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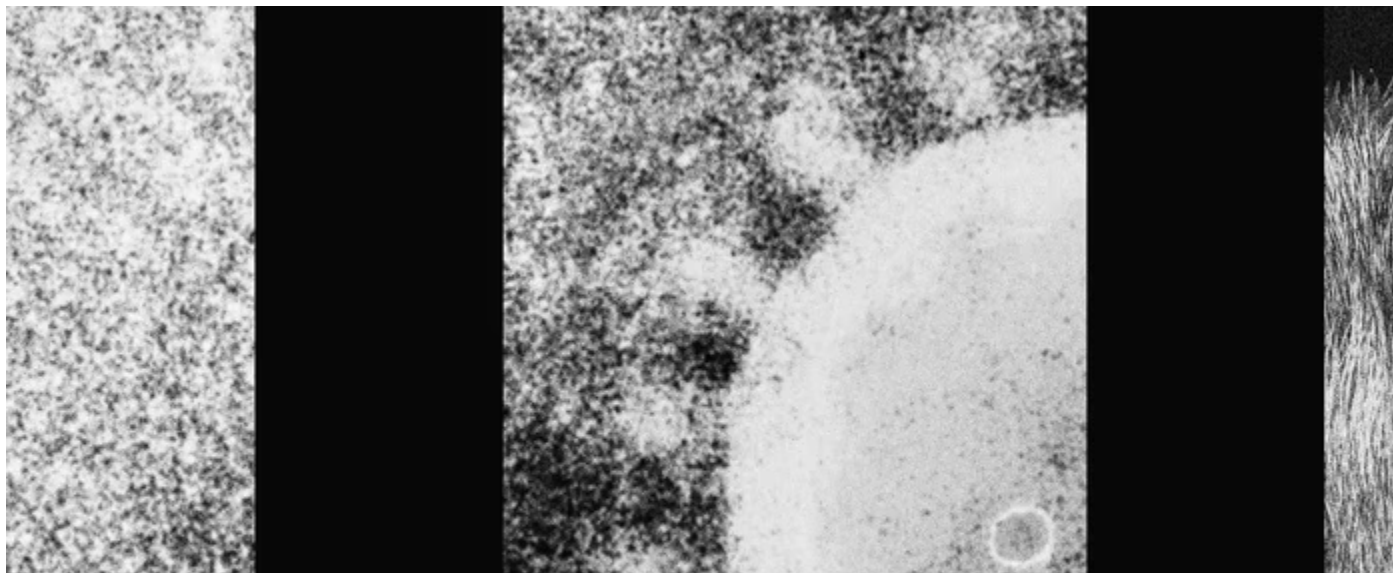
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SCIENCE

The Strongest Evidence Yet That an Animal Started the Pandemic

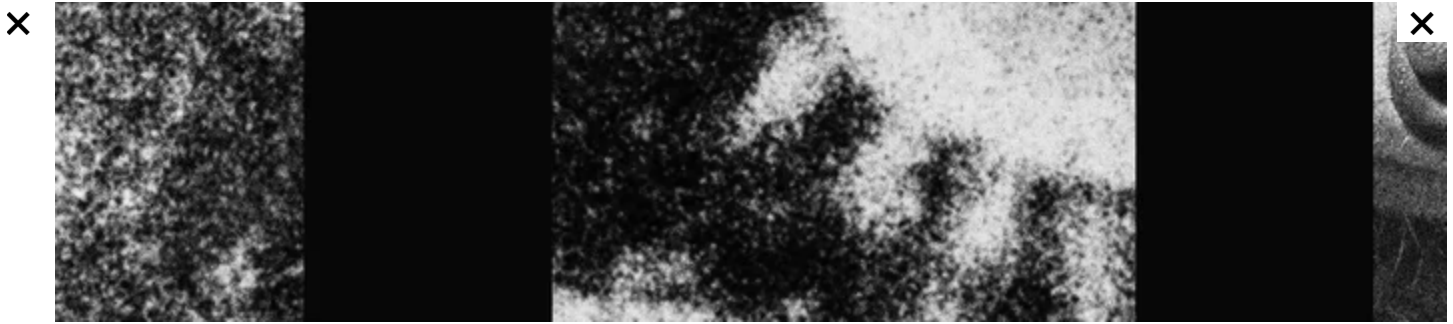
A new analysis of genetic samples from China appears to link the pandemic's origin to raccoon dogs.

By Katherine J. Wu



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For three years now, the debate over the origins of the coronavirus has ping-ponged between two big ideas: that SARS-CoV-2 spilled over from wild-animal source populations directly from a wild-animal source, and that the pathogen came from a lab. Through a swirl of data obfuscation by Chinese authorities and politicalization within the United States, and rampant speculation in the corners of the world, many scientists have stood by the notion that the outbreak—like most others—had purely natural roots. But that has been missing a key piece of proof: genetic evidence from the Seafood Wholesale Market in Wuhan, China, showing that the market was selling infected creatures for sale there.

This week, an international team of virologists, genomicists, and ecologists may have finally found crucial data to help fill that knowledge gap. A new analysis of genetic sequences collected from the market shows that raccoon dogs being illegally sold at the venue could have been carrying the virus, possibly shedding the virus at the end of 2019. It's some of the strongest support yet, experts told me, that the pandemic began when SARS-CoV-2 hopped from animals into humans, rather than in an accident at a

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scientists experimenting with viruses.

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“This really strengthens the case for a natural origin,” says Seema virologist at Emory who wasn’t involved in the research. Angela virologist involved in the research, told me, “This is a really strong case that animals at the market were infected. There’s really no other explanation that makes any sense.”

The findings won’t fully silence the entrenched voices on either side of the origins debate. But the new analysis may offer some of the clearest and most compelling evidence that the world will *ever* get in support of a natural origin for the virus that, in just over three years, has killed nearly 5 million people worldwide.

Read: The lab leak will haunt us forever

The genetic sequences were pulled out of swabs taken in and near Wuhan around the pandemic’s start. They represent the first bits of raw genomic data that researchers outside of China’s academic institutions and their direct collaborators have had access to. Late last week, the data were quickly shared by researchers affiliated with the country’s Center for Disease Control and Prevention, on an open-access genomic database called GISAID. It was a pure happenstance, scientists in Europe, North America, and Australia found the sequences, downloaded them, and began an analysis.

The samples were already known to be positive for the coronavirus, and had been scrutinized before by the same group of Chinese researchers who uploaded the data to GISAID. But that prior

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analysis, released as a preprint publication in February 2022, asserted that “no animal host of SARS-CoV-2 can be deduced.” Any motes of coronavirus at the market, the study suggested, had most likely been chauffeured in by infected humans, rather than wild creatures for sale.

The new analysis, led by Kristian Andersen, Edward Holmes, and Michael Worobey—three prominent researchers who have been looking into the virus’s roots—shows not be the case. Within about half a day of downloading the data from GISAID, the trio and their collaborators discovered that several samples that tested positive for SARS-CoV-2 were also coming full of animal genetic material—much of which was a match for raccoon dog. Because of how the samples were gathered, and because they can’t persist by themselves in the environment, the scientists think these findings could indicate the presence of a coronavirus-infected raccoon dog at the spots where the swabs were taken. Unlike many of the other theories in the discussion that have been volleyed about in the origins debate, these data are “tangible,” Alex Crits-Christoph, a computational biologist of the scientists who worked on the new analysis, told me. “And it’s about a species that everyone has been talking about.”

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Finding the genetic material of virus and mammal so closely —enough to be extracted out of a single swab—isn't perfect pro told me. "It's an important step, I'm not going to diminish that, Still, the evidence falls short of, say, isolating SARS-CoV-2 from ranging raccoon dog or, even better, uncovering a viral sample s mammal for sale at Huanan from the time of the outbreak's ons be the virological equivalent of catching a culprit red-handed. B never go back in time and capture those animals," says Gigi Gro scholar at the Johns Hopkins Center for Health Security. And to knowledge, "raccoon dogs were not tested at the market and had removed prior to the authorities coming in," Andersen wrote to email. He underscored that the findings, while an important ad not "direct evidence of infected raccoon dogs at the market."

Still, the findings don't stand alone. "Do I believe there were inf at the market? Yes, I do," Andersen told me. "Does this new dat evidence base? Yes." The new analysis builds on extensive previo that points to the market as the source of the earliest major out CoV-2: Many of the earliest known COVID-19 cases of the par clustered roughly in the market's vicinity. And the virus's genetic found in many samples swabbed from carts and animal processi at the venue, as well as parts of nearby infrastructure, such as stc sewage wells, and water drains. Raccoon dogs, creatures commo sale in China, are also already known to be one of many mamm can easily catch and spread the coronavirus. All of this left one r the puzzle to fill: clear-cut evidence that raccoon dogs and the v the exact same spot at the market, close enough that the creatur been infected and, possibly, infectious. That's what the new anal Think of it as finding the DNA of an investigation's main suspec

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of the crime.

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The findings don't rule out the possibility that other animals may be carrying SARS-CoV-2 at Huanan. Raccoon dogs, if they were involved, would not even be the creatures who passed the pathogen on to us. We need to search for the virus's many wild hosts will need to plod on. "Do you think an intermediate host was raccoon dogs? No," Andersen wrote to me. "Do you have a term for an animal that can ferry a pathogen between other species? Yes, but it's definitely not the one I had in mind."

On Tuesday, the researchers presented their findings at a hastily convened meeting of the World Health Organization's Scientific Advisory Group of Experts on the Origins of Novel Pathogens, which was also attended by several Chinese researchers responsible for the original analysis, according to a source. Other researchers who were not present but were briefed about it before the meeting included multiple people who were there.

Shortly after the meeting, the Chinese team's preprint went into *Nature Research* journal—suggesting that a new version was being prepared for publication. (I reached out to the WHO for comment and verification of the story when I have more information.)

At this point, it's still unclear why the sequences were posted to GISAID in the first place. They also vanished from the database shortly after appearing. When I emailed George Gao, the former China CDC director and the lead author on the original Chinese analysis, asking for the team's rationale, I didn't immediately receive a response. Given the GISAID data, it does seem that raccoon dogs could have been

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into and clarified the origins narrative far sooner—at least a year or two likely more.

China has, for years, been keen on pushing the narrative that the virus didn't start within its borders. In early 2020, a Chinese official said the novel coronavirus may have emerged from a U.S. Army lab in Wuhan. The notion that a dangerous virus sprang out from wet-market markets echoed the beginnings of the SARS-CoV-1 epidemic two decades ago. At this time, officials immediately shut down the Huanan market, and vehemently pushed back against assertions that live animals being sold illegally in the the country were to blame; a WHO investigation in January 2021 took the same line. “No verified reports of live mammals being sold around 2019 were found,” the report stated. But just three months later, in June 2021, a team of researchers published a study documenting thousands of mammals for sale in wet markets in Wuhan between late 2019, including at Huanan. The animals were kept in largely cramped, and unhygienic settings—conditions conducive to virus transmission—and among them were more than 1,000 raccoon dogs. One himself had been at the market in 2014 and snapped a photo at the market clearly showing a raccoon dog in a cage; another set of images from the market captured by a local in December 2019 and later shared on Weibo showed animals on film as well—right around the time that the first recorded CoV-2 infections in humans occurred.

And yet, Chinese researchers maintained their stance. As Jon Cohen wrote for Science magazine last year, scientists from several of China's leading academic institutions posted a preprint in September 2021 concluding a massive nationwide survey of bats—the likeliest original source of the coronavirus before it jumped into an intermediate host, such as

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and then into us—had turned up no relatives of SARS-CoV-2.✕
 implication, the team behind the paper asserted, was that relative
 coronavirus were “extremely rare” in the region, making it unlik
 pandemic had started there. The findings directly contradicted c
 that cousins of SARS-CoV-2 were indeed circulating in China’s
 bats have also been found to harbor viruses related to SARS-Co

The original Chinese analysis of the Huanan market swabs, from
 2022, also stuck with China’s party line on the pandemic. One o
 graphs suggested that viral material at the market had been mixe
 genetic material of *multiple* animal species—a data trail that sho
 to further inquiry or conclusions, but which the Chinese researc
 have ignored. Their report noted only humans as being linked to
 CoV-2, stating that its findings “highly” suggested that any viral
 the market came from people (at least one of whom, presumably
 elsewhere and ferried it into the venue). The Huanan market, th
 authors wrote, “might have acted as an amplifier” for the epidem
 work involving international coordination” would be needed to
 “real origins of SARS-CoV-2.”

The wording of that report baffled many scientists in Europe, N
 and Australia, several of whom had, almost exactly 24 hours afte
 of the China CDC preprint, published early versions of their ov
 concluding that the Huanan market was the pandemic’s probabl
 and that SARS-CoV-2 might have made its hop into humans fr
twice at the end of 2019. Itching to get their hands on China Cl
 some of the researchers took to regularly trawling GISAID, occa
 odd hours—the only reason that Florence Débarre, an evolutio
 at the French National Centre for Scientific Research, spotted th

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pinging onto the server late last Thursday night with no warning, ×,

Within hours of downloading the data and starting their own analyses, researchers found their suspicions confirmed. Several surfaces in one stall at the market, including a cart and a defeathering machine, had virus-positive samples that also contained genetic material from raccoons—in a couple of cases, at higher concentrations than of humans. It was Stall 29—the same spot where Holmes had snapped the picture of the raccoon dog, nearly a decade before.

Slam-dunk evidence for a raccoon-dog host—or another animal to emerge. In the hunt for the wild source of MERS, another coronavirus that caused a deadly outbreak in 2012, researchers were eventually able to identify the pathogen in camels, which are thought to have caught their infection from bats—and which still harbor the virus today; a similar path has played out for Nipah virus, which hopscoched from bats to

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Proof of that caliber, though, may never turn up for SARS-CoV-2. (The wild origins of Ebola is rarely simple: Despite a years-long search, the wild source of Ebola still has not been definitively pinpointed.) Which leaves just a sliver of ambiguity to keep debate about the pandemic's origins running, indefinitely. Skeptics will likely be eager to poke holes in the team's findings—pointing out, for instance, that it's technically possible for material from viruses and animals to end up sloshed together in a common environment even if an infection didn't take place. Maybe an individual visited the market and inadvertently deposited viral RNA near a crate.

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But an infected animal, with no third-party contamination, s...
 the most plausible explanation for the samples' genetic contents
 experts told me; other scenarios require contortions of logic and
 important, additional proof. Even prior to the reveal of the new
 Gronvall told me, "I think the evidence is actually more sturdy f
 than it is for many others." The strength of the data might even,
 way, best what's available for SARS-CoV-1: Although scientists l
SARS-CoV-1-like viruses from a wet-market-traded mammal ho
 civet, those samples were taken months after the outbreak began
 viral variants found weren't exactly identical to the ones in huma
 The versions of SARS-CoV-2 tugged out of several Huanan-mar
 meanwhile, are a dead ringer for the ones that sickened humans
 early on.

The debate over SARS-CoV-2's origins has raged for nearly as lo
 pandemic itself—outlasting lockdowns, widespread masking, ev
 version of the COVID vaccines. And as long as there is murkine
 it may never fully resolve. While evidence for an animal spillove
 over time, so too have questions about the possibility that the vi
 from a laboratory. When President Biden asked the U.S. intellig
 community to review the matter, four government agencies and
 Intelligence Council pointed to a natural origin, while two othe
 it was a lab leak. (None of these assessments were made with hig
 a bill passed in both the House and Senate would, 90 days after
 law, require the Biden administration to declassify underlying in

If this new level of scientific evidence does conclusively tip the c
 toward the animal route, it will be, in one way, a major letdown
 that SARS-CoV-2 breached our borders because we once again 1