GIANTS OF SCIENCE

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Carl Sagan famously said: "We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology." We talk with four South Australian scientists whose work affects us all, even if we haven't noticed it yet.

"It seems to me that if there's anywhere in this country where we could have a knowledge-led recovery, it would be here in South Australia," Dr Paul Willis says. "If any state had the right to be down in the dumps it would be SA, but there's an optimism here, a willingness to grasp the nettle. Despite the doom and gloom there's a political will - I suspect it comes from both sides of politics - to embrace a different future, to embrace new technology and innovation which will redefine this state."

Willis is the director of RiAus, a national not-for-profit organisation devoted to 'promoting public awareness and understanding of science'. A product of the state government's Thinkers in Residence program, RiAus aims to keep science at the forefront of Australian culture. "We're Australia's science channel. It's a simple message that everyone wants to engage with. We're proudly in Adelaide but our outreach is national and international. If we'd been set up in Sydney or Melbourne, our message could have been lost."

His mission may be national, but Willis says South Australian science has had a huge impact. 'I'm wary of the phrase 'punching above its weight' but in this case it's true. We have the only father and son Nobel prize, won in 1915 by the Braggs for their work in x-ray crystallography. The work they did underpins so much of what we do today, like smart fabrics, materials science and the structure of DNA."

Willis also notes Sir Mark Oliphant for his work on the Manhattan Project in World War II, Howard Florey for his Nobel-winning work on penicillin, and Basil Hetzel, whose research on iodine largely eliminated a number of thyroid conditions around the world. "Footballers and cricketers are idolised in our society, but not every state can lay claim to someone who saved 80 million lives," he says.

Our state's contribution to human knowledge isn't just historic, with a number of notable scientists making their mark in different disciplines. Their work is diverse, but they have a consistent message - that science is fundamental to our future.

At Flinders University, Professor John Long researches the early evolution of vertebrates. With awards including the Eureka Prize for the public promotion of science in 2001, the Australasian Science Prize for peer-reviewed research in 2008 and the 2014 Verco Medal for scientific research, he has also published a number of award-winning books. His study of fish fossils from the Gogo formation in Western Australia has revealed the first instance of internal fertilisation, and he says there's a surprising amount of common ground between these early fish and humans. "Most people have a Hollywood view of evolution," Long
s. They picture some kind of slimy thing in the ocean, then fish, amphibians, reptiles, birds, mammals and humans. The truth is very different. The greatest stages in the progress of evolution aren't the transitions from one type to another but the development of systems such as paired limbs, chambered hearts, skulls made up of plates, jaws and teeth. Ninety percent of our body plan was laid down in the first 100 million years of vertebrate life on earth. Once one fish left the water and invaded land it was all fine-tuning of these existing systems. It puts a fresh perspective on where our human ancestry has come from.

Long does at least one major fieldwork expedition every year, something he describes as part of the fun of the job. It’s a pleasure he traces back to his first fossil discovery at the age of seven. “A schoolmate’s dad took us out to some road cuttings near Lilydale. We found trilobites, brachiopods and crinoids that were about 400 million years old. I was hooked.”

Since then, Long has become credited with discovering a number of hitherto unknown creatures, but he was surprised to learn that his very first fossil discovery was a new species. “I took one of my fossils to the museum and they said it was a trilobite. It was only years later, when I was working there, that I looked it up and found it was only described in 1968 – four years after I found it.”

A large proportion of Long’s time is devoted to spreading the word about science, with a monthly column in Australasian Science magazine, columns in online portal The Conversation and a dozen books to his name. “These days we have to be committed to communicating our work to the public. It’s no longer good enough to silo ourselves away.”

Like many scientists, Long is concerned at the current attitude from the federal government towards science, expressing concern that it lacked a science ministry for the first time since the creation of the portfolio in 1991. “In pure economic terms, countries that invest in research and development have stronger economies,” he says.

Professor Tanya Monro says an exciting aspect of her work is the potential to create new industries and new jobs. One of Australia’s leading physicists, Monro was named South Australia’s Australian of the Year in 2011, just one of a string of civic and scientific awards to her name. In 2005, she became the inaugural
Chair of Photonics and Director of the Institute for Photonics and Advanced Sensing at Adelaide University, and in 2013 moved to the UniSA as head of research and innovation.

Monro specialises in photonics, the study of light. “One of the drivers for me getting into the field of photonics is its amazing potential and capacity to create solutions to a range of very practical problems,” she says. “Just over 50 years ago we saw the first lasers. At the time it was a pure curiosity, but now you have trouble getting through the day without using one. Thirty years ago it was optic fibre, which allow for hundreds of kilometres of photon travel without dimming. We’re now on the verge of the third revolution in photonics – sending photons out asking questions.”

Medicine is one area where photonics promises remarkable advances. “Traditionally, we’ve learned about bodies and cells by looking at them under a microscope. But when you take those cells out of the body, they don’t behave the same. Now we’re taking the microscope into the body.” Monro says nanoscale biophotonics will enable researchers to see how individual brain cells behave when performing activities such as reading and listening to music, to watch the precise moment of fertilisation, and to observe heart cells during a heart attack.

Monro says a trans-disciplinary approach is increasingly important in science. “Over the last 300 years, science has been divided up into disciplines that have enabled us to dive deeper and deeper, but if you start to think beyond the generation of knowledge to solving problems, those boundaries start causing harm. When we start looking inside cells with photonics we have physicists, chemists, biologists, materials scientists – it’s the only way to crack those problems. You can’t do it with one discipline.”

Yet she retains a particular love for physics. “There’s something special about physics as it’s about measuring the unmeasurable, more precisely and in places that couldn’t be measured before – inside a body, three kilometres down a mine or inside a smelter.”
“Most people have a Hollywood view of evolution. They picture some kind of slimy thing in the ocean, then fish, amphibians, reptiles, birds, mammals and humans. The truth is very different.”
In all disciplines, underpinning all of this measurement is mathematics. "No science can be done without a deep understanding of mathematics," Monroe says. "I love this quote from Adam Spencer: 'Numbers are the notes with which the symphony of the universe is written.'"

Professor Corey Bradshaw agrees. A conservation ecologist and chair of climate change at Adelaide University, Bradshaw crunches numbers to model ecosystems and predict extinctions.

"Classically, people have thought biological disciplines were 'soft' compared to physics and chemistry," he says. "That's unjustified. Science is measurement; measurement gives numbers. Ecology deals with millions of species, climate, forests, etcetera – it's chaotic, and more complex than most sciences because there's an immense amount of data. When they say 'it's not rocket science', they should really say 'it's not ecology.'"

Bradshaw says our separation from nature is blinding us to its importance. "About 90 percent of Australians live in cities. The environment ceases to be a priority because people don't see its complexity, but it's our life support system. One in three mouthfuls we eat is due to pollination by animals, mostly bees. To hand-pollinate our crops would require the population of China," he says. "Our population is still growing at an exponential rate but we're degrading ecosystem services like water purification, pollination, carbon sequestration and oxygen production because there's no valuation placed on these things, they're not traded on the stock exchange. We can't even trade carbon properly, what happens when we run out of water? Wars start. When the Himalayan water tower collapses – it's the water supply for two-and-a-half billion people, where do you think they're going to go? You think we have a refugee problem now?"

One of the biggest obstacles to solving problems like climate change, Bradshaw believes, is that ideology takes precedence over evidence.

"This government is ideologically based," he says. "The problem with ideology is that you try to retrofit your choices to your beliefs rather than refine your ideology to suit the evidence." He's not talking about party politics; none of our political parties are immune. "We live in one of the best democracies money can buy. It's a plutocracy. Because we allow massive corporate donations, normal citizens don't have as much power as corporations. If we
want to change to evidence-based policies we need to get the money out of politics."

Bradshaw is a vocal advocate for action on environmental issues. Most recently, his support for nuclear energy seems counter to the traditional thinking in environmental activist groups. He says the new generation of integral fast reactors (IFRs) is an essential element of our response to catastrophic climate change. "The older generation of reactors use two percent of uranium’s energy," he says. "IFRs use 98 percent and the waste has a half-life of 300 years and is a much smaller volume."

He says fears of nuclear accidents are disproportionate to the risk. "If you stand outside a coal-fired power station you are exposed to ten times the radiation from a nuclear plant. Around 2 million people die prematurely every year from fossil fuel-related lung disease. Not one person died from the Fukushima meltdown. But even in the worst-case scenario, if there was an accident and some people died, over three orders of magnitude more people will die from coal. I don’t think we have a choice."

Australia is particularly well placed to benefit from the new generation IFR reactors, Bradshaw says. "We could make a financial killing. We’re geologically stable — we could charge other countries for storing their waste, then process it and sell it back to them and have free fuel for our own reactors."

It’s controversial, but as Bradshaw says, "In science, if you ain’t pissing someone off, you’re not doing it right."

Science in South Australia is in capable hands, but Paul Willis warns that federal funding cuts pose a threat beyond the academic sphere. "The principle of not protecting our investment into science, technology and mathematics is cutting into our future," he says.

"To put it in perspective, at the ABC one in 10 people are losing their jobs. At the CSIRO it’s one in five. These are not arcane, obscure people doing irrelevant things, they’re doing world-class research into biohazards, climate and the environment we live in. Science is our best grip on reality. When you cut science funding, you cut our grip on reality. We cannot get by thinking we don’t need to do that research." ♦

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