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JULY 2015

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Camouflage-clad bush-meat hunters pose in the Democratic Republic of the Congo, site of a 1976 Ebola outbreak.

30 Stalking a Killer

The latest Ebola crisis may yield clues as to where the virus hides between outbreaks.
By David Quammen Photographs by Pete Muller

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On a Roll

Inspired by a bold chef and fueled by social media, a global food-truck craze picks up speed.

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Feeding Frenzy

At feeding time killer whales reveal not so much their appetite as their cunning.

*By Virginia Morell
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Across India, the author sees where Mohandas Gandhi shaped history. But the leader's mark on modern life is less clear.

*By Tom O'Neill
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This month a space-craft launched in 2006 will get a close look at our solar system's former ninth planet.

*By Nadia Drake
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They reenact the early 1800s fur-trading life and celebrate self-sufficiency.

By Jeremy Berlin Photographs by David Burnett

On the Cover In this depiction of Pluto, NASA's spacecraft New Horizons passes across the face of the dwarf planet, while its largest moon, Charon, looms in the background. *Art by Dana Berry*

Corrections and Clarifications Go to ngm.com/more.

**THROUGH THE LENS**

Capturing Natural Light

Nevada Wier, award-winning National Geographic contributing photographer and world traveler, shares her insights on creating the best image.



"Light is the single most important element in photography. The trick is to use it in a startling way. I like photographing at the edge of light, when sunrise and sunset can produce such extreme colors. Both of these images were made in equatorial parts of the world where those transition times and hues are fast and fleeting."

I photographed the U Bein Bridge, in Myanmar, just after sunset. The moving bicycles, tree limbs, bold yellow, and silhouette show how light, color, action, and pattern can combine in one instant to make an image unique. The fishing nets in Cochin, India, were also photographed at sunset. In this case, that little blue sail against the orange sky became the special punctuation that I needed to set the image apart.

You can't plan pictures like these, but you can train your eye to be ready for them. The right design, framing, and moment all matter—but light binds it all together."

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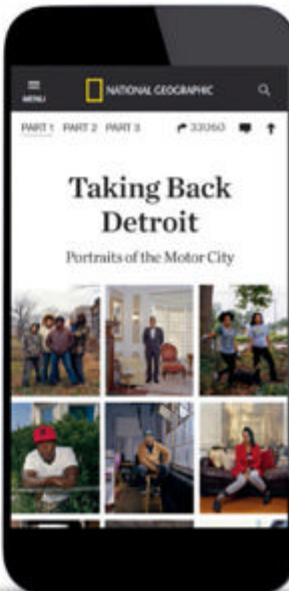


Life well lit.





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The Future of Storytelling

Recently National Geographic was honored in a way that encapsulates what it means to reinvent a brand founded in 1888 during the most disruptive, energizing, difficult, exciting, and transformative time ever in media.

At the 2015 National Magazine Awards, the premier honors in magazine journalism, we won the top prizes for photography and our tablet edition.

I share this not to brag about our tremendously talented staff, but because these accolades reflect how our iconic yellow border is framing platforms both new and traditional in this, our 128th year.

National Geographic and visual storytelling have been inseparable; our pictures touch hearts, raise awareness of urgent issues, and take people on journeys to places they will never go. The power of images to inspire, reveal, transport, and engage transcends language. This is something generations of readers have instinctively understood. From this perspective, the photography award—though difficult to attain against gifted competitors—isn't too surprising.

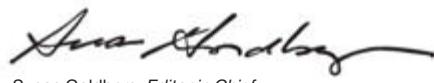
The prize for the best tablet edition, however, is another matter. It illustrates the direction of

our future storytelling.

These days readers can have a National Geographic experience wherever and whenever they want one. That's why, in addition to the print magazine, we have focused on digital products: our tablet; our recently retooled website, *nationalgeographic.com*; our Nat Geo View app; and a new partnership to allow mobile Facebook readers to share everything from a photo, map, or video within a story to the entire story itself. We're all over social media, where, in addition to Facebook, we're leaders on Instagram, Twitter, and Snapchat, to name a few.

It's all part of our passion to explore, innovate, and live up to our motto: "We believe in the power of science, exploration, and storytelling to change the world."

That's our commitment today and for years to come. Join us—on whatever platform you choose to take on the journey.



Susan Goldberg, *Editor in Chief*



American Crocodile (*Crocodylus acutus*)

Size: Body length, including tail, 2.3 - 6.1 m (7.5 - 20 ft) **Weight:** Up to 1,000 kg (2,200 lb)

Habitat: Brackish estuaries, rivers, coastal lagoons and mangrove swamps **Surviving number:** Unknown



Photographed by Kurt W. Baumgartner

WILDLIFE AS CANON SEES IT

Hungry for anything. The American crocodile will eat whatever it can overpower, from fish and crabs to snakes, turtles and small mammals. At home in the water, the crocodile moves surprisingly fast when galloping on land. It is also quite noisy considering its lack of vocal cords; pushing air from lungs to nostrils, it can hiss, cough, growl, grunt and bellow. These

sounds come into play for courtship, contact calls and when threatening. But this formidable predator is also threatened, facing habitat loss, hunting and deadly run-ins with vehicles.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.



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Why Fixing the Climate Is Like Fixing the Economy

Henry M. Paulson, Jr.—who was U.S. treasury secretary during the financial crisis that hit in 2008—now works to sustain the environment as well as the economy. The Harvard-educated investment banker, 69, co-chairs the Risky Business Project (riskybusiness.org), which aims to quantify the risks that climate change poses for key economic sectors in the United States.

You've likened the climate crisis to a financial crisis. How do the two compare?

Excesses of debt created the financial crisis; excess of CO₂ created the climate crisis. These are coupled with flawed government policies and incentives and pervasive, outsize risktaking. The difference is that last-minute government action averted economic Armageddon during the financial crisis. We don't have that option with climate change.

What's the economic risk in doing nothing?

If we don't act, the risks will compound, and we'll lose the opportunity to avoid the worst outcomes. Businesses need to factor the threats from climate change into their investment decisions and to urge local and national policy actions. When climate-related disasters strike, we all pay. We urgently need policies such as carbon pricing to incentivize behavior change and promote clean technologies.

What's your best hope for addressing the problems of climate change?

We can still avoid the worst effects if we act now. In the U.S. we need a national policy to help reduce our use of carbon-based fuels. But ultimately the crux of the challenge lies in the developing world, especially China. To resolve the climate crisis, the U.S. and China—the world's largest economies, energy users, and carbon emitters—must work together to deploy cost-effective new technologies in the developing world. If our countries lead, others will follow.

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*Bravecto kills fleas, prevents flea infestations, and kills ticks (black-legged tick, American dog tick, and brown dog tick) for 12 weeks. Bravecto also kills lone star ticks for 8 weeks.

Bravecto is for dogs 6 months of age or older, and is approved for pregnant, breeding and lactating dogs. Side effects may include vomiting, decreased appetite, diarrhea, lethargy, excessive thirst, and flatulence. Please see Brief Summary of Prescribing Information on following page.

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Animal Health



BRIEF SUMMARY (For full Prescribing Information, see package insert)

Caution:

Federal (USA) law restricts this drug to use by or on the order of a licensed veterinarian.

Indications:

Bravecto kills adult fleas and is indicated for the treatment and prevention of flea infestations (*Ctenocephalides felis*) and the treatment and control of tick infestations [*Ixodes scapularis* (black-legged tick), *Dermacentor variabilis* (American dog tick), and *Rhipicephalus sanguineus* (brown dog tick)] for 12 weeks in dogs and puppies 6 months of age and older, and weighing 4.4 pounds or greater.

Bravecto is also indicated for the treatment and control of *Amblyomma americanum* (lone star tick) infestations for 8 weeks in dogs and puppies 6 months of age and older, and weighing 4.4 pounds or greater.

Contraindications:

There are no known contraindications for the use of the product.

Warnings:

Not for human use. Keep this and all drugs out of the reach of children. Keep the product in the original packaging until use, in order to prevent children from getting direct access to the product. Do not eat, drink or smoke while handling the product. Wash hands thoroughly with soap and water immediately after use of the product.

Precautions:

Bravecto has not been shown to be effective for 12-weeks duration in puppies less than 6 months of age. Bravecto is not effective against *Amblyomma americanum* ticks beyond 8 weeks after dosing.

Adverse Reactions:

In a well-controlled U.S. field study, which included 294 dogs (224 dogs were administered Bravecto every 12 weeks and 70 dogs were administered an oral active control every 4 weeks and were provided with a tick collar); there were no serious adverse reactions. All potential adverse reactions were recorded in dogs treated with Bravecto over a 182-day period and in dogs treated with the active control over an 84-day period. The most frequently reported adverse reaction in dogs in the Bravecto and active control groups was vomiting.

Percentage of Dogs with Adverse Reactions in the Field Study

Adverse Reaction (AR)	Bravecto Group: Percentage of Dogs with the AR During the 182-Day Study (n=224 dogs)	Active Control Group: Percentage of Dogs with the AR During the 84-Day Study (n=70 dogs)
Vomiting	7.1	14.3
Decreased Appetite	6.7	0.0
Diarrhea	4.9	2.9
Lethargy	5.4	7.1
Polydipsia	1.8	4.3
Flatulence	1.3	0.0

In a well-controlled laboratory dose confirmation study, one dog developed edema and hyperemia of the upper lips within one hour of receiving Bravecto. The edema improved progressively through the day and had resolved without medical intervention by the next morning.

For technical assistance or to report a suspected adverse drug reaction, contact Merck Animal Health at 1-800-224-5318. Additional information can be found at www.bravecto.com. For additional information about adverse drug experience reporting for animal drugs, contact FDA at 1-888-FDA-VETS or online at <http://www.fda.gov/AnimalVeterinary/SafetyHealth>.

How Supplied:

Bravecto is available in five strengths (112.5, 250, 500, 1000, and 1400 mg fluralaner per chew). Each chew is packaged individually into aluminum foil blister packs sealed with a peelable paper backed foil lid stock. Product may be packaged in 1, 2, or 4 chews per package.

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EXPLORE



Wild Things

Nesting Instincts

Some twig pieces here, a bit of dry grass there. How sophisticated could a bird nest be? Quite, according to ornithologist Mark Mainwaring. With a team of researchers from the U.K. and France, Mainwaring deciphered four evolutionary drives that have shaped how a given species builds its nest. The structures, he says, are designed to serve one or more of four functions: provide warmth or shade for hatchlings, attract mates, prevent parasite infestations, and protect against predators.

For example, says Mainwaring, to keep adults and babies warm during cold spring nights, a Tennessee warbler used ample foliage to build the nest at right (1). And with an eye toward luring potential mates, a Bullock's oriole adorned its nest (7) with flashy blue ribbons. In other nest designs pine needles act as excellent camouflage in a forest, as do shells on the beach; feathers play a role in repelling fleas and lice.

The team plans to study how climate change affects nestbuilding. Meanwhile the findings may inspire new appreciation for birds and their not-so-humble homes. —Catherine Zuckerman



1. Tennessee warbler, California Academy of Sciences; collected near New Brunswick, Canada, in 1918

2. House wren, California Academy of Sciences; collected in Oakville, California, in 1974

3. Tree swallow, Cornell University Museum of Vertebrates; collected on Tatoosh Island, Washington, in 1995

4. Small ground finch, California Academy of Sciences; collected on San Cristobal Island, Galápagos, in 1906

5. Brown creeper, Museum of Vertebrate Zoology; collected in Pierce County, Washington, 1926

6. Caspian tern, Western Foundation of Vertebrate Zoology; collected in Baja California, Mexico, in 1932

7. Bullock's oriole, Cornell University Museum of Vertebrates; collected in Ithaca, New York, in 2003

8. Western tanager, Museum of Vertebrate Zoology; collected near Carson City, Nevada, in 1934



3



4



5



6



7



8



Easy on the Eyes

A few coats of mascara can make even the puniest lashes look luscious. But some cosmetics companies use rabbits as their guinea pigs, an FDA-sanctioned practice that many people oppose. The tests—which involve applying products to the animals' eyes to determine toxicity—can cause blindness and death.

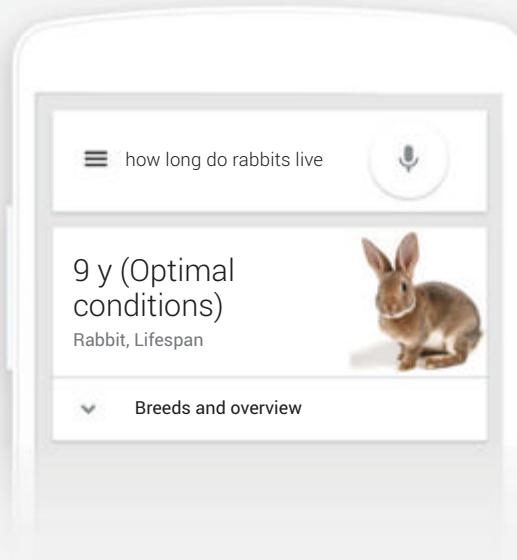
Perhaps not for much longer. New research from the University of Liverpool suggests that protozoa may be a key to developing cruelty-free makeup. According to ecologist David Montagnes, the cheap and abundant single-celled organisms may have enough genes in common with humans to make them good trial subjects.

"This is the future of animal testing," says Montagnes. "Protozoa do not possess a central nervous system and therefore don't feel pain." Using them could spell relief for lab rabbits and their advocates. —Catherine Zuckerman



WHAT SHOULD THE NAMES BE? YOU DECIDE.

If you've ever wanted to name a planet, now's your chance. The International Astronomical Union (IAU) wants help naming 32 exoplanets—planets that orbit a star other than our sun. Scientific and cultural organizations were asked to submit potential names. The public can rank finalists at nameexoworlds.org until July 15. The nearest of all the planets is ten light-years from Earth; the farthest is more than 2,300 light-years away. "We don't think any are habitable," says IAU General Secretary Thierry Montmerle. "But some could be close." —Daniel Stone





Hungry for information? Make a selection from our menu of food facts—and taste more at natgeofood.com.

LOOK-ALIKES

The medieval “doctrine of signatures” held that plants resembling body parts could benefit those parts.



UPSIDE DOWN

Fresh eggs should be stored pointed end down to better preserve their freshness.



JOY OF FRUIT

The word “fruit” comes from the Latin *fructus*, which means “enjoyment.”

7,000

A WIDE VARIETY

There are more than 7,000 different varieties of apples.



BEAUTIFUL OBJECT

Tomatoes were once thought to be poisonous and were grown for their ornamental value.



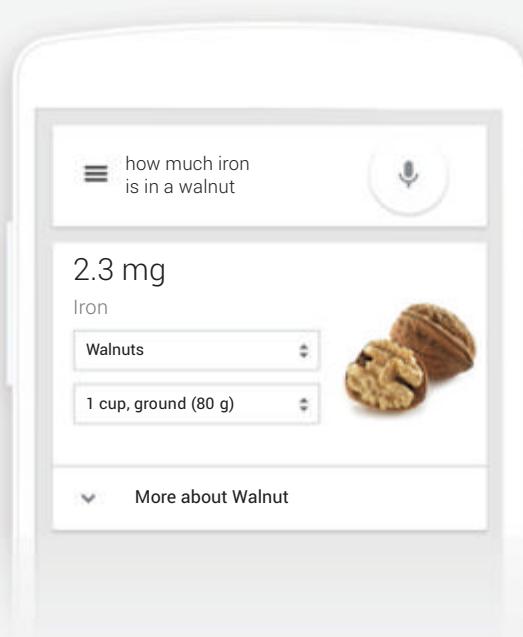
WORLD'S FARE

Ice-cream cones were first popularized at the 1904 World's Fair in St. Louis, Missouri.

10 lb

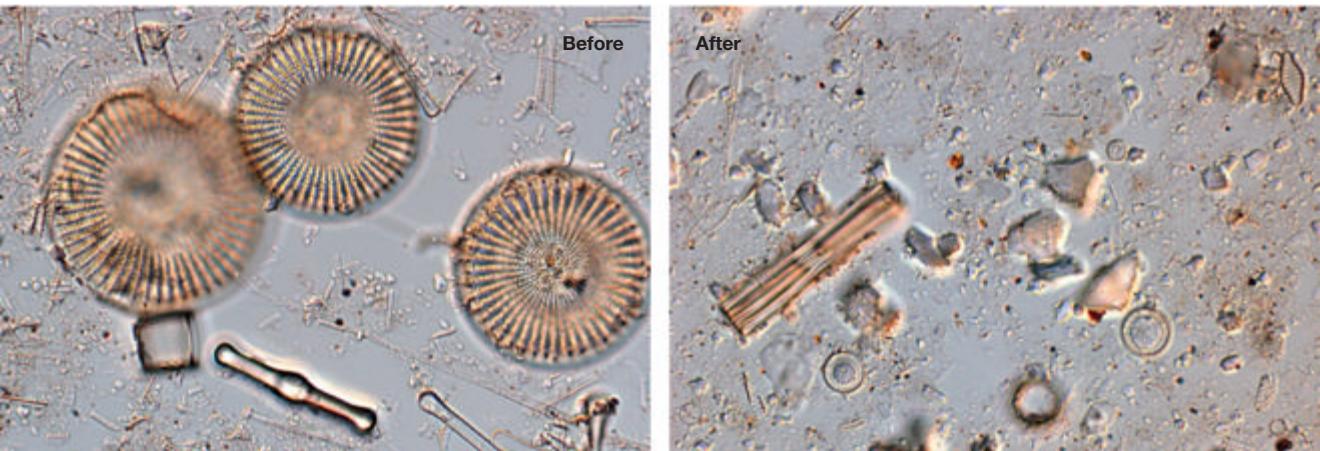
BANANA FANS

Annual per capita consumption of bananas by Americans



g

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Greedy Mussels



Quagga mussel (2X actual size)

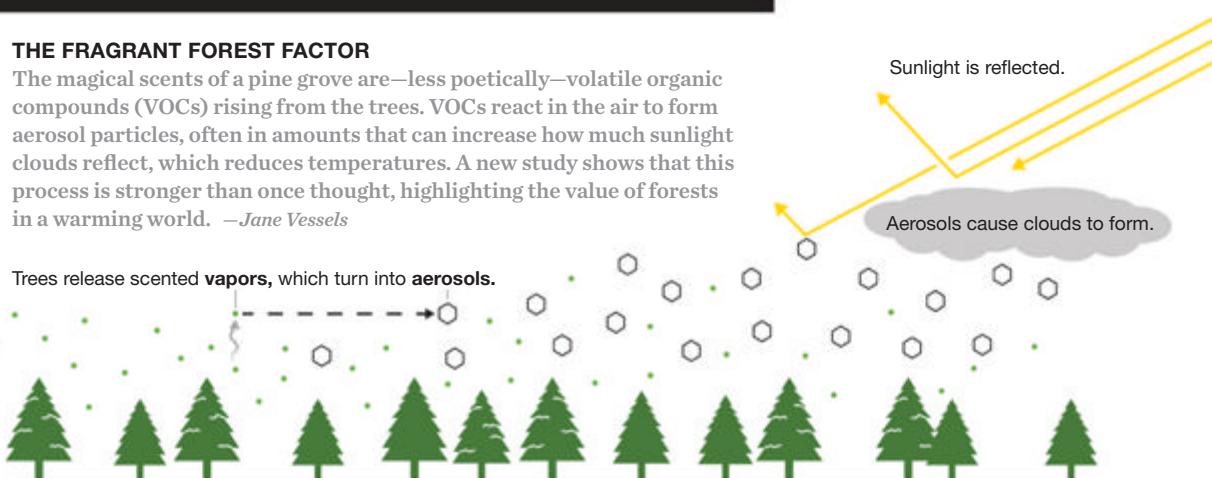
The quagga mussel might be no bigger than a thumbnail, but it's altering the Great Lakes' food web and affecting the lakes' four-to-seven-billion-dollar recreational and commercial fishing industry. Native to Ukraine, the quagga now infests the lakes in even greater numbers than its invasive-species cousin the zebra mussel. Both are believed to have entered North America in the ballast of ships.

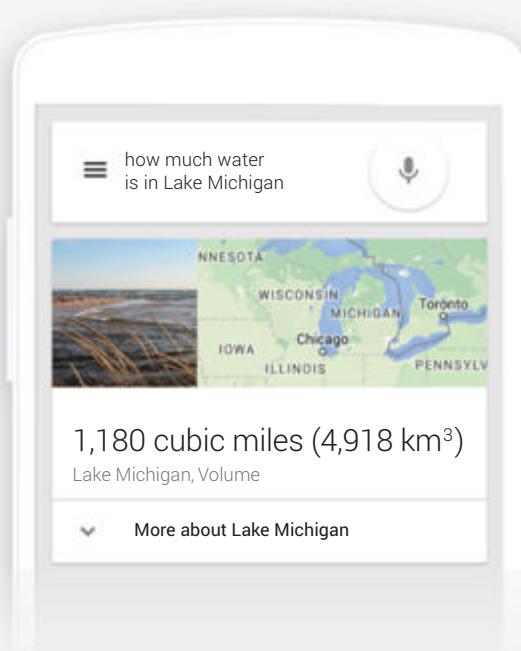
Like zebra mussels, quaggas feed by filtering lake water. Under the right conditions, the trillions of them in Lake Michigan can filter as much water as the lake contains every one to two days, removing algal species they prefer. Magnified 750 times, sediment samples from the lake show the base-of-the-food-web shifts that have resulted from this mussel invasion. The water once teemed with the large, lipid-rich diatom algae called *Stephanodiscus* and *Aulacoseira* (above left) that nourished Lake Michigan's extensive food web. Now that the mussels are hogging the choice algae, that food web is reorganizing to survive on fewer algae of the smaller varieties that are left, such as *Cyclotella* (above right). —Bill McGraw

THE FRAGRANT FOREST FACTOR

The magical scents of a pine grove are—less poetically—volatile organic compounds (VOCs) rising from the trees. VOCs react in the air to form aerosol particles, often in amounts that can increase how much sunlight clouds reflect, which reduces temperatures. A new study shows that this process is stronger than once thought, highlighting the value of forests in a warming world. —Jane Vessels

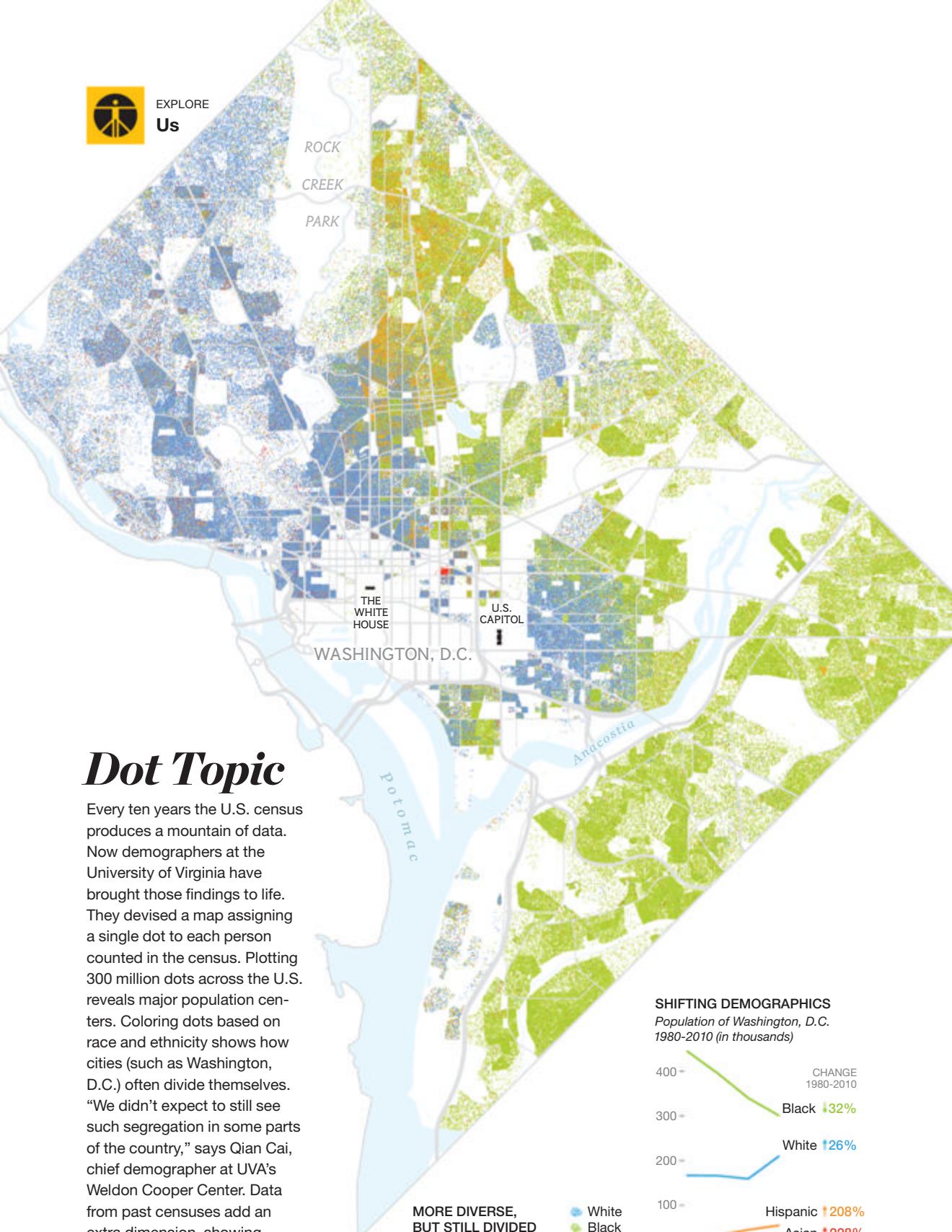
Trees release scented vapors, which turn into aerosols.







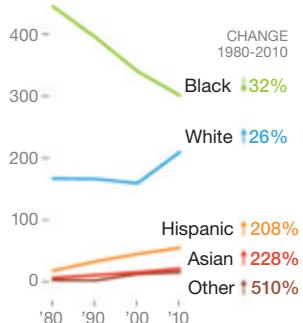
EXPLORE
Us

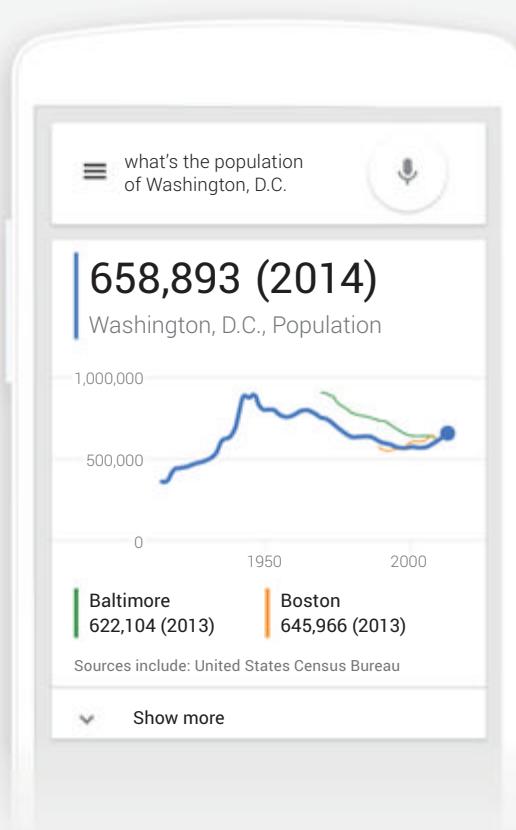


Dot Topic

Every ten years the U.S. census produces a mountain of data. Now demographers at the University of Virginia have brought those findings to life. They devised a map assigning a single dot to each person counted in the census. Plotting 300 million dots across the U.S. reveals major population centers. Coloring dots based on race and ethnicity shows how cities (such as Washington, D.C.) often divide themselves. “We didn’t expect to still see such segregation in some parts of the country,” says Qian Cai, chief demographer at UVA’s Weldon Cooper Center. Data from past censuses add an extra dimension, showing how places have changed over time. —Daniel Stone

SHIFTING DEMOGRAPHICS
Population of Washington, D.C.
1980-2010 (in thousands)







Micrixalus kotigeharensis, a species of dancing frog, shows off his moves.

Fancy (Webbed) Footwork

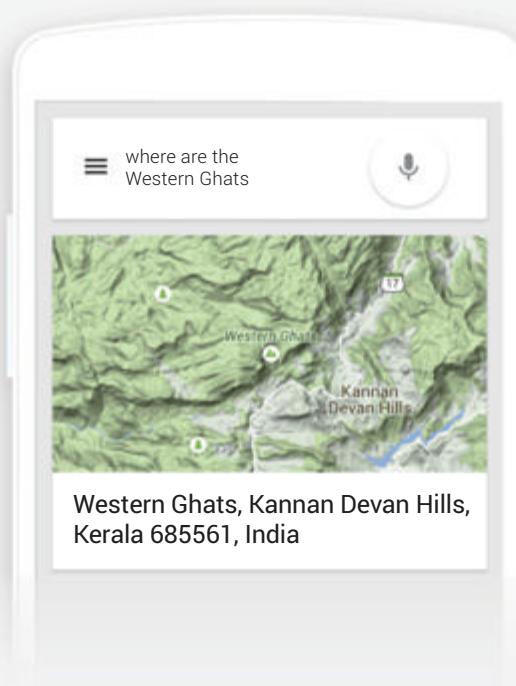
Look out, *Looney Tunes*: Fourteen new species of dancing frogs have been discovered in India. Found only in tropical forests of the Western Ghats, some of these thumb-size amphibians have a peculiar courtship ritual. Males, which vastly outnumber females, perch on rocks and wave their feet vigorously to catch the eye of potential mates. The fancy footwork evolved because singing, another mode of frog communication, is mostly drowned out in the din of their streamside homes, says the University of Delhi's S. D. Biju. The performances also serve to intimidate other males and, if a rival comes too close, to kick him off the rock.

The new discovery brings the known species of dancing frogs to 24, many of which are extremely rare. Biju is concerned that human development will encroach on the frogs' habitat. That could mean a sad curtain call for these high-stepping amphibians. —Christine Dell'Amore

FISHY BEHAVIOR

Rising carbon dioxide levels mean acidifying oceans and strange-acting fish. When exposed to 991 parts per million of CO₂ in the atmosphere—scientists' worst-case prediction for Earth in 2100—laboratory fish became less curious and forgot which side they prefer to turn (similar to handedness in people). One species swam without taking breaks. The CO₂ may alter brain chemistry or cause chronic stress, says Fredrik Jutfelt of Sweden's University of Gothenburg. —CDA







Coldest Casualties

The warming world is revealing the buried past. In the far north of Italy, at altitudes above 6,500 feet, the frozen corpses of World War I soldiers are melting free of their icy tombs.

They're casualties of the White War, waged by Italian and Austro-Hungarian troops from 1915 to 1918. "Many were very young," says lead archaeologist Franco Nicolis, who notes that diaries and unsent letters have been found since the early 1990s. "I think of the mothers who never saw their boys again."

Before being properly buried, each thawed body is analyzed by forensic anthropologist Daniel Gaudio. But without ID tags, he says, DNA traces alone haven't led to a family match.

Retreating glaciers promise more opportunities. In summer Nicolis will guide visitors to a site 12,000 feet up. "Inside this base, this wooden cabin, you can still smell the war." —Jeremy Berlin

EXTINCTIONS IN EGYPT THROUGH THE AGES

Animals both fantastical and real cover a ceremonial stone cosmetics palette sculpted in Egypt in about 3200 B.C. The actual creatures, including wild dogs, giraffes, hartebeests, wildebeests, ibex, oryx, and ostriches, must have roamed Egypt at that time but are not found there today. A recent study used such artifacts as well as texts and fossils to track the disappearance of animals over the course of 6,000 years. "What's unique about Egypt is the high-resolution reporting," says Justin Yeakel, an ecologist on the research team. Animals that dropped out of the finely detailed human observations helped reveal how wildlife populations changed over time. —A.R. Williams





Ask the Google app.

Basic Instincts

A genteel disquisition on love and lust in the animal kingdom

Too Hot to Handle

River terrapins try hard to be fruitful and multiply. Males use their bold breeding colors to entice mates, and their toenails to keep sex partners in their grasp. Females grow larger than males, the better to carry many big eggs. In mating season they couple liberally. Then females travel long distances, sometimes braving salt water, to sandbanks where they lay and bury several clutches of eggs a year. Despite such valiant efforts, five of the six species in the terrapin genus *Batagur* are critically endangered, says Rick Hudson, president of the Turtle Survival Alliance.

Terrapins lose habitat to sand mining and die as bycatch in fishing nets. Eggs are snatched from nests, to eat or sell; adults are shipped to China, where they're a banquet delicacy. Even temperature can influence survival: The sex of birds and mammals is determined by chromosomes, but the sex of many turtles is influenced by temperature during incubation. Often hatchlings from cooler settings will be male; from warmer ones, female. When captive-breeding programs have kept eggs too cool, Hudson says, they've yielded few or no females, which typically lay hundreds of eggs in a lifetime. Conversely, the advance of climate change could mean warmer incubation locations, a preponderance of females—and a shortage of baby daddies. —*Patricia Edmonds*

HABITAT/RANGE

Estuaries in Southeast Asia

CONSERVATION STATUS

Critically endangered

OTHER FACTS

Females lay eggs in nests about 12 inches deep. At different depths, eggs incubate at different temperatures.

In mating season terrapins couple liberally. Then females travel long distances to lay eggs.



This painted terrapin (*Batagur borneoensis*) in breeding colors was photographed at the zoo in Omaha, Nebraska.

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Medium & Wide Widths

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VISIONS

Indonesia

Off the east coast of Sulawesi, on the bottom of the Lembeh Strait, the wide-eyed face of a foot-long stargazer emerges through black volcanic sand. These fish, named for the eyes atop their heads, ambush their prey.

PHOTO: JENNIFER JO STOCK







England

The gnarled landscape of Wistman's Wood—moss-draped boulders, ferns, grass, lichen-covered dwarf oaks—is shrouded in fog and myth. Fairies, druids, and hellhounds are said to haunt this part of Dartmoor National Park.

PHOTO: DUNCAN GEORGE,
GETTY IMAGES



Iceland

Beneath the Breiðamerkurjökull glacier—part of Vatnajökull, one of the largest ice caps in Europe—a man in a boat is dwarfed by the walls of an ice cave. Summer melting expands the tunnel, and the river swells to fill it.

PHOTO: VILHELM GUNNARSSON

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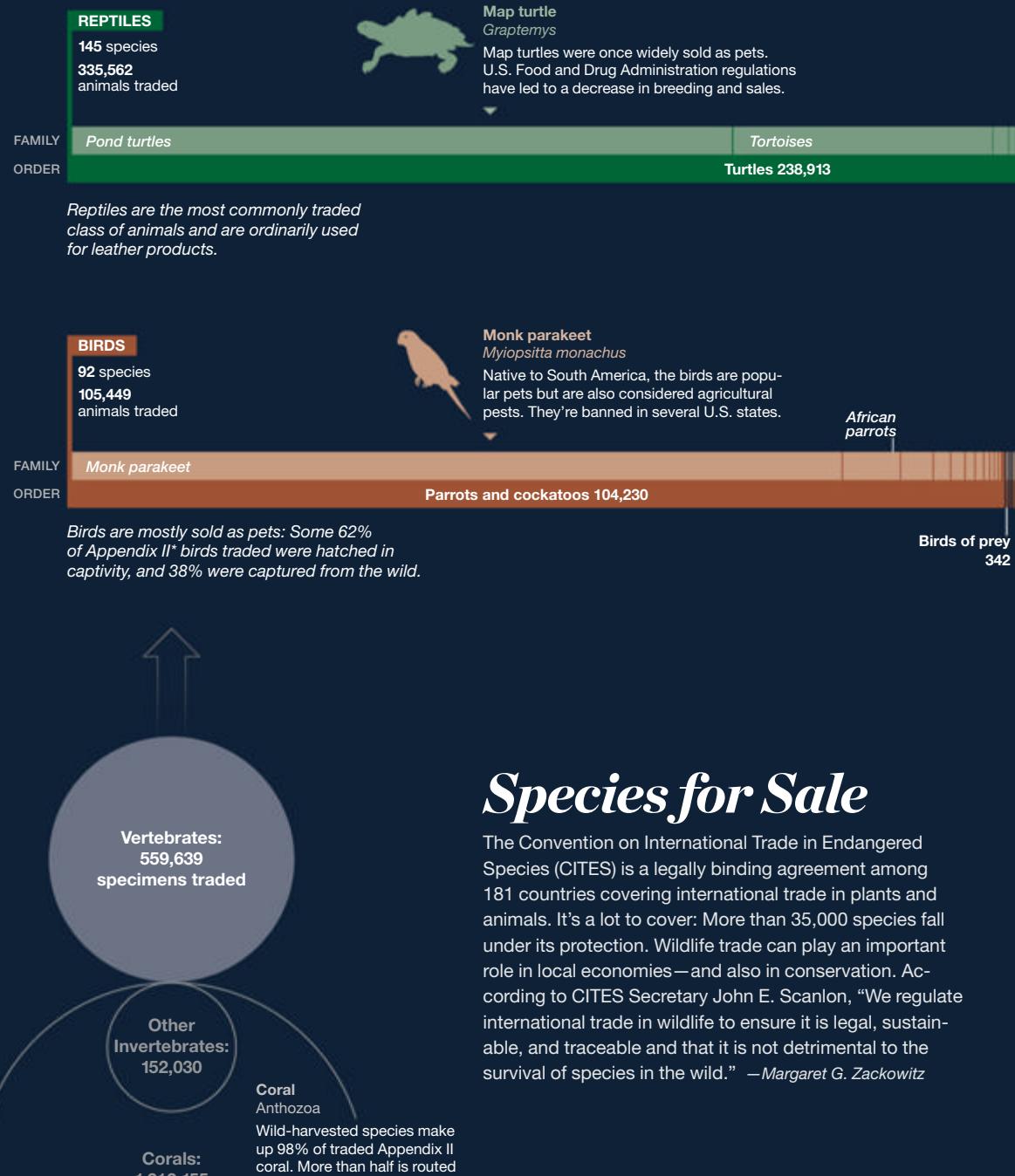
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SPECIAL REPORT

Animal Trade: By the Numbers

Global trade in wild-sourced live animals by species, 2012

***Species for Sale***

The Convention on International Trade in Endangered Species (CITES) is a legally binding agreement among 181 countries covering international trade in plants and animals. It's a lot to cover: More than 35,000 species fall under its protection. Wildlife trade can play an important role in local economies—and also in conservation. According to CITES Secretary John E. Scanlon, "We regulate international trade in wildlife to ensure it is legal, sustainable, and traceable and that it is not detrimental to the survival of species in the wild." —Margaret G. Zackowitz

*Appendix II species are not necessarily threatened but may become so unless trade is controlled.



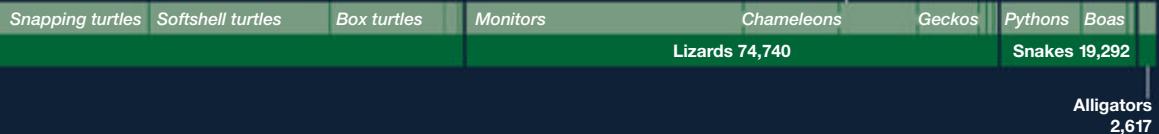
Asiatic softshell turtle
Amyda cartilaginea

Softshell turtles—used as food and in folk remedies—are farmed by the millions, but wild populations are still down.



Royal python
Python regius

Almost all the trade in Southeast Asian python skins is funneled to the European fashion industry.



FISH

15 species
104,520 animals traded



White sturgeon
Acipenser transmontanus

The species of sturgeon most commonly harvested for caviar are endangered or threatened.

Sturgeons

Sturgeons and paddlefish 99,900

Caviar is the most valuable fishery commodity managed by CITES. Wild-sourced exports have declined since 1999.

Seahorses 2,907

AMPHIBIANS

13 species
11,646 animals traded

MAMMALS

72 species
2,462 animals traded

Mammals accounted for 15% of the total value of Appendix II animal trade (2006–2010).

Costly Reptiles

Reptiles and reptile skins are among the most valuable products tracked by CITES—but it all depends on the finishing. A hunter may sell a captured python for just \$30; an elegant handbag crafted from python skin can cost as much as \$10,000.

Estimated value of trade in CITES Appendix II species by taxonomic group, 2010 (in millions of 2010 U.S. dollars)



JASON TREAT AND EMILY M. ENG, NGM STAFF; MEG ROOSEVELT

World
MAGAZINE

SOURCE: CITES SECRETARIAT (2012), "CITES TRADE: RECENT TRENDS IN APPENDIX II-LISTED SPECIES (1996–2010)," PREPARED BY UNEP-WCMC

If You Worked Around Gaskets or Packing Containing Asbestos

The Garlock Bankruptcy May Affect Your Rights.

Certain Personal Injury Claims Must be Filed by October 6, 2015

There is a bankruptcy involving claims about exposure to asbestos-containing gasket and packing products. Garlock Sealing Technologies LLC, The Anchor Packing Company, and Garrison Litigation Management Group, Ltd. ("Debtors") have filed a plan of reorganization to restructure their business and pay claims.

The products (with names like Garlock, Blue-Gard, Gylon, and Flexseal) were used in places where steam, hot liquid or acids moved through pipes, including industrial and maritime settings.

Who is Affected by the Garlock Bankruptcy?

Your rights may be affected if you:

- Worked with or around Garlock asbestos-containing gaskets or packing, or any other asbestos-containing product for which Debtors are responsible, or
- Have a claim now or in the future against the Debtors for asbestos-related disease caused by any person's exposure to asbestos-containing products.

Even if you have not yet been diagnosed with any disease or experienced any symptoms, your rights may be affected. The Court has appointed a Future Claimants' Representative ("FCR") to represent the rights of these future claimants. Future claimants do not need to file a claim at this time.

What Does the Plan Provide?

The Plan is the result of a settlement agreement between the FCR, the Debtors, and the Debtors' parent company. The Plan proposes to use \$357.5 million to pay, in full, all pending and future asbestos claims against Garlock and Garrison. If necessary, up to \$132 million in additional funding will be provided. If the Plan is approved, you will no longer be able to file claims directly against the Debtors or affiliated companies. If you have claims only against Anchor, you are not expected

to recover anything, as that company has no assets and will be dissolved.

Who Must File a Personal Injury Claim?

You must file a claim by **October 6, 2015**, if you:

- Have a claim against Garlock or Garrison based on an asbestos-related injury diagnosed on or before August 1, 2014,
- Have not settled with the Debtors, and
- Filed a lawsuit against any other defendant or a claim against any asbestos trust as of August 1, 2014.

If you do not file a claim, you may lose your right to bring your claim in the future. Individuals diagnosed with disease after August 1, 2014 do not have to file a claim at this time, but may be able to vote or object to the Plan.

Who Can Vote on or Object to the Plan?

All identifiable asbestos claimants or their attorneys will receive the "Solicitation Package". This includes the Plan, Voting Ballot, and other information. If you have not filed a claim yet, you can vote on the Plan by providing certified information about your claim, or making a motion to vote as described in the Solicitation Package available online or by calling the toll-free number.

You will need to vote on the Plan by **October 6, 2015**. The FCR will support and vote to accept the Plan on behalf of the future claimants. **You may also object to the Plan and the adequacy of the FCR's representation of future claimants by October 6, 2015.**

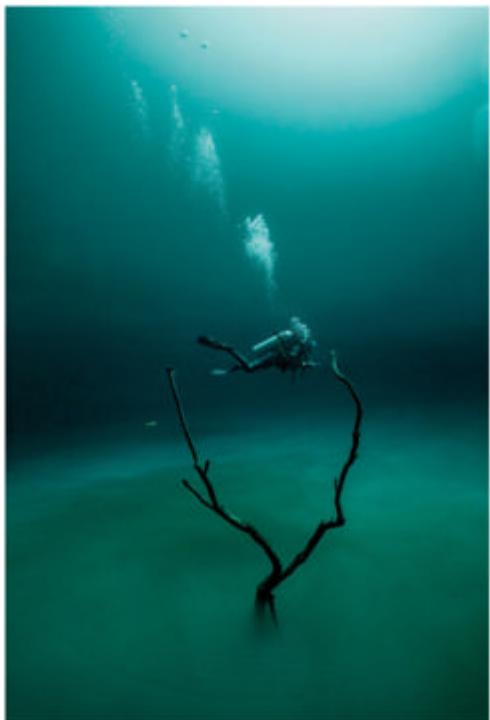
When will the Court Decide on the Plan?

A hearing to consider confirmation of the Plan will begin at 10:00 a.m. ET on June 20, 2016, at the US Bankruptcy Court, Western District of North Carolina, 401 West Trade Street, Charlotte, NC 28202.

For Information: www.GarlockNotice.com 1-844-Garlock

Behind the Adventure

Assignment We asked to see photos that show what inspired you during a challenging new experience.



EDITOR'S NOTE

“Rarely do we see the unguarded moments of an adventure. These images showed the personal, transformative, beautiful, humorous, and even painful moments of exploring.”

—*Jimmy Chin, National Geographic photographer*

Fabrice Guérin
Paris, France

In a cenote near Tulum, Mexico, Guérin went diving with his wife. As they dived deeper, the water color changed from blue to green and the water itself from fresh to salt water. The atmosphere, Guérin says, felt like a lunar landscape.

Gabe R. DeWitt
Morgantown, West Virginia

DeWitt and four friends were hiking near May Lake in Yosemite National Park. While they were camped, he noticed that his photos around the fire were coming out overexposed. Only when the flames died down did he get a softer glow.



DANGEROUS GAME

A hunter from a small village in the Democratic Republic of the Congo (DRC) adjusts the mask that he'll wear while stalking game. The consumption of infected bush meat is one way Ebola virus passes to humans.

STALKING

Ebola doesn't disappear.



A KILLER

It just goes into hiding.

WorldMags.net





UNDER SUSPICION

Straw-colored fruit bats swarm in an Ivory Coast village. Fruit bats, some of which have been suspected of carrying Ebola, are abundant in many parts of Africa and are often eaten.





STRICKEN

Delirious from Ebola, a man is lifted after he tried to climb the wall of the Hastings Ebola treatment center near Freetown, Sierra Leone's capital. Twelve hours later he died, one more fatality in a count that now exceeds 10,000.



BY DAVID QUAMMEN PHOTOGRAPHS BY PETE MULLER

No one foresaw, back in December of 2013, that the little boy who fell ill in a village called Méliandou, in Guinea, West Africa, would be the starting point of a gruesome epidemic, one that would devastate three countries and provoke concern, fear, and argument around the planet.

No one imagined that this child's death, after just a few days' suffering, would be only the first of many thousands. His name was Emile Ouamouno. His symptoms were stark—intense fever, black stool, vomiting—but those could have been signs of other diseases, including malaria. Sad to say, children die of unidentified fevers and diarrheal ailments all too frequently in African villages. But soon the boy's sister was dead too, and then his mother, his grandmother, a village midwife, and a nurse. The contagion spread through Méliandou to other villages of southern Guinea. This was

almost three months before the word "Ebola" began to flicker luridly in email traffic between Guinea and the wider world.

The public health authorities based in Guinea's capital, Conakry, and the viral disease trackers from abroad weren't in Méliandou when Emile Ouamouno died. Had they been, and had they understood that he was the first case in an outbreak of Ebola virus disease, they might have directed some timely attention to an important unknown: How did this boy get sick? What did he do, what did he touch, what did he eat? If Ebola virus was in his body, where did it come from?

Among the most puzzling aspects of Ebola virus, since its first recognized emergence almost four decades ago, is that it disappears for years at a time. Since a 1976 outbreak in what then was Zaire (now the Democratic Republic of the Congo) and a simultaneous episode with a closely related virus in what was then southern Sudan (now South Sudan), the sequence of



Ebola events, large and small, has been sporadic. During one stretch of 17 years (1977-1994) not a single confirmed human death from infection with Ebola virus occurred. This is not a subtle bug that simmers delicately among people, causing nothing more than mild headaches and sniffles. If it had been circulating in human populations for those 17 years, we would have known.

A virus can't survive for long, or replicate at all, except within a living creature. That means it needs a host—at least one kind of animal, or plant, or fungus, or microbe, whose body serves as its primary environment and whose cell machinery it can co-opt for reproducing. Some harmful viruses abide in nonhuman animals and only occasionally spill into people. They cause diseases that scientists label zoonoses. Ebola is a zoonosis, an especially nasty and perplexing one—killing many of its human victims in a matter of days, pushing others to the brink of death, and then vanishing. Where does it hide, quiet and inconspicuous, between outbreaks?

Not in chimpanzees or gorillas; field studies have shown that Ebola often kills them too. Dramatic die-offs of chimps and gorillas have

Scientists wondered whether Angolan free-tailed bats might be Ebola reservoirs after they discovered that the first victim, a small boy named Emile Ouamouno, may have played in a tree (left) in Mériandou, Guinea, where the bats roosted. Above, Emile's father holds snapshots of his family—all gone but him.

occurred around the same time and in the same area as Ebola virus disease outbreaks in humans, and some carcasses have tested positive for signs of the virus. Scavenging ape carcasses for food, in fact, has been one of the routes by which humans have infected themselves with Ebola. So the African apes are highly unlikely to harbor Ebola. It hits them and explodes. It must lurk somewhere else.

The creature in which a zoonotic virus exists over the long term, usually without causing symptoms, is known as a reservoir host. Monkeys serve as reservoir hosts for the yellow fever virus. Asian fruit bats of the genus *Pteropus* are reservoirs of Nipah virus, which killed more than a hundred people during a 1998-99 outbreak in Malaysia. Fruit bats also host Hendra





RISKY BELIEF

A healer prepares to exorcise a girl in Méliandou. Popular beliefs blame many ailments, including Ebola (which this girl did not have), on sorcery or malign spirits. Contact through some traditional practices can help spread the virus.

virus in Australia, where it drops from bats into horses, with devastating effect, and then into horse handlers and veterinarians, often killing them. The passage event, when a virus goes from its reservoir host to another kind of creature, is termed spillover.

As for the reservoir host of Ebola—if you have heard that fruit bats again are the answer, you've heard supposition misrepresented as fact. Despite arduous efforts by some intrepid scientists, Ebola virus has never been tracked to its source in the wild.

"Where is it when it's not infecting humans?"

Karl M. Johnson said to me recently. Johnson is an eminent virologist, a pioneer in Ebola research, the former head of the Viral Special Pathogens Branch at the Centers for Disease Control and Prevention (CDC). He led the international response team against that initial 1976 outbreak in Zaire, a harrowing venture into the unknown. He also led a team that isolated the virus in a CDC lab, demonstrated that it was new to science, and named it after a modest Zairean waterway, the Ebola River. Johnson wondered back then about its hiding place in the wild. But the urgency of human needs during any Ebola outbreak makes investigations in viral ecology difficult and unpopular. If you're an African villager, you don't want to see foreigners in moon suits methodically dissecting small mammals when your loved ones are being hauled away in body bags. Thirty-nine years later, although we're beginning to learn a bit, Johnson said, the identity of the reservoir host "is still largely a monster question mark out there."

A Rain of Bats

In April 2014, soon after word spread that the cluster of deaths in southern Guinea involved Ebola, Fabian Leendertz arrived there with a team of researchers. Leendertz is a German disease ecologist and veterinarian, based at the Robert Koch Institute in Berlin, who studies lethal zoonoses in wildlife, with special attention to West Africa. He reached southern Guinea by driving overland from Ivory Coast, where he has worked for 15 years in Taï National Park

EBOLA IS NOT A SUBTLE BUG. IT KILLS MANY OF ITS HUMAN VICTIMS IN A MATTER OF DAYS, PUSHING OTHERS TO THE BRINK OF DEATH, BEFORE VANISHING.

on disease outbreaks among chimpanzees and other animals. He brought with him three big vehicles, full of equipment and people, and two questions. Had there been a recent die-off among chimps or other wildlife, possibly putting meat-hungry humans at risk from infected carcasses? Alternatively, had there been direct transmission from the Ebola reservoir host, whatever it was, into the first human victim? Leendertz knew nothing at that point about Emile Ouamouno. His team spoke with officials and local people and walked survey transects through two forest reserves, finding neither testimony nor physical evidence of any remarkable deaths among chimpanzees or other large mammals. Then they shifted their attention to the village of Méliandou, talked with people there, and heard a very interesting story about a hollow tree full of bats.

These were small bats, the quick-flying kind that echolocate and feed on insects, not the big creatures that fly out majestically at dusk, like a Halloween vision of nocturnal crows, to eat fruit. The locals called them *lolibelo*. They were dainty as mice and smelly, with wriggly tails that extended beyond their hind membranes. Showing pictures and taking descriptions, Leendertz's team ascertained that the villagers were probably talking about the Angolan free-tailed

bat (*Mops condylurus*). These bats had roosted in great numbers within a big, hollow tree that stood beside a trail near the village. Then, just weeks before, the tree had been burned, possibly during an attempt to gather honey. From the burning tree came what the people remembered as “a rain of bats.” The dead bats were gathered up, filling a half dozen hundred-pound rice sacks, and might have been eaten except for a sudden announcement from the government that because of Ebola, consuming bush meat was now prohibited. So the Méliandou villagers threw the dead bats away.

And there was something else about that hollow tree, the villagers told Leendertz’s team. Children, possibly including Emile Ouamouno, used to play in it, sometimes catching the bats. They would even roast them on sticks and eat them.

Leendertz consulted a colleague with expertise in recovering DNA from environmental samples, who told him it might be feasible to find enough beneath the tree to identify the bat species that had roosted there. “So I started running around with my tubes and spoon collecting soil,” Leendertz told me. Back in Berlin, genetic sequencing confirmed the presence of Angolan free-tailed bats. So this creature—an insectivorous bat, not a fruit bat—joined the list of candidates for the role of Ebola’s reservoir host.

The Hitchhiker

The first clues in this long mystery—clues that seemed to point toward bats—arose from disease outbreaks caused by Marburg virus, Ebola’s slightly less notorious relative within the group known as filoviruses. The story of Ebola is closely connected with that of Marburg, according to a seasoned South African virologist named Robert Swanepoel, who has long studied them both.

“The two are interlinked,” he said, as we sat before a computer screen in his Pretoria home, looking at photographs from his archive. Swanepoel, who hides a genial heart within a bearish exterior, is retired from the National Institute for Communicable Diseases (NICD), in Johannesburg, where he ran the Special Pathogens

Unit for 24 years, but is still busy with research and bristling with ideas and memories.

Back in 1967, nine years before Ebola itself was recognized, a shipment of Ugandan monkeys intended for medical research arrived in Frankfurt and Marburg, in West Germany, and Belgrade, in Yugoslavia, bringing with them an unknown but dangerous virus. Laboratory workers became infected in each place, and then, secondarily, some family members and health workers. Among 32 confirmed cases, seven people died. The new virus, a spooky, filamentous thing, like a strand of toxic vermicelli, was given the name Marburg virus. Eight years later an Australian student died of Marburg virus disease in a Johannesburg hospital after a hitchhiking trip across Rhodesia (now Zimbabwe). He and his girlfriend—she got sick too but recovered—had done a few things that might have exposed them to infection: slept on the ground in a pasture, bought some raw eland meat, fed some caged monkeys. And they had visited the Chinhoyi Caves, a complex of caverns and sinkholes in northern Rhodesia that, like many caves in Africa, have been known to harbor bats. Along the way the hitchhiker also sustained some sort of insect or spider bite, which raised a painful red welt on his back. Investigation of his case in the immediate aftermath focused much on the bite, little on the caves.

Two other early cases of Marburg virus disease did cast some suspicion on caves and the bats that roost within them. In 1980 a French engineer who worked at a sugar factory near the base of Mount Elgon, in western Kenya, ventured into Kitum Cave, a deep passage into the volcanic rock of the mountain sometimes entered by elephants looking for salt. The engineer’s cave visit was evidently a bad idea; he died of Marburg in a Nairobi hospital. In 1987 a Danish schoolboy climbed the mountain and explored the same cave during a family vacation, and he died of an infection with a virus (now known as Ravn virus) closely related to Marburg. These events engaged the notice of Swanepoel, down in Johannesburg. In 1995 came another outbreak—Ebola this time, not

Marburg—centered on the city of Kikwit in what is now the Democratic Republic of the Congo (DRC). The chain of human-to-human infections, which totaled 315 cases and 254 deaths, began with a man who farmed manioc and made charcoal in a forest area at the city's edge. Swanepoel flew to Kikwit, joining an international team of responders. He came down with malaria, went home, recovered, and in early 1996, with the support of the World Health Organization, returned. His primary task was to look for the reservoir host, searching the same ecosystem where the outbreak had begun at the same time of year. "Already by that stage," he told me, "bats were on my mind."

Swanepoel and his crew at Kikwit took blood and tissue not only from bats but also from a wide selection of other animals, including many insects. Screening those samples back at his lab in Johannesburg, he found no evidence of Ebola. So he tried an experimental approach, one that seemed almost maniacally thorough. Working in NICD's high-containment suite—biosafety level 4 (BSL-4), the highest—he personally injected live Ebola virus from the Kikwit outbreak into 24 kinds of plants and 19 kinds of animals, ranging from spiders and millipedes to lizards, birds, mice, and bats, and then monitored their condition over time. Though Ebola failed to take hold in most of the organisms, a low level of the virus—which had survived but probably hadn't replicated—was detected in a single spider, and bats sustained Ebola virus infection for at least 12 days. One of those bats was a fruit bat, the same little insectivore that would later catch Fabian Leendertz's attention in Méliamond. It was proof of principle, though not of fact: These creatures could be reservoir hosts.

Ten Thousand Haystacks

The events in Kikwit highlighted an important difference between Marburg and Ebola viruses that has persisted: Whereas outbreaks of Marburg virus disease usually begin around caves and mines, Ebola virus disease outbreaks usually begin with hunting and carcass scavenging,

EACH HUMAN OUTBREAK SEEMED TO START WITH ONE UNFORTUNATE PERSON, USUALLY A HUNTER.

Ebola outbreaks usually occur in isolated villages connected by bad roads and trails, such as this one in the DRC. The 2014 outbreak in West Africa was different—it quickly spread to urban areas.

which are forest activities. This suggests the two viruses may emerge from two different kinds of reservoir hosts—or if bats are the hosts, two different kinds of bats, cave roosters and tree roosters.

The pattern was reaffirmed during a cluster of Marburg outbreaks from 1998 to 2000, centered on a derelict gold-mining town called Durba, in the DRC. Bob Swanepoel led another expedition and found multiple chains of infection, most or all of which started with miners who worked underground. Miners who worked at open pits in the daylight were far more likely to stay healthy. This led Swanepoel to suspect cave-roosting Egyptian fruit bats as the virus source, though he didn't publish his suspicion at the time.

Then, beginning in late 2001 and extending into 2003, another series of small, independent outbreaks—of Ebola again, not Marburg—afflicted villagers in the densely forested borderlands of Gabon and the Republic of the Congo (which are west of the DRC, on the other side of the Congo River). Roughly 300 people became infected; almost 80 percent died. Meanwhile gorillas, chimpanzees, and duikers, small forest antelopes, started turning up dead in the same region. Each human outbreak seemed to start with an unfortunate person, usually a



hunter, who'd handled an animal carcass.

"People were dying, and different animals were dying," said Janusz Paweska, nowadays Swanepoel's successor as head of Special Pathogens at NICD, when I visited him in Johannesburg. "So we thought, This is a good time to hunt for the Ebola reservoir."

Swanepoel enlisted Paweska and others, then arranged a partnered expedition with Eric Leroy, a French virologist based in Gabon who had responded to earlier Ebola outbreaks there. He met with Leroy in Gabon's capital, Libreville, before heading into the field.

"I gave him a long story about how historically bats have been involved in Ebola and Marburg," Swanepoel told me. His team, he informed Leroy, had found fragments of Marburg, for instance, in the underground bats at Durba. Swanepoel had brought rodent traps, mist nets, and other collecting gear to Gabon. "Although I was fixated on bats, I said we had to cover everything," he recalled. That would include a variety of mammals, birds, mosquitoes, biting midges, and other insects. Swanepoel's group took home a third of the specimens

and sent a third to the CDC in Atlanta, leaving a third to be tested by Leroy. The processing moved slowly in Swanepoel's lab and at the CDC, amid many other projects, and yielded no positives. "We drew a blank."

But Leroy's group went back. Eventually his team made three field trips to the border area, capturing and sampling more than a thousand animals, including 679 bats, on which Leroy too was now fixated. In 16 of those bats, belonging to three different fruit-eating species, they found antibodies—proteins marshaled by the immune system—that had reacted against Ebola virus. In 13 other fruit bats they detected very short fragments of Ebola RNA. It's important to note that those two kinds of evidence, antibodies and viral fragments, are analogous to finding the footprints of a Yeti in snow. You might or might not have something real. Isolating live virus—that is, growing fresh and infectious Ebola from a tissue sample—is the higher standard of evidence, almost like finding a real Yeti's foot attached to a real Yeti in a leghold trap. Leroy's group didn't succeed in growing live virus from any samples. Still, in *(Continued on page 52)*



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MASKED FOR MEAT

Two hunters wearing camouflage stalk monkeys in a forest in northeastern DRC. Hunting isn't always about subsistence; the sale of bush meat sometimes provides cash for education and health care as well as spending money.

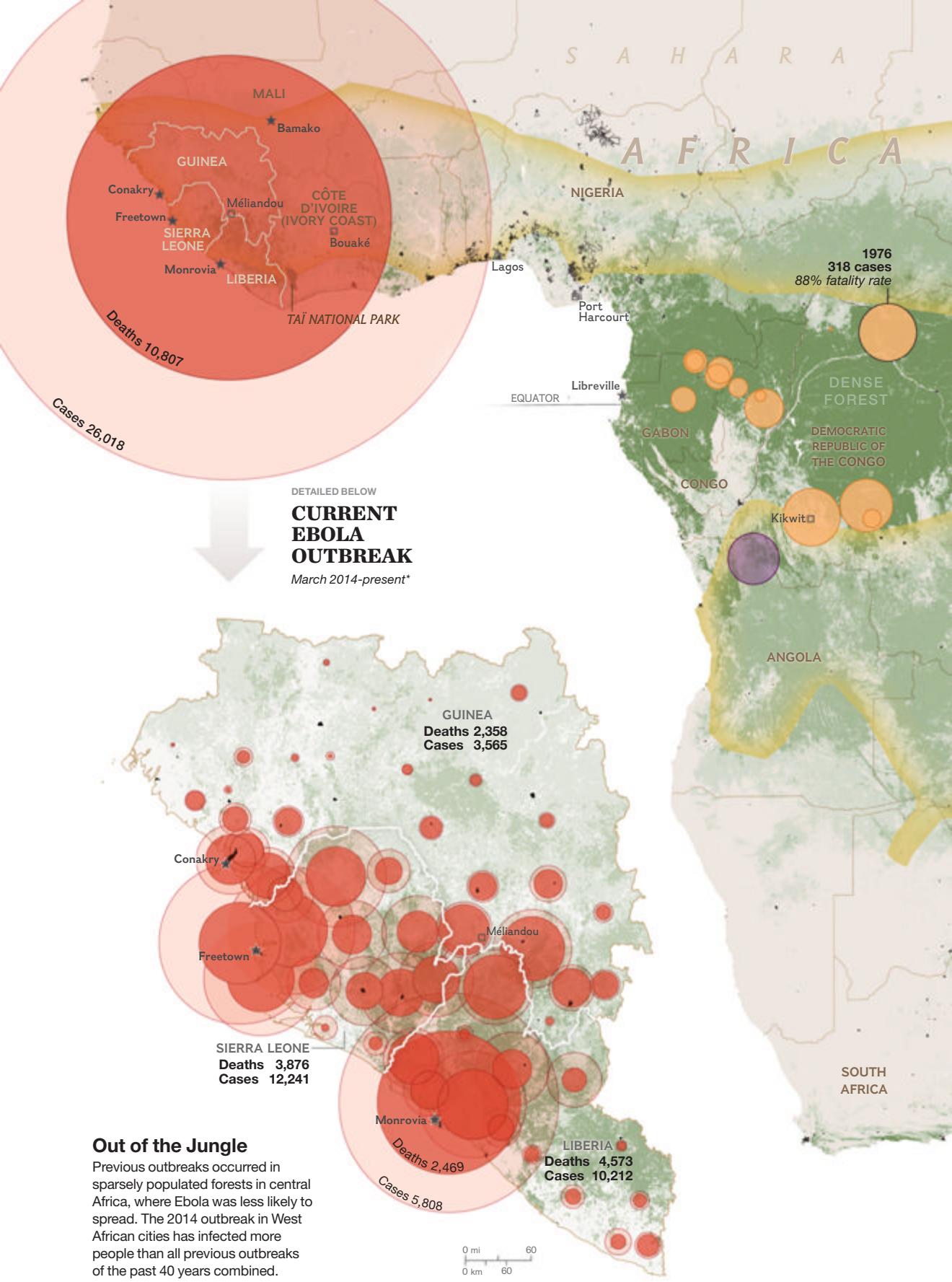


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A GRIEF TOO CLOSE

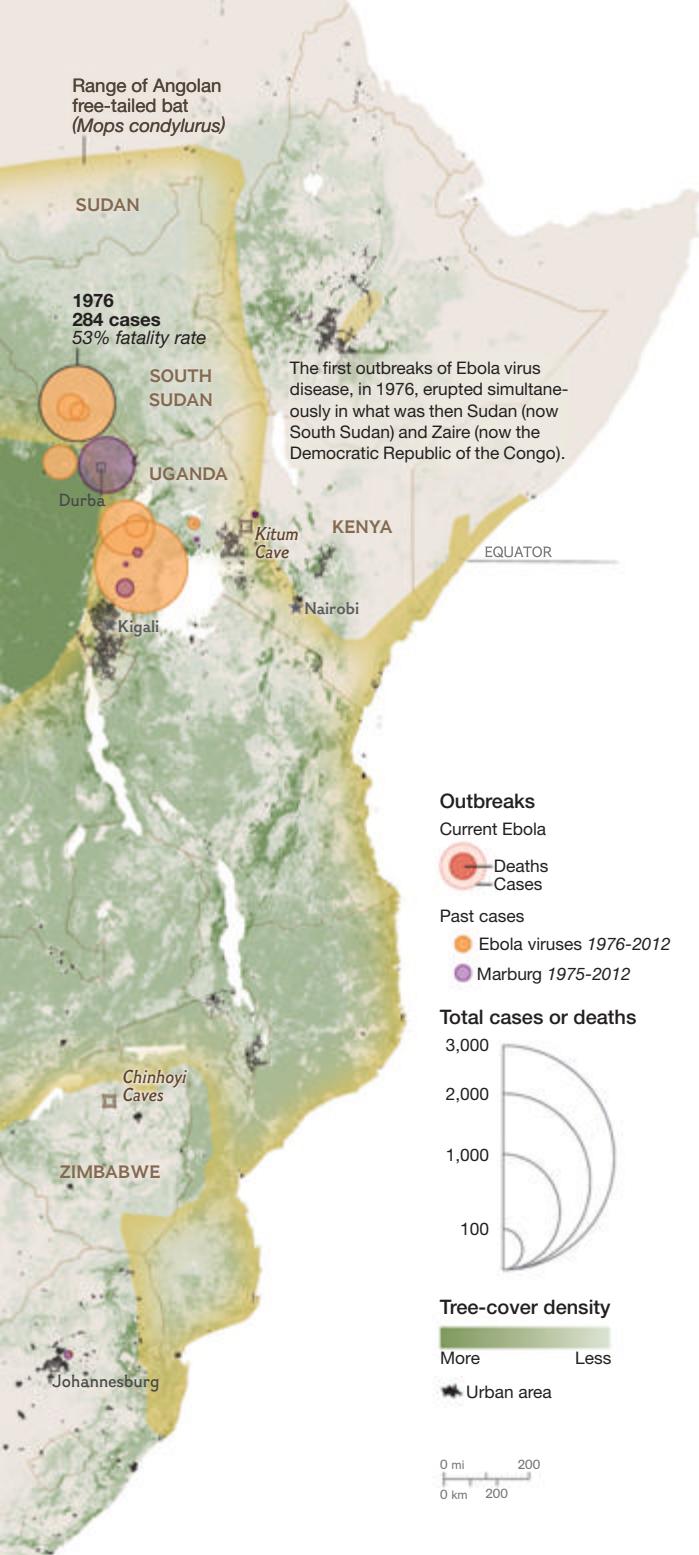
Yalala Therese sleeps beside her dead brother, laid out for his wake. The brother didn't die of Ebola, but if he had, such close contact—a common practice in West Africa as well as the DRC—would have risked infection.



Out of the Jungle

Previous outbreaks occurred in sparsely populated forests in central Africa, where Ebola was less likely to spread. The 2014 outbreak in West African cities has infected more people than all previous outbreaks of the past 40 years combined.

*TOTAL CONFIRMED, PROBABLE, AND SUSPECTED CASES AND DEATHS AS OF APRIL 19, 2015. WHO REPORTED THE FIRST CASES IN MARCH 2014.



A Family of Viruses

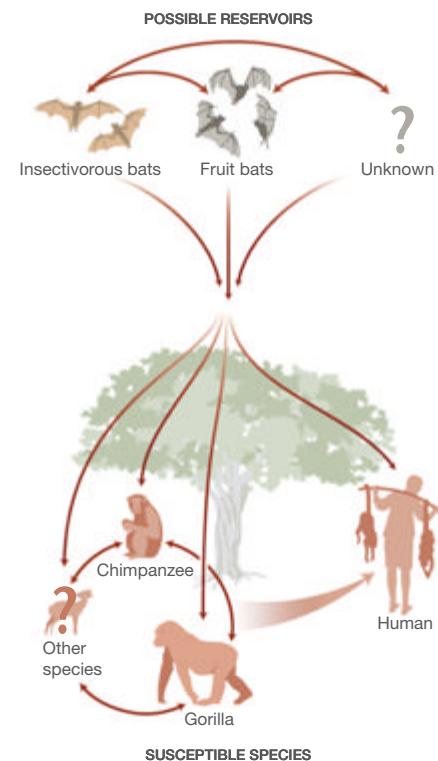
Besides Ebola itself, which is responsible for most outbreaks, four other viruses are recognized within the ebolavirus group: Sudan, Taï Forest, Bundibugyo, and Reston. All cause Ebola virus disease, except Reston, which is probably harmless to humans. Marburg, a closely related pathogen, was discovered in 1967. Marburg virus disease is also often fatal.

AN ELUSIVE ENEMY

No one knows for certain where the Ebola virus lurks between outbreaks; it has never been definitively tracked to a host species in the wild. Transmission to humans has been sporadic and extremely rare—but all too often deadly. Fatality rates in some outbreaks have reached 90 percent. Since Ebola was discovered in 1976, population growth in at-risk countries has nearly tripled, and people have become more mobile.

The Path to Humans

Three bat species have long been suspected of harboring Ebola. But one theory suggests a two-host system, in which the virus's ultimate host—perhaps some insect, tick, or other arthropod—must first infect a bat or other mammal. The virus can then pass to humans, typically when they handle bush meat.





INTO THE CITY

From villages such as Méliandou, the 2014 outbreak spread to urban areas, including Freetown's Kroo Bay. Crowding, poverty, and scant health services accelerated transmission, heightening fear and resentment.



2005 the journal *Nature* published a paper on these results, written by Leroy but with Swanepoel and Paweska credited as co-authors, titled “Fruit Bats as Reservoirs of Ebola Virus.” That paper, though cautious and provisional, is the primary source for all those careless, overly certain assertions you’ve seen in the popular media during the past year to the effect that Ebola virus resides in fruit bats.

Possibly it does. Or not. The paper itself says maybe.

“You tried to isolate live virus?” I asked Leroy during my stop in Gabon. He’s a courteous, dapper Frenchman, now director of the Centre International de Recherches Médicales de Franceville, who works in a white shirt and dark tie, at least when he’s not wearing a full protective suit in his BSL-4 lab or Tyvek coveralls in the forest. “Yes. Many, many, many times trying to isolate the virus,” he said. “But I never could. Because it was—the viral load was very, very low.” Viral load is the quantity of virus in the solid tissues or blood of the creature, and it tends to be much lower in a reservoir host than in an animal or person suffering an acute infection.

That’s just one of three reasons why finding a reservoir host is difficult, Leroy explained. The second is that, in addition to low viral load within each animal, the virus may exist at low prevalence within a population. Prevalence is the percentage of positive individuals at a given time, and if that happens to be as little as one animal in a hundred, then “the probability to detect and to catch this infected animal is very low.” If a single kind of animal amid the great diversity of tropical forests represents a needle in a haystack, then one infected individual within one population of animals amid such diversity represents one needle in ten thousand haystacks.

And the third constraint on the search for a reservoir host? “It’s extremely expensive,” Leroy said.

The Perfect Holiday

The cost of field operations in remote forest locations, as well as the competing demands upon

THE URGENCY OF HUMAN NEEDS IN AN OUTBREAK MAKES SCIENTIFIC INVESTIGATIONS DIFFICULT.

A Freetown couple mourns as a burial worker removes their day-old baby's body. The infant likely died of other causes, but officials ordered that all deaths in heavily affected areas be treated as cases of Ebola.

institutional resources, has hindered even veteran researchers such as Swanepoel and Leroy from mounting long-term, continuous studies of the Ebola reservoir question. Instead there have been short expeditions, organized quickly during an outbreak or just as a crisis was ending. But going to the site of a human outbreak to do research on the ecology of the virus is logically nightmarish and, as I’ve mentioned, offensive to local people. So those expeditions get delayed. The problem with delay is that the prevalence of Ebola virus within its host population, the viral load within individual hosts, and the abundance of virus being shed into the environment may all fluctuate seasonally. Miss the right season, and you might miss the virus.

Fabian Leendertz tried to address these difficulties by organizing a second field expedition, this one at roughly the same season as the fateful spillover that killed Emile Ouamouno, but a year later and in neighboring Ivory Coast. Angolan free-tailed bats are abundant there too, roosting beneath the roofs of village houses. Their very abundance in such close proximity to people suggests a further perplexing question, if the little-bat hypothesis is correct: With the virus so near, why don’t spillovers occur far more often? Leendertz wanted to trap those bats, as many as possible, and sample them for



evidence of Ebola. Photographer Pete Muller and I went with him.

Leendertz and his team, including a graduate student named Ariane Düx, focused on two villages outside the city of Bouaké, a trade hub near the country's center. After shopping for trap materials in Bouaké's market, scouting the villages for bat-filled houses, and paying respects to village elders, the team assembled their apparatus late one afternoon, in time for the fly out at dusk. The traps were cone-shaped structures, jerry-built of long boards and translucent plastic sheeting, designed to capture bats as they emerged from a roof hole and funnel them down into a plastic tub. Amazingly, the system worked. At 6:25 p.m. on the first evening one trap came alive like a popcorn popper, as dozens of small gray bodies slid down the sheeting and thumped into the tub.

For the next phase Leendertz and Düx suited up in medical gloves, respirator masks, gowns, and visors. With a naked lightbulb hanging above their makeshift lab table, they began processing bats: weighing and measuring each animal, noting sex and approximate age, injecting

an electronic chip the size of a caraway seed for later identification, and most important, drawing blood from a vein in the animal's tiny arm. One well-aimed poke with a delicate needle, and a blood drop would appear, to be gathered with a fine pipette. Düx and Leendertz worked together at close range, trustingly sharing tasks, and it occurred to me that if she poked twice at the vein and missed the second time, jabbing Leendertz's finger instead, he could have an Ebola-related needle-stick injury. But she didn't miss.

The blood went into small vials, for freezing immediately in a liquid-nitrogen tank and eventual screening back in Berlin. A small fraction of all the captured bats would be killed and dissected, so that snippets of their internal organs, especially liver and spleen, where viruses often concentrate, could be added to the trove of frozen samples. The other bats would be released. If a blood sample from one dissected individual later tested positive for antibodies or viral fragments, its organs would then be used in an attempt (more dangerous and more expensive, done only in a BSL-4 laboratory) to isolate live Ebola virus.



LAID TO REST

Gravediggers pause after a long, grim day at the Freetown King Tom Cemetery. As the epidemic peaked, in November 2014, the cemetery averaged some 50 burials a day.



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ON HIS OWN

After weeks in the Hastings center near Freetown, Molai Kamara finds himself alone in the world. According to doctors there, the boy lost his entire family to Ebola and, though clear of the virus, still suffers from ulcers himself.



The search for Ebola's hiding place led Fabian Leendertz to gather blood and tissue from an Angolan free-tailed bat (above). Leendertz (right, with flashlight) and local men examine a roosting site of the same small bat, above the ceiling of a house in an Ivory Coast village.

After a few bats Leendertz stepped back from the processing work and allowed an Ivorian graduate student, Leonce Kouadio, tall, mild mannered, and thin as a candle, to take his place. This was a training mission as well as a scientific investigation, after all, and Leendertz wanted to give his protégés a richness of experience. Kouadio had good skills already, and as he got into rhythm, sharing these exacting tasks in the warm African night, I noticed the T-shirt beneath his medical gown, which carried some sort of resort logo and said, IT'S THE PERFECT HOLIDAY. For him, maybe, but not for everybody.

A Strange Host

Back in the United States, I spoke with more experts during a stop at the CDC in Atlanta and

by telephone. When I asked why it's important to identify the reservoir host of Ebola virus, they all agreed: because that information is essential to preventing future outbreaks. On other points they diverged. The most unexpected comment came from Jens Kuhn, a brainy young virologist now at the National Institutes of Health and, by way of his tome *Filoviruses*, arguably the pre-eminent historian of Ebola. I've known Kuhn as a candid source but also a lively and generous friend since we met at a conference hosted by Eric Leroy. Why do you think that after 39 years, I asked him, the reservoir of Ebola is still unidentified?

"It's a strange host."

"A strange host," I repeated, not sure I'd heard right.

"That's what I think."

His logic was complex, but he sketched it concisely. First, outbreaks of Ebola virus disease have been relatively infrequent—only about two dozen in nearly 40 years. Rare occurrences. Almost every one was traceable to a single human case, infected from the wild, followed by human-to-human transmission. This



suggests, he said, that the sequence of events yielding spillover has to be “extraordinary and weird.” Highly unusual circumstances, an unlikely convergence of factors. Second, there’s “the remarkable genome stability of the virus over the years.” It didn’t change much, didn’t evolve much, at least until the human case count in West Africa started going so high, providing many more opportunities for the virus to mutate. That stability might reflect “a bottleneck somewhere,” Kuhn said—a constraining situation that keeps the virus scarce and its genetic diversity low. One possible form of bottleneck would be a two-host system: a mammal host such as a bat species that becomes infected only intermittently, when it gets bitten by a certain insect or tick or other arthropod,

perhaps relatively rare or narrowly distributed, which is the ultimate host of the virus. As we both knew, this harked back to that hitchhiker in Rhodesia in 1975 who suffered an odd little bite and then died of Marburg. It evoked the spider in Bob Swanepoel’s lab that carried Ebola for two weeks.

What would you do, I asked him, if you had a big research grant for nothing but finding Ebola’s reservoir? Kuhn laughed.

“I’m going to make myself unpopular,” he said, “but I would still look into insects and other arthropods.”

He doesn’t have that big grant, nor does anyone else. The mystery remains. The stakes are high. The samples from Ivory Coast have so far yielded no positives. The search continues. □

ONE MORE THING



While on assignment for this story, photographer **Pete Muller** also shot four stories about West Africa’s Ebola outbreak for nationalgeographic.com. He lives in Nairobi, Kenya.

► **Did fear of catching the virus ever prevent you from getting close to your subjects?** Yes. I thought it would be powerful to show home care,

but it’s so dangerous to be in a house with somebody who is actively sick and still alive. There are certain things that are just really inadvisable to do.

FOOD

The Future of Food natgeofood.com

This story is part of National Geographic's Future of Food initiative, a special five-year project that seeks to show how what we eat makes us who we are.





On a Roll

How a Los Angeles chef took a crazy idea and helped launch a food movement on wheels



*By David Brindley
Photographs by Gerd Ludwig*

I

t's 10 p.m. on a chilly Saturday in Los Angeles. Some 30 people, braving 48°F weather—hat-and-scarf cold for L.A.—line up along the sidewalk in front of a converted step van parked on the street. The windows

slide open, and the phenomenon that is the Kogi BBQ food truck kicks into high gear.

Kogi BBQ has been drawing crowds, and accolades, since 2008, when two friends hatched a plan to fuse Korean barbecue with Mexican tacos and then hawk them from a truck on L.A.'s streets. Food trucks aren't new to the city's landscape. For decades they've offered cheap eats along roadsides and at construction sites across southern California. But they were often disparaged as "roach coaches." So a Korean-taco truck was "a crazy idea," writes Kogi BBQ founder Roy Choi in his memoir, *L.A. Son*.

That idea turned out to be "genius and ingenious," says Barbara Fairchild, former editor of *Bon Appétit* and a longtime L.A. resident. The genius came in the kitchen.

Choi, 45, was born in Korea and immigrated with his family to L.A. when he was two. Drawing on

flavors from his native cuisine—fused with Mexican dishes—and his top-notch chef training from the Culinary Institute of America, he concocted the deeply flavored caramelized short-rib barbecue and smoky-spicy salsas that top two crisp corn tortillas. The resulting tacos, what Choi calls "Los Angeles on a plate," were an instant culinary classic. Through his simple yet revolutionary cooking, Choi unleashed the power of food to cross cultures and race.

"I picked up on the feeling that food was important," he writes, "and not just a meal to fuel yourself to do something else."

What put Kogi on the map, though, was its early adoption of social media to lure customers. Initially Kogi's small crew didn't have much luck selling to buzzed late-night bar-hoppers outside nightclubs on Sunset Boulevard. Then the team tapped into the emerging

@RiceBallsOfFire

Trucks use Twitter to broadcast their daily locations, such as this car show and race in Fontana, California. Posing in front of the Rice Balls of Fire truck, model Tyler McEwen displays fare from nearby @Berlinfoodtruck.



@CurrywurstTruck



@EatPizzanco



@dogtowndog



@komodofood



@ChickAndRiceLA



@luckdishLA



@TheLobosTruck



@sayfishtaco



@guerrillatacos



@CVTSoftServe



@Berlinfoodtruck



@GoodGreekGrub



@SteelCitySndwch



@tacozone



@COOLHAUS



@gofusionngrill

Emblazoned with eye-catching graphics, trucks (usually converted step vans or trailers) attract customers along L.A.'s streets as well as at private events. Food varies from hot dogs to rice bowls to ice cream.

Food Truck Nation

Food trucks are no passing fad. Serving freshly cooked food typically with upscale ingredients at affordable prices, they're now part of the urban landscape across the country. Their phenomenal growth since 2008 has been fueled by the strength of social media: Trucks use Twitter and Facebook to update their locations and attract customers. Low start-up costs, compared with restaurants, also allow entrepreneurial chefs to enter this booming food industry. In that respect, food trucks can act as incubators of new trends.

2014 Revenue in the U.S.
\$828 MILLION



The food truck business has grown 80% since 2009, and it's on the way to becoming a billion-dollar industry by 2020.

Getting a Business Rolling

 vs. 
\$75k **\$250k**

Costs can vary depending on the city and type of restaurant, but setting up a food truck is significantly less expensive than opening a brick-and-mortar location.

Outfitting a Truck Major expenses

	\$43,000 Median used truck price		\$5,000 Truck decals		\$500 Electronics		\$500 Permits
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Customers at Food Trucks

50%

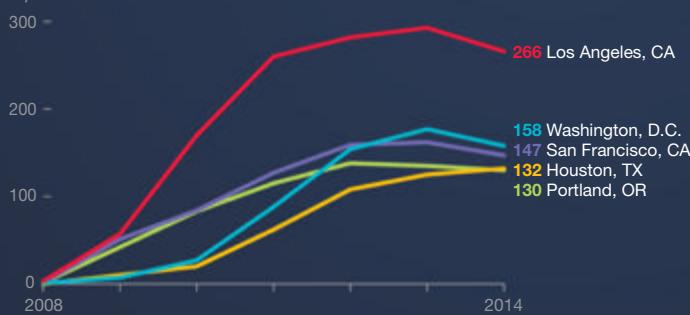


Share of people in the U.S. who have eaten at a food truck

Food Followers

Tracking tweets on Twitter is the best means of charting industry growth in cities across the country.

Top five U.S. cities with the most trucks on Twitter



Social Stats

5,507 x 

trucks, across **236** U.S. cities, actively used Twitter to reach their customers in 2014.

 **4,876,797** tweets were sent by food trucks in 2014.

Most Common Truck Specialties

1. Cheeseburgers



2. Mexican/tacos



3. Desserts



4. American classics



5. Sandwiches



power of social media. Using Twitter—a mobile app that allows users to share short messages with friends and followers—Kogi constantly updated customers on its changing location. A groundswell of young, plugged-in urbanites appeared, tracking Kogi's whereabouts. Within months Kogi was attracting hundreds of customers—and dishing out up to 400 pounds of meat—at several stops every day.

Newsweek called it "America's first

TODAY THOUSANDS of upscale food trucks roam city streets from San Francisco to Austin to Washington, D.C., broadcasting their whereabouts to sell everything from bespoke grilled cheese sandwiches and luxurious lobster rolls to handcrafted ice-cream cones and freshly popped popcorn. What seemed to be a passing fad is now a growing, \$800 million annual industry.

It has spawned books and apps

Jen Ju @jenjunaicha

You know I only joined Twitter back in the day to follow @kogibbq when they didn't have a calendar/schedule...

viral eatery." Kogi BBQ now has 132,000 followers, and its fleet has expanded to four roaming trucks and a truck stall at LAX airport.

Oddly enough, the economic downturn in 2008 was an ideal incubator for the supply and demand for food trucks. Chefs and entrepreneurs supplied talent and passion to start food truck businesses at a fraction of the cost of opening a restaurant. On the demand side, diners strapped by a tanking economy were willing to plunk down up to ten bucks for authentic, creative dishes that were a bargain compared with high-end restaurant prices. Social media then connected trucks and customers to forge an entirely new food movement.

and even, last year, a Hollywood movie. *Chef* stars Jon Favreau as a disgraced former chef who buys a truck and finds redemption slinging Cuban sandwiches on a cross-country road trip with his social-media-savvy son. (Choi makes an appearance during the credits, teaching Favreau to make a grilled cheese sandwich.) And an American invasion of food trucks, dishing up favorites, including, yes, Korean tacos, has arrived in Milan, Italy, for this year's World's Fair.

Yet even in a booming industry, it's a tough business. "You can't just show up and expect to make a lot of money running a food truck," says Ross Resnick, founder of Roaming Hunger, a smartphone app that

ONE MORE THING



Longtime contributing photographer **Gerd Ludwig** (@GerdLudwig) lives in Los Angeles and feels a kinship with food truck owners: "Like me, they have to be flexible, open, and able to react on the spot."



L.A. native **David Brindley** (@wordies) is managing editor of National Geographic. "The less romantic side of street food," he says, "is finding yourself scarfing tacos at a bus stop because there's nowhere else to sit."



@eatsonofabun

Halloween partyers enjoy freshly made meals from food trucks at local public radio KCRW's annual masquerade ball. The fund-raiser features several bands and is held on the grounds of L.A.'s Park Plaza Hotel. Special events guarantee customers—and cash—for area food truck businesses.





@kogibbq



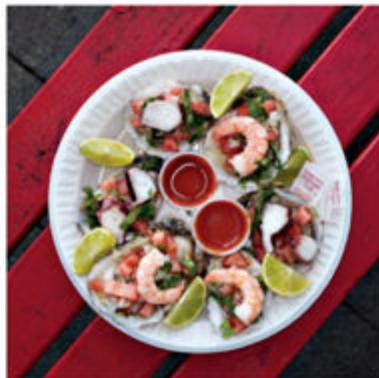
@CometBBQ



@StreetsofThai



@stuffedcrepe



@MariscosJalisco



@eatfrachs



@CurrywurstTruck



@StreetKitchenLA



@japadog



@KingKoneLA



@nomadtruck



@farmersbelly



@SteamyBunTruck



@TheLobosTruck



@ptcow



@wisebarbecue



@VCHOSTRUCC



@keepongrubbins



@RollinLobster



@luckdishLA



@BanhInTheUSA



@Berlininfofoodtruck



@angieswieners



@fryfryfoodtruck

Like street food purveyors around the globe, L.A.'s food trucks offer fast, filling meals to hungry diners. Dishes often mash up diverse cuisines and flavors to create new classics, such as Korean tacos (top far left).

maps real-time locations of hundreds of food trucks in cities across the country. "You have to have a brand and a strategy."

More often than not, branding starts with a punny name: Bánh in the USA (Vietnamese sandwiches), Belly BombZ (spicy chicken wings), Dog Gone It (hot dogs), Ragin' Cajun (Creole), Waff-N-Roll (waffle sandwiches). Strategy often involves finding a niche, as did the Polka Pierogi Truck, which makes

dishes to Chow Mein Chinese food, Dogtown hot dogs, Kabob Kings, and Roadhouse Rotisserie barbecue. Venice Beach's trendy Abbot Kinney Boulevard hosts a bustling food truck rally every first Friday of the month. Food flies fast at the festival, and trucks can bring in thousands of dollars in business. That's a lot of two-dollar tacos.

BACK AT THE KOGI BBQ truck on that cold Saturday night, the line slowly

Mrs. J @mrsjjohnston

Props to @dogzillahotdogs for the recommendations!!! Yakisoba and an egg on my hot dog? Yes please!

Sunday-morning pilgrimages to a predominantly Polish church.

Branding also is emblazoned on the trucks themselves. Leaving behind bare, quilted-aluminum siding, today's trucks are heavily adorned with graphics, spray-painted art, stickers. Their exteriors are almost as heavily tattooed as the typical young chefs working in the trucks' cramped interior kitchens—roughly the size of two large dining tables.

Although trucks strive to make their brands unique, there's also strength in numbers. Many trucks congregate in high-pedestrian areas. On any given day, a dozen or more trucks line up at lunchtime along Wilshire Boulevard across the street from the Los Angeles County Museum of Art. With office buildings on one side and the museum on the other, trucks can rely on a steady stream of customers.

One busy Monday, hundreds of office workers and visitors chose from a veritable smorgasbord on wheels, from Azteca Mexican

snakes forward but stretches longer and longer as more customers arrive. Smartphones in hand, the mostly hipster crowd snap photos of their tacos and send tweets. A murmur rumbles through the crowd that the truck has run out of kimchi, the spicy fermented cabbage that's a staple in Korean cuisine. No problem. There's plenty else on the menu, though people aren't necessarily here just for the food. Drifting along with the scent of spicy grilled meat is a whiff of community, a subtle sense of camaraderie in a shared experience.

There's a social nature to lines. Strangers spark conversations. A young couple from Cleveland on a California holiday reveal they drove two hours to stand in line. The pair ahead admit they walked two blocks from their home, dog in tow, for a quick Kogi fix. The couples share laughs, stories. They order, they get their food, they dig in. Simple, soulful, satisfying. That's not such a crazy idea after all. □

@pienburger

At Pasadena's Rose Bowl, the Pie 'n Burger food truck (bottom right) provides food and drink to tutu'ed participants in the Epilepsy Foundation's fund-raising walk. Snapping photos and sharing via social media (top right) are as much a part of street food culture as the food itself.



THE CHILI PHILO



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Down-home dishes meet high-end, locally sourced ingredients in the Chili Philosopher's \$11 Triple Beef Chili n' Cornbread combo. A strong brand identity and an aggressive social media strategy are essential to differentiate trucks in an increasingly crowded marketplace. That, and delicious food.

CHILI PHILOSOPHER



ORDER

ALL ITEMS SUBJECT TO TAX

GRILL VENISON FEE
DUAL GRILL FEE

ALL ITEMS SUBJECT TO TAX





Orcas hunt for herring in Norway's Andfjorden. Members of the pod coordinate their moves, herding a mass of herring into a manageable ball. They then whip their tails against the ball, stunning or killing the fish.

FEEDING FRENZY

A photograph of several killer whales (orcas) swimming in the ocean. The water is a deep blue, and the orcas are dark with white markings on their heads and around their eyes. They are shown from various angles, some facing forward and others facing away, creating a sense of movement and depth.

Orcas show their smarts by working together to whip up a meal.



An adult male orca helps herd a school of herring in the deep waters of Andfjorden. Male orcas' tall dorsal fins distinguish them from females. Some members of the pod bunch the herring together as others feed.



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There are no orcas to speak of in Western literature. Although they look like mythic creatures, with their sleek bodies, panda-like colors, and pointy-toothed grins, killer whales don't figure as characters in our great novels. There's no orca equivalent of *Moby Dick*, the great white whale.

Many of us, though, do have an image of orcas, one informed by films of them performing in aquarium shows, such as those at SeaWorld—swimming in endless circles in tiny, sterile pools or leaping for our amusement. Some think captive orcas suffer severe psychological trauma from their sadly shrunken lives.

And that's heartbreaking, because when you're out with orcas in the wild, you sense what no show can ever capture: their spirit and sagacity, their joy and cunning, their love of the open ocean and of hunting and of life.

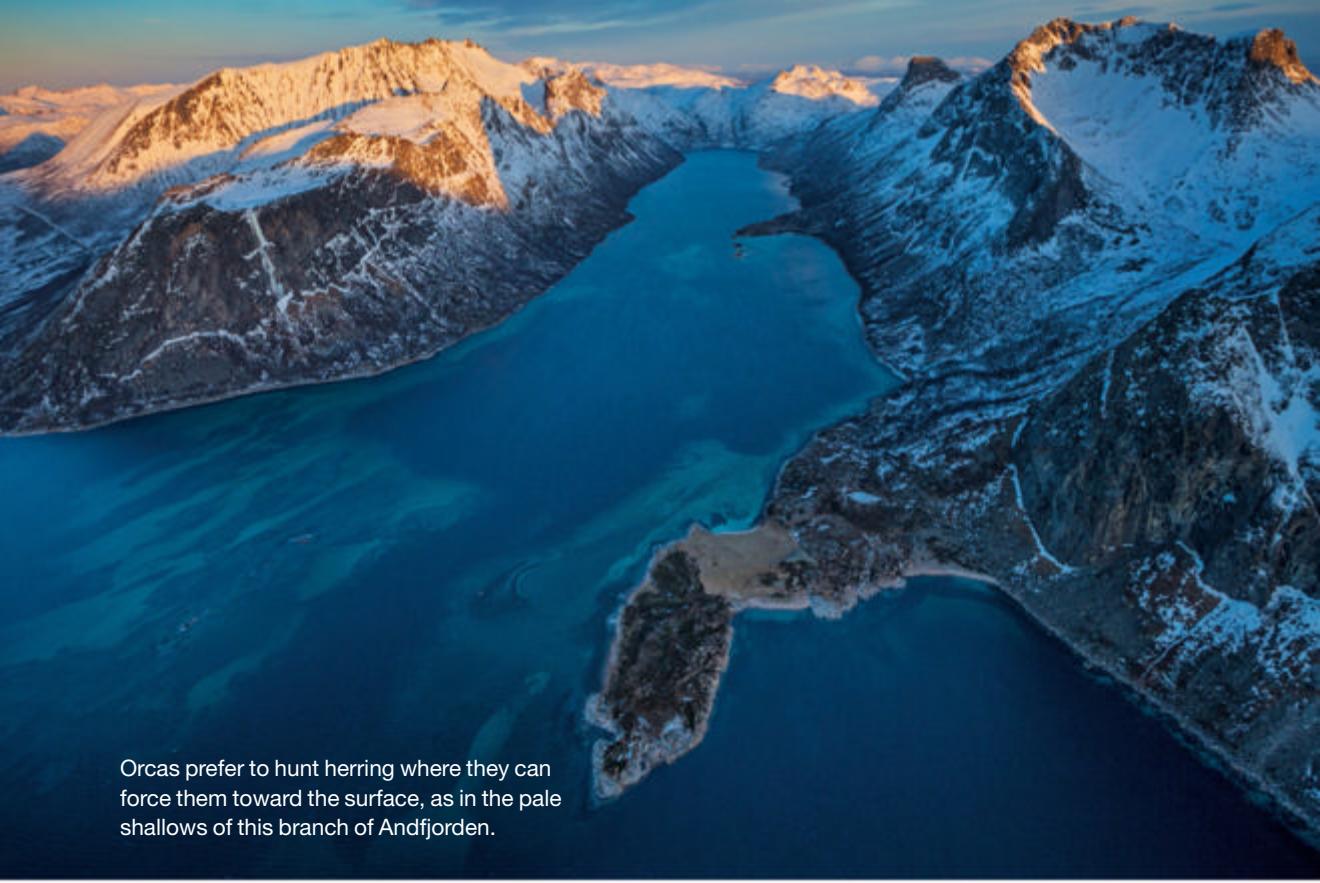
On a cold January day I was surrounded by hundreds of black-and-white killer whales—*Orcinus orca*, not a whale but rather the largest dolphin—streaking like wolves through the waters of Norway's Andfjorden, 200 miles north of the Arctic Circle. Their backs and tall dorsal fins glistened in the Arctic twilight as they dived and surfaced and worked in teams to corral, stun, and devour silver herring.

At times an orca would smack the surface with its tail, as if playing patty-cake with the sea. Orcas make similar tail strikes underwater—death knells for herring, said Tiu Similä, a cetacean biologist who helped pioneer the study of orcas

in Norway and is an expert on an orca hunting method called carousel feeding. The force of the blows doesn't always kill the fish, she said, but it does stun many, making them easy pickings. "What we're seeing here at the surface only gives a hint of what's happening below," she said. "Each whale has a role. It's like a ballet, so they have to move in a very coordinated way and communicate and make decisions about what to do next."

In spite of the numbers of herring, it isn't easy for the orcas to catch the fish, which are faster swimmers and form defensive, wall-like schools. Orcas can't just lunge at them and gulp quantities of fish and seawater as baleen whales do. Instead, like sheepdogs working a flock, they herd the schools into tight groups they can control. "The orcas have to stop the fish from diving," Similä said, "so they force them to the surface and keep them there in a ball by circling around them."

Pod members take turns diving beneath the school and looping around it—an orca carousel—while blowing bubbles, calling, and flashing their white bellies to frighten the herring. In response the fish swim even more tightly together. When a carousel is going full tilt, herding leap about on top of the water, desperately



Orcas prefer to hunt herring where they can force them toward the surface, as in the pale shallows of this branch of Andfjorden.

trying to escape. “It looks as if the sea is boiling,” Similä said.

Once the pod has the herring under control, one orca slams the edge of the school with its tail—serving up dinner.

But the orcas we were watching weren’t engaged in a classic carousel. They were swimming and diving fore and aft of a mass of fish but not circling beneath them. Even though the sea’s surface wasn’t boiling with fish, the orcas were feasting. Their tail strikes, the stunned and dead bodies of herring, and all the fish scales floating in the water like silver coins told Similä that.

CAROUSEL FEEDING IS one of several orca hunting tactics that some scientists, Similä included, consider one aspect of the species’ “cultures,” which include strategies for particular kinds of prey. In Argentina, orcas hurl themselves onshore to seize unsuspecting seal lion pups, timing their hunts to coincide with the waves and tides so that they won’t be beached long. In the Antarctic, pod members cooperate to make large waves that wash seals from ice floes. Younger orcas learn these techniques from older ones.

Orcas haven’t been documented, however,

cooperatively hunting with whales. Indeed orcas prey on sperm, gray, fin, humpback, and many other whales, which is why whalers called them killers of whales. It’s also why Similä was perplexed. Normally the orca pods here fished alone, but on this day humpbacks and fins were swimming among the orcas and eating the herring too. Around us dorsal fins of various shapes and hues broke the water. Orcas shot past, rounding up herring, while humpbacks hurtled skyward, jaws agape, gulping fish before the orcas could pick them off, and the fin whales merely showed their curved fins as they caught a quick breath before sinking back into the depths to feast.

“I’ve never seen anything like this,” she said. “Are they all working together to catch the fish?”

Because humpbacks use a method similar to carousel feeding—circling a school of fish or krill, then blowing bubbles to herd them into a ball—Similä thought they might be cooperating with the orcas. Or the orcas and the whales might be “travel feeding,” simply herding the immense school into a tighter group, then slapping the edge of the herring ball for a quick meal before moving on. “But travel feeding takes more energy than the carousel,” Similä

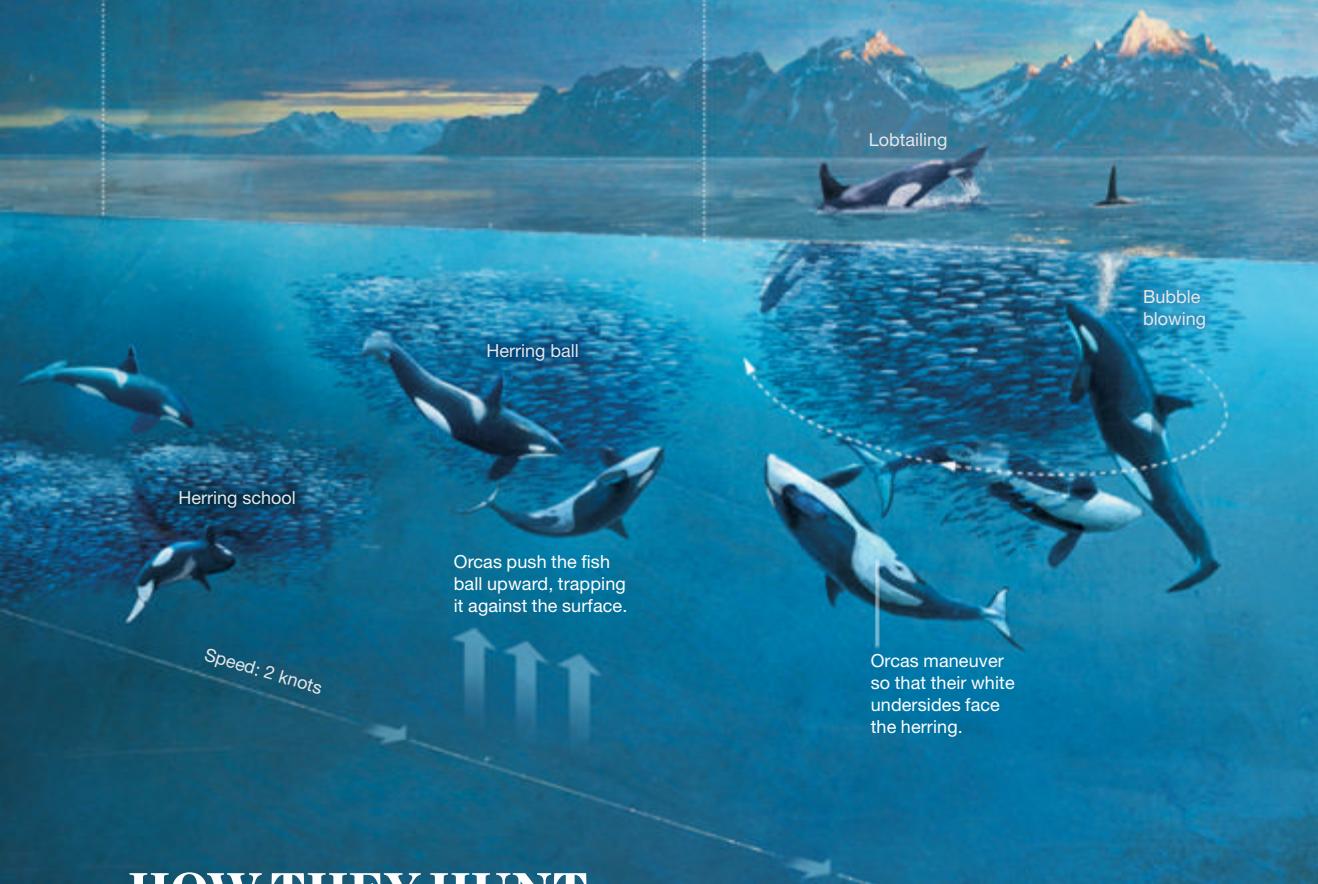
CAROUSEL FEEDING (Norway)

1 Splitting

In winter waters off the coast of Norway, killer whales work as a team—often in groups of three to nine—to round up herring. They're in constant communication, and their first step is to split a group of fish from the larger school.

2 Herding

Swimming in fast circles, the orcas herd the smaller group of herring into a tightening ball, making it easier to control and harder for fish to escape. Orcas blow bubbles, flash their bellies, and slap the surface with their tails (lobtailing) to scare their prey.



HOW THEY HUNT

An orca matriarch leads her pod as it herds a group of herring into a tight ball and pushes it toward the surface. This technique, called carousel feeding, is just one of many inventive methods used by killer whales in different parts of the world when hunting and capturing their prey.

WAVE WASHING (Antarctic waters)

Orcas swim in groups of up to seven toward ice floes, creating waves that break the floes into smaller pieces and eventually wash Weddell seals, a favored prey, off the ice and into the path of pod members lying in wait.



BEACHING (Punta Norte, Argentina, and Crozet Islands, Indian Ocean)

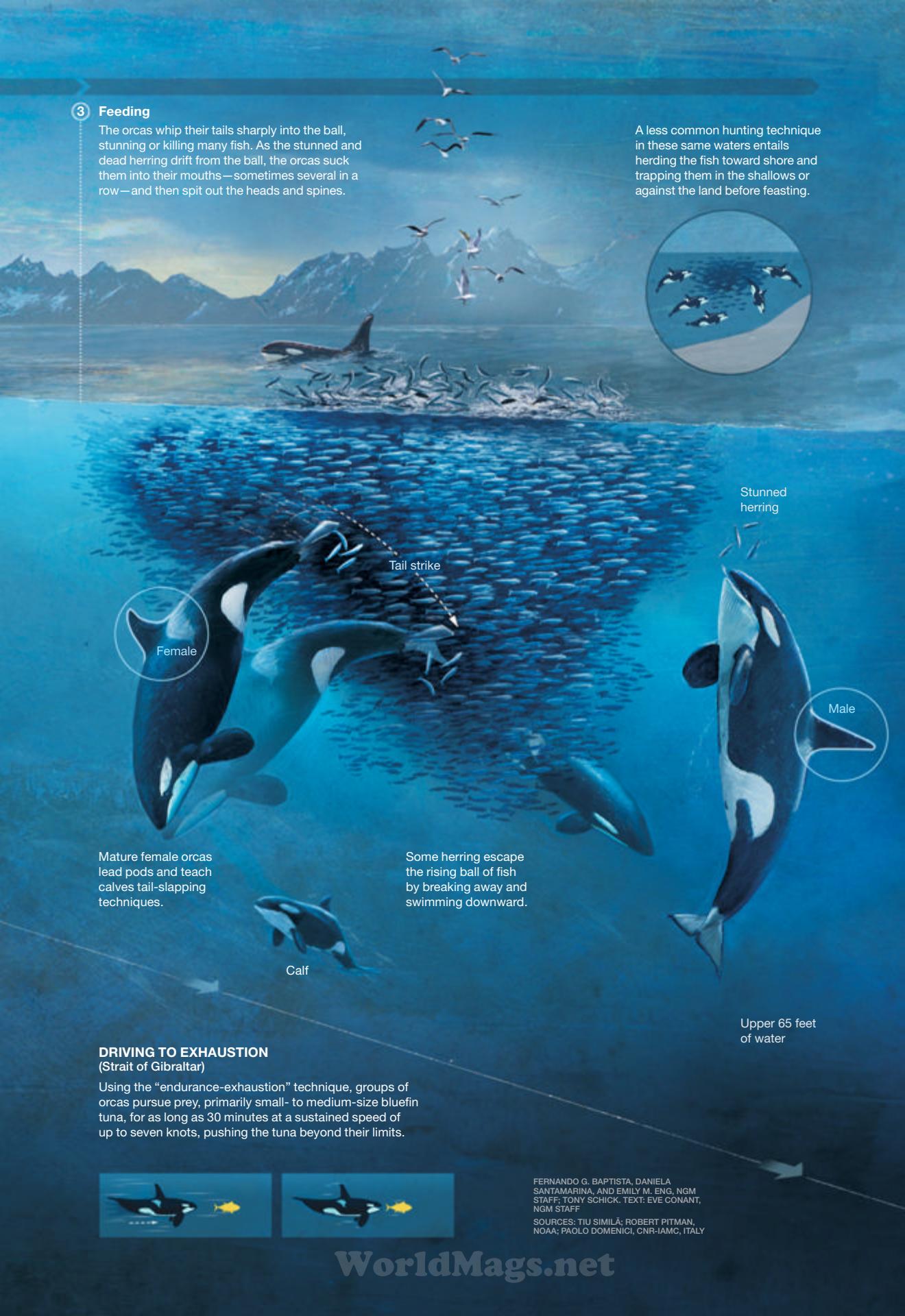
Killer whales chase sea lions or seals into the churning surf, catching them just before they reach the shore. Orcas are generally able to time their attacks and angle their bodies to avoid stranding themselves for long.



③ Feeding

The orcas whip their tails sharply into the ball, stunning or killing many fish. As the stunned and dead herring drift from the ball, the orcas suck them into their mouths—sometimes several in a row—and then spit out the heads and spines.

A less common hunting technique in these same waters entails herding the fish toward shore and trapping them in the shallows or against the land before feasting.



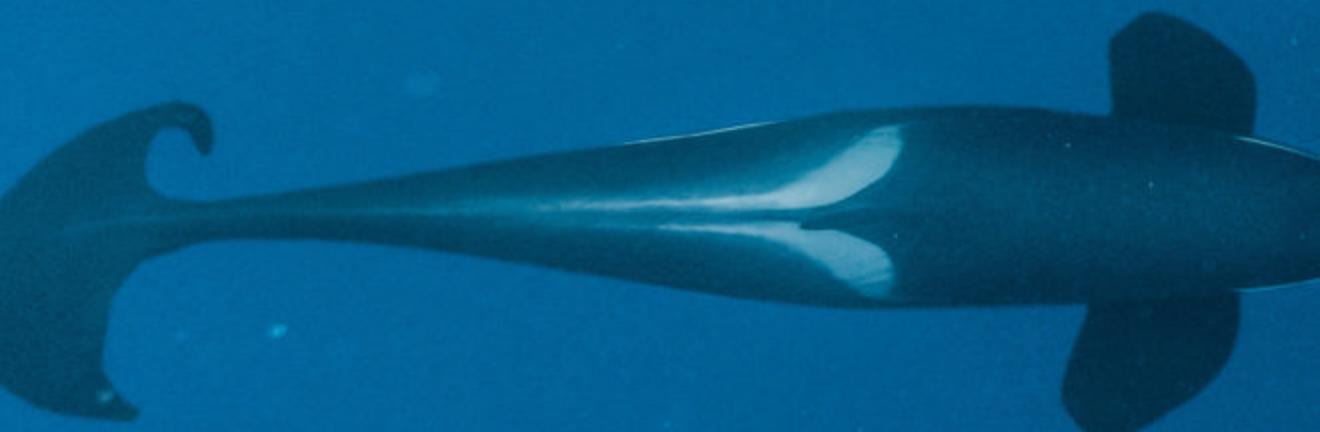
DRIVING TO EXHAUSTION (Strait of Gibraltar)

Using the “endurance-exhaustion” technique, groups of orcas pursue prey, primarily small- to medium-size bluefin tuna, for as long as 30 minutes at a sustained speed of up to seven knots, pushing the tuna beyond their limits.

FERNANDO G. BAPTISTA, DANIELA SANTAMARINA, AND EMILY M. ENG, NGM STAFF; TONY SCHICK. TEXT: EVE CONANT, NGM STAFF

SOURCES: TIU SIMILÄ; ROBERT PITMAN, NOAA; PAOLO DOMENICI, CNR-IAMC, ITALY

An orca moves into position to help nudge a tight ball of herring toward the surface. After herring at the edge of the ball have been stunned, orcas feed, not taking big gulps of the fish but picking them off one by one.





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said. "And with so many herring here, a carousel would seem to make more sense."

But the orcas never lingered long enough to carousel feed. They, the humpbacks, and the fins continued to rush past us as if speeding to a gala event, stopping now and then to snack. When we turned back toward our home base, a handsome yacht called the *Ylajali*, the moon was up, and the milky seas still rippled with whales on the move.

ORCAS, MEMBERS of the Delphinidae family, the marine dolphins, are the most widely distributed of all cetacean species. Yet despite being found in every ocean, often close to shore and at every latitude, from the Arctic to the Antarctic, they remain a mystery. We don't even know how many full-fledged species and subspecies are represented in the rough estimate of their overall population, which is thought to be at least 50,000.

Is that a healthy number? Or are they endangered? No one knows, because researchers

disrupted this pattern, and for a time orcas vanished from Norway's fjords. In the early 1980s herring populations rebounded, and orcas were again spotted in fjords south of Andfjorden. Similä, who's originally from Finland, was then a graduate student, researching plankton in Finnish lakes. She heard that Norwegian biologists were starting orca safaris and volunteered to work on their boats. On her first day a male orca's tall dorsal fin pierced the water beside the rubber dinghy she was riding in. The sight left her speechless—and erased all thoughts of plankton. She switched to orcas the next day.

For the next 20 years she followed the orcas every winter as they headed into the fjords in pursuit of herring. She and her colleagues photographed as many orcas as they could so that they could identify individuals, and they snorkeled with and filmed them as they fed.

"In those days nothing was really known about these orcas," Similä said. "People were

"One orca traveled so far and so fast—hundreds of kilometers in one day—we thought he was being pulled away by a ship."

—Tiu Similä, biologist

began counting them only in the 1970s and aren't sure how many are found in each of the ecotypes now recognized. Here in the North Atlantic there may be multiple ecotypes; Similä and I were observing orcas that specialize in feeding on herring. These orcas range across the Norwegian and Barents Seas and were estimated at around 3,000 in 1990. About a thousand of them—Similä and her colleagues call them Norwegian orcas—follow herring into the fjords. But herring aren't predictable prey. Their numbers can vary dramatically from year to year, and they don't live in the fjords year-round. They spawn along the coast in the spring, disperse into the Norwegian Sea in the summer to feed, and migrate in massive schools in the late autumn to an overwintering area, either off Norway's coast or in its fjords. Wherever they go, the orcas follow.

Overfishing by humans in the early 1960s

told that they were pests and dangerous—that they were eating all our fish."

Fishermen shot orcas on sight, killing 346 between 1978 and 1981, when the official culls stopped. Many Norwegians continued to consider orcas rapacious herring-eaters until 1992. That year a television station aired footage from Similä's study showing them daintily eating one fish at a time rather than gluttonously gulping down entire schools.

Orca pods that lost members to a shooter or had a wounded member appear to have never forgotten. "You can see scars on some orcas from the bullets," Similä said. "We could never get close to those pods. You still can't. As soon as they hear a motor, they move away."

Orca pods are led by the founding matriarch, and Similä thinks these "wise mothers" teach their calves to avoid fishing boats, thus

preserving the pod's memory. "I don't know how they communicate this. Maybe they just lead the others away when they hear a boat's motor. But they have some way of telling them, Look out—that's bad, that's dangerous."

ONE DAY, AFTER SEEING ORCAS spouting on the far side of the fjord, we motored across the two-mile expanse of sea into a calm lagoon. "It's a whale Eden," our guide proclaimed as orca pods surged nearby, their dorsal fins riding like sails above the sea, and humpbacks lunged for fish. One pod's calves playfully surfed in the wake of our boat and then, when the motor was idling, popped up nearby, like prairie dogs, to spy on us. Although these orcas weren't streaming through the sea, as they'd done on our first day, they still weren't carousel feeding.

Similä admired the way each orca had a role in the hunt. She'd seen how adults guided younger ones, how calves imitated their mothers' tail slapping, how pods sometimes made long journeys to the herring's spawning grounds, apparently to keep track of the fish. By attaching satellite tags to several of the orcas, she and her colleagues had mapped some scouting missions. "One of the orcas traveled so far and so fast—hundreds of kilometers in one day—we thought he was being pulled away by a ship," she said. "Now I just laugh at myself for thinking such a thing."

Similä tells an orca story that shows how little we know about them. In 1996 the team spotted a calf with a spine and dorsal fin that had been severely injured, probably from a boat strike.

"We named him Stumpy because of his damaged dorsal fin," Similä said, adding that she doesn't actually know whether the calf is a male or a female. "He's not like other killer whales. He can't hunt, and they care for him."

Instead of living with a single pod, Stumpy swims with at least five different ones, all of which feed him. Once, Similä watched as two females came dashing through the waves, each carrying a large herring for Stumpy. She thinks the orcas understand that a boat injured him, because they keep him away from boats.

"Stumpy is the biggest mystery to me. I don't know what will happen when he becomes sexually mature," Similä said. "But the other orcas know he needs help, and they help him."

Some researchers have suggested that an orca pod has such tight social bonds that its members respond to other animals and their environment as a single-minded group. That may be why entire pods strand when only one sick member heads for shore. And why some males die after the death of their mother. Perhaps it's also why so many orcas help Stumpy.

When you've spent much of your life around beings that live in cooperative societies, remember their past, and care for their weakest, you learn to be open to what else they might be capable of. So Similä entertained the idea that the orcas had joined with the humpbacks and fins to hunt the fish.

She later changed her mind. "No, they're not working together," she told me in a phone conversation after I'd returned home. "Those humpbacks are just spoiling everything the orcas do. Every time the orcas get the herring organized, the humpbacks wreck it. The fin whales are taking advantage too."

The orcas didn't seem to mind. They never made any effort to escape the freeloaders or fight them or chase them away. Maybe this equanimity was evidence simply of the abundance of herring in Andfjorden that winter—more than enough for all. □

ONE MORE THING ngm.com/more



No stranger to brutal temperatures, **Paul Nicklen** grew up in the Canadian Arctic. This assignment had him diving in frigid waters up to 50 times a day—a job that might have been easier had he not had pneumonia.



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As orcas get in place around a school of herring, they stay in close contact with calls, whistles, and echolocation clicks. "Each whale has a role to play," says Finnish biologist Tiu Similä, who follows the Norwegian orcas and herring most winters.



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In the Footsteps of **GANDHI**

*India has moved on,
but its Great Soul endures,
if you know where to look.*

Freed from field labor, Geeta Bhen weaves a sari for a women's cooperative inspired by Mohandas Gandhi, in Sihol, Gujarat state.





A SMALL BODY OF
DETERMINED SPIRITS
FIRED BY AN
UNQUENCHABLE
FAITH IN THEIR
MISSION CAN ALTER THE
COURSE OF HISTORY.

—Gandhi

Workers harvest salt in Dharasana, Gujarat. In May 1930, the month after Gandhi led a march to protest British restrictions on salt, activists trained in nonviolent resistance marched here and were savagely beaten, a seminal event that advanced India's drive for independence.

BY TOM O'NEILL
PHOTOGRAPHS BY RENA EFFENDI

He woke before dawn, as he did every day at the ashram.

In the darkness he led a prayer meeting on a patch of ground overlooking the Sabarmati River. Then he was ready. Dressed in a long loincloth, or dhoti, with a shawl around his shoulders, he grasped a bamboo staff and started out the gate. He was leaving his home of 13 years, a community devoted to his precepts of plain living and high thinking.

Mohandas Gandhi was not alone. As he stepped onto a dirt road on the outskirts of Ahmadabad, the largest city in his native state of Gujarat, 78 men, two abreast, clad in white, fell into a column behind him. Pressing in on the sides of the road, hanging from trees, leaning from windows, tens of thousands of people—supporters and curious alike—cried, “*Gandhi ki jai.* Victory to Gandhi.”

The date was March 12, 1930. Gandhi and his troops walked for 25 days and 241 miles to the Arabian Sea to defy the unjust British law that prohibited the collection of salt in its colony. Master of the dramatic gesture, Gandhi bent over near the shore and scooped up a handful of salty mud. As illegal salt-gathering spread across the country, arrests and beatings followed. Gandhi was jailed for almost nine months. What authorities had dismissed as a minor act of political theater swelled into a nationwide cry for independence. A broad array of India’s population—high caste and low, male and female, Hindu and Muslim—for the first time joined in protest against British rule. Now the masses had a leader. From the day he began the Salt March until his death 18 years later, Gandhi infused India with a revolutionary blend of politics and spirituality. He

called his action-based philosophy *satyagraha*, or truth force.

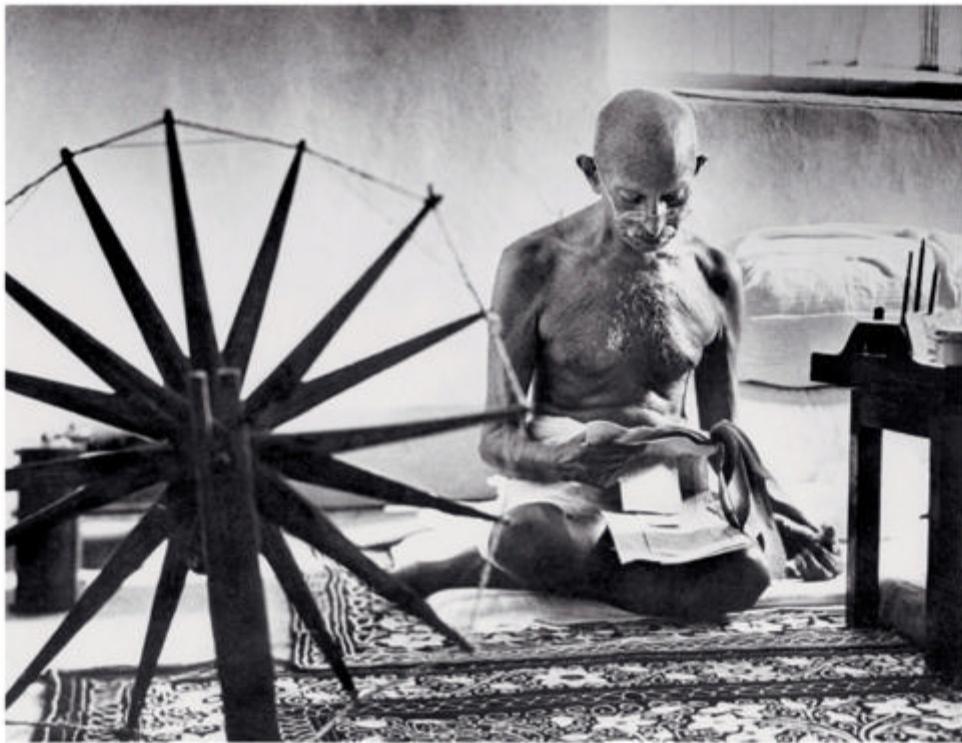
Gandhi’s impact was indelible. He guided India to independence. He forced his countrymen to question their deepest prejudices about caste and religion and violence.

Hours after Gandhi’s death from an assassin’s bullets in 1948, just five and a half months after the new nation was born, Jawaharlal Nehru, India’s first prime minister, proclaimed that the light left behind by the Father of the Nation would shine a thousand years.

HOW BRIGHT does that light burn today?

To find out, I decided to follow Gandhi. “See me, please,” he said, “in the nakedness of my working, and in my limitations, you will then know me.” I would travel his route on the Salt March. The talks he delivered and the articles he wrote speak to issues that still confront India today, and Indians still debate the legacy of the man known as Mahatma, or Great Soul.

Prophet or holy fool? Hero or villain? Right path or dead end? No one questions Gandhi’s incandescent influence on the world stage; his philosophy of nonviolent resistance inspired Martin Luther King, Jr., Nelson Mandela, and the Dalai Lama. On home soil the Gandhi effect is hazier. Gandhi is everywhere and nowhere. His bespectacled face looks out from the rupee note. There are Mahatma Gandhi streets in many cities, statues too. Politicians invoke his name like an endorsement. But the absence of Gandhi is just as evident. Gandhi envisioned an India of self-sufficient villages. Caste and religion would grow faint as identity markers.



Gandhi's spinning wheel symbolized his belief in rural industry and self-reliance.

Governance would stress equality and nonviolence. Try finding that today. The huge, chaotic cities (Delhi, Mumbai, Kolkata), the materialist fever of swelling middle and upper classes, the election of Hindu nationalist Narendra Modi to lead the country, an arsenal of nuclear weapons, and endemic violence against women suggest a very different national identity.

"India is schizophrenic about Gandhi, seeing him as the source of all good or all evil," said Tridip Suhrud, director of the trust overseeing the ashram where Gandhi began his march. "You can quarrel with him, you can embrace him, but if you want to make sense of India, you have to deal with the guy."

Even during his lifetime Gandhi proved a difficult mentor. He made uncompromising demands on family, friends, and political allies, holding them to exalted moral standards. Strict beliefs about diet (he subsisted at various times on nuts, raw vegetables, and dried fruit) and sex (he took a vow of celibacy and heeded it for his last 42 years) alienated the public then as now. Yet the roles he played—politician, social reformer,

guru, journalist, peacemaker, educator, inventor—were so varied, like characters in an epic novel, that he offers something for everyone.

ON DAY ONE OF THE MARCH Gandhi made a sentimental stop two miles from his ashram. Already covered in dust stirred by the crowd, he paused before a school he had founded ten years earlier as an alternative to British education.

Today a sandstone arch opens onto the leafy campus of Gujarat Vidyapith, its paths filled with students. They are dressed in loose shirts and pants made of khadi, the homemade cloth that became a symbol of Gandhi's revolution, standing for the rejection of British goods and the revival of traditional industry. It's safe to say that students on other campuses in India are not wearing khadi, which roughly means "handwoven," snubbing it as unstylish.

Sudarshan Iyengar, a university trustee and noted economist, makes no excuses for the school's unfashionable rules and expectations. "Here we train students in heart, hand, and head, in that order," he said, sitting on the floor





OUR GREATNESS LIES NOT
SO MUCH IN BEING ABLE
TO REMAKE THE WORLD,
AS IN BEING ABLE TO
REMAKE OURSELVES.

—Gandhi

On October 2 children dress like Bapu, a nickname for Gandhi meaning “father,” to mark his birthday in Rajkot, Gujarat, where he spent most of his boyhood. Many Gandhi followers fret that as India grows more urban and materialistic, the young will ignore his injunction to serve the less fortunate.

I DO NOT WANT TO FORESEE THE FUTURE. I AM



Inspired by Gandhi's teachings on equality, women dressed in hand-spun cloth, or khadi, march through Kodaikanal in Tamil Nadu state in a celebration of his beliefs.

CONCERNED WITH TAKING CARE OF THE PRESENT. —Gandhi



A midwife tends a pregnant woman in a remote part of Maharashtra state. Mobile clinics, started in 2013 by Gandhi's Sevagram ashram, honor his commitment to rural health needs.



wearing white khadi. "Like Gandhi, we build character through communal life and work."

Iyengar's Gandhian beliefs run so deep that he can't use his laptop computer without anguish over the implications. "I can see that Gandhi would have seen the computer as a tool to empower the individual," he told me. "But what about the industrial process and the hidden costs that it took to produce?"

What would Gandhi do? It's the core question on this campus. Students I met spoke sincerely of Gandhi as a role model. But they didn't intend to follow him in lockstep. A young woman told me she was there only because her father loved Gandhi. "For me he's so-so," she said, as a teacher nearby lifted her eyebrows in disapproval. Who will wear khadi when you return home? I asked. Only a few raised their hands.

Suddenly a female student with a pink watchband approached me and exclaimed, "When I wear khadi, I feel like an extraordinary person."

Our talk broke up at the sound of bells. It was spinning time. To prepare Indians for independence by inculcating discipline and self-reliance, Gandhi urged women and men, including the highest officials, to produce at least 25 meters of yarn a year, enough to meet one's needs. "Every revolution of the wheel spins peace, goodwill, and love," he preached. Obeying the tradition, some 500 students filed into the auditorium carrying boxes with portable spinning wheels. Sitting cross-legged, they took out tufts of cotton and began spinning, their arms moving in and out, in and out. The only sound was the whisper of hundreds of spinning wheels speaking Gandhi's message.

GANDHI WAS A FAST WALKER, his pace remarkable for a 61-year-old man who was the oldest on the march and whose joints ached from rheumatism. Each day, averaging 10 to 12 miles in inescapable heat, the party stopped in settlements to pray, rest, eat, and allow their leader to speak before rapt audiences. Gandhi was the first national figure to connect with rural Indians. For him the village was the soul of India.

If Gandhi traveled to the same places today, he would see, probably to his dismay, that rural India remains in many ways stuck in time. In Vasana, a cotton-farming village where the marchers halted under a mango tree that still stands, I found a statue of Gandhi with his walking stick. A drift of garbage had collected at its base. Cows and buffalo trod hypnotically on the dirt lane, followed by barefoot boys. Women in saris hurried past with firewood on their heads. As a crowd gathered around me, a man in jeans stepped forward to apologize for the unkempt memorial. I asked him if anyone wore khadi. Not anymore, he said. After a few more questions the man lost his cool. "People come here and talk about Gandhi, Gandhi, Gandhi, but nothing is done for us. There is no development," he complained. "We need a bridge over the river and a roof over the statue's head."

Gandhi's vision of villages as the most fertile ground for India's progress now seems like a utopian fever dream. Cities are where the jobs and schools and social life are. Urban problems—pollution, crime, overcrowding, traffic—dominate the national conversation. But almost 70 percent of India's more than 1.2 billion people still live in the countryside. For Gandhi, a Hindu deeply influenced by the life of Jesus Christ, the highest calling was to go among the poor and "feed them first and then feed ourselves." He appealed for volunteers to live in villages and bring change.

Some still hear the call. Five years before I met him, Thalkar Pelkar, a quiet young man always dressed in khadi, moved to Pedhamali, a scattering of mud-walled homes strung along a dry riverbed in western India. A graduate of Gujarat

Vidyapith, he had committed to two years of unpaid rural development work. He wasn't totally gung ho. "I knew there was a chance I would get beaten up and pushed out," he said.

Pelkar moved into a room without water or electricity. To fit in, he cut his hair and learned the local dialect. For months he battled loneliness and questioned his worthiness. In his room he hung a grainy photo of Gandhi. What would Gandhi do? The question weighed on him like a bag of stones.

Today the portrait hangs prominently in Pelkar's new home, a once abandoned house he fixed up. Sitting on the floor with his wife, Snehan, and his son, Ajay, Pelkar, after some prodding, listed his accomplishments. He had revived the dairy, sparing women a 12-mile walk to buy milk. He had put women in charge of its accounting and testing. He had encouraged parents to send their children to school; enrollment had tripled to more than 150, bringing more classrooms and teachers. Three winters ago, seeing six-year-old Ajay abandoned on the street, he had adopted him.

Is your work done here? I asked. Pelkar sighed. "At first," he said, "I thought two years would be enough to finish my project. Now I think it will take a whole lifetime."

THE CROWDS THAT GREETED Gandhi along the Salt March were unlike any that modern India had seen—in schoolyards and fields, women by the hundreds showed up to hear Gandhi speak. They flooded the streets to accompany the marchers through towns. Fearing violence, Gandhi had chosen only men for the march, but he regarded women as natural allies. "I feel they will be worthier interpreters of nonviolence than men," he said, "not because they are weak, as men in their arrogance believe them to be, but because they have greater courage."

As was the case with many of his moral crusades, Gandhi's campaign for gender equality was too soon. At its roots India remains a conservative, patriarchal society. Gandhi spoke out against child marriage, violence against women, the dowry system, and lack of schooling for

**STRENGTH DOES
NOT COME FROM
PHYSICAL CAPACITY.
IT COMES FROM AN
INDOMITABLE WILL.**

—Gandhi

Solidarity in the workplace spills over to the village well in Rasnol, Gujarat. It is one of thousands of places where the Self-Employed Women's Association, a Gandhian trade union, has taken root. Its founder, Ela Bhatt, calls women "the pillars of village society."







Where Gandhi once walked on his famous Salt March to protest British rule, tribal women in Kapletha are still weighed down by poverty. At a brick kiln they earn less than three dollars a day.

SEVEN HUNDRED THOUSAND VILLAGES. —Gandhi



A cheap ticket buys a man a place to rest on a Gujarat train that tracks the route of the Salt March. On his cross-country tours Gandhi always insisted on traveling third class with India's poor.

women, but all remain embedded in daily life, despite flickers of progress. Yet fighting back, Gandhi style, has also endured.

"My strength is my women," said Ela Bhatt, rocking on a bench swing in her simple home in Ahmadabad. She is the founder of the Self-Employed Women's Association (SEWA), a trade union and cooperative that counts more than 1.8 million members. Bhatt, born three years after the Salt March, looked like a sweet grandmother. The story she told, however, was full of steely determination. Bhatt quit her job as a lawyer for a textile union and in 1972 set up SEWA, reflecting the Gandhian belief in the dignity of work. For a few cents, the women gained access to training classes, bank loans, health insurance, and child care. "Women in India have always been treated as second-class citizens," she told me. "But they are the family leaders. Assets are safer in their hands."

Echoing Gandhi comes naturally to Bhatt. Her grandfather, a doctor, was beaten and jailed during the salt protests. Her parents joined the independence movement. "I owe so much to the atmosphere of those times," she said. "It was filled with idealism." Bhatt's organization started a revolution of its own, seeding women-based labor groups across southern Asia. "I am not a Gandhi scholar, nor a devotee," Bhatt said pointedly. "I am a Gandhi practitioner."

Where SEWA is active, villages are different. Women seem bolder, more self-confident. In Sihol, near the Salt March town of Anand, inside a patched-up building lit by small windows, shuttles clack-clacked as women at wooden looms wove saris and towels. Before, said Gauriben Van-kar, the only work she could find was in tobacco fields for pennies a day. Now she was making many times that for each sari. "We can work out of the sun now, near our homes," she said, "and we have more money for food."

GANDHI WAS A PROVOCATEUR, frequently challenging his audience. In Gajera, ten days after the march began, he sat on a platform before an expectant crowd, and he said nothing. The audience grew uneasy. When Gandhi finally spoke,

he said that he would not deliver his talk unless the village leaders invited Untouchables to sit in their midst. This was an unorthodox demand.

Hindus shunned as polluted these members of the lowest caste. They did the filthiest jobs. They lived separately. They were forbidden to enter temples or draw water from village wells. Even their shadows were not allowed to touch other Hindus.

Gandhi had posed perhaps the most vexing test to those who professed to follow him. Shamed, officials motioned for the Untouchables on a nearby hill to join the gathering.

NONVIOLENCE IS NOT A WEAPON OF THE WEAK. IT IS A WEAPON OF THE STRONGEST AND THE BRAVEST.

—Gandhi

In Gajera no one wanted to tell me where I could find the Dalits (the preferred name now, literally meaning "broken"). Finally I asked the poorest looking person in sight, a sun-beaten woman carrying a jug of water on her head. She pointed to a cluster of blue-painted homes off by themselves. It was her neighborhood. Residents came out to greet me, excited to talk to an outsider. Life has improved some since Gandhi's visit. "In earlier times we had to bring our own cups to tea shops," said a woman. "And when we brought grain to the house of a higher caste, they sprinkled water on the ground afterward to purify it."

Their economic status, though, has hardly changed: The bottom-caste townspeople remain poor, like most Dalits, who comprise one in six Indians. Most older adults in Gajera work in the castor bean fields. Some younger ones have low-paying jobs in a glass factory.

Only in cities did I meet Dalits who could imagine joining India's mainstream. At a street-sweeper colony in Delhi, where Gandhi would often stay, a few young Dalit men approached me to brag that they were students, the first in their families to attend university, thanks to government scholarships.

Gandhi would have been overjoyed to meet them. By example—he adopted an Untouchable child—and by ceaseless campaigning, he fought to remove the stigma of associating with Untouchables, whom he called Harijans, or Children of God. Yet he achieved no significant breakthroughs. Despite government protections, Dalits still suffer widespread, often violent, discrimination. They belong to an India that Gandhi would sadly recognize.

AT LAST THEY COULD HEAR the sea. After walking for more than three weeks, the marchers were closing in on the coastal village of Dandi as much of India and the Western world watched. Security forces, the press, and crowds of onlookers and supporters massed, waiting to see what would happen. Their leader had spent decades preparing for this moment.

Gandhi came of age as an activist and organizer not in India, but in South Africa. He had arrived there in 1893 at the age of 24 as a provincial lawyer, and it was there that he first experienced virulent racism and injustice. In prisons in South Africa, where he was held for leading demonstrations against color-based laws, Gandhi studied the Bible and the Koran and the writings of Leo Tolstoy, Henry David Thoreau, and John Ruskin. He established experimental communities in Durban and Johannesburg, then part of a British colony. By the time he returned to India to live in 1915, Gandhi had conceived his daring vision of satyagraha, a way of pursuing truth through nonviolent resistance, patience, and compassion.

For many historians, biographers, and activists, the Salt March was Gandhi's purest achievement. Through marches, fasts, civil disobedience, and mobilization of women, youth, and the dispossessed, Gandhi created a new playbook for

social movements. In India, Gandhi-inspired organizers have led numerous nonviolent campaigns, especially on environmental issues such as forest destruction and dambuilding. "If you're a Gandhian, you don't just preach, you do," says P. V. Rajagopal, an activist who put himself and his followers to the test.

The issue was landlessness. Since Gandhi's time, the poor in India have steadily lost land to governmental development, corrupt landlords, and natural disasters, with little or no compensation. For Rajagopal and his organization, Ekta Parishad (Unity Association), a modern-day Salt March was needed. To enlist recruits, Rajagopal and a cadre of supporters spent almost a year visiting 26 of India's 29 states, traveling to villages like Chhatapur, in Bihar, one of the poorest states.

In a schoolyard on a scorching day, he addressed a few hundred people, mostly Dalit women. "It's good to be angry," Rajagopal said through a squawking microphone. "We're not asking for computers, or TVs, or vehicles, or other comforts. We're asking for land for houses, and so we can grow food. We've waited long enough. Who will join me on a march to Delhi?" Hands shot up. Rajagopal, a short man with graying hair who moves swiftly between charmer and firebrand, bowed his head in thanks.

As his SUV bumped down a narrow dirt road between villages, Rajagopal explained that he was tapping the best part of Gandhi. "People end up picking what side of Gandhi they want," he said. "I pick the radical side, not the Gandhi of prayer and meditation, but the fighting Gandhi. Bring back the Gandhi who fought against injustice and oppression." Rajagopal also wants to bring back the *padyatra*, or foot march. "Walking is a message," he said. "You're challenging yourself, your comfort, your body. And it's a spiritual act. Your moral power gets stronger and stronger as you go."

Six months later the message stretched for miles on a road leading to Delhi. Tens of thousands walked three abreast. The disciplined marchers started at first light. By midafternoon, after covering about ten miles, they stopped

**RELIGIONS ARE NOT FOR
SEPARATING MEN FROM
ONE ANOTHER; THEY ARE
MEANT TO BIND THEM.**

—Gandhi

Hindu priests breathe prayers into rising smoke on a festival day in Barharwa Lakhansen, Bihar state. Raised in the Hindu faith, Gandhi incorporated passages from the Koran and the Bible into his prayers. His vision of a secular and democratic India is instilled in today's constitution.





LIVE AS IF YOU WERE TO DIE TOMORROW.

under the shade of bushes and trees to eat their one meal of the day: lentils and rice. "We have nothing left to lose," a woman from Bihar said fiercely. "These days on the road are nothing compared to our struggles at home."

MOHANDAS GANDHI broke the law in the early morning of April 6, 1930. In Dandi, near the sea, the man called Bapu, or "father," by friends and strangers, bent over and pulled up a handful of muck. By the day's end hundreds of supporters had done the same. Across India over the next months others joined in, illegally manufacturing salt from the sea faster than police could confiscate it. The Salt March did not topple British rule—independence would come 17 years later—but it cracked the foundations.

It's difficult to re-create the scene. The contours of the coast have changed, and the spot where Gandhi picked up salt is now dry ground. Finding Gandhi in a rapidly changing India is also not easy—nor should it be. When have visionaries, with their demands and ideals, ever dwelled comfortably in the mainstream?

But as I looked for Gandhi, seeking him amid the clamor and complexity of urban and rural life, I found him. His spirit of defiance, high-minded and tough-natured, animates campaigns against corruption, rape, caste violence, and slum clearances. The growing confidence and achievements of women conjure up Gandhi's demand to admit them into India's public life. At his former ashrams, I felt the power of his example of simple living. Gandhi was by some lights a tragic failure, unable, for instance, to prevent Hindu-Muslim conflict or the breakaway of majority-Muslim Pakistan. But on the beach in Dandi, the sight of Muslim and Hindu families wading into the surf, hems of saris lifted,

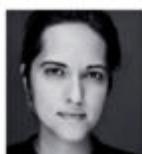
head scarves pushed back, testifies to the endurance of the secular, tolerant democracy that Gandhi saw as India's inheritance.

The light in the darkness, as Nehru described Gandhi's legacy, drew me to a settlement unmarked on maps in a rural area of Maharashtra state. On a 40-acre spread near Gadchiroli, a community has sprung up of doctors, nurses, computer engineers, medical students, interns, family members, and support staff, recruited by Abhay and Rani Bang, co-founders of the Society for Education, Action and Research in Community Health (SEARCH). Since the mid-1980s, Abhay, a physician; Rani, a gynecologist; and their colleagues have trained health workers, most of them illiterate women, in 124 villages. The results have been almost miraculous. In villages that have adopted their model of care for newborns, infant mortality rates have fallen dramatically. This approach to neonatal care, relying on local men and women trained in simple techniques (such as using an abacus to count breaths), has been adapted across India and in Africa, Asia, and Latin America.

Bang never met Gandhi, but he feels close to him, having grown up on his Sevagram ashram in Maharashtra. Sitting behind a desk heaped with reports, Bang told me he often debates in his head with Gandhi about such challenges as environmental threats, religious violence, and healthy diets. "The Old Man predicted so much," Bang said. "His principles are everywhere you look."

To live on the SEARCH ashram means accepting rules: no smoking or drinking, participating in weekly cleanups, attending evening prayer and talk sessions. The unspoken rule: Improve the lives of others. Here no one has to ask, What would Gandhi do? □

ONE MORE THING



Rena Effendi was born in Azerbaijan, but grew up in the U.S.S.R.—a place she learned to make sense of through photography. She has won several awards for her work. This is her second feature story for the Geographic.

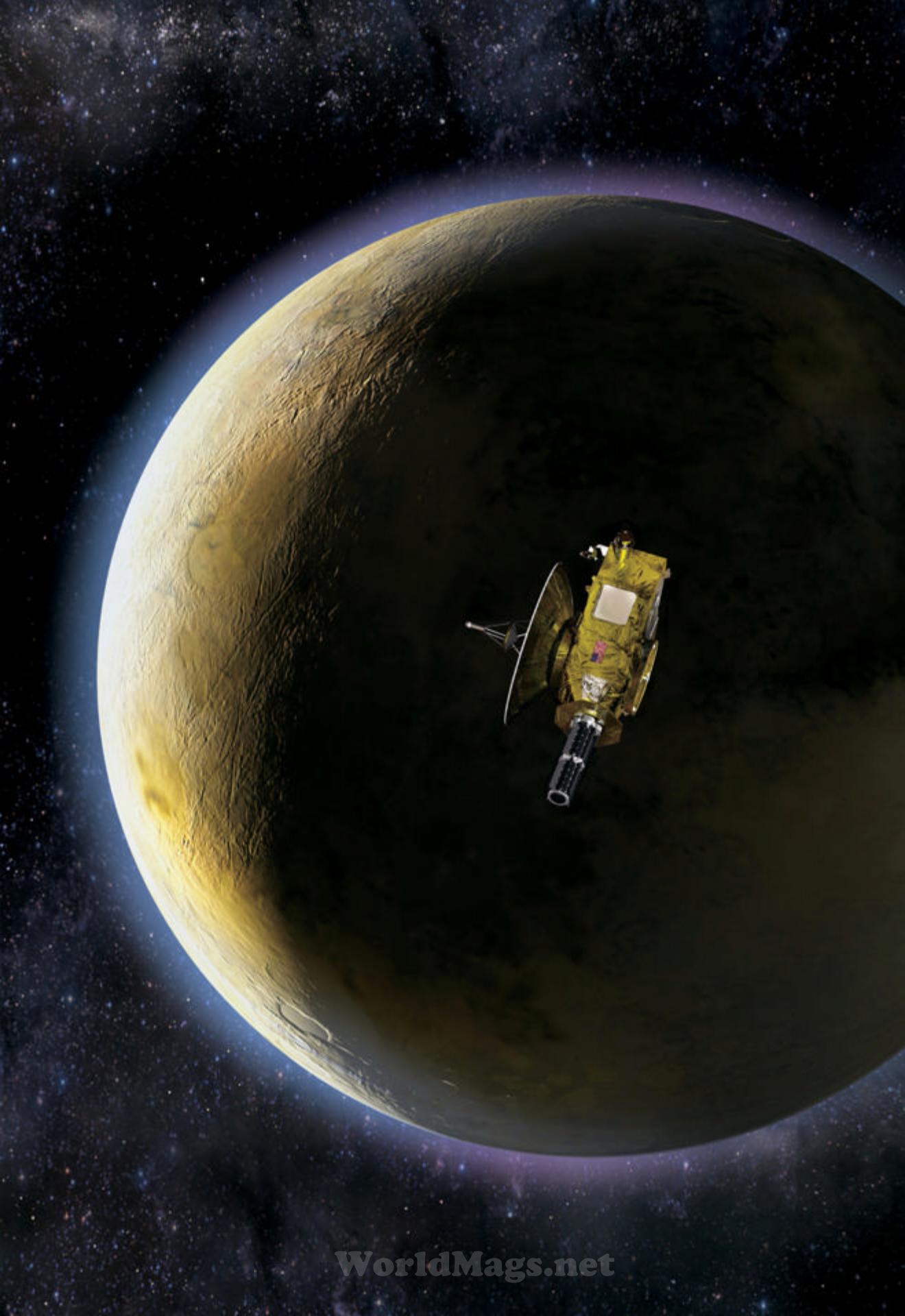


For this story former staff writer **Tom O'Neill** liked to sit beneath trees where Gandhi had spoken. "I'd tell villagers I was meeting Gandhi," he says. "They'd smile and hurry away, convinced a madman had come to town."

LEARN AS IF YOU WERE TO LIVE FOREVER. —Gandhi



Gandhi looks over the shoulders of students at the school for Dalits (once known as Untouchables) that he founded in Ahmadabad, Gujarat, one of his “experiments with truth.”



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**ALMOST A DECADE
IN FLIGHT, THE NEW
HORIZONS SPACECRAFT
IS APPROACHING THE
ENIGMATIC DWARF
PLANET. WHAT IT
WILL FIND THERE IS
ANYBODY'S GUESS.**

PLUTO AT LAST



By mid-July NASA's vehicle will have traveled over three billion miles and will pass within 8,000 miles of Pluto, illustrated here with Charon, the largest of its five known moons.

1930

Kansas farmer Clyde Tombaugh built this telescope in 1928 using the crankshaft of his father's 1910 Buick and some discarded farm equipment. His drawings of Mars and Jupiter led to a job at Lowell Observatory. There, two years later, he discovered Pluto.





2005

At Florida's Kennedy Space Center, the New Horizons spacecraft waits to be wrapped in the fairing that will protect it during its launch and flight through Earth's atmosphere. The fastest spacecraft ever at launch, it will reach Pluto on July 14, 2015.



2006

New Horizons blasts off from Cape Canaveral Air Force Station aboard an Atlas V rocket. After passing Pluto, the craft will continue into the farthest reaches of the solar system.

Small, cold, and absurdly far away, Pluto has always been selfish with its secrets.

Since its discovery in 1930, the dwarf planet has revolved beyond reach, its frosty surface a blurred mystery that even the most powerful telescopes can't bring into focus. We know about Pluto. But we don't really know it.

That will change on July 14, when NASA's New Horizons spacecraft is scheduled to fly within 8,000 miles of the frozen dwarf. It's a risky maneuver, but if all goes well, the fleeting close encounter will unveil the last of the classical solar system's unexplored worlds. We'll finally get to meet the former ninth planet face-to-face—to really see its surface and that of its largest moon, Charon. Scientists have some guesses about what they might find, but the only thing they can say for sure is that Pluto promises to be a surprise.

"The Pluto we imagined will just go away like smoke," says Alan Stern, New Horizons' principal investigator.

The X-Files

It wouldn't be the first time Pluto has confounded expectations. In 2006, the year New Horizons was launched, Pluto vanished from the list of planets and reappeared as a "dwarf planet." That, of course, had more to do with astronomers on Earth than any celestial sleight of hand, but the truth is, Pluto has been a tough world to crack since before it was discovered.

As early as the 1840s, a tricky calculus foretold the existence of a planet beyond the orbit of Neptune. Calculations based on Neptune's mass suggested that the ice giant's orbit, and that of its neighbor Uranus, didn't quite fit the predictions of planetary motion. So some astronomers

reasoned that at least one large, undiscovered world at the edge of the solar system must be jostling the ice giants and causing them to trace errant paths around the sun.

By the turn of the century, the hunt for that missing planet had gathered momentum: Whoever found it would earn the shiny distinction of discovering the first new planet in more than 50 years. Calling the rogue world "Planet X," Boston aristocrat Percival Lowell—perhaps best known for claiming to have spotted irrigation canals on the surface of Mars—vigorously took up the search. Lowell had built his own observatory in Flagstaff, Arizona, and in 1905 it became the epicenter of the search for Planet X, with Lowell calculating and recalculating its probable position and borrowing equipment for the hunt. But Lowell died in 1916, without knowing that Planet X really existed.

Fast-forward to 1930. Late one February afternoon, 24-year-old Clyde Tombaugh was parked in his spot at Lowell Observatory. A transplant from the farm fields of Kansas, Tombaugh had been assigned the task of searching for Lowell's elusive planet. He had no formal training in astronomy but had developed a skill for building telescopes, sometimes from old car parts and other improbable items.

He was also something of a perfectionist. "When I planted the kafir corn and milo maize," he wrote in his 1980 memoir, "the rows across the field had to be straight as an arrow or I was unhappy. Later, every planet-suspect, no matter how faint, had to be checked out... It was the most tedious work I'd ever done."

**OVER
THE YEARS
THE ESTIMATED
MASS OF PLUTO
CONTINUED TO
SHRINK, UNTIL IT
SHRANK ITSELF OUT
OF PLANETHOOD
ALTOGETHER.**

Tombaugh spent about a year searching for the missing world, using an instrument called a blink comparator. The noisy machine let viewers flip back and forth between long exposures of the sky, often containing hundreds of thousands of stars, taken several days apart. Anything that traveled a significant distance during that time—a planet or an asteroid, for example—would appear to move as the images flipped.

On that late afternoon—it was February 18—Tombaugh was manning the comparator and squinting at thousands of stars, evaluating each one by eye. Suddenly, in photos taken six days apart in January, he spied a small speck of light that didn't stay put. In one image, it was to the left of two bright stars. In the next, it had jumped a few millimeters to the right of those stars. Tombaugh flipped back and forth between the images and watched the spot leaping in and out of its original position. He grabbed a ruler and measured the precise difference in the spot's position. Then he found another photo of the sky, taken earlier in January, and searched for the same spot. Finally, he used a hand-magnifier to confirm the potential planet's presence in one more set of photos, taken by a different camera. After 45 minutes, Tombaugh was convinced.

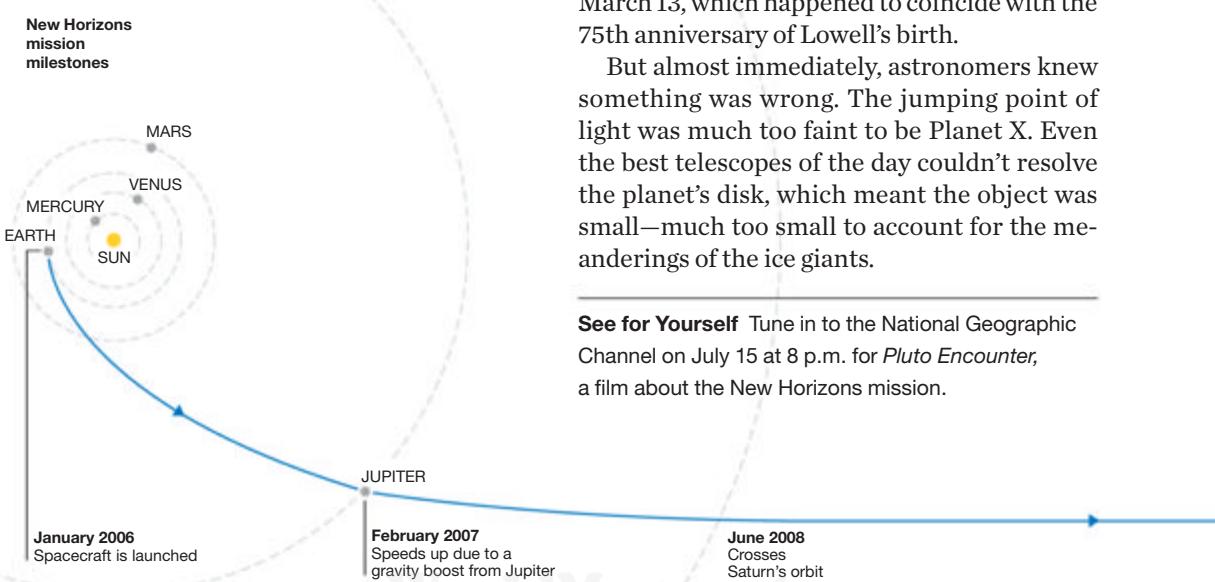
He had found Planet X.

"You look at the spot that is Pluto, and it's a pretty dinky little spot," says Will Grundy, a New Horizons team member who works at Lowell Observatory. "You really had to stare at these things. How he didn't just go blind, I don't know."

After weeks of follow-up observations, Lowell Observatory announced Tombaugh's find on March 13, which happened to coincide with the 75th anniversary of Lowell's birth.

But almost immediately, astronomers knew something was wrong. The jumping point of light was much too faint to be Planet X. Even the best telescopes of the day couldn't resolve the planet's disk, which meant the object was small—much too small to account for the meanderings of the ice giants.

See for Yourself Tune in to the National Geographic Channel on July 15 at 8 p.m. for *Pluto Encounter*, a film about the New Horizons mission.



"They were expecting something brighter than that, something bigger than that," says Owen Gingerich, an emeritus astronomer and historian at the Harvard-Smithsonian Center for Astrophysics. "But they assumed, nevertheless, that it was probably Earth size. So, much smaller than Uranus and Neptune, but a respectable sort of planet."

Indeed, the world's size has never deterred its fans. Right away, Lowell Observatory had to figure out what to name the new planet. Hundreds of letters poured in. "Minerva" was an early front-runner. Lowell's widow, Constance, who'd held up the search for Planet X while battling the observatory for Lowell's fortune after his death, suggested "Percival" and "Lowell"—and then, abandoning humility altogether, "Constance."

Across the ocean, an 11-year-old English girl named Venetia Burney casually proposed the name "Pluto," after the Roman god of the underworld. It seemed an appropriately dark name for a planet on the dusky fringe, and it followed the mythological naming convention. Conveniently, the word also contained Percival Lowell's initials. And so on May 1, Lowell Observatory announced that Planet X would be named Pluto.

But with its peculiar, tilted orbit and confoundingly small size, the world remained an enigma. Over the years the estimated mass of Tombaugh's planet continued to shrink and shrink... and shrink, until it finally shrank itself out of planethood altogether and was rechristened a dwarf planet in 2006.

By observing Pluto's interaction with its satellite Charon, scientists now know Pluto's mass is a mere two-thousandths that of Earth. Discovered in 1978, Charon is almost half the size of Pluto—so big the two actually form a binary system. They revolve around a point in the space between them, a double-dwarf planet churning away in the center of an astoundingly complex system containing at least four more moons.

Scientists suspect there may be yet more moons around Pluto, some perhaps sharing or swapping orbits and maybe chaotically rotating instead of gracefully pirouetting.

"I would not be surprised at being surprised

by finding something really pathologically weird like that," says Alex Parker, a postdoc on the New Horizons team.

By the late 1980s, NASA's Voyager 2 spacecraft had swept through the realm of the giant planets and revealed the real mass of Neptune. When that number, which is the equivalent of about 17 Earths, is plugged into those old equations used to predict the existence of a ninth planet, everything works as expected. Uranus traces a predictable, boring path around the sun. There never was another large planet tugging at its orbit. But if not for the faulty math, and one man's prodigious patience, we could have waited decades to discover the little world that really is out there.

Violent Birth

No longer a planet and no longer a misfit, Pluto isn't even one of a kind anymore. It's one of thousands of worlds populating the Kuiper belt—a vast debris ring beyond Neptune that's home to countless comets and icy dwarfs. Long ago erased from Earth, fingerprints from the early ages of the solar system are still pressed into these 4.6-billion-year-old chunks, waiting to be matched with theories describing the solar system's turbulent early years.

The Kuiper belt's architecture points to a violent rearrangement of the giant planets early on, a great migration that sent small bodies flying and turned the solar system into an overgrown shooting gallery. Scientists are hoping to use the craters dotting Pluto's and Charon's surfaces to take a survey of the Kuiper belt population and reconstruct how it has changed over time. Although tricky to make, those measurements are essential for reconciling ideas about how the migration of the giant planets sculpted the early solar system. "We think the Kuiper belt was a lot more massive early on," Stern says.

What we learn from the dwarf planet could also give scientists a peek at the processes that shaped an early Earth into the planet we know. Once, a gassy envelope of hydrogen and helium surrounded our infant world. Over millions of years, that atmosphere escaped into space. Pluto is the only place in the solar system where

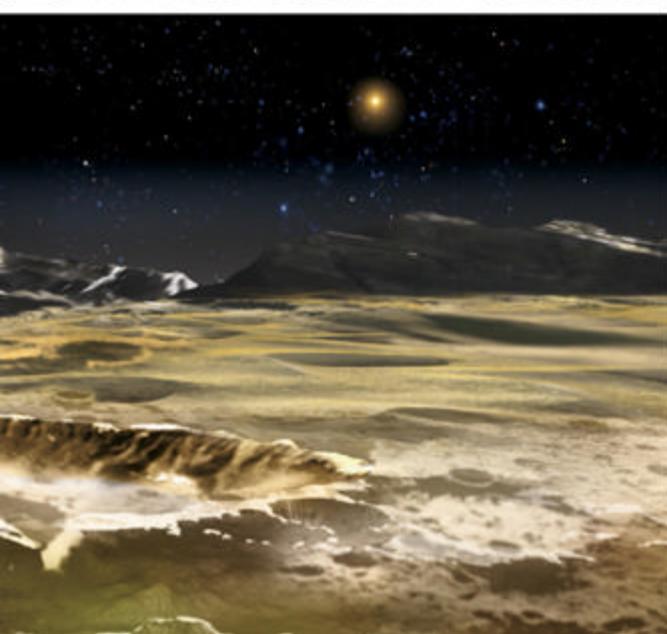
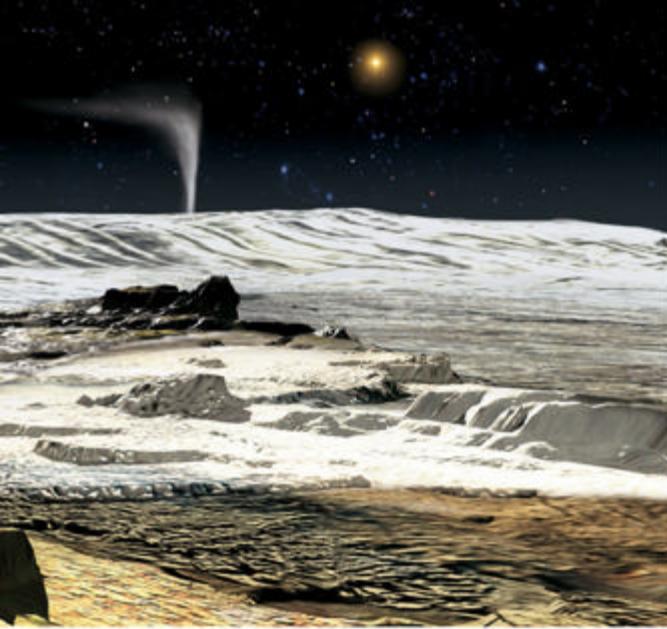
NGM ART. SOURCE: JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

March 2011
Passes through
Uranus's orbit

August 2014
Crosses Neptune's orbit,
then enters the Kuiper belt

PLUTO
July 14, 2015
Flies by Pluto





THREE POSSIBLE PLUTOS

The dwarf planet's landscape is shaped by extreme seasonal fluctuations and dominated by an exotic mix of methane, nitrogen, and carbon monoxide ices. NASA's New Horizons mission will reveal more details during the summer of Pluto's 248-year orbit, when the sun's warmth is at its peak. These scientifically plausible "Plutoscapes" illustrate how the surface might look. Charon hovers in the distance.

Three scenarios, from top to bottom:

TECTONIC SURFACE

Layers of frozen methane turn brown and yellow from the ultraviolet irradiation of ice-bound molecules. The rugged topography, active geysers, and distant rift suggest Pluto has dynamic geological processes that erase the scars of impact craters and could indicate a warm planetary core.

WINDSWEPT SURFACE

Strong winds may be generated when ices change state from solid to gas and back again, helping sculpt Pluto's crust. Eroded peaks remain from ancient impact craters, with water ice forming at the higher elevations. UV radiation strips hydrogen from frozen methane, leaving a swath of dark carbon dust.

UNDULATING SURFACE

As Pluto's ices continually change state by escaping into the atmosphere and condensing back to the surface, they may fill in Pluto's low-lying areas, smoothing its surface into an undulating terrain. The ices react with sunlight and cosmic radiation at different rates, forming an icy gravel (foreground).

we can study something similar happening today, Stern says, even though its atmosphere is made from nitrogen. The similarities don't end there. Scientists think Pluto's moon Charon formed out of a giant impact, much like the one that produced our own moon. But while our moon congealed out of the molten disk of debris created by the collision, Charon was blown off from Pluto relatively intact. And while our moon's growth left our skies relatively clear, Pluto's weaker gravity allowed debris from the smashup to fly farther afield, seeding the binary system with space rubble that could make New Horizons' visit more than a little treacherous.

Dangerous Passage

Launched from Florida's Cape Canaveral, NASA's spacecraft shot through the solar system, covering an average of nearly a million miles a day. It arrived at Jupiter just over a year later, and used the giant planet's gravity as a speed booster to shave almost four years off the total travel time. But even with that boost, New Horizons would still take another eight years to reach the former planet, which is on average about 40 times as far from the sun as Earth is. It's pretty chilly that far out. Temperatures on Pluto can reach close to -400 degrees Fahrenheit.

Scientists don't really know what they will find there—or if the spacecraft's sizzling speed will take it safely through the Pluto system, booby-trapped as it might be with hidden moons and deadly dust particles. "Anything the size of a grain of sand is potentially dangerous to the spacecraft," says the SETI Institute's Mark Showalter, a member of the mission's hazard assessment team. "If it cuts an electrical connection or hits a computer processing unit, it could damage the spacecraft irreparably."

The weeks leading up to the Pluto encounter will be punctuated with tense analyses of the newest images from New Horizons. As Tombaugh did eight decades earlier, the team will be searching for anything that moves, telltale pixels signaling a hidden moon that might be shedding dust. "We're on the crow's nest...looking out for rocky shoals ahead," Showalter says.

Scientists have planned several alternate trajectories through the Pluto system, should such perils appear. All the alternatives would come at a cost to mission science. But nothing is worth setting a course that would put the spacecraft

at risk. "The reason we go to places we haven't been before is to see what's there," Showalter says. "We're going for the surprise, and I just hope it's not the wrong kind of surprise."

Team members are placing bets on what those good surprises will be. They already know that the dwarf planet will be reddish, a hue imparted by sunlight reacting with organic molecules on its surface, and covered in different ices. Blurry Hubble images have revealed both extremely dark and extremely bright patches on Pluto, and some scientists suspect that smears of organic compounds are painting parts of the dwarf planet dark. Other regions of the surface show hints of seasonal frosts forming across the multicolored terrain, and scientists would not be shocked to see plumes erupting from Pluto, as on Neptune's largest moon, Triton. Hovering overhead is a puffy nitrogen atmosphere, potentially 350 times as voluminous as Pluto itself.

"I suspect we're going to see hazes and maybe thick clouds," says team member Fran Bagenal of the University of Colorado Boulder.

But team members are guessing about everything from Pluto's diameter to the number of new moons to whether there will be craters, canyons, or cryovolcanoes on Pluto and Charon. Some team members even think Charon might steal the show from its sibling. "It's an amazingly rich system for such a small place, and probably a lot of what we think we know is wrong," says John Spencer of the Southwest Research Institute in Boulder, Colorado.

To truly know Pluto, we must go there, set aside the mirrors and lenses of Earth, and stare at the world from its doorstep. It's taken 85 years, but we are at last going to meet Tombaugh's contentious little planet. And in a way, he will too: Tucked aboard New Horizons is a small vial of Tombaugh's ashes, a symbolic envoy that will sail by Pluto and head farther into the Kuiper belt, perhaps chasing down another little world to explore. □

ONE MORE THING



The cosmos has always been a part of Nadia Drake's life. Her father, astronomer Frank Drake, conducted the first SETI (search for extraterrestrial intelligence) experiment, in 1960. Read more of her work at ngm.com/phenomena.

PLUTONIC LOVE



9

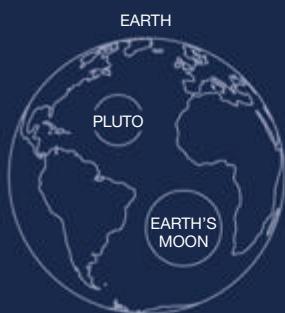
*quick takes on
the former ninth
planet*

Cloak of mystery

1 Just how big is little Pluto? Scientists calculate it's over 1,400 miles across, but the dwarf planet's atmosphere and its great distance from Earth hinder precise measurement. The New Horizons spacecraft should provide the answer.

Spin cycle

2 On Pluto, the sun rises in the west and sets in the east—approximately once each Earth week. This is because Pluto rotates in the opposite direction from Earth, and it spins very slowly.



A speck in space

3 Pluto is only two-thirds the size of our moon. Its five known moons circle in tight, nested orbits. Strung end to end, nearly three Pluto systems would fit between Earth and its moon.

Why not a planet?

4 According to the International Astronomical Union in 2006, planets in the solar system are round, they orbit the sun, and they have enough gravitational heft to clear their orbits of most debris. Unless that last rule is removed, Pluto will remain a dwarf planet.

Celestial census

5 While studying photographic plates of the sky over 14 years, Pluto's discoverer, Clyde Tombaugh, spotted 29,500 galaxies, nearly 4,000 asteroids (775 of them new), and at least one new comet.

Precious payload

6 There are nine “stowaways” aboard the New Horizons spacecraft, among them a vial of Tombaugh's ashes. The other items include two U.S. flags, an unintentionally ironic U.S. postage stamp reading “Pluto: Not Yet Explored,” and a Florida state quarter, given to New Horizons Principal Investigator Alan Stern by then Governor Jeb Bush.



What's in a name?

7 Venetia Burney, the English 11-year-old who casually suggested calling the new planet “Pluto” over breakfast, isn’t the first person in her family to have named an astronomical object. Her great-uncle Henry Madan named the Martian moons Phobos and Deimos. Burney (later Venetia Phair) never could brook people thinking that she’d borrowed the name from Walt Disney’s lovable hound. And indeed, although the cartoon dog did first appear in 1930, he didn’t acquire the name Pluto until May 1931 — a year after Burney had named the planet. “So, one is vindicated,” she said.



Bottled up

8 One slight hesitation in the naming of Pluto had to do with an American laxative. Called Pluto Water, the popular tonic promised, “When Nature Won’t, Pluto Will.”

Bullets are slower

9 New Horizons gained a gravity-assisted speed boost from Jupiter in 2007, reaching a top speed of 51,000 miles an hour. It has enough fuel to continue sailing far beyond Pluto and the Kuiper belt.





Mountain Men

*By Jeremy Berlin
Photographs by David Burnett*

Each year around the Fourth of July, in a vale in the Rocky Mountains, a scene from another century plays out. Dozens of rugged-looking men mill around an encampment. They tether their horses and mules to trees. They wear animal skins. And as they roast slabs of buffalo meat over a fire sparked with flint and steel, they share tips on how best to trap beavers and load a flintlock rifle.

Who are these guys?

They're American mountain men—reenactors of the fur trade that flourished in North America from roughly 1800 to 1840. Like the better known reenactors of the Civil War, they're dentists or lawyers or mailmen in real life. But for a week each year they shake off the yoke of civilization and return to a time when survival meant self-reliance.

Photographer David Burnett recently spent two seasons among them. He found "a welcoming bunch who are really curious about what it took to live before the conveniences of modern life. They love knowing the old stuff, the authentic stuff—things that are no longer taught. And

Richard "Spirit Horse Hunter" Ashburn, an outfitter and guide from Jackson Hole, Wyoming, looks out on Green River Lakes in the Bridger-Teton National Forest.



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A close-up, low-angle shot of a person's arm and hand holding a shotgun barrel. The person is wearing a dark, textured glove. The background is a soft-focus view of a snowy, wooded landscape with tall grasses and trees.

Scott Olsen is a dentist from Dillon, Montana. When he's in mountain man mode, his camp name is Doc Ivory. Here Doc sets out with his dog, Ume, to check beaver traps in the icy creeks of Montana's Ruby Valley.

they love to share that knowledge."

Indeed, the American Mountain Men (AMM) association strives to preserve "the traditions and ways of this nation's most fearless pioneers and daring explorers" and "share the fraternal concept to teach, share, and learn the skills needed and required to survive and live as the great American mountain men did."

For most reenactors, interest in the bygone era began at a young age.

"When I grew up, I read books on Davy Crockett, Kit Carson, and Daniel Boone," says Scott "Doc Ivory" Olsen, a dentist in Dillon, Montana, and a 25-year AMM member. "And I realized I'd been born too late."

The Western fur trade began after the Lewis and Clark expedition of 1805–06. In 1825 the first annual trappers' gathering was held near McKinnon, Wyoming. Called the Rendavouze Creek Rendezvous, it was a boisterous, multiday affair—a chance for mountain men to sell their furs, replenish their supplies, and socialize again after months alone in the wild.

The fur trade died out in the middle of the 19th century, as fashions changed and fur prices plunged. But in 1968 its legacy was revived. That's when a man named Walt Hayward founded the AMM with six other avid outdoorsmen and history buffs.

Today it's a nationwide organization, with local brigades, gatherings in each state, and a national rendezvous each year. They all follow the same mountain man code. But regional differences matter, says Mike "Tio Miguel" (Uncle Mike) Morgan, a trapper and ex-Navy captain who joined his friend Olsen's Montana Brigade in 1998.

"East of the Mississippi," he says,

"mountain men were called long hunters. They'd wear cloth and woolens. Out West, we emulate the fur trade as it existed in the Rocky Mountains. That means we wear hides and skins and learn Western skills"—how to skin a muskrat, ride a horse, throw a knife, pilot a bullboat.

Getting the gear right is its own challenge. "I tried to fit in," says Burnett. "I ordered white cotton, double-button-front britches, a shirt, and moccasins. But when I put it all on, I looked like Little Lord Fauntleroy. So I put everything in a plastic bucket, added red-brown dye, and let it sit for four days. When I took it out, it looked like a 19th-century tie-dye."

To join the AMM, a "pilgrim" needs a member to sponsor and mentor him through a score of requirements and a couple of levels: "bossloper" and "hiveranno." But regardless of rank, the goal is always the same.

"We want to document history in as complete a way as we can," says Morgan, "and pass along valuable, forgotten skills, so that future generations will have access to the past." □

Fur trade reenactors (clockwise from top left): In Canton, Kansas, ex-Navy sonar technician Larry Hanson, 74, wears real buckskin. In Lima Peaks, Montana, Raylene Ashburn—an artist who was married to Richard and passed away in March—freshens up, while Conan Asmussen and his mother, Gail, take a break. At rendezvous, women dress as Native Americans, who sometimes married the trappers and were active in the trade.









After riding 35 miles that day, Rik "Hawk" Hurst (standing) and three other reenactors rest as their horses graze in Lima, Montana. Riders and steeds alike have to be in top shape to follow the original trails of 19th-century Western mountain men such as Jedediah Smith.

In the Loupe

With Bill Bonner, National Geographic Archivist



A Banner Day

Crowds gathered to gaze up at the “largest national flag” flying over New York City’s Times Square, probably during the summer of 1913—though this photograph wasn’t acquired by the *Geographic* until June 1918. By that time the magazine had already devoted its entire October 1917 issue to the topic of flags in a patriotic tribute to America’s recent entry into World War I. “Never before in the history of this country has there been such a phenomenal demand for flags,” noted one photo caption in that issue. “Not only Star Spangled Banners, but the flags of all the European nations with which the United States has joined forces in order to banish autocracy from the world.”

—Margaret G. Zackowitz

PHOTO: BROWN BROTHERS, NATIONAL GEOGRAPHIC CREATIVE

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