

Free Journals Grow Amid Ongoing Debate

Ten years ago, a few scientists started an 'open access' campaign for free journals funded by author fees. Their flagship, the Public Library of Science, is expected to break even soon—but remains controversial

A DECADE AGO, THREE U.S. BIOMEDICAL scientists vowed to start a revolution in science publishing. They wanted to persuade publishers to share research papers normally available only to paying customers in a free online library. The trio threw their weight behind a radical idea: charge authors a fee, give them copyright, and post their peer-reviewed papers on the Internet immediately for anyone to read.

The scientists called their venture the Public Library of Science (PLOS), echoing a frustration among librarians over the escalating cost of journals. They argued that taxpayers shouldn't have to buy subscriptions to see the results of research they had already paid for. Making the world's research papers freely available would "vastly increase the accessibility and utility of the scientific literature, enhance scientific productivity," and bring together disparate communities in biomedicine, wrote PLOS's founders, including

Harold Varmus, the former director of the National Institutes of Health (NIH) who now heads the National Cancer Institute.

Today, the so-called open-access movement is claiming success. Publishers big and small are producing hundreds of free-to-read, peer-reviewed online journals that charge authors fees ranging from about \$500 to \$3000 per paper. (By various measures, between 7% and 11% of the world's peer-reviewed scientific journals are now open access.) The most prominent publisher, the nonprofit organization PLoS, launched its first journal in 2003. This year, PLoS is on track to make a small profit—a "landmark for PLoS, but also for open-access publishing as a whole," testified Catherine Nancarrow, a managing editor of PLoS, at a U.S. congressional hearing last month.

Many biomedical scientists are required by their funding agencies to practice a limited kind of open access by sending manuscripts

of their published papers to free archives like NIH's PubMed Central. A recent study finds that 20% of peer-reviewed articles across all disciplines are now freely available mainly through journals or as manuscripts in online repositories (see graph, p. 898). (This includes journals that make them available after a delay; *Science* does so 1 year after publication.) The portion freely available is growing by about 1% a year, says study leader Bo-Christer Björk of the Hanken School of Economics in Helsinki.

Although the gains seem modest, "that is substantially further than anyone would have thought we would have gotten," says computational and evolutionary biologist Michael Eisen of the University of California, Berkeley, one of PLoS's founders and a board member. The open-access movement "has been remarkably successful, and the momentum now is in our direction."

U.S. policymakers are considering whether to expand NIH's paper-sharing policy to other research agencies. This proposal—and the broader open-access campaign—remains rife with controversy, however. Debates rage about whether open access is speeding scientific progress. Some argue that academic researchers already have good access to the articles they need. Critics suggest that the open-access publishing model encourages mediocre work, noting that PLoS, for example, has succeeded financially only because one of its journals collects fees on thousands of lightly reviewed papers a year.

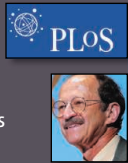
Some traditional publishers—including many scientific societies—fear that at some tipping point in the future, libraries will drop subscriptions and put journals out of business. But so far, the journals haven't shown that public-access mandates have done them harm.

Stick and carrot

Although physicists have shared manuscripts publicly online for 2 decades, the practice was rare in biomedicine until 2000. That year saw the debut of London-based open-access biomedical publisher BioMed Central, founded by entrepreneur Vitek Tracz. The company initially charged authors no fees and planned

2000

- Public Library of Science (PLOS) founded
- NIH launches PubMed Central
- BioMed Central open-access publisher debuts



2002

- BioMed Central begins charging \$500 author fee



- Howard Hughes Medical Institute (HHMI) agrees to pay author fees

2003



- PLoS launches *PLoS Biology*, author's fee \$1500

2005

- NIH, Wellcome Trust ask grantees to post articles in free database after delay



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to recoup costs through other publishing ventures. NIH the same year launched its PubMed Central archive, which Varmus had proposed before moving to Memorial Sloan-Kettering Cancer Center in New York City. It was also in 2000 that Varmus, Eisen, and Stanford University geneticist Patrick Brown founded PLoS. They collected more than 30,000 researchers' signatures on an open letter threatening to boycott journals that didn't allow their papers to be shared freely on PubMed Central within 6 months of publication.

The threat didn't have a big impact, but PLoS's leaders found a better way to foment revolution. With a \$9 million grant from the Gordon and Betty Moore Foundation, PLoS launched a free journal, *PLoS Biology*, in 2003. The new money allowed it to hire talent from top journals such as *Cell*. The nonprofit burned through its grant rapidly at first, and PLoS sharply raised its initial author fee of \$1500. (Today, fees at its six subject-specific journals range from \$2250 to \$2900; hard-pressed authors can ask for a fee waiver.) In 2006, PLoS's fortunes improved after it launched the multidisciplinary *PLoS ONE*, which featured a new peer-review model: Reviewers would check articles for scientific rigor but not for importance, and authors of accepted papers would pay a fee of \$1350.

Submissions to *PLoS ONE* have soared—along with PLoS's revenue. It expects to publish about 7500 papers this year, making it the world's largest journal in terms of volume, PLoS says.

BioMed Central, which began charging author fees in 2002, now charges about \$1300 to \$2400 per paper in most of its 206 journals. It "has been profitable for some time," says Managing Director Matthew Cockerill. As evidence, he points out that BioMed Central was snapped up in 2008 by Springer, which, like other giant commercial publishers, is starting its own open-access journals. Another success is the bargain-rate Hindawi, based in Cairo, which



Rocking the boat. PLoS founders Brown, Eisen, and Varmus.

puts out more than 200 open-access journals in biomedicine and other fields, charging \$600 to \$1500 per paper. Some open-access journals published by societies, such as the *New Journal of Physics* and *Optics Express*, are at the top of their field in impact factor (a measure of how often a journal is cited). "They're working because the community got behind them," says Mary Waltham, a publishing consultant in Princeton, New Jersey.

An academic project called the Directory of Open Access Journals now tracks some 5000 scholarly and scientific journals (up from 861 in 2003). Only two-thirds are peer reviewed, and a couple of publishers, says Björk, "seem more interested in collecting author fees than assuring quality." Still, the list includes respected journals, including many in developing countries that charge no author fees. Ulrich's Periodicals Directory counts 2888 of 27,252 peer-reviewed academic journals as open access, or 10.6%, notes Björk. Marie McVeigh of Thomson Reuters, which derives impact factors for high-quality science and social science journals, says 622 of these 9190 journals are open access, or 6.8%.

The field has received a boost in recent years from so-called public-access policies at funding agencies. NIH, for example, has required grantees since April 2008 to submit copies of their accepted peer-reviewed manuscripts to PubMed Central for posting within 12 months. NIH's chief digital librari-

an, David Lipman, testified last month at a U.S. House hearing that business is booming. The hearing had been called to consider a bill to extend the NIH policy to 11 more agencies and shorten to 6 months the permitted delay in releasing manuscripts. Lipman says PubMed Central attracts 420,000 visitors each weekday. Only 25% of them are using university computers, which suggests that the archive "has become a broad-based repository" for patients, students, and clinicians as well as researchers, Lipman says.

Several other U.S. and European funding agencies, such as the Howard Hughes Medical Institute (HHMI) and Wellcome Trust, have adopted similar mandates for their grantees. Both also offer to pay authors' fees for publishing in open-access journals.

Universities are keen on open access as well. A growing number of institutions, such as Harvard University's School of Arts and Sciences, now ask faculty members to deposit manuscripts in institutional repositories. And many are setting up funds to help pay author fees. Harvard's Stuart Shieber says the goal is to make it easier for publishers to convert journals to open access.

Quantity subsidizes quality

Detractors have criticized *PLoS ONE*, which publishes 69% of submissions, for making money by publishing marginal research. They point out that PLoS's highly ranked journals *PLoS Biology* and *PLoS Medicine*, which reject a much higher portion of submissions, aren't sustainable without a subsidy. The more selective the journal (and therefore higher ranked), the more it costs to produce. That's because it's expensive to manage a rigorous peer-review system, and each rejection represents a lost author fee. High-impact journals *Science* and *Nature*, which also publish news and nonresearch sections, say they have per-article costs of \$10,000 or more—financed in part by subscriptions and advertising.

But supporters of PLoS defend its business model. "There's no shame in the fact that

Online sciencemag.org

Podcast interview
with author
Jocelyn Kaiser.

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2006

- Bill expanding NIH policy to more U.S. agencies
- U.K. Medical Research Council mandates free access to articles within 6 months
- PLoS raises highest author fee to \$2500, launches *PLoS ONE*

2007

HHMI

- HHMI mandates free access to articles within 6 months
- U.K. PubMed Central debuts

2008

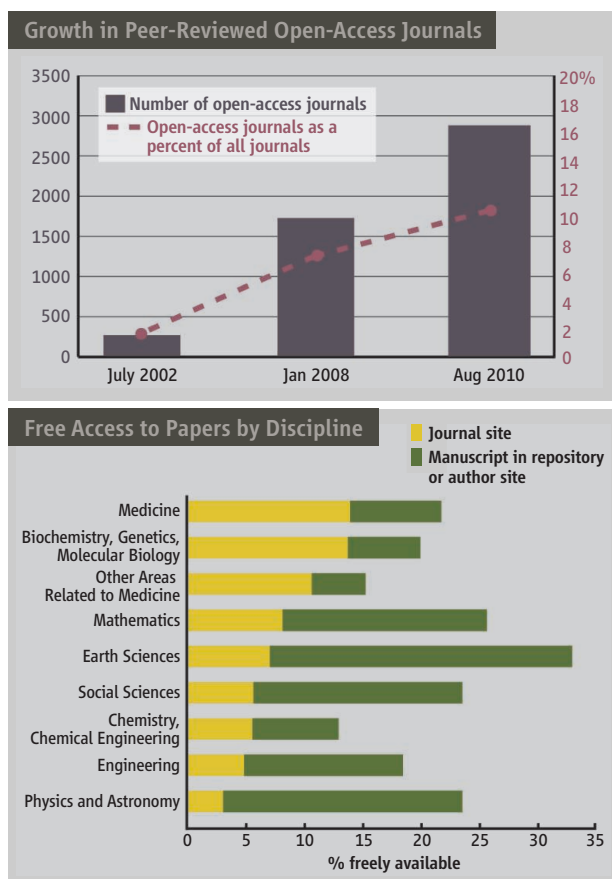
- BioMed Central sold to Springer
- NIH public-access policy becomes mandatory
- Harvard Arts and Sciences faculty agree to put papers in free university repository

2009

- Harvard and four other universities commit to create funds to cover author fees

2010

- Roundtable report endorses public access across U.S. research agencies
- PLoS expected to break even



Free for all. Open-access journals are on the rise; about 20% of a sample of 1837 articles published in 2008 were eventually free.

PLoS ONE is fueling a profitable business,” says Eisen. And he says it has good papers. *PLoS ONE* recently received an initial impact factor that put it in the top 25% of biology journals. Even a skeptic of open access, Martin Frank, executive director of the American Physiological Society in Bethesda, Maryland, says, “They did damn well.” Like others, though, he is puzzled by the results and suggests that they may have been skewed by a few blockbuster papers. Open-access publishers are sensitive about the quality issue. Cockerill notes that one aim of the Open Access Scholarly Publishers Association founded in 2008 is to establish standards and distinguish “reputable journals” from the pack.

Another key dispute centers on the claim that open access gives scientific results wider circulation and use. Several scholars have found that open-access papers are cited at least 100% more often than papers available only by subscription—suggesting that they are more widely read. But critics say these studies failed to control for a bias: Editors and authors tend to make only their most important papers available for free.

A study last year found only an 8% citation advantage for open-access articles, although

the rate was higher in developing countries (*Science*, 20 February 2009, p. 1025). Philip Davis, a graduate student in science communications at Cornell University, has done what he says is the only randomized controlled trial to examine the issue. For his unpublished dissertation, he worked with seven publishers of 36 journals (including *Science*), mostly in biomedicine and social sciences. The journals randomly made 712 of 3245 papers open access. Davis found that after 2 years the open-access papers weren’t cited any more often or more quickly. “For the research community, access is essentially a nonissue,” Davis concludes.

Davis found another story when he looked at usage: Open-access papers were downloaded twice as often as others in the first year. This result suggests that the public might be benefiting from open access, Davis says.

But Eisen says such evidence isn’t crucial: “It is a very hard thing to quantify. You sort of have to accept that it’s a good thing on first principle to have papers freely available.”

Free but expensive?

The move to expand open-access mandates doesn’t please traditional publishers. Some fear it will eventually kill subscription journals. Allan Adler, vice president for legal and governmental affairs for the Association of American Publishers, points to a 2006 survey of librarians finding that if two-fifths of a journal’s articles became free within 12 months, 44% said they would cancel their subscriptions. A research study cofunded by the European Union involving 12 major publishers and 300 journals is studying potential impacts; results are expected next year. It’s too soon to know what the impact of NIH’s mandate will be, says Frank.

Other experts see a strong economic rationale for open-access publishing. A model developed by John Houghton and colleagues at Victoria University in Melbourne, Australia, assumes that author-pays journals save costs and that wider access to papers helps industry scientists in particular. Houghton’s

group has projected that open-access publishing could save three European countries hundreds of millions of euros a year. In preliminary work, he finds that the proposal to extend NIH’s policy to more U.S. agencies would yield benefits to the U.S. economy of more than \$1 billion over 30 years—five times the cost. Because research investments have a high rate of return, says Houghton, even a 1% gain in access “can result in a substantial cost saving.” Publishers, meanwhile, have attacked Houghton’s model as relying on flawed assumptions.

Even advocates of the revolution admit they’re not sure how publishing costs would be distributed in a world totally converted to open access. Questions loom about who will pay. Harvard’s Shieber says that funding agencies can make up for what they spend on grantees’ author fees by reducing the overhead money they add to NIH grants, because universities won’t need to spend as much for library journal subscriptions. “It’s all the same money,” he says. But Frank is skeptical that universities would tolerate a reduction in overhead rates. If the cost is charged to NIH grantees, Frank warns, that will leave less money for doing research: “It’s going to come out of research dollars.”

Despite the hoopla and contention, perhaps the chief obstacle to making more papers freely available is that the average scientist just isn’t engaged. Two years after the NIH policy became mandatory, only 70% of eligible manuscripts are being deposited, and only 40% at the Wellcome Trust. Many “hybrid” journals that offer authors the option of paying a fee (as high as \$5000 for *Cell* and *Nature Communications*) for immediate free access say uptake is less than 10%.

“It’s going to depend on the scientist,” says Avic Meehan, communications chief for HHMI in Chevy Chase, Maryland. For some, open access is of “paramount importance,” she says, but “for others, their priorities lie elsewhere.”

The future of open access likely will depend on what funding agencies do—and particularly on the subsidies they provide. Tighter budgets will add to libraries’ demands for more open-access journals, says industry analyst Claudio Aspesi of Sanford Bernstein. But tighter budgets could also limit public support for author fees. For the time being, Aspesi and many others expect that traditional and open-access journals will coexist. “It will be a mixed economy,” says Waltham. “I don’t think it’s ever going to take over entirely. And that’s healthy overall.”

—JOCELYN KAISER