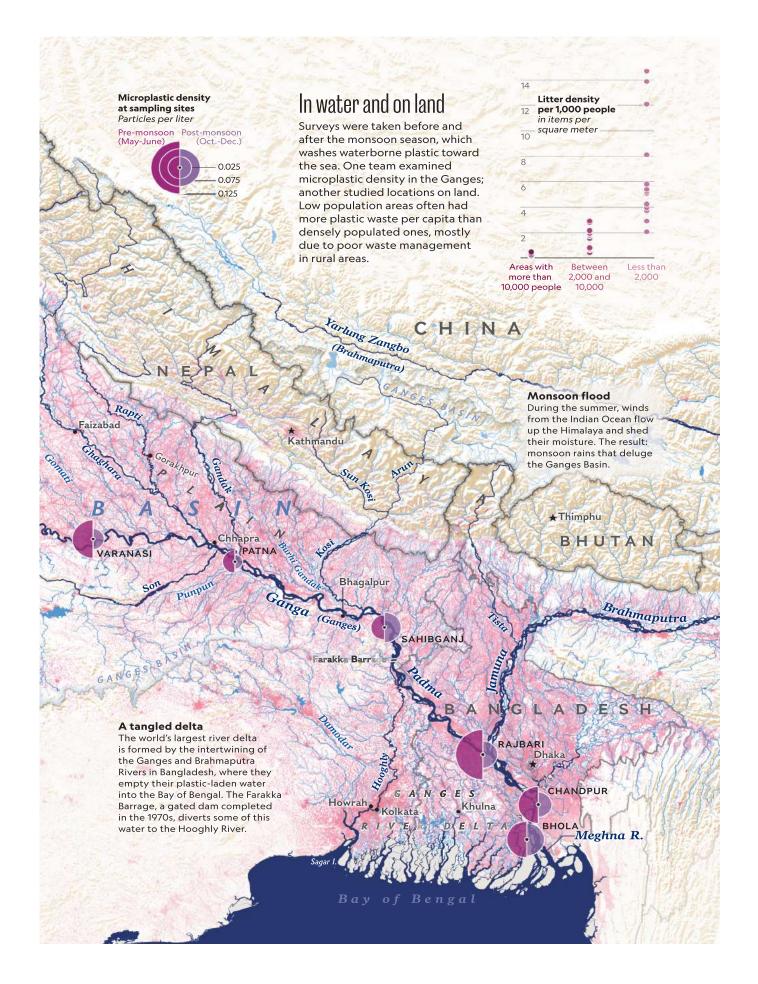
river in the Bay of Bengal. In a busy commercial district, Jambeck walked slowly along a row of shops and cafés, her eyes on the ground. She counted litter piece by piece, logging each one into a phone app that recorded its location. There were a lot of pieces to log: Patna, a rapidly growing city of more than two million, has had municipal house-to-house trash pickup only since 2018, and the practice of dumping trash in the streets has long been a problem.

During the 98-day expedition, Jambeck and her team conducted 146 such litter transects, each about the length of a city block, in 18 cities and villages along the river. They recorded 89,691 individual littered pieces. They also cataloged the products sold in nearby shops—because to design solutions to the waste problem, Jambeck said, you need to know what's "leaking out of the system" and what's not.

"Do you want to ban what ends up on the ground? Do you want a tax? Something else?" she asked. "Or, if you've banned plastic bags, for example, is your ban working?"

The top three plastic items Jambeck documented on Indian streets were filmy food wrappers, cigarette butts, and tobacco "sachets"—single-serving packets that are sold by the billions in Africa and Asia to deliver a wide range of products. About 40 percent of the littered items carried international brand names, including brands from companies headquartered in the U.S. or the U.K. Getting the attention of such companies was one of Jambeck's purposes in doing this research.





"We need those people who are 6,000 miles away to come to the table and be open to change," she told me.

Like climate change, plastic waste is a side effect of our hydrocarbon habit—most plastics are made from oil and gas—and its impacts, as well as the solutions to the problem, are both local and global. At least some of the litter I watched Jambeck record in Patna eventually would make its way into an open curb drain. From there a large pipe emptied it directly into the river, setting it on a course for the Bay of Bengal.

HE GANGES RIVER IS one of the world's largest, worshipped by a billion Hindus as Mother Ganga, a living goddess with power to cleanse the soul. The

headwaters emerge from the Gangotri Glacier high in the western Himalaya, just a few miles from Tibet, and then drop down steep mountain canyons to India's fertile northern plain. There the river meanders east across the subcontinent into Bangladesh, broadening as it absorbs 10 large tributaries. Just after it merges with the Brahmaputra, the Ganges empties into the Bay of Bengal. It's the world's third largest freshwater outlet to the ocean, after the Amazon and the Congo. It supports more than a quarter of India's 1.4 billion people, all of Nepal, and part of Bangladesh.

So sacred is the river that its water, Ganga jal, has been hauled home in jugs by conquering armies and guidebook-toting tourists. Seventeenth-century traders believed it stayed "fresher" on long sailing voyages than water drawn elsewhere. Sir Edmund Hillary, who conquered Everest, was a fan. You can buy it today in blue bottles from Walmart.

Sadly, the Ganges also has long been one of the world's most polluted rivers, befouled by poisonous effluents from hundreds of factories, some dating to the British colonial period. The factories add arsenic, chromium, mercury, and other metals to the hundreds of millions of gallons of raw sewage that still flow in daily. Plastic waste is only the most recent insult.

Yet even in the face of it, and of sometimes

lethal counts of fecal bacteria, belief in the mythic purity of the Ganges endures-and it complicates long-running efforts to clean up the river. Sudipta Sen, who grew up in Kolkata and teaches South Asian history at the University of California, Davis, spent 14 years writing his book Ganges: The Many Pasts of an Indian River. He found the paradox of the modern river, so worshipped and yet so neglected, frustrating to write about.

"The river is really two rivers," Sen said. "There is this belief that the river can clean itself and has magical properties. If the river can clean itself, then why should we have to worry about it? I have seen this. I have heard many people say the river cannot be polluted; it can go on forever."

The Ganges reinforces that story line during the summer monsoon, when it is said to be "in swell." At Patna, where the river is joined by several large tributaries, widening considerably, the monsoon converts it into a raging torrent that regularly floods Bihar, the mostly rural state of which Patna is the capital.

Early one morning, with members of the National Geographic expedition, I crossed from Patna to the Ganges's north side and drove to a small village fringed with banana palms and populated by farmers and fishermen, who eke out a living catching carp. Frayed blue-nylon fishing nets lay in piles near a group of brick houses and thatched-roof shanties. Abandoned fishing nets are a significant source of plastic pollution in the Ganges, one that endangers river dolphins, turtles, and otters.

A large earthen berm stood between the river and the homes, but during the recent monsoon season, it hadn't been enough to protect them. Some of the locals had only recently returned after evacuating during the flood. Chip bags and other litter were scattered about. Not a trash bin was in sight.

The fisherman I had come to see was asleep, so I climbed over the berm, still covered with sandbags, and sat on the ghat—the steps down to the river—watching people go about their morning chores. Five women crouched on the bottom step and washed clothes in the murky water. Several men arrived to bathe. Each emptied shampoo from a plastic sachet before discarding it in the river. When the men had finished, they offered water back to Ganga in cupped, uplifted hands.

N KOLKATA, I MET A FLOWER VENDOR

named Goutam Mukherjee who told me he gave up selling fresh flowers years ago. We were standing in the center of one of Asia's largest and most famous wholesale flower markets, where his booth was sur-

rounded by stalls hawking garlands of fresh marigolds and other fragrant blossoms. Mukherjee ticked off the reasons why his plastic flowers, which were imported from China, were better than the real thing: They cost less, look real, and don't wilt.

The miracle of plastics arrived in India recently enough that there is no Hindi word for the stuff, and in some places take-out food still comes wrapped in banana leaves. The love affair really took off in the 1990s, as the rapid growth of the global plastics industry coincided with the liberalizing of India's economy. If in the U.S. the golden age of plastics ushered in the throwaway culture of convenience, in India, affordable plastic consumer goods simply made life better—not only for the expanding middle class but also for those who live near the bottom rung. Plastic storage containers, bags, and food wrap helped keep food fresh longer. Barefoot children could get cheap shoes, and inexpensive synthetic fabrics allowed them more clothes. Tiny sachets provided people with access to products they couldn't afford to buy in larger volumes.

Yet even with the improving quality of life, the romance faded fast. Before the decade ended, India found itself swimming in plastic packaging waste that outpaced any ability to contain it. By the mid-1990s, newspaper accounts sounded the alarm. Plastic bags, handed out by the thousands in department stores in Mumbai, were "suffocating the city." Delhi landfills were an impending "eco disaster."

The problem has since spread beyond cities to rural areas and even nature reserves, where numerous species, from leopards to foxes to birds, have been seen eating plastic. At the Rajaji National Park outside Rishikesh, a pilgrimage city in the Himalayan foothills made famous in the West by the Beatles, who spent several weeks there in 1968, elephants are eating plastics in dump sites around the edges of the park.

"There are many places just outside the forest where villagers throw trash out, and the wild animals go there to eat," ranger Mohammad Yusuf told me, as we toured the park's grassy meadows and stands of tall pines. "I have seen plastic in elephant poop many times in the last five years."

In nearly every nation struggling to contain plastic waste, the problem is primarily packaging, most of which is discarded immediately after use. Globally, it accounts for 36 percent of the nearly 500 million tons of plastic manufactured annually. India's problem has less to do with per capita consumption than lack of adequate waste collection. In the United States, a person creates an average of 286 pounds of plastic waste a year—the highest rate in the world and more than six times India's rate of 44 pounds per person. But the U.S. **Affordable** plastic goods made life better in India, but the pileup of plastic waste outpaced the nation's ability to contain it.

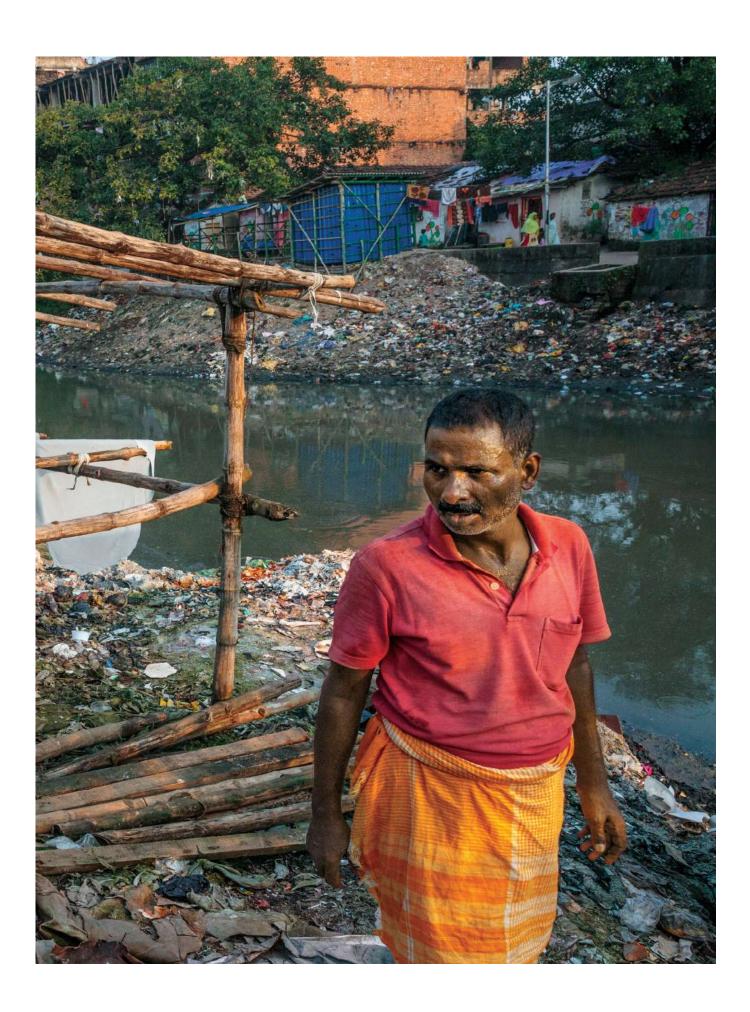
'The biggest
waste
management
infrastructure
is the river
itself ... That's
not an easy
thing to fix.'

Heather Koldewey, National Geographic expedition co-leader



Tannery workers hang hides to dry on wooden poles on the banks of a canal in Kolkata.

The canal carries factory waste, plastic trash, and other pollutants toward the Ganges Delta and the Bay of Bengal.





People in the Ganges
Basin use stairways
such as the Chandi
Ghat in Haridwar to
reach the river for a
dip in what they see as
purifying waters.
Hindu belief in the
river's cleansing
powers draws millions
of pilgrims to the
river every year,
including during the
COVID-19 pandemic.

### OPPOSITE

Swami Shivanand Saraswati, 75, bathes in the Ganges at his Matri Sadan ashram in Haridwar. He leads a long-running and ambitious campaign to protect the river from mining, new dams, and pollution. Plastic waste is just one of many pollutants to befoul it.

has a more or less functioning system of trash collection and disposal.

Trash collection in India's cities is often inefficient, and collection rates are low. The situation is more disheartening in rural areas, where about two-thirds of Indians live. In the state of Bihar, which has a population of 129 million, roughly the size of Japan's, plastic waste gets burned or dumped in ad hoc sites, where foraging cows and other animals inadvertently consume it. Or it's deposited on a sandbar for Ganga to carry away.

Heather Koldewey, a marine and freshwater scientist at the Zoological Society of London and co-leader of the expedition, says she came to understand the river's flushing power in a new light as she traveled the length of the river.

One large municipal dump the team visited—unofficial, but used by city trucks—was so close to the riverbank that the Ganges devoured a portion of it during each monsoon.

"As soon as you'd get to a town or anything smaller, there was no waste management at all... It was like they fell off a cliff," Koldewey told me on the river one morning, as she collected water samples from an inflatable boat. "The fact is, the biggest waste management infrastructure is the river itself. People would put their waste along dry river channels in recognition that it would all be taken away.

"That's not an easy thing to fix. If you are replacing the river with a waste management system that is equivalent, that becomes quite significant in terms of cost."



C

just collect waste from the river itself? In 2017, as global concern about ocean plastics was cresting, two studies were pub-

lished that came to a surprising conclusion: A small number of rivers—one study identified 10, the other 20—were responsible for the overwhelming bulk of what rivers put into the ocean. Most of the rivers on the two lists were in Asia. The Ganges figured prominently on both.

The image of waste-choked rivers was shocking, but the studies' conclusions suggested a silver lining: By cleaning up just a few rivers, one might stanch the flow of plastic into the

ocean—or at least make a big dent in the problem. That hope turns out to have been naive. A more recent and comprehensive survey by some of the same scientists found that you'd actually have to clean more than a thousand rivers to cut the amount flowing from rivers to the sea by 80 percent.

Nevertheless, in Asia, Africa, and both Americas, river-cleansing operations are under way, and they're doing some good. The grandfather of the effort is Mr. Trash Wheel, a googly-eyed trash-eating barge that has been collecting rubbish in Baltimore's Inner Harbor since 2014. But the most ambitious river cleaner is Boyan Slat, the 27-year-old founder of the Ocean Cleanup, a nonprofit in the Netherlands.

Slat came to fame as a teenager, when he





The Ganges is worshipped by Hindus as a goddess with the power to cleanse souls—and itself. That complicates efforts to clean up the river.

Celebrants transport a likeness of the goddess Durga through the streets of Howrah, near Kolkata, during the Durga Puja festival. It ends with the immersion of the idols in the local river—the Hooghly in this case. Hindu rituals often involve offerings to the Ganges or its branches. Plastic is banned now in many temples.



A dump in Patna illustrates a pervasive problem in the Ganges Basin: Lack of adequate trash collection has resulted in plastic being strewn in areas where the monsoon rains wash it and other waste into the river.

### OPPOSITE

A woman in Rishikesh sorts plastic waste by hand, paying particular attention to the most valuable kind: bottles made of polyethylene terephthalate, or PET, which can readily be recycled to make clothing, for example. Thanks to waste pickers. India has a far higher plastic recycling rate than the United States. But much plastic trash has no value.

announced a grand plan to sweep up the Great Pacific Garbage Patch, a collection of loose marine debris, much of it plastic, that swirls around the North Pacific. He raised \$30 million and launched his contraption: a floating, 2,000-foot-long, U-shaped boom that skims waste from surface waters. Several marine scientists told him it was a terrible idea—that he would have to operate his device indefinitely, at unsustainable costs, as long as plastic flows into the Pacific, and that it would be virtually impossible to remove microplastics because they are so tiny and spread throughout the water column. But Slat persisted, and his device is still out there, mostly gathering abandoned fishing nets. Even critics praise it for that.

Meanwhile, Slat has turned his attention to

rivers. It was his organization that funded the new study showing how many rivers were significant sources of plastic pollution. In 2019, he unveiled a solar-powered barge similar in design to Mr. Trash Wheel and announced plans to clean the thousand worst rivers within five years. The pandemic delayed work; so far, Slat's "Interceptors" are operating in Indonesia, Malaysia, Vietnam, and the Dominican Republic. Together with the Pacific device, they have collected more than 2.4 million pounds of trash.

Though Slat has taken on the Pacific, even he thinks trying to skim plastic from large continental rivers, including the Ganges, would be the wrong approach.

"It's too wide, and the trash is diffuse," he said. The better strategy would be to attack smaller





tributaries, to "go to the cities in the delta (Dhaka and Kolkata) and deploy in the small streams of these cities."

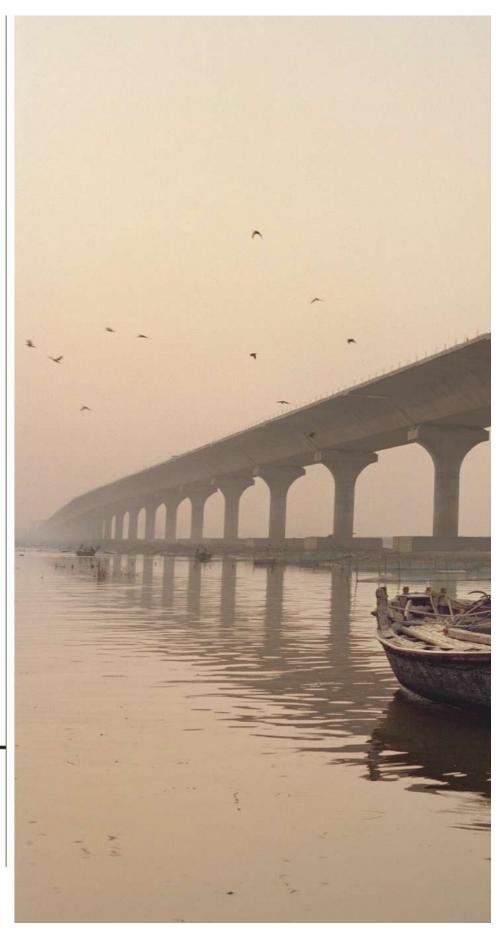
After I returned from India, I visited John Kellett, the inventor of Mr. Trash Wheel, at his marina in an inlet south of Baltimore. He was finishing work on his fourth trash wheel, which later was deployed on a stream near the downtown football stadium of the Baltimore Ravens. The four have collected 3.5 million pounds of trash and dramatically transformed the harbor's appearance. But Kellett was skeptical of a global effort.

"It's good that the interest in it is strong, but it's just one piece of the puzzle," he said. "I don't think we're ever going to clean up the oceans by tackling one river at a time. It needs to go hand in hand with policy changes and behavior changes as well."

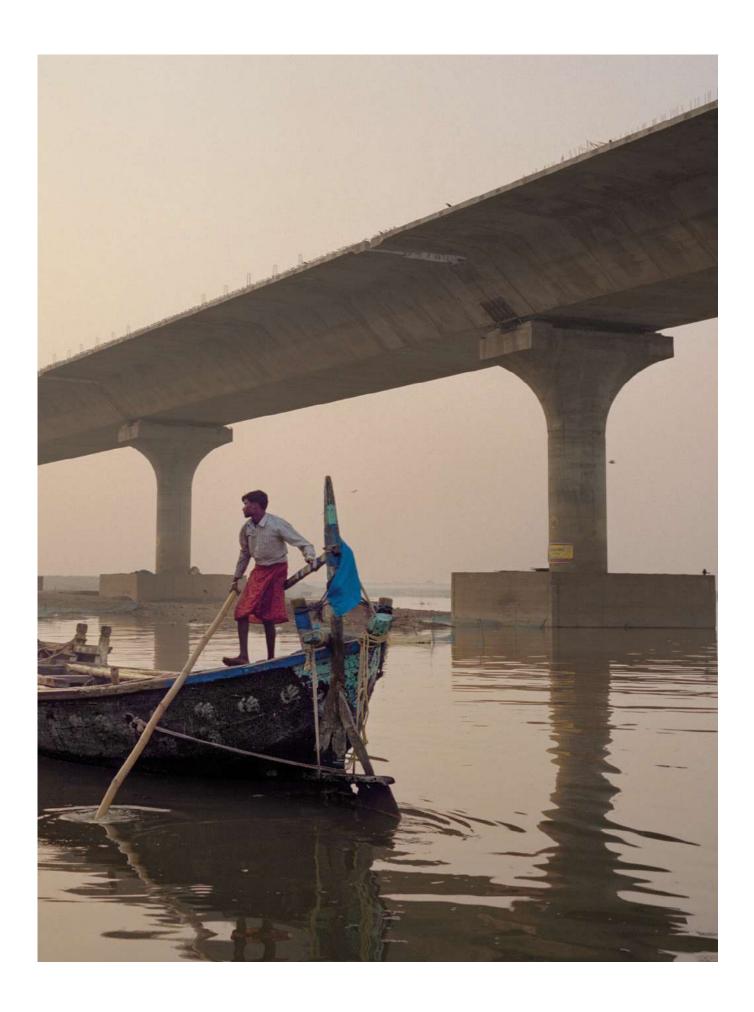
ASTE COLLECTION IN India would be even more dysfunctional if it weren't for the "informal sector": the army of independent operators who collect

plastic waste from households to sell for recycling, and the waste pickers, who scavenge at dumps or on the streets.

These workers, estimated at nearly 1.5 million, are one reason you don't see many plastic bottles In Asia,
Africa, and
both Americas,
river-cleansing
operations are
under way. But
the Ganges is
too wide, and
the trash in it
too diffuse.



In Patna, a boatman surveys the Ganges near a recently constructed expressway. The country's rapid development has fueled demand for plastics, and its plastics industry is now one of the world's largest.



on Indian streets—bottles are the highest value recyclables. Plastic waste makes up roughly half of waste pickers' earnings, and bottles made of polyethylene terephthalate (PET) account for about half of the plastics collected, Bharati Chaturvedi, director of Chintan, a nonprofit that supports waste pickers, told me.

The informal sector is largely responsible for India's high recycling rate, estimated at 60 percent. (In contrast, the U.S. recycles less than 30 percent of its trash overall and just 9 percent of plastic.) But there's no money in nonrecyclables, and so bags, food wrappers, sachets, and so on don't get picked up. Instead they litter Indian streets and wash into the Ganges.

Last October, Prime Minister Narendra Modi launched phase two of his "Clean India" campaign. In the first phase, the country had installed nearly 90 million toilets in a bid to end open defecation, which remains common in India. One goal of the second phase is to make cities garbage free. Modi's government is building waste-to-energy plants—that is, incinerators that generate electricity. It also has announced a wide-ranging national ban on the manufacture and use of single-use plastics. Scheduled to take effect in July, the ban will cover thin shopping bags, foam containers, cutlery, cups, plates, straws, candy and ice-cream sticks, certain films, and other disposable plastics.

In India, however, the gap between ambitious national legislation and its enforcement at the local and state levels is sometimes large. Existing federal waste regulations are "absolutely marvelous, everything you could ever want," said Robin Jeffrey, co-author with Assa Doron of *Waste of a Nation*, a study of India's garbage. "Except nobody in the country could come within a bull's roar of achieving them." India has been trying for more than 35 years to limit discharges of sewage and factory waste into the Ganges—so far with little success.

The pandemic slowed government action on projects to clean India. It also led to a surge in plastic waste here, as it did globally, as people in lockdown ordered more take-out food and home deliveries.

"Post-pandemic, civil society has a better appreciation for plastic and its role in saving humankind," said Deepak Ballani, director general of the All India Plastics Manufacturers' Association. "At the same time, the awareness about environmental impact resulting from littering has increased severalfold." Like the plastics industry

elsewhere, Ballani's group favors recycling and opposes bans, arguing that they cost jobs and that the problem is not single-use plastics themselves but the way people dispose of them.

Since 2016 the Indian government has been working on new regulations that would require producers of plastic packaging to take responsibility for the cost of collecting and recycling their disposable products. Similar regulations, known as extended producer responsibility, or EPR, have helped curb plastic waste in the European Union since the mid-1990s. In the U.S., the plastics industry has opposed national legislation. Only Maine and Oregon have passed laws requiring EPR for plastic packaging.

Meanwhile, the amount of plastic waste flowing into the ocean keeps increasing. The forecast that it will almost triple by 2040 under a business-asusual scenario comes from a report drafted by Pew Charitable Trusts and Systemiq, a Londonbased environmental and investment company. All the localized bag bans, bottle bills, and recycling commitments you hear about would at best shave a few percent off business as usual, the report concludes; solving the plastic waste problem will require all of the above. But it also will require governments to fundamentally realign the plastics industry's economic incentives. In particular, if we don't want plastic waste in the ocean to double or triple, we have to keep plastic production from doubling on land—which is what the industry is projected to do if it's allowed to do business as usual.

Pew and Systemiq are hardly the only voices prescribing such an approach. In December 2021, the National Academies of Sciences, Engineering, and Medicine recommended the U.S. develop a national strategy to reduce plastic waste, one that could include a cap on virgin plastic production. Such a cap would help address the climate crisis as well; the plastics industry accounts for about 6 percent of global oil consumption. The two crises are linked. And the suggestion that the solution to both requires leaving oil in the ground, which once was considered radical, has become part of the mainstream conversation.

In India too, the calls for action have become more urgent and widespread. Brajesh Kumar Dubey, an environmental engineering professor at the Indian Institute of Technology Kharagpur, told me he was surprised, as he traveled the Ganges Basin on the National Geographic expedition, to

meet so many "small islands of people" working to raise awareness about environmental issues. But then, his country has changed so much, and developed so fast, in the past 30 years.

"If someone can bring all these islands together, it can achieve more and tackle this problem in a much better way. Behavior will change," Dubey said. "I am very much an optimist, a glass-half-full person."

NLIKE THE EFFORT TO FIGHT climate change, cleaning up plas-

tic litter in a river basin would have an immediate and visible benefit for the people who live there. But like the fight against climate change, the struggle can sometimes

seem almost Sisyphean—and at the same time essential, if we are to avoid altering the planet irrevocably.

Toward the end of my stay in India, I traveled to Sagar Island, at the western end of the 200-mile-wide Ganges River Delta. Sagar sits on the Bay of Bengal at the mouth of a distributary of the Ganges called the Hooghly, 75 miles downstream from Kolkata. To Hindus, this outlet of the river has special spiritual significance. Every January, thousands of pilgrims come to the island to bathe in the waters where Mother Ganga meets the sea.

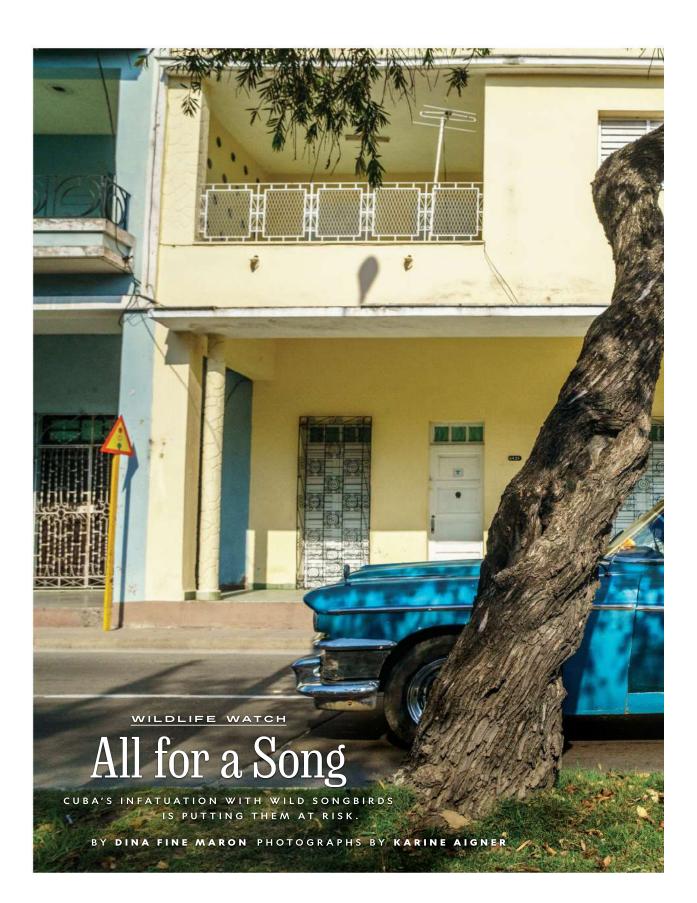
At the island's southwestern point, near a lighthouse the British installed to guide ships into the mouth of the river and on to Kolkata, the beach was trash free when I visited; Ganga had done her monsoonal cleansing well. As I walked along, passing some out-of-season pilgrims, a few stray cows, and a funeral party scattering ashes in the water, I thought of all the other gifts that Ganga bestows on Sagar these days.

According to measurements made by Koldewey's team, aside from carrying away the visible trash, the monsoon rains wash three billion microfibers a day out the main channel of the river into the Bay of Bengal. There they join the growing swirl of tiny plastic fragments in the oceans, whose harmful effects on marine life are just beginning to be understood.

One of the expedition's experiments, dubbed Message in a Bottle, involved releasing a fleet of 25 bottles equipped with electronic trackers to better understand how plastic behaves in rivers and their outlets. Three bottles were released at the mouth in Bangladesh. In the sea, plastic moves easily and can travel hundreds of miles in a matter of weeks. Not long after my visit to Sagar, the three bottles passed by where I had stood. They were riding the East India Coastal Current, destination unknown.

Senior writer Laura Parker's 2018 cover story on ocean plastics won a Scripps Howard Award. Photographer Sara Hylton is based in Mumbai, where she covers stories about gender, Indigenous people, and the environment.

A cap on virgin plastic production would help address the climate crisis as well. The two crises are linked.







# The men began arriving with their champion crooners early on a Sunday morning.

Sidestepping the tall weeds and trash mounds that blocked the narrow path, they gathered at a secluded spot in Havana. It was September—bird migration season in Cuba—and the recent influx of coveted songbirds had set off a flurry of illegal trapping and selling. Painted buntings, indigo buntings, and rose-breasted grosbeaks, a collective riot of color and song, were in high demand. Sundays were popular for songbird competitions.

Days earlier, someone posted the venue on one of the dozen Cuban songbird Facebook groups I'd joined in July 2021. Because of coronavirus restrictions, I couldn't travel to Cuba, and a local contact agreed to attend the clandestine meetup for me on condition of anonymity.

A 2011 Cuban law on biological diversity prohibits capturing many songbirds for anything but scientific research. Competitions, with wagers on birds that sing the longest, most melodious tunes, are illegal too. Yet people openly post footage from the contests, and some Facebook posts offering songbirds for sale explicitly note ones that were *captura*—trapped in the wild.

Pandemic lockdowns have pushed even more

Support Wildlife Watch, a reporting project that shines a light on wildlife exploitation, by donating to the National Geographic Society at natgeo.org/joinus.

of the illegal commerce online, says Xochitl Ayón Güemes, an ornithologist and bird curator at the National Museum of Natural History, in Havana.

Cuban officials did not respond to requests for details about songbird trapping and smuggling and prosecutions for those crimes.

Keeping caged birds is seen as a tradition by many Cubans, "so despite it being a violation, it has been something socially accepted," says Maikel Cañizares, an ornithologist at the Ministry of Science, Technology and Environment.

The hobby dates back to the Spanish conquerors and has become increasingly common, says biologist Giraldo Alayón García, former president of the Cuban Zoological Society and now president of Fundación Ariguanabo, a nonprofit that promotes nature, science, and culture. Many Cubans want to have colorful birds in their homes to enjoy their songs and beauty, and people pass this tradition on from generation to generation, he says.

For some Cubans, songbirds are also a business. Recent food shortages and the economic strain of U.S. policies have increased desperation for cash, and illegally trapping wild songbirds is cheaper and easier than breeding them at home.

"The amount of money to be made from [the songbird trade] is pretty limited," says Lillian Guerra, professor of Cuban and Caribbean history at the University of Florida. On Facebook, some birds may be advertised for no more than \$20. Competition wagers vary widely—up to thousands of dollars.

The trapping of wild songbirds is taking a toll, however. "Today," says Alayón, who is 75, it's "almost impossible" to find a Cuban grassquit in some places, though "they were common when I was a child." The birds, endemic to Cuba, are admired for their clear, high-pitched song and the bright yellow flourish behind their eyes and around their neck. Alayón says his father used to keep Cuban grassquits but he finally persuaded

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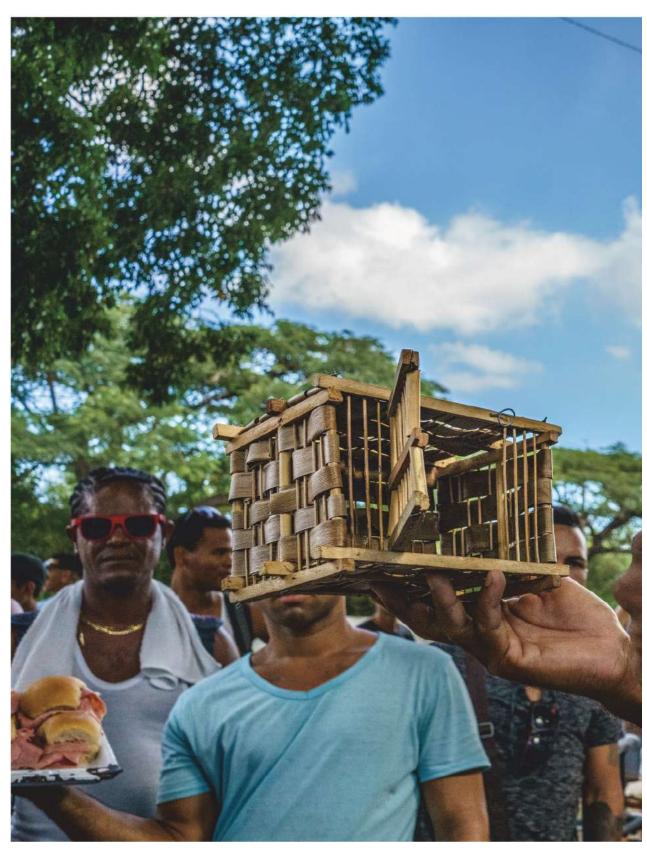
Officers with the Florida Fish and Wildlife Conservation Commission carry seized birdcages and traps. Nearby, an entire shed is filled with such confiscated items, underscoring the scale of illegal trapping around Miami.

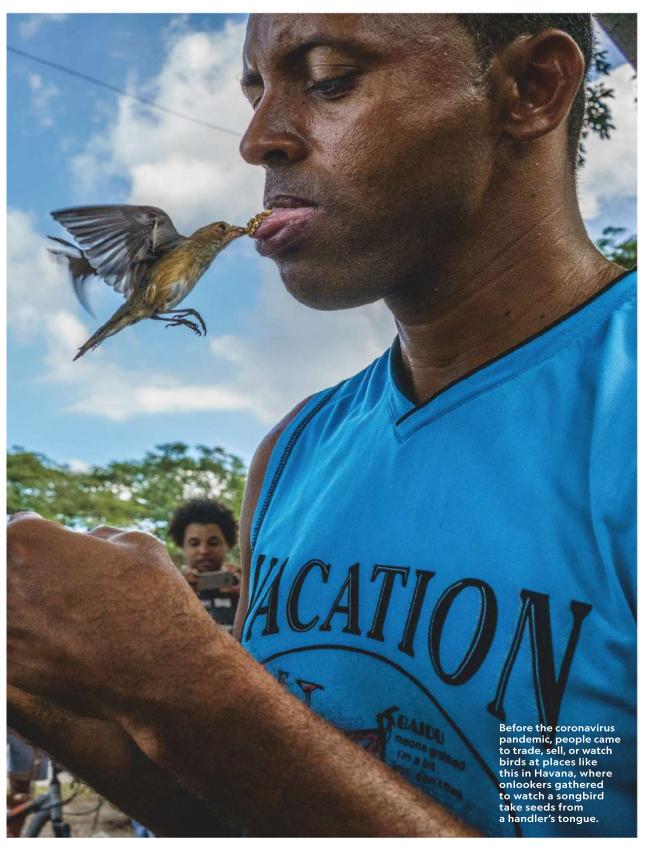
# воттом

Men in a park in Cienfuegos watch as two birds sound off. Some singing competitions are solely about pride in one's birds and socializing with friends; other contests involve lucrative—and illegal—wagers.









him to set them free. There's "no doubt," Alayón laments, that the Cuban grassquit is now "imperiled because of the trapping activities."

With their vibrant red chest, blue head, and green wings, painted buntings (known in Cuba as *mariposa*, meaning "butterfly") also are at risk. The birds migrate between the southeastern United States and the Caribbean, and their numbers have plummeted in recent decades as a result of habitat loss and the illegal trade in Cuba and elsewhere, according to periodic population counts of North American birds.

"There's so little information on how many birds are being captured," says painted bunting expert Clark Rushing, a University of Georgia professor. In a 2004 account, three trappers caught roughly 700 painted buntings in one Cuban province in a single weekend. Such numbers are common anecdotally, Rushing says, but it's hard to know whether they're outliers.

To track the migration of painted buntings, five years ago Rushing and his team used nets to catch the birds in their breeding grounds in Florida and other states. The team put ID bands around the birds' ankles, fitted them with tiny backpacks containing geolocators, and released them. The researchers found that buntings migrating all the way to wintering grounds in Cuba were 20 percent less likely to return north than birds making shorter journeys. The long flight over open water may explain some of the losses, Rushing says, but trapping also may be a factor.

Photographer Karine Aigner says that when she was in Cuba, trappers agreed to sell her a geolocator they'd removed from a bunting they'd just captured. "We were able to confirm it was a bird originally banded in South Carolina," Rushing says. The trappers told Aigner it wasn't the only banded painted bunting they'd caught.

**TEENAGERS DO A LOT** of the illegal trapping, says Eduardo Iñigo-Elias, a retired senior researcher at the Cornell Lab of Ornithology. "They challenge each other to see who can trap more birds and get some cash," he says.

Some Cubans mourn their birds when they die. But when people train songbirds to compete, they may put them in stressful situations, forcing them to learn songs played in a constant loop. Younger trappers are "more cruel," Ayón Güemes says. Some give their birds steroids to invigorate their performances. "Old people don't use steroids" on their birds, she says, but young

#### TOI

A trapper holds up his male Cuban bullfinch in the mountains outside the town of Trinidad. He's hoping his bird's call will lure others of its kind to respond and that this is a promising area for trapping the birds.

# воттом

Investigator Rene Taboas with the Florida Fish and Wildlife Conservation Commission holds a confiscated painted bunting as he and colleagues pack up birds, traps, and cages after a sting in the Miami area

owners also may cauterize contestants' eyes with a hot spoon, hoping that territorial birds unable to see their opponents will keep singing.

Public pressure is building in Cuba to stop the songbird trade. In August 2020 President Miguel Díaz-Canel Bermúdez tweeted, in Spanish and English: "We must tackle illegal actions against the flora and fauna. NO to the smuggling of wild birds!" Accompanying his words were images of songbirds, including the painted bunting and Cuban grassquit.

Songbird trapping has spread to the United States, particularly around Miami, a Cuban American stronghold. Thousands of songbirds in Florida—including some, such as painted buntings, that migrate there from Cuba—are captured in woods and backyards each year. Many trappers are of Cuban descent, according to Florida law enforcement.

Birds are also smuggled from Cuba. In January 2016, customs officials at Miami International Airport snagged Hovary Muniz, a Miami resident who'd arrived from Cuba with nine songbirds concealed in a fanny pack and in plastic tubes in his underwear. After he continued selling protected migratory birds while on probation, he was sentenced to 15 months in a U.S. prison.

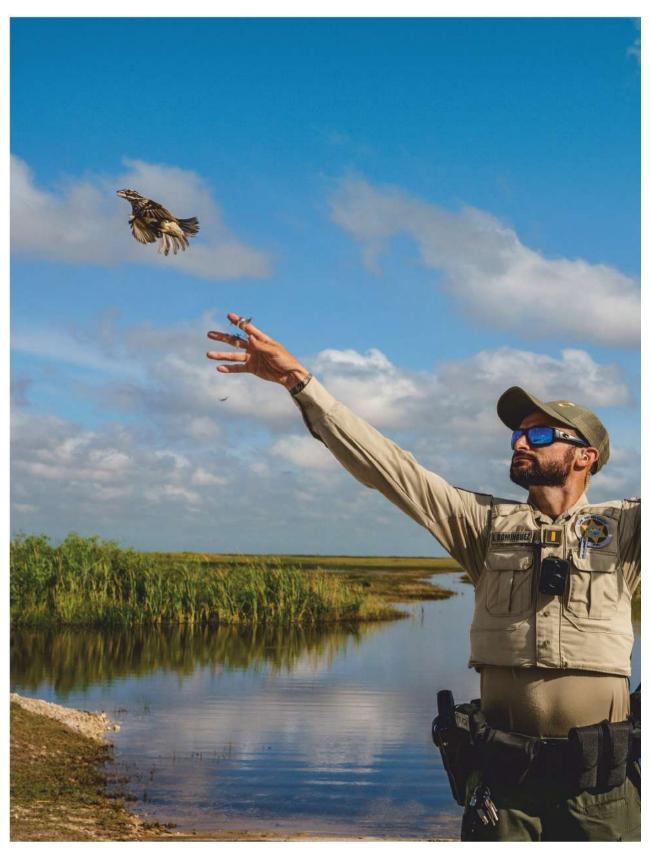
People want to be close to nature, Alayon says, and trapping songbirds is entrenched in Cuban culture. "The most difficult thing in the world in Cuba is to change the mind of the people," he says.

At the Sunday songbird competition in Havana, my contact reported that a police patrol appeared before noon. But no one was arrested—the bird handlers had vanished. One onlooker offered this explanation: They'd been tipped off that the police were on their way.

**Dina Fine Maron** is a staff reporter for National Geographic's Wildlife Watch. **Karine Aigner** photographed harpy eagles in the October 2020 issue of the magazine.









# THE WATER BEHIND US

IN THE ROUGH SEAS OFF WEST AFRICA,

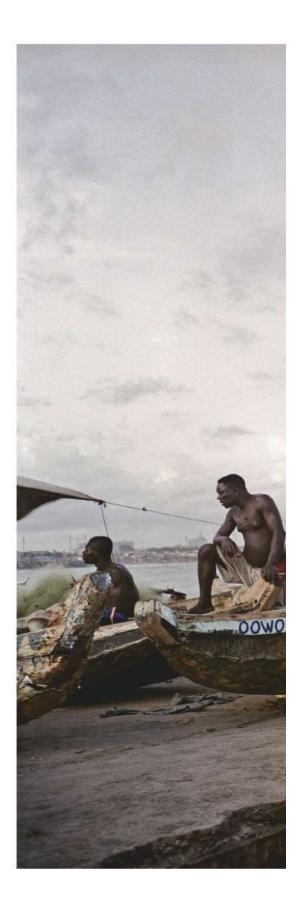
FISHING ISN'T JUST FOR THE BRAVE—

IT'S A TRADITION THAT SHAPES

COASTAL COMMUNITIES AND THEIR

RESPECT FOR NATURE.

ESSAY BY **NII AYIKWEI PARKES**PHOTOGRAPHS BY **DENIS DAILLEUX** 









# Along this coast of ours, nothing is strange.

If you wake early enough to meet the canoes as they come in—in Port Bouet, Côte d'Ivoire; in Ngleshi, Ghana; in Old Jeswang, the Gambia; in Grand-Popo, Benin; in Apam, Ghana—you will hear fishermen speaking Fante, Ga, Ewe, all languages of Ghana.

As the men separate into identifiable bodies in the emerging sun, pulling in the nets, their chants get louder: "Ee ba ei, ee ba ke loo-It is coming, it is laden with fish." Each net comes in heavy with what the deep has to offer in the clutches of its mesh. The fish flop, flail, and trampoline on the sand, catching the sun's light as quick hands sort them into wide metal basins.

The catch is never the same. Yes, there are the easily recognized commercial varieties: snapper, grouper, tuna, mackerel, kpanla (a variety of hake). But invariably there are the coveted: crayfish, eels, rays, and species of odd shapes and sizes, boned and boneless, some with features that would excite fantasy and horror writers in the manner

Nana Adomo, covered in sand, pauses while she plays on the beach in Mumford, a traditional fishing town on Ghana's coast along the Atlantic Ocean's Gulf of Guinea. The government is modernizing the local port, adding roads and a marketplace, net-mending hall, ice depot, gas station, and day care center.

#### PREVIOUS PHOTO

Fishermen prepare their boats in a small harbor in Jamestown. a district of the country's capital, Accra. Many people in the area fish, but this crew lives at a port about 60 miles away. They came to Jamestown to sell their catch and then stay the night.

#### TOP LEFT

Gina Asante, a street vendor in Winneba, another historic fishing port in central Ghana, carries a cage of chickens to be sold. Agriculture accounts for perhaps 50 percent of Ghana's workforce.

#### TOP RIGHT

Friends Kodjo Essel and Kofi Ayikpah attend the popular Aboakyere festival in Winneba. The festival, originating from an ancient rite of sacrifices offered to the tribal god Otu, occurs annually on the first Saturday in May and features activities such as antelope hunts and celebrations. The powder on the festivalgoers' faces is decorative. Historically in Ghana, white clay or powder has been used as a sign of victory over evil.

#### BOTTOM LEFT

Children who have decorated themselves with talcum powder stop for a photo while playing in a house under construction by the sea in Apam, a fishing port. They make up games to entertain themselves while men fish and women sell the catch.

#### BOTTOM RIGHT

Nyamo Adomako, a young fisherman living in Jamestown, plays soccer with friends when he is not out at sea.











#### NEXT PHOTO

Children chase each other on the beach in Apam. Formerly a major harbor, the port now is focused on fishing. Communities in Ghana take a break from fishing at sea and in freshwater one day a week, which enhances conservation.

The Ga, the people
I belong to, have no
fear of the unknown.
'May strangers find
home with us' is a
foundational philosophy
of our culture.

that open-sea *Phronima* creatures apparently inspired the film *Alien*. But there will be no screaming here—there will be spices to render all species delicious.

The Ga, the people I belong to, have no fear of the unknown. The saying "Ablekuma aba kuma wo—May strangers find home with us"—is one of the foundational philosophies of our culture; it is why my European surname, Parkes, imported with a Sierra Leonean grandfather of Jamaican heritage, is considered a Ga name. It is an attitude echoed among most of the coastal peoples of West Africa: They travel without hesitation, they embrace travelers; like the waves that wash their feet, they come and go.

But in fishing families, Ghanaians are unique. In 1963, the now defunct magazine *West Africa* called Ghanaians "pan-African fishermen" because of the number of countries—from Nigeria to Senegal—where Fante, Ewe, and Ga fishermen applied their expertise.

Raised by some of the roughest seas along the coastline, fishermen from the Fante-speaking western and central regions of Ghana became not only the strongest sea swimmers in the world (16th- and 17th-century European travelers including Jean Barbot and Pieter van den Broecke were awed by West African swimming skills) but also expert canoers.

Even among the Ga, the most revered fishermen, the *woleiatse*, often are from the Abese-Fante *akutso* (network of families), a group of Fante naturalized as Ga people. This easy shift in identity from Fante to Ga is rooted in shared values that are tied to a quest to preserve their livelihoods. Neither group fishes at sea on







#### ABOVE

Prince Kafuta poses on a beach in Mumford with a toy boat modeled after the town's fishing boats. The sea is a key part of Ghanaian identity. Along West Africa's coast, most fishermen are from Ghana.

#### RIGHT

Two children at play take a moment to observe their surroundings and peer up at a fish sculpture in the square on Sekondi-Takoradi's beachfront. The monument to fishing is adorned with the red, yellow, and green from the Ghanaian flag's stripes, as well as its black star.

Tuesdays or in freshwater on Thursdays. It is taboo, and thus a weekly break allows water spirits to replenish the fish—a conservation-minded act rooted in culture and tradition.

More tangibly, the idea of conservation guides the range of skills acquired by Ghanaian fishing communities. A large number of fishermen are part-time farmers, returning to the land once or twice annually when fish stocks are less plentiful.

The remainder mimic the migration patterns of the primary species consumed where they live, or go to areas where alternate fish can be found. Ladyfish, for example, which is taken in Senegal and the Gambia, can replace bonefish, a delicacy in the central region of Ghana.

It is also the flux of available fish that has



fueled the mastery of fish brining and smoking along the coast. Good stocks of smoked fish ensure that the staple protein of coastal diets is readily available regardless of the season.

The reality of the occasional man lost at sea and the unpredictability of the catch mean that fishing families ultimately latch their dreams to the twists of fate.

Fishermen deliver their silvered bounty to the women of their towns; the women sell it and perform magic with the proceeds: trading, farming, and educating children who run along the shore, making up games while the men are away riding waves.

Even when the men don't return, they leave something behind.

My cousin who shared my name, Ayikwei, was one of the unreturned. In 1992, when I was making my first journey to live outside the capital, Accra, in Tolon, nearly 400 miles away in northern Ghana, he said something to me that I carry always: You have no cause to be nervous. We are Ga; with the water behind us, we have nothing to fear.

Now, wherever I travel, in the midst of the strange, I close my eyes and listen for water. □

Writer, poet, and performance artist Nii Ayikwei Parkes's books include Tail of the Blue Bird. This is his first story for National Geographic. French photographer Denis Dailleux, of Agence VU, is based in Paris and Cairo. In his work, he has explored Ghanaians' relationship with the sea.



#### INSTAGRAM

### **PAOLO VERZONE**

#### FROM OUR PHOTOGRAPHERS

#### wно

Based in Italy and Spain, Verzone focuses on conveying his subjects' spirits as well as their experiences.

#### WHERE

Arthur's Seat, a volcanic peak in Edinburgh, Scotland WHAT

Phase One XF IQ160 with an 80mm lens

Verzone has spent years photographing something that's hard to capture: joy. Often it's serendipitous. "Ninety percent is unpredictable," he says. But he suspected he'd find it when he went to Scotland in spring 2017 to cover Highland dancing, originally done by men during wartime but now performed by all in lively public shows. Verzone trained his lens on some of the country's most talented dancers as they practiced for the Highland games. For days he marveled at the displays of athleticism, energy—and joy.

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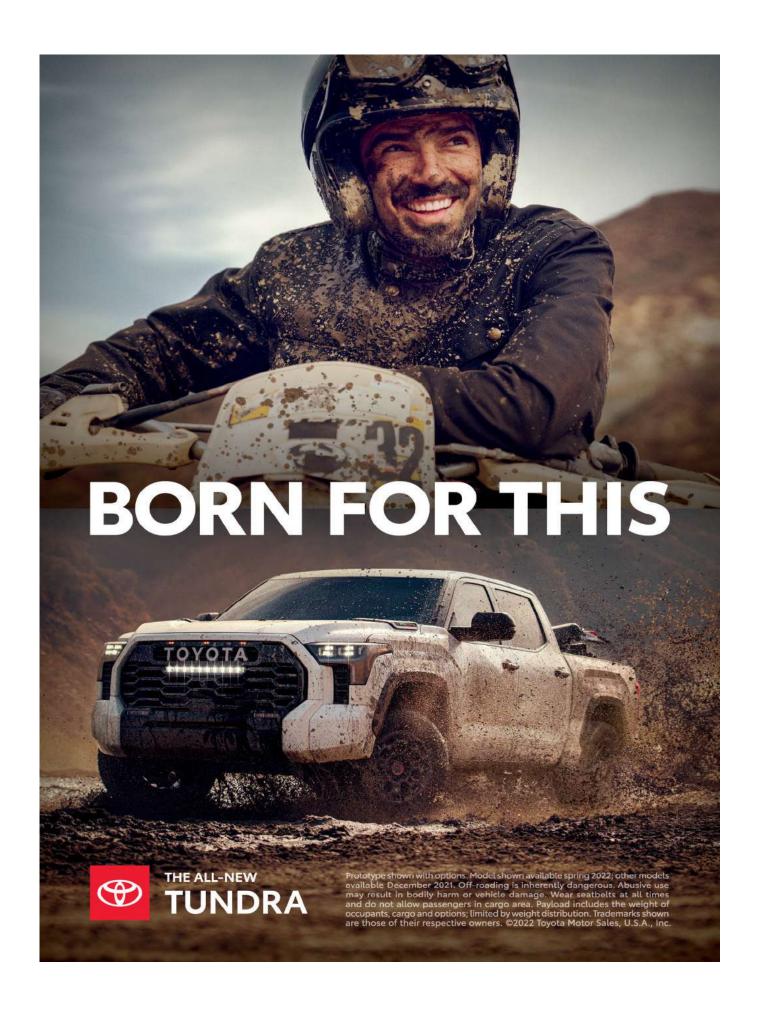


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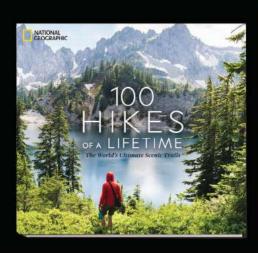
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Above: Samarkand, Uzbekistan

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