In 2020, the rate of spread was three times faster among wild birds than in farmed poultry, because of mutations that allowed the virus to adapt to diverse species.

“What was once very clearly a poultry pathogen has now become an animal-health issue much more broadly,” says Andy Ramey, a wildlife geneticist at the US Geological Survey Alaska Science Center in Anchorage. “That has implications for wildlife and domestic poultry as well as us humans that rely upon these resources.”

Persistent outbreaks

H5N1, classified as a highly pathogenic avian influenza (HPAI) virus because of its high death toll in poultry, first infected birds in China in 1996. Outbreaks are usually seasonal, synchronizing with bird migration in the Northern Hemisphere autumn. But since November 2021, they have become persistent. In 2022, the virus killed millions of birds across five continents and seeded outbreaks among farmed mink and various marine mammals.

To study changes in the virus’s behaviour, the authors examined data reported to the Food and Agricultural Organization of the United Nations and the World Organisation for Animal Health between 2005 and 2022, and analysed more than 10,000 viral genomes.

Their work reveals that in mid-2020, a new H5N1 strain evolved from an earlier variety, called H5N8, which first emerged in poultry in Egypt between 2016 and 2017 and caused global flare-ups throughout 2020 and 2021 (see ‘Bird flu outbreaks’). The new H5N1 virus mutated through interactions with non-deadly varieties of bird flu, called low-pathogenic avian influenza (LPAI) viruses, that had been circulating among wild birds in Europe since 2019.

It developed two subtypes in 2021 and 2022. One spread across the northern coastal regions of central Europe and was eventually carried to North America by birds migrating across the Atlantic Ocean. The other was carried around the Mediterranean Sea and into Africa.

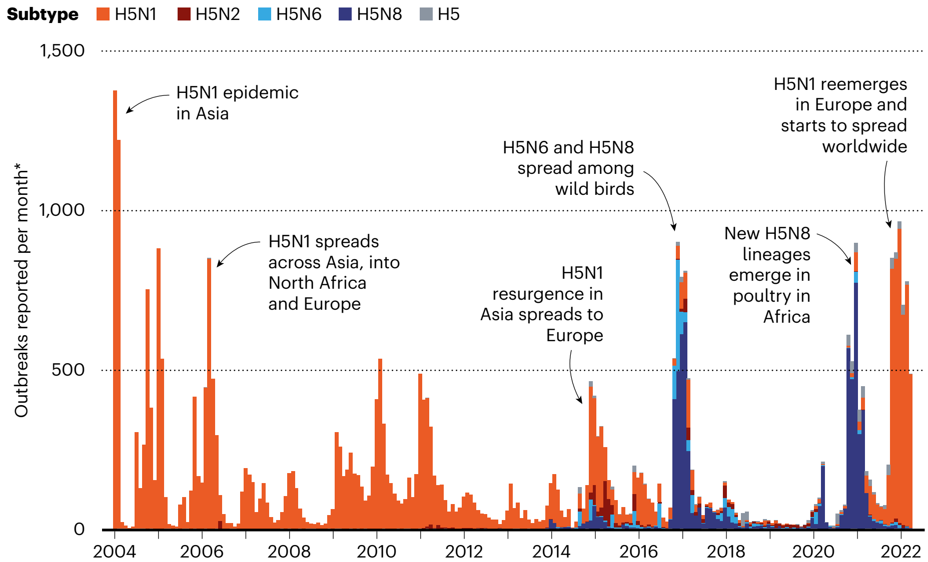
Many bird flu outbreaks begin in poultry, but spillover into wild birds has spread the disease into larger areas, creating a global challenge that is difficult to manage, the study found.

“Once it’s adapted to wild birds, we have no mechanism to control the virus. And I think that’s the biggest impact that has changed now,” says co-author Vijaykrishna Dhanasekaran, an evolutionary biologist and virologist at the University of Hong Kong.

Louise Moncla, an evolutionary virologist at the University of Pennsylvania in Philadelphia, agrees. “Regardless of how much outbreak response you do in poultry, if it’s coming in from wild birds repeatedly, this is going to be really hard to manage.”

BIRD FLU OUTBREAKS

Since the early 2000s, seasonal outbreaks of avian influenza have affected both wild and domestic birds. The highly pathogenic H5N1 strain is currently circulating worldwide.



*Data from the Food and Agriculture Organization of the United Nations

SOURCE: R. XIE *ET AL.* *NATURE* HTTPS://DOI.ORG/KZ6J (2023)

“This is really something that most of the world at this point has skin in the game,” adds Ramey.

Mixing viruses

LPAI viruses often circulate freely in poultry and wild birds. Previous infection with these non-deadly strains is thought to encourage population immunity in wild birds. “You can think of it as an imperfect vaccine, that doesn’t stop infection, but it helps mitigate the effects of disease,” says Ramey.

But “there’s probably two sides of the coin here”, he adds. HPAI viruses can mutate through interactions with LPAI ones. In both, the genome is split into eight segments that can be mixed and matched. “When two viruses co-infect the same cell, they could swap their genes when the virus is getting packaged,” says Dhanasekaran.

Because of this, LPAI viruses — especially a strain called H9N2 — play a major part in the evolution of H5N1, Dhanasekaran adds. But they are not well monitored, he says. “Eradication or elimination strategies that target these low pathogenic viruses would be a huge step forward in terms of controlling avian influenza itself.”

REPRODUCIBILITY GOES ON TRIAL IN ECOLOGY

With same data sets, 246 biologists get different results — showing how analytical choices drive conclusions.

By Anil Oza

In a massive exercise to examine reproducibility, more than 200 biologists analysed the same sets of ecological data — and got widely divergent results. The first sweeping study of its kind in ecology demonstrates how much results in the field can vary, not because of differences in the environment, but because of scientists’ analytical choices (E. Gould *et al.* Preprint at EcoEvoRxiv https://doi.org/gswhwr; 2023).

“There can be a tendency to treat individual papers’ findings as definitive,” says Hannah Fraser, an ecology meta researcher at the University of Melbourne in Australia and a co-author of the study. But the work shows that “we really can’t be relying on any individual result or any individual study to tell us the whole story”.

Variation in results might not be surprising, but quantifying that variation in a formal study could catalyse a larger movement to improve reproducibility, says Brian Nosek, executive director of the Center for Open Science in Charlottesville, Virginia, who has driven discussions about reproducibility in the social sciences.

"This paper may help to consolidate what is a relatively small, reform-minded community in ecology and evolutionary biology into a much bigger movement, in the same way as the reproducibility project that we did in psychology," he says. It would be hard "for many in this field to not recognize the profound implications of this result for their work".

The study was published as a preprint on 4 October. The results have not yet been peer reviewed.

Replication studies' roots

The 'many analysts' method was pioneered by psychologists and social scientists in the mid-2010s, as they grew increasingly aware of results in the field that could not be replicated. Such work gives multiple researchers the same data and the same research questions. The authors can then compare how decisions made after data collection affect the types of result that eventually make it into publications.

The study by Fraser and her colleagues brings the many-analyst method to ecology. The researchers gave scientist-participants one of two data sets and an accompanying research question: either "To what extent is the growth of nestling blue tits (*Cyanistes caeruleus*) influenced by competition with siblings?" or "How does grass cover influence *Eucalyptus* spp. seedling recruitment?"

Most participants who examined the blue-tit data found that sibling competition negatively affects nestling growth. But they disagreed substantially on the size of the effect.

Conclusions about how strongly grass cover affects numbers of eucalyptus seedlings showed an even wider spread. The study's authors averaged the effect sizes for these data and found no statistically significant relationship. Most results showed only weak negative or positive effects, but there were outliers: some participants found that grass cover strongly decreased the number of seedlings. Others concluded that it sharply improved seedling count.

The authors also simulated the peer-review process by getting another group of scientists to review the participants' results. The peer reviewers gave poor ratings to the most extreme results in the eucalyptus analysis but not in the blue-tit one. Even after the authors excluded the analyses rated poorly by peer reviewers, the collective results still showed vast variation, says Elliot Gould, an ecological modeller at the University of Melbourne and a co-author of the study.

Despite the wide range of results, none of the answers is wrong, Fraser says. Rather, the spread reflects factors such as participants' training and how they set sample sizes.

So, "how do you know, what is the true result?" Gould asks. Part of the solution could be asking a paper's authors to lay out the analytical decisions that they made, and the potential caveats of those choices, Gould says.

"We really can't be relying on any individual result or any individual study to tell us the whole story."

Nosek says ecologists could also use practices common in other fields to show the breadth of potential results for a paper. For example, robustness tests, which are common in economics, require researchers to analyse their data in several ways and assess the amount of variation in the results.

But understanding how analytical variation sways results is especially difficult for ecologists because of a complication baked into their discipline. "The foundations of this field are observational," says Nicole Nelson, an ethnographer at the University of Wisconsin–Madison. "It's about sitting back and watching what the natural world throws at you — which is a lot of variation."

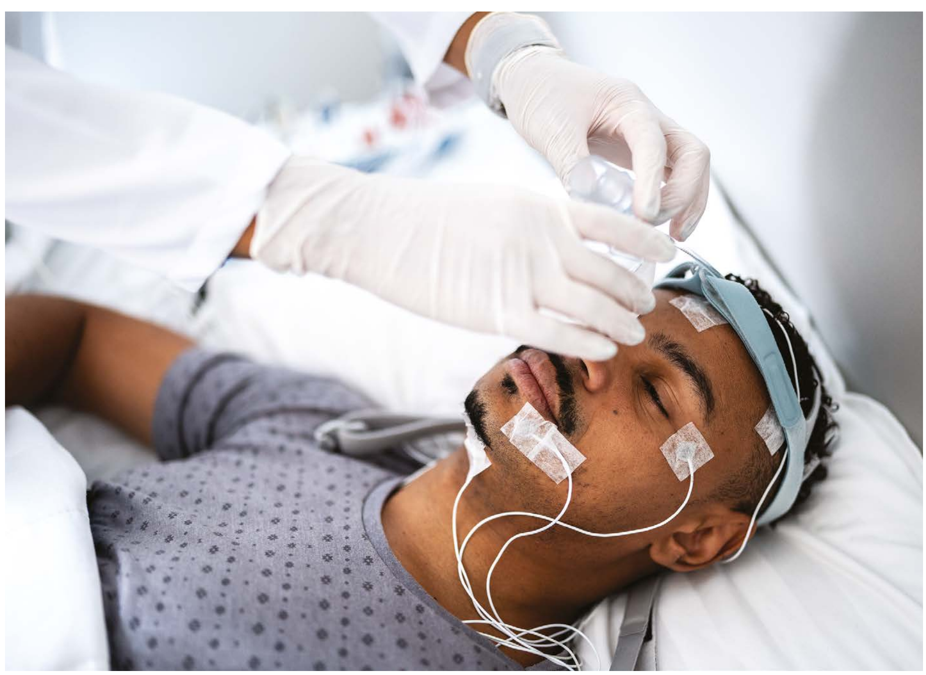
DEEP ASLEEP? YOU CAN STILL FOLLOW SIMPLE COMMANDS, STUDY FINDS

Sleep doesn't cut you off from the outside world as much as scientists had thought.

By Anil Oza

Scientists once considered sleep to be like a shade being drawn over a window between the brain and the outside world: when the shade is closed, the brain stops reacting to outside stimuli.

A study published on 12 October in *Nature Neuroscience* suggests that there might be periods during sleep when that shade is partially open (B. Türker *et al. Nature Neurosci.* https://doi.org/kz6k; 2023). Depending on what researchers said to them, participants in the study would either smile or frown on cue in certain phases of sleep.



GETTY

Sleep studies often involve measuring the electrical activity in a person's brain.