

YOUNG, TALENTED AND FED-UP

BY KENDALL POWELL

Martin Tingley was coming undone. It was late autumn 2014, just over a year into his assistant-professor job at Pennsylvania State University in State College, and he was on an eight-hour drive home after visiting his wife in Boston. He was stressed, exhausted and close to tears. As the traffic zipped past in the dark hours of the early morning, the headlights gave him the surreal feeling that he was inside a video game.

Usually, Tingley thought of himself as a “pretty stoic guy” — and on paper, his career was going well. He’d completed a master’s degree in statistics and a PhD in Earth science, both at Harvard University. With these, and four years of postdoctoral experience, he had landed a rare tenure-track faculty position. He thought he would soon be successfully combining statistics and climate science to produce the type of interdisciplinary research that funding agencies say they want.

In fact, scientific life was proving tough. He found himself working 60–80 hours per week doing teaching and research. His start-up funding had run out, he had yet to secure a major grant and, according to a practice common in US academia, he would not be paid by his university for three summer months. His wife had not been able to move with him, so he was making tiring weekend commutes. It seemed that the pressures had reached unsustainable levels. Something had to give.

Tingley is one of many young scientists who are deeply frustrated with life in research. In September, *Nature* put a post on Facebook asking scientists who were starting their first independent position to tell us about the challenges that they faced. What followed was a major outpouring of grief. Within a week, nearly 300 scientists from around the world had responded with a candid catalogue of concerns. “I see many colleagues divorcing, getting burnt out, moving out of science, and I am so tired now,” wrote one biomedical researcher from Belgium (see ‘Suffering in science’). *Nature* selected three young investigators who voiced the most common frustrations; here, we tell their stories.

But are young scientists whining — or drowning? Our interviewees acknowledge that they are extremely fortunate to have

Scientists starting labs say that they are under historically high pressure to publish, secure funding and earn permanent positions — leaving precious little time for actual research.

an opportunity to direct their own creative, stimulating careers, and they are hardly the only professionals who are expected to work hard. It’s easy for each generation to imagine that things are more difficult for them than they were in the past.

But some data and anecdotal evidence suggest that scientists do face more hurdles in starting research groups now than did many of their senior colleagues 20–30 years ago (see page 444). Chief among those challenges is the unprecedented number competing for funding pools that have remained stagnant or shrunk in the past decade. “The number of people is at an all-time high, but the number of awards hasn’t changed,” says Jon Lorsch, director of the US National Institute of General Medical Sciences (NIGMS) in Bethesda, Maryland. “A lot of people with influence on the system recognize this is a serious problem and are trying to fix it.”

Young scientists and senior scientists alike feel an acute pressure to publish and are weighed down by a growing bureaucratic burden, with little administrative support. They are largely judged on their record of publishing and of winning grants — but without clear targets, they find themselves endlessly churning out paper after paper. The crucial question is whether this is harming science and scientists. Bruce Alberts, a prominent biochemist at the University of California, San Francisco, and former president of the US National Academy of Sciences, says that it is. The current hyper-competitive atmosphere is stifling creativity and pushing scientists “to do mediocre science”, he says — work that is safe and uninteresting. “We’ve got to reward people who do something differently.”

Our informal survey suggests that the situation is already making research an unwelcome career. “Frankly, the job of being a principal investigator and running a lab just looks horrible,” wrote one neuroscientist from the United States. Tingley wouldn’t disagree.

FUNDING FIGHT

Tingley has always had broad interests. At university in Canada, he switched from art history to physics. For his graduate studies, he was drawn to the vibrant research environment at Harvard, in Cambridge, Massachusetts, where he built statistical methods that helped to make sense of data on past climate gathered from sources such as tree rings and ice cores.

By the time he was searching for academic positions, he was already working 60-hour weeks, he says: he would be at work by 8 a.m., go home for dinner, and then pull out his laptop again at night. But by 2013, his research was hitting a high: he had published a statistical analysis in *Nature*¹ and, after applying for jobs worldwide, was offered a joint appointment in meteorology and statistics at Penn State.

By this point, his wife, Gabrielle, ran the communications programme for Harvard’s Research Computing centre in Cambridge. Positions offered to her at Penn State fell far short of her qualifications, and she opted to stay where she was. They were facing the ‘two-body problem’ — a long-standing stress point for scientists.



Like many first-year assistant professors, Tingley immediately felt pressure to publish in top journals, attract funding and students, and innovate in the classroom. He also knew that his roughly US\$200,000 in start-up funding from the university — to cover his summer salary, computing access and more — wouldn't last long, and he applied to the US National Science Foundation for grants. That process was “heartbreaking”, he says.

In one instance, he put in a proposal with his collaborator, organic geochemist Jessica Tierney at the University of Arizona in Tucson, for work on proxies for past sea surface temperatures. On the first round of review, the application got two scores of “excellent” and two of “very good”, yet it still fell short of being funded. The two were encouraged to resubmit, which they did. On the next round, the proposal scored worse. “Part of it is on me, I was unsuccessful,” Tingley says — but the anecdote shows the frustration that young scientists face when trying to get a research programme off the ground. “The funding cycle is brutal.” In the meantime, the pair published the initial stages of the work² in an article that has been cited 40 times.

The views of scientists who responded to *Nature* revealed a generational divide: many feel that today's senior investigators experienced a more comfortable trajectory in science and now have a competitive advantage. The ‘baby boom’ scientists, who have longer track records and well-established labs, are in a stronger position to win funds. (In September, *Nature* asked on Twitter: “What are the challenges facing young scientists?” “Old scientists,” one respondent shot right back.)

In December 2014, shortly after his low point in the car, Tingley and his wife took a month-long trip to Australia and Indonesia for some much-needed time together. The next month, Tingley returned to the winter chill at State College and walked across campus feeling as if his head was scraping against the low-hanging clouds. He knew that much of his time was about to be sucked up teaching two advanced courses, leaving little time for research, and he would be back to the tiring commute to see his wife at the weekends. If he didn't get a grant soon, he would have no summer salary. “My wife and I knew this wasn't a sustainable way for us to live our lives.”

Tingley started googling around late at night, and in March, he spied the perfect job posting. Insurance Australia Group in Sydney was looking for someone with experience in meteorology, statistics and climate. He started there two months later, and his wife easily found a position in communications with the University of New South Wales. Now a senior research analyst, Tingley models and quantifies risks from bush fires, cyclones and other storms. The transcontinental move was not without its difficulties, of course — and as a young researcher moving to the private sector, he's had to prove himself all over again.



“The funding cycle is brutal.”

MARTIN TINGLEY

Tingley now advises others to recognize that there are various paths to a successful career. “It's perfectly legitimate to use your training and skill set in the private sector.” He isn't missing the stress and high expectations placed on young investigators' shoulders, he says. On a sunny spring Saturday in September, he and his wife head out for a walk on their neighbourhood beach. “It turns out that weekends are fantastic,” he says.

NEVER GOOD ENOUGH

Sometimes, pressures come not from chasing funding or tenure, but from chasing an ideal of what makes a good scientist. Young researchers from all disciplines told *Nature* that they wrestle with the lack of clear expectations for success — and materials scientist Eddie López-Honorato is one.

He grew up in Mexico City and studied chemistry there, at the National Autonomous University of Mexico, but for his PhD, he struck out for the University of Manchester, UK. He worked at night and at weekends to complete his experiments, he says, which became more difficult after his son was born. He found it stressful, but his time at Manchester gave him high working standards that he now tries to emulate. Next, he did a postdoctoral fellowship

at the Institute for Transuranium Elements in Karlsruhe, Germany, where he worked on developing safer coatings for nuclear fuels used in reactors.

At the end of his postdoc, he had the opportunity to return to the United Kingdom as a lecturer at the University of Sheffield, but he and his wife, Paola, yearned to go back to Mexico. They weighed up the pros and cons. López-Honorato knew that he would need to build up his professional reputation in Mexico and that the science infrastructure there was less developed than in Europe. But he thought that working in the United Kingdom would be harder for his family, because they faced constant changes in language and culture. The family chose Mexico.

In March 2012, López-Honorato started at the Center for Research and Advanced Studies of the National Polytechnic Institute (CINVESTAV) in Ramos Arizpe. He felt an amazing sense of independence and potential on standing in front of his brand new empty lab space. “You know that you have to get some students and money fast, really fast, and that's when the urge to work kicks in,” he says. Although the government paid his and his students' salaries, he still needed to secure funds to support his research. He sent out a flurry of grant



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EDDIE LÓPEZ-HONORATO

proposals for government funding, without success.

López-Honorato spent 2012 travelling around Mexico and the United States to build collaborations. He cold e-mailed other scientists to explain his work. The grants started trickling in. By 2014, he had secured enough to cover most of his research expenses and had established a second arm to his lab’s work: developing adsorptive materials to remove arsenic from drinking water, a problem that affected nearly half of all wells in certain parts of Mexico³. Since starting at CINVESTAV, he has published 20 research papers and has built up a lab group of 15 people.

Like many of those interviewed, he says that the work to sustain funding is as tough

as winning the first grants. Even though his position is secure, he feels the pressure of maintaining his research projects and launching the careers of younger scientists. “It’s stressful when you don’t have money, and stressful when you do have money, because then you have to deliver. It’s my fault if anything goes wrong.” He points to a recent eight-month bureaucratic delay in purchasing a coating machine that is essential to his nuclear-fuel work; it put the project a year behind schedule, and he feels that he is to blame.

Many scientists, like other professionals, say that there aren’t enough hours in the day. (“My cohort, we feel exhausted,” said one Generation X scientist, who asked to remain anonymous to protect his career.) In the past two months,

López-Honorato says, he has averaged four hours of sleep per night. He and other early-career researchers are “in a stage where our kids and partners need us the most at home”, he says. His second son is now eight months old.

He wrestles with whether he has valid reasons to complain, and knows the pressures are largely self-generated. “It’s a problem of saying, ‘That’s enough,’” he says. It’s an issue that many young investigators struggle with — when you’re the one setting the goals, when do you have enough money, students or publications? Philip Guo, a cognitive scientist at the University of California, San Diego, described in a 2014 blogpost how academics often feel as if they are on an accelerating treadmill. In his previous work as a software engineer at Google, Guo said, he had “tremendous clarity about what and how much I was expected to do”. Academics, however, have obligations to teach, advise, do research, write grants and support departments, universities and the academic community — and “none of these sources of work know of or care about one another”. Alberts highlights the young investigators who need two major grants, one to supply their salary and one for their research programme. “It’s horrible pressure on young people. How are they going to be excellent at anything? The incentives are all wrong.”

This year, López-Honorato is trying to lower his own expectations, applying for only one industry grant — compared with the seven he applied for in 2012 — in the hope that he’ll get home in time to play with his boys. But that internal pressure is hardest to quell. “We want to be the best — that’s how we got to the job we have right now. It’s a personal pressure. But that’s even more difficult to get rid of.”

NO TIME TO THINK

Computing always attracted Felienne Hermans, who taught herself programming at age 10. She specialized in computer science at university and pursued a PhD at Delft University of Technology in the Netherlands. There, she applied methods of software engineering to

SUFFERING IN SCIENCE

We asked young scientists to tell us their concerns. This is what they said.

Desperate pursuit of grants leaves no time for science

“I spent almost all of my time fundraising, and the time spent on executing research was less than 5%.”

Extreme competition drives many scientists to cut corners

“There’s work that is clearly beautifully done, but there’s

also work that is done sloppily, overhyped, even fabricated. Current pressures and incentives mean that being first but wrong pays off better than being second and right.”

Dependence on senior scientists to advance

“If you’re not lucky, if your [senior] professor isn’t good at getting research funding or

doesn’t have much weight or is not supportive of you in any way, then you are completely screwed.”

Administrative overload with no help

“If I asked for an administrative assistant, it would probably double my research time... and my department would probably have a good laugh.”

Long hours

“The kind of culture we have is that you can’t be a successful academic on 40 hours a week. I struggle with how I really don’t want to open my laptop again at 9 p.m. when I sit down on the couch. But I want that *Nature* paper, I want that big grant.”

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spreadsheets, so that end users such as accountants or biologists would have better ways of maintaining and annotating their data⁴. The creative work won her top conference papers, which are key for advancement in this field. When a tenure-track position opened up in her research group of four professors, she asked whether she could apply. She beat internal and external candidates and started as an independent professor in March 2013, at the age of just 28.

Two years into the position, Hermans was feeling overwhelmed. She was grappling with the responsibilities of managing her two graduate students and one postdoc, prepping for teaching courses, and what felt like endless ‘service’ requests to review papers for journals and colleagues. The spreadsheet work had in some ways run its course, and she wanted to pivot to a more stimulating research area. But the pressure to publish continuously and copiously dogged her. Her job is formally split between 40% teaching, 40% research and 20% academic service, but the message is that research should trump everything else. “Four papers are better than three. And five are better than four,” she says.

Like Alberts, she says the idea that research output is now synonymous with publication quashes all creativity. “Papers are just one form of communicating ideas and experiments.” She yearns “for an afternoon of looking out the window and thinking, ‘What will I do next?’”.

Another barrier has been constant throughout her career: being a woman in an overwhelmingly male-dominated field. In 2014, she attended the Code Generation hands-on programming conference in Cambridge, UK, and found herself 1 of only 2 women among roughly 100 attendees. She spent the three days speaking to colleagues about this sad statistic, rather than about her programming, as she would have preferred. “It drags you down and drains your energies,” she says. In the survey, *Nature* received roughly a dozen comments from young scientists who indicated that sexism, gender bias or lack of support for women held back their careers.

Hermans eventually developed a fresh research focus through her Saturday volunteer work at a community centre, where she taught programming to inner-city kids. She and a colleague began thinking about how best to teach the children. Rather than just explaining how to make a robot move forward, say, they wanted to communicate how to maintain code quality through properly naming program features and avoiding ‘code smells’, or poorly designed program sections. The pivot wasn’t totally smooth — her first conference paper about a generic theory for code smells was rejected for not having enough supporting evidence, but now she is hitting her stride.

Looking back, Hermans says that she probably should have ignored the pressure to publish, and ruminated more. “But I was new in the tenure track and super scared about not being able to pay my mortgage in two



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FELIENNE HERMANS

years.” Now, she keeps more careful track of her time. If a colleague knocks on her door for help with a student’s paper, she can turn them down: “I’ve already done my 20% to service.” She’s rearranged her week, cramming teaching, grant writing and service into Monday to Thursday so that she can spend Fridays with her lab group, which now comprises six people.

There are more-organized moves to help young investigators — to win grants, for example. Alberts says that “there has to be a shift of resources to the younger people”. He points to the European Research Council grant programme that divides applicants into three career stages — Starter (2–7 years post-PhD), Consolidator (7–12 years post-PhD) and Advanced (more than 12 years post-PhD) — so that applicants from each career stage compete with their peers. In the same vein, this year the NIGMS piloted a grant called Maximizing Investigators’ Research Award, which separates early-stage investigators from established ones, and offers five years of guaranteed funding. That’s an innovation in the US funding system, says Lorsch, because it means no longer “comparing apples and oranges”. And Lorsch says that older investigators should be encouraged to move into alternative stages of their career — working in teaching, mentoring and science advocacy — that don’t require research funds. This could help younger researchers to break in.

Other scientists vehemently oppose such ideas. And Alberts, like many senior scientists,

doesn’t see the problem as solely based on age. “It’s not about fairness. It’s about how to get the best science for the dollar. We’ll get much better science by funding young or old people to do innovative things.”

Hermans is acutely aware that the grumbles of young scientists can be brushed away. “If people are complaining about an injustice, it’s easy to say they are just moaning,” she says. “But these are not imaginary problems.” She feels it’s her duty to be vocal about the challenges facing young investigators. “Experienced researchers should be observing if a young scientist is failing and asking, ‘Are you overwhelmed? Why aren’t you inspired?’”

Lorsch says that he knows first-hand that Generation X scientists are not whiners: “I do not hear complaining from the people who are trying to get their first grant or renew their first grant, the people trying to get a lab running,” he says. “It’s the really well-funded people who’ve lost one of their grants — that’s who call me and scream.” ■

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