CENTRAL EUROPE UP CLOSE

In the 25 years since the collapse of communism, the countries of central and Eastern Europe have each carved their own identity in science.

BY ALISON ABBOTT & QUIRIN SCHIERMEIER

Scanning electron microscope image of a grain of sand engraved at EIT+ in Wrocław, Poland.

KATARZYNA KOMOROWSKA/WROCŁAW RES. CENTRE EIT+

In a lab so new that it still smells of fresh paint, Katarzyna Komorowska expertly handles what looks like a futuristic coffee machine. It is actually an advanced scanning electron microscope with the power to manipulate delicate samples and visualize minute details — one of several impressive-looking machines in Komorowska's lab in the city of Wrocław in southwest Poland. Komorowska turns on the device's ion beam. Minutes later, a screen shows the razor-sharp image of a bearded dwarf clutching a graphene molecule that she has just engraved on a grain of sand.

The etched sand is a historical reminder as well as a technological feat. The dwarf became an unlikely symbol of the 1980s protest movement that grew in Wrocław against Poland's ruling communist regime. It is now something of a city mascot: Wrocław hosts more than 300 dwarf statues, and visitors can track them down using a brochure and app. The fact that the dwarf can be engraved on a grain of sand in seconds also symbolizes the formidable efforts that this city is making to become a science hub in central Europe. Since 2007, more than €200 million (US$250 million) in European Union (EU) funds have helped to turn Wrocław's abandoned military hospital into a campus dedicated to academic and commercial science — just one part of Poland's high-flying ambitions for science as a whole.

Change has swept through central and Eastern Europe since the collapse of communism there 25 years ago. The revolution was quick and unforeseen. For a few months in 1989, protests swelled behind the Iron Curtain, the political barrier that since the end of the Second World War had isolated communist central and Eastern European countries from the West. Then, on 9 November that year, the East German government opened the Berlin Wall and first a trickle — then a flood — of East and West Germans began to scale the barrier, delirious with joy. A year later, Germany had been reunified and almost every other former communist country in the region had instituted a democratic government.

Researchers shared in the elation: the fall of the Iron Curtain brought them personal and intellectual freedom. But it came with a host of new problems. During the 45-year communist rule, research institutions from the Baltic to the Balkans had been academically isolated and unable to compete with the rest of the world. Now they were suddenly being judged by international standards, and their science looked hopelessly out of date. For many, political change also brought poverty, as economies collapsed. Pitifully low salaries, lack of funding and antiquated labs prompted swathes of scientists to go west or seek careers outside academia. Those who stayed relied almost exclusively on foreign aid. "After the Iron Curtain had come down, science and higher-education institutes were thrown into turmoil," says Liviu Mattei, pro-rector of the Central European University in Budapest. "Few

places in the world have gone through such rapid and brutal changes."

Twenty-five years on, researchers find themselves in a more stable scientific landscape. The economic decline of the 1990s has mostly ended, and in the past decade some countries have enjoyed a marked economic upswing that has allowed governments to inject money into science. Membership of the EU has been a major driver of change. In 2004, the union welcomed eight former communist countries, including Poland, Estonia and Hungary. Romania and Bulgaria followed in 2007, and Croatia in 2014. One EU citizen in five now lives in one of these new member states.

These relatively poor countries have enjoyed huge financial injections from EU structural funds, which are designed to narrow economic and social disparities between European regions and are distributed by each country's government. In the 2007–13 financial period, Brussels invested a staggering €170 billion in cohesion and regional development in the new member states, and more than €20 billion of this was earmarked for science and innovation. Most countries have also created funding agencies that allocate grants on a strictly competitive basis. "Scientists had to learn that performance is now the sole basis of getting funded and published," says Franci Demšar, director of the Slovenian Research Agency in Ljubljana. "It has been a difficult process, but it has greatly improved science produced in this part of the world."

But within central and Eastern Europe, different nations have followed starkly different trajectories in science, as a spotlight on three countries in the region reveals (see 'Science in the new Europe'). Poland hosted relatively little research until recent years, but the nation is now becoming a political and economic powerhouse in the region and is rapidly expanding in science. Estonia, a small country on Europe's northern fringes, reformed its research system early on and is now reaping the benefits. Hungary, by contrast, maintained some scientific strengths during the communist era, but a lack of investment is now putting that legacy at risk.

This means that when it comes to science, central and Eastern European countries — so similar to each other in their communist days — are growing steadily apart. What is more, almost all are still fighting a brain drain to the West. "The talent for science is all there," says Lars Walløe, a physiologist at the University of Oslo and former president of the Academy of Europe. "Now the conditions and institutions in the region need to develop in such a way that the best minds will find it worthwhile to stay."

POLAND: POCKETS OF EXCELLENCE

Poland has embraced science like few other countries in the region, as is evident on the Wrocław campus with its dwarf-engraving machine. The campus has the air of a sprawling, half-built start-up company. Extensive lab spaces are still under construction and will be opened to scientists and entrepreneurs next year. On a rainy September morning, labs and meeting rooms are buzzing with scientists testing equipment and discussing results.

The campus is called EIT+, to echo the Budapest-based European Institute of Innovation and Technology, an EU effort to create a network of research powerhouses. Scientists at EIT+ pursue independent research in subjects including nanotechnology, materials science and biotechnology. But the campus operates as a limited company that aims to provide industry with research and services such as microscopy and crystallography, at a profit. "Twenty years ago the kind of things we're doing would have been unthinkable," says Jerzy Langer, head of EIT+ and a former Polish deputy science minister. "The time has long gone that scientists here could say 'Sorry, I can't do this or that, I haven't got the money and the tools'."

Komorowska joined EIT+ in 2012. She had trained in Wrocław, but left the country for postdoctoral work in France and Belgium, with no plans to return. She changed her mind when she got a job offer from the newly created Wrocław Research Centre, part of EIT+. She now leads the centre's laboratory of nanotechnology and semiconductor structures, where she is developing an automated system for analysing the mineral and metal content of rocks — data of use to the massive Polish mining industry. Some 35 million złoty (US$10.5 million) are being spent on furnishing the lab with the latest electron microscopes for characterizing and observing materials. "The conditions to do science in Poland have improved enormously now that we have the same equipment as most people in the West," says Komorowska.

AFTER THE IRON CURTAIN HAD COME DOWN, SCIENCE WAS THROWN INTO TURMOIL.

That was not true in the communist era, when the country operated just a few basic-research institutes. The situation began to change in 1990, when Lech Wałęsa, leader of the trade union Solidarity, took over as Polish president and began to modernize the country. Poland went through a painful transition when democracy and a market-based economy arrived — and science was shaken to the core. Seeking more lucrative opportunities, thousands of researchers went into business or left to pursue academic careers abroad. What remained of the communist research base was jealously guarded by an increasingly inward-looking group of ageing academics and produced little in terms of internationally competitive science.

The situation really turned around when Poland joined the EU in 2004. With 38.5 million inhabitants, the country is by far the most populous member state in the region, and also receives the most EU structural funds. That money has helped to fuel its remarkable economic growth, which has been outpacing that of most other European countries since 2008. Science has ridden on the coat-tails of the country's thriving economy, and the government has recognized that research is an important route to further growth. Domestic funding has doubled over the past five years, although overall science expenditure is still very low compared to other places in Europe, at less than 1% of gross domestic product (GDP).

Outside Wrocław, the picture is not entirely rosy. Polish science still has a workforce shortage, with fewer than 4 researchers per 1,000 people in the labour force — well below the EU average of just under 7. Scientists acknowledge that many of the country's research institutes — particularly the 80 run by the Polish Academy of Sciences — are reluctant to reform. What is more, says Langer, at some university departments a spirit of obedience lingers from the communist days and tends to stifle creativity. "Many students are too shy," he says. "They think that ideas are no good if the authorities haven't rubber-stamped them."

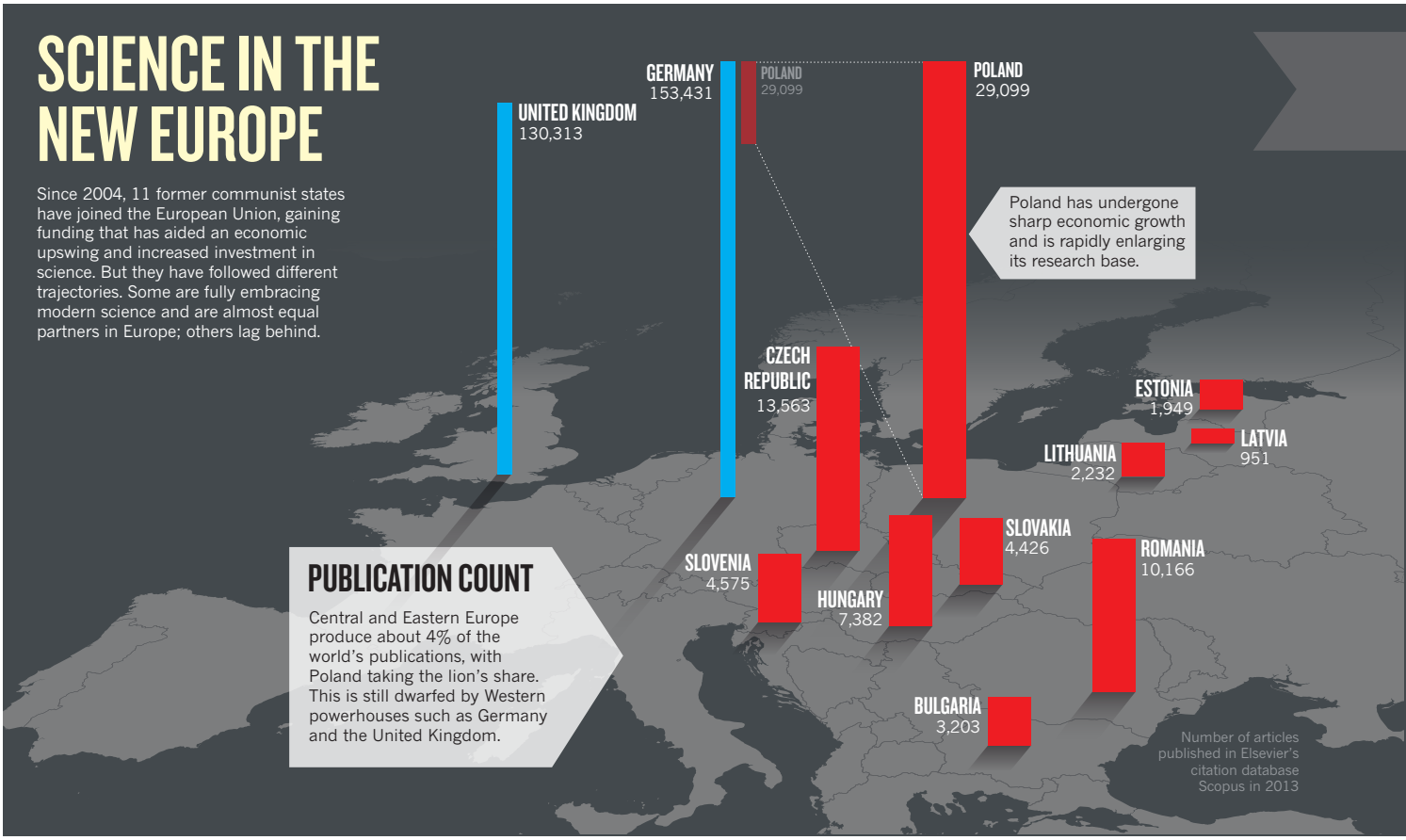
To address the problem, Poland's National Centre for Research and Development now runs a programme designed to bring back early-career Polish scientists who trained abroad, and to attract foreign scientists, by offering them up to 1.2 million złoty to start an independent group. (Securing this funding was another reason that Komorowska was persuaded to return.) And there is a wave of fresh talent on the way. The number of science graduates from Polish universities has more than doubled over the past decade, and overall student numbers have more than quadrupled since 1990. Every tenth student in the EU is now Polish. "This is most encouraging," says Langer.

Scientists in Poland still want to see better standards of science education, and more innovative institutes such as EIT+. "There is sufficient money available now to support promising ideas, but we need to create institutional environs in which science can flower," says Janusz Bujnicki, a molecular biologist at the International Institute of Molecular and Cell Biology in Warsaw. "That task has only just begun."

ESTONIA: SMALL AND FOCUSED

Andres Metspalu, who runs one of the world's most sought-after banks of human DNA, says that his life began at 40. That was in 1991, the year Estonia declared its independence from the Soviet Union and began its bumpy path towards a Western-style research base.

Before this, Metspalu's ambition to do world-class science had been constantly undermined by the absurdities of the isolationist Soviet system. That system had acknowledged his talent:



SOURCE: PUBLICATIONS: SCOPUS; SPENDING: EUROSTAT; GRANTS: ERC

it selected him in 1981 as one of only 25 young scientists across the entire Soviet Union to spend a year training in a US laboratory after his doctorate. (He studied biochemistry at Columbia University in New York, then at Yale University in New Haven, Connecticut.) But his young family had to stay in Tartu, Estonia, so that the authorities could be confident that he would not defect. And after that, he was forbidden further travel until Mikhail Gorbachev swept to power in the Soviet Union in 1985. Over the next few years, Metspalu watched the Soviet Union fall apart.

With a population of just 1.3 million people, Estonia found change easier than some larger countries. This, and some good political decision-making, helped to make the country one of the first in the region to reverse its economic decline. The government was prudent enough to stimulate business-orientated research and entrepreneurship early on. Newly created research centres and technology parks in Tartu and the capital, Tallinn, became the nuclei for a remarkable scientific upswing.

After the human genome was sequenced at the turn of the millennium, Metspalu, who worked at the University of Tartu, saw a scientific opportunity. Thanks to support from Estonia's EU structural funds, he was able to launch a project to recruit individuals to donate their genetic and health data to a national biobank. In other countries, such as Iceland, similar efforts to collect personal information en masse were met with suspicion. But that was not the case among the newly liberated and optimistic people of Estonia, many of whom were happy to sign up. The biobank now includes genetic and health information on 5% of the country's adult population and is a valuable international resource in studies that require very large numbers of people to identify risk genes associated with common diseases, including obesity[1] and schizophrenia[2]. The database has been "extremely helpful", says Michael O'Donovan, a psychiatrist at Cardiff University, UK, who was involved in the schizophrenia study.

TWENTY-FIVE YEARS AGO I'D HARDLY HAVE IMAGINED CONTRIBUTING TO A BIOMEDICAL REVOLUTION.

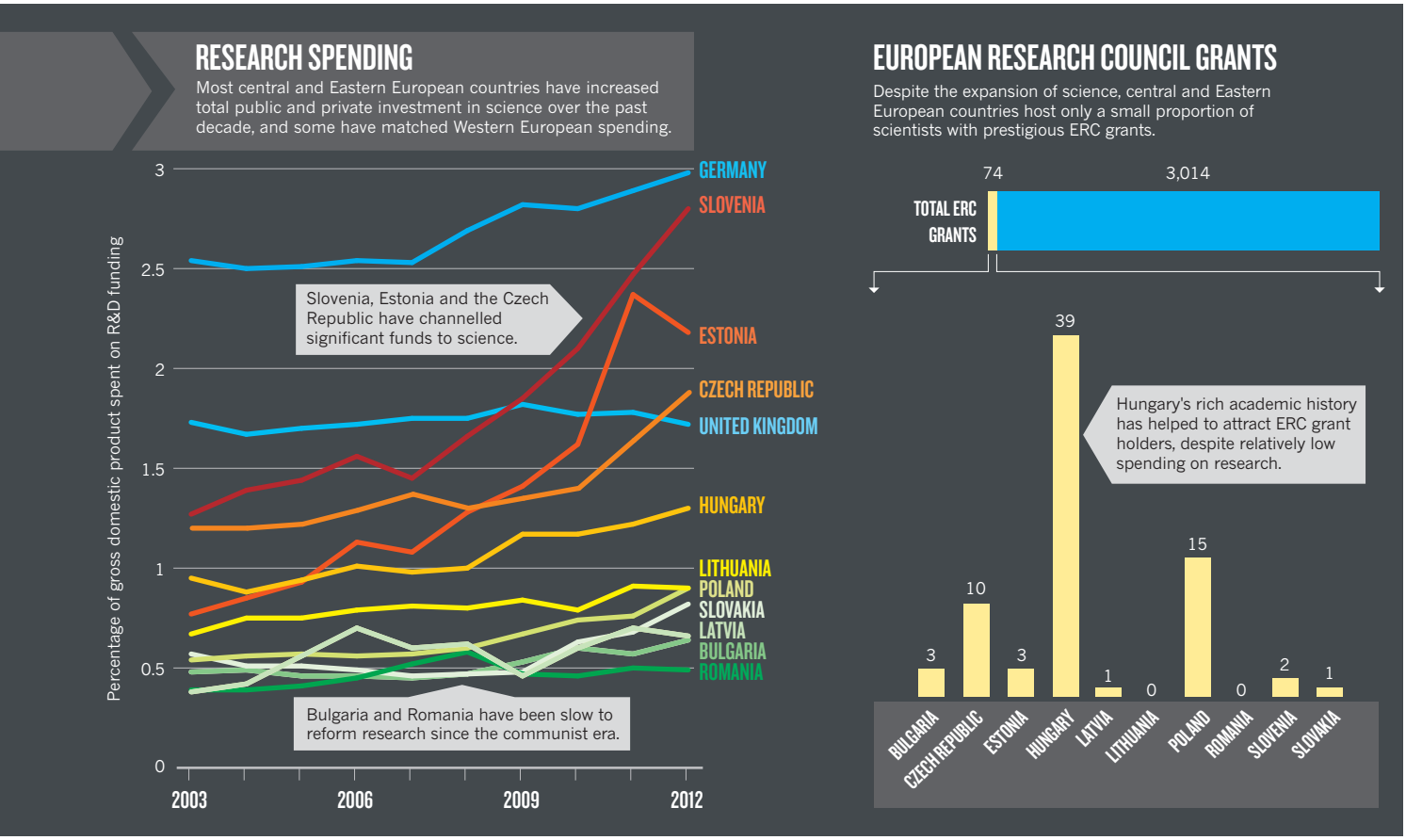
As well as biotechnology, the Estonian government is focusing scientific investment on disciplines such as materials science and informatics. The chemistry department at the University of Tartu, for example, is prominent in the area of superacids and superbases, useful in the development of batteries for electric cars, and has collaborations with car manufacturers in several countries. Estonia has steadily increased its investment in research and development, from 0.72% of the GDP in 2002 to 2.18% in 2012 — the second highest in central and Eastern Europe, after Slovenia.

The country is keen to reap the rewards of its investments by using the biobank for more than just research. This year, the government formally pledged to support a project that would — in the next few years — link the repository with Estonia's centralized health database to allow physicians to support their diagnoses and therapies with individual genetic information. If all goes to plan, this will put Estonia among the world's front-runners in personalized medicine. "Twenty-five years ago I'd hardly have imagined being able to contribute to a biomedical revolution," says Metspalu.

HUNGARY: SCIENCE ON A SHOESTRING

Last year, plant biologist Eva Kondorosi decided to pack up her life in Paris and take her European funding to the Hungarian Academy of Sciences (HAS) Biological Research Centre, where she had begun her research career in the late 1970s. But she found something odd: unlike many research institutes across central and Eastern Europe, this one seemed to be less exciting in the modern era than it had been in the communist one. "It has lost the vibrancy we enjoyed there in the 1970s and 80s," she says.

If that sounds paradoxical, it is because



NIK SPENCER/*NATURE*

science in Hungary is a bit of a paradox. During the communist years, research survived against the odds. It was separated from universities and centralized in institutes — run by the highly politicized HAS — that tended to appoint cronies and members of the ruling communist party to key research posts. At the end of the 1960s, however, the HAS made a bold decision to start afresh in biology by creating the Biological Research Centre in the southern city of Szeged, close to Hungary's southern border and away from the stifling politics of the capital. Staff members at the multidisciplinary centre were appointed on merit, not political status. The centre became a safe haven for intellectuals, and Kondorosi did a doctorate in plant sciences there. The country's borders were slightly more open than those of most of its communist counterparts, and throughout the 1980s researchers could gain permission to visit the West. This kept the science in Szeged cutting-edge, and the atmosphere buzzing.

After the fall of communism, lack of investment dampened enthusiasm, and many scientists left. Funding has never fully picked up. Hungary is one of only three countries to have reduced its public spending on research since 2007 (the others are Croatia and Bulgaria), and it dedicated just 8.5% of its 2007–13 EU structural funds to research — compared to Estonia's 20% and Poland's 14%. What is more, much of the structural funding has gone to companies, not academia.

Despite this, the country's rich academic legacy still attracts the best Hungarian scientists. Hungary has hosted more researchers with prestigious European Research Council grants — including Kondorosi — than any other former communist EU country. Kondorosi returned because the interdisciplinary organization of the Biological Research Centre offered her the opportunity to take the lessons she had learnt from studying plant–bacteria symbiosis and apply them to medicine. She and others have discovered antimicrobial activity in some of the bacteria that plants use for nitrogen-fixing[3], for example.

Hungary's scientific culture has inspired international confidence. In 2012, CERN, the European laboratory for particle physics, built an advanced data centre close to Budapest. And Szeged is going to be home to one of the three nodes of the Extreme Light Infrastructure, a collaborative EU project to advance laser science (see *Nature* **489,** 351; 2012).

Scientists are hopeful that the climate for science is warming up. In June this year, the charismatic József Pálinkás was appointed to the new position of government commissioner for science and innovation. Pálinkás was formerly president of the HAS, where in 2011 he forced through reforms that streamlined the academy's 40 research units into 15 larger centres, and increased scientific competition for funding. In his new role he will be responsible for advising the government on science policy, as well as coordinating the spending of the current round of research-related structural funds. In this round, he says, around 12% will be directed to research.

Scientists in Hungary and elsewhere have their eyes on the EU's Horizon 2020 programme, the €80 billion of research funding that started this year and will last until 2020. In a bid to widen participation, Brussels has launched a 'teaming' scheme that allows less potent member states to create or upgrade competitive research centres in partnership with leading institutions from other countries.

Financial and organizational aid will remain crucial in narrowing the gaps between countries, says Walløe. "Some places will always have more capacity of science than others," he says. "But every country should have at least one thing or the other that is really good. That is how science is organized in the United States — and that's what it should be like in Europe." ■ SEE EDITORIAL P.7

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1. Walters, R. G. *et al. Nature* **463,** 671–675 (2010).
2. Schizophrenia Working Group of the Psychiatric Genomics Consortium *Nature* **511,** 421–427 (2014).
3. Tiricz, H. *et al. Appl. Environ. Microbiol.* **79,** 6737–6746 (2013).