

THE FUTURE OF THE POSTDOC

*There is a growing number of postdocs
and few places in academia for them to go.
But change could be on the way.*

BY KENDALL POWELL

By the time Sophie Thuault-Restituto reached her twelfth year as a postdoctoral fellow, she had finally had enough. She had completed her first postdoc in London, then moved to New York University (NYU) in 2004 to start a second. Eight years and two laboratories later, she was still there and still effectively a postdoc, precariously dependent on outside grants to secure and pay for her position. Her research on Alzheimer's disease was not making it into high-profile journals, so she was unable to compete for academic positions in the United States or Europe. She loved science and had immense experience, but with two young children at home, she knew she needed something more secure. "My motivation was gone. I was done with doing research," she says.

So in 2013, Thuault-Restituto moved into a job as a research-laboratory operations manager at NYU, where she coordinates building renovations and fosters collaboration

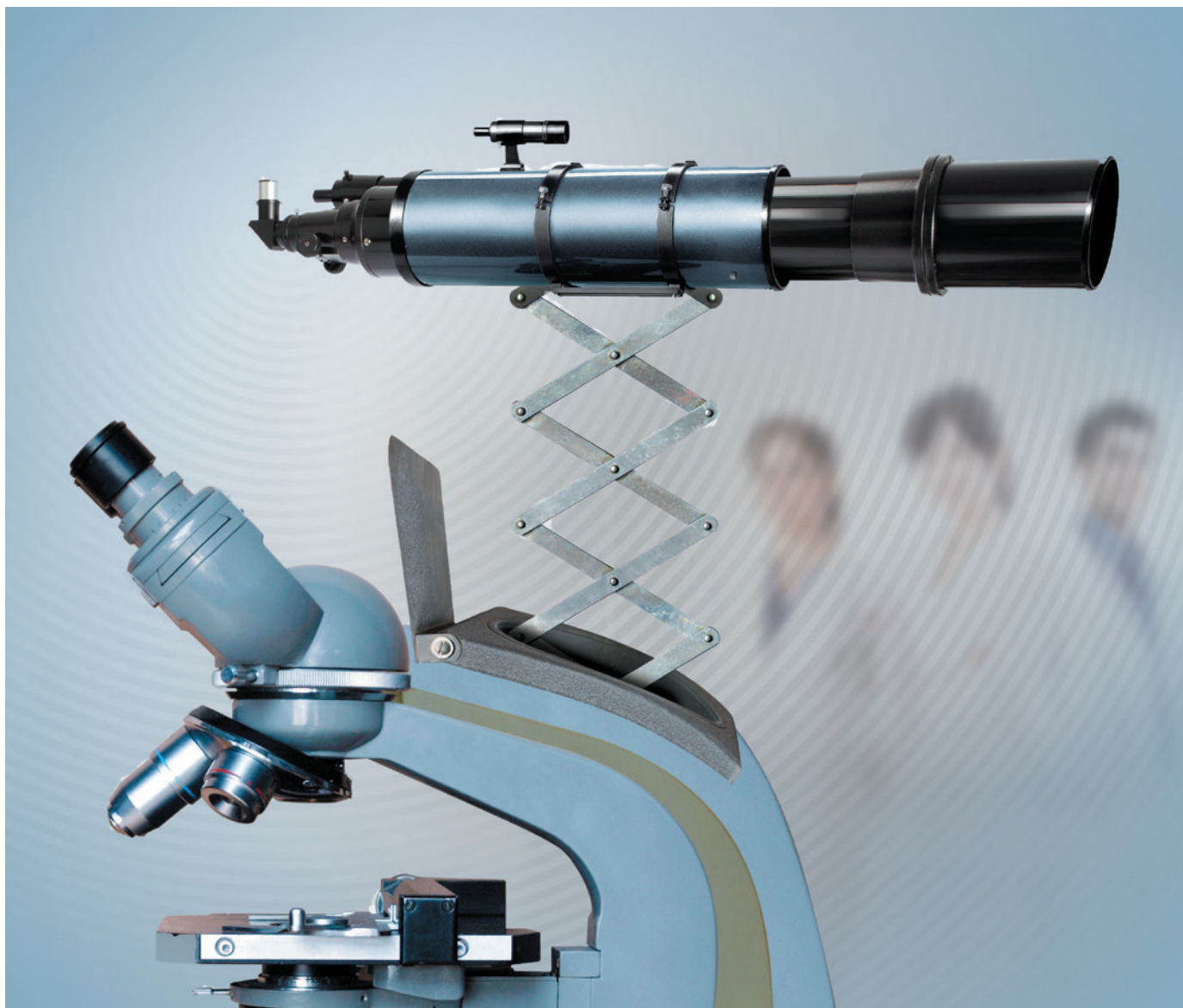
between labs. She enjoys the fact that her staff position has set hours, as well as better pay and benefits. But at the time of the move, she mourned the loss of a research career and she regrets the years wasted pursuing one. "I stayed five years more than I should have," she says.

Thuault-Restituto is the face of a postdoctoral system that is broken. These highly skilled scientists are a major engine driving scientific research, yet they are often poorly rewarded and have no way to progress in academia. The number of postdocs in science has ballooned: in the United States alone, it jumped by 150% between 2000 and 2012. But the number of tenured and other full-time faculty positions has plateaued and, in some places, it is even shrinking (see *Nature* **472**, 276–279; 2011). Many postdocs move on to fulfilling careers elsewhere, but those who want to continue in research can find themselves thwarted. They end up trapped as 'permadoes': doing multiple postdoc terms, staying in these positions

for many years and, in a small but significant proportion, never leaving them. Of the more than 40,000 US postdocs in 2013, almost 4,000 had been so for more than 6 years (see 'The postdoc pile-up').

This problem is felt acutely in the large US biomedical-sciences workforce, but the trends are similar in many other countries and disciplines — and the economic drivers are too. Postdoc salaries have remained low — often less than the stipend and tuition costs of a graduate student. "We had the incentives all wrong," says Paula Stephan, an economist at Georgia State University in Atlanta who studies research labour markets. "We made postdocs so cheap that principal investigators had lots of incentives to hire them."

Discussion about the postdoc problem has grown increasingly loud. In December 2014, a committee convened by the US National Academies released a report aimed at highlighting and improving the postdoc's plight. The



committee called for a hike in salaries, from the current recommended starting salary of US\$42,840 to \$50,000, and a 5-year limit on the length of postdocs. Senior scientists in the United States, who have been urging reforms for the scientific workforce as a whole, have identified the postdoc oversupply as one of the most urgent issues (B. Alberts *et al. Proc. Natl Acad. Sci. USA* **112**, 1912–1913; 2015).

Experts acknowledge that change will be hard; after all, the National Academies made similar recommendations 15 years ago with little effect. But some institutions and countries have started to address the issue. Several US universities have enforced 5-year term limits, New Zealand inadvertently narrowed the pipeline when it slashed the number of postdocs available, and some laboratories are moving permadocs into stable, better-paid positions. Other scientists who are keen to help postdocs are watching the results with interest. “We’ve always been at risk of producing

more scientists than we have places for, but the stresses and strains were not harmful in the way they are now,” says Shirley Tilghman, president emerita of Princeton University in New Jersey, who has studied the workforce problem. “Some changes will have to happen.”

THE FIXED-TERM POSTDOC

In 2008, while Thuault-Restituto was there, NYU’s School of Medicine decided to try a tough-love approach: it began enforcing a rule that researchers could hold a postdoc for a maximum of 5 years — including time spent at other institutions. In 2014, 35 of the roughly 400 postdocs there left because their time was up.

The time limit can be painful for people who feel forced out, says Keith Micoli, chairman of the board of the National Postdoctoral Association and director of the NYU School of Medicine postdoctoral programme. “People coming up against it put me in an ethical quandary:

what’s best for that postdoc and what’s best for postdocs as a whole?”

Micoli says that term limits combat two problematic phenomena. The first is the ‘just one more year, experiment or paper’ syndrome, in which postdocs feel that they must endlessly build their academic CV before moving on. The second is the permadoc who stays on indefinitely, eventually runs into his or her adviser’s retirement and is stranded without a job, a situation that Micoli himself encountered. Having a hard deadline forces postdocs to make career decisions and “people are better for it”, he says. Of the postdocs who left NYU in 2014, Micoli says that roughly equal numbers got faculty positions and left academia.

Other major research universities, such as the University of California system and the University of North Carolina, Chapel Hill (UNC), have also implemented 5-year term limits. But the limits are not always strictly enforced. Postdocs and their advisers can

often request a sixth year and some postdocs are moved into positions that are postdocs in everything but name. When Thuault-Restituto bumped up against the 5-year rule in 2006 — before the university enforced it more strictly — she was promoted to ‘associate research scientist’, a staff position that brought better benefits, but no extra pay or job security. Her position was still contingent on outside grant funding, which was far from guaranteed. “At the end of the day, my job and what I was doing in the lab didn’t change at all,” she says.

Sibby Anderson Thompkins, who directs the postdoctoral affairs office at UNC, says that the most-recent postdocs there embrace the term limit. They enter with a plan to find a career path quickly and exit the postdoc early if an opportunity arises. Anderson Thompkins, who also sat on the 2014 National Academies report committee, says that this type of planning should begin in graduate school, alongside raised awareness of the academic bottleneck that trainees will face. Whereas about 65% of US PhD-holders continue into a postdoc, only 15–20% of those move into tenure-track academic posts. The European situation is even more competitive — in the United Kingdom, for example, about 3.5% of science doctorates become permanent research staff at universities.

Term limits have also been tested in the United Kingdom, France and Germany, where labour laws limit the number of years that academic researchers can remain on short-term contracts before they must be hired permanently. But it is unclear whether these laws help or hurt, because there are often ways around them.

In Germany, for example, a law originally intended to curb postdoc contracts to about six years after completing a PhD was altered so that scientists can remain on short-term contracts as long as they are funded by an external grant and not paid directly by the university. The result is that scientists surf endlessly from one postdoc to another: “There are unlimited numbers of short-term contracts,” says Sibylle Anderl, a German postdoc in astronomy at the Grenoble Institute for Planetary Sciences and Astrophysics in France. “The real problem for German postdocs is that we don’t have enough permanent positions available.”

THE ELITE POSTDOC

Postdocs don’t have to be forced out of the pipeline if, instead, they are never let in. That was the result when, in 2010, the New Zealand government decided to axe a scheme that had funded roughly 90 postdoc slots — eliminating nearly one-third of its postdocs in one fell swoop.

Before this, the government covered salaries for a huge chunk of the country’s postdocs, who enjoy salaries and benefits nearly equivalent to those starting permanent academic positions. For most labs, postdocs are too expensive to

fund from research grants. So when the government funding disappeared — mainly a money-saving decision — so too did many postdoc spots.

Lara Shepherd got caught in the squeeze when fellowships vanished in her field of evolutionary biology and she reached the end of her first postdoc, at the Museum of New Zealand Te Papa Tongarewa in Wellington. She secured a second postdoc at Massey University in Palmerston North, using a grant to pay half of her salary and working part time to cover the rest. But she could not land a coveted academic position. “New Zealand is so small — there are very few jobs in your particular area of expertise,” she says.

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Shepherd eventually found a temporary research position back at the Museum of New Zealand, and scored an early-career grant from the Royal Society of New Zealand, which she leveraged into a permanent position. She now oversees genetic analyses of plant, animal and fossil samples. Without the early-career fellowship, she says, “I would have been looking outside of science.”

Many principal investigators (PIs) in New Zealand are unhappy with the situation. With no postdocs to help them, they struggle with lab management and mentoring, and they say that labs have become dependent on graduate students. “All we’ve done is to outsource our postdocs,” says Shaun Hendy, a physicist at the University of Auckland. “We’ve removed a cohort of young researchers from our system and replaced them with even younger, less-experienced researchers.”

Once trained, the country’s best PhD students tend to head out of science or to postdocs overseas. One lab head describes a top marine-biology graduate who — with no prospect of a postdoc or academic job — ended up driving a forklift before eventually landing a position in

the country’s statistics bureau. Hendy predicts that the postdoc void will result in lower-quality, less-complex research projects. “I’m sure there will be productivity hits down the line.”

Simon Davy, head of the school of biological sciences at the Victoria University of Wellington, says that the research culture of university departments loses vibrancy without any postdocs. His department of 35 research groups hosts fewer than 10 postdocs. His own lab has been lucky enough to have a couple of them in the past 5–6 years and he says that this has tripled his group’s productivity.

If Davy could wave a magic wand and bring back the government-funded postdoctoral positions, he would — and so would 560 of the country’s scientists, who, in 2011, collectively sent a letter of protest to the science minister, among other government leaders. “I’ve struggled to think of positives from our experience,” Hendy says. Science-development manager Anne Berryman, from the New Zealand Ministry of Business, Innovation and Employment, says the decision to cut postdocs was designed to reprioritize government support towards later career stages, and contends that there is no evidence of harm to the country’s scientific research.

Most US researchers balk at the idea of restricting the number of postdocs entering the system. Jennifer Lippincott-Schwartz, a cell biologist at the US National Institute of Child Health and Human Development in Bethesda, Maryland, says that it is nearly impossible to determine who has the characteristics of a superstar researcher until mid-way through a postdoc term. “I don’t think it’s bad when part of that workforce has to leave and move into other professions,” she says. “They carry with them skills that are not wasted. They still have a knowledge base that is valuable to society.”

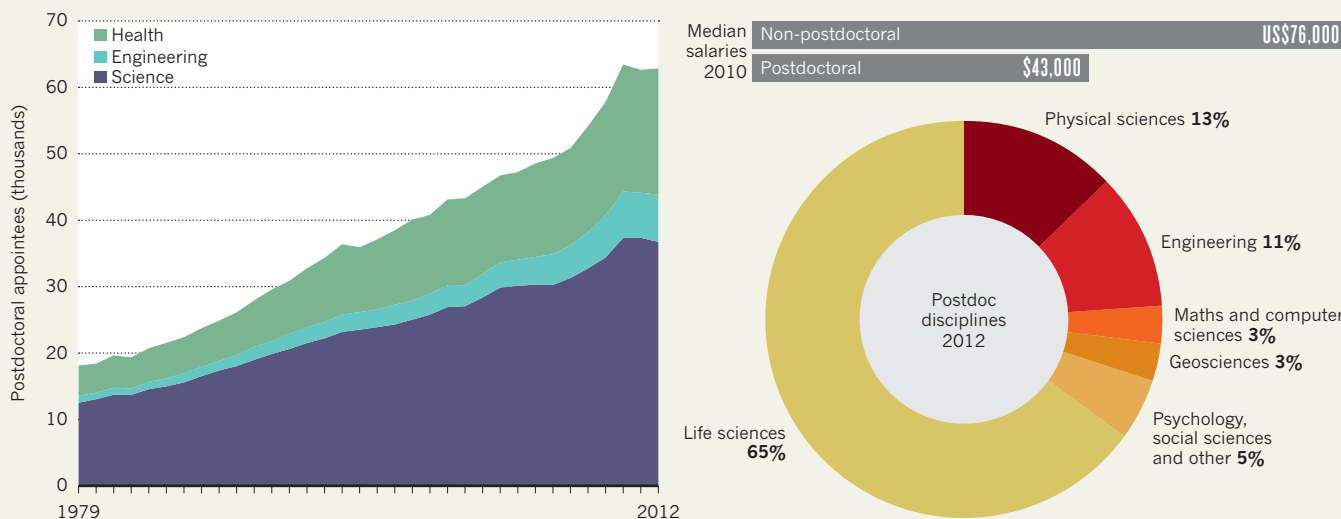
THE SUPERDOC

If postdocs are so prized, then one obvious solution is to reward them. Both the 2014 National Academies report and earlier reports urged US lab heads to consider creating senior staff scientist, or ‘superdoc’, positions. These would be higher-paid, permanent jobs for talented postdocs who have no desire to start their own labs.

Some funding agencies and institutions around the world already offer this option. Lippincott-Schwartz, for example, has two superdocs in her cell-biology laboratory at the National Institutes of Health (NIH). One serves as a software developer for the lab’s super-resolution imaging of intracellular structures. The other is a microscopy specialist and lab manager. They both mentor trainees, help to write publications and keep up with the latest technological advances in the field. “These staff scientists offer so much to individual laboratories,” she says. “They can do the science they love without dealing with all the

THE POSTDOC PILE-UP

The number of researchers in US postdoctoral positions has more than tripled since 1979. The vast majority of postdocs are in the life sciences. Across fields, median salaries for postdocs are outstripped by those for non-postdoc positions, when measured up to 5 years after receiving a PhD.



bureaucratic stuff associated with being the PI.” Each of her superdocs earns \$20,000–30,000 more than postdocs typically earn — a cost she was able to cover by requesting more funds for her lab’s annual budget from the NIH.

But other lab heads say that they struggle to find the resources to pay for superdocs, and without an increase in funding, the inevitable trade-off is fewer workers. That reality is hard to stomach for lab heads who are trying to balance the pressure to produce results and papers — generally maximized by lots of staff on low salaries — with the desire to keep and promote experienced employees. “It’s economics, and we need to face up to that. There may not be as many people working in your lab. No one wants to talk about that,” says Micoli.

One scientist struggling with this dilemma is Leslie Leinwand, a molecular cell biologist at the University of Colorado Boulder’s BioFrontiers Institute. She relies on two postdocs, Massimo Buvoli and Steve Langer, who have been in her lab for nearly two decades. But if she created staff-scientist positions for them — as the National Academies report recommends — the two increased salaries would equal nearly two-thirds of the annual budget for a typical NIH R01 grant, on which many biomedical labs rely. “There needs to be a place for such people who just want to stay at the bench, but I stay awake at night worrying about salaries for Massimo and Steve. Frankly, I can’t afford to pay them what they deserve,” Leinwand says. Anne Carpenter, a computational biologist at the Broad Institute in Cambridge, Massachusetts, requested extra grant funds to hire more permanent scientists rather than trainees, but found that her proposals were criticized by grant reviewers, who questioned why she was using such expensive staff to do the work.

Some funding bodies do offer funds specifically for staff scientists, and others are introducing them. In March, the US National Cancer Institute proposed a grant programme designed for superdocs that would cover a salary in the range of \$75,000–100,000 for five years. It is planning to grant 50–60 such ‘research specialist awards’ throughout the next 18 months (see page 255).

THE REINVENTED LAB

The real solution to the postdoc problem, Tilghman says, lies in dramatically changing the composition of labs to make them smaller, with a higher ratio of permanent staff scientists to trainees. This was also a key recommendation in the National Academies report. “The more I have thought about this question, the more I’m convinced that at the heart of the problem is the structure of the lab,” says Tilghman, who headed up a 2012 study of the NIH workforce (see go.nature.com/wsqqzgj).

The biggest challenge, she says, is persuading lab heads to embrace such a model when there is a tremendous bias in favour of the cheap labour that graduate students and postdocs represent. But that bias is short-sighted, she argues, when one staff scientist can do the work of three less-experienced researchers. “We’ve got to persuade faculty that this is a true trade-off, and a positive trade-off for their research productivity.”

Labs stuffed full of trainees do not always translate to better results, says Gregory Petsko, chair of last year’s National Academies committee and a neuroscientist at Weill Cornell Medical College in New York City. “I don’t think many of us need the labs to be the size we have them.” Petsko proposes combining various strategies — term limits, fewer postdoc

positions and more staff scientists — to deflate the swollen postdoc population. That would stop the postdoctoral fellowship from being the default step after earning a doctorate. “I think the goal is to make the postdoc something special,” he says. “It should be hard to get a postdoc — harder than getting into graduate school.”

The question is, can the scientific community be convinced? No one interviewed for this story — whether lab heads or postdocs themselves — wanted to give up these highly valued research positions. But few lab leaders, institutions or funders seem willing or able to spend what it takes to reward them appropriately. Petsko says that funding agencies could step in and enforce change, by demanding that universities direct a portion of their overhead payments — money given to the university rather than the lab — towards creating more staff-scientist positions.

Davy points out that the solution needs to be global, or else postdocs denied jobs in one country will simply slide across country borders to find them elsewhere. In an ideal world, he says, postdocs would be able to take their funding wherever they like. “People should be going to the best labs, the best places for them to work and be trained, which are dotted around the world.”

As for Thuault-Restituto, she does not regret her postdocs. But if she had to walk that path again, she would move into another career much earlier. She agrees that fewer PhDs should be flowing into postdocs, and is frank with graduate students who ask her for advice: “If you are not 150% sure you want to do it right now, don’t do a postdoc.” ■

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