ACADEMY

FRONTIERS

The Hot Spot

Mongolia's ecosystems reveal invaluable information on biodiversity and climate change

The member magazine of the Academy of Natural Sciences of Drexel University

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Academy membership includes a subscription to *Academy Frontiers*, free admission to the museum, discounts in the Academy Shop and Academy Café, invitations to special events and exhibit openings, and much more.

For information about Academy membership, call 215-299-1022 or visit ansp.org/membership.

On the cover: *Academy entomologist Dr. Jon Gelhaus found this female crane fly near Mongolia's Lake Hövsgöl during a July 2012 expedition. The female has short wings and cannot fly, so she crawls across the steppe grasslands. The Mongolian word for crane fly is "temelskin," meaning "little camel," presumably because of the insect's long legs. More on pages 8–11. Photo by Jon Gelhaus/ANS*

Academy Greetings

Dear Friends,

The conclusion of our 200th year represents a new beginning for the Academy. In our third century, we will weave sustainability into our institutional fabric, working diligently to promote critical evaluation of some of the most crucial environmental issues of our time. We have enlisted the expertise of Resonate (page 14), a strategic sustainability management firm that is enabling us to construct a plan to further integrate sustainability into our public programs, budget, and internal operations. We are exploring innovative ways to help our visitors and other members of the Philadelphia community to reduce their environmental footprints. These initiatives are the perfect additions to our renowned programs in biodiversity and environmental research.

In this issue of *Academy Frontiers* you'll notice a few changes. We hope these adjustments will bring you even closer to our work. A theme of this issue is Mongolia, where our scientists have been working for nearly 20 years to track biodiversity and conduct research that will support environmental management. You'll also see plenty of information on sustainability, including small ways to incorporate this big topic into your everyday life.

As we move forward we want to thank you for your generous gifts to the Academy's 2013 Annual Fund. We encourage others who have not yet contributed to do so prior to the June 30 deadline. Your support enables us to conserve our priceless collections and provide education, outreach, public programming, and exhibits to our community. Your gifts also will help us continue to bolster these activities with relevant, critical research into today's most significant questions in biodiversity and environmental science.

Thank you for your commitment to the Academy as we take this important step into our future. I look forward to seeing you at the museum soon.

All the best,

George W. Gephart, Jr.
President and CEO

Founded in 1812, the Academy of Natural Sciences of Drexel University is a world-class natural history museum dedicated to advancing research, education, and public engagement in biodiversity and environmental science.

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Academy staff photographed this group of foals and their mothers on the road between Lake Hövsgöl and Ulaanbataar in Mongolia. Horses provide transportation for Mongolian nomadic herders. The mares' milk is fermented and serves as an important summer food.

*Above left: Red-banded Fritillary (*Melitaea didyma*); Stephen Mason/ANS*

Jon Gelhaus/ANS

Drawn to Dinosaurs: Hadrosaurus foulkii

Art of Science Gallery
Open through June 9, 2013

The Academy of Natural Sciences was the first in the world to create a mounted dinosaur skeleton for display, and to this day the Academy is known as "the dinosaur museum." *Drawn to Dinosaurs: Hadrosaurus foulkii* is an intimate exhibit that reveals the science and art of visualizing a living animal based on fragmentary fossils. The centerpiece is a full cast of the plant-eating duck-billed dinosaur *Hadrosaurus foulkii*, discovered in 1858 in Haddonfield, N.J., by an Academy member and later reconstructed by the artist Benjamin Waterhouse Hawkins based on Academy research.

Bruce Tepper/ANS

Exhibit IQ

Glow: Living Lights

Special Exhibits Gallery
June 1–September 29, 2013

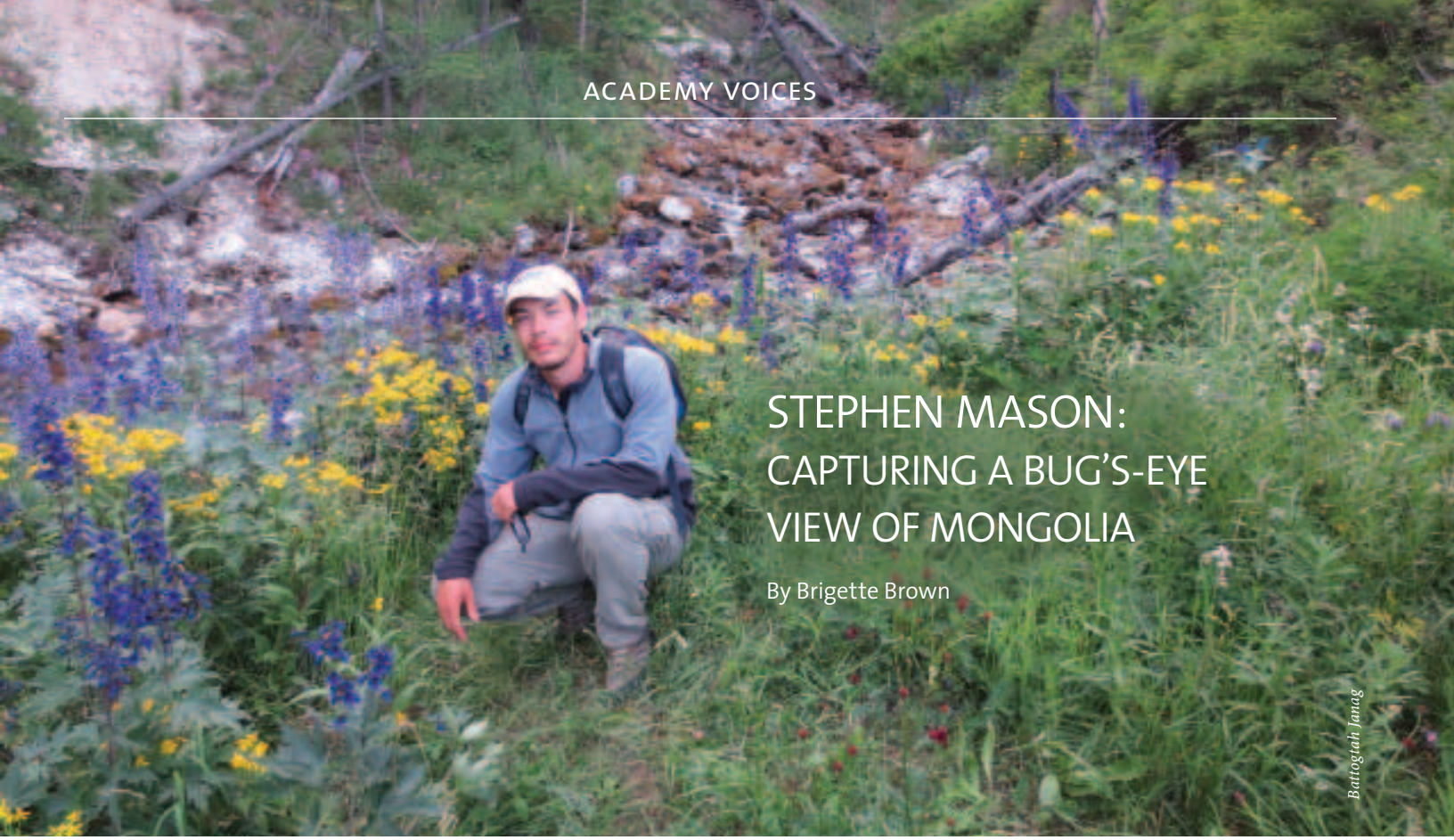
Glow: Living Lights takes visitors on a journey through land and sea in pursuit of creatures with the incredible ability to produce their own light. Fireflies, glow worms, and rarely seen alien-looking creatures from the middle ocean are just a few of the animals lighting up the dark through a mysterious process called bioluminescence. Dramatic video, live organisms, rare preserved specimens, models, and hands-on activities will enlighten and engage families. Visitors can also examine mysterious glowing scorpions. *Glow: Living Lights* is produced by Exhibit IQ.

Serpentine

Art of Science Gallery
June 15–September 15, 2013

Fine art photographer Mark Laita has traveled the world to photograph the beauty and danger of the world's most deadly snakes, from the Honduran milk snake to the black Pakistan cobra. This selection of a dozen colorful and alluring photographs from his latest book, *Serpentine*, depicts what he calls "the sensual attractiveness" of serpents, whose mystery and symbolism have fascinated humanity for thousands of years.

Mark Laita



STEPHEN MASON: CAPTURING A BUG'S-EYE VIEW OF MONGOLIA

By Brigette Brown

Battogtah Janag

Academy Entomologist Stephen Mason is dreaming of a perfect afternoon in a field catching butterflies—and it isn't even his lunch break yet. He knows it's geeky, but he loves working with insects, especially butterflies. And even when he isn't in the Academy's Entomology Collection organizing and labeling insect specimens, you can find him in nearby forests observing and collecting specimens.

"I was always interested in the natural world, ever since I was a kid," Mason explains. But he discovered his love for fluttering invertebrates during his environmental science classes in college.

While in the field birding, Mason noticed the detail and delicacy of local butterflies. They were easy and fun to observe and study, and he quickly became intrigued by their diversity. Over time, this simple curiosity would evolve into a career.

Mason met Dr. Jon Gelhaus, the Academy's curator of entomology, at a local environmental commission meeting. Bonding over their shared interests, the pair would go on to collect and study various insects from dozens of sites in the northeastern United States.

In 2009, Mason joined the entomology team at the Academy. Though his student research focused on the biogeography of butterflies found in the New Jersey Pine Barrens, he also started preparing and studying the Mongolian butterfly specimens that Gelhaus collected during numerous expeditions to the country. Mason's natural interest, field experience, and knowledge of the Mongolian butterfly fauna made him the obvious choice to accompany Gelhaus on a research trip to Mongolia in summer 2012.

"The sky was absolutely beautiful, pure blue, and just grass and mountains as far as you could see," Mason remembers. "It was an awesome place for research. The butterflies were everywhere; they came right up to me."

By uncovering information about the natural history and diversity of the butterflies, Mason hopes to help future scientists understand how overgrazing of plants near Mongolian streams affects butterfly populations inhabiting those areas. Many of the grazing animals had devastated the butterflies' nectar sources and diminished the food supply that the caterpillars need to mature, he notes.

When Mason wasn't catching butterflies, he assisted Gelhaus with lab work and insect identification for an ongoing project dedicated to the research and inventory of Mongolian aquatic insects and their habitats (more on page 8). Many insects that spend their larval stages in water utilize streamside plants and shrubs as resources for food, breeding, and protection as adults, Mason explains. The team theorizes that when cattle graze excessively in insect habitats, the insects move farther than normal from the streams onto land.

Back at the Academy, Mason manages a special inventory project of the Entomology Collection, which thanks to the recent expedition holds the largest and best-curated Mongolian butterfly collection in the Western Hemisphere. He ensures that the specimens are safe, secure, and organized.

He gives equal attention to the cases of stunning multicolored butterfly, moth, and other insect specimens that he uses for his Pine Barrens research.

It's not often you meet people who are thrilled to discuss bugs—at the Academy it's different. When asked about his future plans at the Academy, Mason smiles.

"I never understood what people meant by the saying, 'Do what you love,' until I came to the Academy. It's great working with people who love what they do."

Mark Sabaj Pérez releases an unharmed 1.34 meter taimen (Siberian salmon) trapped above a gill net in a tributary of the Selenge River. The taimen is the largest member of the salmon family, and it can grow to more than 2 meters long and 200 pounds. Large taimen were formerly distributed throughout Siberia and into Eastern Europe. Today, their last healthy populations are found in Mongolia.

Tamra Mendelson

Ichthyologist Dr. Mark Sabaj Pérez traveled to west-central Mongolia in 2011 and 2012 to participate in a study of the geological processes that caused the formation of the Hangay Plateau. Sabaj Pérez is assisting a team of geologists led by Dr. Karl Wegmann of North Carolina State University by analyzing the diversity, distributions, and genetics of fishes that inhabit the streams draining the plateau.

Sabaj Pérez and Dr. Tamra Mendelson, an ichthyologist from the University of Maryland, Baltimore County, are studying fishes native to the plateau, including grayling, a member of the salmon family. Some fishes, such as the Arctic grayling, live in the rivers draining the plateau to the north, while other species, such as the Mongolian grayling, live in the rivers that drain to the west. The scientists think that, before the uplift of the plateau, these rivers may have been connected in a common watershed. The uplift of the plateau divided the watershed and split the ancestral fish populations into separate drainages.

Living apart, the fish populations accumulated enough differences over time to be recognized as distinct species. By analyzing the genetic differences between these species alongside the rate of the accumulated changes, Sabaj Pérez and Mendelson hope to estimate the time at which the plateau first divided the fish populations.

The ichthyologists will compare their findings with those of the geologists, who will use the dates of ancient lava flows, the rates at which rivers have eroded the land, and other data to piece together the history of the landscape. Estimates from the genetic and geological analyses will provide vital data about Mongolia's geological clockwork.

Sabaj Pérez and his colleagues have discovered new species of fishes and provided hundreds of tissue samples to a global effort to DNA barcode life on Earth. Collecting efforts over the past seven years have enabled the Academy to build the most diverse collection of Mongolian fishes in the world.

In arid parts of Mongolia, domesticated Bactrian camels have been used as transportation since ancient times. Although their modern caravan relied on jeeps to carry personnel and gear, Mark Sabaj Pérez and Tamra Mendelson sampled a ride on the two-humped camels during their trip through the Gobi Desert.

Karl Wegmann

Ned Gilmore/ANS

A LEAP INTO SPRING

By Brigette Brown

Anyone can be a naturalist. In each issue of *Academy Frontiers*, our scientists share their knowledge to help you explore the natural world. In this issue, Academy herpetologist Ned Gilmore explains how to spot a common springtime friend, the American toad.

A native inhabitant of the Northeast and Midwest regions of North America, the American toad is a peaceful and versatile resident of forests, fields, and backyards. Ranging from about 2 to 4 inches in length, this small amphibian can be any shade of olive green, brown, or gray. This species has tiny black warts located along its back and on the top of its head. Contrary to popular myth, these warts are not transferable to humans.

Another noticeable characteristic of the American toad is its two large glands, which look like oval-shaped bumps, on each side of its head. These glands are used to secrete a liquid that tastes awful to predators and protects the toad from snakes, birds, and many small mammals. Look for a black throat—this is a distinguishing feature of the male. Also keep an ear open for the pleasant trilling sound of the male's mating call.

The American toad hibernates until late March, burrowed in a little hole under the ground all winter to conserve moisture. The best time to spot one, suggests Gilmore, is right after the first steady, warm rain in April. He explains that during the early spring season, the toad utilizes any nearby water source, stream, or temporary pond for breeding. The American toad is nocturnal, so it is most active during the night.

After the breeding period, the American toad becomes fairly terrestrial as it moves into the surrounding woodlands and fields. Here among the plants, the toad spends the rest of the warm season looking for shelter and food. The American toad's expansive diet consists of invertebrates, such as worms, beetles, snails, and mosquitoes. Some invertebrates in the toad's diet may be considered destructive to garden plants. Having toads in your garden is a cooperative and earth-friendly way to keep your plants healthy!

Gilmore recommends building a rock pile near a shady bush or protective plant to make your own garden toad-friendly. With a helping hand, collect and place medium to large rocks into a pile that creates a space for a toad to find shelter underneath. You can also use a ceramic terra-cotta pot. Place the empty pot on its side a few inches into the soil.

Make sure the toad shelter is sturdy, in the shade, and out of the way of any human activity. Then sit quietly near your garden to watch for the toad. If you don't see the American toad at home, be sure to look for this bumpy but beneficial amphibian at your local parks and trails this spring.

The Hot Spot

21st-century Mongolia is an epicenter for studies of climate change and biodiversity

By Mary Alice Hartsock, Editor

It was his first expedition to Mongolia, and Academy entomologist Dr. Jon Gelhaus was on the edge of his seat. Literally.

Shoulder to shoulder with 18 strangers in the back of a freezing cargo plane, he was worried there might not be enough oxygen to carry him 18,000 feet above the country's grasslands to the capital, Ulaanbaatar. There, he planned to board another plane that would take him to the southern end of Lake Hövsgöl, just a day's drive away from the Academy's study site at the northern tip of the lake.

Sighing with relief when he finally reached the ground on this day in June 1996, Gelhaus was hoping for a relaxing drive up the lake's eastern border. Yet in this area with no paved roads and minimal development, what he got was a bouncing, white-knuckle journey through a rutted, muddy landscape.

The view at the journey's end was worth the jitters. Known to Mongolians as the "blue pearl" because of its clear azure waters, Lake Hövsgöl has intrigued Academy scientists for nearly two decades. The 100-mile-long, 30-mile-wide marvel is one of the world's purest bodies of freshwater, and the complex biodiversity of the lake and its tributaries is helping scientists understand the impacts of climate change on this virtually untouched ecosystem.

Stephen Mason/ANS

A THREATENED CLIMATE

Opened to the world in 1990 following 70 years under the control of the former Soviet Union, Mongolia and its flora and fauna have long been a mystery to Western scientists. Gelhaus traveled there to study Lake Hövsgöl's insects as part of a study led by Academy Asia Center Director Dr. Clyde Goulden.

Eager to assist Mongolian and Russian scientists in their studies of the lake's biota and to learn about Mongolian culture, Goulden and Academy Senior Fellow Robert Peck made their first trip in 1994. At the time, almost no information on Mongolia's ecology was available in English. The pristine countryside, traversed by nomadic herders and their animals, offered insight into the land's natural history.

Goulden was among the first Western environmental scientists to arrive in Mongolia at this crucial time to study conservation. A democratic revolution was spurring rapid economic development in and around Ulaanbaatar, and the changes were radiating through the countryside.

Aware that developers and tourists could soon arrive at Lake Hövsgöl, Goulden and his colleagues began studying the lake and surrounding lands in 1995. Their data would help them understand the biodiversity and ecology of the lake and its streams and provide information to protect these areas, which contain species found nowhere else on Earth. Over the past 20 years, their research has uncovered evidence of adverse climatic shifts that are uprooting the herder families that have lived around the lake for thousands of years.

In the past 70 years, Mongolia's average annual temperature has risen almost 4 degrees Fahrenheit, Goulden explains. Weather patterns have changed drastically as a result of Arctic amplification, a phenomenon in which global warming spurs temperatures in and around the Arctic to rise at a faster rate than they do in the rest of the world. In nearby Siberia, an almost constant snow cover has reflected sunlight back into the atmosphere. Today, soil newly exposed by melting snow is absorbing sunlight and releasing it into the air as heat. Mongolia, located just south of Siberia, is feeling the effects.

To document these changes, Goulden is partnering with his wife and translator, Munhtuya Goulden, who was born and raised in Mongolia and has spent countless hours encouraging her government connections to approve the Academy's long-term ecological research program. He also has partnered with Peck, who several times has photographed Mongolians' evolving lifestyles. In recent years, Clyde and Tuya Goulden have been interviewing herders about their impressions of the weather changes.

"When I first went to Mongolia, I wanted to protect the environment," Clyde Goulden says. "I very quickly learned that the only way to do this is to go through the people."

Of the 130 families the Gouldens interviewed, 98 percent reported that formerly silky, calm rains have become short yet intense downpours that quickly run off, fail to moisten the ground, and upset the herders' migrations. Having experienced calmer weather in her youth, Tuya Goulden appreciates the herders' distress.

"In summer, there are now just a few days of extremely hot weather, burning the grasses to yellow and white, followed by nights with freezing temperatures," she explains. "Combined with heat waves, cool temperatures not supporting grass growth, and autumn arriving too soon, the herders can't get enough winter fodder. Their animals freeze and starve to death."

These firsthand accounts of weather patterns provide long-term, day-to-day data that scientists cannot gather during four- to six-week expeditions. Analyzing these narratives alongside other scientific studies has raised new questions about the profound impacts of climate change on Mongolia's land, waterways, and wildlife. To answer these queries, scientists must first understand the diversity of organisms in the country's ecosystems.

FILLING THE GAPS

After 12 trips to Mongolia, Academy Curator of Entomology and Drexel professor Jon Gelhaus has finally grown used to the jolting drive across the countryside. But he'll always remember

Mongolians herd cattle in a valley near Lake Hövsgöl. The short grass and bare earth reveal the effects of overgrazing and climate change, both of which are becoming widespread in Mongolia.

Jon Gelhaud/ANS

Jon Gelhaus photographed this crane fly, Nephrotoma stackelbergi, *along the eastern shore of Lake Hövsgöl.*

Lake Hövsgöl unfolding before his eyes during that initial expedition.

Upon his harried arrival in 1996, the crane fly expert began to uncover the lake's poorly known insect fauna, which included many species found only in Mongolia. Determined to document the aquatic insects throughout the country, he joined with entomological colleagues in 2002 to establish the Mongolian Aquatic Insect Survey (MAIS). Almost every July since, Gelhaus has led 15 to 20 scientists and students from the United States, Mongolia, and Europe on expeditions across the steppe to collect insects and assess their habitats.

Aquatic insects comprise the majority of any stream's biodiversity, Gelhaus explains. Their larvae play an important role as food for fish and other water-dwelling organisms, and the adults fly throughout the stream areas, becoming prey for birds and terrestrial insects. Examining the aquatic insect diversity at any given site helps scientists to measure water quality. They can reveal the impacts of climate change, development, or animal grazing by evaluating the balance between insect species tolerant of and sensitive to these changes.

MAIS scientists have dislodged rocks and searched stream bank crevices to sample larvae, used aerial nets to sweep adults congregating in stream-edge vegetation, and set netting traps to catch insects flying up and down the stream corridor. The researchers also have documented whether habitats surrounding streams are settled, grazed, mined, or eroded, all of which could affect insect survival. They have measured water quality, analyzed characteristics of stream bottoms, and recorded flow, depth, and width of streams.

After a decade of sampling, the scientists have collected hundreds of thousands of specimens from more than 400 sites across Mongolia. The team has developed guides that help identify the nearly 1,500 species of aquatic insects; a third of these species are known in the country for the first time because of the fieldwork. Some species they discovered are new to science, including crane flies the scientists named in honor of Clyde and Tuya Goulden.

"Our goal has been to understand the aquatic insect diversity of Mongolia—so Mongolians could use that data to make assessments of water quality in the future and protect their biodiversity," Gelhaus says.

In 2012, Academy Curatorial Assistant and butterfly expert Stephen C. Mason Jr. (more on page 7) joined Gelhaus in Mongolia. They were researching how aquatic insects and butterflies functioned in three stream valleys with varying amounts of grazing. With Mongolian researchers, Gelhaus and Mason formed a team that spent 20 hours at each site gathering samples of insects and measuring the surrounding plant life. These samples will link the effects of livestock grazing to the aquatic insect larvae, their adult stages, and the butterflies living in the flower-dotted meadows along the streams.

Andrea Kreit/ANS

The colors of this Hövsgöl grayling, caught in Lake Hövsgöl, often are displayed before breeding.

CONSERVATION

It is up to a growing group of young Mongolian students to apply biodiversity and climate data to conserve Mongolia's resources, and the Academy has joined with these researchers in this undertaking. Since the 1990s, Gelhaus and Clyde Goulden have been collaborating with Mongolian scientists, sharing skills needed to study the country's ecosystems and organisms. Several former students serve in the Mongolian Ministry of Nature and the Environment, and one of Goulden's first students heads the 200-student ecology program at the National University of Mongolia.

"In 2002 we started with 20 young Mongolian students, trained them over a five-year period, and then most applied to grad schools internationally," Goulden says. "All are starting to return to Mongolia to be in the universities to do research, or to work in government ministries."

"We've taken science that is accepted in the U.S. to Mongolia," Gelhaus continues, nodding to the studies of Academy scientist Dr. Ruth Patrick, who in the 1940s pioneered techniques to measure the quality of waterways by assessing the diversity of the organisms within them. "We have been training Mongolian students to identify their fauna and use insects to understand water quality."

This community is essential to maintaining Mongolia's environment. Since the 1990s, Mongolians and international companies have been tearing into stretches of the land in search of gold, copper, coal, and rare minerals. Though the country now boasts one of the fastest growing economies in the world, waters are becoming polluted, and parts of the pristine landscape are marred with dusty mining pits. Gold miners often dig up whole stream beds; mining for other resources may require water to be diverted far from its sources. Coupled with climate fluctuations, these changes are endangering Mongolia's biodiversity.

Mongolian scientists and policymakers will use their knowledge to assess future environmental challenges, Goulden says. Collaborations of Academy and Mongolian researchers may even provide relevant information for scientists working on the other side of the world.

BACK AT HOME

Separated by more than 6,000 miles, the U.S. and Mongolia host distinct economies and dissimilar climates. Yet to some extent, U.S. residents already are noticing the escalating impacts of climate change. Droughts, wildfires, floods, and storms have increased, bringing devastating consequences. Paired with pollution, these fluctuations could transform our ecosystems.

"The changes in Mongolia are much more dramatic than they are in the United States, but by understanding what's going on in Mongolia, we have a better understanding of what could occur here in the future," Goulden says.

"There are interesting comparisons that can be made in what's going on in Mongolia with what's happening in Wyoming, Nebraska, and South Dakota, where you have large tracts of land used to graze animals, and also mining," Gelhaus adds.

We may be far from facing climate hardships as serious as Mongolia's. Still, it is never too early to begin developing innovative plans to protect our environment. Understanding Mongolia's ecological challenges will help us get there.

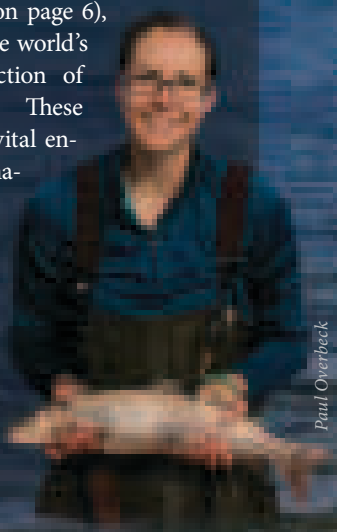
WATER, WATER, EVERYWHERE

Academy scientists help to track climate change in Mongolia by analyzing the health of streams flowing into Lake Hövsgöl. In summer 2012, staff scientist Michelle Brannon and Drexel student Anna Gourlay (supervised by Systems Ecologist and Drexel professor Dr. Jerry Mead) visited streams that Asia Center Director Clyde Goulden had sampled over the last two decades. They asked if the relationship between stream temperature and streamside soil temperature was linked to increasing rain intensity.

Excessive grazing in the watershed had caused the thawing of the soil's permafrost, a frozen layer beneath the surface of the ground. In summer, normal thawing releases cold water into the stream, keeping the water temperature low. Mead's group found that, in the absence of permafrost, the rainwater-soaked soil seeped into and warmed nearby stream water. These findings indicate that water temperatures in streams near overgrazed areas could rise with increasingly intense rains.

Wondering how these changes affect aquatic wildlife, fisheries scientists Paul Overbeck and Andrea Kreit (under the direction of Academy Senior Biologist and Drexel professor Dr. Richard Horwitz) set out to study Arctic grayling, a trout that requires cold water to spawn. Donning rubber waders, Overbeck, Kreit, and Gourlay plunged into 43-degree water to net fishes. They were particularly interested in the fishes' earbones, called otoliths, which contain rings that reveal information on fishes' birth dates, growth rates, and ages. The team is comparing the data with daily water temperature data to determine how water conditions affect fish breeding and growth rates.

Thanks to Overbeck's team and ichthyologist Dr. Mark Sabaj Pérez, who has traveled to Mongolia three times to study fishes (more on page 6), the Academy has the world's most diverse collection of Mongolian fishes. These specimens contain vital environmental information and will be preserved in museum collections.



Andrea Kreit holds a Lenok trout captured in Lake Hövsgöl.

Paul Overbeck

Background: Lake Hövsgöl. Image by Stephen Mason/ANS

What have you always wondered about the Academy's history?

Please send your questions to ans_editor@drexel.edu, and we in the Academy Library and Archives will comb through our collections and respond to an intriguing question in the next issue.

M.A. Hartsock/ANS Archives 2010-004, Box 3, File 18.

Q: HOW DID THE ACADEMY MAKE SURE THAT ITS DIORAMAS WERE REPLICAS OF REAL PLACES?

A. In the 1930s, Academy expeditions were outfitted not only with scientists and sharpshooters, but also with fleets of artisans who documented study sites as fully as possible. An example of their work can be seen in a lovely collection of field sketches, watercolors, black-and-white photographs, and even an earthen sample, preserved in the Archives as part of the documented legacy of the Legendre Southwestern Africa Expedition of 1937. Named for its leaders, Sidney and Gertrude Legendre, this expedition traveled through the countries then known as South West Africa, Bechuanaland, and the Transvaal, with a major detour up the Okavango River.

Why? This was the heyday of the diorama, which natural history museums constructed to enable visitors to see real mammals, birds, insects, and botanicals from around the world. Complete with unparalleled background paintings and carefully crafted foreground props, lifelike dioramas made faraway creatures accessible before critter cams and IMAX-style filming revolutionized wildlife photography.

To obtain those real animals and plants, as well as associated data, museums equipped and sometimes funded full-scale expeditions such as Legendre's, which sought to collect large mammals to expand the Academy's African dioramas. The field sketches, watercolors, and other visuals brought back from the expedition and now preserved in the Academy's Archives helped Legendre's artisans to capture the living colors of botanicals from this area of the world.

The Academy Archives has an excellent collection of original field materials like those shown here. Even today, we acquire these resources, which include the diary-like field notes that our scientists write each year to document who collected what, where, when, and how. Next time you gaze at a diorama, consider the enormous efforts behind each expedition and the fact that the Academy still curates the animals and plants collected on those long-ago journeys. *~Clare Flemming, M.S., C.A., Director (Interim), Academy Library and Archives, and Brooke Dolan Archivist*

THE LOGIC OF BYPRODUCT SYNERGY

By Roland Wall, Senior Director, Environmental Initiatives

IT HAS BEEN SAID THAT NATURE DOESN'T WASTE ANYTHING. This simple idea—sometimes shortened to "waste equals food"—sums up the complicated processes of the world's ecosystems. Driven by the sun's energy, every material in the ecosystem is recycled, converted, and reused by natural processes.

For the human economy, the process is far less efficient. Resources are being depleted, there's an ever-growing demand for energy, and communities are choking on a seemingly endless variety of waste products.

For business and industry, nature may offer a cost-effective, sustainable model for dealing with byproducts, or waste produced during manufacturing. Through a process known as byproduct synergy, business communities are developing systems for using the waste products of one industry as the raw materials for another.

Power companies, for example, often must dispose of large amounts of fly ash, a residue from the burning of fossil fuels that also improves the performance of cement. Instead of paying for disposal, power companies can trade this material with concrete companies, lowering costs for both companies and preventing improper waste disposal.

To significantly decrease the environmental footprint of a region and produce major savings in energy and materials, there must be a network of companies with a variety of byproducts to trade and utilize. The U.S. Business Council for Sustainable Development supports various U.S. cities' byproduct synergy programs with software tools that facilitate byproduct exchanges.

As the Academy moves into our third century, we are exploring a number of sustainability initiatives that will help us to reduce Philadelphia's environmental footprint. From providing sustainability education for corporations to implementing innovative plans to move our community forward, we will continue to build novel partnerships that promote environmental stewardship.

GREENING YOUR CLEANING

SUSTAINABILITY MIGHT SOUND COMPLICATED, but you can take small steps to conserve natural resources and minimize your family's environmental footprint.

Some household cleaning products contain ingredients that both threaten our health and pollute our air and water. Common cleaners for bathrooms, kitchens, windows, and floors may evaporate into our indoor air or transfer onto our bodies, causing possible irritation to our lungs, eyes, and skin.

We often wash cleaning products into drains as we scrub our bathrooms and kitchens. These chemicals eventually flow back into our waterways, where ingredients that remain after the treatment process can impact many aspects of an ecosystem, including aquatic wildlife, and cause unsafe blooms of algae.

Buying "green" household products can help, but do your research and read ingredient labels to be sure products are really "natural," "organic," or "sustainable." These words have many different meanings, and some claims are not federally regulated. The Environmental Working Group (ewg.org/guides/cleaners) and GoodGuide (goodguide.com) provide additional information and product ratings for effective cleaners.

An even better solution is to make your own cleaning products. You'll have peace of mind knowing the ingredients are safe for your family and our planet.

INGREDIENTS FOR HOUSEHOLD CLEANING

Alone or in combination, these ingredients can do wonders for your home. Be sure to read product packaging for household safety information.

BAKING SODA*: removes odors and cleans a variety of surfaces

LEMON JUICE: kills odors, lightens stains, cuts grease

WHITE VINEGAR*: removes soap buildup and odors, loosens stains, cuts grease

ISOPROPYL ALCOHOL: aids in disinfection

SALT: helps remove grease, stains, and odors

ESSENTIAL OILS, SUCH AS TEA TREE AND EUCALYPTUS: some oils can be used to control odors and germs

* Avoid combining baking soda and vinegar in a closed container. Do not use vinegar on linoleum, marble, or waxed surfaces.

ALL-PURPOSE CLEANER

8 cups water

½ cup white vinegar

¼ cup baking soda

Combine white vinegar and water. Then add baking soda to vinegar/water solution.

RESONATE: A LEADER IN SUSTAINABILITY AND SERVICE

Nancy Cleveland and Jen Anderson say they are starting to see the Academy as their Center City office—in a good way. The co-founders of Resonate, a strategic sustainability management firm, empower companies to endure into the future by helping them to understand and manage the ways in which their activities impact people and the planet. Cleveland and Anderson have been partnering with the Academy to develop its sustainability plan for more than a year. In selecting Resonate, the Academy's goal was to integrate sustainability into its strategic operations and to fill gaps in public education and engagement on this critical issue.

Merging Resonate's expertise in sustainability planning with the Academy's long-standing commitment to environmental stewardship has been more rewarding than either team imagined.

"The Academy is a wonderful client because so many things that have come up are already being done," Cleveland says. "The Academy can contribute enormous value to the process of understanding what's happening on the planet with reference back to the long historical record that constitutes its collections. A lot of the Academy's work in water quality and water safety is critically core to understanding what's going on in our climate and working toward a sustainable future."

Jen Anderson (left) and Nancy Cleveland

M.A. Hartsock/ANS

THE PROCESS

Cleveland and Anderson's business management know-how has enabled them to guide the Academy toward a more sustainable future as part of a long-term process. They have deeply considered the institution's economic and operational constraints and have contributed significant time and resources to the project. Using their extensive catalog of sustainability projects, the Resonate team has helped the Academy pare down a long list of opportunities to a manageable field of projects that support the institution's mission, goals, and strategic plan.

Cleveland and Anderson conducted a full assessment of the Academy's physical plant, surveyed stakeholders, gathered feedback from employees, and reviewed internal policies and practices. Then they formed a staff sustainability committee, determined project selection criteria with management, prioritized the work, and designed detailed plans for project implementation.

"We want to help the Academy become a national and possibly an international model for how to engage the public in the subject matter of sustainability and make it very personal and actionable for them," Anderson says. "We would also like to see the Academy's own operations become an example and an educational opportunity for its visitors."

The upcoming year will serve as a foundational year for sustainability planning, as Anderson and Cleveland help the Academy form a staff sustainability support team, educate staff about best practices, implement a waste audit, and improve internal communication.

"At its heart, sustainability is about behavioral change," Cleveland says. "The culture you want to become is defined by your sustainability plan, and the engine that runs that is people. Engaging people in your sustainability plan implementation is critical to whether you'll succeed in becoming a sustainable enterprise."

THE DEDICATION

Resonate's belief in the high value of sustainability education and public discourse around the topic has encouraged the firm to extend its contributions into the Academy's external programming. Several of the institution's upcoming environmental programs will proudly list Resonate as a sponsor.

Anderson and Cleveland also are strong supporters of the Academy's Profitable Pathways for Sustainability programs, which help businesses bring sustainability practices into their everyday operations. In 2008, Anderson co-founded the program with Roland Wall, Academy senior director of environmental initiatives, and H.G. Chisell of Viridity Energy. Their shared vision to make the Academy a convener for discussions of sustainability is at the core of Resonate's work on the Academy's sustainability plan.

"The opportunities that have already arisen out of the synergy between the Academy's mission and sustainability management are remarkable and unique," Anderson says. "It is just a perfect match that will deliver long into the future." *~Mary Alice Hartsock*

CHARTING A SECURE FUTURE FOR YOUR LOVED ONES

Giving is one of life's greatest satisfactions, especially when you know that your gift helps improve the lives of others. Life income gift plans, such as a charitable gift annuity, can make an important difference to your loved ones and to the legacy of the Academy of Natural Sciences of Drexel University.

In exchange for your donation, the Academy promises to pay a fixed annual payment to you or a designated person for life. When the gift annuity ends, the Academy uses the remaining balance of your contribution to support our mission to advance research, education, and public engagement in biodiversity and environmental science.

At the time you establish your annuity, you may choose a loved one to receive the annuity payments. Many donors give the right of the fixed annual payments to someone else who needs a secure income, such as an elderly parent, a college student, or a grandchild. The rate of payment varies with each annuity gift contribution. This rate depends on the ages of the designated beneficiaries, the number of annuitants, the timing of your gift, and the date the payments begin. In addition to many lifelong benefits, the annuity payments provide some tax savings.

If you are considering a charitable gift annuity or other contribution to the Academy, we can provide information to guide your decision. To learn more about how a charitable gift annuity can help you support the lives of others and the legacy of the Academy, contact Vice President of Institutional Advancement Amy Marvin at 215-299-1013 or plannedgiving@ansp.org. Thank you for your support of the Academy!

ACADEMY WELCOMES NEW TRUSTEES

JOHN F. BALES III is a retired senior partner from Morgan, Lewis & Bockius. He was a dedicated member of the Academy's Board of Trustees from 1994 until 2009, when he was elected Trustee Emeritus. He served as Board vice chair from 2003 until 2008 as well as chair of the Joint Science Committee. He is the current chair of the Academy's Education Committee. Bales is a trustee of the McLean Contributionship, one of the Academy's most dedicated funders. He is a former Board member of Presbyterian Medical Center of Philadelphia, vice chair of the Presbyterian Foundation for Philadelphia, and vice chair of Presbyterian Medical Center, as well as a Board member of the Immigration and Refugee Services of America and the U.S. Committee for Refugees.

CATHERINE T. "KATIE" HUNT, PH.D., retired as the director of Innovation Sourcing and Sustainable Technologies for The Dow Chemical Company in 2013. Previously, she was the corporate sustainability director and leader for Technology Partnerships for the Rohm and Haas Company. Hunt has also been a member of the MIT Visiting Committee for the Department of Chemical Engineering and the advisory boards of the Rochester Institute of Technology National Technical Institute for the Deaf, the Wharton School, University of Pennsylvania Initiative for Global Environmental Leadership, the Mayor of Philadelphia's Sustainability Advisory Board, and the National Academies' Roundtable on Science and Technology for Sustainability.

On behalf of the Academy's Board of Trustees, we wish to recognize and thank those who have contributed to the Academy between **December 1, 2012, and February 28, 2013**. Your generosity helps to fund the Academy's many programs of research and education, and we are tremendously grateful for your support.

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DRAWING HADDY

On the opening weekend of *Drawn to Dinosaurs: Hadrosaurus foulkii*, Fossil Prep Lab Manager and paleo-illustrator Jason Poole climbed a ladder to draw the famous duck-billed dino at life-size on a giant chalkboard. If you missed it, be sure to check out the lifelike chalk drawing and accompanying time-lapse video on display through June 9. We've crammed six full hours of illustration into just three minutes! So was Haddy really apple green? Check out the exhibit and find out.

NEW DINO IN THE LAB

A new set of dinosaur fossils from a 25-foot-long hadrosaur that lived 67 to 70 million years ago has arrived in the Fossil Prep Lab. Academy technicians have begun to slowly, carefully work the fossils out of rock and plaster field jackets. When they are finished, they will discover the specific species of dinosaur. As the process unfolds, visitors can watch, take photographs, and ask questions. More at ansp.org.

Mark Laita

BIRD FEST

Join us on Saturday, May 11, for our second annual Bird Fest. Meet our squawking and talking live birds, watch free flight bird shows, see rare specimens, learn about the anatomy of our feathered friends, and find out why some birds fly and some don't. Get your face painted, make a craft for mom, and much more. At Bird Fest it's okay to act like a bird—you might even want to tweet about it! More at ansp.org.

PHILADELPHIA SCIENCE FESTIVAL

On Saturday, April 20, staff from the Academy of Natural Sciences of Drexel University will engage you with dinosaur fossils and interactive activities during the Philadelphia Science Festival Science Carnival on the Benjamin Franklin Parkway. We're joining 100 other exhibitors for this free carnival, which includes family friendly experiments, games, and a packed lineup of live entertainment. More at ansp.org.

Gary Horn

STUDENTS AND SCIENCE

Last fall 1,200 middle school students came to the Academy for two exciting STEM (science, technology, engineering, and math) career days, made possible by a generous grant from Philadelphia-based chemical manufacturer FMC Corporation with additional support from Pfizer, Inc. About 15 FMC scientists demonstrated scientific activities up close and hands-on, all to inspire students to pursue careers in the field. The Academy provided interactive activities and teacher resources for bringing math and science into the classroom.

JUST FOR KIDS

WELCOME to the *Academy Frontiers* page for kids, one of the many great ways you can participate in the Academy's Kids Club!

NATURE SCRAMBLE

Have you ever wondered how you can help the earth? Unscramble the words below to find out six ways you and your family can protect the environment at home.

1. Plant a _ _ _ _ (t e r e) or start a garden.
2. Recycle cans, _ _ _ _ _ _ _ _ (t t l b e s o), paper, and other materials.
3. Turn off the _ _ _ _ _ _ _ (g h t l i s) when you leave a room to help conserve energy.
4. Donate _ _ _ _ _ _ _ _ (l c o h t s e) you've outgrown to kids in need.
5. Start a _ _ _ _ _ _ _ _ (t s o c m p o) pile.
6. Buy local! Visit a farmers _ _ _ _ _ _ (k r t m a e) in your area for fresh fruits and vegetables.

Answers: 1. Tree 2. Bottles 3. Lights 4. Clothes 5. Compost 6. Market

DID YOU KNOW...?

"Are there any mammals that can fly?"
-Ephraim "Junior" S., 11

The only mammal that can fly is a bat! There are more than 1,000 species of bats, and they are all nocturnal—which means they only fly during the night. Some other mammals, such as lemurs and squirrels, can only glide in the air.

Do you have a question about the natural world?

Email **kidspage@ansp.org**, and if your question is chosen for Just for Kids, you'll win a prize!

CONNECT THE DOTS

The Daurian hedgehog is a solitary mammal that can be found in parts of Russia, China, and northern Mongolia. When threatened, the hedgehog curls into a ball so the predator can only bite its sharp spines. Connect the dots to reveal this prickly creature!

Christine Danowsky/ANS

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CALENDAR OF EVENTS

APRIL

Library of Life Exhibition at Philadelphia City Hall
Open through May 24, 9 a.m.–5 p.m. Ⓜ

Bicentennial Town Square: Green Design in Mind With Dr. David Orr
Thursday, April 18, 6:30 p.m. Ⓜ 📞

Gaming as Therapy
Friday, April 19, 6–9 p.m. $ 📞

Science on Tap: Science Quizzo
Monday, April 22, 6 p.m.
National Mechanics,
22 S. 3rd Street Philadelphia Ⓜ

Robert Peck/ANS

Philadelphia Science Carnival
Saturday, April 20, 11 a.m.–4 p.m. Ⓜ

Cheryl Beth Silverman Memorial Lecture
Tuesday, April 23, 6:30–8:30 p.m. Ⓜ

Adult Field Study: Butterflies, Bugs, and Botany
Saturday, April 27, 10 a.m.–2 p.m. $ 📞

Polyommatus sp.

Stephen Mason/ANS

MAY

Adult Field Study: Cretaceous Fossils
Saturday, May 4, 10 a.m.–3 p.m. $ 📞

Friends and Family Safari Overnight
Saturday, May 4, 6:30 p.m. $ 📞

Bird Fest
Saturday, May 11, 10 a.m.–5 p.m. Ⓜ

Urban Sustainability Forum: Unconventional Dwellings
Tuesday, May 23, 6:30 p.m. Ⓜ 📞

Bicentennial Town Square: Beyond Green With Rob Fleming
Tuesday, May 30, 6:30 p.m. Ⓜ 📞

JUNE

Adult Field Study: Blooms and Branches
Saturday, June 8, 11 a.m.–2 p.m. $ 📞

Urban Sustainability Forum: Annual "State of the City"
Thursday, June 20, 6:30 p.m. Ⓜ 📞

Mega-Bad Movie Night
Thursday, June 27, 6:30 p.m. $ 📞

JULY

Academy Explorers Camp
Monday, July 8–Friday, August 23 (weekdays), 9 a.m.–4 p.m. Ages 5–12, Before- and after-care available $ 📞

Tiny Tot Explorers
Wednesdays, July 11–August 22, 10 a.m. $ 📞

Yaks at Lake Hövsgöl

Robert Peck/ANS

Ⓜ Free for members $ Fee 📞 Registration required

Unless otherwise noted, all events held at the Academy are free with museum admission.

Visit ansp.org for more information and to register.