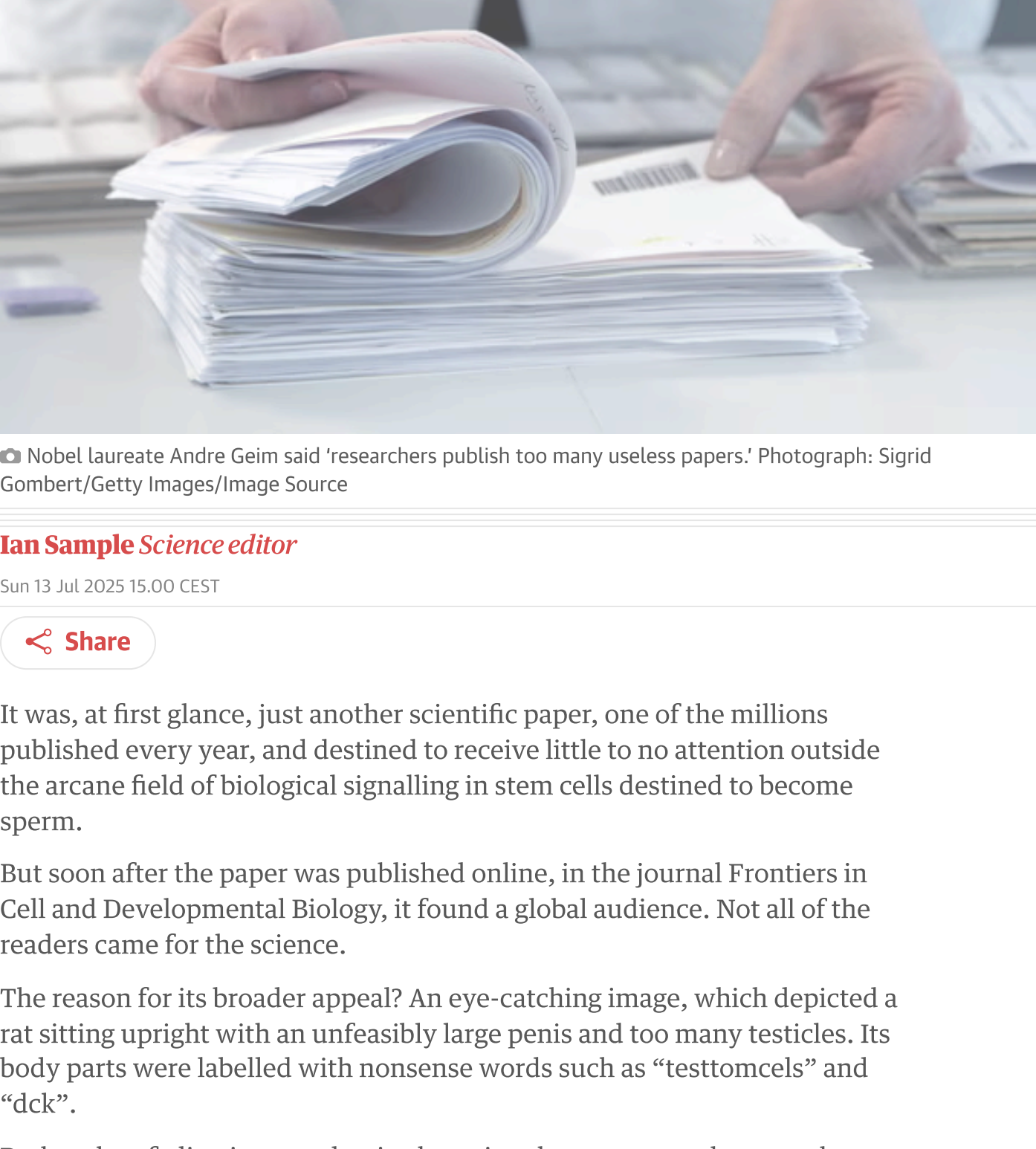


Peer review and scientific publishing

Quality of scientific papers questioned as academics ‘overwhelmed’ by the millions published

Widespread mockery of AI-generated rat with giant penis in one paper brings problem to public attention



📷 Nobel laureate Andre Geim said ‘researchers publish too many useless papers.’ Photograph: Sigrid Gombert/Getty Images/Image Source

Ian Sample *Science editor*

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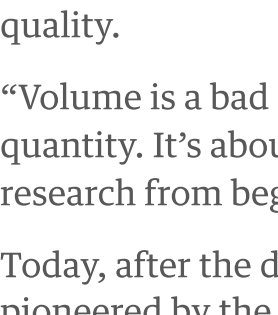
It was, at first glance, just another scientific paper, one of the millions published every year, and destined to receive little to no attention outside the arcane field of biological signalling in stem cells destined to become sperm.

But soon after the paper was published online, in the journal *Frontiers in Cell and Developmental Biology*, it found a global audience. Not all of the readers came for the science.

The reason for its broader appeal? An eye-catching image, which depicted a rat sitting upright with an unfeasibly large penis and too many testicles. Its body parts were labelled with nonsense words such as “testtomcels” and “dck”.

Rather than fading into academic obscurity, the paper soon became the subject of mainstream media mockery. “Scientific journal publishes AI-generated rat with gigantic penis”, reported *Vice News*. “It might be considered an AI cock-up on a massive scale,” intoned the *Daily Telegraph*.

The images had indeed been generated by artificial intelligence (AI), but that was **permitted** under the journal’s rules. The problem was the authors had not verified the accuracy of the AI-generated material. Neither the journal’s staff nor its expert reviewers caught the glaring errors. Three days after publication, the paper was retracted.



Mistakes, fakes and a giant rat penis: why are so many science papers being retracted?

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What separates the anecdote from other stories of AI mishap is the glimpse it provides into wider problems at the heart of an important industry. Scientific publishing records, and plays gatekeeper to, information that shapes the world, and on which life and death decisions are made.

The first scientific journal was published by the Royal Society in 1665. The **maiden issue** of *Philosophical Transactions* told readers about a spot on Jupiter, a peculiar lead ore from Germany, and a “monstrous” calf encountered by a butcher in Lymington.

Since then, journals have been the chronicle of serious scientific thought. Newton, Einstein and Darwin all posited historic theories there; Marie Curie coined the term “radioactivity” in a journal.

But journals are more than historical records. Groundbreaking research in critical fields from genetics and AI to climate science and space exploration is routinely published in the growing number of journals, charting humanity’s progress. Such studies steer drug development, shape medical practice, underpin government policies and inform geopolitical strategies, even estimates of fatalities in bloody military campaigns, such as Israel’s assault on Gaza.

The consequential nature of journals, and potential threats to the quality and reliability of the work they publish, have prompted leading scientists to sound the alarm. Many argue that scientific publishing is broken, unsustainable and churning out too many papers that border on worthless.

The warning from Nobel laureates and other academics comes as the **Royal Society** prepares to release a major review of scientific publishing at the end of the summer. It will focus on the “disruptions” the industry faces in the next 15 years.

Sir Mark Walport, the former government chief scientist and chair of the Royal Society’s publishing board, said nearly every aspect of scientific publishing was being transformed by technology, while deeply ingrained incentives for researchers and publishers often favoured quantity over quality.

“Volume is a bad driver,” Walport said. “The incentive should be quality, not quantity. It’s about re-engineering the system in a way that encourages good research from beginning to end.”

Today, after the dramatic expansion of science and **publishing practices** pioneered by the press baron Robert Maxwell, tens of thousands of scientific journals put out millions of papers annually. Analysis for the Guardian by Gordon Rogers, the lead data scientist at Clarivate, an analytics company, shows that the number of research studies indexed on the firm’s Web of Science database rose by 48%, from 1.71m to 2.53m, between 2015 and 2024. Tot up all the other kinds of scientific articles and the total reaches 3.26m.

In a **landmark paper** last year, Dr Mark Hanson at the University of Exeter described how scientists were “increasingly overwhelmed” by the volume of articles being published. Keeping up with the truly original work is only one issue. The demands of peer review – where academics volunteer time to vet each other’s work – are now so intense that journal editors can struggle to find willing experts.

According to **one recent study**, in 2020 alone, academics globally spent more than 100 million hours peer reviewing papers for journals. For experts in the US, the time spent reviewing that year amounted to more than \$1.5bn of free labour.

“Everybody agrees that the system is kind of broken and unsustainable,” said Venki Ramakrishnan, a former president of the Royal Society and a Nobel laureate at the Medical Research Council’s Laboratory of Molecular Biology. “But nobody really knows what to do about it.”

In the “publish or perish” world of academia, where and how often a researcher publishes, and how many citations their papers receive, are career-defining. The rationale is reasonable: the best scientists often publish in the best journals. But the system can lead researchers to chase metrics. They might run easier studies, hype up eye-catching results, or publish their findings over more papers than necessary. “They’re incentivised by their institute or government funding agencies to put out papers with their names on them, even if they have nothing new or useful to say,” said Hanson.

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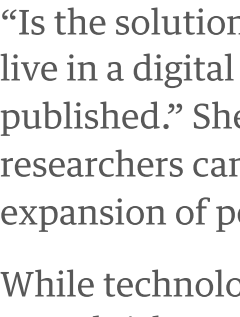
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Scientific publishing has a unique business model. Scientists, who are typically funded by taxpayers or charities, perform the research, write it up and review each other’s work to maintain quality standards. Journals manage the peer review and publish the articles. Many journals charge for access through subscriptions, but publishers are steadily embracing open access models, where authors can pay up to £10,000 to have a single paper made freely available online.

According to a **recent analysis**, between 2015 and 2018, researchers globally paid more than \$1bn in open access fees to the big five academic publishers, Elsevier, Sage, Springer Nature, Taylor & Francis, and Wiley.

Open access helps disseminate research more broadly. Because it is not behind a paywall, the work can be read by anyone, anywhere. But the model incentivises commercial publishers to run more papers. Some launch new journals to attract more studies. Others solicit papers for vast numbers of special issues.

For one Swiss publisher, MDPI, special issues of journals are a major income stream. A single MDPI journal, the *International Journal of Molecular Sciences*, is inviting submissions to **more than 3,000 special issues**. The publication fee, or article processing charge (APC), for one article is £2,600. As of last year, the Swiss National Science Foundation refuses to pay publication fees for special issues **amid concerns over quality**. MDPI did not respond to an interview request.

Unhelpful incentives around academic publishing are blamed for **record levels of retractions**, the **rise in predatory journals**, which publish anything for a fee, and **the emergence of AI-written studies** and paper mills, which sell **fake papers** to unscrupulous researchers to submit to journals. All contaminate the scientific literature and risk damaging trust in science. Earlier this month, Taylor & Francis **paused submissions** to its journal *Bioengineered* while editors investigated 1,000 papers that bore signs of being manipulated or coming from paper mills.

While fraud and fakery are important problems, Hanson is more concerned about the glut of research papers that do little to progress scientific knowledge. “The far greater danger by volume and by total numbers is the stuff that’s genuine but uninteresting and uninformative,” he said.

“It’s now possible to publish a peer-reviewed article in a journal that has practically nothing new to contribute. These papers are a major drain on the system in terms of the money used to publish and pay for them, the time that’s spent writing them and the time that’s spent reviewing them.”

Prof Andre Geim, a Nobel laureate at the University of Manchester, said: “I do believe that researchers publish too many useless papers and, more importantly, we aren’t flexible enough to abandon declining subjects where little new can be learned. Unfortunately, after reaching a critical mass, research communities become self-perpetuating due to the emotional and financial interests of those involved.”

Hanson believes the problem is not open access and APCs per se, but for-profit publishers that seek to publish as many papers as possible. He believes the strain on academic publishing could be substantially alleviated if funding agencies stipulated that the work they support must be published in non-profit journals.

Hannah Hope, the open research lead at the Wellcome Trust, said in general, research that was good enough to fund should be published, and that greater investment in science, particularly beyond North America and Europe, had contributed to the rise in scientific papers. But she agreed that peer review might be used more selectively. “I’m sure peer review does lead to improvement in research. Is it always worth the time that goes into it? I think it’s something that we should be questioning as a field, and whether peer review happens in the current format on everything,” she said.

Ritu Dhand, the chief scientific officer at publisher Springer Nature, rejected the narrative of “greedy journal publishers” making money by publishing poor-quality papers and pointed to the fact that the research landscape has gone through a “radical transformation”, quadrupling in size over the past 25 years. Long dominated by western countries, research is now far more global, and **led by China** rather than the US.

“Is the solution not to allow the rest of the world to publish?” she said. “We live in a digital world. Surely, it doesn’t matter how many papers are being published.” She sees solutions in better filtering, search tools and alerts so researchers can find the work that really matters to them, and a global expansion of peer reviewers to absorb the demand.

While technology poses fresh challenges for academic publishers, Ramakrishnan agreed that it may be the answer to some of the problems. “Eventually these papers will all be written by an AI agent and then another AI agent will actually read them, analyse them and produce a summary for humans. I actually think that’s what’s going to happen.”

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