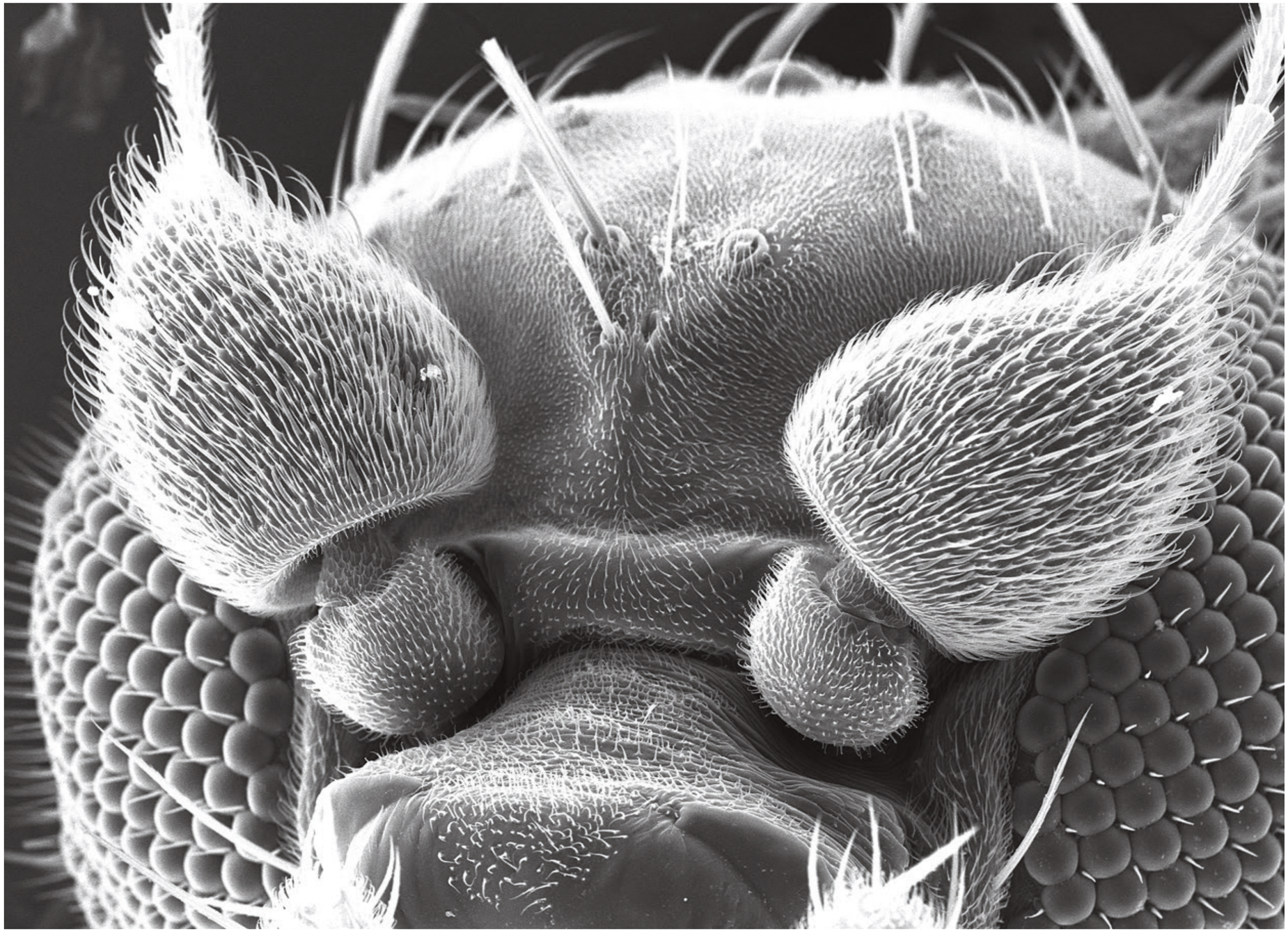

A scanning electron microscopy (SEM) image of a female *Conicera tibialis*'s antennae.

SoCaltech

- Illustrating the biological world
- Carver Mead's big honor
- Meet me at Browne: The dining hall's new name; and more

On the Fly

If lab animals were celebrities, *Drosophila melanogaster*—the common fruit fly—would be a household name. For decades, Caltech researchers have developed genetic tools that allow them to use these flies, among the most common animal research subjects in the world, to answer questions such as how emotions are encoded in the brain and how a fly's microbiome influences its ability to walk.

But some different flies with lesser-known names are making an appearance in the laboratory of Elizabeth Hong (BS '02), assistant professor of neuroscience and Chen Scholar. These include *Termitophilomyia*, which live as a parasite in termite nests; and *Conicera* (shown at left), colloquially known as coffin flies due to their affinity for dead animals. In Hong's lab, research scientist Ezgi Kunttas, in collaboration with Brian Brown, entomology curator at the Natural History Museum of Los Angeles County, studies the evolution of a diverse group known as phorid flies—looking specifically at the evolution of their noses.

Olfaction, or the sense of smell, was one of the first sensory systems to evolve in animals, because it is a necessary tool to sniff out food, avoid predators, and find a mate. The Hong Lab primarily uses fruit flies to study how this primal sense is wired into the fly brain and, by extension, our own. A fly's "nose" consists of its two antennae, which are coated with thin hairs called sensilla that hold the insect's olfactory neurons. Odors diffuse into tiny pores on the sensilla and bind onto corresponding receptors on the olfactory neurons, which send signals down the hairs and into the brain. Though humans do not have antennae, an analogous process

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On the Fly

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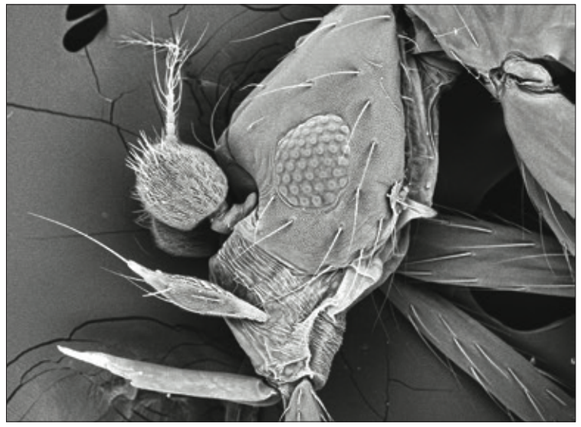
happens in our noses when we lean in to catch a whiff of a delicious dish or recoil from the stench of rotten eggs.

Kunttas uses scanning electron microscopy to take detailed, magnified photos of the antennae of exotic flies to understand how their diversity across different species may relate to the evolution of niche lifestyles: parasitic, scavenger, or herbivorous, for example. Tiny *Conicera*, which measures only 1 millimeter long, feeds on dead animals. But because it is outcompeted by larger carrion feeders such as blowflies, *Conicera* finds sources of food underground that bigger flies cannot access. Such comparative analyses help illustrate the selective pressures that shape antennal form and function to optimize the detection of chemical signals that promote each species' survival.

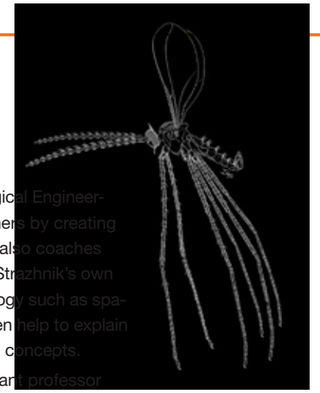
"Fruit flies are interested in the sweet aroma of fermented fruits, which is very different than the decaying organic matter that coffin flies are drawn to," Kunttas says. "Understanding the differences in how odors are processed in the brains of insects that care about very different types of odors provides insight into the broader problem of how complex chemical information can be efficiently coded and read out."



A scanning electron microscopy (SEM) image of a female *Termitophilomyia* head, highlighting the antennae and reduced eyes.

ENGINEERING AN AUDIENCE

Beautiful Biology



Inna-Marie Strazhnik, who joined the Division of Biology and Biological Engineering in 2020 as a visual communications specialist, assists researchers by creating explanatory illustrations to accompany their scientific papers. She also coaches students on visual communication (the bird at left is a drawing from Strazhnik's own student days). Her work typically focuses on topics in molecular biology such as spatial genomics and computational workflows, and the illustrations often help to explain the mechanics of molecular interactions or to break down high-level concepts.

Strazhnik works closely with the labs of Matt Thomson, assistant professor of computational biology and Heritage Medical Research Institute Investigator; Mitchell Guttman, professor of biology; and Long Cai, professor of biology and biological engineering. "Every single illustration presents its own little challenge," Strazhnik says. "First, you have to understand what the main point is, and what concepts you'll have to put in. You kind of know immediately how you can take all that information and distill it into just those key points. Then you also get this clear picture in your head of how you should do that. A really elegant visual tells a much bigger story in just a few simplified graphics. So that's what I think the puzzle is: trying to figure out how to do the most with as little real estate in an illustration as possible."

Short Stories, Big Ideas

A new short-story collection is bringing the imaginations of Caltech and JPL graduate students, postdocs, alumni, faculty, and staff to life. Released in March 2023, *Inner Space & Outer Thoughts: Speculative Fiction from Caltech and JPL Authors* was spearheaded and edited by members of TechLit, Caltech's creative writing club. The anthology features original stories in themes across science, technology, space, and time. The idea for the project came about in 2020 during the COVID-19 pandemic, says Rachael Kuintzle, a biochemistry and molecular biophysics grad student who founded TechLit and served as the book's editor in chief.

"A lot of people weren't able to spend as much time on their research—they had more time to write," Kuintzle says. "So we thought, why don't we take advantage of this time and put out a call for submissions? We got some great pieces, and then, over the next year, our editors worked intensively back and forth with the authors to develop their stories."

Notable contributors include award-winning speculative fiction authors and Caltech alumni David Brin (BS '73), S.B. Divya (BS '96), and Larry Niven (EX '60).

"The authors took their expertise and came up with these beautiful creative stories, sometimes grounded in their own work, sometimes grounded in an area of science that they've always been curious about but never got to explore professionally," Kuintzle says.

Read more about the anthology and order your own copy:
magazine.caltech.edu/innerspace

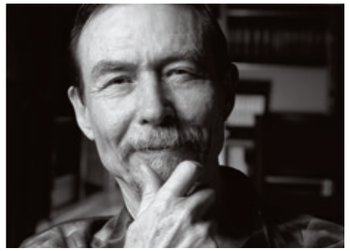
Dining Hall *Distinction*

The Caltech community gathered in November to formally dedicate the Lee F. Browne Dining Hall, Caltech's central dining facility. The dining hall was renamed in fall 2021 in honor of the late Lee Franke Browne, a former Caltech employee and lecturer who joined Caltech in 1968 and served for two decades as director of secondary school relations and special student programs before retiring as a lecturer in education, emeritus. Browne, who died in 2010, dedicated his life and career to efforts that expanded students' access to STEM. He also advanced human rights through his involvement with community organizations such as the National Association for the Advancement of Colored People (NAACP), and others. Speaking for the extended Browne family, Adriene Tri, the youngest of Browne's four children, described her father as "a man of strength and dedication, whose commitment to our education was paramount."

Read more about the event:

Chip Memory

Carver Mead (BS '56, MS '57, PhD '60), *recipient of the 2022 Kyoto Prize in Advanced Technology, on teaching Caltech students how to build integrated circuits in the early 1970s:*



"I redefined what semiconductor devices were. They're just more complicated than you thought. … What I taught them was exactly what I had learned in the last three years figuring out how to design my own chip: that you can get a conceptual picture of each of the process steps and what it does in terms of the structure of the geometry, what that does in terms of the electrical circuit diagram, and what that does in terms of logic. If you have those conceptual pictures in your head, you can hold the whole process in your head. One person can do this whole thing. I had done it; the students are smarter than I am, so they'll certainly be able to do it, and they were."

Mead delivered these remarks in his Kyoto Prize commemorative lecture from November 2022. Learn more about his invention of VLSI (very large-scale integration), the cornerstone of modern computing:

A Light in the Shadow

Astronomers using W. M. Keck Observatory on Maunakea in Hawai'i have discovered that aurorae at visible wavelengths appear on all four major moons of Jupiter: Io, Europa, Ganymede, and Callisto. A team led by Caltech and Boston University observed the moons in Jupiter's shadow so their faint aurorae, caused by the gas giant's strong magnetic field, could be spotted without competition from sunlight reflected off their surfaces.

"These observations are tricky because, in Jupiter's shadow, the moons are nearly invisible," says Katherine de Kleer, assistant professor of planetary science and astronomy and Hufstedler Family Scholar. "The light emitted by their faint aurorae is the only confirmation that we've even pointed the telescope at the right place." De Kleer was lead author of one of two research papers describing the discovery published in the *Planetary Science Journal* in February. She was also one of the Caltech researchers and alumni photographed by Christopher Michel, artist in residence at the National Academy of Sciences, for his *New Heroes* series, which celebrates the scientists and engineers working on solutions to society's biggest challenges.

View more ***New Heroes*** portraits:

Nitika Yadlapalli (fifth-year graduate student)

#SoCaltech *is an occasional series celebrating the diverse individuals who give Caltech its spirit of excellence, ambition, and ingenuity. Know someone we should profile? Send nominations to* ***magazine@caltech.edu.***

For more #SoCaltech, go to magazine.caltech.edu/post/category/SoCaltech

Nitika Yadlapalli (MS '21) works in the lab of Vikram Ravi, assistant professor of astronomy, studying millimeter-range electromagnetic-spectrum emissions from high-energy astrophysical sources. She has spent a lot of time at the Owens Valley Radio Observatory (OVRO) working first with the Deep Synoptic Array (DSA), and now with the Stokes Polarimetric Radio Interferometer for Time-domain Experiments (SPRITE). Sometimes, she says, the wildlife gets too close for comfort.

"Early in my second year, a couple of us went to OVRO to work on tests for the first DSA dish. Vikram [Ravi] had decided we were going to observe a bright radio source that would pass through the north–south meridian at 10 p.m. The DSA dishes are pointed north and only move in elevation, meaning you can't spin them to point east or west. And because this was the first dish online, we didn't have computer control or any computer monitoring of where the dish was pointed. The only way to point it was to strap a digital level onto one of the axes, then flip a switch at the bottom. I was responsible for pressing the button on the data recorder. Vikram was on a ladder, reporting the digital-level reading, like, 'We're at 60 degrees! Sixty-five degrees!' Finally, everyone said, 'OK, we're on the source! Hit the button!' The thing is, it's the middle of the night, I'm sitting there with this giant glowing box, all these bugs are flying around me, and this really big scorpion runs past my feet. I screamed. Vikram is going, 'Hit the button!' And I'm yelling, 'No, there's a scorpion!' I pressed it, but I was scared. Everything worked out though, and I still loved the whole experience enough to keep coming back to OVRO and work on instrumentation for the rest of my thesis."

Origins

The Personal Computer

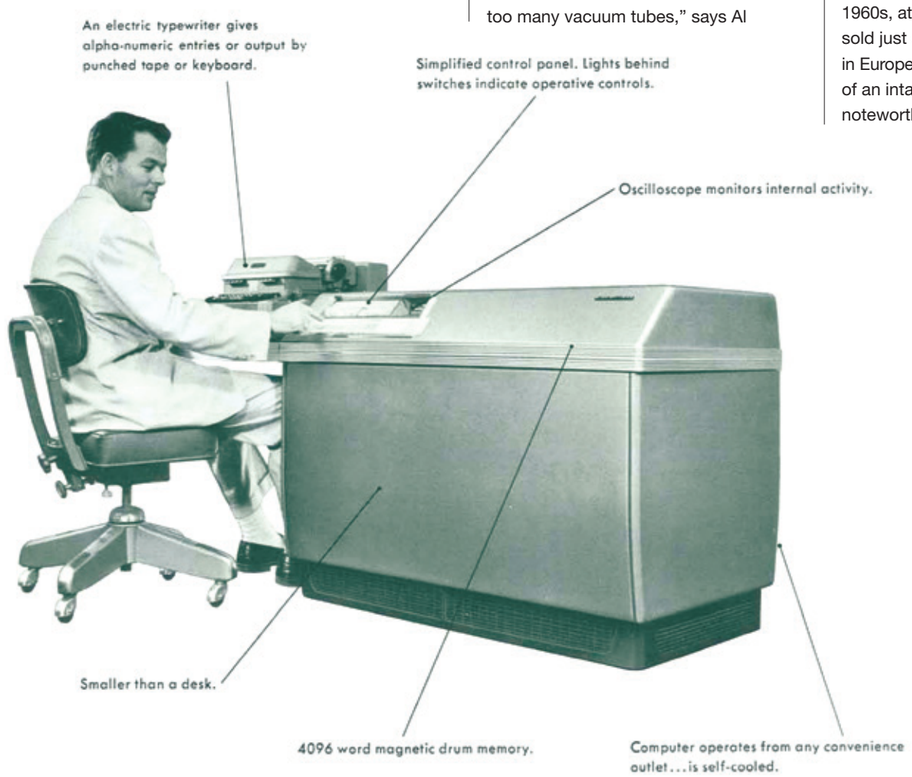
A nearly 70-year-old 800-pound machine found in a German basement last November turned out to be, according to the website Ars Technica, an innovation that changed the course of computer history. And it has its roots at Caltech.

Known as a Librascope General Precision-30 (LGP-30), the machine was designed by Caltech researcher Stanley Frankel in 1954. Frankel, who had performed calculations for the Manhattan Project using the first electronic computer, ENIAC, was recruited by Caltech in the early 1950s to head the Institute's new digital computing unit. The LGP-30, which Frankel described as a "simple general purpose computer," was considered small at the time though it weighed as much as a grizzly bear. It was called MINAC before a Glendale-based company called Librascope licensed the design and hired Frankel and Caltech graduate student James Cass (BS '50, MS '53) to create a production-ready product.

The result was the first personal computer: a desk-sized single-user machine that plugged into a wall socket. It contained 113 vacuum tubes for logic circuitry, and its primary memory device was a magnetic drum—a metal cylinder that measured 6.5 inches in diameter and 7 inches long. Data was entered and received through an attached Flexowriter, which was a typewriter that used punched paper tape.

"Much of the computer hardware before the LGP-30 used far too many vacuum tubes," says Al Barr, professor of computer science at Caltech. "Vacuum tubes used a great deal of electrical power, produced a lot of heat, and were fairly unreliable since they frequently burned out like incandescent light bulbs. The LGP-30 used a goodly amount of solid-state diode logic to reduce the number of vacuum tubes, increasing its reliability and decreasing its power use. The hardware design was one of the stepping stones that opened the door to the modern computer revolution."

The LGP-30, which could be used for a variety of mathematical and applied engineering computations, was released in 1956 at a reported cost of $47,000 (around $500,000 today). Although more than 500 units were sold through the 1960s, at a time when most designs sold just a handful, only 45 were sold in Europe. This makes the discovery of an intact LGP-30 all the more noteworthy.



A graphic from the original LGP-30 brochure published in 1956.

Rocking Out

In 2020, Caltech graduate students launched the Caltech GPS Outreach GO-Outdoors Program, which connects students, postdocs, and faculty members in the Division of Geological and Planetary Sciences with local K–12 teachers. The program aims to increase exposure and access to geosciences fields through curated lesson plans, classroom visits, and, most importantly, field trips (about eight per year), during which elementary, middle, and high school students have the opportunity to see what they are learning about up close.

The more than three dozen Caltech members of GO-Outdoors also provide teachers and administrators with additional educational resources for their classrooms. In its more than two years, the GO-Outdoors program has reached nearly 250 students across eight Pasadena-area schools and is continuing to grow.

"The outdoor experience for the kids enabled them to visually see and get a deeper conceptual understanding of real-life applications in their own backyard," says Yolanda Muñoz, a teacher at Sierra Madre Elementary School. Muñoz's third- and fourth-grade students learned about landslides and debris flow through a field trip to Bailey Canyon Wilderness Park in Sierra Madre to look at debris catchments. This built on an earlier class visit in which Caltech volunteers taught the students how to construct their own miniature debris flows with water and sand. The children then performed tests to see how much water it took to knock over plastic dinosaurs.

Last year, students from Pasadena Unified, Alhambra Unified, and San Gabriel Unified school districts participated in a field trip to the San Gabriel Mountains, where they developed a real-world understanding of seismic faults. "It was amazing," says Maia Dimas, a Pasadena Unified high school student, who notes the field trip enriched her understanding of geology and seismology. "I loved walking around and trying to find faults, discussing how the faults worked, and how seismologists map out faults and geography."

Shaelyn Silverman (MS '21), a graduate student in geobiology and GO-Outdoors co-founder, says the program is tailored to meet the expressed needs of the teachers. "Our activities always draw upon evidence-based strategies for effective student learning," she explains. "During outreach trips, I always feel incredibly energized from the students' excitement for engaging in science and being in the outdoors."

The Caltech team also purposefully structured GO-Outdoors so it can continue in perpetuity, says Claire Bucholz, a Caltech assistant professor of geology and GO-Outdoors advisor. "It took some very conscientious efforts on their part to design the leadership roles and mentoring structure so that, even with the cycle of graduate students joining and leaving Caltech, there will always be a core group who can lead the endeavor," she says.

Caltech research technician and GO-Outdoors volunteer Katie Ann Huy says the program means a lot to her since she came from an underrepresented background where access to science education was scarce. "Joining GO-Outdoors has given me the opportunity to give back to communities like those I was brought up in and find belonging within the division," she says. "I believe GO-Outdoors and outreach groups like it can allow underrepresented students to feel supported in their identity and their desire to give back to their communities."

Juliet Ryan-Davis (MS '20), a graduate student in geology and GO-Outdoors co-founder, says she is grateful that programs like this one are valued by the Institute community. "The fact that Caltech supports this program just reinforces what I strongly believe: that science and society are inseparable no matter what."

—Sabrina Pirzada