

WHAT THE CRUISE-SHIP OUTBREAKS REVEAL ABOUT COVID-19

Closed environments are an ideal place to study how the new coronavirus behaves.

By Smriti Mallapaty

When COVID-19 was detected among passengers on the cruise ship *Diamond Princess*, the vessel offered a rare opportunity to understand features of the new coronavirus that are otherwise hard to investigate. Some of the first studies from the ship have provided estimates of the disease's severity and allowed researchers to investigate the share of infections with no symptoms.

Information gleaned from such outbreaks is crucial for people making decisions on how to manage the epidemic, say researchers.

"Cruise ships are like an ideal experiment of a closed population. You know exactly who is there and at risk and you can measure everyone," says John Ioannidis, an epidemiologist at Stanford University in California. This is different from studying the spread in a wider population, where only some people, typically with severe symptoms, are tested and monitored.

On 1 February, a passenger who had disembarked from the *Diamond Princess* days earlier in Hong Kong tested positive for the COVID-19 coronavirus. The ship was quarantined immediately after it arrived in Japanese waters on 3 February, with 3,711 passengers and crew members on board. Over the next month, more than 700 people were infected.

Outbreaks seed easily on cruise ships because of the close confines and high proportions of older people, who tend to be more vulnerable to the disease. Since the *Diamond Princess*, at least 25 other such vessels have confirmed COVID-19 cases – including 78 cases on the *Grand Princess*, which was quarantined off the coast of California.

Japanese officials ran more than 3,000 tests aboard the *Diamond Princess*. Testing almost all of the passengers and crew helped researchers to understand a key blind spot in many infectious-disease outbreaks – how many people are actually infected, including those who have mild symptoms or none at all. These cases often go undetected in the population.

One team reports in *Eurosurveillance* that by 20 February, 18% of all infected people on the ship had no symptoms (K. Mizumoto *et al. Euro Surveill.* **25**, 2000180; 2020). "That is a substantial number," says co-author Gerardo

Chowell, an epidemiologist at Georgia State University in Atlanta.

Another team used data from the ship to estimate that in China, the proportion of deaths among people confirmed to have the disease – the case fatality rate (CFR) – was 1.1% (T. W. Russell *et al. Preprint at medRxiv* <http://doi.org/dqrk>; 2020), lower than the 3.8% estimated by the World Health Organization.

The agency divided China's total number of deaths by the number of confirmed infections,

says Timothy Russell, an epidemiologist at the London School of Hygiene and Tropical Medicine. This does not take into account that only a fraction of infected people are tested, and makes the disease seem more deadly than it is, he says.

Russell and his colleagues used data from the ship – where almost everyone was tested, and all 7 deaths recorded – and compared it with more than 72,000 confirmed cases in China, making their CFR estimate more robust.

The group also estimates that the infection fatality rate (IFR) in China – the proportion of all infections, including asymptomatic ones, that result in death – is even lower, at roughly 0.5%. The IFR is especially tricky to calculate in the population, because some deaths go undetected if the person didn't show symptoms.

The IFR helps public-health officials to understand disease severity and how to intervene, says Marc Lipsitch, an infectious-disease epidemiologist at the Harvard T.H. Chan School of Public Health in Boston, Massachusetts.

RARE OZONE HOLE OPENS OVER THE ARCTIC — AND IT'S BIG

Cold temperatures created the hole, which is about three times the size of Greenland.

By Alexandra Witze

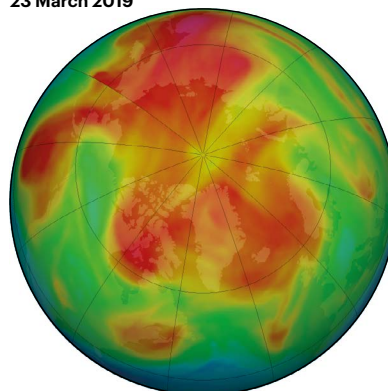
Avast ozone hole – probably the biggest on record in the north – has opened in the skies above the Arctic. It rivals the better-known Antarctic ozone hole that forms in the Southern Hemisphere each year.

Record-low ozone levels currently stretch across much of the central Arctic, covering an area about three times the size of Greenland (see 'Arctic opening'). The hole doesn't threaten people's health, and will probably disappear in the coming weeks. But it is an extraordinary atmospheric phenomenon that will go down in the record books.

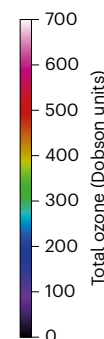
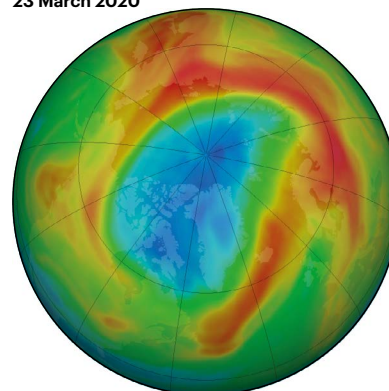
ARCTIC OPENING

A rare and record ozone hole has formed over the Arctic. An opening in the ozone layer appears each spring over the Antarctic, but the last time this phenomenon was seen in the north was in 2011.

23 March 2019



23 March 2020



SOURCE: NASA OZONE WATCH

“From my point of view, this is the first time you can speak about a real ozone hole in the Arctic,” says Martin Dameris, an atmospheric scientist at the German Aerospace Center in Oberpfaffenhofen.

Ozone normally forms a protective blanket in the stratosphere, about 10 to 50 kilometres above the ground, where it shields life from solar ultraviolet radiation. But each year in the Antarctic winter, frigid temperatures allow high-altitude clouds to coalesce above the South Pole. Chemicals, including chlorine and bromine, which come from refrigerants and other industrial sources, trigger reactions on the surfaces of those clouds that chew away at the ozone layer. These cold conditions are much rarer in the Arctic, which has more-variable temperatures and isn't usually primed for ozone depletion, says Jens-Uwe Grooß, an atmospheric scientist at the Jülich Research Centre in Germany.

But this year, powerful westerly winds flowed around the North Pole and trapped cold air in a ‘polar vortex’. There was more cold air above the Arctic than in any winter recorded since 1979, says Markus Rex, an atmospheric scientist at the Alfred Wegener Institute in Potsdam, Germany. In the chilly temperatures, the high-altitude clouds formed, and the ozone-destroying reactions began.

Balloon measurements

Researchers measure ozone levels by releasing weather balloons from observing stations around the Arctic. By late March, these balloons had measured a 90% drop in ozone at an altitude of 18 kilometres, which is right in the heart of the ozone layer. Where the balloons would normally measure around 3.5 parts per million of ozone, they recorded only around 0.3 parts per million, says Rex. “That beats any ozone loss we have seen in the past,” he notes.

The Arctic experienced ozone depletion in 1997 and in 2011 (G. L. Manney *et al.* *Nature* 478, 469–475; 2011), but this year's loss looks on track to surpass those. “We have at least as much loss as in 2011, and there are some indications that it might be more than 2011,” says Gloria Manney, an atmospheric scientist at NorthWest Research Associates in Socorro, New Mexico. She works with a NASA satellite instrument that measures chlorine in the atmosphere, and says there is still quite a bit of chlorine available to deplete ozone in the coming days.

The Arctic ozone hole isn't a health threat because the Sun is only just starting to rise above the horizon in high latitudes, says Rex. However, in the coming weeks, there is a small possibility that the hole will drift to lower latitudes over more populated areas – in which case, people might need to apply sunscreen to avoid sunburn. “It wouldn't be difficult to deal with,” Rex says.

TOUGH CHOICES LOOM FOR RESEARCHERS WORKING WITH ANIMALS

Cull, release or relocate: scientists are struggling to protect their research and their lab animals.

By Anna Nowogrodzki

The eggs were close to hatching, but Vivian Páez wasn't sure they would survive. She and her husband Brian Bock, both herpetologists, were incubating nearly 100 temperature-sensitive turtle and tortoise eggs in their laboratory at the University of Antioquia in Medellín, Colombia. By 17 March, they realized that a lockdown due to COVID-19 was imminent.

The next day, as the university shut down all of its research and teaching activities, Bock and Páez carefully moved all of the eggs into their garage at home. They placed them in plastic containers on Bock's workbench, covered them with a tarpaulin and held their breath.

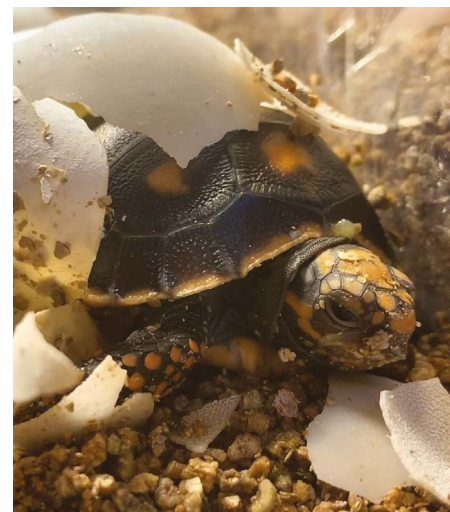
Researchers everywhere are facing difficult decisions over what to do with research organisms amid lockdowns, university closures and shelter-in-place orders. Some scientists are able to care for animals in their usual facilities, with animal-care workers taking extra precautions for social distancing. Others, like Bock and Páez, have taken animals home or re-released wild-caught specimens. And many creatures have been, or will be, killed, particularly small animals such as mice.

Life-and-death decisions

The choices are particularly hard for scientists whose work directly affects human patients. Maria Eugênia Duarte, research chief at the National Institute of Traumatology and Orthopedics in Rio de Janeiro, Brazil, oversees studies on rare and malignant sarcomas, mostly in children. Her team cares for roughly 100 immunocompromised mice, which have been implanted with patient tumours to study how these grow and how best to treat them.

With Rio on lockdown, only one researcher can go into the animal facility per day. Duarte herself can't, because she's over 60. Her lab members take turns spending 12 hours in the lab feeding the mice, cleaning and sterilizing cages, and checking on the animals' health. But if equipment breaks, such as the machine used to sterilize the cages, no one will be able to fix it. “We don't know how long this is going to be possible,” Duarte says. “Maybe we will need to prioritize and sacrifice [some of] the animals.”

Many labs have already taken this difficult decision. One researcher at Oregon Health &



A tortoise hatches, shortly after relocation.

Science University has had to euthanize more than two-thirds of her mice. Elsewhere in the United States, a researcher at Carnegie Mellon University reports culling 600 mice; two scientists at Harvard say they have had to kill half of their research mice; and a team at the Memorial Sloan Kettering Cancer Center has been asked to designate no more than 60% of its animals as essential.

The Jackson Laboratory, a non-profit biomedical research institute based in Bar Harbor, Maine, that sells millions of research mice per year, has noticed a several-fold increase in requests to freeze mouse sperm or embryos so that specific lines can be re-established later, says Rob Taft, a senior programme manager at Jackson. The institute has sent trucks to various cities to collect mice for cryopreservation; more pickups are planned.

But for some labs, particularly those that use wild-caught research organisms, there are few options when it comes to maintaining or preserving a research programme. Solomon David, a fish biologist at Nicholls State University in Thibodaux, Louisiana, decided last week to re-release 48 wild spotted gar (*Lepisosteus oculatus*) that his team had recently collected.

As for Páez and Bock's turtles, about 15 eggs have hatched so far, and the animals are living with the family until travel restrictions are lifted and they can be returned to their wild habitats. “At least we don't work with jaguars or crocodiles,” Páez says.