

O'Connor and Johnson's team continued tracking the variant and studying its properties.

Since its discovery, the lineage had gained extra mutations and its genetic diversity had grown — hallmarks of a virus evolving in a single person's body without spreading. Experiments showed that the variant was even better than the Omicron lineage BA.1 at thwarting antibodies triggered by vaccination and previous infection.

But it wasn't clear what risk the variant posed to anyone other than the person carrying it. "The vast majority of these lineages are not transmitting to the best of our knowledge," says O'Connor.

Ryan Westergaard, the state epidemiologist for communicable diseases at the Wisconsin Department of Health and Safety in Madison, says that his team thought long and hard before asking the company and its employees whether they would be tested for SARS-CoV-2. "We didn't want to cause panic and say there's a dangerous new variant lurking in our community," he says. But he wanted to help the person carrying the infection to get treatment — and reduce any risk of spread.

About 60% of the company's employees have come forwards for nasal swab testing but none seems to carry the cryptic lineage. Westergaard's team is now looking out for the variant in community SARS-CoV-2 testing, and in waste water from other Wisconsin sewers. The researchers are also going back to previously collected clinical specimens to see whether the variant has turned up already. "We're remaining vigilant," says Westergaard.

### Gut instinct

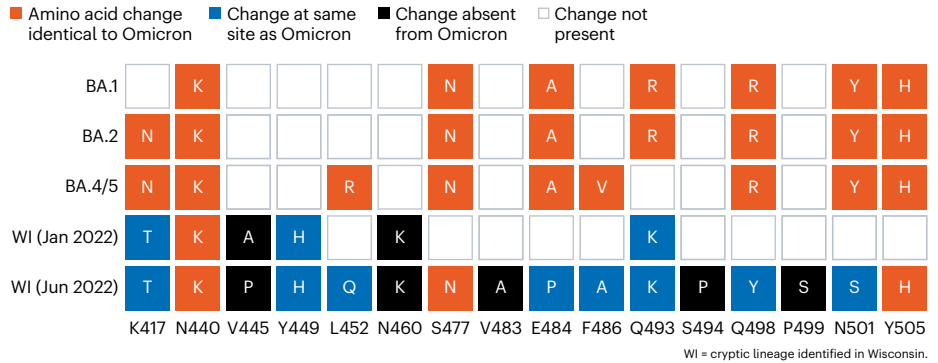
Johnson, O'Connor and their team haven't given up their search. They continue to detect the variant, and at quantities that Johnson has never seen before in waste water. At those levels — and combined with the employees' negative nasal swabs — Johnson wonders whether the infected person is harbouring the virus mainly in their gut, rather than their airways. The team hopes to analyse stool samples from willing employees and is seeking ethical approval for such a study.

Smruthi Karthikeyan, a computational biologist at the University of California, San Diego, noticed something similar while conducting wastewater sequencing at university buildings. Some people shed large quantities of SARS-CoV-2 genetic material for weeks after their airway infections and symptoms disappeared.

Chronic gut infections are a strong candidate for the source of SARS-CoV-2 variants of concern such as Omicron, says Kristian Andersen, an evolutionary biologist at Scripps Research in La Jolla, California. Immune cells in the gut are more tolerant of microorganisms than are those elsewhere

### CRYPTIC COMPARISON

The cryptic SARS-CoV-2 lineage identified in Wisconsin has continued to evolve since researchers discovered it in January 2022. Over six months, the variant has gained several of the same changes to the spike protein as are found in various Omicron lineages — as well as some unique mutations. The changes to the spike receptor-binding domain, shown here, help the virus to evade immune responses.



in the body, potentially allowing the virus to evolve in the presence of some — but not too much — immune pressure. In most cases, such gut infections will never transmit to others, Andersen says — unless something in the body changes and the virus moves back to the airways. "Then that gives the risk of an emergence event like Omicron," he hypothesizes.

Identifying the person in Wisconsin might therefore help researchers to understand how variants such as Omicron emerge, Andersen adds. "What this shows you is the engine of variants," he says. "The detective work they've done is unbelievable."

Even if the researchers cannot identify a person carrying the Wisconsin lineage, studying cryptic lineages like it might help to predict

SARS-CoV-2's future, says O'Connor. Most of its standout mutations are in the spike protein, but his team has identified changes to key regions of another viral molecule, called membrane protein ectodomain, that might also be important to immunity (see 'Cryptic comparison').

Cryptic lineages might not turn out to be the "oracle of the toilet bowl", says O'Connor, but if they can help to forecast broad trends in SARS-CoV-2 evolution, this could help researchers to test vaccines and treatments against potential future variants — which might already be bobbing around a sewer somewhere in the world. "If we see this in Wisconsin by shining a bright light on it," says O'Connor, "you have to know that it's happening everywhere."

## NASA'S MARS ROVER MAKES 'FANTASTIC' FIND IN SEARCH FOR PAST LIFE

Perseverance has collected rocks from an ancient river delta where organisms might have thrived.

By Alexandra Witze

Since July, NASA's Perseverance rover has drilled out and collected four slim cores of sedimentary rock, formed in what was once a lake on Mars. They are the first of this type of rock to be gathered on another world — and scientists are excited because at least two of the cores probably contain organic compounds.

On Earth, organics — certain types of molecule that contain carbon — are often associated with living things, although they can form without the involvement

of organisms.

Adding to the buzz over the rock samples, Perseverance collected them from an ancient delta in Mars's Jezero Crater, where a river once deposited layers of sediment — and possibly other matter. River deltas on Earth often teem with living organisms. If life ever existed in Jezero, these cores are probably NASA's best chance of finding it.

Having the cores is "fantastic" if scientists ever hope to answer that question, says Tanja Bosak, a geobiologist at the Massachusetts Institute of Technology in Cambridge.

In the coming years, NASA and the European

## News in focus

Space Agency plan to send other spacecraft to Jezero to pick up the cores that Perseverance has collected and bring them back to Earth, where scientists will analyse them with advanced laboratory techniques. The samples, which are expected to arrive no earlier than 2033, will be the first ever returned from Mars.

“To undertake the challenge and the expense of a Mars sample-return mission, we need a great suite of rocks to bring back,” Laurie Leshin, director of the Jet Propulsion Laboratory in Pasadena, California, said at a press briefing on 15 September. “We are off to a great start.”

### Sedimentary search

Perseverance landed in the 45-kilometre-wide Jezero Crater in February 2021. Its main goal is to look for signs of past life, and its prime destination is the 3.5-billion-year-old river delta, where sediments long ago turned into rock.

Perseverance spent more than a year making its way to the delta to do its main studies. After landing farther away from the delta than scientists had hoped, it drove around Jezero's floor, where, to researchers' surprise, it found igneous rocks formed directly from molten magma or through volcanic activity. Scientists expected the crater floor, once the bottom of a lake, to contain sedimentary rock.

It wasn't until April 2022, when Perseverance finally arrived at the delta, that scientists found what they had been looking for. In the past few months, the rover has collected two pairs of cores from different types of sedimentary rock that make up the edge of the delta.

One pair comes from an outcrop known as Skinner Ridge, which is made of fine-grained sandstone similar to a type of rock seen in many places on Earth. Viewed up close in Perseverance's sampling tubes, the Skinner Ridge cores are light-coloured and studded with round grains of dark material. These



Perseverance used its robotic arm to collect rock cores from an outcrop called Skinner Ridge, which is part of an ancient river delta on Mars.

darker grains were probably carried by the ancient river that once flowed into Jezero from regions that lie perhaps hundreds of kilometres away. So, studying the grains might tell scientists about the history of far-flung areas of Mars.

The other recently collected pair of cores comes from a spot called Wildcat Ridge, which lies just 20 metres from Skinner Ridge. These samples are lighter in colour, and are more homogeneous. They seem to be a mudstone – even more fine-grained than the Skinner Ridge cores. The finer the grains in a rock, the more likely it is to contain evidence of past life. On Earth, small grains tend to settle out in low-energy environments such as the bottom of a pond, where they can preserve decaying organisms or other signs of life that settle there.

Wildcat Ridge is also where scientists spotted the organic molecules. Next to the sites

from which Perseverance drilled its two cores, the rover ground a 5-centimetre-wide circle into the rock to expose its interior texture. The rover then stretched out its robotic arm and inspected the mineralogy of the rock.

It turned out to be richer in organics than any spot studied by Perseverance so far, said Sunanda Sharma, a planetary scientist at the Jet Propulsion Laboratory. And the organics seem to be most concentrated in spots that are also rich in sulfate minerals, which can harbour signs of life. This suggests that organics and sulfate minerals were concentrated as the lake that once filled Jezero was evaporating, Sharma said.

### Rolling on

Perseverance has already moved on to another area, known as Enchanted Lake, that it had previously explored. There it will work to collect another pair of samples of fine-grained rock, as well as some of the material lying around on the Martian surface.

Sometime before the end of the year, it will probably place six or more core samples on the ground, where they will serve as a first collection of rocks that could be picked up in the future. Perseverance will keep the rest of its tubes on board – some filled and some empty – and continue exploring Jezero. Ultimately, it will roll up on top of the delta and then continue out of the crater, onto the ancient terrain beyond.

Perseverance's sidekick, the miniature helicopter Ingenuity, has lasted much longer than its designers ever thought it would. It recently made its 32nd flight, having been designed for only five. Ingenuity has been flying along with the rover, helping it to scout paths forwards.



The rover examined sedimentary rock at Skinner Ridge (left, containing dark grains) and Wildcat Ridge (right, containing fine grains) by grinding circular patches into it.