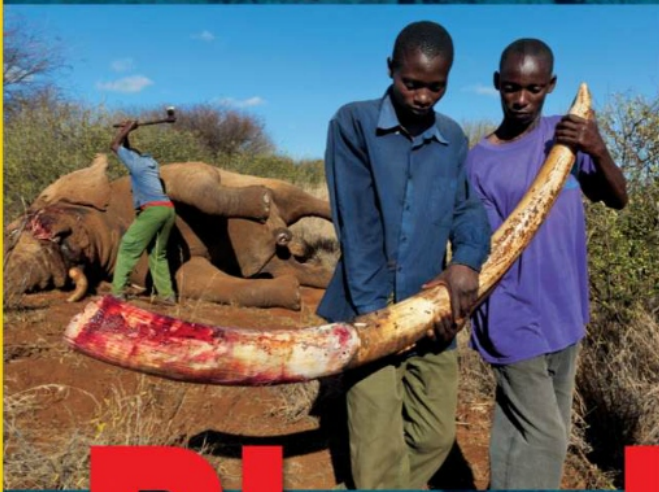


REMAKING RIO | NEPAL'S SECRET CAVES | MESOAMERICAN REEF

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NATIONAL GEOGRAPHIC



Blood Ivory

INVESTIGATIVE REPORT

25,000

ELEPHANTS WERE
KILLED LAST YEAR

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DAVID ALAN HARVEY

You can buy nearly anything from a vendor along the 50-plus miles of Rio beaches: Popsicle, ball, cover-up emblazoned with the city's statue of Christ the Redeemer.

October 2012

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A *National Geographic* investigation reveals how the religious art market fuels ivory smuggling.

By Bryan Christy Photographs by Brent Stirton

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Sleek or prickly, waxy or spiny, pure green or silvery white... why do they look the way they do?

By Rob Dunn

72 A New Face for Rio

With the Olympics coming in 2016, the city is spending millions to fix up its hillside slums.

By Antonio Regalado Photos by David Alan Harvey

92 Amazing Mesoamerican Reef

In this world, mangrove forests, sea grass beds, and coral reefs strike a delicate balance.

By Kenneth Brower Photographs by Brian Skerry

114 The Sky Caves of Nepal

Explorers scramble up cliffs to find out who created these ancient dwellings.

By Michael Finkel Photographs by Cory Richards

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The people moved away from their cottages in a rural Finnish town. And the animals moved in.

By Carolyn Butler Photographs by Kai Fagerström

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Baboons Recognize Words

But it is not yet clear if they can learn the meaning behind "banana."

Feathered Dino

It weighed a ton. It was kin to *T. rex*. And it had a coat of down.

Elephant Toys ▶

If a pachyderm twists the bolts on the pyramids at right, it gets a treat.



Chinese Driving Test

Among the questions: How should you jump from an overturning car?

Eau de Whale ▶

Ambergris emerges from a sperm whale's belly, enters high-end perfumes.

Birth of Amasia

In 100 million years Earth's shifting landmasses may form a new continent.



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DIGITAL EDITIONS



Ivory
Video

See video from Bryan Christy's investigation.



Mesoamerican Reef
Video

Swim amid a school of spawning snappers.



Mustang Caves
Video + 3-D Animation

Explore a model of a cliffside burial cave.



On the Cover The ivory market reaches from Africa to Asia. In Kenya (left) a ranger removes tusks from an elephant killed illegally; the aim is to keep the ivory off the black market. In China (right) a carver works with ivory.
Inset photos by Brent Stirton; background photo by Michael Nichols

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Blood Ivory

In an exclusive luxury-goods shop in Beijing, I watch a Chinese couple admire an elaborate ivory carving selling for hundreds of thousands of dollars. They see the exquisitely made object as an affirmation of personal wealth. I see carnage and death. I can smell the death too. About 15 years ago, on assignment in Zimbabwe, I photographed a group of rotting African elephant carcasses—the tragic remains of a family massacred for ivory.

Every year at least 25,000 elephants are killed by poachers for their tusks to feed the hunger of ivory collectors and the market for religious

The slaughter is massive and accelerating.

objects. The slaughter is massive and accelerating.

The very existence of these magnificent beasts is at risk.

The fate of elephants has become an obsession for investigative reporter Bryan Christy. He has been digging into this story for more than two years. His findings are shocking. Elephant poaching declined after the 1989 ban on ivory sales, but that trend has now reversed.

As Bryan explains in this issue, the reasons for this reversal are many, but the conclusion is singular: The killing must stop. Blood ivory can no longer be a badge of wealth or religious belief.

The cost is too high.





Greater Prairie-chicken (*Tympanuchus cupido*)

Size: Head and body length, 40 - 45 cm (16 - 18.8 inches); wingspan, 56 - 66 cm (22 - 26 inches)

Weight: Males, 0.9 - 1.2 kg (2 - 2.6 lbs); females, 0.75 - 0.95 kg (1.7 - 2.1 lbs) **Habitat:** Primarily mixed and tall-grass prairie **Surviving number:** Estimated at 460,000 mature individuals



Photographed by Wendy Shattil and Bob Rozinski

WILDLIFE AS CANON SEES IT

Room to boom. Male greater prairie-chickens establish booming grounds during breeding season, where they announce their prowess through vocalizations produced via their bright orange neck sacs. To impress females, they also strut and “flutter jump,” flapping their wings and jumping with a whoop, cackle or whine. Females, who usually visit more than one booming ground prior to mating, lay clutches of about a dozen eggs

in bowl-shaped nests lined with dry grass and feathers. But as their native prairies are converted to crop land, they are feeling the squeeze. Populations have fallen by 90% in the last 40 years.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.



Solar Storms

Those researching space weather seem to have neglected to study geomagnetic reversals, which are the basis of seafloor spreading. One would hope that meteorologists, astronomers, and geologists would utilize information from

- ▶ other sciences. It would seem to be significant that we have evidence that solar storms have, over geologic time, reversed Earth's magnetic field. The severity of electromagnetic disruption that could be attendant with such a future solar storm would be staggering.

MICHAEL H. FRIMPTER
USGS Geologist, Retired
Naples, Florida

I was wondering if there is any way to organize a graceful shutdown of the electrical grid in a large area if we had two days to prepare. I'm doubtful that humans could get past the political, bureaucratic, and security concerns, and I'm sure the crazies would be out in force if we could accomplish this. But how much money, effort, and tragedy could we save if we thought that far ahead?

DANE WARNER
Glendora, California

I have a friend who for some reason monitors Russian websites. For the past few months she's been telling all of her friends about how huge solar storms can wipe out electricity and shut down entire cities. We just ignored her, thinking she was just being paranoid. And then I got this issue. Thanks to your magazine's coverage, she now has something to hold over us.

BIANCA WILHELM
Windermere, Florida

Your "Sun Struck" article, and other publications, declare it a mystery why the corona is so much hotter than the sun's surface—an anomaly that any heat source object should be hotter at a greater radius, rather than cooler. To me, the riddle has been answered. Solar flares and their magnetic reconnection events are a nuclear fusion process known as the CNO cycle, an early hypothesis of [physicist] Hans Bethe's for the sun's core yet never imagined at the sun's surface.

NOEL EBERZ
Naalehu, Hawaii

Hong Kong

Your article reminded me of my five-day visit in 1957. When our plane landed, we were surrounded by groups of tailors—mine were three supposed brothers, John, Robert, and Patrick. The material was picked out on day one, sewn and fitted on day two, boxed on day three, and fell apart when I got back to Okinawa on day six.

BERNARD A. YABLIN
Rochester, New York

FEEDBACK Reader responses ran hot and cold on our solar storms coverage.

"I was immediately sunstruck by the story! Wow."



"The sun is good. We need the sun to live. The sun is bad. The sun will kill you."

"Like most people, I take the sun for granted."

"I was lost throughout most of the story."

"Forecasting was done for the past several thousand years, possibly more accurately."

"Will houses with solar panels still have electricity when power grids are down?"

"I find it dubious, if not irresponsible, to continually link this subject to a pending doomsday scenario."



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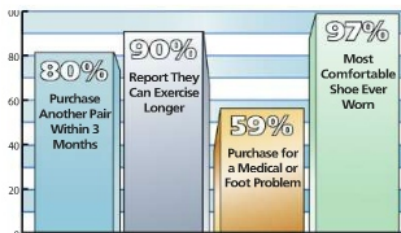


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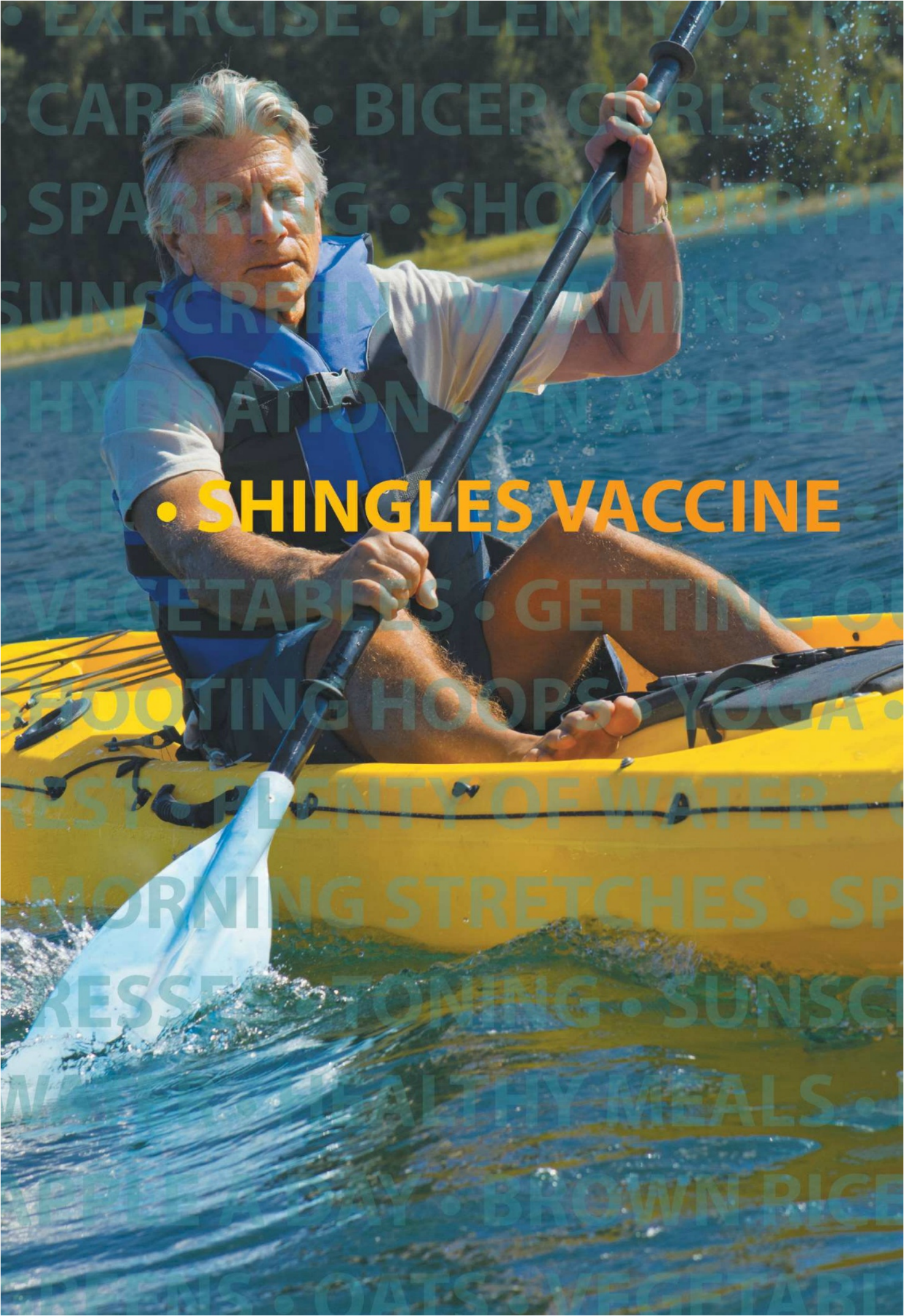


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Now's the time to help prevent Shingles with ZOSTAVAX® (Zoster Vaccine Live).

ZOSTAVAX is a vaccine that helps prevent Shingles in adults 50 years of age or older. Shingles is caused by the same virus that causes chickenpox. The virus stays in your body and can resurface at any time as Shingles—a painful, blistering rash. And no matter how healthy you feel, your risk increases as you get older.



The sooner you get vaccinated with ZOSTAVAX, the better your chances of protecting yourself from Shingles. In fact, the ACIP* of the CDC (Centers for Disease Control and Prevention) recommends that appropriate adults 60 years of age and older get vaccinated to help prevent Shingles.

Talk to your health care professional to see if ZOSTAVAX is right for you.

ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. For more information, visit ZOSTAVAX.com or call 1-877-9 SHINGLES.

ABOUT ZOSTAVAX

ZOSTAVAX is a vaccine that is used for adults 50 years of age or older to prevent Shingles (also known as zoster).

Important Safety Information

- ZOSTAVAX does not protect everyone, so some people who get the vaccine may still get Shingles.
- You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin or neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. You should not get ZOSTAVAX to prevent chickenpox.
- Talk to your health care professional if you plan to get ZOSTAVAX at the same time as PNEUMOVAX®23 (Pneumococcal Vaccine Polyvalent) because it may be better to get these vaccines at least 4 weeks apart.
- Possible side effects include redness, pain, itching, swelling, hard lump, warmth, or bruising at the injection site, as well as headache.
- ZOSTAVAX contains a weakened chickenpox virus. Tell your health care professional if you will be in close contact with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care professional can tell you what situations you may need to avoid.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

Please read the Patient Information on the adjacent page for more detailed information.

*ACIP=Advisory Committee on Immunization Practices

Before you get Shingles, get vaccinated.



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ZOSTAVAX®
Zoster Vaccine Live

9989115

**Patient Information about
ZOSTAVAX® (pronounced "ZOS tah vax")
Generic name: Zoster Vaccine Live**

You should read this summary of information about ZOSTAVAX before you are vaccinated. If you have any questions about ZOSTAVAX after reading this page, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 50 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles.

If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people. ZOSTAVAX does not protect everyone, so some people who get the vaccine may still get shingles.

ZOSTAVAX cannot be used to treat shingles, or the nerve pain that may follow shingles, once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including non-prescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

Can I get ZOSTAVAX with other vaccines?

Talk to your health care provider if you plan to get ZOSTAVAX at the same time as the flu vaccine.

Talk to your health care provider if you plan to get ZOSTAVAX at the same time as PNEUMOVAX®23 (Pneumococcal Vaccine Polyvalent) because it may be better to get these vaccines at least 4 weeks apart.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, hard lump, warmth, or bruising where the shot was given.
- headache

The following additional side effects have been reported with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- chickenpox
- fever
- hives at the injection site
- joint pain
- muscle pain
- nausea
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX. For a complete list of side effects, ask your health care provider.

Call 1-800-986-8999 to report any exposure to ZOSTAVAX during pregnancy.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

This page summarizes important information about ZOSTAVAX. If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

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Sarah McNair-Landry

MISSION *To inspire youth to get outdoors and get active, promoting a healthy lifestyle and a love of nature*

LOCATION
Arctic Ocean, Canada

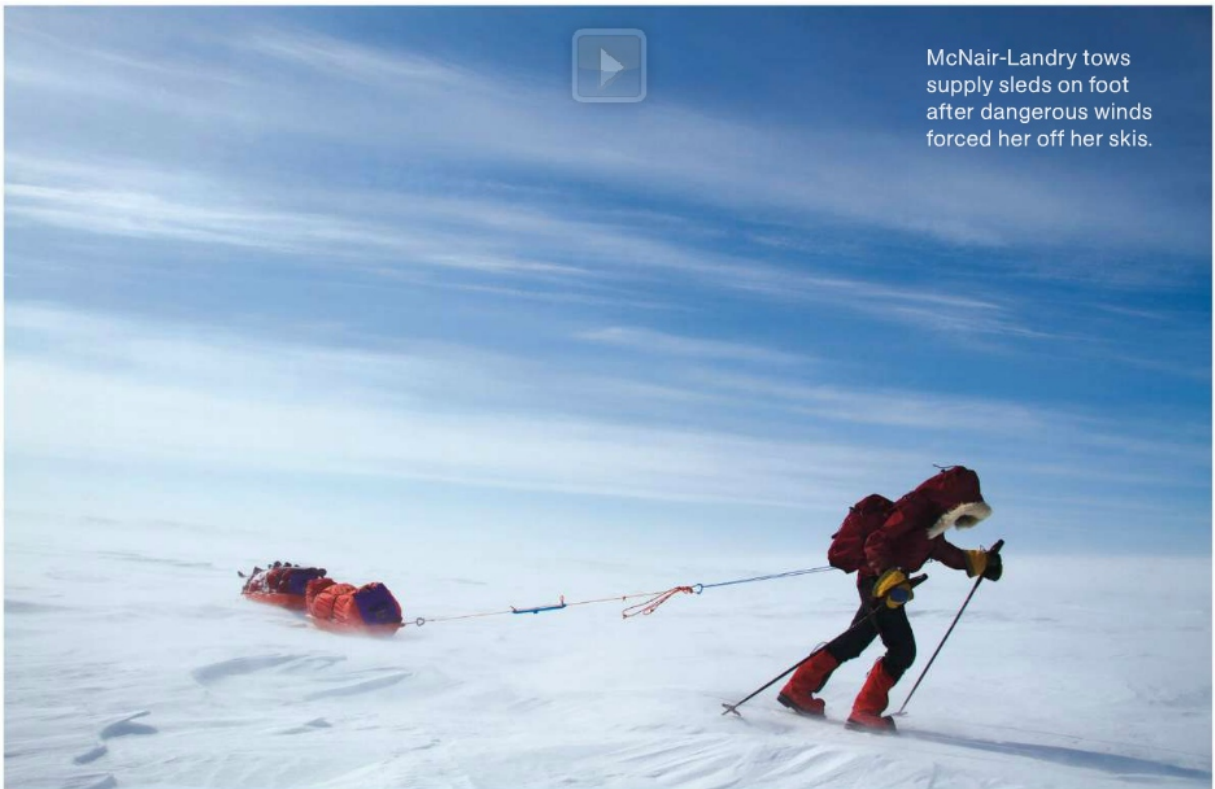
Across the Ice

Something woke me at four in the morning, and it's a good thing it did. A polar bear was about to attack the tent right above my head. As claws started to rip the fabric, I kicked and screamed. That woke my brother, Eric, who charged after the bear with a camp shovel. In the chaos I managed to find our shotgun, fire it in the air a couple times, and scare off the bear for good.

Eric and I were attempting the first kite-skiing traverse of the frozen Northwest Passage. We had set off in March 2011 from Tuktoyaktuk, in Canada's Northwest Territories, and hoped to end on Baffin Island, Nunavut, where we had grown up. Our

parents are adventure guides, so we spent weekends on dogsleds learning to have fun in the cold. As teenagers we took up kite skiing—catching the strong polar winds with a kite to pull us over the ice and snow. Now we're showing how it can open new routes by moving expeditions quickly over long distances.

On this trip the native Inuit tracked our progress through the radio interviews we did along the way. When we got to a town, they were always waiting for us. After 85 days and 2,050 miles, we pulled into Pond Inlet, on Baffin Island, where people welcomed us with a square dance. There was only one thing to do. We took off our skis and joined in. —Sarah McNair-Landry



McNair-Landry tows supply sleds on foot after dangerous winds forced her off her skis.

For patients 12 years and older whose asthma is not well controlled on a long-term asthma medicine or whose disease severity warrants

IF YOU THINK ASTHMA 'COMES AND GOES'

THINK AGAIN.

IT'S MISUNDERSTOOD. ASTHMA DOESN'T COME AND GO. Inflammation, the root cause of asthma is always there, making your lungs more vulnerable to triggers. So, while it's important to avoid triggers, it's also important to treat this inflammation. SYMBICORT helps reduce the underlying inflammation. SYMBICORT helps keep airways open and improve lung function for better breathing all day and night.* SYMBICORT does not replace a rescue inhaler for sudden symptoms. Once your asthma is well controlled, your doctor will decide if you can stop taking SYMBICORT without loss of control and may prescribe a long-term asthma control medicine such as an inhaled corticosteroid.

* When taken twice daily.

Ask your doctor about SYMBICORT.

IMPORTANT INFORMATION ABOUT SYMBICORT

Important Safety Information About SYMBICORT for Asthma

SYMBICORT contains formoterol, a long-acting beta₂-adrenergic agonist (LABA). LABA medicines such as formoterol increase the risk of death from asthma problems. It is not known whether budesonide, the other medicine in SYMBICORT, reduces the risk of death from asthma problems seen with formoterol. SYMBICORT should be used only if your health care provider decides that your asthma is not well controlled with a long-term asthma control medicine, such as an inhaled corticosteroid, or that your asthma is severe enough to begin treatment with SYMBICORT.

If you are taking SYMBICORT, see your health care provider if your asthma does not improve or gets worse. It is important that your health care provider assess your asthma control on a regular basis. Your doctor will decide if it is possible for you to stop taking SYMBICORT and start taking a long-term asthma control medicine without loss of asthma control. Children and adolescents who take LABA medicines may have an increased risk of being hospitalized for asthma problems.

SYMBICORT does not replace rescue inhalers for sudden asthma symptoms.

Be sure to tell your health care provider about all your health conditions, including heart conditions or high blood pressure, and all medicines you may be taking. Some patients taking SYMBICORT may experience increased blood pressure, heart rate, or change in heart rhythm.

Do not use SYMBICORT more often than prescribed. While taking SYMBICORT, never use another medicine containing a LABA for any reason. Ask your health care provider or pharmacist if any of your other medicines are LABA medicines, as using too much LABA may cause chest pain, increase in blood pressure, fast and irregular heartbeat, headache, tremor, and nervousness.

Patients taking SYMBICORT should call their health care provider or get emergency medical care:

- if you experience serious allergic reactions including rash, hives, swelling of the face, mouth and tongue, and breathing problems.
- if you think you are exposed to infections such as chicken pox or measles, or if you have any signs of infection. You may have a higher chance of infection.
- if you experience an increase in wheezing right after taking SYMBICORT, eye problems including glaucoma and cataracts, decreases in bone mineral density, swelling of blood vessels (signs include a feeling of pins and needles or numbness of arms or legs, flu like symptoms, rash, pain and swelling of the sinuses), decrease in blood potassium and increase in blood sugar levels.

If you are switching to SYMBICORT from an oral corticosteroid, follow your health care provider's instructions to avoid serious health risks when you stop using oral corticosteroids. Common side effects include nose and throat irritation, headache, upper respiratory tract infection, sore throat, sinusitis, stomach discomfort, flu, back pain, nasal congestion, vomiting, and thrush in the mouth and throat.

Approved Uses for SYMBICORT for Asthma

SYMBICORT is a medicine for the treatment of asthma for people 12 years and older whose doctor has determined that their asthma is not well controlled with a long term asthma control medicine such as an inhaled corticosteroid or whose asthma is severe enough to begin treatment with SYMBICORT. SYMBICORT is not a treatment for sudden asthma symptoms.

Please see Important Product Information on adjacent page and discuss with your doctor.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

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If you're without prescription coverage and can't afford your medication, AstraZeneca may be able to help. For more information, please visit www.astrazeneca-us.com

Symbicort[®]
(budesonide/formoterol fumarate dihydrate)
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AstraZeneca 

IMPORTANT INFORMATION ABOUT SYMBICORT

Please read this summary carefully and then ask your doctor about SYMBICORT.

No advertisement can provide all the information needed to determine if a drug is right for you or take the place of careful discussions with your health care provider. Only your health care provider has the training to weigh the risks and benefits of a prescription drug.

WHAT IS THE MOST IMPORTANT INFORMATION I SHOULD KNOW ABOUT SYMBICORT?

People with asthma who take long-acting beta₂-agonist (LABA) medicines, such as formoterol (one of the medicines in SYMBICORT), have an increased risk of death from asthma problems. It is not known whether budesonide, the other medicine in SYMBICORT, reduces the risk of death from asthma problems seen with formoterol.

SYMBICORT should be used only if your health care provider decides that your asthma is not well controlled with a long-term asthma control medicine, such as an inhaled corticosteroid, or that your asthma is severe enough to begin treatment with SYMBICORT.

Talk with your health care provider about this risk and the benefits of treating your asthma with SYMBICORT.

If you are taking SYMBICORT, see your health care provider if your asthma does not improve or gets worse. It is important that your health care provider assess your asthma control on a regular basis. Your doctor will decide if it is possible for you to stop taking SYMBICORT and start taking a long-term asthma control medicine without loss of asthma control.

Get emergency medical care if:

- breathing problems worsen quickly, and
- you use your rescue inhaler medicine, but it does not relieve your breathing problems.

Children and adolescents who take LABA medicines may be at increased risk of being hospitalized for asthma problems.

WHAT IS SYMBICORT?

SYMBICORT is an inhaled prescription medicine used for asthma and chronic obstructive pulmonary disease (COPD). It contains two medicines:

- Budesonide (the same medicine found in Pulmicort Flexhaler™, an inhaled corticosteroid). Inhaled corticosteroids help to decrease inflammation in the lungs. Inflammation in the lungs can lead to asthma symptoms
- Formoterol (the same medicine found in Foradil® Aerolizer™). LABA medicines are used in patients with COPD and asthma to help the muscles in the airways of your lungs stay relaxed to prevent asthma symptoms, such as wheezing and shortness of breath. These symptoms can happen when the muscles in the airways tighten. This makes it hard to breathe, which, in severe cases, can cause breathing to stop completely if not treated right away

SYMBICORT is used for asthma and chronic obstructive pulmonary disease as follows:

Asthma

SYMBICORT is used to control symptoms of asthma and prevent symptoms such as wheezing in adults and children ages 12 and older.

Chronic Obstructive Pulmonary Disease

COPD is a chronic lung disease that includes chronic bronchitis, emphysema, or both. SYMBICORT 160/4.5 mcg is used long term, two times each day, to help improve lung function for better breathing in adults with COPD.

WHO SHOULD NOT USE SYMBICORT?

Do not use SYMBICORT to treat sudden severe symptoms of asthma or COPD or if you are allergic to any of the ingredients in SYMBICORT.

WHAT SHOULD I TELL MY HEALTH CARE PROVIDER BEFORE USING SYMBICORT?

Tell your health care provider about all of your health conditions, including if you:

- have heart problems
- have high blood pressure
- have seizures
- have thyroid problems
- have diabetes
- have liver problems
- have osteoporosis
- have an immune system problem
- have eye problems such as increased pressure in the eye, glaucoma, or cataracts
- are allergic to any medicines
- are exposed to chicken pox or measles
- are pregnant or planning to become pregnant. It is not known if SYMBICORT may harm your unborn baby
- are breast-feeding. Budesonide, one of the active ingredients in SYMBICORT, passes into breast milk. You and your health care provider should decide if you will take SYMBICORT while breast-feeding

Tell your health care provider about all the medicines you take including prescription and nonprescription medicines, vitamins, and herbal supplements. SYMBICORT and certain other medicines may interact with each other and can cause serious side effects. Know all the medicines you take. Keep a list and show it to your health care provider and pharmacist each time you get a new medicine.

HOW DO I USE SYMBICORT?

Do not use SYMBICORT unless your health care provider has taught you and you understand everything. Ask your health care provider or pharmacist if you have any questions.

Use SYMBICORT exactly as prescribed. **Do not use SYMBICORT more often than prescribed.** SYMBICORT comes in two strengths for asthma: 80/4.5 mcg and 160/4.5 mcg. Your health care provider will prescribe the strength that is best for you. SYMBICORT 160/4.5 mcg is the approved dosage for COPD.

- SYMBICORT should be taken every day as 2 puffs in the morning and 2 puffs in the evening.
- Rinse your mouth with water and spit the water out after each dose (2 puffs) of SYMBICORT. This will help lessen the chance of getting a fungus infection (thrush) in the mouth and throat.
- Do not spray SYMBICORT in your eyes. If you accidentally get SYMBICORT in your eyes, rinse your eyes with water. If redness or irritation persists, call your health care provider.
- Do not change or stop any medicines used to control or treat your breathing problems. Your health care provider will change your medicines as needed
- **While you are using SYMBICORT 2 times each day, do not use other medicines that contain a long-acting beta₂-agonist (LABA) for any reason. Ask your health care provider or pharmacist if any of your other medicines are LABA medicines.**
- SYMBICORT does not relieve sudden symptoms. Always have a rescue inhaler medicine with you to treat sudden symptoms. If you do not have a rescue inhaler, call your health care provider to have one prescribed for you.

Call your health care provider or get medical care right away if:

- your breathing problems worsen with SYMBICORT
- you need to use your rescue inhaler medicine more often than usual
- your rescue inhaler does not work as well for you at relieving symptoms
- you need to use 4 or more inhalations of your rescue inhaler medicine for 2 or more days in a row
- you use one whole canister of your rescue inhaler medicine in 8 weeks' time
- your peak flow meter results decrease. Your health care provider will tell you the numbers that are right for you
- your symptoms do not improve after using SYMBICORT regularly for 1 week

WHAT MEDICATIONS SHOULD I NOT TAKE WHEN USING SYMBICORT?

While you are using SYMBICORT, do not use other medicines that contain a long-acting beta₂-agonist (LABA) for any reason, such as:

- Serevent® Diskus® (salmeterol xinafoate inhalation powder)
- Advair Diskus® or Advair® HFA (fluticasone propionate and salmeterol)
- Formoterol-containing products such as Foradil Aerolizer, Brovana®, or Perforomist®

WHAT ARE THE POSSIBLE SIDE EFFECTS WITH SYMBICORT?

SYMBICORT can cause serious side effects.

- Increased risk of pneumonia and other lower respiratory tract infections if you have COPD. Call your health care provider if you notice any of these symptoms: increase in mucus production, change in mucus color, fever, chills, increased cough, increased breathing problems
- Serious allergic reactions including rash; hives; swelling of the face, mouth and tongue; and breathing problems. Call your health care provider or get emergency care if you get any of these symptoms
- Immune system effects and a higher chance for infections
- Adrenal insufficiency—a condition in which the adrenal glands do not make enough steroid hormones
- Cardiovascular and central nervous system effects of LABAs, such as chest pain, increased blood pressure, fast or irregular heartbeat, tremor, or nervousness
- Increased wheezing right after taking SYMBICORT
- Eye problems, including glaucoma and cataracts. You should have regular eye exams while using SYMBICORT
- Osteoporosis. People at risk for increased bone loss may have a greater risk with SYMBICORT
- Slowed growth in children. As a result, growth should be carefully monitored
- Swelling of your blood vessels. This can happen in people with asthma
- Decreases in blood potassium levels and increases in blood sugar levels

WHAT ARE COMMON SIDE EFFECTS OF SYMBICORT?

Patients with Asthma

Sore throat, headache, upper respiratory tract infection, thrush in the mouth and throat

Patients with COPD

Thrush in the mouth and throat

These are not all the side effects with SYMBICORT. Ask your health care provider or pharmacist for more information.

NOTE: This summary provides important information about SYMBICORT. For more information, please ask your doctor or health care provider.

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No More Mr. Nice Watch

Forget sleek and subtle, the Stauer Colossus Hybrid is one tough timepiece...now for less than \$50!

Never underestimate your competition. Just ask Demetrius, the unfortunate Greek general who set out to conquer Rhodes in 305 BC. He assumed that a massive force of 40,000 men, a fleet of Aegean pirates and an arsenal of wall-smashing war machines would be enough to crush the tiny Greek island. He was wrong. The Rhodians were tougher than he thought. And so is this watch. If you've always believed that the biggest, baddest watches had to cost big, bad money, the \$49 Stauer *Colossus Hybrid Chronograph* is here to change your mind.

A monument to toughness. The people of Rhodes were ready for Demetrius and repelled his attack. To celebrate, they built the Colossus of Rhodes, a 107-foot bronze and iron giant that towered over the harbor like a ten-story trophy. It warned future invaders that "Rhodes is tougher than you think." You give the same message when you wear the Stauer *Colossus*.

The timepiece that works twice as hard. In designing the *Colossus Hybrid Chronograph*, our instructions to the watchmaker were clear: build it as tough as a battleship and fill it full of surprises. Make it a hybrid, because it should work twice as hard as a regular watch. And make it look like a million bucks, because when you put it on, you should get excited about rolling up your sleeves. Mission accomplished.

A toolbox on your wrist. It will keep you on schedule, but the *Colossus Hybrid* is about much more than time. The imposing case features a rotating gunmetal bezel that frames the silver, black and yellow face. You'll find a battalion of digital displays on the dial arranged behind a pair of luminescent hands and a bold yellow second hand.

Powered by a precise quartz movement, the watch is doubly accurate in analog and digital mode. And it's packed with plenty of handy extras including a bright green EL back-light for enhanced nighttime visibility, a tachymeter along the outer dial and a full complement of alarms and split-second countdown timers. The *Colossus Hybrid* secures with a folded steel bracelet that highlights a row of striking dark center links. It's a rugged watch that's more than ready for your daily grind.

Your Satisfaction is Guaranteed. Wear the Stauer *Colossus Hybrid* for 30 days and if you are not 100% thrilled with your purchase, return it for a full refund of your purchase price. But once you get a taste of more watch for less money, it's likely you'll be back for more... and we'll be waiting.

WATCH SPECS: -Easy-to-read analog/digital modes -Back-lighting and luminescent hands - Tachymeter, countdown timers and alarms
-Folded stainless steel bracelet fits a 6 3/4"-9" wrist

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Colossus Hybrid Digital/Analog Watch—~~\$395~~
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VISIONS



Germany

High above Bavaria's Zugspitze mountain, Swiss tightrope artist Freddy Nock nears the end of his 2011 quest to walk a two-inch-thick, 3,264-foot-long cable without a balancing pole. He succeeded, as photographers looked on.

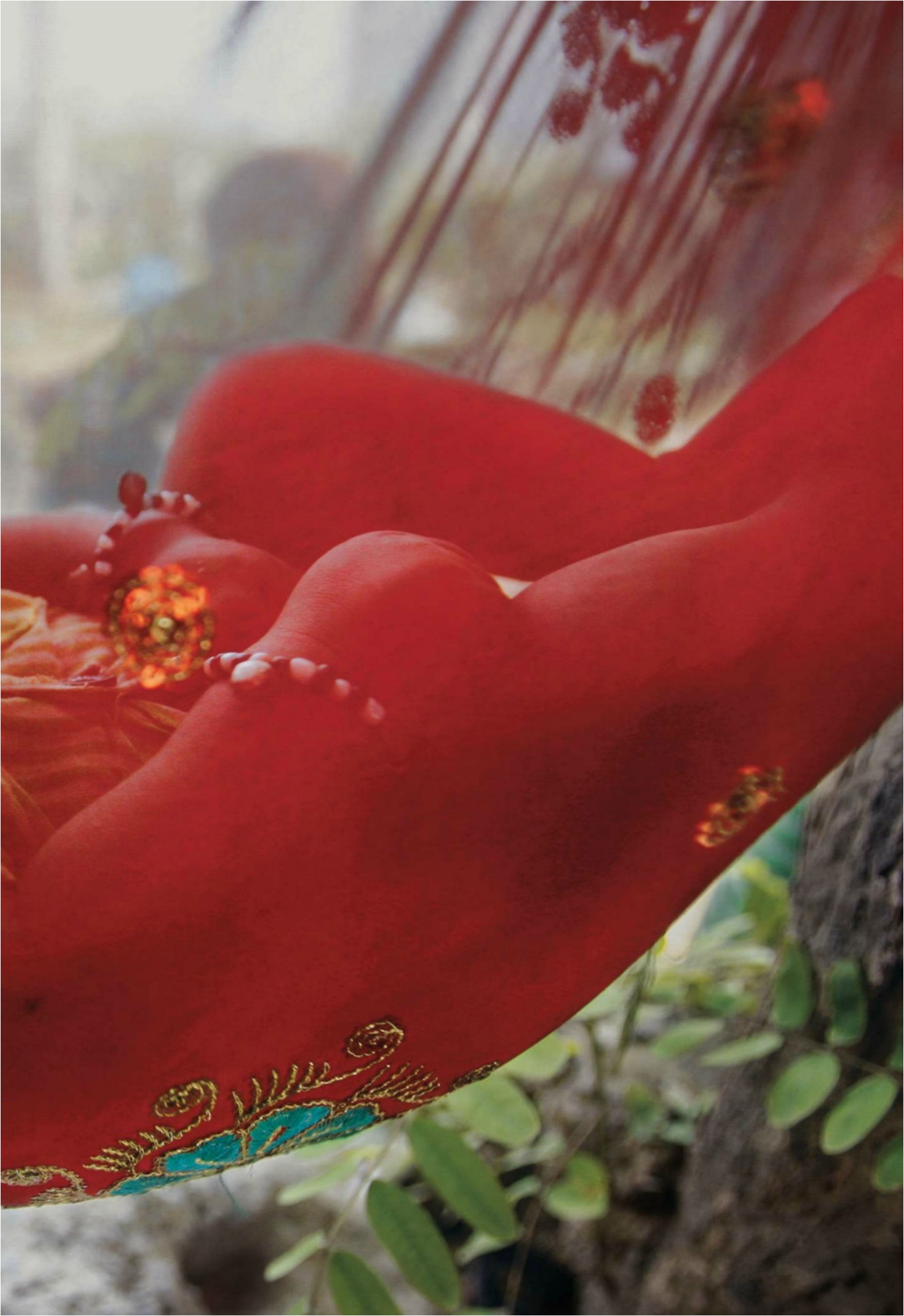
PHOTO: MICHAELA REHLE, REUTERS



India

Suspended in a hammock, a boy slumbers peacefully in the noontime heat of a summer day. His family relaxes nearby on a roadside in Uttar Pradesh.

PHOTO: PARIVARTAN SHARMA, REUTERS





India

At twilight on floodwaters from the Brahmaputra River, a fisherman maneuvers a net on bamboo poles to catch fish for local consumption. The site lies near the city of Guwahati, a key river port in northeast India.

PHOTO: EPA/CORBIS

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"When I learned my AFib puts me at 5 times greater risk of stroke, my first thought was about my family."

Patient portrayal

What is Pradaxa® (dabigatran etexilate mesylate) capsules?

PRADAXA is a prescription blood-thinning medicine used to reduce the risk of stroke and blood clots in people with atrial fibrillation not caused by a heart valve problem.

IMPORTANT SAFETY INFORMATION

PRADAXA can cause bleeding which can be serious and sometimes lead to death. Don't take PRADAXA if you currently have abnormal bleeding or if you have ever had an allergic reaction to it.



Your risk of bleeding with PRADAXA may be higher if you: are 75 years old or older, have kidney problems, have stomach or intestine bleeding that is recent or keeps coming back or you have a stomach ulcer, take other medicines that increase your risk of bleeding, like aspirin products, non-steroidal anti-inflammatory drugs (NSAIDs) and blood thinners, have kidney problems and take dronedarone (Multaq®) or ketoconazole tablets (Nizoral®).

Call your doctor or seek immediate medical care if you have any of the following signs or symptoms of bleeding: any unexpected, severe, or uncontrollable bleeding; or bleeding that lasts a long time, unusual or unexpected bruising, coughing up or vomiting blood; or vomit that looks like coffee grounds, pink or brown urine;



If you have an irregular heartbeat called atrial fibrillation, or AFib, not caused by a heart valve problem, **PRADAXA** can reduce your risk of stroke.

- In a clinical trial, PRADAXA **reduced stroke risk 35% more** than warfarin.

Risk reduction was greatest when compared to patients on warfarin whose blood tests showed lower levels of control.

- **Unlike warfarin:**
No regular blood tests.
No dietary restrictions.

Ask your doctor about

Pradaxa[®]
dabigatran etexilate
CAPSULES 150mg

red or black stools (looks like tar), unexpected pain, swelling, or joint pain, headaches and feeling dizzy or weak.

It is important to tell your doctor about all medicines, vitamins and supplements you take. Some of your other medicines may affect the way PRADAXA works.

Take PRADAXA exactly as prescribed by your doctor. Don't stop taking PRADAXA without talking to your doctor as your risk of stroke may increase.

Tell your doctor if you are planning to have **any** surgery, or medical or dental procedure, because you may have to stop taking PRADAXA for a short time.

PRADAXA can cause indigestion, stomach upset or burning, and stomach pain.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

Please see more detailed Medication Guide on next page.

Pradaxa[®]
dabigatran etexilate
CAPSULES 150mg

For more information or help paying for your medication, call 1-877-PRADAXA or visit pradaxa.com.



MEDICATION GUIDE
PRADAXA (pra dax' a)
(dabigatran etexilate mesylate)
capsules

Read this Medication Guide before you start taking PRADAXA and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking with your doctor about your medical condition or your treatment.

What is the most important information I should know about PRADAXA?

- PRADAXA can cause bleeding which can be serious, and sometimes lead to death. This is because PRADAXA is a blood thinner medicine that lowers the chance of blood clots forming in your body.
- **You may have a higher risk of bleeding if you take PRADAXA and:**
 - are over 75 years old
 - have kidney problems
 - have stomach or intestine bleeding that is recent or keeps coming back, or you have a stomach ulcer
 - take other medicines that increase your risk of bleeding, including:
 - aspirin or aspirin containing products
 - long-term (chronic) use of non-steroidal anti-inflammatory drugs (NSAIDs)
 - warfarin sodium (Coumadin[®], Jantoven[®])
 - a medicine that contains heparin
 - clopidogrel (Plavix[®])
 - prasugrel (Effient[®])
 - have certain kidney problems and also take the medicines dronedarone (Multaq[®]) or ketoconazole tablets (Nizoral[®]).

Tell your doctor if you take any of these medicines. Ask your doctor or pharmacist if you are not sure if your medicine is one listed above.

- PRADAXA can increase your risk of bleeding because it lessens the ability of your blood to clot. While you take PRADAXA:
 - you may bruise more easily
 - it may take longer for any bleeding to stop.

Call your doctor or get medical help right away if you have any of these signs or symptoms of bleeding:

- unexpected bleeding or bleeding that lasts a long time, such as:
 - unusual bleeding from the gums
 - nose bleeds that happen often
 - menstrual bleeding or vaginal bleeding that is heavier than normal
- bleeding that is severe or you cannot control
- pink or brown urine
- red or black stools (looks like tar)

- bruises that happen without a known cause or get larger
- cough up blood or blood clots
- vomit blood or your vomit looks like “coffee grounds”
- unexpected pain, swelling, or joint pain
- headaches, feeling dizzy or weak

Take PRADAXA exactly as prescribed. Do not stop taking PRADAXA without first talking to the doctor who prescribes it for you. Stopping PRADAXA may increase your risk of a stroke.

PRADAXA may need to be stopped, if possible, for one or more days before any surgery, or medical or dental procedure. If you need to stop taking PRADAXA for **any reason**, talk to the doctor who prescribed PRADAXA for you to find out when you should stop taking it. Your doctor will tell you when to start taking PRADAXA again after your surgery or procedure.

See “What are the possible side effects of PRADAXA?” for more information about side effects.

What is PRADAXA?

PRADAXA is a prescription medicine used to reduce the risk of stroke and blood clots in people who have a medical condition called atrial fibrillation. With atrial fibrillation, part of the heart does not beat the way it should. This can lead to blood clots forming and increase your risk of a stroke. PRADAXA is a blood thinner medicine that lowers the chance of blood clots forming in your body.

It is not known if PRADAXA is safe and works in children.

Who should not take PRADAXA?

Do not take PRADAXA if you:

- currently have certain types of abnormal bleeding. Talk to your doctor, before taking PRADAXA if you currently have unusual bleeding.
- have had a serious allergic reaction to PRADAXA. Ask your doctor if you are not sure.

What should I tell my doctor before taking PRADAXA?

Before you take PRADAXA, tell your doctor if you:

- have kidney problems
- have ever had bleeding problems
- have ever had stomach ulcers
- have any other medical condition

- are pregnant or plan to become pregnant. It is not known if PRADAXA will harm your unborn baby.
- are breastfeeding or plan to breastfeed. It is not known if PRADAXA passes into your breast milk.

Tell all of your doctors and dentists that you are taking PRADAXA. They should talk to the doctor who prescribed PRADAXA for you, before you have **any** surgery, or medical or dental procedure.

Tell your doctor about all the medicines you take, including prescription and non-prescription medicines, vitamins, and herbal supplements. Some of your other medicines may affect the way PRADAXA works. Certain medicines may increase your risk of bleeding. See **“What is the most important information I should know about PRADAXA?”**

Especially tell your doctor if you take:

- rifampin (Rifater, Rifamate, Rimactane, Rifadin)

Know the medicines you take. Keep a list of them and show it to your doctor and pharmacist when you get a new medicine.

How should I take PRADAXA?

- **Take PRADAXA exactly as prescribed by your doctor.**
- Do not take PRADAXA more often than your doctor tells you to.
- You can take PRADAXA with or without food.
- **PRADAXA comes in a bottle or in a blister package.**
- **Only open 1 bottle of PRADAXA at a time. Finish your opened bottle of PRADAXA before opening a new bottle.**
- **After opening a bottle of PRADAXA, use within 4 months. See “How should I store PRADAXA?”**
- **When it is time for you to take a dose of PRADAXA, only remove your prescribed dose of PRADAXA from your open bottle or blister package.**
- **Tightly close your bottle of PRADAXA right away after you take your dose.**
- Swallow PRADAXA capsules whole. Do not break, chew, or empty the pellets from the capsule.
- If you miss a dose of PRADAXA, take it as soon as you remember. If your next dose is less than 6 hours away, skip the missed dose. Do not take two doses of PRADAXA at the same time.
- Your doctor will decide how long you should take PRADAXA. **Do not stop taking PRADAXA without first talking with your doctor. Stopping PRADAXA may increase your risk of stroke.**

- Do not run out of PRADAXA. Refill your prescription before you run out. If you plan to have surgery, or a medical or a dental procedure, tell your doctor and dentist that you are taking PRADAXA. You may have to stop taking PRADAXA for a short time. See “What is the most important information I should know about PRADAXA?”
- If you take too much PRADAXA, go to the nearest hospital emergency room or call your doctor.
- Call your healthcare provider right away if you fall or injure yourself, especially if you hit your head. Your healthcare provider may need to check you.

What are the possible side effects of PRADAXA?

PRADAXA can cause serious side effects.

- See “What is the most important information I should know about PRADAXA?”
- Allergic Reactions. In some people, PRADAXA can cause symptoms of an allergic reaction, including hives, rash, and itching. Tell your doctor or get medical help right away if you get any of the following symptoms of a serious allergic reaction with PRADAXA:
 - chest pain or chest tightness
 - swelling of your face or tongue
 - trouble breathing or wheezing
 - feeling dizzy or faint

Common side effects of PRADAXA include:

- indigestion, upset stomach, or burning
- stomach pain

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

These are not all of the possible side effects of PRADAXA. For more information, ask your doctor or pharmacist.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store PRADAXA?

- Store PRADAXA at room temperature between 59°F to 86°F (15°C to 30°C). After opening the bottle, use PRADAXA within 4 months. Safely throw away any unused PRADAXA after 4 months.
- **Keep PRADAXA in the original bottle or blister package to keep it dry (protect the capsules from moisture). Do not put PRADAXA in pill boxes or pill organizers.**
- **Tightly close your bottle of PRADAXA right away after you take your dose.**

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

General information about PRADAXA

Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. Do not use PRADAXA for a condition for which it was not prescribed. Do not give your PRADAXA to other people, even if they have the same symptoms. It may harm them.

This Medication Guide summarizes the most important information about PRADAXA. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about PRADAXA that is written for health professionals.

For more information, go to www.PRADAXA.com or call 1-800-542-6257 or (TTY) 1-800-459-9906.

What are the ingredients in PRADAXA?

Active ingredient: dabigatran etexilate mesylate

Inactive ingredients: acacia, dimethicone, hypromellose, hydroxypropyl cellulose, talc, and tartaric acid. The capsule shell is composed of carrageenan, FD&C Blue No. 2 (150 mg strength only), FD&C Yellow No. 6, hypromellose, potassium chloride, titanium dioxide, and black edible ink.

This Medication Guide has been approved by the U.S. Food and Drug Administration.

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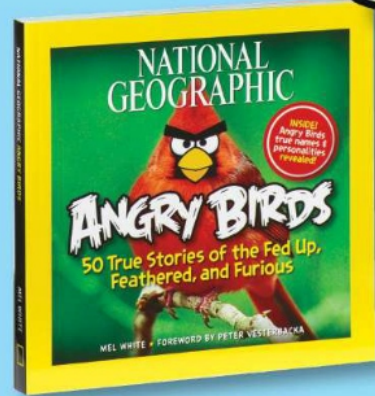
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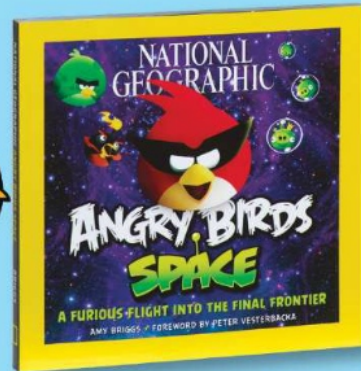
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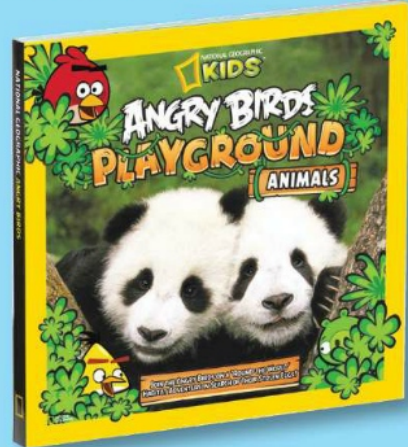
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Grace Cleere included
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A communications expert for the government, Grace Cleere recently named National Geographic as a beneficiary in her will. "I included a bequest intention to National Geographic because I believe in everything the organization represents," says Cleere. "If we don't understand our world, we are bound to mistreat it. And if we are not curious about all living things on our planet, we are bound to lose them through thoughtlessness and indifference. National Geographic shines a spotlight on the critical issues of the day and proposes innovative solutions that are grounded in science. I feel good about my legacy knowing that National Geographic will leverage my gift so it can have the greatest impact."

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EDITORS' CHOICE **Zhang Xuan** Toronto, Canada

On the shore of Canada's Lake Ontario, Zhang enjoyed watching the elegant feathers of mute swans. While feeding, this one opened its wings and gave the photographer the shot he'd hoped for. "My original aim was to capture the swan facing me," he says, "but this angle was good."



READERS' CHOICE

Ko Cheng

Taichung, Taiwan

As a medical student in Taichung, Cheng visited Gaomei wetland, a protected habitat where water sculpts the mud. The 27-year-old reflects, "Taking off one's shoes and walking on the tidal flat is the most direct way for people who live in the concrete jungle to contact nature."

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DEBATES IN RIO & ASPEN

SPOTLIGHT ON
SUSTAINABILITY
AND ADAPTATION

MEGASUMMIT FOSTERS KEY COMMITMENTS

Marking the 20th anniversary of the first Earth Summit, in Rio de Janeiro, heads of state from nearly 200 countries as well as 50,000 activists came to Brazil for the sprawling **Rio+20 United Nations Conference on Sustainable Development** (June 20–22, 2012). The agenda? To drive global initiatives to reduce carbon, increase clean energy, and address food and water shortages. Among his remarks, United Nations Secretary-General Ban Ki-moon said that with 1.5 billion more people in the world today than in 1992, we'll need 50 percent more food and 45 percent more energy in 2030 than we do now. The three-day event drew mixed reviews and produced a sizable outcome document entitled "The Future We Want." But words translated into action with some of the world's largest companies agreeing to take deforestation out of food supply chains and proposing to roll out internal carbon fees on operations throughout the world. Another significant side meeting brought about commitments from development banks, now poised to lend billions of dollars to major cities to lessen congestion, pollution, and energy waste.

FINITE RESOURCES, EXPANDING NEEDS

Later that week, 6,000 miles northwest, the sustainability conversation continued when distinguished thought leaders and interested citizens convened at the fifth annual **Aspen Environment Forum** (June 22–25, 2012) for dialogue surrounding the theme of "Living in the New Normal." The National Oceanic and Atmospheric Administration's recent declaration that the long-term average temperature in the U.S. has warmed by a half degree in the past decade set the baseline for discussions on how to adapt to the new environmental paradigm. The forum permitted insightful exchanges among experts such as Edward O. Wilson, Stewart Brand, Fred Krupp, and Sylvia Earle, among many others. In its goal to illuminate ways to preserve the Earth's finite resources, developments in urbanization were presented along with improvements in freshwater conservation, technologies, and energy-efficient alternatives. These and other solutions are helping us meet some of the greatest challenges of our time.

BIG-PICTURE

Vale continues to support and encourage dialogue on critical sustainability issues.



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Botafogo Bay, Rio de Janeiro, Brazil (top).

Elliot Gerson, Executive Vice President for Policy and Public Programs, International Partners, The Aspen Institute at left; Edward O. Wilson, University Research Professor Emeritus, Harvard University at right (above right).

Attendees on The Aspen Institute Campus (right).

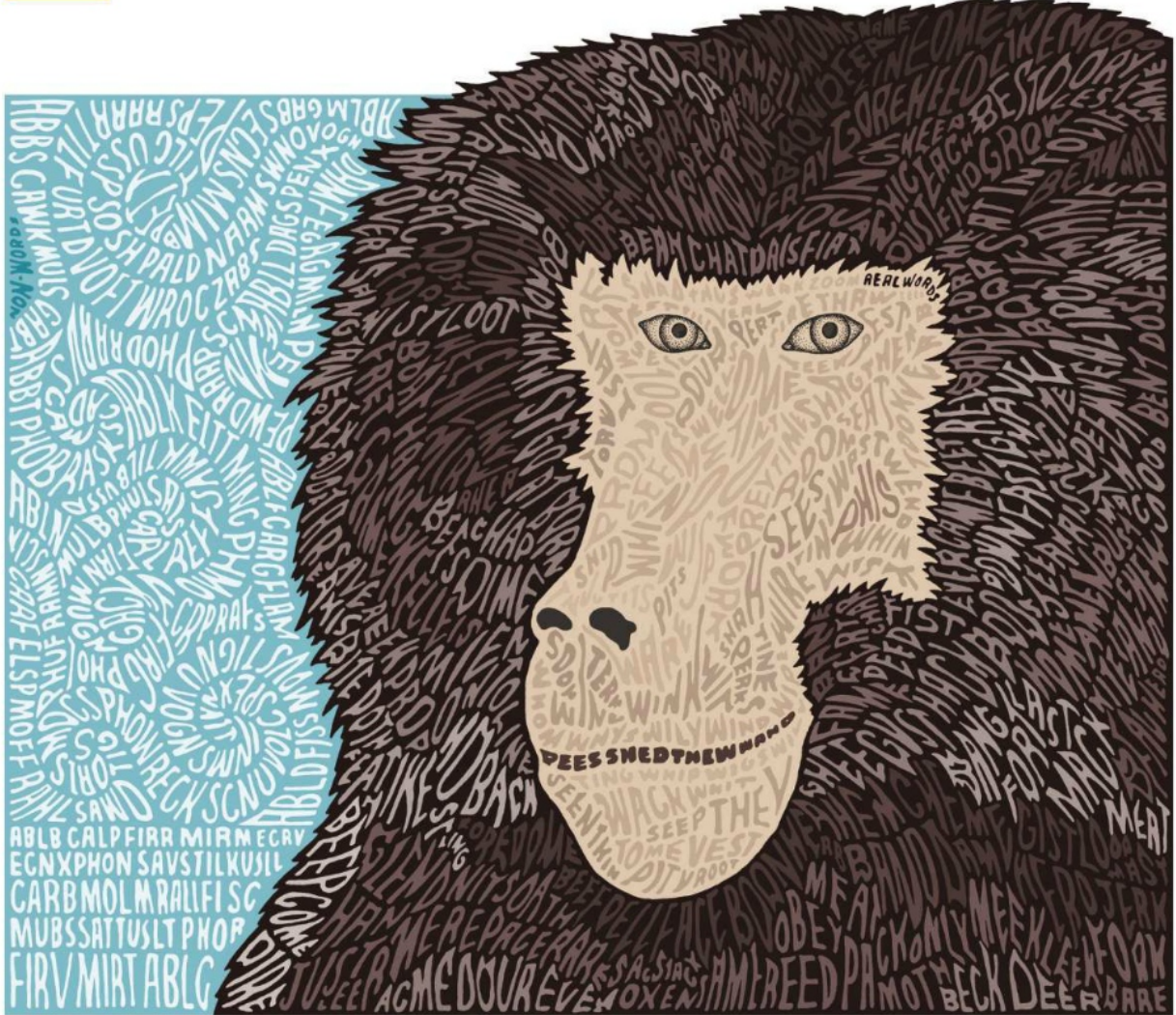


NEXT

SKYCAST

Overhead this month
in parts of the world

October 21
Orionids meteor
shower



Choice Words Reading this page starts with the ability to distinguish real words from garble by identifying letters and their relationship to one another. Baboons, a new study reveals, have that skill too—countering a common theory that reading requires prior knowledge of language.

Researchers at France's Aix-Marseille University presented four-letter combinations to six Guinea baboons, which touched one of two shapes on a screen to indicate word or nonword. After some 10,000 attempts each, they could spot actual words with nearly 75 percent accuracy—and could even predict whether a new sequence was a word. The results suggest that human reading might involve recognizing letters purely as objects, rather than symbols associated with spoken language, says co-author Jonathan Grainger. The next step: seeing if baboons can connect words with meaning. —Luna Shyr

Baboons learned to identify English words (in brown) from nonwords (blue) with up to 75 percent accuracy.

A new tyrannosaur is the largest feathered animal ever found.

DOWNY DINOSAUR | Kin to the mighty *T. rex*, 30-foot-long carnivorous *Yutyranus huali*—a mix of Mandarin and Latin that translates to “beautiful feathered tyrant”—is the first big dinosaur known to have feathers. Three near-complete fossils of the dinosaur discovered in China’s Liaoning Province are streaked with remnants of eight-inch filaments—an indication that the one-ton predator had a downy coat, like a supersize chick, says Corwin Sullivan, a paleontologist at the Chinese Academy of Sciences who’s studying the new species.

Unlike the stiff quills of modern birds meant for flight, *Y. huali*’s soft down may have kept the animal toasty during a Cretaceous cold spell about 125 million years ago. Did big dinosaurs need feathers for warmth? Modern biology would suggest not, since large living animals retain heat better than small ones. But the *Y. huali* find, added to numerous smaller feathered dinosaur species unearthed in the same rock formation, points to yes. “Now we have evidence, and it’s quite a large tyrannosauroid that apparently did need insulation,” says Sullivan. “It changes the picture.” —Christine Dell’Amore





Smaller than *T. rex*, *Y. huali* reached 30 feet head to tail.



Head-to-foot fossils of *Y. huali* have streaks along their length—remnants of feathers up to eight inches long.

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Above: A kayaker paddles in the clear blue waters of Belize.

Elephant Toys

Known affectionately as “the girls,” Ruth and Emily have a lot of fun for two Asian elephants. Ages 54 and 48, they spend their days tinkering with an array of special toys at the Buttonwood Park Zoo in Massachusetts. No mere plastic playthings, these toys have been engineered to appeal to the pachyderms’ social nature, psychology, and intelligence.

The toymakers are students from the Massachusetts College of Art and Design, assigned to create elephant gadgets after research excursions to the zoo. “The class discovered that the elephants first want to play with a new object in the yard, then try to eat it,” says Professor Rick Brown. That’s why a crank-operated canister (right) is packed with popcorn; other toys have fruit tucked inside.

Typically the elephants find and finish off the treats within a half hour, says zoo director William Langbauer. He reports that the girls haven’t rejected any toy yet but sometimes use them in surprising ways. A steel box with the word “elephant” cut into it, for example, is meant to be a puzzle. Emily prefers to bang it like a drum.

—Catherine Zuckerman



Balls inside the Octo-log make noise when it’s rolled.



The 425-pound Pachy-sac, made of tire treads, is a favorite.



Twisting a bolt unlocks the treat-filled Pyramid Toy.

Toys designed by art students are a hit with elephants at a Massachusetts zoo.



China's Car Crackdown With Chinese cities choking on traffic—the number of cars has more than doubled since 2007—governments are struggling to prevent permanent gridlock. Beijing has chosen the radical solution of holding a lottery for 20,000 license plates each month, with about 900,000 total applicants.

That's forcing Beijingers to take countermeasures. Some enroll family members to boost their odds; others buy cars registered in neighboring cities. Shanghai auctions plates to the tune of \$10,000 each, while other cities are raising downtown parking fees or building subway lines. "Gridlock should be avoidable," says Shao Chunfu of Beijing Jiaotong University. "But given trends in China's development, I'm afraid it's unavoidable, even in small cities." —Jan Johnson

In Cangzhou, Chinese police check counterfeit license plates as part of a campaign against illegal vehicles.

PASSING THE TEST To combat the more than 60,000 traffic deaths each year, China requires new drivers to pass a tough test. They must score 90 percent or more on an exam drawn from hundreds of possible questions on topics like road judgment, etiquette, and civil law. —JJ



See more driving-test questions on the iPad.

Sample question ▶ When a vehicle overturns slowly and jumping out of the vehicle is possible, the driver should jump _____.

A. in the driving direction C. in the opposite direction of the overturn
 B. in the overturning direction D. to the overturning side



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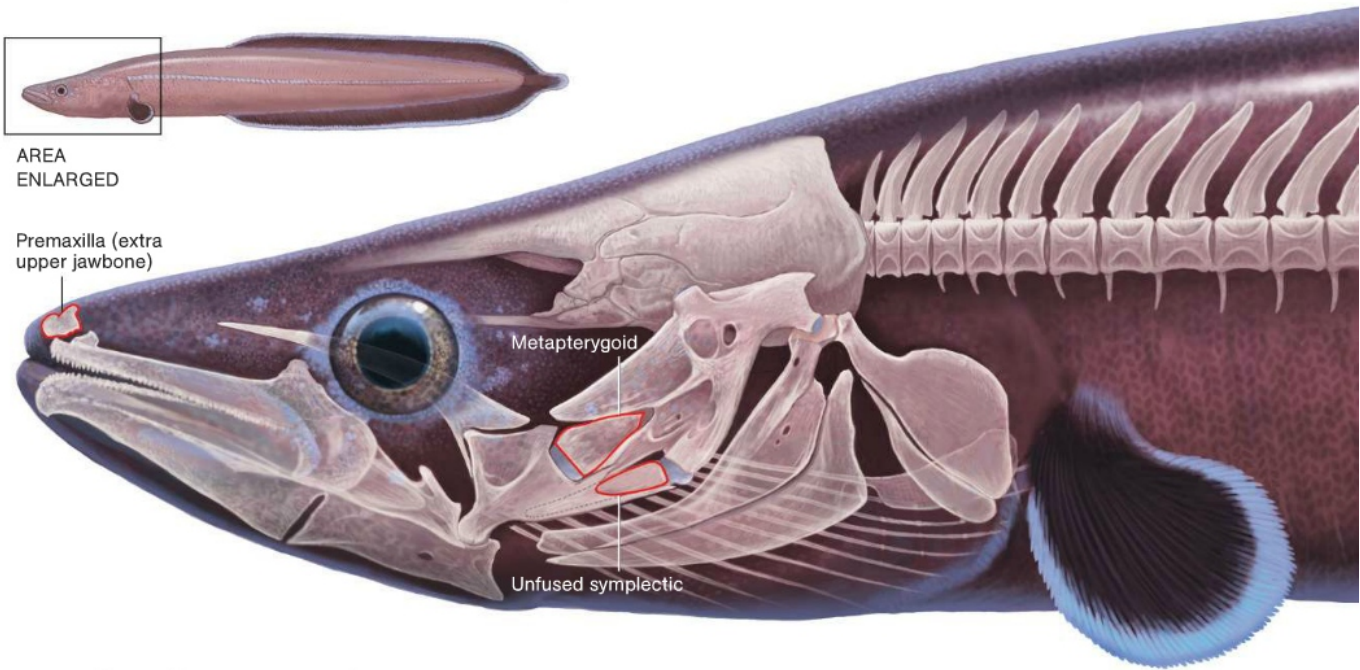
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Eel of Another Era Age and beauty, it seems, may not be mutually exclusive. A comely eel displaying anatomical features not seen in its kin for 140 million years has prompted the rare creation of a new family of fish. Researchers dubbed the purplish, ribbonlike *Protanguilla palau* a living fossil—a descriptor for creatures (like the coelacanth) largely unaltered since ancient times. Discovered in 2009 in a reef cave off the Republic of Palau, the eel sports an extra upper jawbone, characteristic of its Cretaceous-period brethren. It also has fewer than 90 vertebrae, an even more primitive feature. Other traits raised doubts that it was a true eel until anatomical and molecular analysis confirmed the classification, says the Smithsonian Institution’s G. David Johnson, lead author of the findings. —*John Briley*

Ancient structures (in red) make Protanguilla palau the most primitive eel of all. Collected specimens range from 1.7 to 7 inches long.



The Beetle and the Bottle

It seems a twisted love story—insect and inanimate object. But to a two-inch Australian jewel beetle, a discarded brown beer bottle looks like an extra-large female. Bemused, amorous males make what Darryl Gwynne of the University of Toronto calls a “mating mistake.” Larger partners are incredibly enticing—“superstimuli,” Gwynne says—because bigger females mean more eggs to fertilize. Most often, it’s a fatal attraction for persistent males. Beetles that approach from the top exhaust themselves and fry in the sun; those with a foot on the ground may end up a meal for ants. —*Johnna Rizzo*

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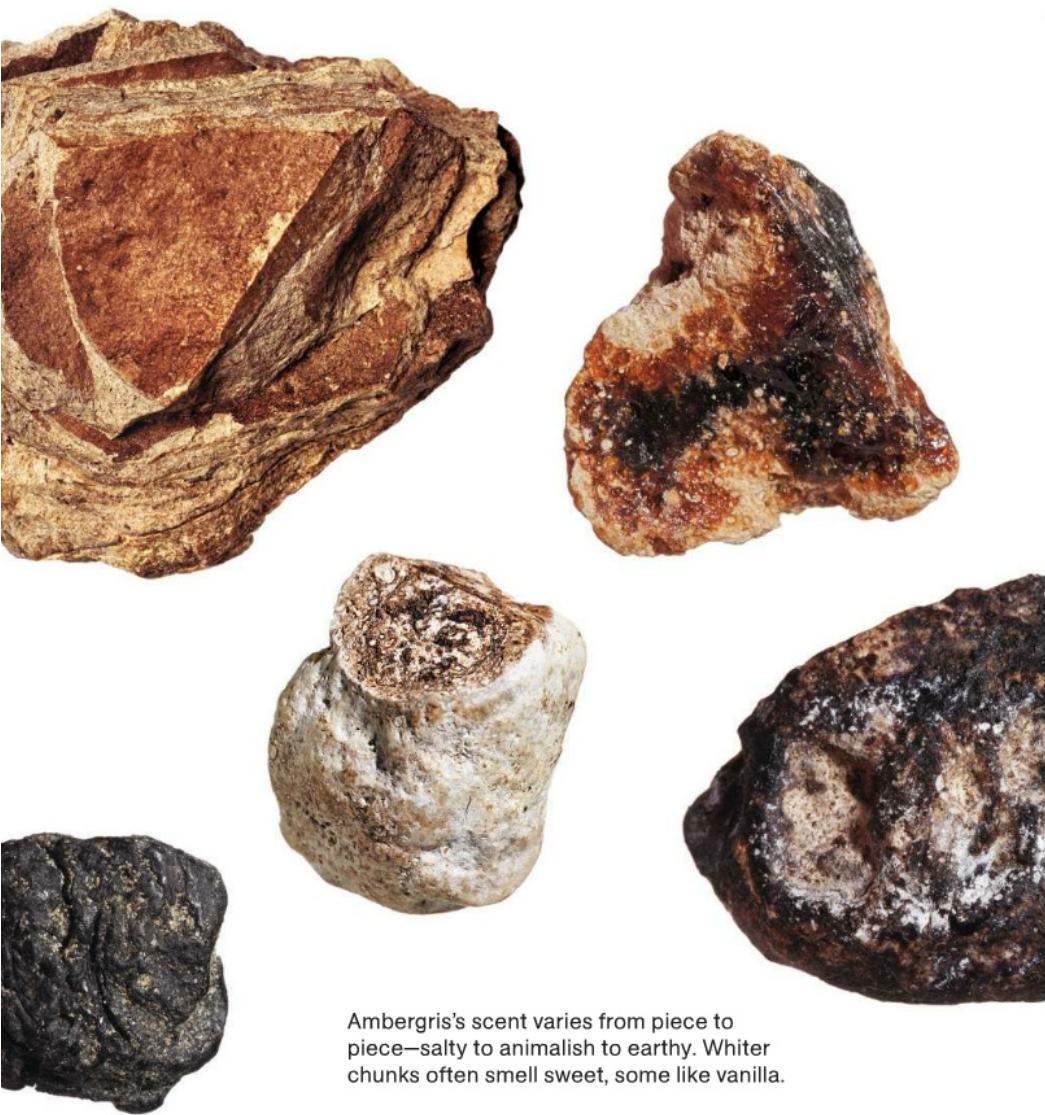
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Ambergris's scent varies from piece to piece—salty to animalish to earthy. Whiter chunks often smell sweet, some like vanilla.

Eau de Whale Ambergris is the unlikeliest of perfume ingredients. The nuggets start forming as a slurry in the guts of sperm whales around stomach irritants like squid beaks, then are ejected into the ocean. (Once thought to be spewed, they're now believed to be excreted.) The scent is said to be dunglike at first but grows musky after exposure to seawater and air. For centuries perfumers have capitalized on the ability of ambergris, which is collected along shorelines, to amplify fragrances and fix them to the skin. But the sea mammal's endangered status might limit supply, so nonanimal options are being explored. Among them: Molecular biologist Joerg Bohlmann's team has found a way to reproduce a balsam fir compound that provides a perfume fixative, without cetacean input. —*Johnna Rizzo*

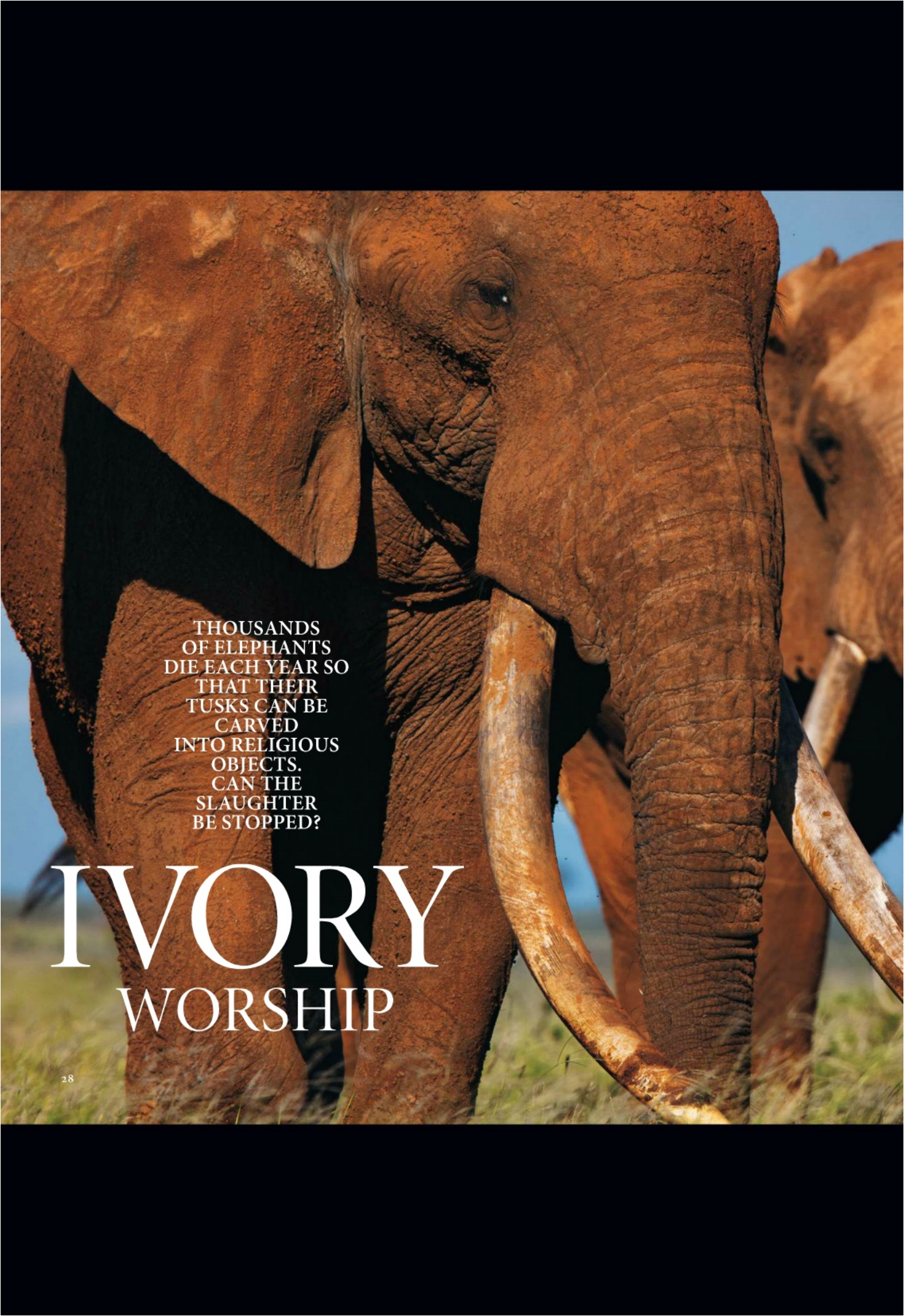
Landmassive

Amasia—named for the crash and subsequent connection of the Americas and Asia—will fuse in 100 million years. It won't be a first. The Earth's landmasses are constantly shifting, all together—a supercontinent—then apart again, no faster than a fingernail grows. The most recent convergence, Pangaea, formed 300 million years ago; Rodinia, 1.1 billion; Nuna, 1.8 billion.

Most theories of Amasia's creation show the Atlantic seafloor stretching or being swallowed, but geologist Ross Mitchell's model, using paleomagnetic data from ancient rocks, predicts the Arctic Ocean will close up instead, the supercontinent sliding north into its place. Where the rebroken land goes from there is unknown. "It's not like an accordion, in and out," says Mitchell. —*JR*



Amasia about 100 million years from now, as it begins to form



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THAT THEIR
TUSKS CAN BE
CARVED
INTO RELIGIOUS
OBJECTS.
CAN THE
SLAUGHTER
BE STOPPED?

IVORY WORSHIP



Some of the last big tuskers gather in Tsavo, Kenya. A single large tusk sold on the local black market can bring \$6,000, enough to support an unskilled Kenyan worker for ten years.



The largest ivory crucifix in the Philippines (left) hangs in a museum. It is 1.5 meters long, is carved from a single tusk. The piece dates to the early 17th century.

THE UNIVERSITY OF SANTO TOMAS MUSEUM (LEFT)



seum in Manila. The body of Christ, 30 inches
1600s, when Spanish galleons began bringing

Asian ivory craftsmanship to Spain and the New World. The home of a Filipino collector (above) is lavish with
ivory religious icons. "I don't see the elephant," says another Filipino collector. "I see the Lord."





Bodies are what remain in Cameroon's Bouba Ndjidah National Park after one of the largest mass elephant slaughters in decades. Armed with grenades and AK-47s, poachers killed more than 300.





A worker in China's largest ivory-carving factory finishes a piece symbolizing prosperity. China legally bought 73 tons of ivory from Africa in 2008; since then, poaching and smuggling have both soared.

IN JANUARY 2012 A HUNDRED RAIDERS ON HORSEBACK CHARGED OUT OF CHAD INTO CAMEROON'S BOUBA NDJIDAH NATIONAL PARK, SLAUGHTERING HUNDREDS OF ELEPHANTS—entire families—in one of the worst concentrated killings since a global ivory trade ban was adopted in 1989. Carrying AK-47s and rocket-propelled grenades, they dispatched the elephants with a military precision reminiscent of a 2006 butchering outside Chad's Zakouma National Park. And then some stopped to pray to Allah. Seen from the ground, each of the bloated elephant carcasses is a monument to human greed. Elephant poaching levels are currently at their worst in a decade, and seizures of illegal ivory are at their highest level in years. From the air too the scattered bodies present a senseless crime scene—you can see which animals fled, which mothers tried to protect their young, how one terrified herd of 50 went down together, the latest of the tens of thousands of elephants killed across Africa each year. Seen from higher still, from the vantage of history, this killing field is not new at all. It is timeless, and it is now.

THE PHILIPPINES CONNECTION

In an overfilled church Monsignor Cristobal Garcia, one of the best known ivory collectors in the Philippines, leads an unusual rite honoring the nation's most important religious icon, the Santo Niño de Cebu (Holy Child of Cebu). The ceremony, which he conducts annually on Cebu, is called the Hubo, from a Cebuano word meaning "to undress." Several altar boys work together to disrobe a small wooden statue of Christ dressed as a king, a replica of an icon devotees believe Ferdinand Magellan brought to the island in 1521. They remove its small crown, red cape, and tiny boots, and strip off its surprisingly layered underwear. Then the monsignor takes the icon, while altar boys conceal it with a little white towel, and dunks it in several barrels of water, creating his church's holy water for the year, to be sold outside.

Garcia is a fleshy man with a lazy left eye and bad knees. In the mid-1980s, according to a 2005 report in the *Dallas Morning News* and a related lawsuit, Garcia, while serving as a priest at St. Dominic's of Los Angeles, California,

sexually abused an altar boy in his early teens and was dismissed. Back in the Philippines, he was promoted to monsignor and made chairman of Cebu's Archdiocesan Commission on Worship. That made him head of protocol for the country's largest Roman Catholic archdiocese, a flock of nearly four million people in a country of 75 million Roman Catholics, the world's third largest Catholic population. Garcia is known beyond Cebu. Pope John Paul II blessed his Santo Niño during Garcia's visit to the pope's summer residence, Castel Gandolfo, in 1990. Recently Garcia helped direct the installation of Cebu's newest archbishop in a cathedral filled with Catholic leaders, including 400 priests and 70 bishops, among them the Vatican's ambassador. Garcia is so well known that to find his church, the Society of the Angels of Peace, I need only roll down my window and ask, "Monsignor Cris?" to be pointed toward his walled compound.

Some Filipinos believe the Santo Niño de Cebu is Christ himself. Sixteenth-century Spaniards declared the icon to be miraculous and used it to



Smugglers failed to get this contraband past Kenya's law enforcement, but the animals are still gone. Small tusks indicate that young elephants were poached.

convert the nation, making this single wooden statue, housed today behind bulletproof glass in Cebu's Basilica Minore del Santo Niño, the root from which all Filipino Catholicism has grown. Earlier this year a local priest was asked to resign after allegedly advising his parishioners that the Santo Niño and images of the Virgin Mary and other saints were merely statues made of wood and cement.

"If you are not devoted to the Santo Niño, you are not a true Filipino," says Father Vicente Lina, Jr. (Father Jay), director of the Diocesan Museum of Malolos. "Every Filipino has a Santo Niño, even those living under the bridge."

Each January some two million faithful converge on Cebu to walk for hours in procession with the Santo Niño de Cebu. Most carry miniature Santo Niño icons made of fiberglass or wood. Many believe that what you invest in devotion to your own icon determines what blessings you will receive in return. For some, then, a fiberglass or wooden icon is not enough. For them, the material of choice is elephant ivory.

I press through the crowd during Garcia's Mass, but instead of standing before him to receive Communion, I kneel.

"The body of Christ," Garcia says.

"Amen," I reply, and open my mouth.

After the service I tell Garcia I'm from *National Geographic*, and we set a date to talk about the Santo Niño. His anteroom is a mini-museum dominated by large, glass-encased religious figures whose heads and hands are made of ivory: There is an ivory Our Lady of the Rosary holding an ivory Jesus in one, a near-life-size ivory Mother of the Good Shepherd seated beside an ivory Jesus in another. Next to Garcia's desk a solid ivory Christ hangs on a cross.

Filipinos generally display two types of ivory *santos*: either solid carvings or images whose heads and hands, sometimes life-size, are ivory,

Investigative reporter Bryan Christy's January 2010 story, "The Kingpin," exposed wildlife trafficker Anson Wong. Documentary photographer Brent Stirton's March 2012 "Rhino Wars" won a World Press award.

while the body is wood, providing a base for lavish capes and vestments. Garcia is the leader of a group of prominent Santo Niño collectors who display their icons during the Feast of the Santo Niño in some of Cebu's best shopping malls and hotels. When they met to discuss formally incorporating their club, an attorney member cried out to the group, "You can pay me in ivory!"

I tell Garcia I want to buy an ivory Santo Niño in a sleeping position. "Like this," I say, touching a finger to my lower lip. Garcia puts a finger to his lip too. "*Dormido* style," he says approvingly.

My goal in meeting Garcia is to understand his country's ivory trade and possibly get a lead on who was behind 5.4 tons of illegal ivory seized by customs agents in Manila in 2009, 7.7 tons seized there in 2005, and 6.1 tons bound for the Philippines seized by Taiwan in 2006. Assuming an average of 22 pounds of ivory per elephant, these seizures represent about 1,745 elephants. According to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the treaty organization that sets international wildlife trade policy, the Philippines is merely a transit country for ivory headed to China. But CITES has limited resources. Until last year it employed just one enforcement officer to police more than 30,000 animal and plant species. Its assessment of the Philippines doesn't square with what Jose Yuchongco, chief of the Philippine customs police, told a Manila newspaper not long after making a major seizure in 2009: "The Philippines is a favorite destination of these smuggled elephant tusks, maybe because Filipino Catholics are fond of images of saints that are made of ivory." On Cebu the link between ivory and the church is so strong that the word for ivory, *garing*, has a second meaning: "religious statue."

THE CATHOLIC-MUSLIM UNDERGROUND

"Ivory, ivory, ivory," says the saleswoman at the Savelli Gallery on St. Peter's Square in Vatican City. "You didn't expect so much. I can see it in your face." The Vatican has recently demonstrated a commitment to confronting transnational

criminal problems, signing agreements on drug trafficking, terrorism, and organized crime. But it has not signed the CITES treaty and so is not subject to the ivory ban. If I buy an ivory crucifix, the saleswoman says, the shop will have it blessed by a Vatican priest and shipped to me.

Although the world has found substitutes for every one of ivory's practical uses—billiard balls, piano keys, brush handles—its religious use is frozen in amber, and its role as a political symbol persists. Last year Lebanon's President Michel Sleiman gave Pope Benedict XVI an ivory-and-gold thurible. In 2007 Philippine President Gloria Macapagal-Arroyo gave an ivory Santo Niño to Pope Benedict XVI. For Christmas in 1987 President Ronald Reagan and Nancy Reagan bought an ivory Madonna originally presented to them as a state gift by Pope John Paul II. All these gifts made international headlines. Even Kenya's President Daniel arap Moi, father of the global ivory ban, once gave Pope John Paul II an elephant tusk. Moi would later make a bigger symbolic gesture, setting fire to 13 tons of Kenyan ivory, perhaps the most iconic act in conservation history.

Father Jay is curator of his archdiocese's annual Santo Niño exhibition, which celebrates the best of his parishioners' collections and fills a two-story building outside Manila. The more than 200 displays are drenched in so many fresh flowers and enveloped in such soft "Ave Maria" music that I'm reminded of a funeral as I look at the pale bodies dressed up like tiny kings. Ivory Santo Niños wear gold-plated crowns, jewels, and Swarovski crystal necklaces. Their eyes are hand-painted on glass imported from Germany. Their eyelashes are individual goat hairs. The gold thread in their capes is real, imported from India.

The elaborate displays are often owned by families of surprisingly modest means. Devotees have opened bankbooks in the names of their ivory icons. They name them in their wills. "I don't call it extravagant," Father Jay says. "I call it an offering to God." He surveys the child images, some of which are decorated in *lagang*, silvery mother of pearl flowers carved from nautilus shells. "When it comes to Santo Niño devotion,"



he says, “too much is not enough. As a priest, I’ve been praying, ‘If all of this stuff is plain stupid, then God, put a stop to this.’”

Father Jay points to a Santo Niño holding a dove. “Most of the old ivories are heirlooms,” he says. “The new ones are from Africa. They come in through the back door.” In other words, they’re smuggled. “It’s like straightening up a crooked line: You buy the ivory, which came from a hazy origin, and you turn it into a spiritual item. See?”

ALTHOUGH THE WORLD HAS SUBSTITUTES FOR ALL OF IVORY’S PRACTICAL USES, ITS RELIGIOUS USE IS FROZEN IN AMBER.



he says, with a giggle. His voice lowers to a whisper. “Because it’s like buying a stolen item.”

People should buy new ivory icons, he says, to avoid swindlers who use tea or even Coca-Cola to stain ivory to look antique. “I just tell them to buy the new ones, so the history of an image would start in you.”

When I ask how new ivory gets to the Philippines, he tells me that Muslims from the southern island of Mindanao smuggle it in. Then, to signal a bribe, he puts two fingers into my shirt pocket. “To the coast guards, for example,” he says. “Imagine from Africa to Europe and to the Philippines. How long is that kind of trip by boat?” He puts his fingers in my pocket again. “And you just keep on paying so many people so that it will enter your country.”

It’s part of one’s sacrifice to the Santo Niño—smuggling elephant ivory as an act of devotion.

HOW TO SMUGGLE IVORY

I had no illusions of linking Monsignor Garcia to any illegal activity, but when I told him I wanted

an ivory Santo Niño, the man surprised me. “You will have to smuggle it to get it into the U.S.”

“How?”

“Wrap it in old, stinky underwear and pour ketchup on it,” he said. “So it looks shitty with blood. This is how it is done.”

Garcia gave me the names of his favorite ivory carvers, all in Manila, along with advice on whom to go to for high volume, whose wife overcharges, who doesn’t meet deadlines. He gave me phone numbers and locations. If I wanted to smuggle an icon that was too large to hide in my suitcase, I might get a certificate from the National Museum of the Philippines declaring my image to be antique, or I could get a carver to issue a paper declaring it to be imitation or alter the carving date to before the ivory ban. Whatever I decided to commission, Garcia promised to bless it for me. “Unlike those animal-nut priests who will not bless ivory,” he said.

A few families control most of the ivory carving in Manila, moving like termites through massive quantities of tusks. Two of the main dealers are based in the city’s religious-supplies district, Tayuman. During my five trips to the Philippines I visited every one of the ivory shops Garcia recommended to me and more, inquiring about buying ivory. More than once I was asked if I was a priest. In almost every shop someone proposed a way I could smuggle ivory to the U.S. One offered to paint my ivory with removable brown watercolor to resemble wood; another to make identical hand-painted statuettes out of resin to camouflage my ivory baby Jesus. If I was caught, I was told to lie and say “resin” to U.S. Customs. During one visit a dealer said Monsignor Garcia had just called and suggested that since I’d mentioned that my family had a funeral business, I might take her new, 20-pound Santo Niño home by hiding it in the bottom of a casket. I said he must have been joking, but she didn’t think so.

Priests, *balikbayans* (Filipinos living overseas), and gay Filipino men are major customers, according to Manila’s most prominent ivory dealer. An antique dealer from New York City makes regular buying missions, as does a dealer from Mexico City, gathering up new ivory

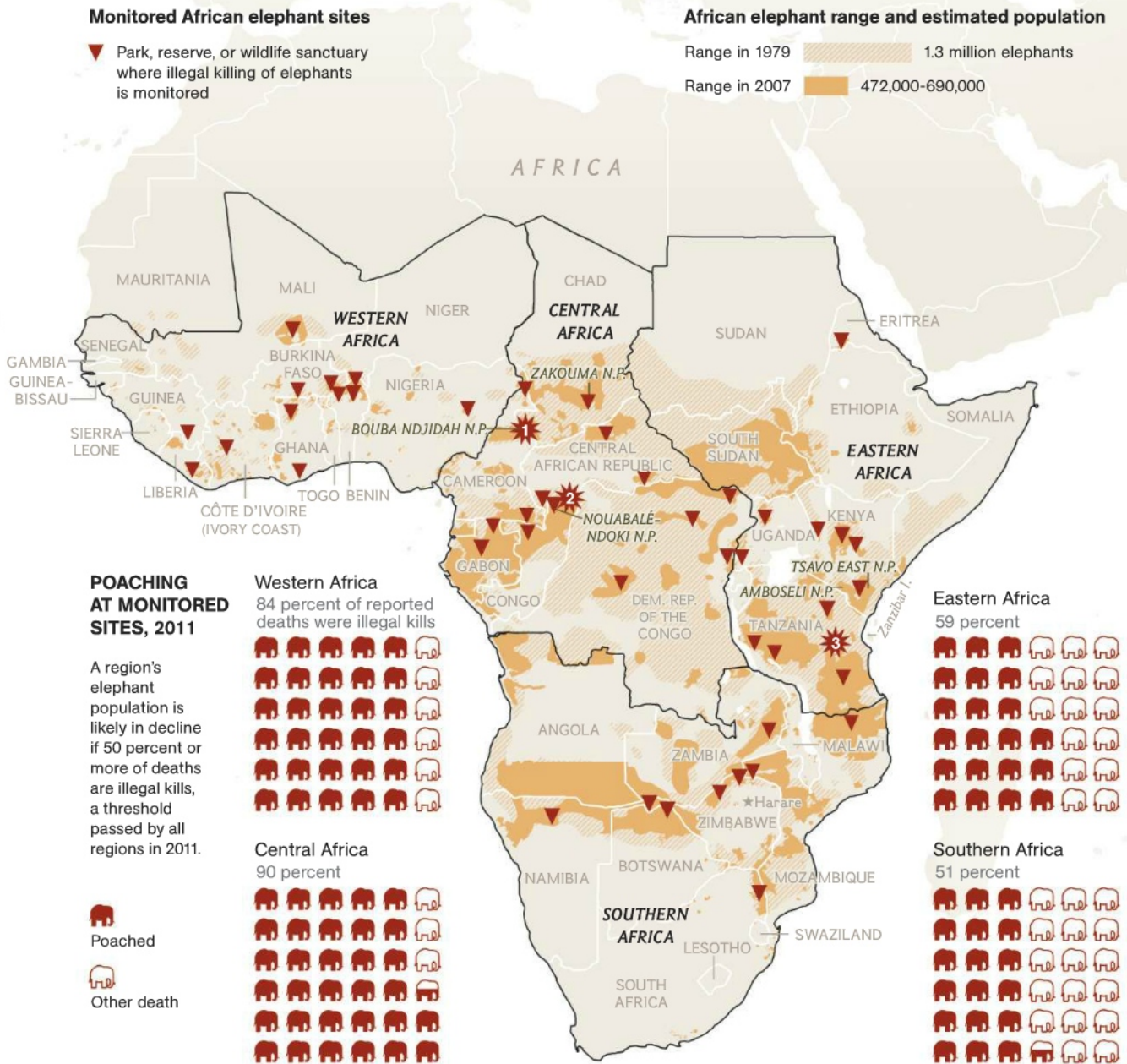




Kruba Dharmamuni, aka the Elephant Monk, keeps Asian elephants at his temple in Thailand. Activists accuse him of starving one elephant to use its ivory for amulets, a charge he rejects.

ELEPHANT POACHING

Killing African elephants for their ivory is devastating a species that's already losing ground to a growing human population. Estimates of poaching come from examining elephant carcasses at monitored sites (map). In 2011 poaching hit the highest levels in a decade, with the greatest impact in the central Africa region (charts below).



LARGE-SCALE POACHING

1 Cameroon, early 2012
Organized raiders on horseback from Chad and Sudan killed more than 300 elephants in Bouba Ndjidah National Park.

2 Congo, 2006-2011
Nearly 5,000 elephants died in lands outside Nouabalé-Ndoki National Park; new logging roads make the area more accessible.

3 Tanzania, 2012
Poachers are using poison so gunshots won't attract park wardens. Tanzania is a main shipping point for illegal ivory to Asia.

IVORY SEIZURES

Most of the world's countries agreed to ban international trade in ivory in 1989. Yet demand has grown in Asia, driven by new wealth in China. The illegal ivory that is seized represents only a fraction of what gets through—and the number of large seizures has risen, evidence of organized smuggling syndicates.

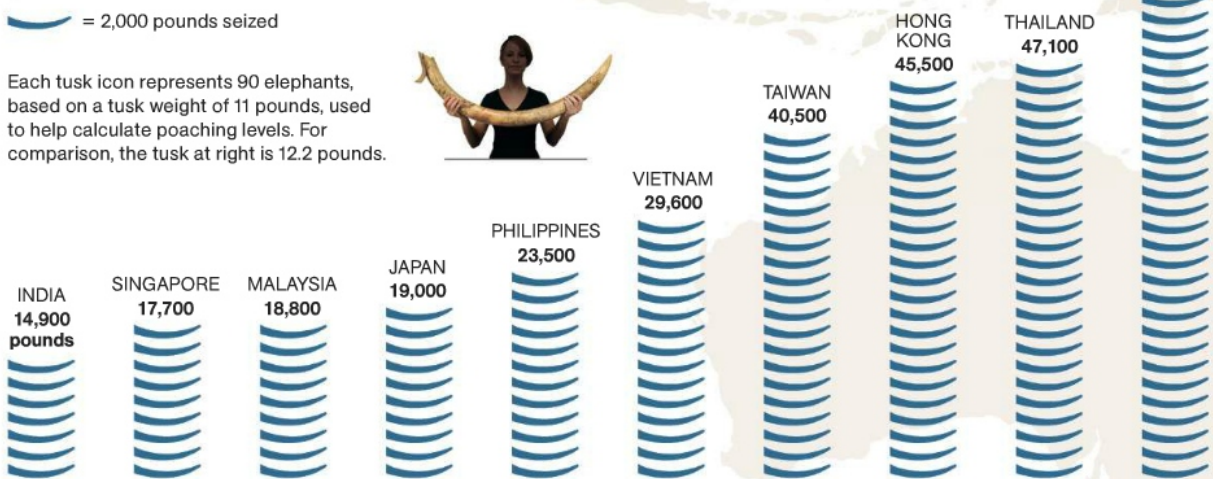


TEN ASIAN COUNTRIES WITH THE MOST IVORY SEIZED, 1989-2011

Total weight of seizures in pounds by country or region*

= 2,000 pounds seized

Each tusk icon represents 90 elephants, based on a tusk weight of 11 pounds, used to help calculate poaching levels. For comparison, the tusk at right is 12.2 pounds.



*HONG KONG AND TAIWAN DATA COLLECTED SEPARATELY FROM CHINA'S

SMUGGLING TACTICS

- 1 Bangkok, Thailand, 2011**
An x-ray scan found 247 large tusks, valued by authorities at \$3 million, in a shipping container of frozen mackerel from Kenya.
- 2 Malaysia, 2011**
Shipping containers of recycled plastic from Tanzania also held nearly 700 tusks destined for China via Malaysia.
- 3 Guangdong Province, China, 2009**
A rented Chinese fishing boat returned from the Philippines with 770 whole and partial tusks packed in five wooden crates.

crucifixes, Madonnas, and baby Jesuses in bulk and smuggling them home in their luggage. Wherever there is a Filipino, I was often reminded, there is an altar to God.

And it seems Father Jay was right about a Muslim supply route. Several Manila dealers told me the primary suppliers are Filipino Muslims with connections to Africa. Malaysian Muslims figured into their network too. "Sometimes they bring it in bloody, and it smells bad," one dealer told me, pinching her nose.

Today's ivory trafficking follows ancient trade routes—accelerated by air travel, cell phones, and the Internet. Current photos I'd seen of ivory Coptic crosses on sale beside ivory Islamic prayer beads in Cairo's market now made more sense. Suddenly, recent ivory seizures on Zanzibar, an Islamic island off the coast of Tanzania—for centuries a global hub for trafficking slaves and ivory—seemed especially ominous, a sign that large-scale ivory crime might never go away. At least one shipment had been headed for Malaysia, where several multi-ton seizures were made last year.

The Philippines' ivory market is small compared with, say, China's, but it is centuries old and staggeringly obvious. Collectors and dealers share photographs of their ivories on Flickr and Facebook. CITES, as administrator of the 1989 global ivory ban, is the world's official organization standing between the slaughter of the 1980s—in which Africa is said to have lost half its elephants, more than 600,000 in just those ten years—and the extermination of the elephant. If CITES has overlooked the Philippines' ivory trade, what else has it missed?

THE ELEPHANT MONK

The ivory carvers in Phayuha Khiri and Surin are the most famous in Thailand and the targets of most investigations there into the illegal ivory trade. Phayuha Khiri is so dedicated to ivory that in the town center, where one might expect to see a fountain, there's a circle of four great white tusks. It takes me only minutes on the main street to realize I've seen this place before: Tayuman, Manila's religious-supplies

district; only here, instead of crucifixes and images of the holy family, are life-size images of famous monks, small images of the Buddha wrapped in plastic, and bracelets and other religious items bagged by the dozens. Vendor after vendor on both sides of this long street is a Buddhist wholesale outlet. The only people I see shopping during my visits to Phayuha Khiri are small knots of orange-robed monks.

I track down the village's head ivory dealer—Mr. Thi, who's wearing an amulet on an ivory necklace and an ivory belt buckle—tour his shops and carving operation, and also visit his McMansion-size home. Mr. Thi tells me that Phayuha Khiri's carving industry was founded by a monk who liked to carve ivory amulets. Standing in his shop, I look over his shoulder and see a painting of Ganesh, the elephant-headed Hindu god, and beside him a Happy Buddha. Monks, I discover, give out amulets in return for donations. The better the donation, the better the amulet. Amulets blessed by certain monks are even more valuable.

The Elephant Monk, Kruba Dharmamuni, who used to be the Scorpion Monk and still displays a life-size statue of himself as a scorpion in his temple, wants to take me ivory shopping in Surin. Once upon a time Surin was home to the king of Siam's royal elephant catchers, but today government-subsidized elephant keepers, mahouts, live a shadow of their old lives, dependent on their animals' ability to kick a soccer ball or hold a paintbrush and create a "self-portrait" on an easel for tourists. Vendors selling ivory rings, bangles, and amulets line the entrance to Surin's tourist park.

"Ivory removes bad spirits," the Elephant Monk tells me. He wears the brown robes of a forest monk and chews steadily on betel-infused *maak*, which he spits out in great blood-like wads. He also wears ivory. Around his neck is an ivory elephant-head pendant suspended from ivory prayer beads representing the 108 human passions.

The elephant is a symbol of Thailand and is revered in Buddhism. According to legend, a six-tusked white elephant entered the right side



of Queen Maya the night she became pregnant with Siddhartha Gautama. The Elephant Monk believes he was an elephant in a past life and is well-known among mahouts. He tells me he has 100,000 followers around the world, though during my visit to his temple only a few show up. They kneel before him with offerings and receive an amulet he has blessed.

Many Thais wear amulets, sometimes dozens, to bring them luck and protect them from harm

IN ALMOST EVERY SHOP I VISITED IN MANILA SOMEONE PROPOSED A WAY I COULD SMUGGLE IVORY TO THE U.S.



and black magic. Bangkok's amulet market is huge, with countless vendors selling tens of thousands of small talismans made of materials such as metal, compressed dust, bone—and ivory. High-end amulets can fetch \$100,000 or more. There are magazines, trade shows, books, and websites devoted to amulet collecting. Amulets hang from the rearview mirror of almost every Thai cab. Ousted Thai leader Thaksin Shinawatra credits his Buddhist amulet with saving him in assassination attempts, and the Thai Army has distributed amulets to its border soldiers to ward off Cambodia's black magic.

The Elephant Monk's main income is from amulets, and he offers a strange variety, including images of himself and of the Buddha as well as amulets made with plastic-encased bits of bone from the skulls of dead pregnant women, pure corpse oil, soil from seven cemeteries, tiger fur, elephant skin, and carved ivory. Business is good enough that he's building a new temple, Wat Suanpah, modeled in part after Thailand's popular tiger parks—often front organizations, critics

say, for the illegal tiger trade. The Elephant Monk suffered similar controversy when a recent television exposé reported that he'd starved an elephant to death for its skin and ivory, but he says it died of natural causes and he was only holding an elephant funeral. Besides, by shopping in Surin, he tells me, he can find all the elephant ivory and skin he needs. Before the exposé, he took in about one million baht (\$32,000) a month from his gift shop, the Internet, and foreign travels. Now he's down to about 300,000 baht a month. But, he says, in just three days in Malaysia or Singapore he could sell his followers one million bahts' worth or more.

Thailand has a small, natural population of Asian elephants, an endangered species long off-limits to international trade. Inside Thailand, however, the rules are less rigid. Mahouts and others may sell the tusk tips of live domesticated elephants and the tusks of ones that died of natural causes. For years international ivory traffickers have capitalized on this, smuggling in African ivory to mix with Asian ivory.

Conservationists refer to this as the "Thai loophole." But there's a far bigger loophole enjoyed by every country in the world. African ivory brought into a country before 1989 may be traded domestically. And so anyone caught with ivory invokes a common refrain: "My ivory is pre-ban." Since no inventory was ever made of global ivory stocks before the ban, and since ivory lasts more or less forever, this "pre-ban" loophole is a timeless defense.

Thailand's ivory market has been evolving. "Ivory traders are stockpiling," says Steve Galster, director of the Freeland Foundation, a Bangkok-based nongovernmental organization (NGO). "Since CITES has a history of relaxing trade bans, they feel it's a safe gamble."

Thailand, like the Philippines, has another commodity traffickers value: corruption. A ton of seized African ivory disappeared recently from a Thai customs warehouse. When I ask to see the rest, customs officers refuse and suggest that journalists stole it. Only when I say I heard otherwise am I told the truth: Customs officers are believed to have been the culprits. Corruption is

To keep the ivory from the black market, a plainclothes ranger hacks the tusks off a bull elephant killed illegally in Kenya's Amboseli National Park. In the first half of this year six park rangers died protecting Kenya's elephants; meanwhile, rangers killed 23 poachers.









A Chinese reporter in Kenya covers the 2011 burning of 5.5 tons of smuggled ivory. Kenya helped launch a global ivory ban in 1989 but lately has been stockpiling its ivory. The ivory here belonged to other countries.

so bad in the Philippines that in 2006 the wildlife department sued senior customs officers for “losing” several tons of seized ivory. Chastened, the customs office turned its next big ivory seizure over to the wildlife department, which soon discovered that its own storeroom had been raided. Piles of tusks had been replaced with exact duplicates made of plastic.

The Elephant Monk’s favorite carver, Jom, lives on a dirt road in a place so remote that I blink when I realize that the vegetable stands in front of Jom’s house are actually glass jewelry cases filled with ivory Buddhist figurines. On the outside of one case is a bumper sticker bearing the Elephant Monk’s face. Most of the ivory is Thai. “That is African,” the Elephant Monk says, pointing to a piece that’s especially white.

“If I could get you African ivory,” I ask Jom, “could you carve it?”

“*Dai*,” he replies.

“No problem at all,” his wife agrees.

And that was all it took to get the Elephant Monk to talk smuggling. He tells me to cut the ivory to fit into my suitcase, holding out his hands to show me how long to make the pieces. That’s what his followers do, he says. When I arrive at the Bangkok airport, his assistant will pick me up and drive me to him. He has followers in immigration, but if anything goes wrong, I should say I’m bringing the ivory to his temple. Religion, apparently, will cover me.

Because this is about faith, and because faith requires suspension of disbelief, ivory traded for religious purposes doesn’t garner the aggressive scrutiny it might if it were carved into, say, chess pieces. God’s ivory has its own loophole.

CHINA’S IVORY FACTORIES

Inside the Beijing Ivory Carving Factory it smells and sounds like what it essentially is: a vast dentist’s office. The whirl of electric drills on tusks fills the air. Ivory dust lies heavy on windowpanes and doorframes and even coats my teeth as I make my way among men and women bent over images that repeat the religious and mythological motifs I find throughout China, such as Fu, Lu, and Shou, the gods of luck, money, and long

life; the Happy Buddha; and Guanyin, Buddhist goddess of mercy, a Madonna-like figure who doubles as a fertility goddess and who sometimes holds in her arms a male child, the “giving sons” Guanyin, popular under China’s one-child policy. No matter where I find ivory, religion is close at hand. “Chinese people believe in the concepts these figures represent,” the head of the Daxin Ivory Carving Factory in Guangzhou tells me.

At the time of the ivory ban, Americans, Europeans, and Japanese consumed 80 percent of the world’s carved ivory. Today in the heart of Beijing, dealerships offering Maseratis, Bentleys, and Ferraris rub shoulders with Gucci and Prada. Nearby is the Beijing Arts and Crafts Emporium, whose first-floor ATM dispenses 24-karat gold bars. Up the escalator, past galleries of jade and silk, the main ivory boutique sparkles like a snow-covered Tiffany’s. One of the first items I notice is a carved ivory Guanyin behind glass with so many zeros on its price tag I have to ask for help—1360000.00 (about \$215,000).

By all accounts, China is the world’s greatest villain when it comes to smuggled ivory. In recent years China has been implicated in more large-scale ivory seizures than any other non-African country. For the first time in generations many Chinese can afford to reach forward into a wealthy future, and they can also afford to look back into their own vibrant past. One of the first places many look is religion.

“We don’t all only think of money,” Xue Ping corrects me as we sip tea in his Buddhist art gallery inside the Grand Hotel Beijing. During a 2007 pilgrimage retracing the Buddha’s life from Nepal to India, the advertising executive had a vision: The Buddha challenged him to do good with his life. He returned home and in 2009 founded a company he called Da Cheng Bai Yi (transmitting great heritage), dedicated to supporting China’s great masters in five art forms: lacquer, lacquer carving, porcelain, thangka scrolls, and ivory carving. Xue tracked down 62-year-old Li Chunke, one of only about 12 national master ivory carvers in China. Xue built Li an ivory-carving studio in Beijing’s arts district, rented him an apartment, and opened



this stunning new gallery. Nothing in it is for sale. Xue is Li's only customer.

"The elephant is a good friend of man," Li says. "When elephants die, they want to leave man something behind as a good deed to have a good next life." Li carves ivory to honor the elephant's gift. As Buddhists, Li and Xue abhor killing. Their ivory comes from the government, they explain, and so is supposed to be from elephants that died of natural causes.

MANY THAIS WEAR IVORY AMULETS TO BRING THEM LUCK AND PROTECT THEM FROM HARM AND BLACK MAGIC.



Just as some Filipino priests baptize ivory images, Buddhist monks perform a ceremony called *kai guang*, the opening of light, to consecrate religious icons. "Ivory is very precious," Xue tells me, "so to be respectful of the Buddha one should use precious material. If not ivory then gold. But ivory is more precious." It is a version of the same message I heard from Filipino Catholics: Ivory honors God.

In every shop and factory I visit in China, a substantial portion of the inventory consists of religious carvings, including many of the most valuable pieces. Among the high-end buyers are military officers—surprisingly well paid in China—who give ivory to superior officers and companies that give carvings to other businesses and government regulators to influence them. "We call it the back door," a representative of the government's China Arts and Crafts Association (CACA) explained. And so ivory is used the way a bottle of Johnnie Walker Blue might once have been, except that if the gift works, then ivory blesses its giver as well as its recipient.

At a gallery in Guangzhou, Gary Zeng shows me a photo of a 26-layer "devil's work" ball on his iPhone. The 42-year-old Zeng has just bought two of these ivory balls from the Daxin Ivory Carving Factory, one for himself and one on behalf of an entrepreneur friend. He's come to this retail store to see whether he got his money's worth. I climb into his new Mercedes, drive to his double-gated community, and watch as he hands the less expensive ball to his three-year-old for *National Geographic's* Brent Stirton to photograph. It will become a centerpiece in a new home Zeng is building, to "hold the house against devils," but for a moment the \$50,000 ball is simply a very precious toy. I ask Zeng why young entrepreneurs like him are buying ivory.

"Value," he replies. "And art."

"Do you think about the elephant?" I ask.

"Not at all," he says.

On the corner of one of the most popular ivory-selling streets in China, outside the Huailin International Buddhist jewelry arcade, a four-story electronic billboard runs a video announcing to passersby a hot new investment opportunity: Sales of Buddhist jewelry and related religious products have reached \$15.8 billion a year and are growing by 50 percent a year. "There are nearly 200 million Buddhism believers in China," the sign declares. Inside the building two stores deal exclusively in ivory carvings. Down the street other galleries offer Buddhist ivory carvings—some legal, some not.

Everything about China's ivory industry is poised for growth. The government has licensed at least 35 carving factories and 130 ivory retail outlets and sponsors ivory carving at schools like the Beijing University of Technology. Most telling of all, as in the Philippines, Chinese carvers such as Master Li are training their relatives—they're investing in their own blood.

THE JAPAN EXPERIMENT

In 1989, after ten years during which at least one elephant died every ten minutes, President George H. W. Bush unilaterally banned ivory imports, Kenya burned its 13 tons of ivory stocks, and CITES announced the global

ivory ban, which began in 1990. Not all countries agreed to the ban. Zimbabwe, Botswana, Namibia, Zambia, and Malawi entered “reservations,” exempting them from it on the grounds that their elephant populations were healthy enough to support trade. In 1997 CITES held its main meeting in Harare, Zimbabwe, where President Robert Mugabe declared that elephants took up a lot of space and drank a lot of water. They’d have to pay for their room and board with their ivory. Zimbabwe, Botswana, and Namibia made CITES an offer: They would honor the ivory ban if they were allowed to sell ivory from elephants that had been culled or had died of natural causes.

CITES agreed to a compromise, authorizing a one-time-only “experimental sale” by the three countries to a single purchaser, Japan. In 1999 Japan bought 55 tons of ivory for five million dollars. Almost immediately Japan said it wanted more, and soon China would want legal ivory too. If Kenya’s Daniel arap Moi is the father of the ivory ban, then Zimbabwe’s Robert Mugabe is the father of its first rupture.

Before it would allow another ivory sale, CITES demanded the results of the Japan experiment: Had the sale increased crime? Specifically, had elephant poaching or ivory smuggling gone up? To find out, it launched one program to count illegally killed elephants and another to measure ivory smuggling. For a science-based organization, it was an odd way to conduct an experiment. CITES had approved the sale and had then set about constructing a way to gauge its impact, which is a bit like pushing the button to test the first atomic bomb and then building a device to measure the explosion.

It’s easy to kill an elephant (lately poachers in Kenya and Tanzania have been using poisoned watermelons), but it’s hard to locate dead bodies, and it’s taken CITES years to get the counting program running. CITES officials refuse to issue a formal estimate of the elephants killed annually for fear that any number, which would derive from 2007 population estimates and limited 2012 poaching data, will “become embedded as hard truth in the public psyche.” Still, according

to Kenneth Burnham, official statistician for the CITES program to monitor illegally killed elephants, it is “highly likely” that poachers killed at least 25,000 African elephants in 2011. The true figure may even be double that. Meanwhile, last year saw an estimated 34.7 tons of illegal ivory seized globally. Using an Interpol rule of thumb that says seized contraband equals 10 percent of actual smuggling, and assuming that each elephant carries 22 pounds of ivory, that weight equates to 31,500 dead elephants. “The point is this,” says Iain Douglas-Hamilton of Save the Elephants, “tens of thousands of elephants were killed last year. And the figures are going up drastically.”

Quantifying the illegal ivory trade is difficult too. Smugglers don’t file sales reports. To estimate smuggling activity, CITES uses ivory seizures as a proxy. Even as a proxy, seizures are tricky. They accurately tell you only the bare minimum of illegal activity going on in a country, and there’s a lot they can’t tell you. More ivory seizures in one year can mean that smuggling has increased, or that law enforcement is working harder, or both. Fewer seizures can mean what you might hope, but they can also mean that law enforcement is on the take. Big-time smugglers have connections in local wildlife departments, customs offices, and freight-forwarding and transportation companies that enable them to move multi-ton shipments from one country to another. (In the Philippines, for example, ivory traders I met accused customs officers of seizing illegal ivory only when someone hadn’t made a payoff.) Worst of all, a seizures-based system rewards countries for confiscating ivory, when what they really need to do is follow smuggled ivory up the demand chain to the kingpins, a reason good investigators consider seizures to be bad law enforcement.

To audit ivory seizures, CITES engaged Traffic, an NGO that monitors global wildlife trade. Traffic is not an independent auditor, however. It is a subsidiary of the World Wildlife Fund (WWF) and of the International Union for Conservation of Nature (IUCN), which, like many NGOs, have research projects and offices



in ivory-trafficking countries, complicating Traffic's ability to render independent judgments. Traffic based its new ivory-seizures monitoring program, the Elephant Trade Information System (ETIS), in Africa's leading pro-ivory-trade country, Zimbabwe.

From the beginning, Traffic boasted that its ETIS database extended back to the 1989 ivory ban, but countries were not asked to report ivory seizures to ETIS until 1998. For a decade

IN 1997 ZIMBABWE'S PRESIDENT DECLARED THAT ELEPHANTS MUST PAY FOR THEIR ROOM AND BOARD WITH THEIR IVORY.



its data came from random Traffic surveys, and it had scant data on seizures by key countries, such as Japan (20 cases in a decade), Thailand (21 cases), the Philippines (5 cases), and China (2 cases). Even after ETIS was up and running, many governments rarely bothered to report their seizures, so when it was time to judge the Japan experiment, Traffic's database was heavy on cases from the U.S. and European Union (more than 60 percent) and light on cases from where it mattered: Asia (less than 10 percent). ETIS had no good baseline to judge the effects of the Japan sale.

CITES might have taken a holistic approach to the Japan experiment, combining reports of international NGOs, whose undercover investigators found an increase in illegal ivory trade after the Japan sale, with data from Traffic, whose ETIS statistics did not show a definite correlation between the Japan sale and seizures. It might have recognized the limitations of ETIS—whose core metric, seizures, is, after all, controlled by the countries being evaluated.

Since CITES also had problems calculating how much elephant poaching was going on, it might have declared the Japan experiment inconclusive, or even a failure.

A failure is what China considered it. In a 2002 report China warned CITES that a main reason for China's growing ivory-smuggling problem was the Japan experiment: "Many Chinese people misunderstand the decision and believe that the international trade in ivory has been resumed." Chinese consumers thought it was OK to buy ivory again.

CITES ignored China's warning and placed its faith entirely in the ETIS statistics. "The data we have from ETIS is that there is no correlation between decisions made at CITES and the illegal trade," Willem Wijnstekers, CITES secretary-general, would later assert in anticipation of more CITES-approved ivory sales. Tom Milliken, director of ETIS, would likewise suggest that the Japan sale had worked: "It is encouraging to note that the illicit trade in ivory progressively declined over the next five years." But Milliken didn't know what the illicit trade had done; what he knew was his seizure statistics. Nevertheless a judgment was made, and the future of the African elephant may forever be clouded by the moment when CITES, lacking the data to evaluate the impact of its first ivory sale, endorsed a second.

By 2004 China had forgotten its concerns and petitioned CITES to buy ivory. In March 2005 CITES sent a team of three people, including Milliken, to China for five days to evaluate its ivory-control system. The team returned "more than satisfied" and predicted that China's system could "eradicate, or at least significantly reduce, illicit trade." They also noted, however, that two successive ETIS reports had found that China was the single most important reason the illegal ivory trade was increasing. The CITES secretariat therefore refused China's request to buy ivory.

But ETIS could be manipulated. It scored countries not only on ivory seizures weight but also on law enforcement. It was possible to game the ETIS system by reporting lots of small seizure cases, such as a tourist wearing





Some two million Catholics join a yearly procession celebrating the Santo Niño de Cebu (Holy Child of Cebu). Seen here is the Mother Mary image, Our Lady of Consolation, with ivory head and hands. On Cebu the word for ivory also means "religious statue."





A cemetery for privately owned elephants in Surin, Thailand, shows deep devotion. Thailand allows internal trading of ivory from domesticated Asian elephants, and smuggled African ivory finds its way into the mix.

ivory earrings. “Tom Milliken told me to make raids on Chatuchak [a Bangkok market] to get my cases up,” a frustrated Thai official told me. In 1999, the year of the Japan sale, China had reported seven ivory seizures to ETIS. Soon after it petitioned CITES, China was reporting dozens of cases a year to ETIS, most the personal effects of tourists. Recently it has been reporting hundreds of cases a year. This past February China made public one of its big ivory-enforcement efforts of 2011, involving 4,497 personnel and 1,094 vehicles and leading to 19 cases. It had resulted in the confiscation of 63.5 pounds of ivory, the weight of an overfed poodle.

In July 2008 the CITES secretariat endorsed China’s request to buy ivory, a decision supported by Traffic and WWF. Member countries agreed, and that fall Botswana, Namibia, South Africa, and Zimbabwe held auctions at which they collectively sold more than 115 tons of ivory to Chinese and Japanese traders.

As a test for whether ivory sales increase crime, the Japan experiment was flawed. As a prognosticator for China, it had deeper problems. Japan is an island nation with a narrow primary use for its ivory: signature stamps called *hanko*. China shares borders with 14 countries; it has a vast coastline, a booming economy, ten times the population, a separate system for ivory-loving Hong Kong, extensive investment in Africa, and uses for ivory ranging from sculptures to cell phone covers. After Japan bought ivory, China said its smuggling problem went up. Now China itself was entering the ivory business. CITES urged the world not to worry.

DEVILS LURK IN DETAILS

Meng Xianlin is executive director general of China’s CITES management authority, making him China’s top wildlife-trade official. He attended the 2008 ivory auctions in southern Africa. Over sheep tripe and noodles near his Beijing office, he shares a startling secret with me: The African auctions had not been competitive. Before they left for Africa, the Japanese team of buyers flew to Beijing, where they made a strategic suggestion. Since Japanese use primarily

medium-size, high-quality tusks for *hanko* and Chinese prefer either large, whole tusks for big sculptures or small pieces for decorative touches, the Japanese proposed that each country bid on separate types of ivory and keep all the prices low. The prices they paid were so low, Meng tells me, that an official from Namibia, which had held the first auction, followed the Asian delegations from country to country hoping for evidence her country had been cheated.

Still, to the CITES secretariat, the auctions had been a success. They’d raised \$15.5 million, most of which was supposed to go to African conservation projects. And while an average price of only about \$67 a pound for the ivory meant that the Africans had less to spend on conservation, it also meant, according to CITES, that China could now do its part for law enforcement by flooding its domestic market with the low-priced, legal ivory. This would drive out illegal traders, who CITES had heard were paying up to \$386 for a pound of ivory. Lower prices, CITES’s Willem Wijnstekers told Reuters, could help curb poaching.

Instead the Chinese government did the unexpected. It raised ivory prices. Through an affiliate of its craft association, CACA, the government charged entrepreneur Xue Ping \$500 a pound, a markup of 650 percent, and imposed fees on the Beijing Ivory Carving Factory that brought the company’s costs to \$530 a pound for Grade A ivory. China also devised a ten-year plan to limit supply and is releasing about five tons into its market annually. The Chinese government, which controls who may sell ivory in China, wasn’t undercutting the black market—it was using its monopoly power to outperform the black market.

Applying the secretariat’s logic that low prices and high volumes chase out smugglers, China’s high prices and restricted volumes would now draw them in. The decision to allow China to buy ivory has indeed sparked more ivory trafficking, according to international watchdog groups and traders I met in China and Hong Kong.

And prices continue to rise. According to Feng You Min, sales director at the Daxin Ivory



Carving Factory, the price of raw ivory has risen to 20 times the price paid in Africa. The genie cannot be returned to her bottle: The 2008 legal ivory will forever shelter smuggled ivory.

There is one final flaw in the CITES decision to let China buy ivory. To win approval, China instituted a variety of safeguards, most notably that any ivory carving larger than a trinket must have a photo ID card. But criminals have turned the ID-card system into a smuggling tool. In the

**BY ALL ACCOUNTS,
CHINA IS THE WORLD'S
GREATEST VILLAIN
WHEN IT COMES
TO SMUGGLED IVORY.**



ID cards' tiny photographs, carvings with similar religious and traditional motifs all look alike. A recent report by the International Fund for Animal Welfare found that ivory dealers in China are selling ivory carvings but retaining their ID cards to legitimize carvings made from smuggled ivory. The cards themselves now have value and are tradable in a secondary market. China's ID-card system, which gives a whiff of legitimacy to an illegal icon, is worse than no system at all.

Just before elephants were discussed at an August 2011 CITES meeting, China orchestrated the expulsion of all attending NGOs. It was an extraordinary act. Among those expelled were representatives of the Born Free Foundation, the Humane Society International, the Japan Federation of Ivory Arts and Crafts Associations, the Pew Charitable Trust, Safari Club International, and me (for the National Geographic Society). Traffic's Tom Milliken was allowed to remain to deliver his latest ETIS results. The reason for the expulsion, Meng tells me, was a report by a small but influential London-based

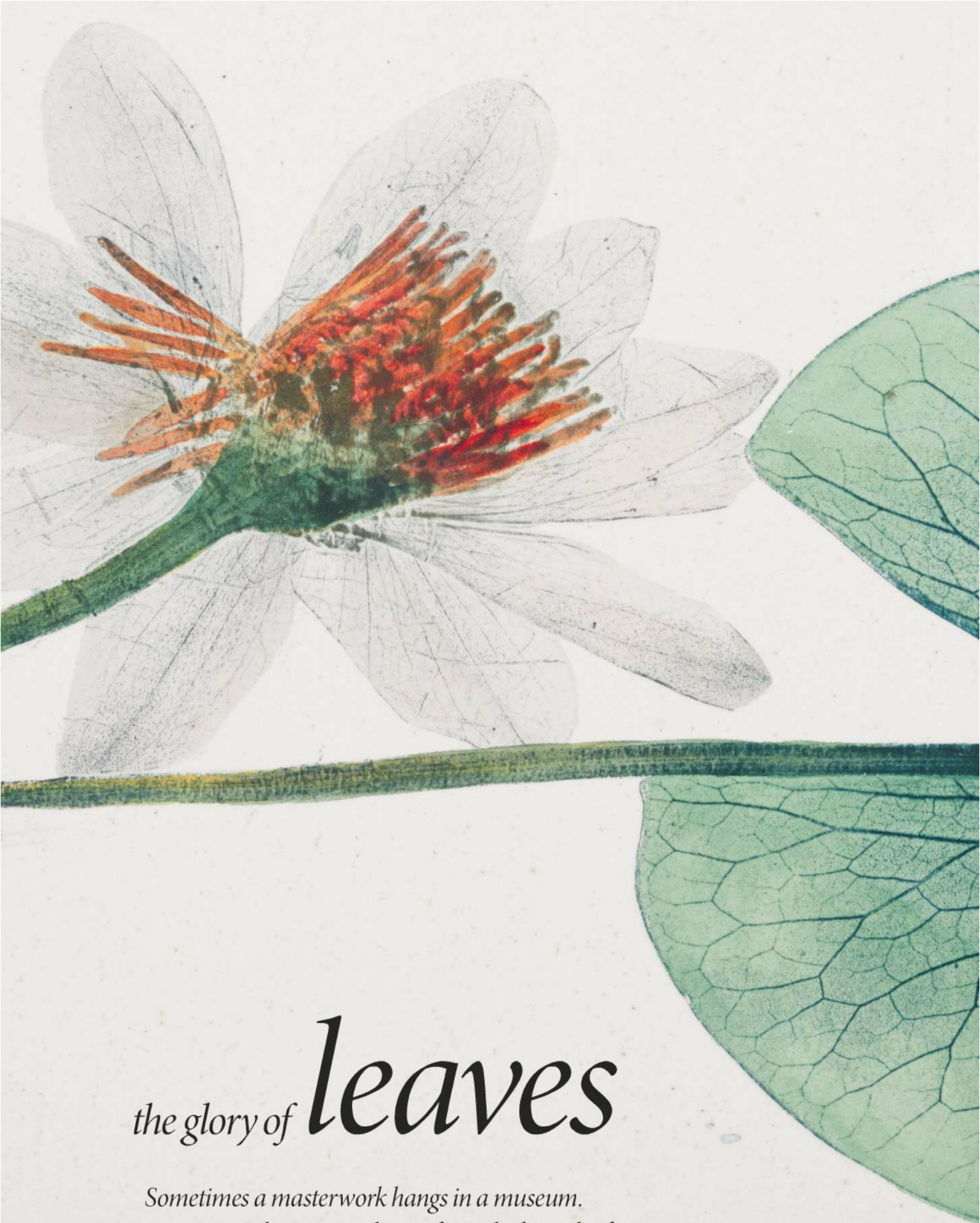
NGO, the Environmental Investigation Agency (EIA), which had sent undercover Chinese operatives into China. EIA alleged that China's ivory-control system was a failure, that up to 90 percent of the ivory on the Chinese market was illegal, and that the 2008 auctions had resurrected the illegal ivory trade. Meng was outraged. Yes, he said, 80 percent of EIA's report was true, "but they should have come to us first."

Last year CITES made a startling admission: "The Secretariat continues to struggle to understand many aspects of the illegal trade in ivory." This past April, Tom Milliken confessed something to the BBC that was eerily reminiscent of China's warning after the Japan experiment: "Did allowance of legal ivory to go into China exacerbate a situation? One could probably argue now, with hindsight, that indeed it did. It created perhaps an image in the minds of many potential Chinese consumers that it was OK to buy ivory."

Meng chuckles as I pour him another bottle of beer. He tells me that after the African ivory arrived in China, a strange sound could be heard coming from one shipment. It took some time to discover the source. During the bidding South Africa's ivory had looked the best and the whitest. Now some tusks were splitting open. "You could hear it cracking," Meng says. To get a good price, he speculates, the South Africans had bleached their ivory white, and now dehydration was causing the tusks to crack.

Even more precious than the savanna elephant's white ivory is the yellow ivory of the smaller, forest elephant. "This is the best," the Daxin Ivory Carving Factory's Feng tells me, holding up a chunk of forest elephant tusk. Carvings made from forest elephant ivory sell out so quickly that customers have been commissioning them. The only carved image he has left to show me is an old one of Chairman Mao with a crack in it. Trouble is, forest elephants don't live in any of the countries where China legally bought ivory. They live in central and western Africa, including in Cameroon, the country raided by Muslim poachers earlier this year.

In March CITES will meet again to discuss the future of the African elephant. □



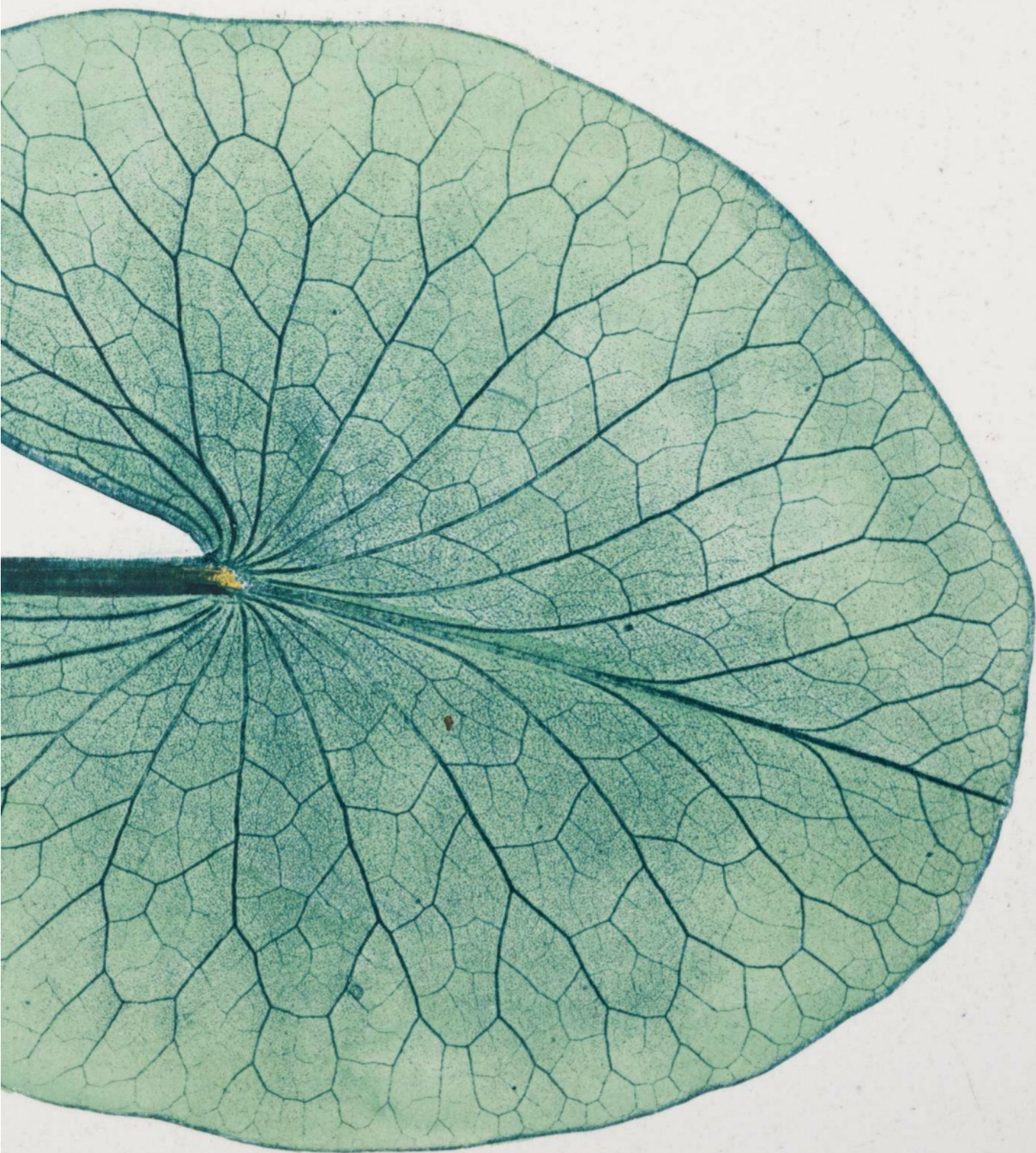
the glory of *leaves*

Sometimes a masterwork hangs in a museum.

*Other times it hangs from the branch of
a tree or rounds out a slender stem.*

Water Lily

*Like snorkels, the
mouthlike stomata on
water lily leaves point
up, where they find the
air they need.*



We have all held leaves, driven miles to see their fall colors, eaten them, raked them, sought their shade. Since they are everywhere, it's easy to take them for granted.

But even when we do, they continue in their one occupation: turning light into life. When rays of sunlight strike green leaves, wavelengths in the green spectrum bounce back toward our eyes. The rest—the reds, blues, indigos, and violets—are trapped. A leaf is filled with chambers illuminated by gathered light. In these glowing rooms photons bump around, and the leaf captures their energy, turning it into the sugar from which plants, animals, and civilizations are built.

Chloroplasts, fed by sun, water, carbon dioxide, and nutrients, do the leaf's work. They evolved about 1.6 billion years ago when one cell, incapable of using the sun's energy, engulfed another cell—a cyanobacterium—that could. That cyanobacterium became the ancestor of every living chloroplast. Without their chloroplasts plants would be left like the rest of us, to eat what they find. Instead they hold out their green palms and catch light. If there is magic in the world, surely this is it: the descendants of tiny creatures in leaves, capable of ingesting the sun.

If you gather a bouquet of leaves to consider their magic, it is hard to overlook their diversity and, if you are the curious sort, to wonder why there exists such a preponderance of forms. Some leaves don't seem to be leaves at all, having become flower petals, thorns, or the spines on a cactus. But even an ordinary oak leaf, dandelion leaf, and grass blade differ in size, thickness, shape, hue, texture, taste, and nearly every other feature.

Leaves are large, small, thick, thin, compound, simple, curved, or lobed. And these terms just begin to describe the differences botanists have tried to catalog in their rich poetry of obscure adjectives—pinnate, ciliate, barbellate, bearded, canescent, glabrous, glandular, viscid, scurfy, floccose, arachnoid, and my favorite, tomentose (covered with woolly hairs). But putting the variety of structures aside, most leaves do

Fern

Once, forests were crowned with the waving leaves, or fronds, of ferns.

Some modern ferns qualify as trees, but most are smaller plants. Their fronds reach up out of understories—and other realms where living is difficult—to catch some light.



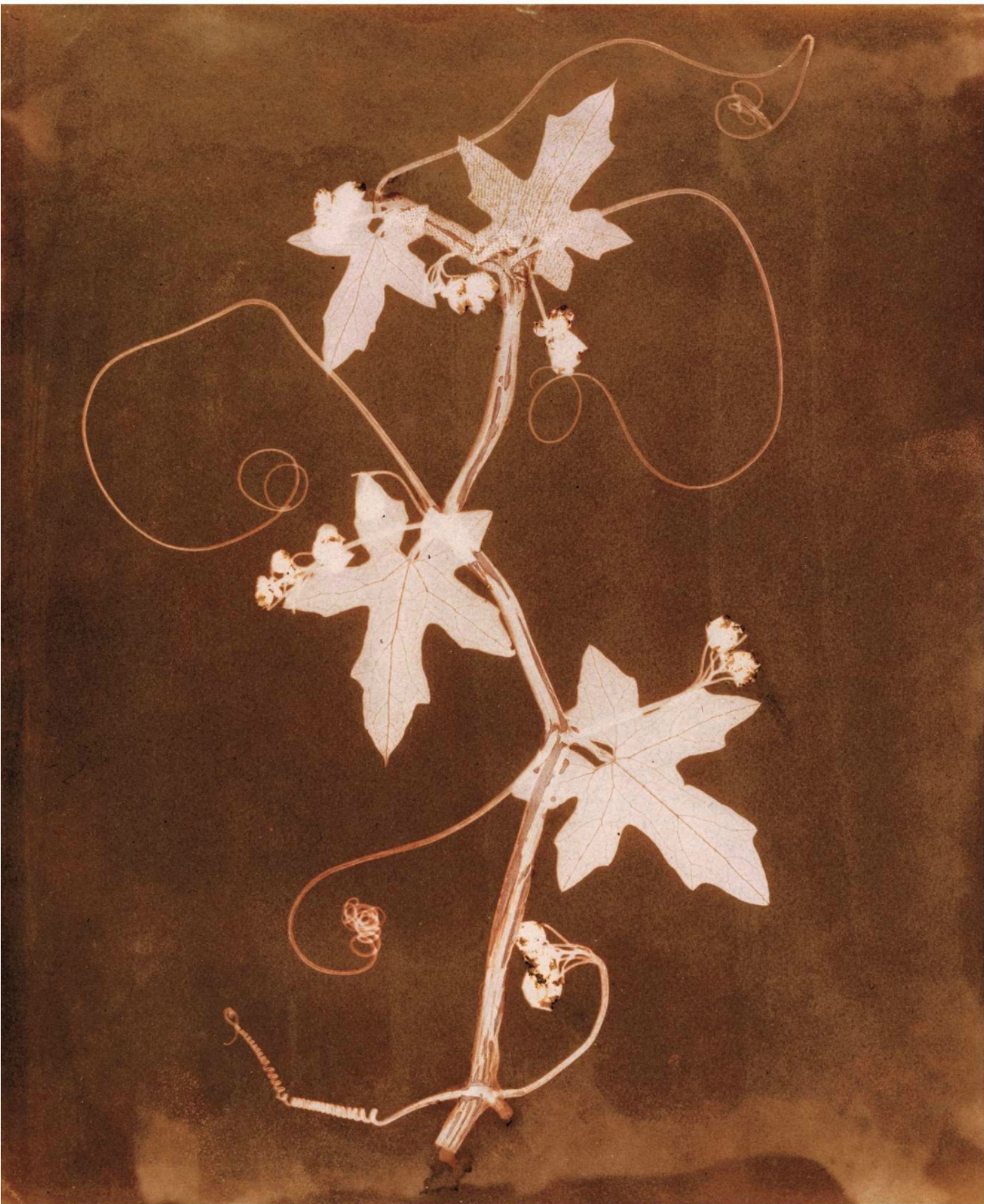
Direct Nature Printing
H. Arthur
Apr 1854



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Seaweed

It looks like a plant with its branches reaching out, but this seaweed is in fact a kind of marine alga. Seaweeds evolved independently from plants; the resemblance shows that the streams of evolution often converge.



WILLIAM HENRY FOX TALBOT, SCIENCE & SOCIETY PICTURE LIBRARY

Grape

*Blood circulates through human veins without leaving the body.
Grapevine leaves are open to the universe. Gases diffuse from veins to the leaf surface,
where the exchange of water and carbon dioxide takes place.*



Leaf Veins

Arranged in various patterns, veins in leaves may follow paths that range from one simple canal per leaf to parallel systems and branching, high-density networks.

ART: YANA BEYLINSON
SOURCE: C. KEVIN BOYCE,
UNIVERSITY OF CHICAGO

essentially the same thing: They exist in the main to hold chloroplasts aloft. How can so many different geometries all perfectly capture the sun?

The work of natural selection offers a key to the puzzle. Desert leaves tend to be small, thick-skinned, waxy, or spiny, just like leaves in salty regions or other harsh lands—clear examples of the relatively few ways evolution can deal with a lack of water. Rain forest plants often have narrow leaves, with long, thin “drip tips,” to drain away excess water. In cold places one finds leaves with teeth—like birches and cherries—though why this particular pattern exists is the subject of debate.

Some of the most extreme examples of the way natural selection shapes leaves can be found at high elevations in the tropics, where nights are consistently cold and damp and the days hot and dry. Scramble high enough above the tree line in the mountains of Africa, Asia, Hawaii, and the Americas, and you will see thick towers of plants crowned by mops of living and dead leaves.

In a poetic moment botanists named these lovely circular leaf arrangements “giant rosettes.” The thick living leaves of these rosettes shelter new buds. They’re hairy too, which adds insulation. The dead leaves help the plants withstand freezing at night and, simultaneously, save the night’s cold dew for the dry day. Remove those decaying leaves from rosettes at high elevations and the plants can freeze to death, naked without their dead-leaf fur.

In many environments natural selection tends to favor a limited number of similar forms again and again, given the genes it has to work with. Sometimes there really does seem to be just one or a few best ways to deal with a particular set of conditions. If rosettes are not convincing, consider the meat-eaters. In nutrient-poor bogs, plants have repeatedly turned to animals to supplement what the soil alone cannot provide. They have evolved rolled leaves, sticky hairs, mucous pools, or snap traps, all for capturing live prey. A bog is a terrifying place to be a fly.

But if climate and nutrient availability were the only explanations for leaf diversity, all of the leaves in a particular environment—a desert, a mountaintop, your backyard—would tend to be the same. Of course they are not. Many of the qualities of the leaves in your yard or salad are due to the limits of genes and time. Not all plants have the genetic variation it takes to become, under the natural selection imposed by desert conditions, a cactus. Conditions change. Species move. Every leaf is a work in progress. One suspects, for example, that leaves are evolving now to deal with the conditions in cities—pollution, drought, intense heat, and animal waste—but it may require more generations for natural selection to stumble, death by death, upon the more successful forms.

Other specific traits may have to do with the battles that have gone on among plants each day for more than 400 million years. Plants fight for nutrients and water in the soil, and they fight for sunlight in the canopy. Competition is why trees grow tall, stems become trunks, and forests grow dense. Trees have evolved in the struggle of plant against plant many times, in vastly different lineages. The highest leaves win, and so

trees tend to evolve to be as tall as possible, given the limits of physics and precipitation. Without competition, every forest would be a thick film of green life.

The battles among plants have changed their stems and their veins. Leaves with more veins can carry more water to the chloroplasts, allowing the chloroplasts to make more sugar and the plants to grow faster. These species in turn can hold their leaves aloft to occupy more space in the sky and consume more sunlight before others get to it. Through time the plants that were able to produce more and more veins in their leaves won many battles and some wars.

Leaves with densely branched patterns of veins are also able to grow more quickly. The veins of a maple leaf, for instance, are like the roads of a city; they go everywhere and often intersect. They traffic in nutrients and water. The maple leaf can quickly get what it needs to continue to feed from the sun. Other leaves are not so lucky. Amid the seething competition for space in tropical forests, pity the single-veined leaf.

Plants have more to cope with than competition from other plants. The evidence of animals eating leaves is almost as ancient as the evidence for leaves themselves. In fossil dinosaur poop one finds evidence of ancient leaves. In fossil leaves one finds the holes made by ancient mouths. Nothing on life's menu is more popular. Moths, butterflies, beetles, fungi, monkeys, sloths, and great loping monsters like cows, bison, and giraffes eat the hard-earned greenery of plants, which, for all of their ingenuity, have never figured out how to run away.

So leaves resort to self-defense. Some plant leaves have become specialists in deadly tricks. Grass blades evolved the ability to accumulate the silica from the soil—becoming like tiny glass slivers, which ruin the teeth of browsers like cows one bite at a time. Other plants use chemicals to make themselves unpalatable or even poisonous. Sometimes the weapons are visible: latex oozing out of a vein or tingly hairs projecting from leaf blades. Other times they lurk unseen, waiting for the unsuspecting victim, be it the larva of a moth or an indiscriminating sheep.

Climate, competition, defense—these evolutionary saws and scissors can explain much of the diversity of leaves. Yet if you pick up two leaves in your backyard, most of what differs between them—the details naturalists have spent thousands of years naming—remains unaccounted for. Evolution can whittle similar forms again and again when confronted with similar circumstances. But through innovation and chance, evolution can also work in the abstract: Jackson Pollock dashing paint on the canvas of life. We should not expect to understand every tomentose blade or arachnoid lobe. Sometimes it is enough to step back and know a masterwork when we see one, whether it hangs in a museum or from its petiole on the branch of a park tree. Not that leaves care whether you notice; the blessing they convey comes each day with the rise of the edible sun. □

Rob Dunn's most recent book is The Wild Life of Our Bodies. Illustrations are from Impressions of Nature: A History of Nature Printing, by Roderick Cave.





Thistle

Life is not easy for a thistle. It grows low, where the big heads and mouths of cows, sheep, and other grazers bow. It resists with spines. These spines are not foolproof. Sometimes thistles get eaten or, in the case of this specimen, picked.



To celebrate Carnival, the city's elite socialize at a masquerade ball in a grand old hotel.



playing **RIO**

Rio is a city of glamour and glitz—but also of poverty and violence in the favelas that climb its hills. With the Olympics coming in 2016, the slums are getting a face-lift.

Photographs by David Alan Harvey



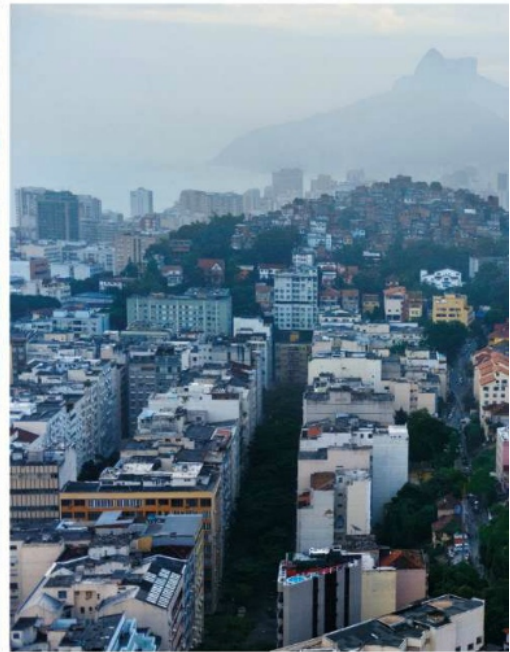
On sunny days a million
people with their sea
of umbrellas may crowd
Rio's beaches.



Ballet students strike a pose outside their school in the Cantagalo favela (top). Tickets to the Carnival parades are expensive, so neighbors often gather curbside to watch for free on TV.

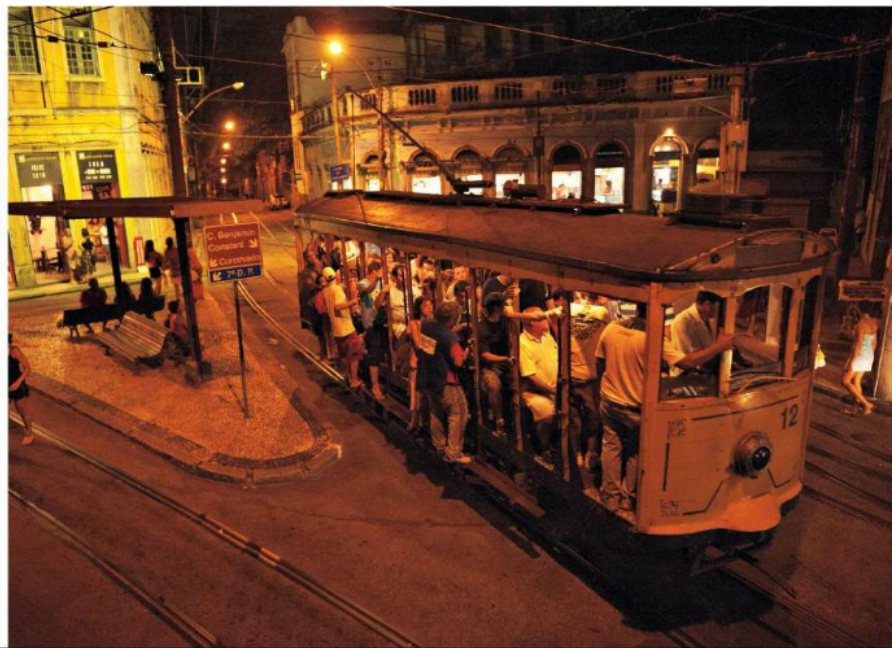


The stacked houses of a hillside favela near the ocean (top). A Carnival dancer's hatband represent the colors of his s



a overlook a neighborhood
er's white shirt and blue
amba school.

Finishing her errands, a favela resident passes military police
taking part in a training exercise (top). A trolley now idled
for repairs normally services the historic area of Santa Teresa.





The landmark 125-foot-tall statue of Christ the Redeemer rises over bays and beaches from the peak of Corcovado, in a panorama made from two images stitched together.



Roving vendors in Copacabana sell everything under the sun, including whimsical trinkets (top). At Carnival, ticket holders fill the Sambadrome to watch a parade that lasts until dawn.

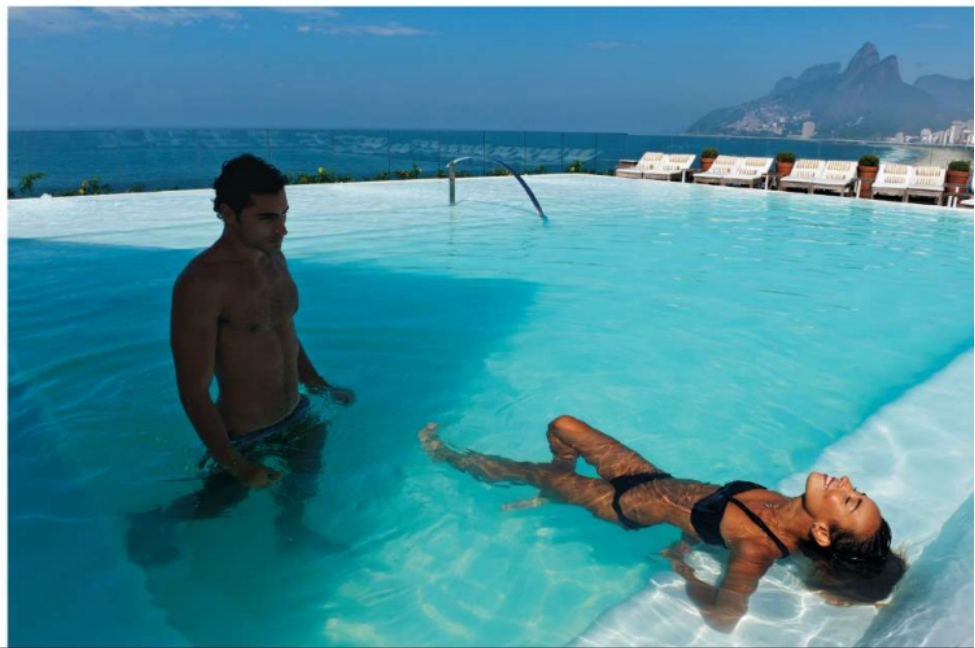


Yachts bob in Botafogo Bay, cradled between the beach and the rock known as Sugar Loaf (top). Romance sizzles during the summer season, when revelers fill the city.



and the tall
Carnival

A rock band plays oldies at a Copacabana bar (top). Local TV actors kick back at an Ipanema hotel also favored by international celebrities like Beyoncé and Madonna.



“W

we are guinea pigs,” declares Fabio do Amaral, a drug-gang killer turned evangelical minister. Brother Fabio preaches at a church in Santa Marta, one of Rio de Janeiro’s favelas. What he means is that the citizenry of Santa Marta is part of a plan to clean up the hillside slums for the 2016 Olympics.

The experiment was set in motion in November 2008, when special operations police invaded the slum, a collection of brick and cinder block houses rising like a rickety skyscraper threaded with footpaths ascending 788 steps along a steep incline below the famed Christ the Redeemer statue. Unlike your usual Rio police assault on favela drug dealers—a bloody hit-and-run using armored trucks known as “big skulls”—a contingent of 112 “pacification officers” arrived in Santa Marta that December and stayed to restore order and evict the gang. Then the government built brightly colored apartment blocks and installed new electrical service along with 700 free refrigerators. These days, the place is overrun by film crews and such red carpet visitors as Madonna and John McCain. (Many Brazilian tourists visit too, often entering a favela for the first time.)

Brother Fabio used to be part of the problem. Born in the slum in 1973, he grew up to be a hit man with the nickname “Bananeira” because he reminded people of a banana tree, walking the favela steps on his hands with his feet splayed in the air. He found faith with the help of a local nun, but full reform didn’t happen overnight. “I believe in gradual repentance,” says Fabio, flashing white teeth as he restrains two pit bulls that live on his roof. He looks like Mike Tyson

dressed in church clothes: a short-sleeved yellow shirt and black nylon dress pants.

When he’s not preaching, Fabio chases down men with flip-flops and cracked toes to sign them up for construction-worker training classes. That’s a big step for people who, in Rio terms, were *lixo*, human garbage. Now companies aren’t afraid to hire them. There’s more respect. But it’s still not luxurious living. Signs at Santa Marta’s entrance warn of dengue, and “high up there it’s only sorrows,” says Fabio, pointing to the shanties on the hill, beyond the reach of social programs, where some still cook outside on open fires.

RIO NEEDED THE SOLUTION to an economic puzzle involving low wages, poor public transport, a weak state, and income distribution about as fair as a tin-pot kleptocracy’s. “It happens in the whole world, but I would say here the dose was greater,” says José Mariano Beltrame, state secretary of public security.

Beltrame is a principal author of the “pacification plan,” meant to occupy the slums and push out the gangs with a force of some 12,500 pacification officers in 165 communities by 2014 for the soccer World Cup. Beltrame hopes to leave behind a functioning civilian state with a legal economy after the Olympics in 2016. Many citizens with high hopes believe Beltrame is the first security chief who is not corrupt. He’s not from Rio either; his accent—and the gourd of maté tea tucked under his desk—is the mark

Antonio Regalado writes about science, technology, and culture. David Alan Harvey’s take on North Carolina’s Outer Banks appeared in June 2012.



A drug dealer holding bags of cocaine worth a few dollars apiece is one of a disappearing breed in Vidigal. Police officers who now occupy the favela are working to eradicate all such activity.

of a straight-talking gaucho from Brazil's southern plains. "I understood that we had to have a plan, not a bunch of opinions," says Beltrame. "The solution, without any doubt whatsoever, is what I am doing."

In other slums now occupied by police, life has improved. Children are playing again in the streets. Friends will come for a visit. Yet people are still suspicious. One of Fabio's fellow preachers, Sérgio Souza de Andrade, led me to the church basement to explain. "People don't want to say so, but our greatest fear is that tomorrow will be like yesterday," he says. "What will happen when the police leave?"

Consider Cantagalo, an amphitheater-shaped favela with sweeping views of Rio, where drug traffickers made the rules for roughly 35 years.

Their spray-painted slogans, on building walls now covered with less violent graffiti by local artists, announced: "We are the crazies" or "Psychos are born here." Since police took over in December 2009, gang members have no longer been carrying unconcealed weapons. But they may not all have left either. "They're up there somewhere," says Luiz Bezerra do Nascimento, the community association president, waving a hand toward the top of the hill. Everyone is still sorting out the new roles. "We had to respect them before because they were the authority. Now I tell them, 'You don't rule here anymore. The police do.'"

The police are more welcome, if not beloved, in Cantagalo these days, partly because of a big publicity effort. It's a strategy as old as military

occupations, explained Capt. Leonardo Nogueira, who runs the local pacification unit. He was tossing candy out a window in police headquarters to a horde of children while a local TV crew filmed. “The children who live here without the influence of drug traffic will be different people. We want to come back here in 20 years and find that they’re not like their parents,” Nogueira says.

IN A WAY, with gangs gone, it’s every man for his capitalistic self. Electricity in Santa Marta used to come free via a tangle of wires. Now everyone pays bills. But why does the amount go up and down so much every month? Real estate prices are soaring too. Nearby in more upscale Botafogo, once terrorized by stray bullets, apartment prices have more than doubled. Students and foreigners want a shack with a view in Santa Marta.

Despite the early success of the pacification plan, Rio’s poor distrust many government efforts to reshape the city. Tempers rise periodically, as when workers began building a multimillion-dollar plastic and concrete wall along the Linha Vermelha highway a couple of years ago. Officials called it a sound barrier, but critics denounced it as a vanity screen to hide the squalid creeks of Complexo da Maré, an expanse of houses built on marshland, where residents used to clamber onto the highway leading from the airport to sell peanuts and cell phone chargers.

Similar doubts surround the coming Olympics spectacle. Half the new arenas and facilities will be in Barra da Tijuca, a Miami-like middle-class refuge full of cars and malls about 20 miles from the city center. Here the poor are less in evidence, and strangely, the charm of the *cidade maravilhosa*, the “marvelous city” that invented the world’s great tropical brands—Carmen Miranda, “The Girl From Ipanema”—is also absent. The place is known as “the Rio that forgot it is Rio.” A Spanish academic named Jordi Borja, who studies mega-events and has advised Rio’s government, says, “You should use the games to improve the inner city, not the suburbs, to reduce inequalities, and to do urbanism in favor of the poor.”

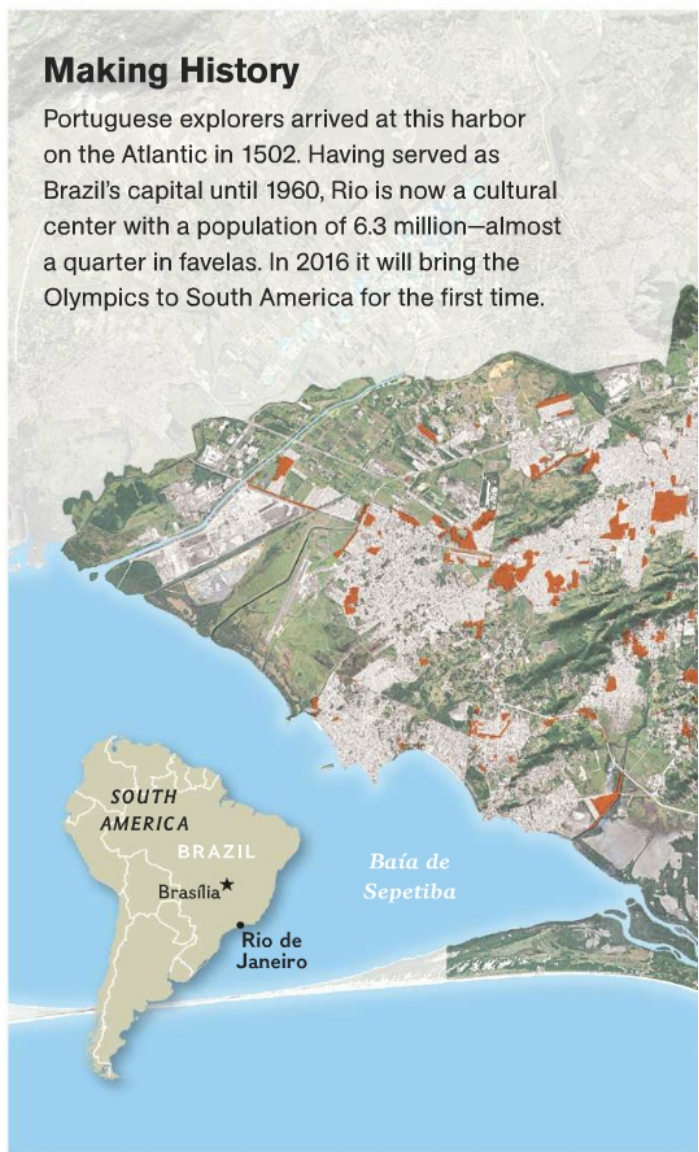
Certainly some real money is reaching impoverished areas, to good effect. In Cantagalo, two soaring elevators wrapped in colorful steel tubes now connect the upper reaches of the slum to the street. And the Complexo do Alemão, a

confused agglomeration of several favelas that has been a main redoubt of the Red Command, Rio’s largest gang, was recently abuzz with workers funded by a federal program. They erected a few thousand new apartments and a sports complex, and have completed work on an immense cable car system, based on the one in Medellín, Colombia, spanning the hills.

Some hope such structures will be like the London Tube or the Brooklyn Bridge: symbolizing civic values, the opening up of the slums, and the return of civil rights to all Cariocas, as Rio’s residents call themselves. But others say it’s asking too little of Rio—dominated as it is by natural wonders and human drama—to expect man-made structures to represent the city’s aspirations, as the Bird’s Nest declared Chinese power during the Beijing Olympics.

Making History

Portuguese explorers arrived at this harbor on the Atlantic in 1502. Having served as Brazil’s capital until 1960, Rio is now a cultural center with a population of 6.3 million—almost a quarter in favelas. In 2016 it will bring the Olympics to South America for the first time.



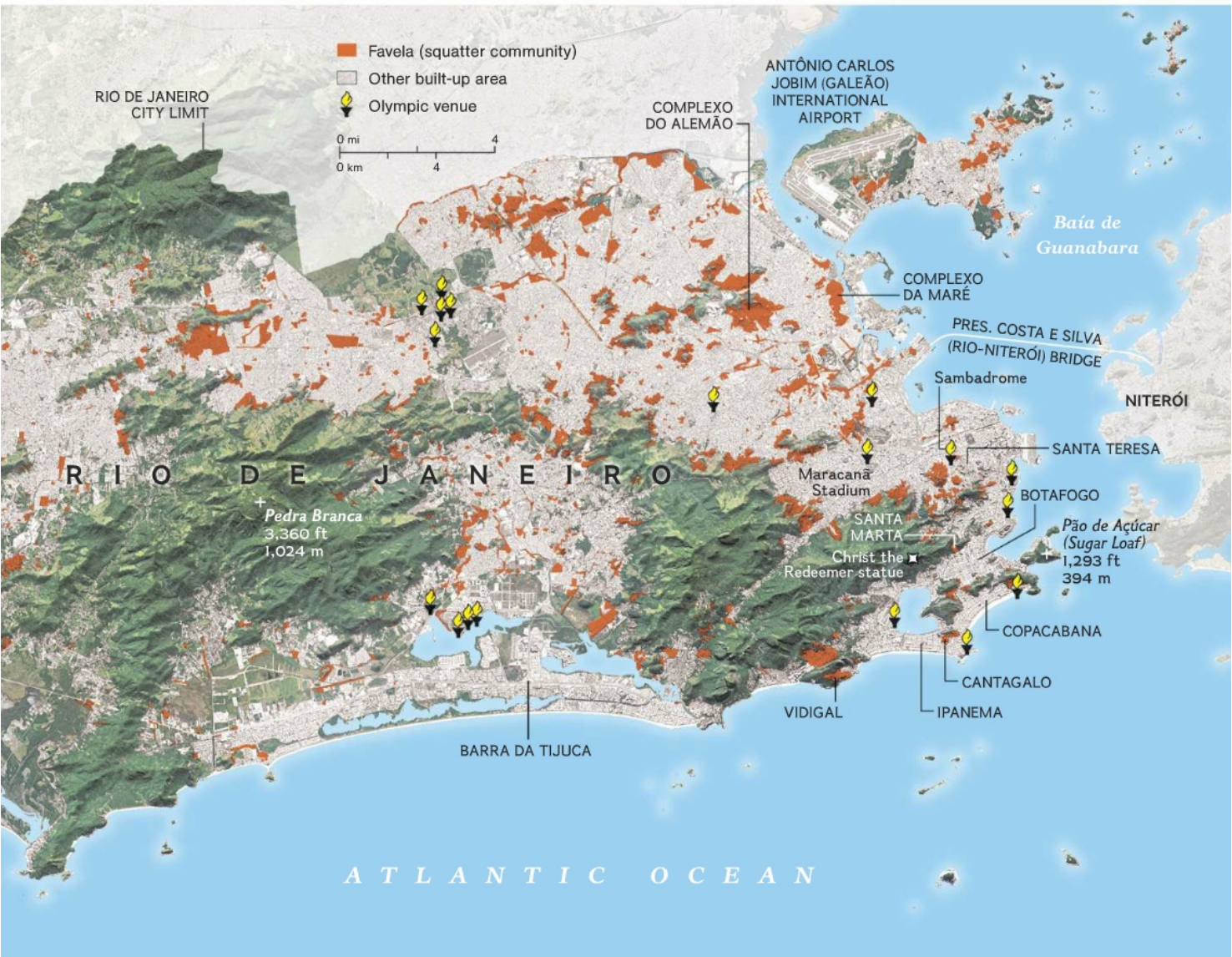
Plus, people are sure the money will somehow be stolen, and they point to the City of Arts. The city that turned samba into a spectacle created a \$250 million boondoggle: an immense, gloomy, concrete music hall in Barra da Tijuca that, ten years into construction, has yet to sound a note.

If you are looking for an Olympic legacy, how about a city where people live in peace? Since this is Rio, everyone says look to Carnival for answers. The festival is a time of inversion, a chance to stand the world on its head. “This is a city of celebration,” says Mayor Eduardo Paes, “but we have to organize it. Carnival represents the kind of organized disorder we’re trying to copy.” During Carnival’s big parades the poor dress as kings, beach-neighborhood socialites tear their clothes to parade as beggars, and 60,000 participants and close to a hundred

floats—orchestrated and on time—samba like clockwork until dawn.

But Carnival is once a year. And even the big push to change Rio for the Olympics will eventually come to an end. Then the future of the favelas may rest in the hands of people like Brother Fabio, with his message of personal redemption.

His church stands next to a plaza with a statue of Michael Jackson; it’s where the pop star recorded the music video “They Don’t Care About Us.” The church is full of poor children, and adults who can’t escape from drugs. On a day when the building’s metal shutters are closed against wet ocean wind, Fabio’s voice booms over a tinny PA system. “The flesh is weak,” he sings out, “and the spirit is strong.” It is his fanfare for the common man, his dream for the favelas that shaped him. □





Despite Rio's deep social divisions, the beach is democratic. Rich and poor share the sand all day and into the evening.





Central America's **MESOAMERICAN REEF**
is half the length of its famous Australian counterpart
but in many ways more remarkable.

MESO



A whale shark, biggest of fishes, hangs out with small fry off the northern tip of the Yucatán Peninsula.

AMAZING





A view from 12,000 feet, off the coast of Belize, shows the parts of the system that make the whole. The outer reef breaks the force of the ocean swells. Next comes the white line of coral rubble along the reef crest, then the sandy back reef, and, finally, the lagoon: a maze of sand islets, mangrove cays, and sea grass beds.





SEA GRASS

left

A loggerhead turtle grazes. Sea grass is not the typical meal for the primarily carnivorous species, which feeds on jellyfish, crabs, and conchs.

CORAL REEF

right

Corals build the rampart that shelters the landward provinces of mangrove and sea grass. The reef's calcium carbonate city teems with species, among them this spiny-headed blenny.

MANGROVE

following pages

Mangroves contribute to the system by trapping reef-bound sediment, filtering out pollution, and serving as nursery for many reef fish and invertebrates. The arched roots of mangroves like these form gateways through which multitudes of juveniles swim toward adulthood on the reef.





By Kenneth Brower

Photographs by Brian Skerry

IN THE MANGROVES OFF THE EAST COAST OF CENTRAL AMERICA, AT THE EDGE OF THE MESOAMERICAN REEF, THE WORLD IS DIVIDED IN TWO:

the above and the below. As we killed the engines and poled the skiff from the hot April sun into the shade of the forest, Will Heyman, my marine biologist companion, and I gazed into the simplicity above. We saw the green crowns of one of the least diverse of all tropical forests, where there is often but a single species of tree, the red mangrove.

Salinity, storm waves, and oxygen-poor mud discourage understory growth in the mangroves, so there was little beneath the canopy for us to see. The occasional orchid. Rarely, a vine. A troop of fiddler crabs guarding holes in the mud. A big mangrove crab low on a trunk. Some insects. A tricolored heron perched on the stilt of a mangrove root.

I leaned over the gunwale to sample the mud around the roots, scooping up sherds of pottery. The mangroves of the Mesoamerican Reef were once at the fringe of the ancient Maya civilization. I contemplated slipping a souvenir into my pocket—with such a lode here, what possible harm? “Strictly catch-and-release,” Heyman said. With a splashing of jettisoned sherds, we poled to another spot. There, in the still water, we witnessed the miracle of the below.

At the waterline the roots in this forest blossom downward, expanding all shaggy-bearded with mats of algae, and slender brittle stars, and boxy starfish, and the little translucent vases of the filter feeders called tunicates—their “tunics” orange or purple or white—and soft corals and

oysters and sponges in still more hues. Nothing here goes unadorned.

Mangroves are crucial nurseries. Schools of small fry shift away through the Moorish architecture of arched roots, each school a pale cloud of translucent fish. The palest clouds are hardly there at all, composed of hatchlings no bigger than the smallest mosquito wigglers. These living motes are too small to name. Are they destined for adulthood in a sea grass bed, or coral reef, or open ocean, or right here in the mangroves? Too soon to tell.

And so it goes on Central America’s reef system. Each component of this tripartite world of mangrove, sea grass, and coral reef is itself divided in two: the world above elementally simple, the one below bafflingly complex.

The Mesoamerican Reef system stretches more than 600 miles along the coasts of Mexico, Belize, Guatemala, and Honduras. Its Australian cousin, the Great Barrier Reef, is great indeed at 1,429 miles long—the biggest structure created by living things on this planet. Yet the Mesoamerican Reef, at less than half the length, is in its own way the more remarkable.

The contours of the continental shelf here encouraged the development of an underwater reef platform that begins within a few hundred yards of shore in some places and as much as 20 miles offshore in others. This platform supports a variety of reef types and a profusion of corals unique in the Western Hemisphere. If the



Gulf of Mexico

Caribbean Sea

Yucatan Current

System Under Stress

Coastal development along with increased tourism can lead to harmful dredging and sewage pollution.

Offshore oil exploration and drilling pose risks to the entire reef system, including the Belize Barrier Reef World Heritage site.

Corals off the coasts of Honduras and Belize are slowly recovering from bleaching and disease worsened by 1998's Hurricane Mitch.

Multiuse protected areas like Gladden Spit balance conservation with the needs of the local economy, allowing limited fishing and tourism.

Deforestation, agriculture, and urban development, especially in Honduras, result in runoff that damages habitats.

Yucatan Peninsula

MEXICO

Cozumel Island

M E S O A M E R I C A N

A DELICATE BALANCE

Local economies and the livelihoods of nearly two million people rest on the health of the Mesoamerican Reef. The eco-region, an interconnected system of critical, fragile habitats, faces growing threats from overfishing, inland land clearing, and offshore oil exploration.



Critical Habitat

- Mangrove
- Sea grass
- Coral reef
- Marine protected area
- Protected fish spawning site

0 mi 25
0 km 25

Belize

Barrier

Reef

Gulf of Honduras

Caribbean Current

Roatan Islands

Cordelia Banks

CONTINENTAL SHELF

Bay

GUATEMALA

HONDURAS

MAGGIE SMITH, NGM STAFF; DARCY BELLIDO DE LUNA
SOURCES: MELANIE MCFIELD, HEALTHY REEFS INITIATIVE;
NATURE CONSERVANCY; SEAGRASSNET; WASHINGTON
DEPARTMENT OF NATURAL RESOURCES; CATHALAC, USGS;
INSTITUTE FOR MARINE REMOTE SENSING; INEGI; SCRIPPS
INSTITUTE OF OCEANOGRAPHY; NOAA

Mesoamerican Reef has any advantage over its massive Australian counterpart in the Pacific, it is in this proximity to land and the intimacy of its connection with inshore habitats. Here the provinces of mangrove, sea grass, and coral reef are bound so tightly together by currents, tides, and mutual need that it's really not possible to tease them apart.

MANGROVES

Mesoamerican mangroves form multiple lines of defense for the reef system. The first line is the tall mangrove forest along the coast and up the mouths of tidal rivers. The second line, and sometimes a third and fourth, occur offshore, in places where pointy mangrove seedlings have taken root atop a series of shallow marine ridges. Each clump slowly gathers the makings of an islet under itself. These islets grow into islands—mangrove cays—arranged in linear archipelagoes. The clusters of cays work as screens, benefiting the sea grass by moderating wave action and the coral reef by intercepting silt, fertilizers, and toxins in runoff from land.

The mangroves, in addition to defense, provide mulch. They can shed tons of leaves per acre every year. Fungi and bacteria break down this leaf litter and consume it, then are consumed by tiny worms and crustaceans, which in turn feed small fish, which feed larger fish and birds and crocodiles.

Life wells outward from the mangroves into the sea. At the same time, a living countercurrent flows back in: the eggs, larvae, and sometimes the gravid females of reef creatures that use the mangroves as a nursery. If any fish is emblematic of this life cycle—kindergarten in the mangroves, graduate school on the reef—it is the rainbow parrotfish.

The scientific name for this species is perfect, *Scarus guacamaia*, from the native Taino *huacamayo*, “macaw.” The resemblance is eerie: The fish has the parrot beak and the coloration of the blue-and-yellow macaw. The parrotfish starts small in the mangroves, as drab as a sparrow, and ends in full color on the reef,

four feet long, the largest herbivorous fish in the Atlantic.

Mangroves are not just a convenience for *Scarus guacamaia*. They are a necessity. When mangroves are carved away, to make room for tourist venues, for example, the species tends to go locally extinct, with repercussions in all directions. Coevolution has brought the coral reef and its parrotfish into balance; when the horny-beaked herbivores are fished out or otherwise eliminated, the reef declines, its corals overgrown by carpets of the algae the parrotfish normally eat.

John Muir told us what we can expect when humans with their habits begin to unravel a sound ecosystem. “When we try to pick out anything by itself, we find it hitched to everything else in the universe,” he wrote. The parrotfish are a case in point. The Mesoamerican Reef is one section of the universe where the hitches are particularly tight.

SEA GRASS

A sea grass bed begins with the sprouting of a pioneer species like shoal grass, with flat, thin leaves; or long and threadlike manatee grass. The pioneer grasses eventually give way to turtle grass, the climax species, which has flat, straplike blades up to two feet long. Of the various species of sea grass identified off Central America, turtle grass is commonest. Like the others, it is an angiosperm, a flowering plant, having solved the problem of pollination underwater—no bees—and having mastered submarine dispersal of fruit, which simply detaches and tumbles away on the current. Sexual reproduction is not a big preoccupation of the species. Most of the time, turtle grass is chaste. Maintenance and expansion of the bed are largely by vegetative reproduction—asexual sprouting from buried stems.

The turtle-grass rhizomes, or underground stems, creep horizontally under the sand and are anchored by an extensive root system. Like the mangroves, they trap silt that might otherwise settle on corals.

This is a vital service. Reefbuilding corals

HERE THE PROVINCES OF MANGROVE, SEA GRASS, AND CORAL REEF ARE BOUND SO TIGHTLY TOGETHER BY MUTUAL NEED THAT IT'S REALLY NOT POSSIBLE TO TEASE THEM APART.

require clear water. The basic unit of a coral colony, the tiny coral animal—the polyp—produces most of its food through photosynthesis by algae resident in its tissues. Sedimentation, which screens out sunlight and kills polyps, is one of the principal causes of coral-reef decline worldwide. De-sedimentation by sea grass is a reciprocal service. Turtle grass thrives in calm waters protected from surf and wind-driven currents by the barrier reef; its sequestering of sediments is merely a return of the favor. Just as the coral polyp lives in internal symbiosis with its resident algae, so the coral reef lives in external symbiosis with sea grass.

All in these waters is quid pro quo. The Meso-american Reef is an edifice built of mutualisms.

From a boat adrift above it, the turtle grass looks as monotonous as a field of corn or alfalfa. But snorkel the prairie at the level of the grass, your face mask parting the blades, and the detail and diversity jump out. Older, darker blades are encrusted with epiphytes, undersea “mosses” in hundreds of species. Films of algae and bacteria on the blades are food for tiny organisms, which in turn feed shrimp and small fish. Sea grass is a way station, a middle school, for many species hatched in the protection of the mangroves and bound for adulthood on the reef.

Bright schools of small fish hang over the undersea prairie as the current stirs in the grass. Occasionally you flush adult parrotfish and surgeonfish, come in from the reef to feed on the grass itself. Sometimes in the turtle grass, you meet one of those: a foraging green turtle, hawksbill, or loggerhead. Here and there the sea grass prairie is crossed by what appears to be a game trail. The big game here is blimp shaped, weighs a thousand pounds or more, and is distantly related to the elephant: These are the feeding swaths of manatees.

When foraging in turtle grass, a manatee really digs in. Sometimes it starts with a salad of grass-blades, steering those toward its mouth with wafting, gathering motions of its foreflippers. But often it goes straight for the starch in the stems beneath. Rooting these out, it churns up clouds of sediment. The big myopic head lifts

from the muck; the huge upper lip, muscular and prehensile, makes a variety of indescribable chewing motions, the broken ends of plants sticking out past the whiskers; and then the manatee is obscured by the mud cloud it has made. A blizzard of detached turtle-grass leaves swirls above the cloud, like confetti on Armistice Day. Burying its face in the mud again, the manatee rejoins its own parade, plowing onward across the prairie.

CORAL REEF

From the deck of a skiff on the surface, the reef makes a lovely but minimalist seascape: the white line of surf breaking along the reef front, the turquoise of the reef flat, the royal blue of the open ocean beyond. But like the inshore habitats that it shelters, the rampart of the barrier reef is a world divided.

Adjust your mask, take a breath, and roll overboard. Now the real reef reveals itself: a concentration of life and a spectrum of colors unlike anything up in the world of air. The reef is a teeming city of hard corals, soft corals, fire corals, lace corals, brain corals, staghorn corals, sea whips, sea fans, sea grapes, coralline algae, sponges. Taking refuge everywhere in the alleys of the coral city, or countersunk in holes drilled in the corals themselves, or perched atop the coral heads, are hosts of invertebrates—clams, crabs, shrimps, worms, sea cucumbers—of stunning diversity. Add to these the hundreds of new species scientists identify worldwide each year.

Schooling above the reef are fish painted extravagantly in an array of electric colors we are missing in the upper world. There is an auto-luminescence to the palette here, as if each fish and feather worm came equipped with its own battery to power its stripes, bars, blazes, and dots.

The coral reef, like all reefs across the tropics, is threatened by ocean acidification and warming episodes caused by climate change. Overfishing,

Ken Brower contributed to Ocean, a 2010 National Geographic special edition. For another of Brian Skerry's photos, see The Moment, page 145. This article was funded in part by the Oak Foundation.



A manatee mother with her calf in tow grazes on turtle grass at Swallow Cay in Belize. The West Indian manatee divides its time between sea grass pastures and the waterways of the mangrove forest.



coastal development, and the accelerating pace of oil exploration are worrisome too.

But at dusk in springtime, when the moon is full, age-old magic still happens. Near the Silk Cays off southern Belize, thousands of cubera snappers, dog snappers, and mutton snappers come to spawn at a reef called Gladden Spit. They draw platoons of whale sharks, which feast on the eggs, and sometimes marine scientists as well. These sharks, the biggest fish in the sea, are plankton-eaters; Gladden Spit is the first place they have ever been observed eating spawn. The assembly here of snappers, the predators that eat them, and the colossal sharks that feed on the spawn is the most spectacular convocation I have ever witnessed in the ocean.

In scuba gear, 50 feet deep, Heyman and I swam toward a huge ball of spawning cubera snappers, a dark, slow-rotating, cyclonic tower that resolved itself, as we swam close, into thousands of particular fish. From the smooth rotation, tight groups flurried upward to spawn, releasing white clouds of eggs and milt. These coalesced into a great thunderhead, which billowed up to envelop us. For a time we were lost in a sperm-and-egg whiteout. Then a dim gray shape materialized, like *Titanic* in the fog, and out of the whiteness came the gigantic gape and spread pectoral fins of a feeding whale shark. Then more whale sharks arrived, and finally bottlenose dolphins and bull sharks.

We chased the party until we ran out of air. Surfacing, we inflated our vests and swam backward toward the skiff anchored under the newly risen moon. The full April moon had called snappers here, their spawning timed to catch the high spring tide that would carry their fertilized eggs into the mangroves. The whale sharks were guided in from afar by whatever mysterious cues they use in navigation. Tonight the shallow, tight-knit ecosystems of the Mesoamerican Reef had opened up. When you try to pick out anything by itself, you find it hitched to everything else in the solar system.

We paced ourselves, finning backward toward the bobbing skiff, under the moon that had brought us. □



A Caribbean reef shark samples a Pacific lionfish at Cordelia Banks in Honduras. A few spiny lionfish escaped from an aquarium 20 years ago, and today they're a plague, preying on the reef's fish population. Scientists are helping sharks acquire a taste for the invaders by feeding them speared lionfish.



Three-foot-long cubera snappers, drawn to Gladden Spit in Belize by a full moon in spring, produce clouds of eggs and sperm in a thunderhead of fertility that rises to envelop divers. Snappers of several species gather here by the thousands, releasing hundreds of billions of eggs.









CORAL REEF
left and right

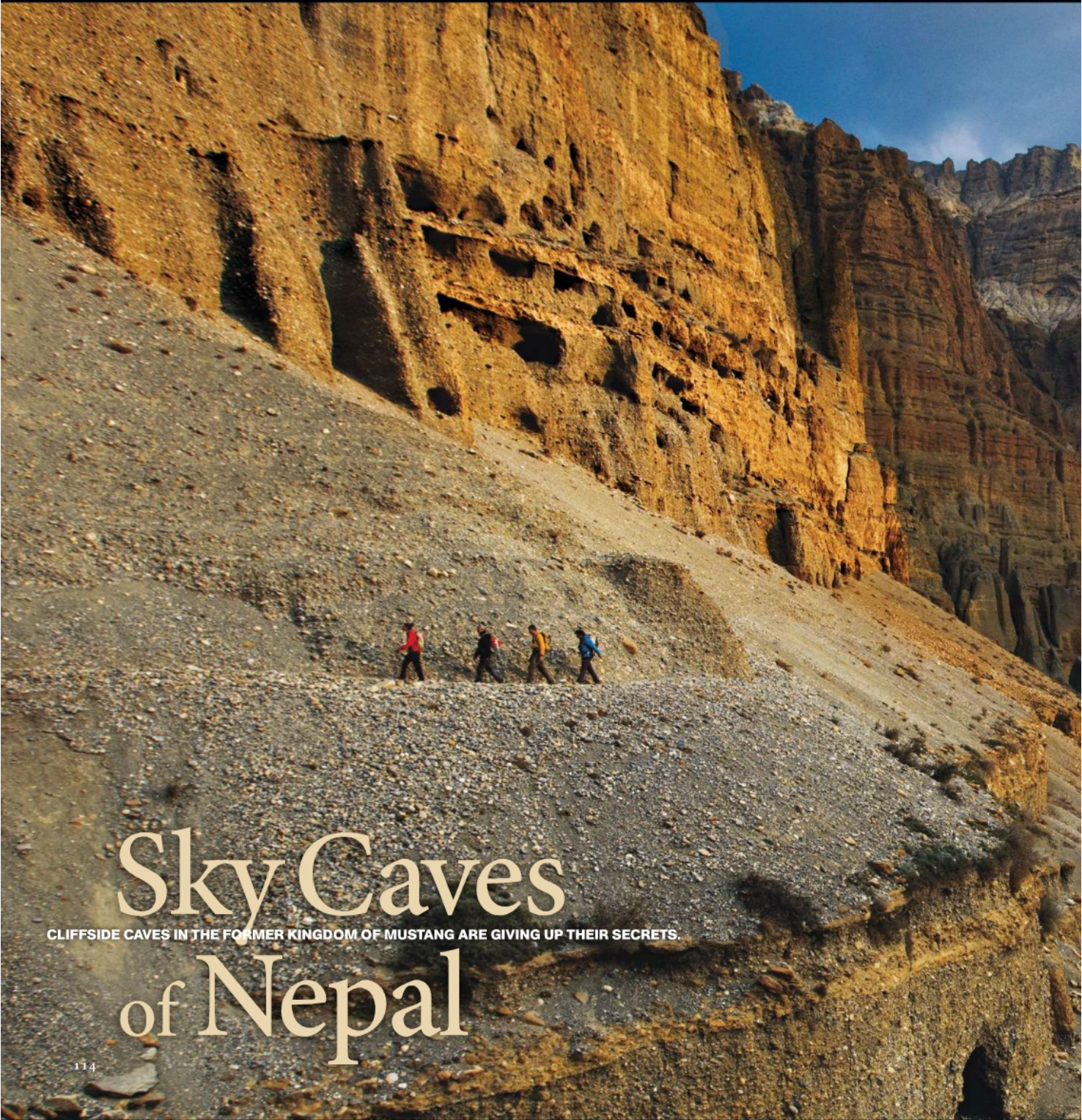
A trumpetfish (left) hangs in the coral gardens of Lighthouse Reef atoll off Belize (right), one of the most seaward outliers of the Mesoamerican Reef.

SEA GRASS
following pages

A nine-foot American crocodile, an endangered species, hunts in turtle grass at the edge of a bed of mangroves on Banco Chinchorro, off the Yucatán Peninsula. “Just make sure, whatever happens, that my body comes back home,” muttered Jeff Wildermuth, photographer Brian Skerry’s assistant, as he and Skerry entered the water. “I don’t want to be stuffed under a mangrove log somewhere.” When Wildermuth poked at the advancing croc with a length of plastic pipe, it did not veer off, as a shark would have. It opened its jaws and kept coming. “There’s nothing quite like the feeling of being hunted,” said Skerry after he and Wildermuth escaped.





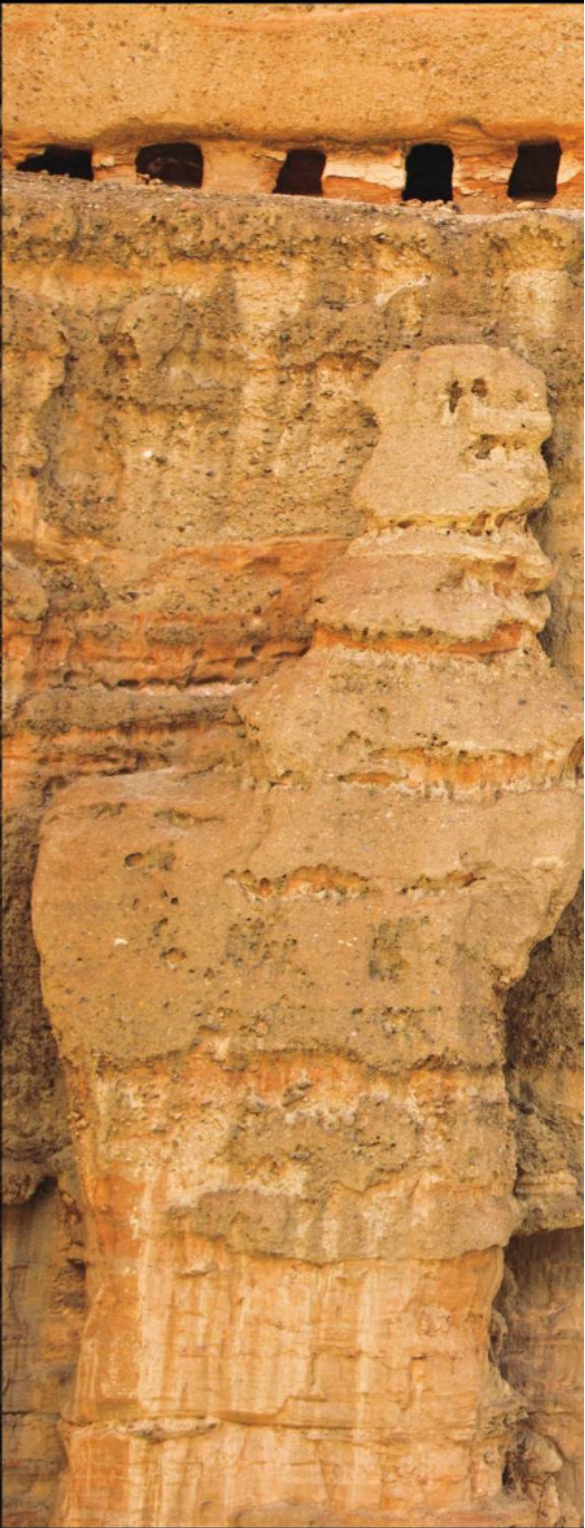


Sky Caves of Nepal

CLIFFSIDE CAVES IN THE FORMER KINGDOM OF MUSTANG ARE GIVING UP THEIR SECRETS.

Climbers and scientists follow a trail above the Kali Gandaki River in Nepal's remote Mustang region. More than 60 feet above are rows of unexplored man-made caves dug centuries ago. There may be thousands in the region.







To reach a series of caves dug into a cliff 155 feet above the valley floor, Matt Segal (above) scales a rock face so fragile it breaks off to the touch. Linked by a ledge, the 800-year-old caves, empty now, may once have stored manuscripts. Ted Hesser (left) hoists himself up at a cave entrance.

BY MICHAEL FINKEL

PHOTOGRAPHS BY CORY RICHARDS

The skull, a human skull, was perched atop a crumbly boulder in the remote northern reaches of the Nepalese district of Mustang. Pete Athans, the leader of an interdisciplinary team of mountaineers and archaeologists, stepped into his harness and tied himself to a rope. He scrambled up the 20-foot boulder, belayed by another climber, Ted Hesser.

When he reached the skull, he pulled on blue latex gloves to prevent his DNA from contaminating the find, and gradually removed it from the rubble. Athans was almost certainly the first person to hold this skull in 1,500 years. Dirt spilled from the eye cavities. He placed it in a padded red bag and lowered it to three scientists waiting below: Mark Aldenderfer of the University of California, Merced; Jacqueline Eng of Western Michigan University; and Mohan Singh Lama of Nepal's Department of Archaeology.

Aldenderfer was especially excited by the presence of two molars. Teeth can provide insights into a person's diet and health and general place of birth. Eng, a bio-archaeologist, swiftly determined that the skull likely belonged to a young adult male. She noted three healed fractures on the cranium and one on the right jaw. "Signs of violence," she mused. "Or maybe he was kicked by a horse?"

But more intriguing than the skull itself was where it fell from. The boulder Athans scaled sat directly below a soaring cliff, tan rock streaked with bands of pink and white. Toward the top

of the cliff were several small caves, painstakingly hand-dug from the brittle stone. Erosion had triggered the partial collapse of the cliff face, dislodging the skull. Now the same tantalizing question was on everyone's mind: If a skull tumbled out, what remained up there?

MUSTANG, A FORMER KINGDOM in north-central Nepal, is home to one of the world's great archaeological mysteries. In this dusty, wind-savaged place, hidden within the Himalaya and deeply cleaved by the Kali Gandaki River—in spots, the gorge dwarfs Arizona's Grand Canyon—there are an extraordinary number of human-built caves.

Some sit by themselves, a single open mouth on a vast corrugated face of weathered rock. Others are in groups, a grand chorus of holes, occasionally stacked eight or nine stories high, an entire vertical neighborhood. Some were dug into cliffsides, others tunneled from above. Many are thousands of years old. The total number of caves in Mustang, conservatively estimated, is 10,000.

No one knows who dug them. Or why. Or even how people climbed into them. (Ropes? Scaffolding? Carved steps? Nearly all evidence has been erased.) Seven hundred years ago, Mustang was a bustling place: a center of Buddhist scholarship and art, and possibly the easiest

In the August issue, Michael Finkel wrote about a medicinal Tibetan fungus. This is photographer Cory Richards's first story for the magazine.



Matt Segal blows dust off a manuscript fragment found in a cache of documents. Most pages date to the 15th century and cover topics both sacred and mundane, from Tibetan Buddhist doctrine to legal matters.



connection between the salt deposits of Tibet and the cities of the Indian subcontinent. Salt was then one of the world's most valuable commodities. In Mustang's heyday, says Charles Ramble, an anthropologist at the Sorbonne in Paris, caravans would move across the region's rugged trails, carting loads of salt.

Later, in the 17th century, nearby kingdoms began dominating Mustang, says Ramble. An economic decline set in. Cheaper salt became available from India. The great statues and brilliantly painted mandalas in Mustang's temples started crumbling. And soon the region was all but forgotten, lost beyond the great mountains.

Then, in the mid-1990s, archaeologists from the University of Cologne and Nepal began peeking into some of the more accessible caves.

They found several dozen bodies, all at least 2,000 years old, aligned on wooden beds and decorated with copper jewelry and glass beads, products not locally manufactured, reflecting Mustang's status as a trade thoroughfare.

Pete Athans first glimpsed the caves of Mustang while trekking in 1981. Many of the caves appear impossible to reach—you'd have to be a bird, it seems, to gain entry—and Athans, an exceptionally accomplished alpinist who has stood atop Everest seven times, was stirred by the challenge they presented. It wasn't until 2007, however, that he secured the necessary permits. Mustang immediately became, he says, "the greatest expedition of my life." This trip in the spring of 2011 was his eighth to the area.

During previous visits Athans and his team

In the private chapel of a home in the city of Lo Manthang, a Tibetan Buddhist lama performs a rite with cymbals, drum, and incense. Once part of greater Tibet, Mustang remains suffused with Tibetan culture.

had made some sensational finds. In one cave they discovered a 26-foot-long mural with 42 exquisitely rendered portraits of great yogis in Buddhist history. In another was a trove of 8,000 calligraphed manuscripts—a collection, most of it 600 years old, that included everything from philosophical musings to a treatise on mediating disputes.

What Athans and the scientists wanted most was a cave with items from before the era of written records to shed light on the deepest mysteries: Who first lived in the caves? Where did these people come from? What did they believe?

Most of the caves Athans had peeked into were empty, though they showed signs of domestic habitation: hearths, grain-storage bins, sleeping

spaces. “You can spend your life looking in all the wrong caves,” says Aldenderfer, whose long career as an archaeologist has included no shortage of frustrating quests.

The ideal cave, he felt, would be one used as a cemetery rather than a home, with pre-Buddhist-era ceramic remains scattered below, on a cliff too high for looters to reach, in a part of Mustang where locals are comfortable with foreigners disturbing their ancestors’ bones. All this, and one additional factor. “Sometimes,” Aldenderfer admits, “you just need to get lucky.”

THE MOST PROMISING SITE was a cave complex near a tiny village called Samdzong, just south of the Chinese border. Athans and Aldenderfer had



visited Samdzong in 2010 and found a system of funerary caves. On the first workday at the site in the spring of 2011, during a scouting hike at the base of the caves, the team's photographer, Cory Richards, noticed the skull.

The next morning, the climbers prepared to investigate the caves above the skull find. Mustang's cliffs are gorgeous beyond measure—the immense walls appear to be melting like so much candle wax under the intense high-elevation sun. The ridgelines have eroded into wild shapes: bony fingers supporting colossal rocky basketballs, towering tubes arrayed like an endless pipe organ. The color of the rock, shifting as the day passes, seems to encompass every shade of red and ocher and brown and gray.

But the climbing is horrible. "Pure thuggery," says Athans. "Industrial, inelegant—the Dumpster diving of climbing." The rock, fragile as peanut brittle, breaks off with every touch. It's extraordinarily dangerous. A few months earlier, Lincoln Else, a videographer, was struck in the head with a rock shortly after he'd removed his helmet. His skull was fractured. He underwent emergency brain surgery in Kathmandu and survived. In 2010, Richards, a climber as well as a photographer, tumbled and broke a bone in his lower back. Like Else, he had to be evacuated from Mustang by helicopter.

To access Samdzong's caves, Athans and Hesser, the team's chief climbers, hiked around the back side of the cliff and reached a flat area above the caves. Here, with special permission from authorities, they hammered several long pieces of rebar into the rock and tied on a rope. Athans was going to entrust his life to this anchor. There was a discussion of what to do if the rebar started to loosen. Hesser suggested that he shout an expletive at the top of his lungs.

"That will work," said Athans. He then calmly rappelled off the edge. A rain of dirt and rocks clattered off the dome of his helmet.

Below, on flat ground, sat Aldenderfer, his prodigious mane of silver hair corralled by a red bandanna—he hasn't had a legitimate haircut, he says, in 20 years. Aldenderfer held a small monitor that received a wireless feed from

Athans's video camera, allowing the anthropologist to direct the search from a safe position.

Nearby, sitting cross-legged in his maroon robe, was the local lama, 72-year-old Tsewang Tashi. He lit a small juniper twig fire and filled a chalice with holy water from an old plastic Pepsi bottle. Then he chanted softly while ringing a brass bell and dipping his fingers in the water—a Buddhist protection ceremony to remove troublesome spirits that could endanger the team's work.

Athans, dangling on the green rope, maneuvered nimbly into the smallest cave. He had to crouch to get in—it was only five feet high and roughly six feet wide and six feet deep. This cave, it was clear, was once a hidden shaft tomb, or mortuary cave, dug in the shape of a wine decanter. When it was excavated, only the very top of the shaft was visible. Bodies were lowered down the sewer-pipe-size shaft, and the hole was backfilled with rock. When the cliff face collapsed, the entire cave was exposed, creating a cross-sectional view.

A large boulder, once part of the ceiling, had landed on the cave's floor. If there was anything in the cave, it was beneath that rock. Athans tugged at it, levering it gradually toward the cave's mouth. Then he shouted, "Rock!" and the boulder thundered down the wall, kicking up a cloud of amber dust. Fifteen centuries or so after it was sealed, as carbon dating later proved, the cave was once again clear of debris.

ALDENDERFER DIVIDES CAVE USE in Mustang into three general periods. First, as long as 3,000 years ago, the caves were burial chambers. Then, around 1,000 years ago, they became primarily living quarters. Within a few centuries, the Kali Gandaki Valley—the neck in the hourglass connecting Asia's highlands and lowlands—may have been frequently battled over. "People were scared," Aldenderfer says. Families, placing safety over convenience, moved into the caves.

Finally, by the 1400s, most people had moved into traditional villages. The caves were still used—as meditation chambers, military look-outs, or storage units. *(Continued on page 130)*





Tsewang Tashi, a Tibetan Buddhist lama, leads his horse through the village of Samdzong, near the Chinese border. During a turbulent era 800 years ago, residents likely took refuge in caves, returning to the village generations later, after the region stabilized. "One good place to live, if you're worried about your neighbors, is in caves," says archaeologist Mark Aldenderfer.

Cliff Caves of the Dead

The adult in Tomb 5 in Samdzong, wearing a gold-and-silver funerary mask, was probably a local leader 1,300 to 1,800 years ago. Iron daggers, a copper pot, and sacrificed animals reflect his status, as does a painting depicting a man, horses, and trees on his well-preserved wooden coffin.

Bronze mirror

Painted coffin front

A copper vessel may have once held chang, a barley beer.

Iron daggers

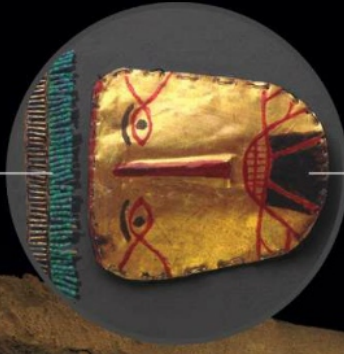
Iron tripod

Wood and bamboo cups

Tsampa, ground barley flour

Multicolored glass beads

Painted burial mask



Little is known about a child also found in the tomb.

Yak horns

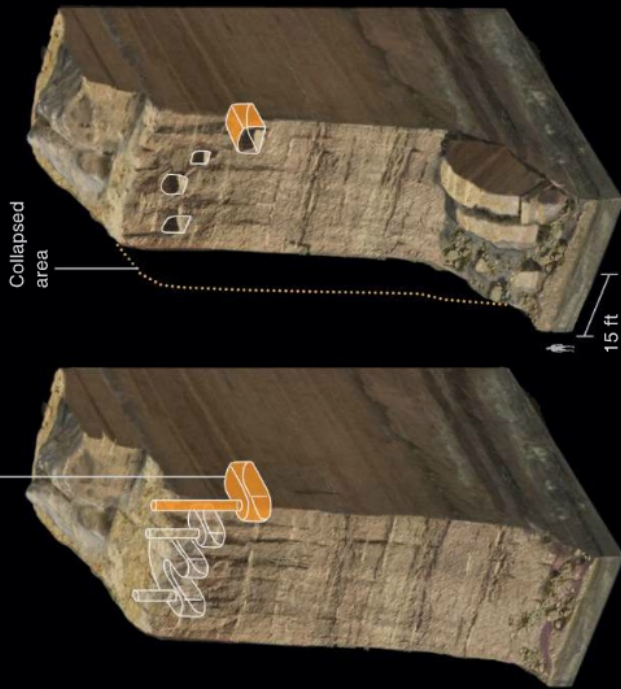
Horse and goat sacrifices

The mystery of defleshing

Human bones in this and nearby mortuary caves bear numerous cut marks—evidence, scientists say, that skin and muscle were removed before burial. It's possible this practice was a precursor to Tibetan Buddhism's "sky burial" tradition, in which bodies are left for vultures.



Tomb 5



The Samdzong tombs

Tunneled from the slope above, the tomb complex was situated away from the bustle of life in Mustang. To access some mortuary caves, narrow shafts led down to chambers. When the cliff face collapsed, it exposed the tombs, including Tomb 5 (reconstructed above).

ART AND MODEL: FERNANDO G. BAPTISTA, NGM STAFF; FANNA GEBREYESUS
PHOTO: MARK THIESSEN, NGM STAFF
NGM MAPS

SOURCES: MARK ALDENREER, UNIVERSITY OF CALIFORNIA; MERGED, JACQUELINE ENG, WESTERN MICHIGAN UNIVERSITY; PETER ATHANS



Mummies of Mustang

An infant and an adult female's foot were among the naturally mummified remains of 30 people discovered in a mortuary cliff cave at Mustang's Mebrak site in 1995 by German and Nepalese archaeologists. Dating back some 2,000 years, the bodies were bound with cloth strips and placed in wooden coffins with copper bangles, glass beads, and shell necklaces.







Some caves remained homes, and even today a few families live in them. “It’s warmer in winter,” says Yandu Bista, who was born in 1959 in a Mustang cave and resided in one until 2011. “But water is difficult to haul up.”

The first thing Athans found in the closet-size chamber—later designated Tomb 5—was wood, superb dark hardwood, cut into various planks and slats and pegs. Aldenderfer and Singh Lama eventually fitted the pieces together, creating a box about three feet tall: a coffin. It was ingeniously constructed so that the sections

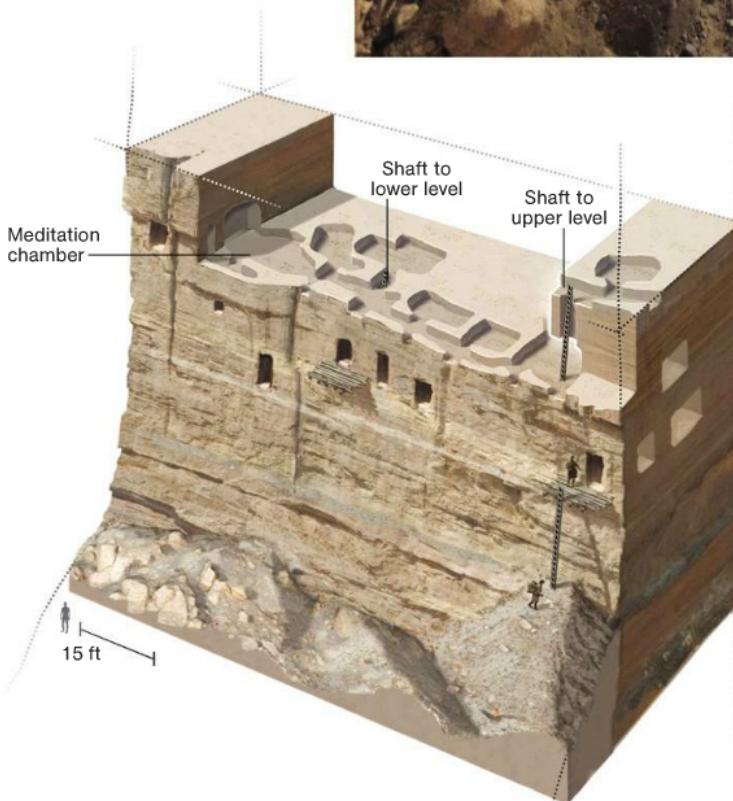
■ **Society Grants** Aldenderfer’s and Athans’s research was funded in part by your membership.

fit through the tomb’s narrow entrance and then could easily be assembled in the main chamber. “Like Ikea before Ikea,” says Eng.

Painted on the box, in orange and white pigments, was a rudimentary but unmistakable image: a person riding a horse. “Probably his favorite horse,” Aldenderfer guessed. Later, as if to confirm the man’s status as an equine aficionado, a horse skull was found in the cave.

On the 2010 trip to Samdzong, in the two biggest caves on the cliff wall, the team had located human remains from 27 individuals, including men, women, and one child. There were bedlike or rudimentary coffins in those caves as well, but they were made of much inferior wood and far

Walkie-talkie in one hand and human jawbone in the other, expedition leader Pete Athans picks his way through a looted mortuary cave while Matt Segal surveys a pit from which robbers tossed bones. Scientists hope that DNA from teeth will help pinpoint the origins of the bodies. At right, Ted Hesser enters a maze of rooms in a looted cave where people once lived.



Cities in Stone

With its storage rooms, meditation chambers, and ledges, the cave complex near the town of Tsarang served as a cliffside annex for the community. The many functions are typical of the apartment-style caves of Mustang. Shielded by a rocky facade, a series of chambers were intricately linked. Narrow shafts, up to 15 feet long, provided access between different levels.

FERNANDO G. BAPTISTA AND MATTHEW TWOMBLY, NGM STAFF
SOURCE: MARK ALDENDERFER, UNIVERSITY OF CALIFORNIA, MERCED

Dusk falls over the temples and homes of Tsarang, once the region's most important town. In Mustang, where the centuries have not disrupted the traditional rhythm of life, the caves offer clues to a time when the remote Himalayan kingdom was a hub linking Tibet to the rest of the world.





simpler construction, with no paintings.

Tomb 5, Aldenderfer theorized, was the burial plot of a high-ranking person, perhaps a local leader. The tomb, it turned out, held two bodies—an adult male and a child, maybe ten years old. The youth was a source of much speculation. “I don’t want to characterize the child as any kind of sacrifice or slave because I really don’t have a clue,” says Aldenderfer. “But a child in there does suggest a complex ritual.”

When Eng, the team’s bone sleuth, took a close look at the remains, she made a startling discovery: The bones of 76 percent of all the individuals she examined bore the unmistakable scars of knife slices. These marks, says Eng, were clearly made after death. “This wasn’t hacking and whacking,” she says. The bones were relatively whole and lacked signs of deliberate breakage and burning. “All the evidence,” Eng notes, “indicates there was no cannibalism here.”

The bones date from the third to the eighth centuries—before Buddhism came to Mustang—but the defleshing may be related to the Buddhist practice of sky burial. To this day, when a citizen of Mustang dies, the body may be sliced into small pieces, bones included. These are all swiftly snatched up by vultures.

In the age of the Samdzong cave burials, Aldenderfer posits, the body was stripped of flesh but the bones were still articulated—“like a Halloween skeleton,” he says. The skeleton was lowered into the tomb and folded to fit in the wooden box. “Then whoever was down there with him,” says Aldenderfer, “climbed back out.”

BEFORE DOING SO, the ancient burial crew had made sure the corpse was regally adorned for the great beyond. As Athans hunched inside Tomb 5, sifting through dust for hour upon hour, he discovered these adornments. “It was so mesmerizing,” he says, “that I forgot to eat or drink.”

A trove of beads, the garment they’d been sewn on long disintegrated, was scooped up by Athans and placed in plastic sample bags. Singh Lama painstakingly sorted them. There were more than a thousand beads, made of glass, some as minuscule as poppy seeds, in a

half dozen hues. As lab studies later showed, the beads were of various origins: some from what is now Pakistan, some from India, some from Iran.

Three iron daggers, with gracefully curved hilts and heavy blades, also emerged. Then a bamboo teacup with delicate circular handle. A copper bangle. A small bronze mirror. A copper cooking pot and a ladle and a three-legged iron pot stand. Bits of fabric. A pair of yak or cow horns. An enormous copper cauldron, roomy enough to boil a beach ball. “I’m betting that’s a chang pot,” said Aldenderfer, referring to the regional beer made of fermented barley.

Finally Athans sent down a funerary mask. It was made of gold and silver pounded together, with high relief facial features. The eyes were rimmed in red, the mouth was slightly turned down, the nose was linear; there was a hint of a beard. Pinholes outlined the edge. Likely the mask was sewn to fabric and draped over the face. The beads had been part of the mask.

Aldenderfer, normally restrained and scholarly, could not contain himself as he cradled the mask in his palms. “It’s stunning,” he marveled. “The workmanship that’s involved, the obvious wealth it represents, the colors, the delicateness—it’s the best thing ever found in Mustang. Period.”

Nearly all the items in the cave had been imported from elsewhere. Even the coffin’s wood had come from a tropical environment. How could a person from this place—today so bereft of resources that merely accumulating firewood requires hours of effort—gather such riches? Salt, most likely. Controlling a piece of the salt trade may have been the current equivalent of owning an oil pipeline.

The entire haul, from what seemed a nondescript cave, left Aldenderfer giddily struggling to place the find in historical context. “This is unique,” he said. “Spectacular. This is rewriting the region’s prehistory in a serious way.”

EVERYTHING THE TEAM FOUND was left behind, in the care of Samdzong’s village leaders. Athans, as he’s done elsewhere in Mustang, also donated personal funds to endow a modest museum. “The people of Mustang should have pride in

Jacqueline Eng, a bio-archaeologist, examines 1,500-year-old human and animal bones from mortuary caves as a Samdzong villager looks on. Shallow cuts on many human bones suggest ritual removal of flesh.



their own rich history,” he says. Only tiny sample chips and bits of bone were removed by the scientists. These will be studied in various labs—teeth go to the University of Oklahoma; metals to University College London. Paints will be separated into chemical constituents, to see which plants were used to make them. A splinter of wood, a thread of textile, a powder of tooth enamel; all will be rigorously analyzed. The process could take a decade.

That’s without any additional materials. Early Mustang, it’s thought, was ruled by powerful kings. With so many exposed caves and an unknown number of hidden crypts, far more remarkable troves may be awaiting discovery.

“It could be in the next cave we visit,” says Aldenderfer. “It could be in a hundred more caves.” Indeed, as the team finished their work in Samdzong, there was one more find. Walking across the cliff top after removing the rebar anchors, Hesser came across a distinct, unnaturally round depression in the gravel. Very likely, he had stumbled upon the entrance to another shaft tomb—this one still plugged, its contents sealed within.

The team’s travel permit was set to expire; they had a long journey ahead of them. There was little choice but to let this pass by. At least for now. As ever in Mustang, the cliffs hold secrets yet to be uncovered. □



ONCE UPON A HOME

*There were some charming
cottages in Finland.
The people moved away.
And the animals moved in.*

PHOTOGRAPHS BY KAI FAGERSTRÖM





It was the air of desolation that drew Kai Fagerström to the handful of derelict dwellings near his family's summer home in rural Suomensjärvi, Finland. As the amateur photographer peered through broken windows and cracks in doors, he noticed tiny tracks: Mice, badgers, and other feral trespassers had made themselves at home after the residents had died or relocated. "When I go into these houses, it's like stepping back in time—the past lingers in the corners," says the 48-year-old, who works by day managing properties for a parish in his hometown of Salo. "But there's consolation in the idea that nature is reclaiming the places it has lent to people." —Carolyn Butler



NGM MAPS

*Exploring a ramshackle cottage (above)—left vacant after a fire killed its elderly owner—sparked Fagerström's decadelong quest to document his wild new neighbors, including this red squirrel. The project culminated in *The House in the Woods*, a book published in Finnish, German, and English. Preceding pages: A fox pup peeks out from a cat door in a dilapidated shed.*







On a summer night a family of badgers file into the kitchen from a tunnel they dug under the fireplace. It took four years before Fagerström finally caught the skittish, nocturnal weasels. For this shot he set his camera on a windowsill, then stood outside on a ladder for hours before pressing the shutter via remote control.





Typically, Fagerström envisions an image, then plans the photo shoot. He'll set his camera at the perfect angle, throw out peanuts as bait, and wait for wildlife to wander into the picture frame. "Sometimes you get lucky, but often it takes all night," says the photographer, who has to adjust his settings for natural light since he doesn't even own a flash. He spent several evenings waiting to capture his dog staring down a bank vole as well as the squirrel poking around a door. Every so often a shot is pure happenstance. A pygmy owl flew in through a smashed window, surprising Fagerström: "He looked at me and sort of stamped his foot, as if to say, Go away, this is my place!"



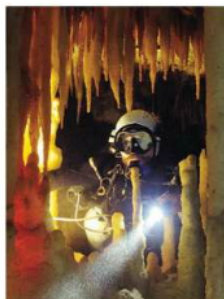
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Forecast: Disaster

Whipping wind, floods, avalanches, and earthquakes take center stage in this National Geographic Channel series. Find out what it takes to withstand weather at its worst as scientists simulate natural disasters and record their effects on specially constructed buildings (like this house in Toronto, left). Joplin, Missouri, residents contribute personal accounts of surviving a catastrophic tornado.

LECTURE



KENNY BROAD The environmental anthropologist (left) was named a National Geographic Explorer of the Year in 2011 for his daring explorations of submerged caves. Listen to his tales from the depths, and learn about his research on freshwater resources. For speaking dates in Canada and the U.S. go to nglive.org.

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EXHIBIT

DESERT AIR To photograph the desert from above, George Steinmetz piloted a motorized paraglider. See his work at the National Geographic Museum; visit ngmuseum.org for details.

Free Download of the Month



Grupo Fantasma

This Grammy Award-winning, ten-piece band is back with a new album recorded live in the members' hometown of Austin, Texas. Get a taste of their signature combination of salsa, *cumbia*, and mambo—which heats up against a backdrop of funk and jazz—by downloading a free song at natgeomusic.net/free.

Big Fish, Little Fish Trapped under ice, lost at sea, chased by sharks—Brian Skerry has had more than a few scares in 35 years of photographing underwater wildlife. This close encounter with a whale shark was quite the opposite. Snorkeling off Mexico's Yucatán Peninsula, amid some 400 of the world's biggest fish, Skerry spotted a massive maw coming at him with a remora darting around inside the giant filter feeder. "It's not something the shark would eat," notes Skerry of the suckerfish. Neither is he. Nonetheless, he quickly moved out of the way. —Luna Shyr



BEHIND THE LENS

Were you scared to be in the path of a 30-foot whale shark?

BS: Fear is a good thing when working with wild animals. Whale sharks aren't harmful to people. The worst thing is you might get bumped by one, but it's not like a bluefin tuna swimming like a torpedo at 60 miles an hour. This thing is moving very slow and steady, kind of just mowing the grass, so my only concern was that I would bump it and somehow bother it.

What's unusual about this picture?

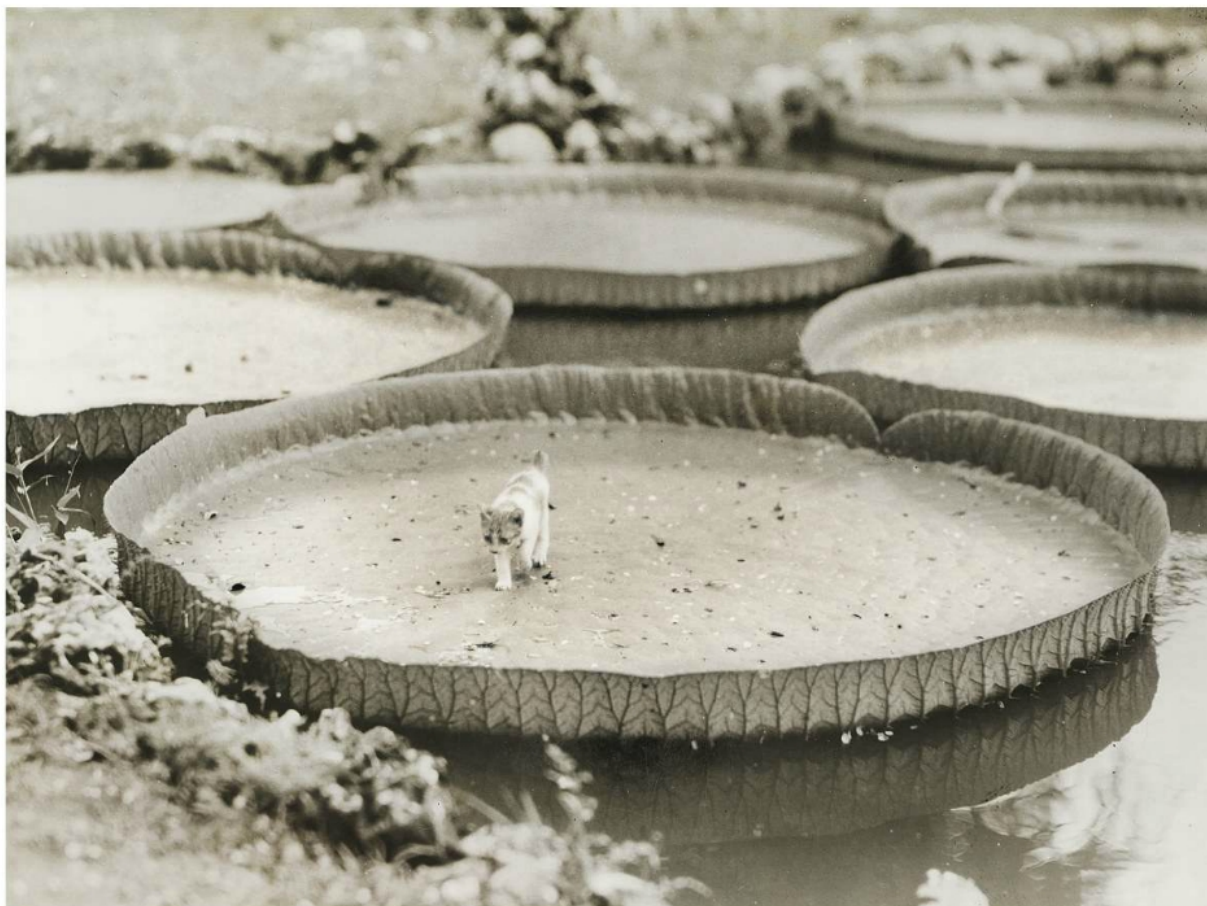
Sharks are near and dear to my heart, and this is a view that many people don't get to see. I saw behavior in this area I'd never seen before: several hundred whale sharks all feeding

right at the surface of the water. It blew me away. It's pretty rare to see more than one animal at a time.

Wouldn't it have been safer to use a telephoto lens?

Underwater photographers don't

always have the luxury of using them. We have to get very close to our subjects to capture color and details because the water refracts and scatters light. I never cease to be amazed how these animals allow us into their worlds.



Parade Float “This kitten, perhaps, is wondering how he is going to get ashore without wetting his feet,” opines the note accompanying a 1935 Alfred T. Palmer photo from the Philippines. “But he is perfectly safe so long as he stays aboard this floating giant of the vegetable world, the ‘Queen Victoria’ (*Victoria regia*) water lily.”

The tiny cat’s perfect safety wasn’t ever in question. Now more commonly called the giant water lily—reaching eight feet across and staying afloat by means of a substantial amount of air trapped in the spaces between its ribs—the plant is strongest at its center and can hold up to a hundred pounds. —*Johnna Rizzo*

👉 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: ALFRED T. PALMER, NATIONAL GEOGRAPHIC IMAGE COLLECTION

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THOUGH I KNOW
THEIR VENZA HAS
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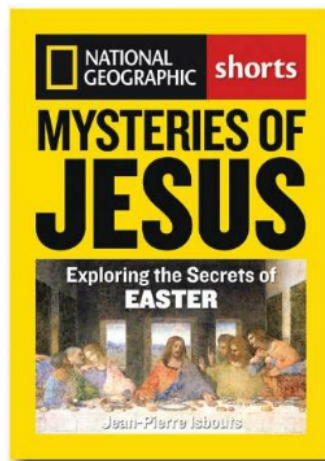
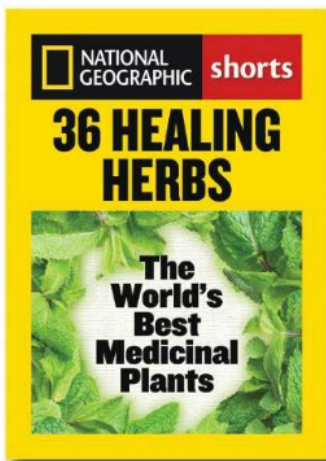
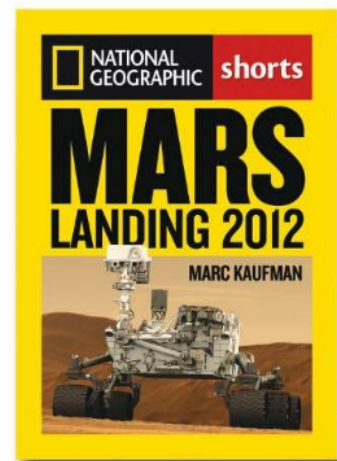
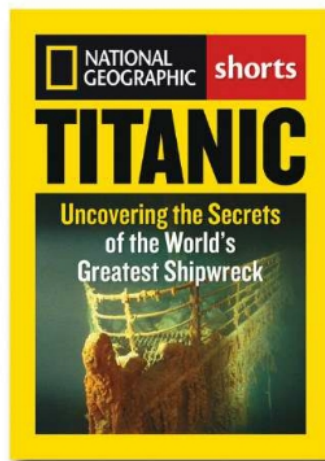
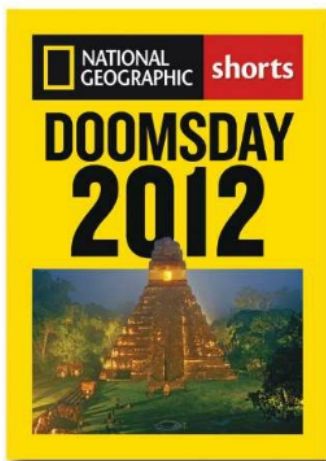
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