

## News in focus

first time since 1972. Starship is nearly twice as powerful as NASA's new mega rocket, the Space Launch System (SLS), which took off for the first time in November.

But researchers say that Starship still has a long way to go to show its worth. There are still a lot of things still to be proved, says Jonathan McDowell, an astrophysicist at the Center for Astrophysics Harvard & Smithsonian in Cambridge, Massachusetts, who tracks space launches. For example, SpaceX will need to demonstrate that Starship and the rocket booster on which it launches can be flown back to Earth and reused for future missions.

### Most powerful rocket

Starship is much larger than other existing space vehicles, which means that more scientific instruments could fit on each flight. It can carry objects up to 8 metres across. That means an observatory such as the James Webb Space Telescope (JWST) could fit inside without having to fold up its 6.5-metre-wide mirror, as was necessary to fit into the 4.6-metre-wide space that was available when it launched. The need to be folded up, and then unfolded in space, made designing and launching JWST much more complicated.

Starship could launch several space telescopes simultaneously to work as an array to probe the Universe, and could allow engineers to use cheaper materials to build observatories because they don't have to worry so much about mass. "Let's see if we can do one of these big machines for half the cost," says Martin Elvis, an astronomer at the Center for Astrophysics.

In planetary science, Starship could enable new types of mission, including crewed and uncrewed trips to Mars. It is designed to carry dozens of people and 100 tonnes of cargo to Mars, which would allow explorers to cache supplies for future missions.

Scientific missions using Starship could include robotic spacecraft to map ice beneath the Martian surface as a resource for future explorers, or instruments that are designed to search for signs of life on Mars, says Jennifer Heldmann, a planetary scientist at NASA's Ames Research Center in Moffett Field, California. "We could do those quickly and take advantage of Starship's capabilities," she says.

Starship could also pull off endeavours such as bringing rocks back from Mars, which NASA and the European Space Agency are currently planning to do with several spacecraft in a complex system over many years. "Starship could enable you to do that in one go," says Tanya Harrison, a planetary scientist at the Outer Space Institute who is based in Seattle, Washington. "It's really a whole new way of being able to think about the possibilities of what you could do on Mars."

Starship is the only existing rocket capable

of sending astronauts to Mars. This could happen through SpaceX alone or in an as-yet undecided partnership with NASA.

### Return to the Moon

For now, NASA is focusing on how Starship can help with its Artemis missions. In 2021, the agency gave SpaceX US\$2.9 billion towards

development of the vehicle; it followed this with another \$1.15 billion in November 2022. NASA plans to use the SLS to send astronauts to the Moon and then transfer them to Starship to descend to the lunar surface. Starship can be refuelled in space, allowing it to act as a sort of ferry service down to and back up from the Moon's surface.

# HOW A RURAL SCHOOL TEACHER BECAME A TOP COVID SLEUTH

Indiana man is among a cadre of community scientists who scour the SARS-CoV-2 genome for mutations.

By Max Kozlov

In late January, a team of scientists reported an ominous discovery: the widely used COVID-19 drug molnupiravir might be spurring the evolution of SARS-CoV-2 variants (T. Sanderson *et al.* Preprint at medRxiv <https://doi.org/j6rp>; 2023). Four of the authors work at prominent UK universities. But one has neither attended graduate school nor stepped foot in a research laboratory.

The outlier is Ryan Hisner, a school science teacher from rural Monroe, Indiana. He has attracted notice from leading virologists from all over the world for his uncanny ability to detect unusual mutations in the SARS-CoV-2 genome – mutations that might be a harbinger of the next variant to sweep the world.

Hisner is just one of a motley crew of

self-taught 'community scientists' from around the globe who spend hours poring through genetic sequences to track SARS-CoV-2's evolution. Among the ranks are science enthusiasts, retired researchers and anonymous sleuths who go only by their online usernames. Most do this work for no pay.

They might be amateurs, but their work is indispensable, says Jesse Bloom, an evolutionary virologist at Fred Hutchinson Cancer Center in Seattle, Washington. SARS-CoV-2 spawns variants at a rapid clip, leaving scientists such as Bloom scrambling to keep up. Hisner's Twitter profile, which has now garnered more than 15,000 followers, is one of Bloom's first stops to stay up to speed on the latest mutations and publications, he says.

### Biology by the book

"Ryan has an almost encyclopaedic knowledge of the virus," Bloom says. "It's refreshing to see someone who is so up to speed on the literature – more so than any other 'professional' I've ever met."

SARS-CoV-2 mutates quickly, and there is an "unprecedented flood of data": tens of thousands of viral genetic sequences are added to online repositories every day, says Angie Hinrichs, a bioinformatician at the University of California, Santa Cruz. Trained public-health officials monitor these uploads, but "it really helps to have more eyes", says Hinrichs.

Tom Peacock, a virologist at Imperial College London who co-authored the molnupiravir study, which has not yet been peer reviewed, says that without Hisner and other community scientists, new SARS-CoV-2 mutations "would go under the radar for a little longer. Even a couple days' advance notice can be really helpful for updating vaccines if need be."

After COVID-19's onset in 2020, Hisner's students would ask him questions about the



Teacher Ryan Hisner spends hours every week poring over SARS-CoV-2 sequences.

CHERYL HISNER

pandemic that stumped him. To find answers and to track the latest research, Hisner started following scientists on Twitter. When it became evident in mid-2021 that SARS-CoV-2 variants would threaten efforts to control viral spread, Hisner became curious about how mutations were helping the virus to evade immunity. His curiosity landed him in small group chats in which scientists discussed the technical minutiae of emerging SARS-CoV-2 mutations. He realized he had large gaps in his knowledge of basic biology and sought textbook recommendations from the group members.

After a year of lurking in these group chats and reading textbooks, Hisner learnt how to download coronavirus sequences from online databases and compare them with millions of others using phylogenetic software. Soon he started to contribute to Pango, a group that tracks and names SARS-CoV-2 lineages.

### Sequence spotter

Bioinformatician Áine O'Toole at the University of Edinburgh, UK, helped to create Pango, which initially included about a dozen scientists. But it soon became clear that there were far too many samples for the original Pango members to track them all, Hinrichs says. In early 2021, O'Toole spread the word about an online site where users can submit proposals for new lineages, which opened this process to the world. Today, most lineage proposals come from community scientists, Hinrichs says.

Hisner first proposed a new SARS-CoV-2 lineage in June 2022. He has since made more than 100 more proposals, making up about 7% of all submissions, and has become a specialist in identifying variants from chronic infections – rare cases in which someone doesn't clear the virus within a few weeks, offering it ample opportunity to mutate and adapt to human hosts. Even during the school year, he has continued to devote an hour every morning and a couple more in the evening to variant-hunting.

### Going pro

Although Hisner is not compensated for his work, his labour has paid dividends: Darren Martin, a bioinformatician at the University of Cape Town in South Africa, reached out through Twitter to offer Hisner the opportunity to do research and obtain a graduate degree. "That's my unusual path to graduate school, thanks to Twitter," says Hisner.

For now, he plans to complete his graduate work remotely and continue teaching. But he's open to the idea of pursuing a doctorate after he finishes his master's work.

Peacock says it's been refreshing to have community scientists help with surveillance. "People in academia get jaded, so it's nice to work with someone so enthusiastic" such as Hisner, he says.



A World Mosquito Program worker releases modified mosquitoes in Niterói, Brazil.

# MASSIVE MOSQUITO FACTORY IN BRAZIL AIMS TO HALT DENGUE

Facility will produce up to five billion bacteria-infected mosquitoes per year.

By Mariana Lenharo

**T**he non-profit World Mosquito Program (WMP) has announced that it will release modified mosquitoes in many of Brazil's urban areas over the next 10 years, with the aim of protecting up to 70 million people from diseases such as dengue. Researchers have tested the release of this type of mosquito – which carries a *Wolbachia* bacterium that stops the insect from transmitting viruses – in select cities in countries such as Australia, Brazil, Colombia, Indonesia and Vietnam. But this will be the first time that the technology is dispersed nationwide.

**"We're interested in how we can distribute mosquitoes in communities in an automated way."**

A mosquito factory will be built in a location yet to be determined in Brazil to supply the WMP's ambitious initiative, in partnership with the Oswaldo Cruz Foundation (Fiocruz), a Brazilian public science institution in Rio de Janeiro. The facility should begin operating in 2024 and will produce up to five billion

mosquitoes per year. "This will be the biggest facility in the world" to produce *Wolbachia*-infected mosquitoes, says Scott O'Neill, a microbiologist at Monash University in Melbourne, Australia, and head of the WMP. "And it will allow us in a short period of time to cover more people than in any other country." Brazil has one of the highest rates of dengue infection in the world, reporting more than two million cases in 2022.

Despite the positive results from past mosquito releases, researchers expect that it will be challenging to operate the technology at such a massive scale.

### A competitive bacterium

The bacterium *Wolbachia pipiensis* naturally infects about half of all insect species. *Aedes aegypti* mosquitoes, which transmit dengue, Zika, chikungunya and other viruses, don't normally carry the bacterium, however. O'Neill and his colleagues developed the WMP mosquitoes after discovering that *A. aegypti* infected with *Wolbachia* are much less likely to spread disease. The bacterium outcompetes the viruses that the insect is carrying.

When the modified mosquitoes are released into areas infested with wild *A. aegypti*, they slowly spread the bacteria to the wild mosquito population.