ISLANDS OF SCIENCE

MANY PEOPLE DREAM OF RETIRING TO ONE OF THE CARIBBEAN'S SUN-DRENCHED ISLANDS. BUT WHAT'S IT LIKE TO BE A SCIENTIST THERE? SEAN MCDOWELL (TWAS FELLOW 2008), A THEORETICAL CHEMIST, WHO WAS BORN IN JAMAICA AND NOW RESIDES IN BARBADOS, SPEAKS ABOUT HIS LIFE AND WORK ON A TROPICAL ISLAND.

As the saying goes, no man is an island. But island life can be confining for a theoretical chemist like Sean McDowell, a professor of chemistry at the Cave Hill, Barbados campus of the University of the West Indies (UWI). After all, his colleagues are spread across the world – some tens of thousands of kilometres and four time zones away.

"I don't know of any other theoretical chemists in the English-speaking Caribbean. There may be some people in my field in the non-English speaking islands, or in South America. But the scientists who I mainly collaborate with are in England, Canada and the US," he says.

Born in Jamaica, Sean McDowell has racked up an impressive number of accolades during his 14 years back in the Caribbean after having spent more than eight years studying and working in Europe and North America.

In 1999, he won a Caribbean Academy of Science young scientist award and in 2008 he was presented with the prestigious Caribbean Community (CARICOM) Award. He is a member of the UK's Royal Society of Chemistry, and in 2009, at age 45, he was elected to TWAS as its youngest-ever Caribbean member.

But even as one of the region's most prominent scientists, he still struggles to find time and funding for his research.

McDowell, in fact, is fortunate that his research does not require very expensive equipment. All he needs are computers with reasonable processing speeds to perform the calculations that he normally performs.

BONDS THAT TIE

As a theoretical chemist, his primary interests are the properties of the weak bonds that hold molecules

NETWORKING FOR SCIENCE

CARISCIENCE is a Caribbean network promoting research, development and postgraduate education in the basic sciences. Launched in 1999, it is supported by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and collaborates with TWAS.

CARISCIENCE has supported workshops, conferences, academic visits and a small number of R&D projects. It also oversees a Caribbean Young Scientist Fellowship Programme that enables PhD students to visit research institutions in Brazil, Mexico, Cuba, India and Italy.

On September 21, 2010, CARISCIENCE launched a Caribbean Science Foundation (CSF) in Port of Spain, Trinidad. The foundation's objective is to promote science, technology and innovation in the Caribbean and to harness scientific advances for the development of the region.

Drawing on support from Caribbean governments, private-sector donors and the Caribbean diaspora, CSF will offer research funding to Caribbean scientists, focusing on the following areas: energy, water and materials; transportation; agriculture and food science; medicine and health care; manufacturing; small and medium business development and entrepreneurship; information and communication technologies (ICTs); environmental science and engineering; and crime prevention.

The goal is to raise approximately USD13 million over the next three years to support 15 to 20 R&D projects. Each country in the Caribbean will be expected to contribute money to the foundation. The goal is for the CSF to be self-financing within seven years. For more information, see www.cadsti.org.

together. These are not the chemical bonds we are familiar with from atomic models — for example, the bonds that hold hydrogen and oxygen atoms together in a water molecule. Rather, they are other, weaker bonds, some of which are essential for better understanding important biological processes.

A prime example of such a weak, yet vital bond, is the hydrogen bond that forms between hydrogen atoms on one molecule and electron-rich sites on other molecules. This bond determines the structure and behaviour of DNA molecules.

"Even though our knowledge of the hydrogen bond dates back over a century, there are still surprising things about it that need to be explained. This is what my colleagues and I try to do," he says.

Over the past decade, much theoretical and experimental work has been devoted to the study of the non-conventional "blue-shifting" evident in some hydrogen-bonded complexes. While much has been learned, there is still a need for a widely accepted general theory or model.

It is not easy to explain to non-scientists the value of such fundamental work, McDowell admits.

"You can't tell how such work may be applied in the future. We set the broad framework for the science behind hydrogen and other bonding so that scientists can eventually exploit the knowledge and insights gained from this research to better understand the chemical and biological systems that play such a vital role in our environment and for our health."

Being a theoretician in a developing country isn't always easy, he adds. Politicians and funders favour more applied research that may prove fruitful in the short-term.

"But big discoveries," he states, "usually depend on driven individuals with insatiable curiosity who prefer

UNIVERSITIES IN THE CARIBBEAN

University enrolment in the Caribbean is low. For many countries it hovers between 10-15% of the population, which is the lowest enrolment ratio in the Western hemisphere.

Aside from a sizeable university sector in Cuba, the University of the West Indies (UWI) – consisting of three main campuses and a handful of centres and institutes scattered across the islands – dominates higher education in the Caribbean. Its three main campuses are separated by up to 2,000 kilometres.

UWI's enrolment exceeds 40,000 students, who come predominantly from the region's English-speaking countries. The oldest campus is at Mona in Jamaica, which was established in 1948 as a College of the University of London and gained independent university status in 1962. The two other campuses were established in 1961 and 1963 in St. Augustine, Trinidad and Cave Hill, Barbados, respectively. The university also has a school of tourism in Bermuda. In 2008, it established an open campus for distance learning.

Other universities in the region include the University of Havana founded in 1728, the University of Guyana, the University of the Virgin Islands, the University of St. Maarten, the Anton von Kom University in Suriname, and the University of Belize.

Since the early 1990s, the UWI's three main campuses have become increasingly autonomous. Whereas 30 years ago, chemistry was chiefly taught in Jamaica, the subject is now common to all campuses. The same is true for most other subjects.

This proliferation of courses means that the lion's share of students at any one campus today comes from the host country. A report published by UNESCO in 2007 identified this as a barrier to collaboration between campuses.

to explore more fundamental ideas and concepts that may not be immediately useful."

"I am such a person," he says.

CHEMICAL ATTRACTIONS

The joy of discovery has been with McDowell since he was a youngster growing up in Kingston, Jamaica. He inherited his curiosity from his father, an accountant, who enjoys reading. "My father's large library, containing books on literature, history, science and art, among other topics, provided me with enjoyment from an early age and helped me develop a wide-ranging interest, curiosity and appreciation of the world."

At 11, McDowell received a chemistry set for Christmas from his parents. In his diaries from that time he writes about chemical reactions, physics and the inspiring historical accounts of the great scientists who made important contributions to our understanding of the wonders of nature. "This was before I started learning about those subjects at school," he says.

The place to study chemistry in the English-speaking Caribbean is the University of the West Indies, Mona campus, in his home country — one of the three campuses that make up the institution (see box, Universities in the Caribbean). In 1985, he earned a bachelor's degree in chemistry from UWI with first class honours. "My path was set from then."

After his first degree and a stint as a graduate student at the Mona campus, a Commonwealth scholarship gave McDowell the opportunity to study for a PhD at the University of Cambridge, UK. There, his work brought him in close contact with some of the world's best theoretical chemists. He obtained his PhD in theoretical chemistry in 1992. While at Cambridge, he also played table tennis for the university and he still dusts off his racket whenever he visits.

The joy of discovery has been with McDowell since he was a youngster.

McDowell then became a postdoctoral student at the University of Western Ontario in Canada, where he stayed for three years until 1996 when he returned home. The choice was straightforward, he says.

"I could have opted to remain in Canada. But it's very cold up there and the competition for faculty posts is stiff. I thought it was time to return to the West Indies." He had a young family and believed it best to raise his family in the Caribbean with the traditional values that he was exposed to as a child. During his time in Canada, McDowell continued to do computational work, mainly exploring the three-body non-additive interactions between molecules in small clusters.

RED SHIFT BLUE

His work since returning to the Caribbean has mainly focused on the study of unusual rare-gas compounds and, more recently, on the properties of hydrogen bonding.

The molecular motion of the hydrogen atom tends to slow down when binding to electron-rich sites on other molecules. This is called the "red shift". It is so widespread that it was once thought to be the "signature" of hydrogen bonding.

By contrast, a "blue shift" occurs when the relative speed of the hydrogen atom increases upon binding. McDowell has recently made important theoretical contributions to our understanding of the unusual "blue shift" observed in some hydrogen-bonded complexes.

A particularly interesting new finding is the prediction of strong cooperative bonding between several hydrogen bonds and an unusual non-chemical bond called a halogen bond to produce a new class of complexes.

This finding implies that it is possible to produce very localized regions of opposite charge on a single atom in a molecule and suggests new ways of anchoring specific weak interactions to halogen atoms like chlorine that are ubiquitous in organic and inorganic chemistry. This also raises the possibility of exploiting, on the nanoscale, such highly directed weak interactions.

McDowell's move back to the Caribbean made it challenging for him to keep his research career going. In 1996, the number of chemistry faculty at UWI's Cave Hill Barbados campus numbered just five, and for the first time, McDowell was expected to devote the majority of his time to teaching.

"From 1985 to 1996, I focused on research. I did little teaching except for undergraduate laboratory supervision while at the Mona campus of the UWI in Jamaica. Within maybe a week of arriving in Barbados, however, I had to start teaching," he explains. The first

years were tough. I like teaching, and I think that I'm good at it. But for me research is what is most important personally and professionally."

He was able to develop several projects to continue his research career, while balancing his new teaching duties. As he settled into his job, his teaching duties became more routine and less burdensome.

IN TOUCH

Since his promotion to professor in 2005, McDowell's time has also been taken up by administrative duties, culminating in his appointment to head the department of biological and chemical sciences at the Barbados Cave Hill campus in August 2009. Although his teaching has been scaled back in favour of his increased administrative responsibilities, he still manages to find some time for research.

The isolation from colleagues in his own field is less of a problem than it used to be, McDowell says. Modern information technologies have revolutionized his ability to engage with colleagues far away.

"During the year, I am in touch with my collaborators by e-mail. The only thing missing is day-to-day conversations. How I get around this is to go away during the summer, which I usually spend in the chemistry department at the University of Cambridge. There I can talk with colleagues in person and take advantage of the computational facilities and expertise that is available," he says.

FINDING FUNDS

Funding remains challenging for Caribbean scientists. Their governments dedicate little money to basic research. The UWI has some discretionary resources, but the amounts granted are typically small, says McDowell. Officials believe that the faculty are in a good position to find funding outside of the university.

But this is easier said than done. Caribbean scientists struggle to compete with better-resourced colleagues in the US, Europe and elsewhere. External funding sources also rarely focus on topics of particular interest to Caribbean scientists, such as the study of local plant and animal species, or developing ways of improving local agricultural practices.

There is, however, a silver lining for Caribbean science. This September, CARISCIENCE, a network promoting research in the region, launched the Caribbean Science Foundation, which aims to generate funding for indigenous research projects in disciplines of local interest. (See box, Networking for science, p. 21)

The foundation also hopes to boost collaboration within the region, which is currently more of an exception than a rule. Even at UWI, the three campuses rarely coordinate their research due mainly to their geographical separation.

Language is a major barrier to interactions between scientists from the English- and non-English-speaking countries of the Caribbean . "A lot of good science may be taking place in Cuba, but cultural and language barriers prevent us from collaborating," says McDowell.

Funding remains challenging for Caribbean scientists.

The Caribbean science foundation is a step in the right direction for the region, says McDowell. But he adds that Caribbean governments will need to put more money into science if they want to catch up with fast-developing regions like South America or Asia.

"There is some appreciation of the importance of science for development," he says. "Government officials understand and accept that science has played a part in the development of countries like Singapore. But they have yet to fully appreciate that it requires a lot of money and commitment to sustain research." ■

PARADISE ISLANDS?

Comprised of more than 7,000 islands and inhabited by over 36 million people, the Caribbean islands are known throughout the world as a vacation paradise. And to some extent that reputation is well deserved. The islands enjoy an extensive array of beautiful beaches and wonderful weather (an average of 3,500 hours of sunshine each year with temperatures rarely dipping below 20°C). Tourism provides on average 10% of the governments' annual revenues, nearly 15% of the gross domestic product and 12% of regional employment.

Yet, when it comes to science, the story is not as bright. For example, Trinidad and Tobago and Jamaica, two of the more scientifically proficient countries in the Caribbean, spent just 0.06% of their gross domestic product on research and development in 2007. That is about the same percentage as Lesotho in Africa. By comparison, Brazil spends more than 1% of its GDP on R&D.

KEY DATA FOR SELECTED CARIBBEAN ISLANDS

Country	Population (millions)	Surface area (sq km, thousands)	Life expectancy (years)	GNI per capita (current USD)	Human Development Index (rank)	Scientific publications (2001-2007)
Antigua & Barbuda	0.1	0.44	75	13,020	59	19
Bahamas, The	0.3	13.88	73	21,390	50	59
Barbados	0.3	0.43	77	9,330	30	345
Cuba	11.2	110.86	79	n/a	52	4,612
Dominica	0.1	0.75	77	4,790	70	32
Dominican Republic	10.0	48.67	73	4,330	95	134
Grenada	0.1	0.34	75	5,870	66	87
Haiti	9.9	27.75	61	n/a	154	84
Jamaica	2.7	10.99	72	4,800	97	1,191
St Kitts and Nevis	0.0	0.26	71	11,210	49	9
St Lucia	0.2	0.62	73	5,430	75	16
St Vincent and the Grenadines	0.1	0.39	72	5,130	85	5
Trinidad and Tobago	1.3	5.13	69	15,580	57	821

Sources: World Bank, 2008; UNESCO Science Report 2010.