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Young science in an old city

The political, cultural and scientific capital of the world's most populous nation is on the hunt for global talent.

BY FLYNN MURPHY

Beijing, 'northern capital' in Mandarin, was so named by the third Ming emperor Zhu Di more than 600 years ago when he made it the centre of his empire.

Today, the city is home to many of China's most prestigious universities and state research institutes, including Peking University (PKU) and Tsinghua University, as well as a litany of institutes nested within the sprawling and Beijing-headquartered Chinese Academy of Sciences (CAS), the world's top-ranked scientific institution for high-quality output, according to the Nature Index.

This city is also a formidable technology hub. In the northwestern Haidian district, the largest and most successful of China's high-tech development parks — Zhongguancun — houses the head offices of technology powerhouses such as the search giant Baidu, the tech behemoth Lenovo and Xiaomi, the world's fifth-largest smartphone maker.

"Researchers, entrepreneurs and local officials have jointly fostered collaborative relationships between Beijing's academic research organizations and commercial enterprises," says Abigail Coplin at Yale University's Council on East Asian Studies in New Haven, Connecticut, who researches Chinese science from a sociological perspective. Many of the early successful technology companies in the area were majority-owned by nearby universities and research institutions. These collaborations helped to develop Beijing's scientific standing alongside its existing role as the Chinese capital. "Beijing is not just the seat of the central government. It is also the cultural capital and human capital hub of the country," says Coplin (see 'Big city').

Dutch astrophysicist Richard de Grijs agrees. "Beijing is the gateway to China," he says. He works at the Kavli Institute for Astronomy and Astrophysics, which is based at PKU in Haidian. "Many scientists enter China through Beijing, so we tend to get a lot of visitors from abroad. That helps with our international visibility."

STRIVING FOR SCIENTISTS

In efforts to improve its research culture and scientific infrastructure — and to promote its international reputation — China has ramped up its bid to attract foreign scientists such as de Grijs over the past decade, with generous grants and other support. In January, Chinese Premier Li Keqiang hinted at additional measures the government is considering to foster foreign talent, including simplifying the immigration and visa process and strengthening intellectual-property protection (see 'Credit where it's due').

Chinese policymakers are building a unique science and technology ecosystem, according to Coplin. It's "science and technology with Chinese characteristics", she says — a confluence of initiatives aimed at increasing China's technological independence, ▶

using innovation as an economic driver, and aligning this development with the government's priorities.

China hopes to grow by "bringing individuals with innovative ideas to China, and giving them the resources necessary to start labs and companies", Coplin says. The nation's headline policy in this regard is the Thousand Talents Plan. Initiated in 2008, it comprises cash incentives, government support and favourable visa treatment in an effort to recruit 'expert talents' to China. The scheme will run up to 2021.

Applicants to the scheme are divided into two streams — one for foreigners, and one for those with Chinese heritage. Successful applicants to either stream are entitled to a 1 million yuan (US$154,000) subsidy from the Chinese government and have access to a 3-million- to 5-million-yuan research grant.

The way these policies have been implemented is "distinctively pragmatic", says Coplin. The Thousand Talents Plan has short-term and long-term options available for returnees of Chinese ethnicity. These let them try out academic life in their home country, perhaps for a few months, before committing to a full return. "Although the practice is somewhat contentious, these programmes also enable some part-time returnees to simultaneously operate laboratories in two different countries, and thus essentially have research being conducted in their name 24 hours a day," she says.

But this treatment is not expected to last forever. As China's science and technology ecosystem advances, and so becomes more attractive to overseas students, Coplin thinks future incentive programmes will require greater levels of commitment.

A HARD SELL

Despite these efforts, Beijing still does not always attract the foreign talent it hopes for. De Grijs, a popular figure in Beijing's research community known for his science advocacy and outreach work, has made an interesting observation over years of trying to fill positions at his institute. "If you offer postdoc positions or fellowship positions to Chinese citizens, it's almost 100% guaranteed that they'll come here. If you offer them to people from Asia — and that's India, Korea and other Asian countries — I think we had a success rate of 60–70%. And if you offer them to US or European scientists you might get 10% or 20%."

De Grijs often contributes English-language columns on science and policy to the Chinese government news portal China.org.cn, where he has both defended and criticized elements of China's science sector. He says his writing has never been censored. In one January column, de Grijs analysed what he sees as the three challenges facing China's foreign recruitment push.

The first is a perception that China is an unattractive or intimidating place to live — "it still has this perception of not being very open".

The second is a concern that researchers may lose visibility in their field — China's location, many hours' travel from the world's scientific centres in the United States and Europe, means that networking and establishing oneself in an international field can become a costly endeavour. "You have to work to not be forgotten by your peers," says de Grijs. Publishing often and organizing local conferences is one option, he suggests.

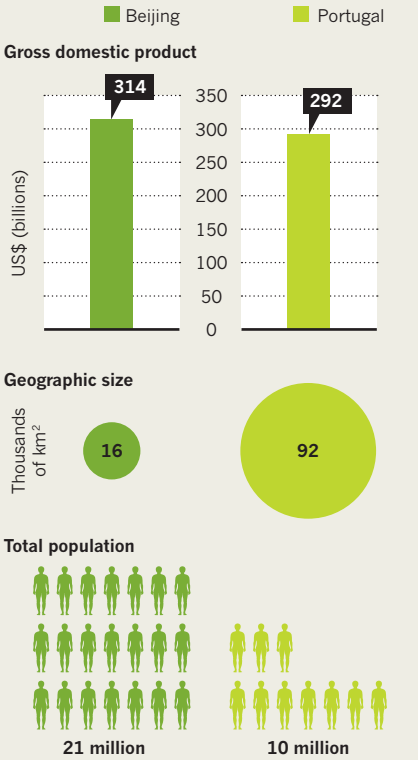
The third challenge is the relatively low international ranking of many Chinese universities, which de Grijs thinks dissuades senior scientists from taking permanent posts in the country. "Attracting senior foreign talent to long-term appointments will only succeed if they feel at home and respected in their new positions," he wrote.

Another worry for many researchers is the integrity of scientific research in China. Numerous scandals have damaged its reputation on the international stage. In April, the journal *Tumor Biology* retracted 107 papers written by Chinese scientists after its publisher, Springer Nature, determined that fabricated reviews had been submitted to support those publications. (Springer Nature no longer publishes the journal; it does publish *Nature*, but *Nature*'s news and comment team is editorially independent of the publisher.) But de Grijs is exasperated by the Western perception that Chinese science is untrustworthy. "There's a huge range — there is some absolutely excellent science at the top end, and there is a whole range of different gradations of quality." And he adds that academic fraud is not a problem limited to China. "It's international. China gets picked up because it's a high-profile country. And yeah, there are certain practices that are unethical and that have to be worked on."

The Chinese government has launched various initiatives to combat academic fraud — and a new interpretation of China's criminal code could, in extreme cases, see researchers who fake clinical data executed. De Grijs doesn't agree with the use of the death penalty, "but I think it's good that fraudulent practices are being addressed".

BIG CITY

In many respects, Beijing is more comparable to a small nation, such as Portugal, than to most cities.



SOURCES (DATA FROM 2013): OECD/CN.GOV/WALL STREET JOURNAL/ENCYCLOPAEDIA BRITANNICA

SUCCESS IN THE CITY

For those who have made the move, the rewards can be plentiful, but Beijing presents its own unique challenges to foreign researchers. De Grijs relocated there in February 2010 with his wife, a Chinese biologist and research fellow who gained a post at Tsinghua University at around the same time. He calls the Peking campus, with its serene lakes, an "oasis in a big, bustling city", and has just applied for his eighth year-long residence permit — a relatively painless exercise given his academic affiliation. "I'm supported by Peking University so they take care of all the paperwork."

Previously an associate professor of astrophysics at the University of Sheffield, UK, de Grijs describes his Mandarin as "not very good" but says he gets by just fine at the institute, one of a growing number of Chinese research bodies that function primarily in English. He also has university translators on hand to help.

Beijing's smog and light pollution would render a research telescope on campus useless. The small telescope that sits in a dome atop the School of Physics is instead used to train budding stargazers. "It's good for showing students how you can use a telescope and what sort of physics you can do with simple observations," de Grijs says.

For research-level observations de Grijs uses larger telescopes in more remote parts of China, such as the Qinghai Observation Station in Delinha, or sends his students there. His current research primarily involves the Hubble Space Telescope, which means booking observing time, then sending coordinates and instructions to scientists in Baltimore on the US east coast to be beamed spaceward.

GROWING GLOBALIZATION

In the city's north, next to the main site of the Beijing 2008 Olympic Games, sits the CAS Olympic Village Science and Technology Park, which is peppered with research institutes dedicated to genetics, genomics, physics, microbiology, geography and more.

Much of Beijing's Olympic infrastructure remains, including the iconic blue bubble-surfaced 'water cube' that held swimming

BRIGHT IDEAS

Credit where it's due

Dan Harris is a lawyer and founding member of Harris Bricken, a China-focused international law firm headquartered in Seattle, Washington. Harris, who runs the influential China Law Blog (www.chinalawblog.com), says a big question for foreign researchers in China is over intellectual property, or: "Who owns what of the results of the research?"

"Will the foreign researcher just work for salary and own nothing? Some percentage? Based on what?" he asks. "This is what they need to think about, and then if they want any part of the results, they need a China-specific contact to make sure they get it, or they will return to their home country empty-handed."

David Bennett is an intellectual-property counsellor for the Australian government, based at the nation's Beijing embassy. He is the first such consultant to any country on behalf of Australia. According to Bennett, Chinese patent laws are rare in providing intellectual-property protection for employees. Although Chinese institutes generally own their employees' inventions, unlike most countries they have a statutory obligation to compensate the inventor. "Chinese law provides that an employee is entitled to reasonable compensation for such an invention, usually a percentage of profit derived from a patent," he says.

"In this regard, China is one of the more inventor-friendly countries." **F.M.**

events. Nearby is the Institute of Zoology, CAS, where chemical ecologist Jacob Wickham is crouching next to an ailanthus tree. The tree is wrapped in a sheet of sticky white paper dotted with slow-moving insects. Wickham, who hails from Buffalo, New York, and who moved to China in 2006, has set insect traps with different chemical lures along a row of 64 trees inside the institute's fence.

The trees are a Chinese native introduced in the eighteenth century to the United States, where they're known as the 'tree of heaven'. They are rendered less charitably in Mandarin as *chouchun* — *chou* means stink. "In the US they only grow alongside railroad tracks and around junkyards," Wickham says. "They're really junky, but they're nice shade trees."

They're also a gold mine for anyone targeting the brilliantly red-and-black insect Wickham now holds in the palm of his hand. The spotted lanternfly (*Lycorma delicatula*), a Chinese export that feasts on stone fruits and timber trees, is currently wreaking havoc in Pennsylvania, where it threatens a $12-billion hardwood industry.

Conventional approaches to controlling the lanternfly have proved ineffective, partly because its bright colours advertise its toxicity. "I've seen ants walk by the corpses of these things. They're like indestructible beasts. Not much will eat them," Wickham says.

Instead, he hopes to use a chemical–ecological approach to identify the pheromones that influence insect behaviour. "I'm researching attractants — and also looking at what sticky bands are most effective at catching them." Eventually, he hopes, these chemical smells will help to confuse, control and — where necessary — eradicate the lanternfly.

Wickham collaborates with the Canadian Food Inspection Agency and the US Animal and Plant Health Inspection Service. But he moved to China to be closer to the invasive insect species that fascinate him — originally the wood-boring Asian long-horn beetle (*Anoplophora glabripennis*), which formed the basis of his PhD.

"It was one of the first really big nasty invasives that spread from China to other parts of the world," Wickham says. The wood-borer, which lays larvae that tunnel into bark and wood, is thought to have stowed away in packing materials dispatched from China. "It was one of the unintended consequences of globalization, the movement of invasive species around the world," he says. "Think of all the shipping crates."

Wickham's move has not been without problems. Back in his lab, he recounts being caught in the "vortex of China's talent recruitment and bureaucracy" as he positions an emerald ash borer beetle (*Agrilus planipennis*) for an experiment.

He was offered a permanent position at the Institute of Zoology, which requires either a Chinese green card or a 'foreign expert certificate' to get on the payroll. He has no green card, and his current certificate is tied to a previous employer. This complication has left him in employment limbo. Fortunately, he edits a zoological journal at the institute, which entitles him to remain until the situation is resolved. Wickham's experience is illustrative of the red tape that most foreign researchers must learn to accept as part of life in China.

FOSSILS AND FUNDING

Palaeontologist Jingmai O'Connor hasn't found China's administrative culture as stifling as Wickham has. In fact, she feels less weighed down by red tape than she did in the United States, with "the freedom to do my research unfettered by paperwork and bureaucracy". The American-born researcher has also, as de Grijs advises, worked hard to maintain her international visibility, publishing nearly 100 papers since taking a post eight years ago with the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), a CAS institute in west Beijing.

Early last year, O'Connor contributed to CAS's third-most-impactful journal article ▶

SIM CHI YIN/VII/REDUX

Ecologist Jacob Wickham is investigating ways to control the spotted lanternfly (*Lycorma delicatula*).

Jingmai O'Connor has found success in Beijing, helped in part by ready access to some of the finest fossil collections in the world.

SIM CHI YIN/VII/REDUX

by Altmetric score in any field — which details the plumage of bird wings fossilized in a mid-Cretaceous Burmese amber deposit and their similarities with those of modern birds living 99 million years later (L. Xing *et al. Nature Commun.* **7,** 12089; 2016).

"I am thrilled to be somewhere where science is appreciated and funded," O'Connor says. She compares the experience with her home country where she had to "scrape by with minimal funding, only able to see the one or two most important collections and attend a single conference a year".

"My boss has been awarded two of the largest grants ever given by the Chinese government and we have money to do everything and anything we want. It means when we want to check collections or bring in collaborators — often to teach mini-courses and help our students stay on top of the latest techniques — or buy the latest equipment, we don't even bat an eye."

A recent grant O'Connor's team received for multidisciplinary research was designed to be large, she says, "so that the receiver doesn't have to waste time applying for grants for five years, so they can focus purely on the research".

In fact, the IVPP has been so successful that it is shifting towards more independent projects. "Research in China has been rapidly moving forward, taking advantage of funding to stay on top of the latest techniques and technologies and moving towards less dependence on foreign collaborators," O'Connor says.

World-leading research is not the only draw for O'Connor — the lifestyle is important as well. She has lived among Beijing's hutongs — the narrow streets that snake between low-rise buildings and characterize traditional residential areas — for most of her time here, and says the city gives her a degree of freedom distinct from her experience in the United States. O'Connor also makes favourable comparisons between China and the United States in relation to gender bias. "I don't feel particularly discriminated against and in fact, I feel less so than I would in the USA. I have tattoos and piercings and feel like these things in America would hold me back, whereas in China, as long as I'm productive, they couldn't care less how I look — and if they find my behaviour odd, it gets chalked up to being foreign."

THERE IS SOME ABSOLUTELY EXCELLENT SCIENCE AT THE TOP END.

"This institute has really become home," O'Connor says of the IVPP, which she first visited in 2003 as an undergraduate researching mammals. "I've spent my entire career here, and see no need to move on in the near future. At first this bothered me, but now I recognize that I have a great thing going so why should I feel the need to add other institutions under my belt? Beijing was the only choice. I really love it here, both as a place to live and to work." (See 'A capital of contradictions'.)

Although her salary is the same as that of local scientists, there are perks: travel funding and year-end productivity bonuses among them. But she says it would be hard for her to set up her own lab because she can't read Chinese.

O'Connor describes her spoken Chinese as "pretty poor" but has had fun learning. "I make the effort to learn because I want to understand people: friends, colleagues, taxi drivers." She's even given presentations in Mandarin. "It's important to try to integrate and also to put yourself in the shoes of a majority of scientists, whose first language is not English. For most Chinese colleagues, giving a talk in English is difficult and stressful and I think that my willingness to make an utter fool of myself and give a talk in Chinese goes a long way to developing good camaraderie."

To her, China has a complex image problem. O'Connor says that many researchers in her

field are envious that she lives so close to the world's great fossil collections, but they aren't willing to live here themselves. "I don't think Beijing is for everyone," she says. "The fossils and funding are certainly alluring, but most people see China as unliveable for whatever reason. They may love to visit but seem intimidated by the idea of life in Beijing. It certainly can be lonely for foreigners and it even took me a couple years to make a happy life for myself. But now that I've found it, I don't want to give it up for the world."

GOOD COMPANY

The man who founded Beijing, Zhu Di, today lies entombed with 12 other Ming emperors in a northern suburb of the city. In his lifetime, he sponsored some of the largest naval expeditions ever undertaken, and his desire to expand China's influence endures.

Last week, the Beijing-based Center for China and Globalization, an independent think tank an hour's drive from the Ming tombs, co-published a report setting out some of the problems the country has faced in attracting more overseas talent. Whereas international recruitment figures are dismal in comparison with other developed countries, the report suggests further changes to China's research system that might improve its showing. These suggestions are likely to be taken seriously in Beijing's political sphere.

As China looks to solidify and grow its economic power, it continues its hunt for highly skilled overseas scientists, engineers and investors. "We cannot do the work well without the help of international workers," said Wang Huiyao, president of the centre. Whatever the experiences of researchers who have already made Beijing their home, one thing seems certain: they will soon have company. ■

Flynn Murphy *is a freelance reporter based in Beijing.*

LIFE IN THE CITY

A capital of contradictions

China's capital is a bustling city built high and wide, laid out among five concentric ring roads. Beijing's motorists frequently disobey traffic ordinances — it is often inertia that confers right of way. Yet traffic generally flows, albeit sometimes at a trickle.

The city itself — part of a wider municipality also called 'Beijing' — is more than 4,500 km^2 in area — around five and a half times the size of New York City. Beijing municipality is more than three times that.

With a size and population comparable to a small nation, it's understandable that Beijing often seems to be a tale of two cities. At the first sign of a rainstorm, a frequent occurrence in summer, emergency SMS messages warn citizens of inevitable urban flooding that regularly claims lives, even as a sophisticated centuries-old plumbing system quickly drains the imperial palace. Mountains that historically shielded Beijing from attack to the north and the west now conspire with high-pressure weather systems to trap a layer of air over the city, resulting in Beijing's infamous smog.

Smartphone apps send push notifications when pollution levels peak, prompting the use of industrial-grade facemasks while outside. Yet parks and open areas around the city spring to life at dawn and dusk as groups of elderly people take part in semi-structured exercise classes timed to electro-folk remixes. Cycling is a popular form of transport in the largely flat cityscape, and at least one company is working on share-bicycles that filter the air as they're pedalled.

But it is this variety of experience that Maxim Titushin, a science teacher, likes most about his adopted city. Titushin came to Beijing in 2007 for the second year of his PhD on jellyfish luminescence at the Institute of Biophysics, Chinese Academy of Sciences, as part of an exchange programme. After finishing his PhD in Siberia, he completed a postdoc at the same lab in Beijing before backpacking around the rest of China. But eventually his passion for science and the draw of the city brought him back.

Titushin grew up in a working-class Siberian family, but finds that Beijing suits him. Its hutongs (the small alleys formed by low-rise residential buildings) remind him of summers in the countryside. "I don't like tall buildings and busy streets, I like to hear dogs barking and the sound of falling rain drops, stepping out on a roof terrace, little cafes to drink tea and work at. At the same time, I get a buzz when I go to teach in the business centre of the city."

This balance between chaos and calm isn't the only positive: "Life is affordable; teachers are well paid in Beijing, science teachers even better." When the time comes for Titushin to have a family, he says he may move, given the pollution and other strains of city life, but he's been trying to leave for years, and has always returned.

The city has grown around him. "When I first arrived in 2007, there were only three subway lines in Beijing. Now there are around 20." F.M.