150 YEARS | American Museum of Natural History

ROTUNDA

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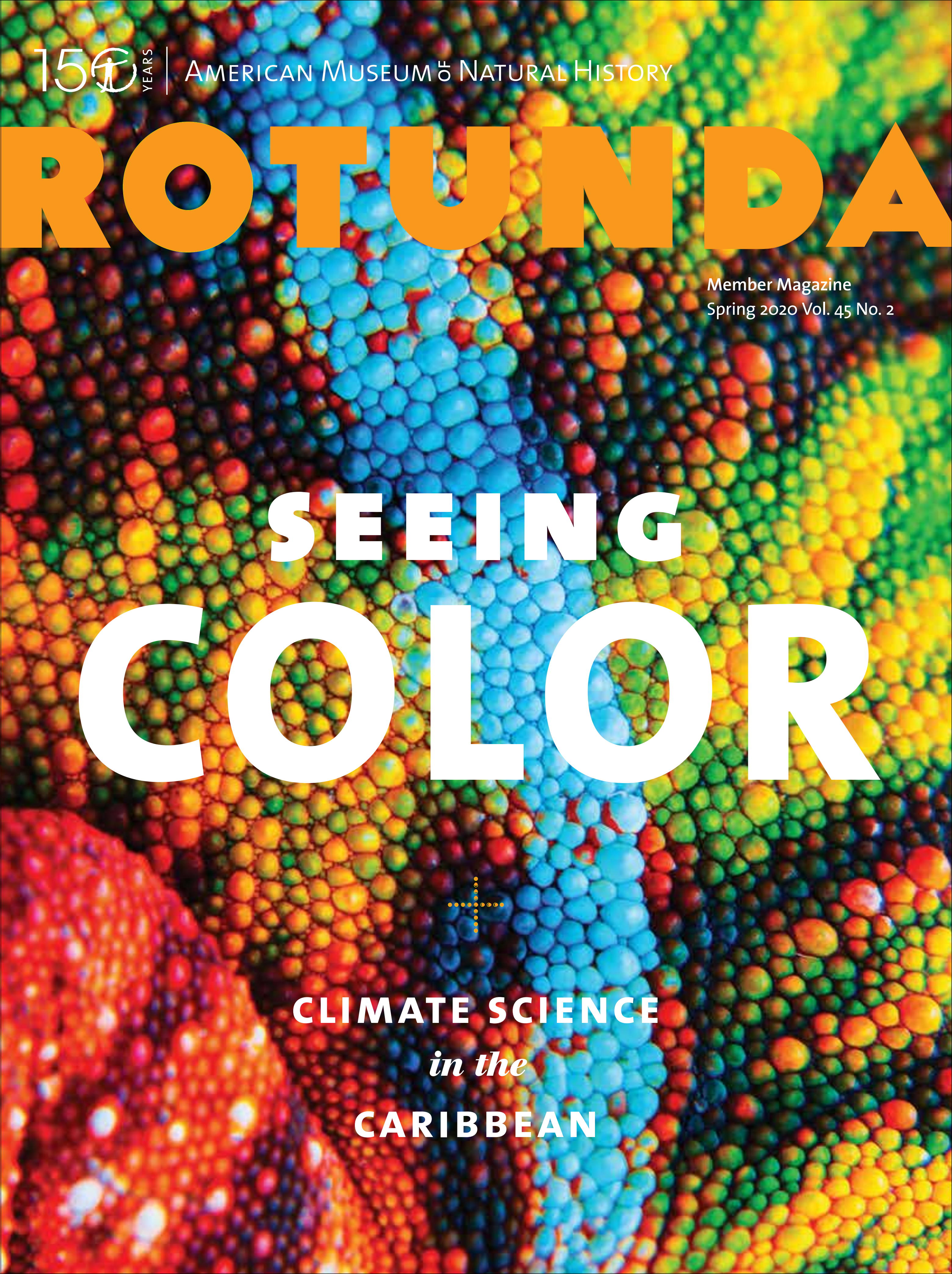
Spring 2020 Vol. 45 No. 2



SEEING COLOR

CLIMATE SCIENCE *in the* CARIBBEAN

From the President

Ellen V. Futter

In these truly extraordinary, profoundly unsettling times, the Museum is committed to maintaining a healthy and safe environment for our Members, visitors, staff, and volunteers. To this end and in response to New York State Governor Andrew Cuomo's announcement of a statewide ban on large gatherings and Mayor Bill de Blasio's declaration of a State of Emergency for New York City, on March 13, the Museum temporarily closed to the public.

Our commitment to our community goes beyond health and safety, of course. We are a scientific and educational institution in a time when education, reliable information, and community are more important than ever. And so, we are working to deliver more content online to ensure that the Museum's essential work of educating the public, demystifying complex science-based issues, and inspiring wonder and discovery is ongoing. Please check **amnh.org/health-safety** for status updates, and **amnh.org/explore** for Museum programs being offered online.

The Museum, of course, is a place, albeit virtual at the moment, where we can help foster a sense of community and purpose. We invite you and your family to continue to turn to the Museum for educational opportunities and enrichment.

Most of all, I wish you and your family and friends good health and strength through this challenging situation. We look forward to seeing you at the Museum in better times soon, and, in the meantime, to being with you online.

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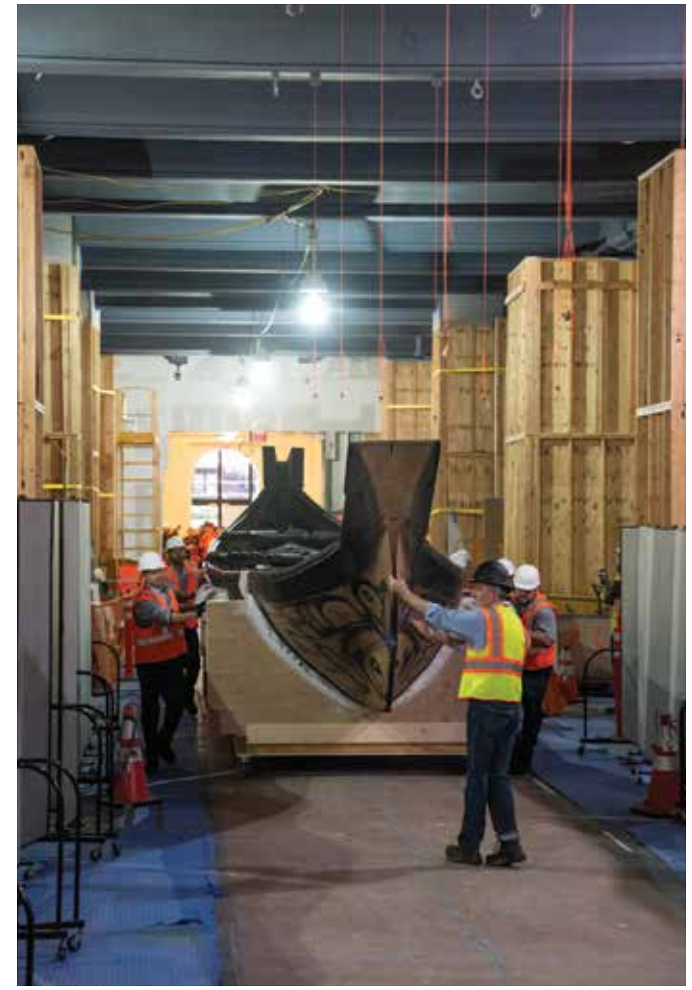
For updates about re-opening, please see **amnh.org/health-safety**

Great Canoe Relocated to Northwest Coast Hall



In January, the Great Canoe was moved from the Grand Gallery into the Northwest Coast Hall, where it will be displayed suspended from the ceiling.

D. Finnin/© AMNH

With the reopening of the historic Northwest Coast Hall just a year away, the iconic 63-foot Great Canoe has been moved from the Grand Gallery into the Hall, which is undergoing a major restoration to enrich the interpretation of the gallery's exhibits.

One of the largest dugout canoes in existence, the Great Canoe was hewn from a single Western red cedar tree and shows design elements from both the Heiltsuk and Haida Nations of the Pacific Northwest Coast.

Since its arrival at the Museum in the 1880s, the Great Canoe has been displayed in multiple locations. For the January move, Curator Peter Whiteley was joined by Haa'yuups (Ron Hamilton), Nuu-chah-nulth artist and cultural historian who is co-curating the Northwest Coast Hall restoration project, as well as by Jisgang (Nika Collison), Haida Nation, Ts'aahl clan, director of the Haida Gwaii Museum at Kay Llnagaay, Chief Wigviłba Wákas (Harvey Humchitt), Heiltsuk, community leader, and Kaa-xoo-auxch (Garfield George), head of the Raven Beaver House of Angoon/Dei Shu Hit "End of the Trail House," Tlingit, three project advisors from a core group that includes Native scholars, artists, and other authorities from Alaska, Washington State, and British Columbia. Megan Humchitt, council member at Heiltsuk Tribal Council, Waglisla, in British Columbia and daughter of Chief Wigviłba Wákas, was also in attendance.

The Great Canoe will return to view when the Northwest Coast Hall reopens with new interpretation produced in consultation with Native advisors in Spring 2021. "In renovating this hall," said Whiteley, "We want to honor the perspectives and interests of the people who made these objects."

The Museum gratefully recognizes the Eugene V. and Clare E. Thaw Charitable Trust, Lewis Bernard, and the City of New York, whose leadership support has made the restoration of the Northwest Coast Hall possible.

Critical support has also been provided by the Selz Foundation and the Andrew W. Mellon Foundation.

The conservation of painted totem poles has been made possible by the Institute of Museum and Library Services under grant number MA-30-17-0260-17.

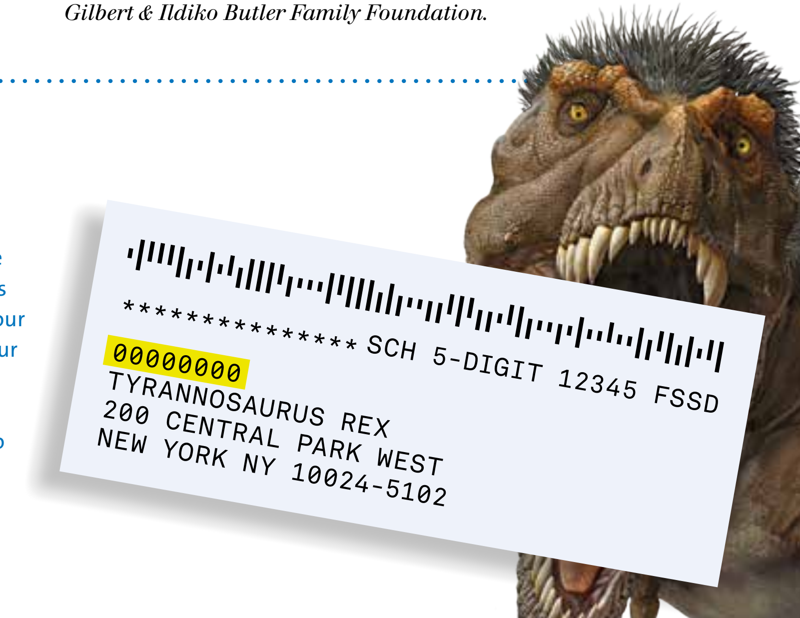
Additional support has been provided by the Family of Ned Hayes, Bank of America, the Stockman Family Foundation, and the Gilbert & Ildiko Butler Family Foundation.

Don't Miss Updates from the Museum

During these uncertain times, we want to be sure that we can continue to serve Members like you.

Help us stay in touch by sharing your email address. First, locate your subscriber number in the label (right) on the back cover of this issue. Then, visit **amnh.org/MemberSurvey** to enter the number, your last name, and email address. The Museum does not sell or rent your personal information.

To thank you for supporting this initiative, every Member who shares their email will receive a free guest pass. We look forward to staying in touch, and to welcoming you back.



Paleozoic Roly Poly

To survive for hundreds of millions of years, trilobites—a vast group of extinct arthropods that populated the world's oceans until about 250 million years ago—had to develop a variety of defenses against the hazards in their environment.

Of the more than 20,000 described species of trilobites, some deployed a mechanism that today is associated with roly polys, armadillos, and hedgehogs: they enrolled, or curled up into a tight ball, shielding their underside with a protective exterior from potential predators. "Trilobites may have been eaten by nautiloids, fish, and other arthropods—we've even found healed injuries on some specimens," says Melanie Hopkins, associate curator in the Division of Paleontology.

Some species were able to curl up completely, tucking in their entire bodies. Late Ordovician species like *Flexicalymene retrorsa*, which lived around 488-443 million years ago, and Middle Devonian species like *Eldredgeops rana* and *Greenops boothi*, which lived 393 million years ago, are among trilobites that resembled a ribbed ball in their enrolled state. Some, like the *Drotops armatus* specimen pictured below, were even preserved as enrolled fossils, likely while facing down a fatal threat.

The first known example of enrollment among trilobites, dates back even farther, to about 510 million years ago, to a species called *Mummaspis muralensis*. Researchers first speculated that this early trilobite had spiny points protruding from its head. But a closer look revealed that the animal had actually tucked its head under its spiky tail in its last moments.

By the Ordovician period, the proportion of trilobite species with this defensive talent increased significantly. Some even developed a structure, called a vincular furrow, which allowed their heads and tails to seal together by way of small interlocking notches—perhaps becoming watertight for additional protection. "It's possible that as larger, more complex marine predators evolved, so did more species of trilobites with the ability to enroll," explains Hopkins.

Trilobites on Display

An array of trilobite specimens in the exhibit case *Trilobites: Life in the Ancient Oceans* is on display in the Grand Gallery on the first floor. Examples include an exceptionally large Cambrian-era *Paradoxides gracilis* from the Atlas Mountains of Morocco; a grouping of *Asaphus expansus* from the Wolchow River near St. Petersburg, Russia; and an *Asaphus kowalewskii*, also from Russia, which had eyes perched atop long stalks, possibly so it could see while burrowed beneath the sand.

National Treasure

Trilobites can be found in fossil deposits all around the world, but a few of the best places to find them are right here in North America. Some of the first descriptions of trilobites were of specimens found in the Rochester Shale in upstate New York. The Silica Shale of Sylvania, Ohio, is known for its abundance of exceptionally preserved enrolled specimens. And Utah's Fillmore Formation is world-famous as a spot for finding Cambrian and Ordovician species.

Spiny Mystery

Trilobite species of many orders evolved to have long protruding spikes on their spines and heads. Scientists think these protrusions were most likely an added defense mechanism, but others suggest they may have been used for stabilization on muddy sediment or as flotation devices for swimming.

A partially enrolled Drotops armatus, *AMNH 80135*.

C. Chesek/© AMNH

Desmoxytes purpurosea

Oliver Thompson-Holmes / Alamy Stock Photo

Brilliant Defense

When a new species of "dragon millipede" was discovered in 2007, the researchers who described it took the unusual step of insisting that its scientific name didn't do this striking arthropod justice. "We think that such an unusually colored, conspicuous millipede deserves more than a Latin name," the team wrote. They proposed "shocking pink dragon millipede"—and the name stuck.

The spectacularly colored species was discovered in Thailand, in a limestone cavern called Hup Pa Tard. Here, these millipedes were observed on the ground and on palm leaves during the daytime, in plain view of would-be predators—and, seemingly, unprotected.

Or are they? Scientists think that this species may wear its loud hue as a sort of dazzling armor. In nature, bright coloration often serves as a warning signal, flashing "danger" to anyone looking for a meal. In some cases, called Batesian mimicry, organisms take on a poisonous counterpart's distinctive colors to fake out predators. In other examples, classified as Müllerian mimicry, several toxic species resemble one another in what seems to function like a group insurance policy: if a predator knows to avoid one, it's more likely to skip the look-alikes. "This beautiful species is a perfect example of how color is used in nature to stand out, to warn other organisms with its coloration and to stay alive," says Museum Curator Rob DeSalle, who curated the new exhibition *The Nature of Color*.

In the case of the shocking pink dragon millipede, its remarkable color is truth in advertising: this millipede packs a toxic punch. Like some other millipedes, *D. purpurosea* has defensive glands that produce cyanide in amounts that can be lethal to birds and reptiles. And, like its brightly colored cousin—the vividly red and likely toxic *D. delfae* millipede, which has also been observed out on foliage in the daytime as though unconcerned about predation—the shocking pink dragon millipede appears secure in its protective colors.

A model of the shocking pink dragon millipede is featured in the special exhibition *The Nature of Color* (see more on p. 12), which is free for Members and open through August 2021.

Misleading Moniker

Despite the Latin root and nickname "thousand leggers," millipedes do not have a thousand legs. Millipedes have two pairs of legs per body segment, with most having fewer than 100 legs and some having as few as 24. The record for the most legs on an individual is 750.

On the Move

Some 18 species of dragon millipede have been identified in northern China and Southeast Asia, including Myanmar, Thailand, Vietnam, and southern Malaysia. But one, *D. planata*, has also been observed in Sri Lanka, the Andaman Islands, Seychelles, Java, Great Coco Island, and Fiji—a species expanding its range through human activity.

Imposing Ancestor

At about 1.2 inches (3 cm) in length, the shocking pink dragon millipede is among the largest in its genus, but not among millipedes in general, which can grow up to 15 inches (38.1 cm) long. And as a group, they started out on a grander scale: ancient millipedes measured more than 8 feet (2.5 m) long!

TRACING CLIMATE HISTORY THROUGH CORALS

Above: *The island of Little Tobago is one of several locations in the Caribbean where Curator Nathalie Goodkin and colleagues collect coral samples.*

Below: *Researchers extract cores from corals at several different sites to track how climate has changed over time.*

Last fall, oceanographer Nathalie Goodkin traveled to Tobago in the Caribbean with a team of colleagues and graduate students to study the history of global environmental change.

Goodkin, an associate curator in the Museum's Department of Earth and Planetary Sciences, analyzes the chemical make-up of coral skeletons over several centuries to understand environmental conditions before and after recent human impact, using the hundred-year-old skeletons of these marine organisms as a way to peer back in time. In an interview with Dr. Goodkin conducted in the field, during the Constantine S. Niarchos Expedition, she explains how cutting-edge research is helping scientists understand the past–and think about the future.

You study climate systems. What's the focus of your current project?

The North Atlantic Oscillation (NAO) is an Atlantic-based climate system driven by the seesaw of atmospheric pressure between Iceland and the Azores. The difference in atmospheric pressure at these two locations impact the wind patterns between the U.S. and Europe and subsequently wave heights, ocean temperature, and precipitation patterns, among other conditions.

The NAO is incredibly important to the very densely populated regions of the northeastern United States and Europe. One of the concerns of the next 50 to 100 years is that as our climate system changes, the NAO patterns will change. This will impact shipping routes, energy supply through hydroelectric dams and wind farms, and droughts and water supply for large population centers. And so the first thing we really need to do to understand the NAO's future behavior on a changing planet is to understand how this system has operated in the past.

In 2008, we published a very important paper demonstrating how an ocean record of the NAO showed changes to its behavior over the past 200 years. We did this from a single-point ocean reconstruction near Bermuda, and the only way to really document whether or not this finding is significant across the whole ocean is to go to another important location and reconstruct the same record.

Above: *Curator Nathalie Goodkin topside on one of the expedition boats.*

Below: *Coral cores will be x-rayed in the laboratory to understand their ages and growth histories.*

L. Stevens/©AMNH

How did you identify Tobago as that location?

What we're looking to do is to use the change in sea surface temperature due to the NAO to examine the NAO back in time. Tobago sits in a key center of action where NAO-driven temperature changes are largest. The northeast corner of Tobago has the most open ocean conditions, and there are several smaller islands off the large island, where coral reefs form.

How can corals help you understand a climate system?

Corals grow for several hundred years in one location, and as they lay their skeleton down, they leave us information about the seawater when that coral skeleton was formed. As the temperature or the salinity changes, the skeleton changes as well. At each individual location we're able to look at the density of that skeleton, and reconstruct an environmental history at that place.

There are a number of colleagues on this trip. Can you tell us about the team?

The first thing you really need when you want to go work in a foreign country is to find a collaborator who wants to work with you, is interested in the science questions you're asking, and has some science questions of their own. I called Dr. Reia Guppy at The University of Trinidad and Tobago. She is very interested in anthropogenic, or human, impacts on reefs, particularly in Trinidad and Tobago. Across the Caribbean, the islands continue to develop, tourism continues to increase, and we see increasing threats to corals. Dr. Guppy is an ecologist and an expert in understanding and studying threats to coral health.

Dr. Guppy and her lab group are biologists, and Dr. Konrad Hughen of Woods Hole Oceanographic Institution and my lab groups are chemical oceanographers, looking at physical processes. The combination is particularly unique because the [coral] cores hold so much information that it will take us decades to extract all of it from them. Because of our collaboration between disciplines, we'll be able to learn as much as we can, both about the biology of the corals and about the physical conditions of the ocean.

And what about the students on this trip?

We decided we would involve two students on this project: one in the U.S. working on the climate questions, and one here in Trinidad working on the anthropogenic [human impact] questions. The nice thing about this is that it looks like there will be years of work here in Tobago to better understand the corals and the climate of this region.

Ross Ong is a graduate student at Columbia University supported by the Museum's Richard Gilder Graduate School Lerner-Gray Fund for Marine Research and the National Science Foundation. She's working with me on the climate component of the study, trying to reconstruct a 300- or 400-year record of changes to sea surface temperature and sea surface salinity here in Tobago, to better understand how the climate has changed naturally, what the role of the NAO has been in those changes, and how those changes have impacted the corals through time.

Jonah McComie is a first-year Ph.D. student at The University of Trinidad and Tobago. He has an undergraduate degree in marine science, and he's going to be looking at how coral growth rates have changed over the last 50 years as the oceans have become more acidic due to $C0_2$ emissions in the atmosphere and as the oceans have had increased nutrients from development and agriculture.

What kinds of corals are you sampling on this trip?

We're looking for massive corals: very large colonies that are taller than three feet in height. Some of these are star corals and brain corals, and they can grow in the same place for several centuries–300 to 400 [years] in some locations–and give you a very, very long record of what the environment has been at the site.

A lot of Atlantic corals grow very slowly, on the order of 4 to 6 millimeters (0.16 to 0.24 in) a year. So, that's basically two years every centimeter. This trip, we were able to collect a core that was 2.8 meters (9.2 ft) long, which could possibly be 500 years of environmental record.

When we get the corals back to the labs, we'll slice the corals into slabs. We will x-ray them to look for changes in density to the skeleton through time and to determine which coral actually has the longest climate record held within its core.

Then we'll start to study the chemistry of the skeletons over the past 30 years for each species. We've collected multiple cores of each species, and we'll confirm that the geochemistry is showing us the environmental conditions we expect. We're also going to be comparing the geochemistry to other climate records–satellite and local records of SST–to make sure the corals are recording what we think they are.

> **"Corals grow for several hundred years in one location, and as they lay their skeleton down, they leave us information about the seawater when that coral skeleton was formed."**

THE TEAM

Nathalie Goodkin
American Museum of Natural History

Reia Guppy
The University of Trinidad and Tobago

Konrad Hughen
Woods Hole Oceanographic Institution

Jonah McComie
Ph.D. student, The University of Trinidad and Tobago

Rosabelle (Ross) Ong
Ph.D. student, Columbia University and the American Museum of Natural History

Goodkin and Guppy confer during a dive.

Below: Retrieving core samples was a team effort. From L to R: Boatman Curtis Antoine, Konrad Hughen, Nathalie Goodkin, Jonah McComie, Reia Guppy, Rosabelle (Ross) Ong.

To sample the cores, the team has to work under water. Can you tell us a bit about the preparation that this requires?

On the third day here, we traveled to Kelleston Drain to sample the biggest coral we've found. It was a *Colpophyllia* brain coral that Dr. Guppy says is suspected to be the largest in the world of this species. It's about 5 meters (16.4 ft) in diameter, and 2.5 to 3 meters (8.2 to 9.8 ft) in height, and we were able to core through to the bottom.

We were lucky because the current was noticeably absent, and so we were able to drill to the bottom of the coral in one day when we suspected it would take us two to three days. We had been planning for this particular day for months, trying to make sure that we had really set everything in place. We had several meetings in the days leading up to the drilling, first with our team and then with the Trinidad and Tobago Coast Guard.

Will you be back in Tobago after this expedition?

The biological and climate research that's being done is going to be incredibly relevant in managing Tobago's reefs going forward. We're working in places that are very dependent on the ocean. In addition to one last coring trip, members of the team will be [coming] back and we'll be talking to fishermen and school children in those communities about what we learned and making sure that the information gets shared with them so that the best decisions can be made for the reefs going forward. We'll also be checking on the corals, which grow over the hole [from sampling] in two to three years.

Watch a video with Dr. Goodkin and Dr. Guppy about this expedition on amnh.org/videos.

This 2019 Constantine S. Niarchos Expedition was generously supported by the Stavros Niarchos Foundation.

This work was supported in part by the U.S. National Science Foundation, grant #1903586.

Spectrum of Sight

Among Animals, Color Vision Is Varied and Versatile

BORNEAN ORANGUTAN
PONGO PYGMAEUS

You—yes, you—may be able to recognize up to 10 million colors on the visible light spectrum. That may sound impressive, until you consider that birds and crocodiles can see ultraviolet light, a "superpower" that may have been shared by their ancient relative *Tyrannosaurus rex*.

In nature, the colors visible to us humans are just one small part of the evolutionary story—and what animals see depends in large part on how they have adapted to their world.

Middling Mammals

Most mammals, including dogs, elephants, and some species of New World monkeys have two color receptors. They see the world in the same tones as red-green color-deficient humans. Why? Early mammals were likely nocturnal, avoiding daylight and dinosaur predators–and had less need for color cues in their dark environment.

Primates like humans, apes, and Old World monkeys, on the other hand, have trichromatic vision and are able to distinguish between shades of red, green, and blue to see many glorious hues. Some humans see even more: an estimated 12 percent of women have an additional cone cell–the photoreceptor in our retina that registers colors–and can recognize 100 times more colors. This expanded color vision includes a broader range of reds and oranges–an adaptation, scientists think, that may have helped some ancient humans figure out which berries and fruits were ripe for picking.

The Museum gratefully acknowledges the ***Richard and Karen LeFrak Exhibition and Education Fund.***

Generous support for The Nature of Color *has been provided by the Eileen P. Bernard Exhibition Fund.*

The Nature of Color *is generously supported by* ***Chase Private Client.***

Eric Kilby/Flickr; © J. Sparks, D. Gruber, and V. Pieribone; BRIJESH EP/Flickr

Shark Vision

Seeing more colors isn't necessarily better. In some environments, such as dark waters, seeing fewer works just fine.

Take two species of catshark, the chain catshark and the swell shark. These bottom-dwellers are found in deep waters, between 1,600 and 2,000 feet (500–600 m). They're monochromats–their eyes have just one photo receptor–which allows them to see shades of blue-green. This narrow slice of the spectrum makes a lot of evolutionary sense for marine organisms, considering that longer-wavelength colors, such as reds and oranges, are absorbed quickly at shallow depths of 16 to 32 feet (5–10 m), limiting the visible spectrum to shorter-wavelength colors–green and blue–at depths below 190 feet (58 m).

Although their color range is more limited, these species have excellent vision–and a special adaptation that helps them see other catsharks. A special pigment in their skin absorbs blue light and re-emits it as green, producing glowing green markings. Museum Curator John Sparks and Research Associate David Gruber, who have studied the phenomenon, think that catsharks use these glowing patterns to recognize each other and possibly even to communicate.

SWELL SHARK
CEPHALOSCYLLIUM VENTRIOSUM

Pollinator Power

Insects are even more impressive when it comes to seeing colors–and shaping the world around them.

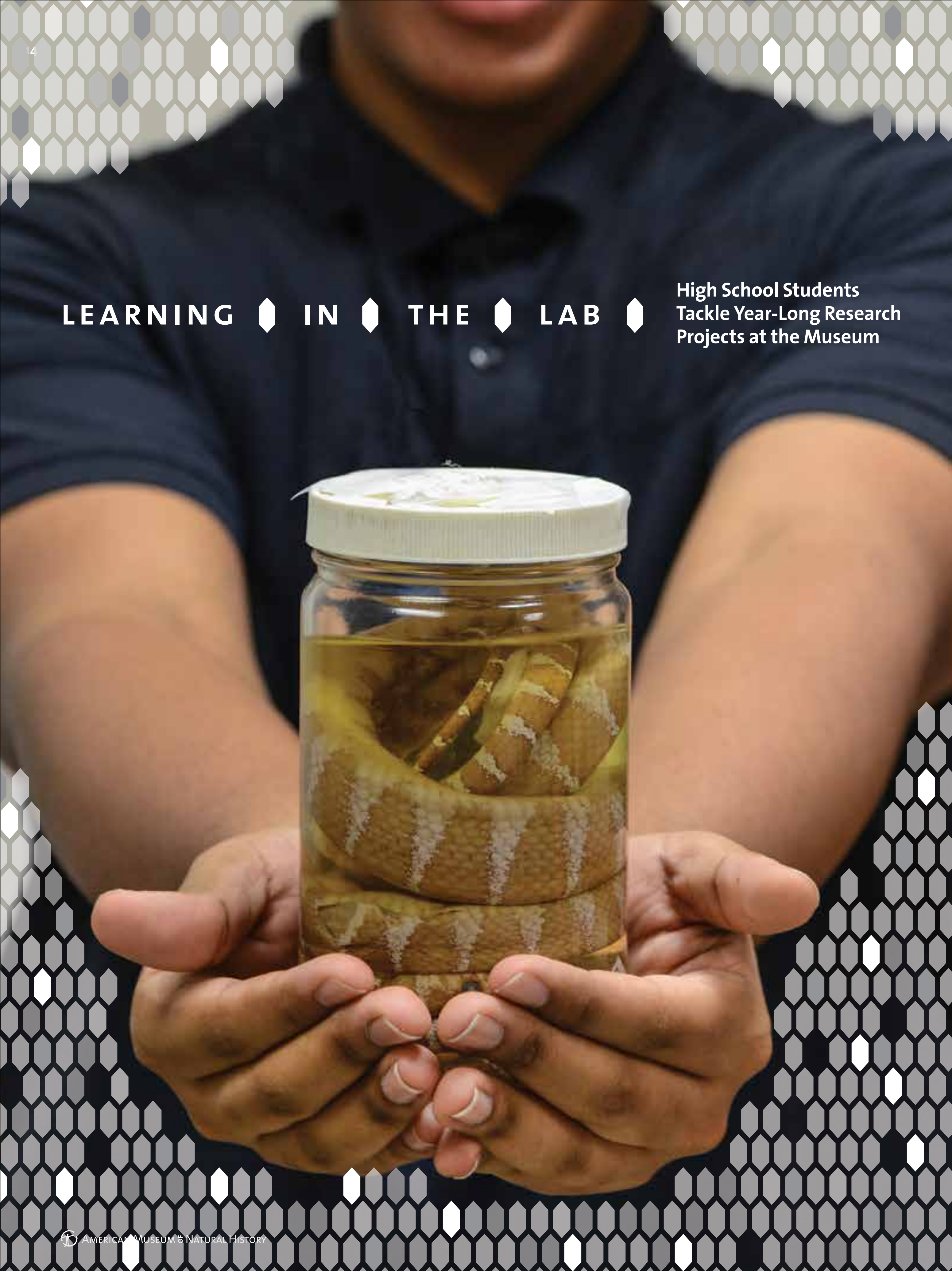
Winged insects and flowering plants emerged around the same time 400 million years ago, and some flowers have evolved to blossom in colors that attract specific pollinators. Take columbine flowers, which bloom in different colors depending on the species and attract different insects. Buff-tailed bumblebees (*Bombus terrestris*) cannot see red, so they prefer to pollinate blue and purple varieties of the common columbine (*Aquilegia vulgaris*). Meanwhile white-line sphynx moths gravitate toward the white species, *Aquilegia pubescens*, which is more visible at dusk.

When it comes to the most expansive color vision, one butterfly may have the rest of the animal kingdom beat. The common bluebottle (*Graphium sarpedon*) has up to 15 distinct photoreceptors for color, or 11 more than most butterflies, including those that see ultraviolet light. Scientists think its advanced color vision may help males of this iridescent blue species spot potential rivals against a blue sky.

As for humans, we may not have as many types of receptors, but we do have another advantage. "We are the only species that can actively, and with perception, play with colors," says Museum Curator Rob DeSalle, who curated the new exhibition *The Nature of Color*.

The Nature of Color is free for Members and open through August 2021.

COMMON BLUEBOTTLE BUTTERFLY
GRAPHIUM SARPEDON



LEARNING IN THE LAB

High School Students Tackle Year-Long Research Projects at the Museum

On Tuesdays and Wednesdays earlier this year, Johanna, 16, and Xavier, 17, could be found in the herpetology lab on the Museum's fifth floor. The two teens have been working with Phillip "Skip" Skipwith, a postdoctoral researcher in the Department of Herpetology, as part of the Science Research Mentoring Program (SRMP), which matches high school students with Museum scientists for a year-long research project.

For the past few months, Johanna and Xavier have been analyzing Malagasy gemsnakes, exploring questions that have fascinated their mentor for years. "There is evidence that under the same environmental and selective pressures different snakes will develop a similar overall appearance, or phenotype," says Skipwith. "It's called convergent evolution. While the Malagasy gemsnakes have generated an astounding degree of ecological diversity, they've managed to replicate phenotypes seen elsewhere in unrelated snakes."

One day last winter, hoping to help prove that point, Johanna and Xavier sat looking intently at side-by-side monitors as they rotated high-resolution micro CT scans of snake skulls, trying to isolate a specific bone structure essential to eating called the pterygoid.

"That's a beautiful skull!" said Xavier, pointing to his screen. He explained that too often details are hard to see, but the *Madagascarophis* skull on view is clearly defined.

Not so for Johanna, who noted that on her screen, the image of *Langaha madagascariensis*–known as a Pinocchio or leaf-nosed snake because of its elongated snout–had an odd nodule obscuring the piece of bone she was looking to identify. "I'll have to edit it out," she said.

SRMP students Johanna and Xavier are working with postdoctoral researcher Phillip "Skip" Skipwith to analyze snake specimens from the Museum's herpetology collection.

Like all SRMP students–there are 58 in the program this year–Johanna and Xavier had completed one year of after-school preparatory courses at the Museum before embarking on their work with Skipwith. While they are working with him to analyze snake specimens from the herpetology collection, their peers are working with mentors from across the Museum's scientific disciplines on subjects ranging from spider venom to brown dwarfs (see sidebar). Each student has an opportunity to learn cutting-edge techniques and use state-of-the-art tools, in addition to attending sessions about science professions, practicing

SRMP CLASS OF 2020

This year's class of high school juniors and seniors have been working with Museum scientists on year-long research projects, learning cutting-edge techniques and using state-of-the-art tools. The students are scheduled to present their findings in June.

Raisa and Brooke
Uncovering the Differences Between Two Gelada Monkey Populations, with primatologist Dagmawit Abebe Getahun

Megana and Avery
Understanding the Evolutionary Relationships Between Colobine Monkeys, with primatologists Julia Arenson and Brian Shearer

Michelle and Nacera
DNA Barcoding of Pacific Northwest Coast Native Artifacts, with botanist Lauren Audi

Kevin, Noah, and Alexandria
The Transcriptome and Evolution of Spider Venom, with invertebrate zoologist Richard Baker

Ryan, Marika, and Kelly
Dynamics of Exoplanets Based on Ultracool Dwarf Light Curves, with astrophysicist Daniella Bardalez Gagliuffi

Sophia and Mariel
Are NYC Coyotes Interbreeding with Domestic Dogs? with geneticist Anthony Caragiulo

David and Amy
The Impact of a Hungry, Non-native Plant on Local Animals, with biologists Seth Cunningham and Michael Tessler

Angeli, Isabella, and Linus
Repairing the Cosmic Clock with TESS Data, with astrophysicist Jason Curtis

Hunter and Henry
A Bronx Tail: Searching for Coyotes in New York City, with conservation biologist Peter Galante

Grace and Daphne
Demystifying Fires in the Amazon Forest, with conservation scientist Nadav Gazit

presentation skills, and participating in college-readiness activities. Students also earn a stipend after completing program requirements, to help make it possible for youth who may be forgoing a part-time job to participate.

"SRMP is a chance for high school students to do real science, with real scientists," says Maria Strangas, SRMP manager and Museum herpetologist. "They get a sense of what it's like to do research, and along the way they build skills that prepare them for any career, whether they choose to go into science or not."


Johanna and Xavier examine high-resolution micro CT scans of snake skulls in the Museum's herpetology lab.

Based on the success of the SRMP model, the Museum has helped to launch a city-wide consortium of similar programs. The NYC Science Research Mentoring Consortium now consists of 23 institutional partners at 24 sites across New York City that are providing mentored research experiences to about 500 youth annually.

Johanna and Xavier, for example, are analyzing morphological data, making comparisons with snakes in other groups, reading scientific articles, and blogging about their work. In June, they are scheduled to present their findings at the annual SRMP Research Colloquium.

In the meantime, their work with Skipwith has already opened up new and exciting possibilities. Johanna, a junior at Manhattan Center for Science and Mathematics High School, is weighing her dream of becoming a pediatrician against a newfound passion for lab research. Xavier, a senior at Archbishop Molloy High School in Queens, hasn't narrowed his options yet, recalling a scientist who told him her career path was wildly different from what she thought it might be at Xavier's age. For now, Xavier says, "I want to take advantage of all the skills I can learn."

Support for the Science Research Mentoring Program at the American Museum of Natural History is provided by Christopher C. Davis; The Shelby Cullom Davis Charitable Fund; The Pinkerton Foundation; the Doris Duke Charitable Foundation; and the Adolph and Ruth Schnurmacher Foundation.

Chen and Lisvanny
Nematocysts: High-Tech Cellular Weaponry Under the Sea, with invertebrate zoologist Luciana Gusmão

Nika and Raya
Neusticurus Rudis: *Lizards from the Lost World,* with herpetologist David Kizirian

Katelyn and Genesis
Potential New Species of Rupicolous Gecko, with herpetologist Arianna Kuhn

Amaya, Muniyat, and Sharon
Investigating Cultural and Marketing Issues in Pharmacies and Medicines in Tanzania, with anthropologist Jacklyn Lacey

Alice and Aaron
Biolocomotion of the Ocean, with Earth scientist David Lindo-Atichati

Harley and Nicol
Conservation and Restoration of Mangroves and Wetlands in American Samoa, with conservation biologist Alex Moore

Karen and Esme
Picky Parasitoids and Human Pressures, with entomologist Sara Oppenheim

Andres, Ryan, and Taite
Age and Rotation Rate of M Dwarf Stars, with astrophysicist Mark Popinchalk

Seowon and Isabel
Drivers of Phenotypic Evolution in Downy and Hairy Woodpeckers, with ornithologist Lucas Rocha Moreira

Johanna and Xavier
How Snake Skull Morphology is Impacted by Its Environment, with herpetologist Phillip Skipwith

Sophia, Elijah, and Anika
Assessing the Habitability of Exoplanets Using Global Climate Models, with planetary scientist Linda Sohl

Shiym, Lara, and Ethan
Thermal Ecology of Terrapene carolina carolina *in Black Rock Forest,* with herpetologist Maria Strangas

Amira and Ryan
Using Old Museum Data to Understand Distribution of South Pacific Birdlife, with ornithologist Paul Sweet

Izzy, Otis, and William
Brown Dwarf Binarity, with astrophysicist Johanna Vos

Jason and Chenjie
Deforestation in Madagascar, with primatologist Darice Westphal

Know a high school student who would be interested in SRMP? Visit amnh.org/SRMP to learn more.

Explore and Learn Online with the Museum

For Virtual Visits

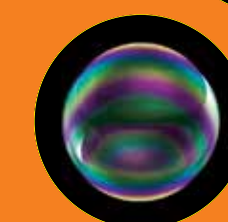
Get a behind-the-scenes look at dioramas or go on a virtual tour with Google Arts and Culture.

For Families and Students

OLogy: Visit the Museum's science website for kids.

Curriculum Collections: Find activities, articles, videos.

Science Topics: Browse by topic, from color to whales.


Khan Academy: Try one of four Museum classes.

Kahoot: Test your knowledge with Museum quizzes.

Coursera: Take one of several Museum courses.

Find these and other online resources for science enthusiasts of all ages at **amnh.org/explore**

Windows on the Sea

As the Museum celebrates its 150th anniversary, each issue of *Rotunda* will bring you stories about iconic exhibits, including beloved dioramas.

The Andros Coral Reef, the only two-level diorama in the Museum, has delighted visitors since it was first unveiled in 1935 in the Hall of Ocean Life. The display, which took 12 years to complete, is an exceptional example of how the Museum combines art with science to illuminate the natural world.

LIVING LINK

"The ideal museum group is not merely a work of art," Miner wrote in *Natural History* magazine in 1931. "It is a record of living beings in their natural state and environment, depicted in their proper relations to their surroundings, and emphasizing the truth that the real unit in nature is the association rather than the individual."

MODEL AMBITION

To create the diorama, Curator Roy Waldo Miner led a team that included painter and modeler Chris Olsen, glassblower Herman Mueller, and background artist Francis Lee Jaques on five field expeditions starting in 1923 to Andros and other Bahamian islands. He described the diorama as "probably the most extensive and difficult group yet attempted in this Museum, in view of the multiplicity of life presented and the character of the problems involved."

AQUATIC ART

Underwater scenes were recorded with cameras in watertight boxes and through a "submarine tube" that stretched like an accordion from the bottom of a boat to a glass-fronted chamber on the seafloor. Painter Chris Olsen also painted preliminary oil sketches for the diorama's reefs while submerged as far as 25 feet (7.62 m) underwater, breathing through a 65-pound (29.48 kg) tethered helmet. He sketched on an oiled canvas stretched over glass and attached to a weighted easel.

AMNH Library/Image no. 314539
AMNH Library/Image no. 314563
D. Finnin/©AMNH

ART IMITATES LIFE

Specimens of coral—primarily elkhorn, staghorn, and fan species—were shipped to the Museum in sponge clippings, cleaned, and given a thin coating of beeswax, then colored in oils to simulate the living animal tissue that covers them in life. About 6 tons of structural steel support the specimens in exactly the position in which they were found.

PLANNING TOOLS

The upper-level painting of flamingos soaring above the islands of Andros and Goat Cay was painted by Francis Lee Jaques, best known for his paintings of birds. His techniques included taping cut-out drawings of birds to the wall to plot flight patterns before painting, and some of his original bird cut-outs were discovered during an update of the Milstein Hall of Ocean Life that was completed in 2003.

A LOOK BACK

Like the other habitat dioramas in the Museum, the Andros Coral Reef is a depiction of a real place at a specific point in time, offering an invaluable window into a thriving marine habitat in the early 20th century. Today, coral reefs, which are home to a quarter of all known marine species, face existential threats worldwide. (Read about how Museum scientists are studying corals to trace climate history on p. 6.)

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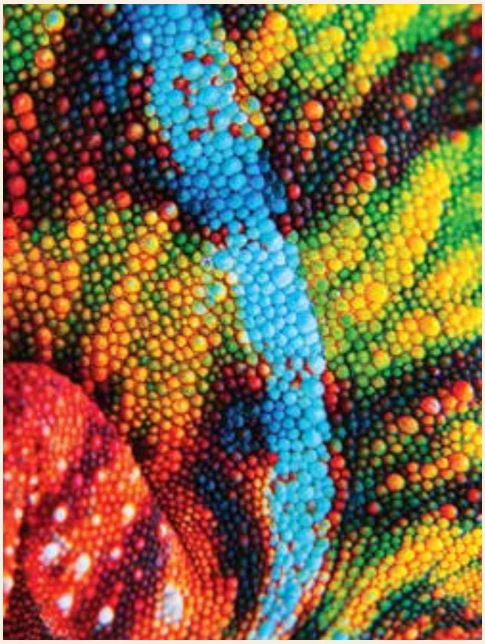

If you guessed this is a close-up of a chameleon's skin, you were right! Discover how color is used in the natural world and across human cultures in the new exhibition *The Nature of Color*. For more, see p. 12.

For updates about re-opening, please see **amnh.org/health-safety**

General Information

Hours
Museum: Open daily, 10 am–5:45 pm; closed on Thanksgiving and Christmas.

Entrances
During Museum hours, Members may use the Member entrance on Central Park West (ground level via the driveway), the 81st entrance, and the subway entrance (lower level). On weekends, the 77th Street entrance is also designated for Members.

Restaurants
Museum Food Court, Café on One, and Café on 4 offer Members a 15 percent discount. Hours are subject to change.

Museum shops
The Museum Shop, Dino Store, Planetarium Shop, Cosmic Shop, *T. rex* Shop, *The Nature of Color* Shop, and Online Shop (shop.amnh.org) offer Members a 10 percent discount.

Phone numbers
Central Reservations 212-769-5200
Membership Office 212-769-5606
Museum Information 212-769-5100
Development 212-769-5151

Transportation and parking
Subway: B (weekdays) or C to 81st Street; 1 to 79th Street, walk east to Museum
Bus: M7, M10, M11, or M104 to 79th Street; M79 to Central Park West
Parking Garage: Open daily, 8 am–11 pm; enter from West 81st Street. Members can park for a flat fee of $10 if entering after 4 pm. To receive this rate, show your membership card or event ticket when exiting the garage.

Accessibility
For information on accessibility, email accessibility@amnh.org or call 212-313-7565.