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SN 10 ENVIRONMENT

A biogeochemist is tracking the movements of toxic mercury pollution

Jacqueline Gerson hopes illuminating mercury's movements can help mitigate exposure



Biogeochemist Jacqueline Gerson uncovers the hidden movements of mercury to help reduce human exposure.

SAM WILSON

By **Nikk Ogasa**

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One of the world's richest biodiversity hot spots is Peru's Madre de Dios, a region of the Amazon nestled at the base of the Andes mountains. When

biogeochemist Jacqueline Gerson first traveled there in 2017, she found herself on a boat headed downstream through the forest. As the riverbanks passed by, she observed a scenic shift.

At first, "it was beautiful, primary old-growth forest, lots of birds, lots of different wildlife," says Gerson, a Ph.D. student at Duke University at the time. "Then, as I continued downstream ... first you see these rocks," she adds. "As you keep going, you see pile after pile after pile, and then you started to see some deforestation."

She was witnessing the signs of artisanal and small-scale gold mining. Unlike large-scale industrial operations with fleets of dump trucks and excavators, workers here use basic tools or their own hands to extract ore. These informal gold-mining efforts are so prolific in Madre de Dios that they support [at least half of the region's economy](#).



In Madre de Dios, artisanal and small-scale gold miners tear down lush tracts of Amazonian rainforest to make way for mining operations, leaving behind mounds of sediment and pits that fill with water.

MELISSA MARCHESE

But there is a price to that gain. The small-scale miners mix mercury into riverbank sediments that contain flecks of gold. This produces a gold-mercury amalgam that can easily be separated from the muck and then burned to isolate the gold. But that burning also releases fumes of mercury into the open air.

For Gerson, now at Cornell University, illuminating how toxic contaminants flow through the environment is a calling. She studies how human activities contribute to these contaminants and alter their paths.

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Globally, people unleash more than 2,000 metric tons of mercury into the air each year, from coal combustion plants, waste incineration facilities, cement production sites, mining operations and other sources. Artisanal and small-scale gold mining generates more than 35 percent of these mercury emissions, making it the leading anthropogenic source.

In the environment, bacteria convert the element into the more toxic methylmercury, which bioaccumulates more readily in [wildlife and people](#) (SN: 6/19/14). Exposure to large amounts of mercury can wreak havoc on the central nervous system, digestive tract and kidneys, leading to seizures, blindness, sleep loss, memory loss, headaches, muscle weakness or even death.

Most of Gerson's work is centered on mercury, but she has studied the movements of other hazardous contaminants, such as selenium set loose by coal mining and sulfur released from agriculture. In most cases, Gerson already has a good idea of where the substances are coming from when she begins investigating. It's the rest of the story — where they go, where they end up — that she's after.

Before we can better manage and reduce the risks these contaminants pose to people, she says, "we need to first understand their fate."

An Amazon hot spot

Even before her first trip to Madre de Dios, Gerson was aware that signs of mercury exposure had been reported in communities far upriver of the mining areas. Perhaps people were eating mercury-laden fish that had swum

upstream, but Gerson wondered whether there might be other routes of exposure. So she and colleagues returned to the region gathering samples during the summer of 2018 and the following winter.



Jacqueline Gerson (front) and two undergraduate students collect water samples in the Peruvian Amazon.

ARABELLA CHEN

Unsurprisingly, mercury levels in the air correlated with the proximity to mining. But water shed by leaves in the forest canopy, known as throughfall, offered a more complicated picture. The denser the canopy, [the more concentrated the mercury in the throughfall](#), with the highest levels showing up in a conservation area called the Los Amigos Biological Concession, Gerson and colleagues reported in 2022 in *Nature Communications*. The mercury levels in the throughfall at Los Amigos are “the highest loads of any location in the globe,” Gerson says. “That was really surprising [to find] in this area ... that we think of as being one of the most remote areas in the world.”

What set Los Amigos apart was its pristine, old-growth forest. The large

leaves in the mature forest canopy work like quicksilver collectors, providing wide surfaces for airborne mercury to gather on, accumulate and later be washed to the ground by rain, Gerson says. "If you have a mining community surrounded by old-growth forests, that's where you're going to see really high loads of mercury."

And it wasn't just the leaves. The mining contaminated wildlife too. Mercury levels in feathers from three songbird species with varied diets were on average two to three times higher at Los Amigos than at another old-growth forest located far from mining. Throughfall and shed leaves deliver mercury to the soil, where the contaminant gets methylated by bacteria and consumed by plants and animals, Gerson explains.

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"It's important to get this information out," says biogeochemist Mae Gustin of the University of Nevada, Reno, who was not involved in the research. The impact is more pervasive than people are realizing, she says. "The whole [eco]system is being contaminated."

A spark in Senegal

Gerson's fascination with mercury did not begin in the Amazon, but instead

dates back to a trip to central Senegal. After getting her undergraduate degree at Colgate University in Hamilton, N.Y., she went to Senegal as a volunteer with the Peace Corps.

There, Gerson met another Peace Corps volunteer who had been living in the Kédougou Region, a full day's drive away in southeastern Senegal. "I remember her talking about needing to switch communities because [the] Peace Corps was worried about her personal exposure" to mercury from mining operations there, Gerson says. "It really sparked my interest."

With mercury on her mind, Gerson returned to New York and began a master's program at Syracuse University in 2014. Her master's adviser, Charles Driscoll, provided her with "incredible flexibility to choose what I wanted to do for my thesis," Gerson recalls. Over the next few years, she would publish some of her earliest work on how patterns of mercury and methylmercury evolved over a decade in a remote area of the Adirondack Mountains, kick-starting a career chasing quicksilver.

Research eventually drew Gerson back to Senegal. For a study reported in 2023 in *Cleaner Production Letters*, she and colleagues worked with local community members — more than 80 percent of whom identified as miners — to spread awareness of the dangers of mercury. The team also distributed locally made devices called retorts that mitigate miners' exposure to mercury fumes. Surveys showed [that the work helped](#): The portion of respondents who reported believing that mercury was dangerous increased from 83 to 94 percent, and the percentage of individuals using retorts at least sometimes went up from 3 to 64 percent.

Back in the United States, the movements of contaminants aren't the only pathways that Gerson is bringing attention to. She's also committed to illuminating entryways into science. As a Ph.D. student, she cofounded [GALS](#), a free summer science program that organizes overnight camping and backpacking trips for high school girls and gender nonconforming students. And she coauthored a 2023 article in the *Bulletin of the Ecological Society of America* titled "[Demystifying the graduate school application process](#)."

"There's a lot of hidden curricula in getting into grad school and getting into the sciences in general," Gerson says, that are not easily accessible to those who don't already know the process. "I'm really passionate about trying to make STEM a lot more inclusive, and help people find their way into it as well."

CITATIONS

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