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EDITORIAL

Building networks for a new era of science

The global culture of science is constantly evolving, but today we are in a period of profound, rapid change. TWAS is changing, too, to maintain and extend its leadership on issues of science and engineering in the developing world.

Since the founding of the Academy 30 years ago, our membership has been divided into Fellows and Associate Fellows. Fellows were scientists from developing countries who had achieved the highest standards of excellence in their work. Associate Fellows lived and worked in developed countries, but their work had brought dramatic benefits to science in developing countries. Historically, they were about 15% of our members.

Under a decision taken by the Academy at its 24th General Meeting in Buenos Aires, the division will be erased. TWAS membership beginning next year shall consist of 'Fellows' only.

This could seem like a change of limited impact on the affairs of our Academy. Even under the revised statute, scientists who live and work in the developing world will continue to make up about 85% of our membership. But this shift reflects TWAS's changing relationship with global science.

Increasingly, scientists and engineers from the developing world are making major contributions not just in their home countries, but also at the global level. That is evident in Argentina, where scientists at the private company INVAP have built a satellite for NASA. China is leading the world in materials science publications. Brazil is a global leader in energy development, and India's tech sector has renowned strength.

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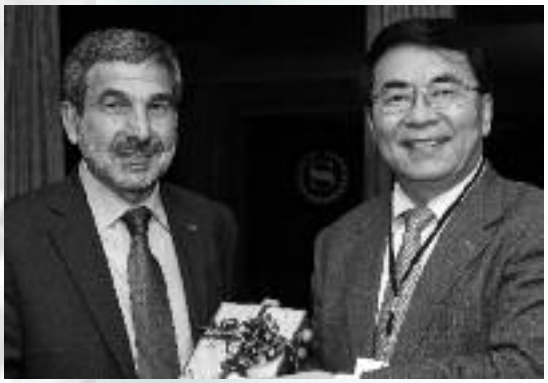
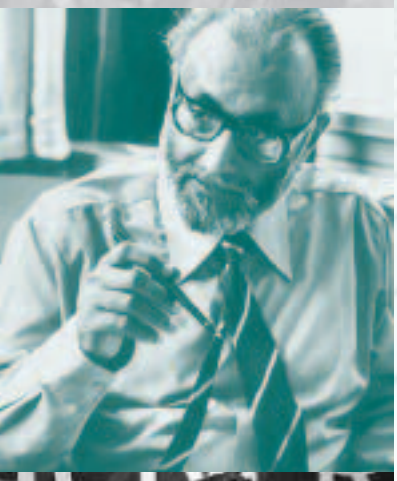


Top to bottom: Roberto Salvarezza, president, CONICET, Argentina, left, and Bai Chunli, president, TWAS (Photo: Roque Silles); TWAS founder Abdus Salam (Photo: Ludovico Scrobogna); Argentinian science minister Lino Barañao. (Photo: Roque Silles)



At the same time, researchers from the developed world are making vital contributions in the developing world, in fields ranging from agriculture and health to energy and even astronomy. But most importantly, with increasing frequency these researchers are working together, across borders and cultures, as true partners. And their partnerships are models for addressing the challenges that confront humanity locally, regionally and globally.

This shift in our historic structure reflects an undeniable fact: When it comes to science, the borders between nations are fading. We are seeing the emergence of a more closely knitted global science culture, where interdependence is embraced and genuine partnerships are essential.

We welcome and celebrate that change. It is a measure of the success initiated by our founder, Abdus Salam, and the Founding Fellows. And it reflects the new opportunities to advance science for the benefit of people everywhere.

The Academy recognized this new reality in 2012, when it changed TWAS's name to The World Academy of Sciences. But make no mistake: TWAS remains an academy focused on the developing world, and that will not change.

Toward that end, under the direction of TWAS President Bai Chunli, TWAS will be making a push for new Fellows from two vitally important groups: from nations where there currently are few or no TWAS members, and from the ranks of excellent women scientists in the developing world.

In Salam's vision, both South-South and South-North cooperation were required to advance science in the developing world. At TWAS, we know that cooperation – truly global in nature – is becoming ever more important.

* * *

In the early years after its founding, TWAS was like a seedling – full of possibility, but vulnerable. With support and shelter from the government of Italy, the International Centre for Theoretical Physics and other partners, we survived to grow healthy and strong.

So much has changed in the world, but our partnerships remain central to our operations and crucial to our ability to advance science. China and Brazil, India, Argentina – these are among the great success stories of the past 30 years. Yet today there remain the 48 Least Developed Countries, plus other science-lagging nations, and the opportunities TWAS offers can be crucial for their futures.

The importance of our partners, and the significance of their contributions, could be seen

in the weeks leading up to our General Meeting in Buenos Aires, and in every day of the meeting itself. Lino Barañao, Argentina's minister of Science, Technology and Productive Innovation, and Roberto Salvarezza, president of the National Council of Scientific and Technical Research (CONICET), provided extraordinary support and guidance. TWAS Vice President Francisco Barrantes was essential in every facet of developing and organizing the meeting.

During the meeting, Barañao announced that Argentina would support 30 new PhD fellowships annually, plus 15 postdoctoral fellows, and five visiting scientists; in addition, the nation has opened 175 of its centres of excellence to researchers from the developing world under the TWAS-UNESCO Associateship Scheme.

Thirumalachari Ramasami, secretary of India's Department of Science & Technology, announced that his government would create 25 new fellowships per year, funded over the next five years at total cost of USD3.3 million.

South African Science Minister Derek Hanekom said his government will sponsor at least 100 new fellowships for students from developing countries to study for PhDs in South Africa.

These generous contributions followed a series of new cooperative initiatives begun in 2013. The Chinese Academy of Sciences (CAS), under the leadership of Bai Chunli, announced a fellowship programme to provide 140 early career scientists every year a chance to earn their PhDs in China. In addition, CAS made a significant new investment in five CAS-TWAS Centres of Excellence, all of which offer education, training and research opportunities to developing world scientists.

The Kuwait Foundation for the Advancement of Sciences recently increased its contribution to TWAS publications. And the Swedish International Development Cooperation Agency (Sida) in 2012 provided significant new funding for fellowships at the Organization for Women in Science for the Developing World and for TWAS's growing science diplomacy programme.

Meanwhile, the Italian Ministry of Foreign Affairs provides steadfast support to our Academy, as it has from the start. And UNESCO continues to provide excellent administrative support and guidance, as it has since 1991.

The commitment among emerging nations is inspiring. They have long been TWAS partners, and they have made historic progress in building prosperity for their people. Now they are sharing their success with other developing nations that seek to follow their model.

"We feel it's very important for developing countries in the world to get together – and bring their scientists together – to try to find solutions to some of the problems that are particularly prevalent in developing countries," Hanekom said at the meeting. "It's important that among the developing countries, those which have some advantages or who are slightly stronger take greater responsibility to strengthen TWAS."

The vision and generosity of our partners is humbling, and it places a responsibility on TWAS to achieve a consistent standard of excellence. That means a process of constant building, consistent improvement and enduring creativity. It is a challenge, yes, but with partners like these, TWAS is up to the task. ■

Edward W. Lempinen

Top to bottom: Romain Murenzi, TWAS; Elías Micha Zaga, CONACYT, Mexico; then-science minister of South Africa Derek Hanekom. (All photos: Roque Silles)

BAI CHUNLI: "AT 30, I STOOD FIRM"

IN HIS OPENING ADDRESS TO THE TWAS GENERAL MEETING, ACADEMY PRESIDENT BAI CHUNLI CITED THE WORDS OF CONFUCIUS TO UNDERSCORE THE SIGNIFICANCE OF THE ACADEMY'S 30TH ANNIVERSARY. "WE HAVE EARNED A POSITION OF RESPECT IN THE WORLD OF SCIENCE," HE DECLARED. "THE GLOBAL FAMILY OF SCIENCE RELIES ON US."

Bai Chunli

The following address was delivered to TWAS members and Young Affiliates gathered for the 24th General Meeting on 1 October 2013 in Buenos Aires.

Esteemed colleagues, dear friends, ladies and gentlemen –

Welcome to Buenos Aires, and to the start of the 24th TWAS General Meeting. I am honoured to be with you this morning, and greatly pleased. We have an excellent meeting ahead of us, with a strong programme and also an opportunity to celebrate our 30th anniversary.

As you probably know, this is my first meeting as the president of TWAS. And so I would like to thank those who have preceded me and taught me so much by their examples. Former President José Vargas – I'm delighted to see that he is joining us this year. Former President C.N.R. Rao, one of our Founding Fellows, who remains a vital voice within the Academy. Immediate Past-President Jacob Palis, who has generously shared his insight with me in recent months. I would like to thank, as well, our admired executive director of many years, Mohamed Hassan, who has done so much to shape and guide the Academy as it has grown over these three decades. These are eminent scientists and leaders, and I hope that I will live up to the example they have set and the accomplishments they have achieved. Thank you all very much.

Thanks, also, to current Executive Director Romain Murenzi. He has put a great deal of energy and effort into this meeting, and I am confident that his work and the work of TWAS's staff will result in a great success here in Argentina.

In China, the age of 30 is auspicious. The lessons of youth have been learned, and youth gives way to a mature, steadfast character. In the *Analects,* Confucius put it simply: "At 30, I stood firm." This well describes TWAS as we celebrate our 30th anniversary. We are established and well known; we have earned a position of respect in the world of science, both South and North. The global family of science relies on us.

Over the past 30 years, tremendous changes have swept across

the world's science landscape. Just since the start of the 21st century, developing countries have more than doubled their expenditure on R&D. The investments have paid off in growing numbers of researchers and publications, and in surging economic growth, especially in such countries as Brazil, India, and my own country, China. Other nations have seen this success and are following a similar path. International scientific collaboration is flourishing. Today, thanks to a great and continuing effort, the powers of innovation are being distributed across the globe.

I believe that TWAS deserves some credit for this. From the time of its birth in 1983, founder Abdus Salam, the 42 Founding Members and other Academy leaders advanced a basic idea: Through science, engineering and technology, developing nations can empower themselves to solve problems and build prosperity. In schools, laboratories and political capitals throughout world, TWAS has built valuable programmes and networks. Just as important, it has helped to convey a sense of scientific confidence where confidence often had been absent.

TWAS members, and those who have received our research grants and fellowships, have made discoveries that led to patents and new businesses. They have improved life for countless thousands of people. TWAS has supported research centres in developing nations that have become regional and even global centres of innovation. Members of the TWAS family have taken leadership positions in government, in industry, in education and non-governmental organizations.

We have good reason to celebrate these successes. But an anniversary is also a time of reflection. Today, because of our success, much more is expected of us.

Recently, I have been thinking of TWAS founder Abdus Salam. If he were still alive, what would he think of us today? What goals would he set for us?

And I would ask: What goals should *we* set for *ourselves*?

If we wish to fully activate the scientific potential of the developing world, we should do more to encourage young women to pursue research careers. We should take a leadership role in helping educational and scientific institutions learn how to support women and bring out their best scientific talents.

Leadership also requires that we elect more women as members of TWAS. At the start of 2013, women accounted for just under 10% of our membership. I firmly believe that we can find women of the highest stature who qualify for our Academy, and raise their numbers, without compromising our standards of excellence.

We also must focus efforts on the Least Developed Countries.

Fifty years ago, in 1963, Salam addressed this issue in an essay called 'Diseases of the Rich and Diseases of the Poor'. He described the education and training of excellent scientists in small nations as immensely important. He wrote:

Bai, left, and Argentinian science minister Lino Barañao at the opening ceremony of the TWAS General Meeting in Buenos Aires. (Photo: Roque Silles)

The opening ceremony of the 24th TWAS General Meeting. (Photo: Roque Silles)

"The only one way to do this is to build up a true scientific tradition there. By locating international research programmes in smaller countries, by awarding research contracts to their growing research centres, by visiting and by responding generously to their staffing requests, these incipient centres could be brought into the vigorous mainstream of science." And, he added: "This in the end will also bring economic salvation."

Clearly, that idea has found some success. A diverse corps of smaller nations – Colombia and Mexico, South Korea and Malaysia, Rwanda, Bangladesh and others – are successfully growing healthy science cultures. And yet, the United Nations counts 48 Least Developed Countries, or LDCs – 31 of them in Africa, many of them small and less populated. The global science transformation has scarcely touched them.

LDCs are defined by their poverty, low levels of education, and poor health. The average per capita annual income of LDCs in 2012 was about 750 US dollars. Where investment in research and development is approaching 2% of gross domestic product in some developing countries, in LDCs it has been stagnant at about 0.1%. Many LDCs are simply too poor to invest much in science.

For TWAS, one of the central challenges is to find a way to help LDCs build a foundation in science.

We should work more diligently to discover excellent scientists in these lagging countries, and to elect them as TWAS members. Before our latest election, we had members from 91 nations. But there are more than 70 nations that have no TWAS member. In many of them, development of a scientific culture will be critically important for future stability and improving the human condition.

I hope that, in coming years, we can expand our membership to at least 100 nations.

Another way to build science in LDCs is by educating and training scientists. It is our core belief that in developing countries, even a single scientist can make a difference. Not only do they conduct research that solves human problems and drives economic growth, but they also become teachers and mentors. They provide advice to policymakers and build international networks.

With this idea in mind, TWAS has taken significant steps in recent months to advance the education and training of scientists in the developing world.

During the 2012-13 biennium, TWAS provided some 220 PhD fellowships. Thanks to a series of recent agreements, TWAS is now able to offer scientists in the developing world more than 400 fellowships per year for PhD study and post-doctoral research. That is a significant increase.

An agreement in early 2013 with the Chinese Academy of Sciences (CAS) created the CAS-TWAS President's Fellowships; this will allow up to 140 young researchers from developing countries per year to travel to China for an all-expenses-paid PhD programme at a major Chinese university.

Under another new agreement, the COMSATS Institute of Information Technology in Pakistan will provide up to 90 PhD fellowships, post-doctoral fellowships and visiting scholar posts per year at its institutions and laboratories. Other agreements to expand and support fellowships have been reached recently with *Universiti Putra*

Malaysia, the World Meteorological Organization, and the German Research Foundation.

TWAS and the Chinese Academy of Sciences also are collaborating in five CAS-TWAS Centres of Excellence in China. These centres, every year, will provide hundreds of scientists from the developing world a range of valuable opportunities, from PhD study and joint-research projects to conferences and workshops, on topics ranging from green technology and water resources management to disaster mitigation.

The programmes will bring in top scholars from both the developed and the developing world. Many will include support for women scientists. We envision the TWAS regional offices playing an important role in supporting and advancing the centres of excellence.

These scientists will then return to their nations, bringing knowledge that can be used for research and policymaking, and with access to new international research networks.

TWAS has dozens of other centres of excellence in other countries, and we should seek to energize those relationships and fully benefit from these resources.

For TWAS to work successfully in a challenging global environment, a third strategic element is critically important: fundraising.

Last year, at our General Meeting in Tianjin, the TWAS Council authorized a new fundraising appeal. In recent months, we have reached out to you for support. A number of members and Young Affiliates have made generous contributions. Yet much more is needed, on an ongoing basis, if we are going to expand our programmes and work through a difficult global economy.

TWAS President Bai Chunli at the 24th TWAS General Meeting. (Photo: Roque Silles)

In the weeks ahead, we will be reaching out to you again. Please, if you can, make a contribution to support our work. You can be confident that at the same time, we are making appeals to governments, foundations and private industry.

I was elected a TWAS member in 1997, and I served for a number of years as a vice president of the Academy. Through the years, I have often heard the reminder: *There is still more to be done*. I heard it from Professor Rao and Professor Palis, I heard it many times from Professor Hassan. I am quite sure that Abdus Salam must have said it too. And they were right. All of them have been right.

But though we've heard it often, we must hear it *well* and take it to heart.

I said at the start of my talk that the world relies on us. It relies on us to continue our work of building science in the developing world. We have a strong organization and excellent personnel, and if we bring our best energy and recognize our opportunities, we should continue to make good progress.

Also at the start of my talk, I mentioned Confucius's line: "At 30, I stood firm." In the *Analects,* the following line says: "At 40, I had no more doubts."

Ten years from now, I expect to be with you celebrating another anniversary. And I expect to declare then, with pride: At 40, there are no doubts that TWAS is a world-leading institution, and that it plays a major role in shaping the world's science agenda, in promoting science for sustainability, and in building scientific capacity in developing countries.

I look forward to sharing four good days with you. Thank you all very much for taking the time to be with us. ■

LOOKING BACK, MOVING AHEAD

AT THE 2013 GENERAL MEETING IN BUENOS AIRES, TWAS MEMBERS CELEBRATED 30 YEARS OF ACCOMPLISHMENTS BY THE ACADEMY AND ITS MEMBERS. BUT THERE WAS A STRONG FOCUS ON THE FUTURE.

Once a year, the *TWAS Newsletter* has the opportunity to highlight the pinnacle of TWAS's work: our General Meeting, bringing together top-shelf scientists from across the globe to a developing country. This edition is even more special, however, because the General Meeting was the scene of another special milestone – the Academy's 30th anniversary.

Since its founding in 1983, TWAS has become a force behind the prosperity of science in countries that don't enjoy the resources or scientific infrastructure found in the developed world. The Academy's 30th anniversary presented a chance to celebrate TWAS's long history of accomplishments and envision what the future may bring.

"In this meeting we are celebrating 30 years of the academy and this is a reason to be proud", Elías Micha Zaga, adjunct director for regional development at Mexico's National Council on Science and Technology (CONACYT), told the audience.

The 2013 TWAS General Meeting in Buenos Aires, Argentina, was the scene of hope and celebration. More than 300 researchers, top science policy officials and educators attended to share ideas and reinforce global connections. At the meeting, Argentinian science Minister Lino Barañao said this century will be critical for the future of humanity because the planet will have to support more than two billion additional people by 2050.

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Left to right: Minister Lino Barañao, Argentina; Minister Derek Hanekom, South Africa; Elías Micha Zaga, CONACYT, Mexico. (Photos: Roque Silles)

From left: José I. Vargas, Jacob Palis, Immacolata Pannone, Mohamed H.A. Hassan, Alessandra Di Pippo, C.N.R. Rao, Bai Chunli, Romain Murenzi. (Photos: Roque Silles)
Below left to right: Fang Xin, OWSD; Fu Shuqin, CAS; Romain Murenzi, TWAS. Jorge Grandi, UNESCO. Palis, TWAS; filmmaker Nicole Leghissa. (Photos: Roque Silles)

"This implicates tantamount challenges in terms of food, energy and health that can only be dealt with through transforming achievements in science and technology", Barañao said.

Further PhD opportunities through TWAS are also on the horizon through pledges from India, Argentina and South Africa to begin new fellowship programmes.

"It's important that among the developing countries, those that have some advantages or who are slightly stronger take greater responsibility to strengthen TWAS", said Derek Hanekom, the South African minister of Science and Technology at the meeting. "I include South Africa in that. Because there are some countries with very little resources. Countries that are better resourced need to take the greatest burden of responsibility to strengthen the Academy."

Countries that are better resourced need to take the greatest burden of responsibility to strengthen the Academy.

In reflection of the long road TWAS has travelled, the Academy honoured two women who provided decades of commitment to our common cause: Immacolata Pannone, scientific expert in the Bilateral and Multilateral Scientific and Technological Unit of the Italian Ministry of Foreign Affairs, and Fu Shuqin, past director of the TWAS Regional Office for East & Southeast Asia within the Chinese Academy of Sciences. They received plaques that commemorate their tireless efforts to support TWAS in its mission.

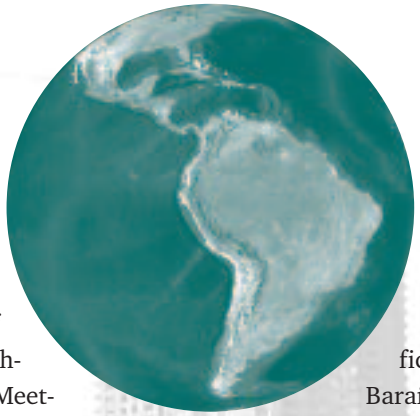
TWAS also premiered the new film *Seeds of Science* by Trieste filmmaker Nicole Leghissa, presenting a rich example of how the Academy's work building scientific skill in the developing world improves the lives of ordinary citizens.

Jorge Grandi, the Uruguayan who directs UNESCO's regional bureau for science in Latin America and the Caribbean, highlighted the role of academies like TWAS. "UNESCO is pleased for its collaboration with TWAS over the years", Grandi said, "and looks forward to future opportunities to work together, especially with the challenges we face in targeting science to ensuring global sustainability." ■

Sean Treacy


THE POWER OF GLOBAL SCIENCE COOPERATION

SCIENCE MINISTERS AND TOP POLICY LEADERS MEETING IN BUENOS AIRES EXPLORED HOW TO ADVANCE SCIENCE EDUCATION AND INNOVATION IN A CHALLENGING INTERNATIONAL ENVIRONMENT



Over the past 30 years, science and engineering have helped drive economic growth in a range of developing countries, and nations such as Argentina, China, Brazil and India have been so successful that they have moved into the ranks of emerging economies. But during a high-level discussion at the TWAS General Meeting in Buenos Aires, top science policymakers urged that developing nations at every stage of progress must increase investment and build closer ties in order to reinforce and extend these historic gains.

In a series of sessions on the opening day of the meeting, government science ministers and other science policy leaders cited a range of areas that should be science policy priorities for developing nations: increasing the corps of PhD researchers; building the ranks of women scientists and engineers; expanding international educational and research exchanges; and creating more joint ventures – with other developing nations and with developed nations – to address global challenges.

The landscape is complex and difficult to navigate, said chemist Lino Barañao, Argentina's minister of Science, Technology and Innovative Production. Developing nations must be like the Roman god Janus, Barañao said, with one face "looking outside to narrow the divide with the developing world, and the other facing inwards, to find advances and new technologies to aid those still excluded" from the nation's progress.

"We feel it's very important for developing countries in the world to get together and bring their scientists together to try to find solutions to some of the problems that are particularly prevalent in developing



countries", said Derek Hanekom, the South African Minister of Science and Technology. "We can't sit back passively and wait for the better-resourced countries and more prosperous countries of the world to find solutions… So this South-South collaboration is very important."

Science is "the new grammar for shaping the future", said Thirumalachari Ramasami, secretary of India's Department of Science & Technology.

"We look at cooperation and sharing among the developing world of science [as something that] makes sense for shaping our own future."

The science policy leaders, joined by TWAS President Bai Chunli, were prominent on the first day of the 24th TWAS General Meeting, held 1–4 October in Buenos Aires. Several spoke at the opening ceremony; the traditional ministerial session convened the first afternoon including nine top science policy officials from around the world. In addition, the policy leaders held a news conference that attracted a corps of Argentinian and other journalists.

Education and training were recurring themes, just as they were for Pakistani physicist Abdus Salam and other science leaders who had founded TWAS 30 years earlier. But the meeting in Buenos Aires made clear that science has created new progress and new global relationships.

A familiar message emerged from the discussions: A nation with strength in science and engineering is more capable of independence, problem-solving and true international cooperation. Nations such as Argentina, China, Brazil, India and South Africa can serve as models and mentors for others that want to pursue economic growth and human progress through science and engineering.

Underscoring those themes, the science leaders used the opening sessions to announce a series of new commitments to TWAS:

Barañao pledged that Argentina would support 30 new PhD fellowships annually, plus 15 postdocs, and five visiting scientists. In addition, Argentina opened 175 of its centres of research excellence to visits by researchers from the developing world under the TWAS-UNESCO Associateship Scheme.

Hanekom announced that the South African government will sponsor at least 100 new fellowships for students from developing countries to study for PhDs in South Africa.

Ramasami announced that the government of India would create 25 new PhD fellowships per year for African students, funded over the next five years at total cost of USD3.3 million.

A nation with strength in science is more capable of independence, problem-solving and true international cooperation.

'LOST DECADES' OF EDUCATION

For many of the ministers and other top policy officials who spoke on the first day of the meeting, one concern topped all others: funding, and especially national investment in research and development. Funding, they suggested, is the fuel that drives education,

Left to right: Argentinian science minister Lino Barañao and TWAS President Bai Chunli; Elías Micha Zaga, CONACYT, Mexico, and then-science minister of South Africa Derek Hanekom; Gabriel Casaburi, Inter-American Development Bank. (Photos: Roque Silles)
Below: Bai Chunli; T. Ramasami, Department of Science & Technology, India; and Yasutaka Moriguchi, Ministry of Education, Culture, Sports, Science and Technology, Japan. (Photo: Roque Silles)

research and cooperation. And it is a clear measure of national commitment.

Ramasami, for example, said that India's investment in R&D has been increasing by 15% to 20% a year. China's R&D investment is nearing 2% of gross domestic product (GDP), surpassing other developing countries.

But investment in Latin America is lagging far behind developed nations in Asia, North America and Europe, said Gabriel Casaburi, lead specialist in the Competitiveness and Innovation Division at the Inter-American Development Bank.

R&D as a percentage of GDP "is very low in Latin America in general", Casaburi said. While developed countries spend 2% to 4% of GDP on R&D, in Latin America, he said, only Brazil spends 1% on R&D. Other nations in the region spend less than 0.5%.

"Even if we reach that desired level of 1% of GDP, we still have a long way to go", Casaburi added. Most R&D is done by Latin America's public sector, but in developed countries, most is done by the private sector. Meanwhile, the number of researchers per 100,000 people in Latin America also lags behind developed countries.

Mexico's economy ranks 14th in the world, but even so, it is among the countries with a "very low" rate of R&D investment, said Elías Micha Zaga, adjunct director for regional development of Mexico's national research council, *Consejo Nacional de Ciencia y Tecnología* (CONACYT). But, he said, new Mexican President Enrique Peña Nieto has a strong commitment to bring the investment up to 1% of GDP by 2018.

A lack of R&D investment results in a cycle of lagging scientific progress, brain drain and economic stagnation, speakers said. And while a nation's education system is a linchpin in its scientific development, it often suffers from weak policy and financial support.

TWAS Fellow Calestous Juma, an influential author and Harvard scholar, cited the developing world's "long neglect of higher education" in a paper he prepared for the General Meeting that was delivered by TWAS Executive Director Romain Murenzi. Without high-end skills in the science and technical workforce, Juma asked, how can a nation address challenges such as agriculture, health and environment?

"To make up for lost decades of education and training, you need greater investment in scientific, technical and engineering capabilities", he wrote. "The recent history of India and Brazil has demonstrated how such investments can drive rapid advancement in electronics and agriculture. Other regions of the world, however, have not registered such improvements. Why? It's at least partly because of their low levels of investment in higher technical training."

INVESTING IN GLOBAL BRAIN CIRCULATION

At the core of TWAS's philosophy is that students – and science-lagging nations – can build strength through opportunities to study at good universities outside of their home countries.

"TWAS has been working in many special projects that support younger scientists for study in countries such as Brazil, India and China", TWAS President Bai said at the Buenos Aires press conference. Bai, who also

Left to right: Jorge Grandi, Elías Micha Zaga; Romain Murenzi seen through the viewing screen of a video recorder; Glaucius Oliva, president, Conselho Nacional de Desenvolvimento Científico e Tecnológico *(CNPq), Brazil; Roberto Salvarezza; Jorge Grandi, Yasutaka Moriguchi. (Photos: Roque Silles)*

serves as president of the Chinese Academy of Sciences, offered an example: the new CAS-TWAS President's Fellowship, which brought 140 students from the developing world to China in 2013 to pursue their PhDs.

Top officials from Japan, Argentina and Brazil said their nations, too, had policies in place to promote global brain circulation.

"We have a strong international cooperation with many countries, and in particular we work to foster mobility of research and research fellows", said Roberto Salvarezza, president of Argentina's national research council, *Consejo Nacional de Investigaciones Científicas y Técnicas* (CONICET).

For example, Argentina has strong relations with Germany and with Latin American countries, and with TWAS.

Argentina welcomes young scientists from other nations. At the same time, Salvarezza said, "we are very interested to promote the formation of our PhDs, not only in Argentina, but also in other countries."

Added Barañao: "Every scientist who comes back to the country brings back new knowledge and new ways of doing things."

Brazil, too, has established overseas study and research programmes as a pillar in the nation's campaign to build science capacity. Brazilian students need "exposure to an environment where competitiveness, innovation and entrepreneurship are already the standard", said Glaucius Oliva, president of Brazil's national research council, *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq).

Today, as Brazil's enrolment in higher education nears 7 million students, it offers scholarships to the nation's best students to study abroad at the world's top universities. Of 100,000 total scholarships, 25% are being funded by the private sector, explained Oliva, a TWAS Fellow (2011). "That was a strategic decision at high levels of government to invest in people – in the development of skills and competencies needed for… the knowledge-based economy."

Brazil also welcomes students from overseas into its best universities and research centres. In 2013, CNPq offered 60 fellowships to early-career scientists from the developing world through TWAS PhD and postgraduate programmes. Over the past decade, Oliva reported, CNPq welcomed more than 500 TWAS Fellowships from such nations as Egypt, China, Cameroon, Pakistan, Ethiopia, India, Nigeria and Mozambique.

Brain circulation helps to build strength in all the nations involved.

Clearly, brain circulation helps to build strength in all the nations involved, said Yasutaka Moriguchi, senior advisor to Japan's Ministry of Education, Culture, Sports, Science and Technology. But, he added, it's critically important for another reason: addressing global challenges.

"DRAW FROM EACH OTHER'S STRENGTH"

Ramasami, the Indian S&T secretary, called it "solution science". Moriguchi cited such issues as environment, climate change, natural disaster preparation, energy and infectious disease. For example, he said, Japan is supporting a joint research project with Argentina and



Chile to develop the social management system for atmospheric environmental risks in South America.

"The global challenges we face today are of a type and scale never before experienced by humanity, and not all of them can be overcome by existing technology and experience", Moriguchi said. "These problems must be resolved while the world maintains sustainable development. What is important is that they cannot be solved by the efforts of any single country. Rather, they must be tackled through solidarity on a global scale."

Hanekom, the South African science minister, agreed. "The global challenges of underdevelopment, poverty and inequality cast a huge burden on individual states and have little respect for borders", he said. "We need to draw from each other's strength and work in partnership by pooling resources – financial, human and institutional."

Several speakers cited the importance of TWAS in building a culture of South-South cooperation. Hanekom extended the recognition to the "enlightened role" played by the Italian government, which provides core funding to TWAS and two other international research centres based in Trieste: the Abdus Salam International Centre for Theoretical Physics and the International Centre for Genetic Engineering and Biotechnology.

Hanekom called it "critical" to strengthen TWAS. The Academy should be "properly resourced to execute its mandate" of nurturing science and young scientists in the developing world, he explained. "It's important that among the developing countries, those that have some advantages or who are slightly stronger take greater responsibility to strengthen TWAS. And I include South Africa in that."

A VISION OF SCIENCE WITHOUT BORDERS

From R&D investment to international collaboration, the imperative of building science in the developing world requires strong policy. For strong policy, commitment from science and education ministers and other high-ranking leaders is essential.

In his paper, Harvard scholar Calestous Juma wrote that the "most important challenge" for top policymakers will be to advance PhD training in science and technology by engaging a wide base of scientists, educators and leaders from business and politics. He acknowledged that can be a difficult challenge.

"The effectiveness of science and technology ministers in promoting the expansion of doctoral training will depend very much on their political courage", he wrote. "But even more importantly, a great deal of political and diplomatic tact will need to be brought to the task so that the public good prevails."

Barañao, the Argentine science minister, reminded the audience that building science is not just a matter of policy goals, but also a matter of spirit. He cited the famous quote of physiologist Bernardo Houssay, Argentina's first Nobel laureate: "Science has no country, but scientists do."

The TWAS General Meeting "enables us to confirm that science has no borders", Barañao said. "Beyond our own languages and national borders, we have common values and shared work." ■

Edward W. Lempinen

TWAS ELECTS 52 NEW MEMBERS

Fifty-two new members were elected to TWAS during the Academy's 24th General Meeting, held in Buenos Aires from 1 to 4 October 2013. With those new Fellows, TWAS membership rose to 1,105.

Of the new members, 12 are from India; 11 from Brazil; nine from China; four from Taiwan, China; and two from Vietnam. One each was elected from Australia, Azerbaijan, Benin, Ethiopia, France, Japan, Kenya, Pakistan, South Korea, Tanzania, Thailand, the United Kingdom, the United States, and Venezuela. Regionally, 29 are from developing countries in Asia, 11 from Latin America, and three from sub-Saharan Africa. Six of the new members are women.

The full list of new TWAS members elected in 2013:

01-Agricultural Sciences: Ricardo Antunes de Azevedo of Brazil; Zeyaur Rahman Khan of India; Papa Abdoulaye Seck of Senegal; and Zhu Yuxian of China.

02-Structural, Cell and Molecular Biology: Soo-Chen Cheng of Taiwan, China; Takashi Gojobori of Japan; Tao-Shih Hsieh of Taiwan, China; Helena B. Nader of Brazil; and Jayant Udgaonkar of India.

03-Biological Systems and Organisms: Anwar Gilani of Pakistan; Jitendra Paul Khurana of India; Luiz Drude de Lacerda of Brazil; Lee Sang Yup of the Republic of Korea; and Raman Sukumar of India.

04-Medical and Health Sciences including Neurosciences: Abraham Aseffa of Ethiopia; Mauricio L. Barreto of Brazil; Kathryn Song Eng Cheah of Malaysia; Yuk Ming Dennis Lo of China (winner of TWAS's 2012 Ernesto Illy Trieste Science Prize); Narinder Kumar Mehra of India; and Viswanathan Mohan of India.

05-Chemical Sciences: Christian Amatore of France; Vanderlan da Silva Bolzani of Brazil; Pratim Kumar Chattaraj of India; Chen Xiao-Ming of China; Gao Song of China; Martyn Poliakoff of the United Kingdom; and Tian He of China.

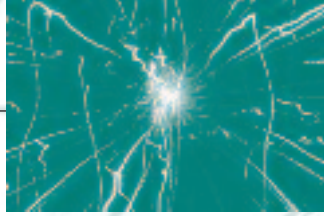
06-Engineering Sciences: Ali Abbasov of Azerbaijan; Chennupati Jagadish of Australia; Anurag Kumar of India; Ranjan Kumar Mallik of India; Hong Mei of China; and Bhim Singh of India.

07-Astronomy, Space and Earth Sciences: Eduardo Luiz Damiani Bica of Brazil; Alexander Wilhelm Armin Kellner of Brazil; Shaw Chen Liu of Taiwan, China; Evelyne Isaack Mbede of Tanzania; David Ruffolo of Thailand; and Sreedharan Krishnakumari Satheesh of India.

08-Mathematical Sciences: Artur Oscar Lopes of Brazil; Phan Quoc Khanh of Vietnam; Phu Hoang Xuan of Vietnam; and Ivan Shestakov (Chestakov) of Brazil.

09-Physics: Nathan Berkovits of Brazil; Adalberto Fazzio of Brazil; Anamaría Font of Venezuela; Shih-Chang Lee of Taiwan, China; Juan Martin Maldacena of the United States; Deepak Mathur of India; and Shen Bao-Gen of China.

10-Social and Economic Sciences: Kaushik Basu of India; and Huang Jikun of China. ■



BRINGING LIGHT INTO THE DARKNESS

TWAS-LENOVO PRIZE WINNER CLAUDIO BUNSTER WEITZMAN ADVANCED BOTH THEORETICAL PHYSICS AND CHILEAN SCIENCE

Theoretical physicists frequently serve as the stewards of impossible-seeming ideas, trying to reconcile the inconceivably enormous with the inconceivably small. Similarly, scientists from the developing world can be caught between their desire to practice on the edge of their field and the realities of paltry science budgets or even authoritarianism. Scientists who manage to reconcile this conflict leave an impact like few others.

The 2013 TWAS-Lenovo Science Prize, one of the most prestigious prizes given to scientists in the developing world, was awarded to such a reconciler: Chilean theoretical physicist Claudio Bunster Weitzman. The prize, the most important given by TWAS, was awarded for his contributions to understanding gravity and the quirky physics of tiny, fundamental particles of matter. It was presented to Bunster on 1 October at a special ceremony during the 2013 TWAS General Meeting in Buenos Aires, Argentina, and he joyfully thrust the prize into the air as applause from the crowd washed over him.

"Coming to Buenos Aires to receive this prize from The World Academy of Sciences and Lenovo is to be rewarded at home by the world," Bunster said. "It is perhaps symbolic that the phone call from TWAS President Professor Bai Chunli with the good news was placed from Beijing in China to Valdivia in Chile: two places with a time difference of 12 hours, and whose latitudes are the same in magnitude, but one North and the other South."

The honour includes a prize of USD100,000 provided by Lenovo, the Chinese technology firm. Lenovo is a

Chilean physicist Claudio Bunster Weitzman (centre) celebrates after receiving the TWAS-Lenovo Science Prize. (Photo: Roque Silles)

USD30 billion personal technology company, and one of the top two PC makers globally, serving customers in more than 160 countries. Dedicated to building exceptionally engineered PCs and mobile Internet devices, Lenovo's business is built on product innovation, a highly efficient global supply chain and strong strategic execution.

"Being a global technology firm originated from a developing country, we understand how science and technology can be of great value and importance to a growing economy," said George He, chief technology officer at Lenovo. "We felt deeply the responsibility to help promote and support fundamental research in developing countries. Work like Dr. Bunster's, which started a school of theoretical physics in Chile, is most meaningful and has far-reaching impacts in this sense."

Bunster's work has been on the frontier of several areas of theoretical physics, sometimes even bringing them together in creative ways. He has tackled such mysterious topics as black holes, incredibly massive collapsed stars where the gravity is so intense that even light cannot escape, and magnetic monopoles, extremely minuscule particles that some physicists suspect generate magnetic field lines. Equations consistently give physicists cause to believe magnetic monopoles exist even though they have never been seen in action. Bunster has worked with other leaders in the field to consider creative ideas, such as that the particles might be so elusive because they are hiding in the difficult-to-observe black holes.

"The work done by Claudio Bunster Weitzman over the course of a very productive career has improved our understanding of the fundamental workings of nature," said Bai. "He is a world-class scientist, and he is a powerful symbol of the excellent science that is being done by researchers in the South."

Bunster was born in Santiago, Chile, on 15 April 1947. He was educated at *Universidad de Chile* and Princeton University (USA). He has taught at Princeton, the University of Texas at Austin and *Universidad de Chile*, and he has been a long-term member of the elite Institute for Advanced Study in Princeton. He has

received the Chilean National Science Prize, the Humboldt Award, is an honorary member of the International Solvay Institutes and a foreign associate of the US National Academy of Sciences.

Bunster's interest in theoretical physics began with the problem in classical dynamics called the radiation reaction – a recoil force from when a charged particle emits electromagnetic radiation. His work on the problem led to a new interpretation of the equation behind the motion. Later, his work focused on general relativity – the theory describing the curvature of spacetime by gravity – shedding light on areas such as the nature of black holes. For example, his work has shown that when a black hole swallows a magnetic monopole, the black hole stars rotating, like the enormous one in the centre of the Milky Way does.

The prize not only honours Bunster's scientific achievements, but acknowledges his role as a scientist who stood for promoting scientific research in his home country even while it was enduring the oppressive dictatorship of General Augusto Pinochet. After about 15 years abroad in the United States, Bunster returned to Pinochet's Chile to show through example that a world-class science institute could be established in the developing world.

Claudio Bunster Weitzman is a powerful symbol of the excellent science that is being done by researchers in the South.

"I felt that precisely at that time I could be more useful, and this could be best accomplished by having an independent place where colleagues from all over the world could visit and bring some light into the darkness", Bunster told the US National Academy of Sciences in an interview for a 2008 profile.

In 1984, he founded the *Centro de Estudios Científicos* (CECs) in Chile, an independent research centre. Even though he was forbidden from teaching at Chilean universities by the Pinochet regime, CECs' success eventually led Bunster to permanently settle in Chile. He has been the director of CECs since its founding, and the centre is currently home to first-rate research in theoretical physics, biological sciences, glaciology and climate change.

He was elected to TWAS in 1991. At the beginning of his lecture at the Buenos Aires meeting, Bunster reminisced the early days of the 'dear little centre' in Trieste, ICTP, out of which TWAS emerged. He said the Academy's current state as a promoter of science in the developing world provides valuable proof that such an institution can work. "I think that Abdus [Salam] would be happy and proud."

He then, with the help of five whiteboards and a short length of rope, gave a lecture on the physics of electromagnetism and spacetime. Electricity and magnetism are part of the same physical force, called the electromagnetic force, a principle first established in Scottish physicist James Maxwell's equations a century-and-a-half ago. But this duality is in tension with theories describing spacetime.

This is the first year ever for the TWAS-Lenovo Science Prize, the successor to The Ernesto Illy Trieste Science Prize that ran for eight years. During its first four-year cycle (2013–2016), the TWAS-Lenovo prize subject is focusing on the basic sciences, with the subject area changing each year: physics and astronomy in 2013, biological sciences in 2014, mathematics in 2015 and chemical sciences in 2016.

"I want to thank Lenovo for their generous support to TWAS," Bai said. "We sincerely hope the establishment of TWAS-Lenovo Science Prize will further stimulate science advancement in important fields, across the developing world." ■

Sean Treacy

HONOURING THE BEST AND BRIGHTEST

TWAS PRIZES RECOGNIZE ACHIEVEMENTS OF SCIENTISTS FROM THE SOUTH

Drought and salinity in dry regions can make the soil less fertile, causing challenges for farmers and suffering among the people they feed. But, as work by one recently honoured Uzbek researcher's work shows, there's a clever way to help crops survive using tiny, industrious microbes.

Microbes that seek out plant roots as a safe place to thrive in rough conditions know a few ways to help out their host plants. Scientists can use such root bacteria to keep ailing crops healthy through trying times of nutrient-poor soil. These microbes, called 'plant growth promoting rhizobacteria', have given scientists clues on how to improve the endurance of ailing crops.

Dilfuza Egamberdieva of the National University of Uzbekistan in Tashkent and her colleagues determined how the bacteria stimulates plant growth under environmental stress and created new ways to use salt-tolerant bacteria to help boost the health of crops. They also discovered that the roots of some plants growing in salt-rich soils contained high levels of bacteria that could infect humans, explaining some diseases that commonly infect Uzbek farmers.

Egamberdieva is one of the 12 winners of the 2012 TWAS Prizes for scientific excellence, all of whom attended the TWAS General Meeting this October in Buenos Aires, Argentina, and gave presentations on their research. The TWAS Prizes are awarded every year to scientists in eight different fields: agriculture, biology, chemistry, earth science, engineering, mathematics, medicine and physics, and are among the highest honours given to scientists in the developing world, each carrying a cash prize of USD15,000.

Egamberdieva hopes to apply her new agricultural technique in Uzbekistan soon to boost the yield of eco-

Left to right: Cotton boll opening (Photo: Flickr/Judy Baxter); TWAS Prize winner Ann-Shyn Chiang (second from left), China. On previous page: TWAS Prize winner Dilfuza Egamberdieva, Uzbekistan. (Photos: Roque Silles)

nomically important crops such as wheat, cotton, tomatoes and cucumbers. The country uses 4.4 million hectares for agriculture, but excessive salt from the Aral Sea basin has rendered more than half of it unproductive.

Globally, about 52% of the land used for agriculture shows soil degradation. Land impoverishment is often due to salt infiltrations in the ground, which weaken the plants and lower the yield. Salt inhibits 'nodulation', the development of tiny nodules on plants' roots, limiting plant growth. The bacteria Egamberdieva study convert the atmospheric nitrogen absorbed by plants into a more usable compound, ammonia.

Egamberdieva hopes to apply her new agricultural technique in Uzbekistan to boost the yield of economically important crops.

"We have already completed some experiments, both in protected greenhouses and in open fields, working in close contact with local farmers", said Egamberdieva, who is also engaged in promotional campaigns with the Uzbek government and in outreach campaigns among farmers. Soon, Egamberdieva hopes, she will receive the green light to test her findings on actual agricultural fields.

FRUIT FLY BRAIN-MAPPING

Research commended by the TWAS Prize doesn't just help feed the world, but can shed light onto the fundamentals of cutting-edge scientific fields such as neuroscience. One example is research by TWAS Prize in Biology winner Ann-Shyn Chiang of National Tsing Hua University, Taiwan, China, into the neural networks of fruit flies.

It is difficult even to imagine what it's like in the brain of a fruit fly. But research by Chiang and his colleagues gave science tremendous insight into the minuscule drosophila fruit fly's brain and its 130,000 neurons. Their research also helped bring Taiwanese science into prominence with a string of publications in prestigious journals.

Born in Taiwan, Chiang graduated from National Chung-Hsing University in 1981, received his Master of Science from National Taiwan University in 1983, and left his home country to obtain his PhD from Rutgers University in New Jersey (USA) in 1990. He returned to Taiwan in 1992 to be an instructor at National Tsing Hua University, and in 2001 took his sabbatical to study fruit fly memory at Cold Spring Harbor Laboratory in New York.

In 2004, Chiang founded the Brain Research Center at National Tsing Hua University, aiming to understand how genes and neural circuits combine to create the fruit fly behavior scientists can observe. He then

constructed a comprehensive map of connections among fruit fly neurons that govern the insect's sense of smell and in 2007 published the first paper in the influential journal *Cell* to come from Taiwanese scientists.

Chiang later published another map revealing brain-wide neural networks in the fruit fly. The study managed to barcode 16,000 neurons in the drosophila brain and in 2010 *The New York Times* called the work the first step toward decoding the human brain. An open-access database of images showcasing the fruit fly brain down to individual cells is even available at *www.flycircuit.tw*.

He became the adjunct International Faculty of the Kavli Institute for Brain and Mind at the University of California, San Diego, in 2011, and Chiang and his colleagues discovered that long-term memory formation requires the creation of new proteins in only a small number of neurons in the fruit fly brain. This finding was published in *Science* in 2012 and was the first full article in *Science* from Taiwanese scientists.

MAKING AIDS IN AFRICA SURVIVABLE

The TWAS Prize also raises the profile of research that helps solve some of the most pressing health issues in the developing world.

Of the 33 million people living worldwide with HIV, the majority are in sub-Saharan Africa, and the virus spreads mostly through sexual intercourse. About half the adults living with HIV/AIDS are women, and women younger than 24 in sub-Saharan Africa are eight times more likely to have HIV than young men of the same age range.

In South Africa specifically, more people suffer from HIV infection than any other nation in the world — an estimated 5.7 million, according to 2007 figures from the US Agency for International Development. However, thanks to greater access to antiretroviral treatments in Africa, AIDS is a chronic but manageable condition instead of a certain death sentence.

Work by TWAS Prize in Medical Sciences winner Quarraisha Abdool Karim of the Centre for the AIDS Programme of Research in South Africa has had a massive influence on understanding the spread of HIV in that country, and especially its effect on women. She also led the trial that provided the first clinical evidence that tenofovir gel, an antiretroviral drug, can prevent sexually transmitted HIV and genital herpes in women. This discovery has been a key finding in AIDS prevention and is the culmination of two decades of research.

Karim's contributions in programmes and research complement her passionate promotion of human rights. She has extensive policy experience that stems from her term as the first director of the South African National HIV/AIDS and STD Program established by the Nelson Mandela government shortly after the country's first democratic elections in the mid-1990s.

Karim's work has also been instrumental in the education of other scientists. She directs the Columbia University-Southern African Fogarty AIDS International Training and Research Program, which trained more than 300 young scientists in HIV and tuberculosis

Left to right: TWAS Prize winners Quarraisha Abdool Karim (centre); Yu Jun; Chen Xiao-Ming; Swapan Kumar Pati; Patrick George Eriksson; Abdul Latif Ahmad.
Below: The group of prize winners honoured at the 24th TWAS General Meeting. (Photos: Roque Silles)

research in South Africa, Namibia, Swaziland and Lesotho. The programme has enabled and supported the growth of scientific study in South Africa, and trainees now play leading roles in almost every major AIDS research center in South Africa.

She is also a consultant to numerous United Nations organizations and AIDS-related expert committees on HIV prevention, TB-HIV treatment, gender, ethics, treatment access in low-resource areas, and research capacity building.

MORE 2012 PRIZE WINNERS

Yu Jun, a geneticist with the Beijing Institute of Genomics in China, and winner of the TWAS Prize in Agricultural Sciences, has been a leader in the study of plant genomes, particularly rice, for which he and his colleagues built a series of databases. His research contributed not only to the stronger understanding of basic structure of the rice genome, but insights into how to build vigorous hybrid species and how rice genomes vary.

Sun Yat-Sen University chemist **Chen Xiao-Ming** from China is a winner of the TWAS Prize in Chemistry. He has researched the creation, structures and properties of coordination polymers – interlinked networks of metallic atoms and organic molecules. Chen pioneered the study of how the metal atoms assemble with binding organic molecules called ligands to create coordination polymers.

Graphene, the extremely light two-dimensional pure-carbon substance, has opened up many new possibilities for miniaturized electronic devices. **Swapan Kumar Pati**, a materials chemist with the Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India, and winner of the TWAS Prize in Chemistry, studies the properties of graphene by observing how electrons behave when released into thin nanometer-scale strips of graphene and their nanoribbons.

Patrick George Eriksson of the University of Pretoria

Left to right: The opening ceremony of the 24th TWAS General Meeting. TWAS Prize winners Fernando Codá Marques; Kalyanmoy Deb; Gao George Fu; Juan Pablo Paz. A collection of TWAS prizes on display. (Photos: Roque Silles)

in South Africa and his colleagues have recently begun to challenge concepts like the 'great oxidation' a tipping point at which oxygen produced by living organisms began to accumulate in the atmosphere about 2.4 billion years ago. Eriksson, the winner of the TWAS Prize in Earth Sciences, has a long history of key findings in the study of Earth's deepest history.

The winner of the TWAS Prize in Engineering Sciences, **Abdul Latif Ahmad** of *Universiti Sains Malaysia*, engineers membranes – thin films that only allow certain chemicals from any given substance to pass through them – for uses that range from medical diagnosis to environmental protection. Some of Ahmad's most significant work has been on membrane technology to better control the release of effluent from palm oil mills into the environment.

The 12 winners of the 2012 TWAS Prizes for scientific excellence attended the TWAS General Meeting in Buenos Aires, Argentina.

Kalyanmoy Deb, an engineer with the Indian Institute of Technology, researches algorithms that emulate evolution and how they can optimize machine learning – the ability of artificial intelligence to learn from information. He is widely known for his influential research using evolutionary principles to develop decision-making procedures that take multiple criteria into account. He won the TWAS Prize in Engineering Sciences.

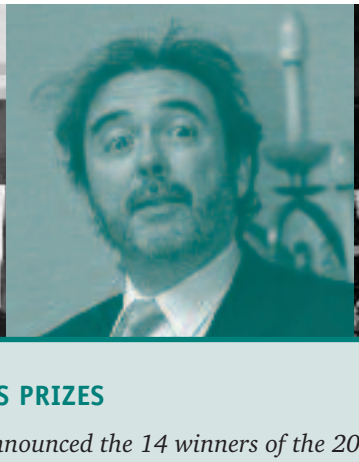
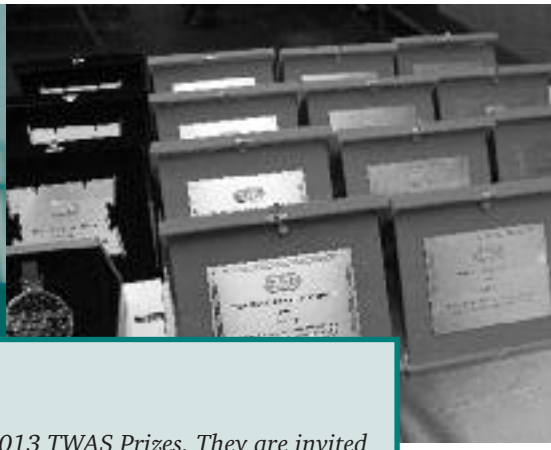
A mathematician with the National Institute of Pure and Applied Mathematics in Brazil, **Fernando Codá Marques**, has made several major contributions to differential geometry, solving and yielding results from numerous problems mathematicians have been working on for decades. The most prominent work by Marques, who won the TWAS Prize in Mathematics, is a complete proof of the Willmore Conjecture, which predicts the equilibrium state of a curved surface with one hole – shaped like an inner-tube.

Microbiologist **Gao George Fu**, winner of the TWAS Prize in Medical Sciences, is a pioneer in the study of germ transmission – influenza in particular – between species. His team at the Institute of Microbiology of the Chinese Academy of Sciences studied the virus H5N1, commonly known as bird flu, predicting that the virus' spread through the birds' migratory flight paths in a study published in *Science* in 2005. His team has tracked bird flu's spread around the world ever since.

How do the reliable rules of classical physics emerge from the erratic and random quantum world of the incomprehensibly small? **Juan Pablo Paz** of the University of Buenos Aires in Argentina studies that border between the worlds of the intuitive and counterintuitive, and won the TWAS Prize in Physics for his work on 'decoherence', which is the loss of quantum information into its environment. ■

Sean Treacy and **Cristina Serra**



WINNERS ANNOUNCED FOR 2013 TWAS PRIZES

At the Buenos Aires meeting, the Academy announced the 14 winners of the 2013 TWAS Prizes. They are invited to present on their research at the 2014 General Meeting, which will take place Muscat, Sultanate of Oman. The winners:

- *Zhu Yongguan of Xiamen, China, received the Agricultural Sciences prize for his research on arsenic pollution in soil and plants, especially rice.*
- *Xu Guoliang of Shanghai, China, received the Biology prize for his work on the role of genetic changes in the development of mammals.*
- *Sue Duan Lin-Chao of Taipei, Taiwan, China, gained the Biology prize for her work on RNA degradation in bacteria.*
- *Ayyappanpillai Ajayaghosh of Kerala, India, received the Chemistry prize for his work that led to a new class of soft functional materials.*
- *Chung-Yuan Mou of Taipei, Taiwan, China, received the prize in Chemistry for work on tiny porous structures that have chemical and biomedical applications.*
- *Li Xia of Guangzhou, China, won the prize in Earth Sciences for his work on models simulating land uses and planning for sustainable land development in China.*
- *Indranil Manna of Kanpur, Uttar Pradesh, India, won the prize in Engineering Sciences for work on nanometric materials.*
- *Mohammad Ahmad Al-Nimr of Irbid, Jordan, won the prize in Engineering Sciences for his work on understanding the behavior of environmentally friendly devices, systems and processes that use, generate, convert, store and manage energy efficiently.*
- *Artur Avila of Rio de Janeiro, Brazil, won the prize in Mathematics for his contributions to several mathematical theories dealing with, for example, systems in a low number of dimensions.*
- *Mei-Hwei Chang of Taipei, Taiwan, China, received the prize in Medical Sciences for her work proving the effect of a hepatitis B vaccine in preventing a common kind of liver cancer and promoting the idea of vaccines to prevent cancer.*
- *Turgay Dalkara of Ankara, Turkey, got the prize in Medical Sciences for work on mechanisms leading to brain damage and migraines following a lack of blood reaching the brain.*
- *Rajesh Gopakumar of Allahabad, India, received the prize in Physics for his discovery of duality symmetry between a class of two-dimensional conformal field theories and higher-spin theory in three-dimensional anti-de Sitter space.*
- *Marcos Pimenta of Belo Horizonte, Brazil, received the Physics prize for his contribution to our understanding of the optical and electronic properties of carbon nanomaterials.*
- *Zhang Linxiu of Beijing, China, won the TWAS-Celso Furtado Prize in Social Sciences for her policy-relevant studies on rural development in China.*

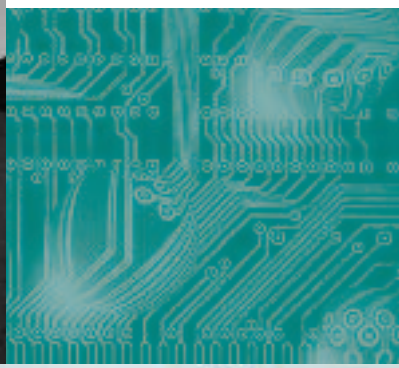
SHARING A VISION OF PROGRESS

FU SHUQIN AND IMMACOLATA PANNONE RECEIVED TWAS-UNESCO LIFETIME ACHIEVEMENT HONOURS IN BUENOS AIRES

They seem to have little in common, at first sight. Immacolata Pannone, a veteran in the Italian Ministry of Foreign Affairs, and Fu Shuqin, past director of the TWAS Regional Office for East & Southeast Asia within the Chinese Academy of Sciences (CAS), do not share language, culture, hobbies or lifestyle. But they possess something vitally important: a vision of how science and engineering can drive economic growth and build human prosperity in the nations of the developing world, and the energy to bring that vision to life.

Working with unceasing enthusiasm for almost 30 years, Fu and Pannone have been indispensible allies to TWAS, devoting significant parts of their careers to the promotion of development, progress and justice through the power of research. For their role in the Academy's success, the women received TWAS-UNESCO Special Lifetime Achievement Awards during a ceremony held during the 24th TWAS General Meeting, on 1 October in Buenos Aires, Argentina.

"Immacolata Pannone and Fu Shuqin have played, sometimes behind the scenes, an essential role in shaping the collaboration between TWAS and CAS and, as a consequence, between Italy and China", commented Mohamed H.A. Hassan, the former executive director of TWAS and co-chair of IAP, the global network of science academies. "Their keen understanding of the importance of science for developing countries has been a driving force, a stimulus to work hard to improve the quality of research and education in developing countries. By strengthening the TWAS-CAS partnership from the early years of the Academy's work to the present days of uncertainties, Fu and Pannone have certainly written some important paragraphs of TWAS's history. This is why they have been honoured in the 30th anniversary of our Academy."



Above: From left, Immacolata Pannone, Mohamed H.A. Hassan, Alessandra Di Pippo, C.N.R. Rao. Right: Pannone receives her award. (Photos: Cristina Serra)

Pannone has a cheerful spirit and the sharp focus of a scholar, and these have served her well as she has worked to build a constructive relationship between TWAS and the Ministry of Foreign Affairs (MAE), where she has served since 1991.

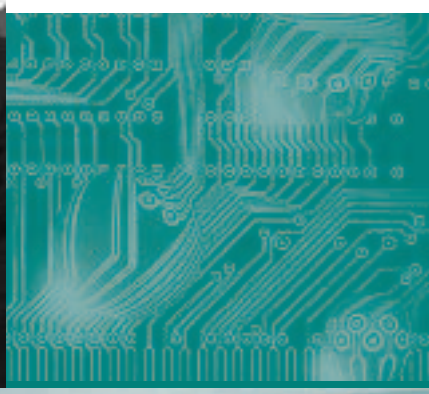
"One of the very first assignments I successfully carried out during my career at MAE", she points out, "was the agreement between Italy and UNESCO, which ratified that TWAS and IAP, the global network of science academies, should be headquartered in Trieste. The agreement also stated that the Italian government should provide, on an annual basis, a mandatory financial contribution to cover the operational costs and the costs for the promotion of their activity worldwide. I immediately realized TWAS's potential and the importance of its focus, at a time when the Academy was still in its infancy. Now TWAS is always on my agenda, and the successful achievements of this organization tell me I was right in my judgement."

Their keen understanding has been a driving force to improve the quality of research.

Pannone, who holds a *Laurea* in philosophy and a master's degree in epistemology from Sapienza University in Rome, is a scientific expert in MAE's Bilateral and Multilateral Scientific and Technological Unit. Her institutional role has brought her into close contact with many diplomatic headquarters in Europe, in the Mediterranean region and Middle East, where she scouts for scientific excellence and then promotes it.

"Promoting science and research worldwide, but especially in developing countries, is an investment", she explains. "We fuel the deployment of international networks, and through multidisciplinary approaches we enrich each country with skills and competences. TWAS is the voice of the South for the South, and its activity must be seen as a precious tool that helps to create win-win situations where all the actors have access to international research and receive benefits. In addition, science is a peace-keeping tool."

Pannone was cited for "her continuous commitment in enhancing the special relationship between Italy and TWAS in support of science in the developing world."



Above: Fu Shuqin accepts her award. Right: Fu receives her award. (Photos: Cristina Serra)

Fu Shuqin was honoured for her "continued commitment in enhancing scientific collaboration between developing countries, and especially between the Chinese Academy of Sciences and TWAS".

Fu joined the Chinese Academy of Sciences as a programme officer in 1983, and she has helped to forge a close and constructive bond between TWAS and China's powerhouse academic institution and R&D centre. She was among the leaders in the 2003 establishment and later operations of the TWAS Regional Office for East & Southeast Asia.

She set up the office in a way that has guaranteed a smooth workflow. Among her duties were the coordination of international workshops and the implementation of the CAS-TWAS fellowship programme; the promotion of the associateship scheme at centres of excellence in the South; and, in general, building and maintaining positive relationships between China and TWAS.

And it is no coincidence that two TWAS General Meetings have been successfully organized in China, in 2003 and in 2012, at a time when Fu Shuqin was heading the general organization of what is certainly the most important event in the Academy's year.

Promoting science worldwide is an investment in people – and peace.

"One rewarding aspect of my collaboration with TWAS", recalls Fu, "was working in close contact with TWAS scientists from different countries. I broadened my personal perspectives." Her kind manners and professional approach have been praised by TWAS fellows and others in the Academy's extended global family, and by colleagues at TWAS's headquarters in Trieste, Italy, who value her reliable assistance and cooperative spirit.

In view of her excellent management and contributions, Fu is now working as consultant to the TWAS regional office in China. "I have good memories from the times spent working with TWAS colleagues", she said. "And I am glad I could serve the CAS-TWAS mission for so many years, giving my personal contribution to the promotion of science as a tool for development and peace." ■

Cristina Serra

PRIZES HONOUR WORK ON HEALTH, POVERTY

HIGH-IMPACT VACCINATION PROGRAMMES. REACTORS TO PURIFY DRINKING WATER. A DATABASE THAT ILLUMINATES THE CAUSES OF POVERTY. THREE HIGHLY FOCUSED PROJECTS CARRIED OUT BY SCIENTISTS FROM THE DEVELOPING WORLD WON HIGH HONOURS AT THE TWAS GENERAL MEETING.

In a rapidly changing world where the rise of global economy is aggravating gaps between nations, goals such as mass vaccination, safe drinking water and poverty alleviation become a priority. Three different projects addressing these problems were selected for international recognition during the 24th TWAS General Meeting held in Buenos Aires.

Firdausi Qadri, the director of the Centre for Vaccine Sciences at the International Centre for Diarrhoeal Disease Research in Bangladesh, was awarded the C.N.R. Rao Prize for Scientific Research. The prize, named after TWAS Founding Fellow and former president C.N.R. Rao, acknowledged Qadri's highly focused determination in achieving widespread vaccination plans against a disease common in her country.

Bangladeshi scientist Mohammad Abdul Hasnat, the recipient of the Atta-ur-Rahman Prize in Chemistry, was honoured for building a special reactor able to get rid of dangerous water-dissolved chemicals. Access to clean water in South, West and Central Asia is an urgent problem, affecting almost 200 million people. By establishing this prize, world-renowned organic chemist Atta-ur-Rahman, president of the Pakistan Academy of Sciences and former TWAS vice president, meant to encourage young chemists to pursue original investigations at the interface with other disciplines.

Brazilian economist Ricardo Paes de Barros was awarded the Celso Furtado Prize, named for the late Brazilian economist and intellectual. The prize recognizes social scientists who have lived and worked in a

developing country for at least ten years. It was assigned to Paes de Barros for his efforts to illuminate and alleviate poverty and inequality in Brazil, and for his advocacy of the need to refine public policies to address these two conditions more efficiently.

QADRI: VACCINES FOR ALL

Qadri, the Rao Prize winner, has devoted more than 25 years of her career to the study of infectious diseases. Her passion and knowledge of the immunological basis of infections have led her to identify factors that affect children's response to oral vaccines, especially in developing countries.

Bangladeshi chemist Mohammad Abdul Hasnat (centre) accepts the Atta-ur-Rahman Prize in Chemistry at the 2013 TWAS General Meeting.
Facing page: C.N.R. Rao Prize winner Firdausi Qadri discusses her work. Far right: Bai, Qadri, Barañao and Salvarezza. (Photo: Roque Silles)

"Nutrition and inadequate hygienic measures promote enhanced susceptibility to infectious disease", she explains. "Toxin-producing strains of *Escherichia coli*, a bacterium whose healthy cousins live in our guts, and other dangerous pathogens such as *Vibrio cholerae* represent a major burden in Bangladesh, especially for children. That's why it is urgent to devise new diagnostics and innovative therapies. But it is likewise important that we make better use of existing drugs."

By working in close collaboration with international organizations and merging disciplines such as immunology, genomics and proteomics, Qadri has collected data that prompted her to actively advocate mass vaccinations against cholera and typhoid fever.

"Every year between 100,000 and 300,000 people die of *E. coli*-associated diarrhoea, and 100,000 of cholera worldwide", she said in a recent interview.

Qadri, who sits in international councils such as the Bangladesh Academy of Science, the Infectious Disease Society of America and on the advisory panel of the World Health Organization, is the promoter and coordinator of the project 'Introduction of Cholera Vaccine in Bangladesh'. The project is funded by the Bill and Melinda Gates Foundation and advocates the introduction of a low-cost oral vaccine.

Her scientific contributions to the clarification of the dynamics of such enteric infections as those caused by *Vibrio cholerae*, *Helicobacter pylori* and *Salmonella typhi* are internationally acknowledged. Her past honours include the Gold Medal from the Bangladesh Academy of Sciences, in 2008, and the *Institut de France*'s and Rodolphe Mérieux Foundation 'Grand Prize' in 2012.

HASNAT: PURIFYING H_2O

A chemist by training and by passion, Hasnat won the Atta-ur-Rahman Prize in Chemistry for building an innovative reactor to remove nitrates from drinking water.

In the last 200 years, human activities have unbalanced the natural nitrogen equilibrium existing between air, soil and water. Massive atmospheric release of nitrogen has caused this element to accumulate in water through precipitation. Water pollution by nitrogen compounds may cause the 'Blue Baby Syndrome' triggered by the conversion of nitrates into nitrites by an infant's digestive system.

"This chemical reaction is particularly dangerous", explains Hasnat, "because nitrites then react with blood haemoglobin turning it into methaemoglobin" with the effect that the blood is "no longer able to carry oxygen."

He has created a reactor to purify polluted water by exploiting an electrochemical reaction that makes nitrates flow towards absorbing membranes. This process, ultimately, removes the noxious substances from the water.

"The reaction is quite selective towards nitrates", he explained, "as it leaves in place other minerals that are useful for the human body."

Hasnat carried out his first investigations at the University of Dhaka, Bangladesh, from 1997 to 1999, and soon became an expert in chemical reactions called catalysis, where specific substances, or catalysts, are used to increase the speed of the chemical reaction.

The Atta-ur-Rahman Prize, with an award of USD5,000, is the latest in a series of scholarships and honours Hasnat has received since 1984. Along with his lab work, Hasnat is also a busy mentor. To date, he has supervised 15 PhD students, helping them to publish in peer-reviewed journals.

PAES DE BARROS: OPPONENT OF INEQUALITY

Extreme poverty and a lack of opportunities limit the lives of people in Latin America and throughout the developing world. And in some conditions, they can undermine the strength of a democratic political system.

Urged by professional curiosity, he has spent some time abroad, carrying out research at the Indian Institute of Technology in Madras (2001) before moving to Japan's Kumamoto University (from 2006 to 2009), where he earned a PhD working on the optimization of reactions aimed at nitrate reduction. Then he spent time at Leiden University in the Netherlands before moving to Professor Norita Mohamed's lab at *Universiti Sains Malaysia* in Penang in 2011 to investigate metal recovery from waste.

His latest interest is new sensors which he is trying to build after acquiring expertise as a visiting fellow at the University of Bath in the United Kingdom.

In a rapidly changing world, mass vaccination, safe drinking water and poverty alleviation are a priority.

Ricardo Paes de Barros, the secretary of strategic actions at the Secretariat of Strategic Affairs of the Presidency of the Republic in Brasilia, Brazil, has been trying to address inequality for decades, with a special attention to the situation in his home country.

For his careful and passionate studies and for his achievements, Paes de Barros has been selected as the first-ever winner of the Celso Furtado Prize in Social Sciences. TWAS established the prize in 2012 to honour the late Brazilian economist Celso Furtado who had committed himself to help poor people in South America and to promote economic strategies to sustain and advance "peripheral economies".

Ricardo Paes de Barros, left, winner of the TWAS-Celso Furtado Prize in Social Sciences, accepts his prize for work on understanding poverty, economic inequality, and public policies. Right: Paes de Barros discusses his work. (Photos: Roque Silles)

Paes de Barros has spent most of his late career pursuing goals that are in line not only with Furtado's vision, but with TWAS's mission as well. However, his research on economics started later in his life.

After graduating in electronic engineering in 1977 at the *Instituto Tecnológico de Aeronáutica* in São José dos Campos, Brazil, Paes de Barros in 1982 earned a master's degree in statistics at the Institute of Pure and Applied Mathematics in Rio de Janeiro. In 1987, he obtained a PhD in economics from the University of Chicago and then spent six years at Yale University, USA, as a visiting professor, from 1990 to 1996. There, he developed his passion as an advocate of poor people and opponent of inequality.

We need to harness science to fight for health and against poverty.

Paes de Barros' clear vision of Brazilian society helped him shape a new trend in his country's public policy. He has promoted a more conscious engagement of Brazilian policymakers in social matters. In addition, he has devised a set of formulas to measure inequality of opportunities systematically, in particular among children.

Children not only suffer for circumstances that are beyond their control, such as gender, age and birthplace. They are also affected by the lack of access to education and to clean water.

His most famous book is *Measuring Inequality of Opportunities in Latin America and the Caribbean*, written with Francisco H. G. Ferreira, J.R. Molinas Vega and Jaime S. Chanduvi and published by the World Bank and Palgrave Macmillan in 2009. In this book, he and his co-authors examine inequality in seven Latin American countries. By unifying data across services, children and circumstances, the authors determine how equitable (or not) a society is.

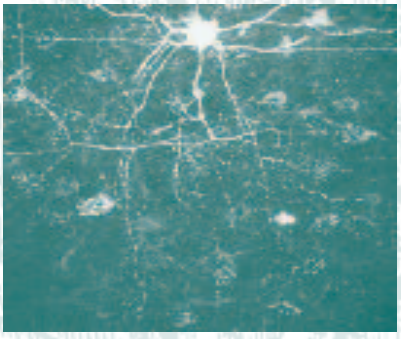
Their analysis makes use of the 'Human Opportunity Index', a measure of the absolute level of basic opportunities in a society. The Index examines how many opportunities in terms of basic services a child has, and how equitably these opportunities are distributed. Using data representing some 200 million children and spanning roughly the last decade, Paes de Barros and colleagues built a comprehensive picture for each of the 19 largest Latin American countries.

Before this work, no one had devised systematic measures to summarize the level of inequality of opportunity observed in Latin America. Now, researchers may be able to explore with greater precision how children's personal circumstances influence their access to services that are necessary for a productive life. ■

Cristina Serra

BEAUTIFUL, COMPLEX AND MYSTERIOUS

ARGENTINIAN NEUROSCIENTIST FRANCISCO BARRANTES HAS SPENT A CAREER BRINGING THE FINEST DETAILS OF THE NERVOUS SYSTEM INTO SHARP FOCUS. ADVANCED TECHNOLOGY PROVIDES NEW INSIGHTS, HE SAYS, BUT MANY MYSTERIES REMAIN



After decades of research and investment amounting to billions of dollars, some of the basic workings of the human brain still remain a mystery to science. Brain diseases and disorders are especially frustrating, because they cause profound pain and loss in communities all over the world.

What causes Alzheimer's disease? What is the chemistry of addiction? Why do schizophrenics often have auditory hallucinations, and how can the symptoms be eliminated, or at least controlled?

TWAS Fellow Francisco J. Barrantes, an Argentinian neuroscientist, has contemplated these questions through a research career spanning four decades and four continents. The mysteries of many disorders remain locked tight, he says, but as imaging technology improves, science is acquiring insights that may someday yield important advances.

The challenge is fundamental. "The brain is by far the most complex machinery known in the universe, far surpassing – by many orders of magnitude – the most advanced supercomputers", Barrantes says. "A small galaxy contains in the order of 100 billion stars. Our cerebral cortex… contains approximately the same number of neurons as the number of stars in a small galaxy."

But some 5,000 synapses make contact with every neuron, he said, and the varied chemical components of each neuron add a further dimension of complexity.

Barrantes heads the Laboratory of Molecular Neurobiology in the Biomedical Research Institute at the Pontifical Catholic University of Argentina. He was elected a TWAS Fellow in 1991, and today serves as the Academy's vice president for Latin America; he was named to deliver one of three TWAS Medal Lectures at the Academy's 2013 General Meeting in Buenos Aires.

While brain diseases challenge researchers in the world's most advanced laboratories, he said, it is essential that scientists in the developing world join in the pursuit of knowledge that can lead to treatments, and perhaps cures.

"I think developing nations need to develop their own skills in all disciplines of human knowledge", Barrantes said in the interview. "Neuroscience is no exception. I feel the ability to pursue research in neurosciences sometimes can be accomplished with simple tools, which even the lesser-developed countries can tackle. I think this is a very important concept that has to be told to our youngsters in developing nations: try to tackle any kind of questions, and don't be afraid of facing apparently insurmountable tasks."

As imaging technology improves, science is acquiring insights that may someday yield important advances.

AN EARLY START IN NEUROSCIENCE

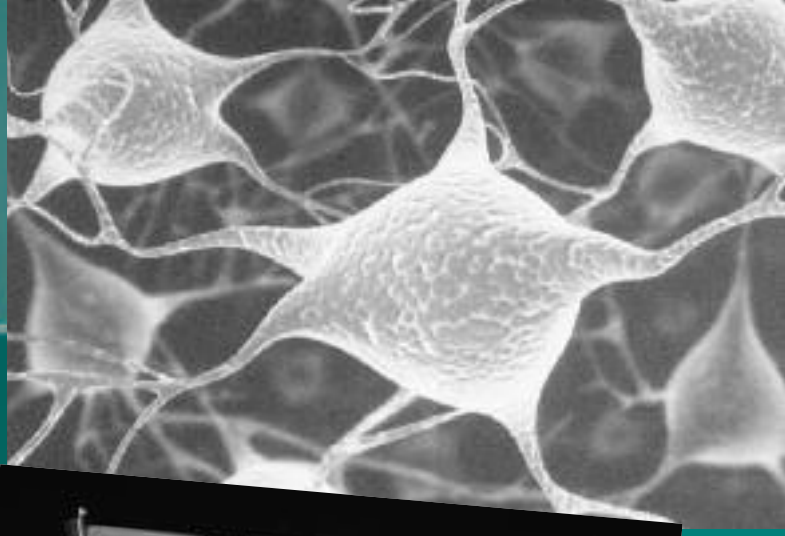
Barrantes' mother was an obstetrician, and his father was a gynaecologist, and he too initially set a course for a career in medicine. But by his second year of medical school in Buenos Aires, he was already a teaching assistant in neurobiology under Eduardo de Robertis, a pioneer of electron microscopy and neuroscience. De Robertis had been one of a small international team that revealed the structure of the synapse in 1954, in a pioneering paper in the *Journal of Cell Biology*.

"I knew that my destiny was in science – I was going to be a basic scientist, not a practicing MD", Barrantes says now. "Neuroscience came very early in my life, and I loved the idea of doing research."

That was the start of a rich, high-impact research career. After earning his PhD in 1973 at the University of Buenos Aires, he spent nine years at the Max Planck Institute for Biophysical Chemistry in Germany, serving for nearly five years as the joint head of the Membrane Biophysics Group. He has had research posts and visiting professorships in Europe, the United States, India and Israel, but has been based back in Argentina since 1983. He formerly served as director of the Bahia Blanca Science and Technology Centre of the Argentinian national research council *Consejo Nacional de Investigaciones Científicas y Técnicas* (CONICET) and as director of the Institute of Biochemistry there. He remains a top-ranked researcher at CONICET, and holds the UNESCO Chair of Biophysics and Molecular Neurobiology.

DEEPER AND DEEPER INTO THE BRAIN

During his 40-minute TWAS Medal lecture at the General Meeting, Barrantes offered an eloquent tour of the brain, with a mix of knowledge and passion that could engage both scientists and a general audience.



From left: TWAS Vice President Francisco Barrantes at work; Barrantes discusses the science of the human brain at the 24th TWAS General Meeting; former TWAS President C.N.R. Rao, Barrantes and former TWAS President José I. Vargas. Above: Barrantes's award. (Photos: Roque Silles)

Starting from the cerebral cortex cellular organization, he focused in on smaller and smaller units of the brain's complex system. Glial cells, which support and protect neurons. Neurons, the "extremely exquisite" and excitable cells that transmit information through electrical and chemical signals. Dendrites, the arborisations of neurons, covered in thousands of nanoscale protrusions called spines, where excitable synaptic contacts occur. The synapse is a main element of information flow, traffic and storage in the brain, Barrantes explained, and in those spines there are thousands of different proteins that serve as signalling enzymes, receptors and fulfill other functions. Synapses conduct chemical or electrical signals between neurons and other cells.

"The operation of the brain can be envisaged as a multi-stratified time-dependent system, which involves genes, molecules, cell, networks, and the whole brain", he said. "The brain's performance is exceptional. Light and sound are sent chemically to regions of brain, where they are processed by complex mechanisms. Sometimes – but not always – they become conscious."

And when that happens, functional magnetic resonance imaging shows the result: "The whole brain lights up."

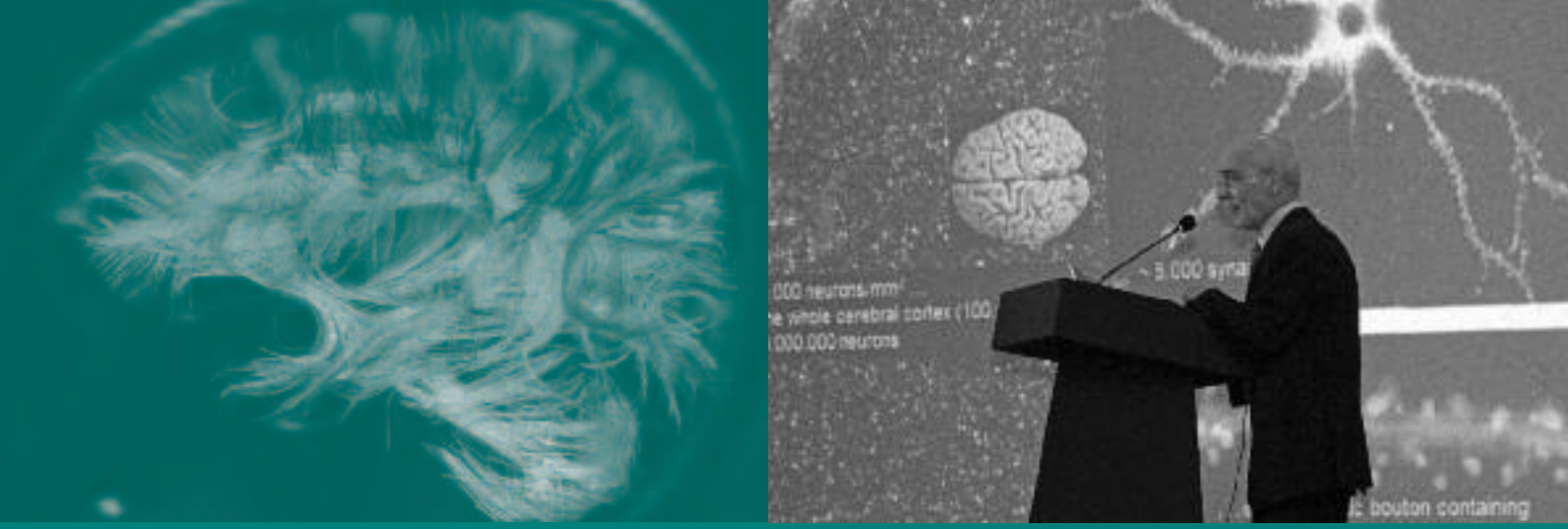
Why is the brain so complex?

"Probably for two reasons", Barrantes said in the interview after his address. "One is because of the sheer numbers involved – the number of connections that we have. The static view would put complexity at the level of the 1015 different synapses in the brain, especially human brains. And the second thing is the dynamics – the fact that the connections as we speak are modifying… When we sleep, we reshape, we destroy, we redo, and our dreams convey new connections. We reconnect and disconnect, and as we age we destroy at an accelerated rate. This makes establishing the connectivity not only a daunting challenge, but it seems an impossible task."

READING THE BRAIN IN ACTION

That's where technology becomes so important. With the best conventional microscopes, researchers can see that the dendrites appear like tiny buttons on the top of the neuron. But researchers around the world are working to surpass existing limits and achieve 'super-resolution' in brain imaging.

For example, Barrantes explained, electron microscopy, also called nanoscopy, is allowing researchers to



Left: Nerve fibres traced by diffusion spectrum imaging, from Barrantes's presentation (J. Bordin, Nature, *2012). Right: Francisco Barrantes discusses the brain during his lecture at the TWAS General Meeting. (Photo: Roque Silles)*

see the process of synapses with much more detail – and to understand them better. His group in Buenos Aires is using super-resolution microscopy to look at brain processes at the molecular level, for example by assessing clusters of synaptic receptor molecules in living neurons.

Researchers at the Max Planck Institute in Germany have successfully pushed super-resolution to a new power, so that they can look at the behaviour of neurons in a whole animal. Using stimulated emission depletion fluorescence nanoscopy, they have been able to see, with amazing clarity, "spines along the dendrites dancing in a live mouse", Barrantes said. "This is a really major accomplishment."

EASING THE TOLL OF BRAIN DISEASE

Disease strikes various parts of the brain. Some of the disease is organic, and some is genetic. To varying degrees, brain disease can be influenced by environmental factors. Taken together, however, the toll is enormous. According to Barrantes, the burden of these diseases is now "far greater than all the communicable diseases put together."

The more powerful new methodologies in the basic neurosciences imaging technology could play a strong role in research on many of these pathologies.

Alzheimer's disease and other pathologies may result from 'cross-talk' malfunctions between neurons. Other diseases directly target specific types of neurons; amyotrophic lateral sclerosis (ALS), the most common of five motor neuron diseases, is devastating and finally deadly to those afflicted.

Autism spectrum disorders and addiction also appear to result from synapse disorders. Schizophrenia may be a disease resulting from an interplay of genetics and environment, with malfunctions in multiple neural circuits and networks.

That gives rise to a central, intriguing hypothesis in Barrantes' recent work. A key problem in neuroscience is the accurate storage of information in densely packed synapses; cross-talk and breakdowns in storage functions may be at the root of a number of brain pathologies having in common alterations in cognition and memory.

Barrantes is reluctant to predict that neuroscience will solve these complex diseases in the near future. Perhaps there will be significant advances in treatment to ease some of the symptoms. But the effort will go on – and, he says, young scientists in the developing world must invest their energy in this important work.

"The inherent complexity may preclude some young people from getting into the neurosciences", he concludes. "But once we convince the young people, people at the age of secondary school… neuroscience in particular offers the ability to understand the way we function at higher levels, and to understand the world with a different perspective. I think that is something that can have a very positive impact." ■

Edward W. Lempinen

IT'S IMPORTANT FOR YOUNG SCIENTISTS TO WORK OVERSEAS, SAYS INFLUENTIAL BRAZILIAN PHYSICIST LUIZ DAVIDOVICH. AND IT'S IMPORTANT THAT THEY RETURN HOME TO STRENGTHEN THEIR NATIONS AND THEIR PEOPLE.

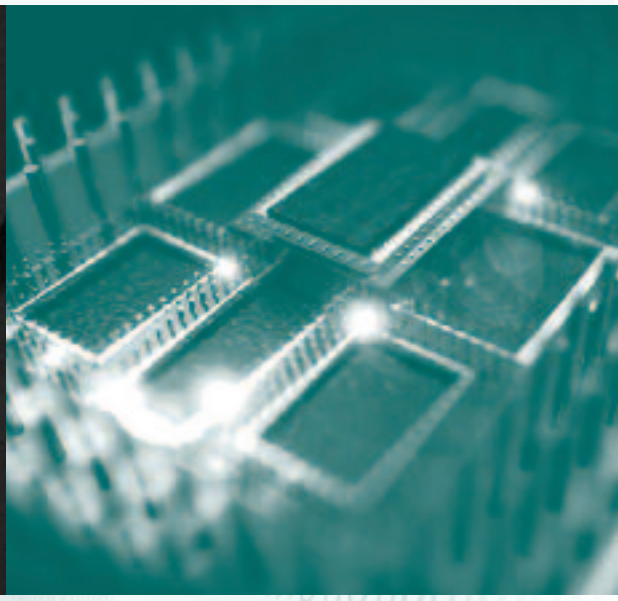
Luiz Davidovich is the personification of an international science scholar. Born in Brazil. PhD in the United States. Visiting positions in France, Germany and the UK. Member of national science academies in Brazil and the US. Along the way, though, he learned an important lesson: Physics is "a universal endeavour", so a young scientist from the developing world needs the experience and networks that come from working overseas. But back at home, "there is much to build, there are big challenges, and they should be part of it."

LEAVING HOME, AND GOING BACK AGAIN

Elected a TWAS Fellow in 2002, Davidovich today is a professor of physics at the Federal University of Rio de Janeiro. During the TWAS General Meeting in Buenos Aires, Argentina, he organized a symposium on quantum information and quantum computing with 2012 TWAS Fellow Pan Jian-Wei, a professor at the University of Science and Technology of China. Later, in an e-mail interview with TWAS Public Information Officer Edward Lempinen, Davidovich emphasized the importance of physics for the developing world, and the social responsibility of physicists and other scholars.

Growing up in Brazil in the 1950s and '60s, how did you come to realize that you wanted to pursue research in physics? Along the way, did you encounter important encouragement or significant obstacles?

In middle school, I decided to take a correspondence course on the topic of radio, TV, and electronics, which involved building radios and amplifiers, and got me curious about the 'inner workings', about what was going on inside the electric wires, electronic tubes and transistors. I also enjoyed very much mathematics, but the big push towards physics came when I started to read books on physics written for the general public. I remember one by Einstein and Infeld, and also books written by George Gamow.



From left: Mohamed H.A. Hassan, Jacob Palis, Luiz Davidovich. (Photo: Peter McGrath)

I was afraid, however, that physics would not be economically viable as a profession, so I took entrance exams for both engineering and physics courses. I passed both, but after two weeks I got convinced that I should follow my heart and plunge into physics, thanks also to a wonderful undergraduate physics teacher.

You received your PhD in the United States and did additional work in Europe. Many top physicists from the developing world chose to make their careers in the developed world. Why did you return to Brazil?

I went back to my roots. As a student, I was very much involved in the movement against the military dictatorship (the result of a military coup in 1964, one year before I entered university). Participation in a movement like that changes you on a permanent basis. You get aware of the responsibility of each citizen in the development of society, in the establishment of democracy, in the reduction of inequalities. After my stay abroad, I thought that, through my work as scientist and professor, I could have a much higher social impact in Brazil than in the United States or Europe. Family and friendship ties also played a very important role.

At the TWAS General Meeting in Buenos Aires, you organized a symposium on quantum information and quantum computing. Does research in those fields have applications of specific value for the developing world?

Research on quantum information and quantum computing may have important applications, useful for both developed and developing worlds. One possible application is quantum cryptography, that is, securing the transmission of information. One envisages also the possibility of having efficient computers that may realize certain tasks faster than classical computers (like, for instance, databank search), and simulate efficiently complex systems (an idea introduced in the 1980s by Richard Feynman, Nobel laureate in physics).

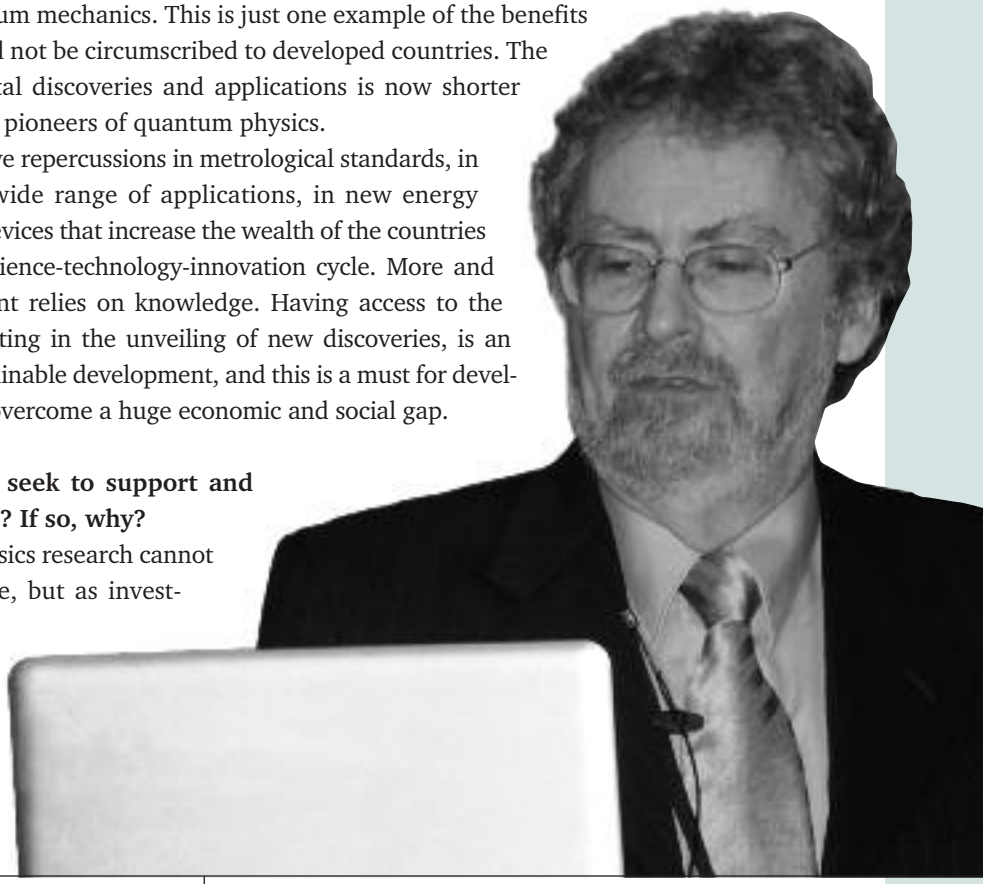
As recent facts have indicated, securing communications is a universal concern nowadays, and one cannot depend on the technology developed in other countries for that purpose. But there are other concerns, of a more general nature. It is very important that all the countries have the possibility to have access and contribute to the frontiers of knowledge. More than ever, they are intimately connected to economic and political power. One often thinks about short-range applications of scientific research, however unexpected applications of basic research have promoted technological revolutions that have deeply affected our quotidian.

Often, when people think of science and its importance for the developing world, they think of science with specific applications – for agriculture and health, for example. Physics, on the other hand, seems esoteric and abstract. In your view, is it important for developing nations to build expertise in physics? If so, why? Are there particular applications that are valuable?

When a bright group of young physicists developed quantum physics in the beginning of the 20th century, they did not have the least idea of what would be the application of that new and revolutionary view of the world. Their aim was to understand nature, to marvel at the subtleties of the microscopic world. None of them could imagine that their work would allow the development of new technologies that have had a strong impact on our quotidian life, like the laser, semiconductors in computer chips, magnetic resonance imaging in hospitals, atomic clocks, the GPS system.

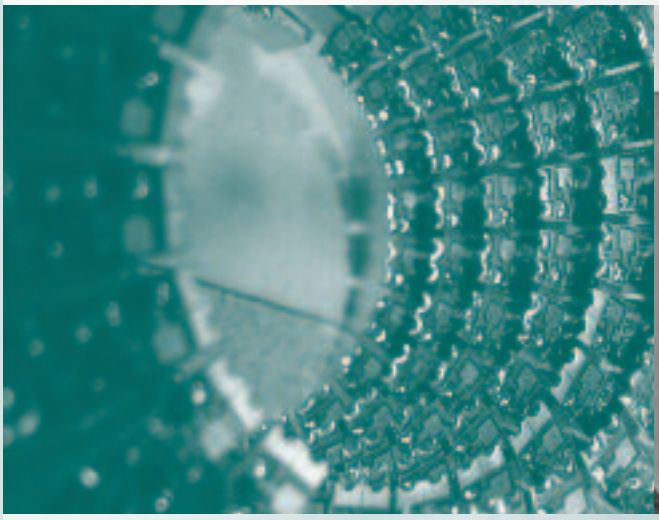
In 2001, Max Tegmark and John Archibald Wheeler estimated, in an article published in *Scientific American*, that about 30% of the US gross national product is based on inventions made possible by quantum mechanics. This is just one example of the benefits of basic science, which should not be circumscribed to developed countries. The distance between fundamental discoveries and applications is now shorter than it was at the time of the pioneers of quantum physics.

Basic results in physics have repercussions in metrological standards, in new materials that have a wide range of applications, in new energy sources, in high-technology devices that increase the wealth of the countries that support the full basic science-technology-innovation cycle. More and more, nowadays, development relies on knowledge. Having access to the frontiers of science, participating in the unveiling of new discoveries, is an essential ingredient for a sustainable development, and this is a must for developing countries that need to overcome a huge economic and social gap.



Should government policy seek to support and encourage physics research? If so, why?

It is clear that support for physics research cannot be considered as expenditure, but as investment, one of the most profitable ones. Huge returns of this investment come in the form of innovations that benefit society as a whole.



Can you point to any specific cases where physics research has had a beneficial human and/or economic impact for nations or regions in the developing world?

There are many examples. In Brazil, for instance, physicists working with lasers have had a strong impact on medical applications, including photodynamic therapy of cancer and dentistry. A synchrotron light source, developed in Campinas under the leadership of physicists, has been used not only for basic research but also for applications that have benefited Brazilian companies, from reducing the viscosity of oil and the development of new materials for the cable anchoring of oil platforms in deep water, to the control of citrus disease.

In addition to these specific examples, one should note that the outcomes from basic quantum physics, mentioned before, also play an important role in several sectors of activities in developing countries, which use semiconductors, lasers, magnetic resonance devices, GPS etc. Access to the newest technology would be easier, and money for imports and royalties could be saved, if these developing countries had a participation in the development of these devices.

For a student in the developing world who is interested in physics as a career, is it necessary to go overseas to study or to work?

Right now, many developing countries have high-level graduate schools, so it is not necessary in these countries to go overseas in order to get a PhD. It is important, however, to have the experience of working in other countries, either before the PhD or as a postdoc. Physics research is a universal endeavour, so international contacts and communication are an important part of it.

For those who do go overseas, would you advise them to return home, as you have done?

I would certainly advise them to return home, so as to reinforce the scientific capacity of their country. The impact of their work would be much bigger in their home country, the level of influence on the definition of scientific and educational policies much higher than what they could have in a developed country. There is much to build, there are big challenges, and they should be part of it. This does not hinder intensive contacts with the worldwide scientific community, made possible by several financing mechanisms, and necessary to keep up to date with the frontiers of research. ■

SCIENCE DEFINITELY IS NOT BORING

DIEGO GOLOMBEK, ONE OF LATIN AMERICA'S MOST INFLUENTIAL SCIENCE COMMUNICATORS, HAS A MESSAGE FOR RESEARCHERS EVERYWHERE: ABANDON JARGON, EMBRACE ENTHUSIASM – AND PLEASE, NO MORE POTTED PLANTS

When Diego Golombek thinks about contemporary science communication, he thinks about Napoleon's invasion of Russia in 1812 – and his epic defeat on the frigid Russian plains.

Napoleon had assembled an extraordinary multi-national army, 600,000 men in all, and marched east with the hope of conquering the Russian empire. But the French commander was surprised at what he found: a vast emptiness. The Russians had pulled away from his army, yielding the countryside but luring the invading troops into a wintry trap. The rest, of course, is history.

"That's the way we try to communicate science", Golombek said during an interview at the 2013 TWAS General Meeting in Buenos Aires. "We gather the most fabulous army that humankind has invented, this very powerful scientific thinking, and we go out with our torch of knowledge – and nobody is there."

Napoleon in effect defeated himself – and, says Golombek, scientists often do the same. "When scientists run a TV show, the usual format is to have a long table, with a plant if possible, because it's nice to have a plant, and two people talking. And that's absolutely *boring*. Nobody will watch a show with two people talking at a long table with a plant."

In fact, Golombek told the TWAS audience, science is inherently interesting, even exciting, and there's enormous public interest. But it's up to scientists to understand what interests different audiences and to tell the story with verve and flair. That means good writing, good images, film and music, even fiction. It means sharing a view of the hard work, excitement and even the humour of discovery.

Golombek, a neuroscientist and high-profile science communicator, was one of five scientists in the developing world to be awarded a TWAS 2013 Regional Prize

TWAS 2013 REGIONAL PRIZE WINNERS

Every year, each of TWAS's five regional offices awards a USD3,000 prize to scientists in one of three areas: popularization of science, development of scientific educational material, and building scientific institutions. In 2013, the TWAS Regional Prize was in popularization of science.

The winners:

- *For Latin America and the Caribbean: Argentinian neuroscientist and author* ***Diego Golombek****, a professor at National University of Quilmes and a researcher at Argentina's national research council,* Consejo Nacional de Investigaciones Científicas y Técnicas *(CONICET). He has written numerous books and developed television shows with broad public appeal.*
- *For Central and South Asia: Bangladeshi nuclear physicist* ***Mohammad Shamsher Ali****, who has worked as a science communicator for over 30 years in radio and television, including a series on BBC.*
- *For East and South-East Asia and the Pacific: Neuroscientist and molecular biologist* ***Custer C. Deocaris*** *of the Technological Institute of the Philippines (TIP), a creative and prolific communicator. He hosts and produces Radyo Agila's* Pinoy Scientist*, an award-winning weekly nationwide science radio programme in his home country.*
- *For sub-Saharan Africa:* ***Anusuya Chinsamy-Turan****, a palaeobiologist who leads the Department of Biological Sciences at the University of Cape Town, South Africa. Besides authoring two academic books, Chinsamy-Turan has written a popular children's book,* Famous Dinosaurs of Africa, *and served as the chair of the advisory board for Scifest Africa.*
- *For the Arab Region:* ***Farid A. Badria*** *of the Mansoura University Faculty of Pharmacy in Egypt, who has been deeply influential in the development of Egyptian medicine, with over 100 publications and 16 patents.*

in the field of popularization of science. Because the TWAS General Meeting was held in his home country, he was invited to give an address on the closing day of the conference.

The talk was wide-ranging, sometimes provocative, and always engaging. To illustrate his message about the value and techniques of effective science communication, he cited not only Napoleon, but rock-and-roll legend John Lennon; 19th century writer Edgar Allan Poe and 21st century modernist Michel Houellebecq; and C.P. Snow, whose own work straddled the worlds of art and science.

Golombek's career started early. By the age of 15, he was writing about sports and culture for a Buenos Aires newspaper. As his studies advanced, he gravitated toward science.

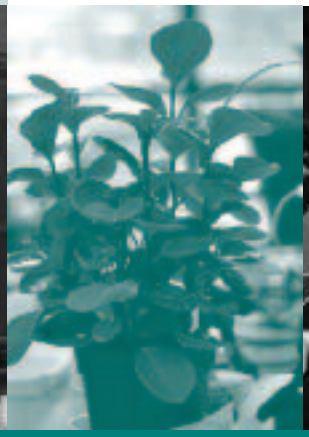
"I have no idea why", he said in an interview. "It did not go very well when I first started. But then something happened and I started loving it. Probably when I started learning about the brain. And then I got the opportunity of putting those two worlds together – the worlds of communication and science – and that was the best."

Today, Golombek is a professor at National University of Quilmes and a researcher at Argentina's national research council, *Consejo Nacional de Investigaciones Científicas y Técnicas* (CONICET). He heads the chronobiology lab at Quilmes, and continues research into circadian rhythms – the changes experienced by most living things during the daily cycle of light and darkness. But his high public profile has come from advancing popular science in books and on television shows.

In his presentation at the TWAS General Meeting, Golombek stressed that researchers have a responsibility to communicate science because communication advances science – and because public funds often pay for their research.

He acknowledged that science can be difficult to communicate. While the material can be complex and technical, news coverage tends to simplify and usually doesn't allow for historical context. Plus, research advances often don't relate directly to the daily experience of the audience.

Even so, Golombek says those challenges don't excuse uninspired coverage – they simply require sci-



From left: The Emperor Napoleon in His Study at the Tuileries, by Jacques-Louis David, 1812 (Source: Wikipedia); Good science communications needs more than a potted plant. (Photo: Flickr/Demetri Mouratis); Diego Golombek, left, with TWAS Council Member Farida Shah of Malaysia. (Photo: Roque Silles)

entists and science journalists to work more effectively.

Certainly some scientists communicate well. But there's a risk: If they do it too well, like the iconic scientist-writer-TV personality Carl Sagan, they can be dismissed by the science community as insufficiently serious. On this point, his critique of conventional science culture is unsparing.

Science could communicate – it could *inspire* – by using more creativity to connect with a broad audience. Unfortunately, "we tend to forget about those possibilities because… science is *solemnerious*", Golombek says. "But that's not true. People will not read something that's written in jargon, or when it's not written in a literary way. When we do it well, the audience is there.

> ***Researchers have a responsibility to communicate science because communication advances science.***

"If you go into a lab, it's really a vivid place. People laugh and tell jokes and listen to music and work a lot, and they are often very enthusiastic. Why, when we communicate science, can we not communicate that enthusiasm?"

Could it be that many scientists secretly enjoy being difficult? He ticks off a quick list of jargon words and phrases: 'connectome', 'proteomic' and others. "We love to talk when nobody understands us. It makes us feel important. But that's wrong – it's not the way to communicate with our audience."

Golombek sees one sector of the audience as particularly important, but often overlooked – youths aged 12 to 15. Research suggests that those are the years when many young people decide on a career in research or technology. To reach them, and to reach many audiences, it may be more effective to talk about the science of everyday life – the science of sport and romance, for example, of cars and computers. Once they're interested, they may be more willing to learn abstract chemistry.

Among established scientists, the reaction to Golombek's message is mixed, though he says that younger scientists tend to be more open to these ideas. And with increasing frequency, he said, science journalism is more open to new ideas, too. Science coverage in Latin America is more sophisticated than ever; there's better education and training available for science journalists, and more outlets for their work. Argentina recently debuted Latin America's first television station devoted to science.

Which reminds Golombek of an anecdote. Albert Einstein visited Argentina in 1925, at the invitation of a newspaper. "The guy who accompanied Einstein was the paper's sports journalist", he says. "Of course – because the newspaper assumed that nobody would understand Einstein anyway. But today that wouldn't happen. You would have a professional science journalist." ■

Edward W. Lempinen

IN A NEW DOCUMENTARY, *SEEDS OF SCIENCE*, ITALIAN FILMMAKER NICOLE LEGHISSA EXPLORES HOW RESEARCHERS IN KENYA ARE TRANSFORMING FARMS, LABORATORIES, COMMUNITIES – AND PEOPLE'S LIVES.

It is not a sentimental film, nor does it deal in stereotypes. You won't see sick children or graphic images of extreme poverty. Rather, *Seeds of Science* is a candid, grassroots look at challenges facing communities in Kenya, and how work by four African scientists is developing solutions that improve farm production, reduce the need for toxic agricultural chemicals and provide clean water.

THE HUMAN FACE OF TWAS IN AFRICA

What is striking about *Seeds of Science*, above all, is its vibrant humanity. Nicole Leghissa, a filmmaker based in TWAS's home city of Trieste, spent time in the summer of 2013 in the Kenyan countryside and in the capital, Nairobi. She talked with people who are growing maize, trying to feed their families; she interviewed local teachers and students, and people who worry that tainted water is making them sick. And she looked at the work of four scientists who are making a difference. Each of the researchers is supported by TWAS, one with a PhD fellowship, another with a research grant, two others with prizes that recognized their important work.

"TWAS has given me legs to start walking", is Peterson Momanyi Guto's heartfelt comment. Guto is currently a lecturer at University of Nairobi, in the department of chemistry. Along with his team, he regularly performs chemical analysis of the water from Nairobi River, which causes health problems in the local population due to the contaminants it contains.

The other three Kenya-based scientists, Zeyaur Khan, Vitalis Wafula Wekesa and Segenet Kelemu, describe how they have initiated important changes within their communities, provid-



Filmmaker Nicole Leghissa speaks at the TWAS General Meeting. (Photo: Roque Silles)

ing Kenyans with knowledge and tools to overcome local problems and to achieve a better life.

Khan, for example, has devised and introduced a 'green technique' to get rid of pests and weeds without using pesticides and chemicals. His technique, called 'push-pull', is now widely used by some 60,000 Kenyan farmers.

Vitalis Wekesa's dreams of a science career came true thanks to a TWAS PhD fellowship and the Brazilian National Council for Scientific and Technological Development. The doctorate he earned at the University of São Paulo has opened the doors of international research for him, and upon returning to his home country he was able to establish his own microbiology laboratory where he studies microbes that protect plants against common parasites. Wekesa is currently a lecturer at the Technical University of Kenya.

Segenet Kelemu, who has been recently appointed the director of the International Centre of Insect Physiology and Ecology (*icipe*), headquartered in Nairobi, is currently engaged in training young scientists in the most common biological techniques. She provides them with lab facilities, thus helping avoid the brain drain that impoverishes African countries of their best human resources.

Some 3,500 miles to the north, the film explores the efforts of TWAS's secretariat in Trieste, Italy, where the Academy in 2013 marked its 30th anniversary.

The 37-minute film is a joint production of TWAS and RAI-Friuli Venezia Giulia, the Italian public broadcasting company RAI's regional office for Trieste and Friuli Venezia Giulia. The documentary has been supported indirectly by the Italian Ministry of Foreign Affairs, which supports TWAS, and by Sida, the Swedish international development cooperation agency. The Italian version premiered at the annual TriesteNext science festival on 27 September 2013, followed by the English-language premier at the TWAS General Meeting in Buenos Aires, Argentina. It was screened for a small audience of political and educational leaders at RAI's Trieste office, and then was broadcast twice on RAI-TV in late October.

By weaving past and present, images and music, the fields of Kenya and hills of Trieste, Leghissa paints an exquisite fresco of how a global network based in Italy is helping to solve human problems in Africa. In an interview with TWAS staff writer Cristina Serra, the filmmaker discussed the ideas, experiences and lessons that brought *Seeds of Science* to life.

Leghissa shakes hands with TWAS President Bai Chunli as former TWAS President Jacob Palis stands by. (Photo: Roque Silles)

Until recently, your experience as a filmmaker has focused mostly on historical themes. Why did you decide to engage in scientific movies?

My previous works have addressed historical themes because I thought I could portray present days more effectively by using the past as an example. Then I realized that exploring what science can do in terms of addressing problems and finding potential solutions could bring the audience and me into a more real world. In addition, two inspiring events put me onto this road, prompting me to engage in a more science-oriented production: my first documentary on Italian virologist Ilaria Capua, called *Revolutionary Mind*, and *Unwired*, the documentary on wireless communication in Africa that the Abdus Salam International Centre for Theoretical Physics (ICTP) asked me to produce in 2012. Both have been really inspiring in forging this new trend in my career.

How did you organize the logistics and the settings, from Italy?

I started my preparation well in advance. I met with people at TWAS, to get a gist of what the Academy has been doing for some 30 years. I read the history of this institution and I flicked through old and recent pictures. I began writing the script when I was still in Trieste, and I plotted a detailed flowchart of all the locations throughout Kenya. Most importantly, I got through to the scientists who would later become the actors in my film. These were essential preparatory steps, and when we later met, in Kenya, it was like meeting old friends. Sometimes, words were unnecessary.

What were your expectations before your departure to Kenya?

I had mixed feelings. I was excited for the subject and for the geographical features I was about to film. But I was also a bit anxious for my technical equipment and feared that my plans could be difficult to observe. My schedule was quite dense and unexpected events, if they had happened, could have thrown the whole plan awry. However, the project was born under a lucky star, and apart for a small health problem that has affected me, everything was smooth.

What is the subject of *Seeds of Science*?

The film aims at portraying the most common challenges the world is now facing: energy, hunger, lack of safe drinking water, poor sanitation and health risks. It shows what agriculture

PORTRAIT OF THE FILMMAKER

Nicole Leghissa writes, films and produces documentaries and news reports. She holds an Italian Laurea *in international relations and diplomatic sciences and a master's degree in risk management.*

Her first experience in the film industry dates back to 1998, when she set up collaboration with foreign news agencies and television networks, including the German public broadcasting consortium ARD, Reuters, and Worldwide Television News (WTN).

A few years later she took her early steps towards docu-fiction productions, working as an assistant director for American and British television channels such as Channel 4, the Public Broadcasting Service (PBS) and HBO.

Her first reportage, Magic and Masks in Sardinia*, was produced in 1998 and then broadcast by WTN News UK.*

In recent years, Leghissa has gained broad experience in making films about scientific themes. Her Revolutionary Mind *on Italian virologist Ilaria Capua has been broadcast by the Italian public broadcaster RAI, both for the national and the regional audience of Friuli Venezia Giulia.* Unwired*, her second scientific documentary, was produced in collaboration with the Abdus Salam International Centre for Theoretical Physics (ICTP) to report about wireless communication projects promoted by ICTP's scientists. In 2012, Leghissa started her own film company, HYPHAE.*

Seeds of Science *is a joint TWAS-RAI collaboration. It was broadcast in the autumn of 2013 by the Italian RAI and the Slovenian* Radio Televizija Slovenija *(RTSI).*

means in a developing country. It gives voice to people who have much to say but often go unnoticed. All these people are scientifically skilled, they know their country, and they often spot solutions in local problems that could help solve critical situations. They simply need somebody who listens and supports them. *Seeds of Science* shows that science is made of human beings.

Tell us a bit about the people you met in Kenya.

I have met farmers and shared their worries for harvests to come. Remigius Bwana was one of them. He is one of the Kenyan farmers who live exclusively on agriculture (farmers are 75% of the population), often possessing as little as half a hectare, barely enough to support a family. Bwana, for example, has 12 sons. I came across scientists who try to fight pests with natural approaches that do not call for pesticides; who investigate ways to increase the yield of a land that is just 17% fertile; who share their knowledge with farmers trying to raise awareness and create a self-sufficient, chemical-free community.



Did these people leave an especially lasting impression on you?
Yes, they have moved my innermost feelings, for the way they are all fuelled by strong inner dignity. They were never afraid of laying bare in front of my camera, showing the hardships they encounter in their life. Thanks to these people, the film has grown, moving from the first draft to a fully mature product. They were eager to help me, to assist me in the production, to be part of the project. In addition, they wanted to express their gratitude for the gifts received.

What gifts?
Through TWAS's help they have been able to bring innovations and to make a difference in their communities. They wanted me to know this, and communicate it to the audience.

Can you share with us the first memory that comes to your mind?
I experienced a sense of intense intimacy when I met Ethiopian scientist Segenet Kelemu, one of the winners of the TWAS Prizes for 2011 who is now the director general of the *icipe*. During our meeting, we identified ourselves in each other, we 'sensed' each other and immediately fine-tuned our souls. That was a true gift. Another gift was the huge amount of time that some people, like microbiologist Vitalis Wekesa, have dedicated to this project, by accompanying me around and easing my work.

What have you drawn from this experience?
I have experienced how contagious the scientists' enthusiasm is, their driving purity and their strong desire to improve the life in their country or their society. I'm not a scientist, and I think this has been an asset. Without any prejudice or biased opinions, I could take an unblemished view all around. Perhaps my natural curiosity has stimulated me more than it would have if I had had a scientific background. I have found a great humanity and goodwill – no cynicism, but sharp awareness. I have appreciated how science can bring people together.

What do you think will be the take-home message for the audience?
I have no doubts about it: Where there is a will there is a way. This is especially true in developing countries, but it has lost credibility in developed countries.

Do you have future projects?
Yes, I am already working at two new series of documentaries. The first set will depict some medium-sized European cities and witness social, economic, urban and cultural changes that have occurred in recent times. The second project is a documentary to celebrate the 50th anniversary of ICTP, aimed at following the life of some of its foreign scientists who upon going back home now hold prominent positions in the society. ■



SAND, CANCER AND THE POWER OF INNOVATION

FROM CHINA AND SOUTH AFRICA, TWO WOMEN SCIENTISTS DEVISE NEW STRATEGIES TO SOLVE PROBLEMS AND MAKE A DIFFERENCE IN THEIR COUNTRIES.

Zheng Xiaojing of China and Tebello Nyokong of South Africa work in dramatically different fields: mathematical modelling to understand the spread of sand dunes, and novel methods to combat human cancer. But both share a common determination: to understand profoundly complex problems that threaten human lives and human communities, and then to use science to develop potential solutions. Their scientific results were showcased at the 24th TWAS General Meeting in Buenos Aires.

STUDYING EVERY GRAIN OF SAND

Zheng Xiaojing, a member of the Chinese Academy of Sciences and TWAS Fellow since 2010, is an expert in the fields of elastic, structural and electromagnetic mechanics. By using mathematical simulation and complex algorithms, she has come up with a model that predicts the dynamics of dune formation in deserts.

As she explained: "To predict the speed of desertification we must have a good understanding of the formation and evolution of a dune field. But existing methods, such as field measurements and aerial photography, cannot reproduce this formation and evolution in a precise way. So we thought that the theoretical simulation was perhaps a better solution to our problem."

The model Zheng Xiaojing has devised is called the 'triple-jump model' and begins with the simulation of single particle's motion. It allows a precise schematization of the evolution of aeolian dune fields, sand dunes shaped by the combined force of wind speed, erosion dynamics and surface conditions.

"Desert-spread has dramatically increased in recent years, taking almost one-third of Earth's land surface", she noted during the lecture she offered at the TWAS General Meeting in Buenos Aires. "Even worse, the speed of desert spread is also increasing. Ten years ago deserts were moving three to four meters per year. Now they run as fast as eight to 10 metres per year, or more."

This trend is common to all the largest desert areas in the world, from Australia to South America, from Africa to North America and Asia. China, in particular, is massively affected; desert areas cover now almost one-third of the Chinese territory, with sand dunes invading villages, pastures and meadows resulting in severe degradation.

The model set up by Zheng Xiaojing takes into account several elements that may influence dunes' formation, such as the grain's diameter, the thickness of sand sources and the season, because the strength and direction of wind change massively during the year.

"To evaluate our model and confirm that the growth of dunes also depends on the thickness of the initial layer, we ran simulations across one century data and came to a formula that can be applied to predict the growth rate", explained the scientist.

Using this formula, it is possible to predict that dunes move in response to the forces of wind at various speeds inversely proportional to their heights. For example, a two-metre dune under the influence of spring winds will, in principle, be able to cover 28 metres in as little as six months.

Sand-prevention methods such as fences used to block sand flows, and straw checkerboard barriers used to prevent the shift and flow of sand particles are currently employed. However, if correctly applied, the 'triple-jump model' could help people save money.

"Knowing the pattern of dune formation," Zheng said, "we may optimize the size and placement of checkerboard barriers. Instead of laying them following a continuous pattern, people should lay them as belts, optimizing the distance between stripes. Both layers have the same effect but the second coverage pattern is less expensive."

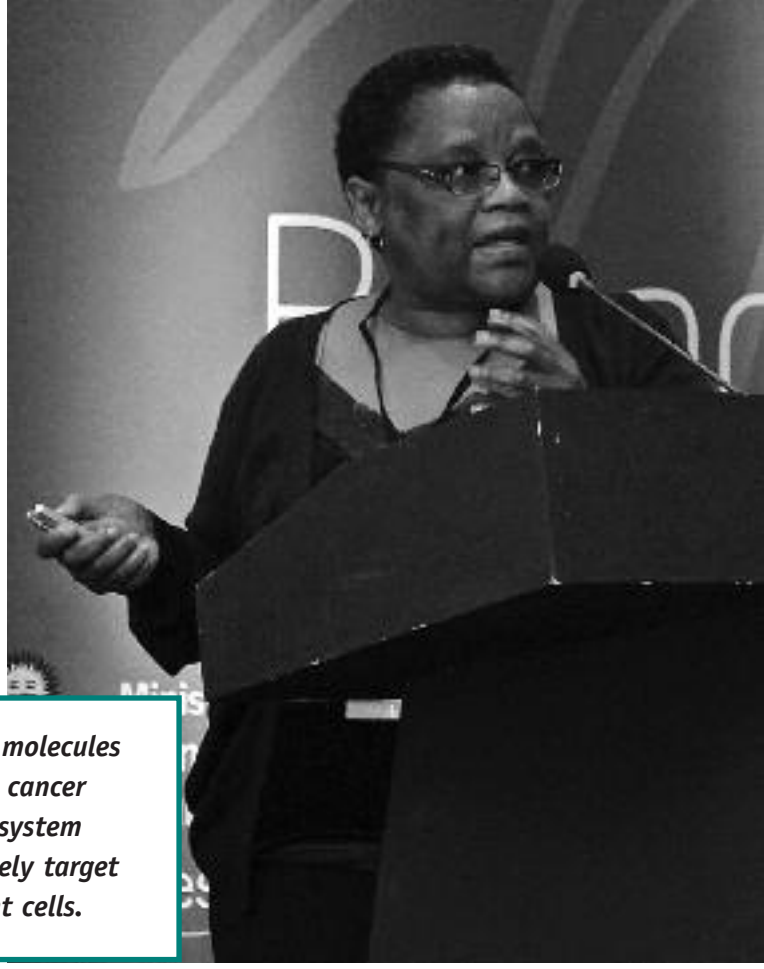
LIGHT THAT KILLS AND HEALS

It's hard to imagine using light to kill cancer cells. But this is just what happens in lab experiments performed on cells, in Tebello Nyokong's laboratory. Nyokong, a South African professor known for her ground-breaking work in harnessing light for cancer therapy, is currently engaged in finding new drugs that can recognize cancer cells and ultimately destroy them. And her strategy makes use of light.

According to recent figures, one in six South African men and one in seven South African women will get cancer during their lives. And the statistics are even worse in other countries, where one in three people could potentially develop this disease. Despite all cancers being common in the population, some cancers seem to affect espe-

Desert-spread has dramatically increased in recent years.

TWAS Fellow Zheng Xiaojing of the Chinese Academy of Sciences discusses her research on sand dune dynamics. (Photo: Roque Silles)



South African Professor Tebello Nyokong discusses her work on combined cancer therapies at the TWAS General Meeting. (Photo: Roque Silles)

cially black South African women: cervical, breast, uterine and even lung cancer.

Nyokong, who is a determined advocate of the role of women in science, has been long pursuing an innovative strategy against the No. 1 enemy of human health. "I started the cancer research a long time ago", she explained. "The therapeutic tool I'm trying to refine is, in principle, more effective than other anti-cancer therapies, because it targets cancer cells, sparing the healthy ones."

Her strategy lies at the interface between nanotechnology, the discipline that works at atomic level, and standard cancer therapy. It is called 'combination therapy' because it applies more than one substance to cure one disease. As she points out, the approach is based on the so-called photodynamic therapy.

Therapeutic molecules enter the cancer vascular system and selectively target malignant cells.

"We irradiate a low-energy drug – a dye from the family of phthalocyanines – with red laser light, to turn it into a high-energy molecule. Then we combine this high-energy drug with oxygen naturally present in the body, to trigger its switch from a low-energy to a high-energy, excited status. This final compound kills cancer cells."

But how does the therapeutic molecule tell healthy from cancerous cells? "Tumours need a highly vascularized environment to grow", Nyokong explains. "And tumour veins are leaky, compared with healthy vessels. This feature allows therapeutic molecules to enter the cancer vascular system and selectively target malignant cells", Nyokong said, pointing at recent results she and her collaborators obtained using animal models.

According to preliminary results, cancerous cells die within two to three months from irradiation. This approach is particularly good for inoperable cancers – such as brain, bladder and lung cancer – but also for small cancers like those found in the breast and oesophagus, and in the follow-up treatment of other types of cancer.

Nyokong, who won the Africa-Arab State L'Oréal-UNESCO Award for Women in Science in 2009, has positive comments on South African diagnostic tools.

"We have highly qualified hospitals that do biopsies", she said. "The problem is that poor people do not have access to these facilities: money, distance and even culture are still a problem."

Indeed, Nyokong's therapeutic strategy, given its low costs and easy applicability, could help reduce the gap in medical care between people of different economic classes.

Still in its infancy, her research is moving fast in the direction of human clinical trials, which will start as soon as the scientist solves some side effects – induced photosensitivity – and clarifies more precisely the mechanism of action of her strategy.

"In my research", Nyokong said, "I apply what my father used to advise. He used to say: 'You can do everything.' This belief is what still moves me, also in my training activities with young women scientists to help them escape the still-existing gender bias." ■

Cristina Serra

BRINGING GLOBAL SCIENCE TO LIFE

AT THE ANNUAL TRIESTENEXT SCIENCE FESTIVAL, TWAS JOINED WITH OTHER LOCAL SCIENCE CENTRES ON A PHOTOGRAPHIC EXHIBITION THAT SPANNED THE WORLD OF SCIENTISTS AT WORK

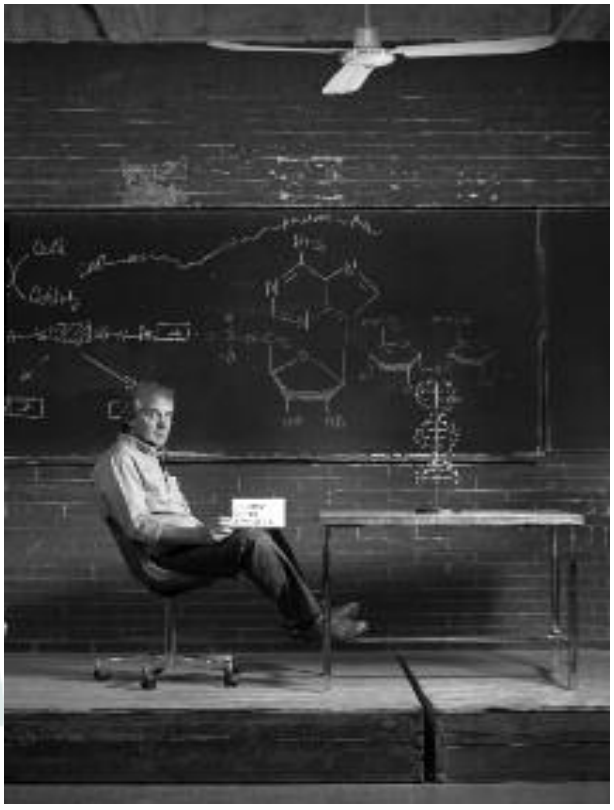
A photo shows two researchers from the Okavango Research Institute in Botswana stand in the muck of the Okavango Delta with a pair of fishing nets, one no bigger than a pool skimmer, the other big enough to fit a small shark. Scientists at the institute, which is dedicated to studying the delta, teach local people about how biodiversity is valuable for economic development, while the people share their traditional knowledge about fish and plants of the delta with the researchers.

This photo is one of nine provided by TWAS for a photo exhibit called 'Around The World in 80 Clicks'. The exhibit consisted of 80 photos from 10 Trieste science institutions, and TWAS provided nine photos for the exhibit, featuring scientists at work. Among them were the 2012 TWAS Prize in Agricultural Sciences winner Dilfuza Egamberdieva of the National University of Uzbekistan in Tashkent, and 2011 TWAS Prize in Medical Sciences winner Alberto R. Kornblihtt of *Facultad de Ciencias Exactas y Naturales* of the University of Buenos Aires, Argentina.

TWAS is one of several scientific organizations clustered in Trieste, Italy. As part of the 'Trieste System', the Academy participates in local events such as TriesteNext, which brings the public together with Trieste's scientific institutions every autumn. In 2013, TriesteNext featured 'Around The World in 80 Clicks' among other exhibits.

TWAS also screened its new documentary film, *Seeds of Science*, during TriesteNext on 27 September,

Clockwise from top: Dilfuza Egamberdieva (left) of the National University of Uzbekistan; the Okavango Research Institute is dedicated to the study and conservation of the Okavango Delta, one of the world's largest and most intact wetland ecosystems; molecular biologist Alberto R. Kornblihtt of the University of Buenos Aires, Argentina.



coinciding with the Europe-wide event 'Researchers' Night' *(La Notte dei Ricercatori)*. The documentary, by Italian filmmaker Nicole Leghissa, explores how TWAS prizewinners and grantees are transforming agriculture in Kenya (also see article on p. 44, 'The Human Face of TWAS in Africa').

Trieste has more than 30 research institutes and an unusually high density of researchers: more than 35 per 1,000 employees, compared to a European average of less than six. That figure, when paired with its strategic position in the centre of Europe, makes Trieste a global hub of science and innovation.

Other contributors to 'Around The World in 80 Clicks' were the Abdus Salam International Centre for Theoretical Physics, *Elettra Sincrotrone Trieste*, *Istituto Nazionale di Oceanografia e di Geofisica Sperimentale*, The International Centre for Genetic Engineering and Biotechnology, the Italian Liver Foundation, the National Institute for Nuclear Physics, the Tartini Conservatory and the University of Trieste. ■

Sean Treacy

IN MEMORIAM

PAOLO BUDINICH, AN INFLUENTIAL ITALIAN PHYSICIST, HAD A VISION AND A PASSION FOR BUILDING SCIENCE IN THE DEVELOPING WORLD

• Physicist **Paolo Budinich**, who played a significant role in the founding of the International Centre for Theoretical Physics and later TWAS in Trieste, Italy, passed away on 14 November 2013.

Budinich joined forces with founder Abdus Salam to create TWAS and ICTP, both headquartered in Trieste, Italy. He convinced the Italian government to support ICTP's establishment at the International Atomic Energy Agency's General Conference in Vienna in the early 1960s.

Two decades later, he helped to organize and lay the foundation for TWAS in its early years. He was instrumental in helping to secure political and financial support for TWAS and its mission from top Italian lawmakers – support that has been sustained throughout the Academy's three decades.

"Paolo had been a great supporter of TWAS ever since its inception in 1983," said Mohamed H.A. Hassan, TWAS treasurer and former executive director. "After the ICTP, I count his immense contributions to the establishment and growth of TWAS as his second legacy."

"Paolo was a great friend and a wonderful human being," Hassan added. "He was very much concerned with the great challenges facing Africa, especially the lack of capacities in research and education. He spent the last few years of his life trying hard to obtain substantial funding from the European Union to support higher education in Africa."

Budinich had a vision and a passion for building science in the developing world and a talent for galvanizing supporters, teams and whole communities. He also played a vital role in the entire Trieste science community: He founded and was the first director of the International School for Advanced Studies (SISSA), and played a crucial role in the establishment of the International Centre for Genetic Engineering and Biotechnology (ICGEB), the *Elettra Sincrotrone*, and the *Immaginario Scientifico*, among others. TWAS is headquartered at the ICTP campus in Trieste.

Budinich was born on the island of Lussingrande (now Lošinj, Croatia) and raised in Trieste. After studying in Pisa's *Scuola Normale Superiore*, he brought high-quality physics research to Trieste, an area now enormously expanded to other fields of science thanks to his tireless work, enthusiasm, and dedication.

"Professor Budinich will be missed by all who knew him and by all who knew of him," said TWAS Executive Director Romain Murenzi. "But I am confident that his work in support of scientific progress will continue to bear fruit long into the future."

NEW DIRECTOR GENERAL FOR ICIPE

• Ethiopian scientist and TWAS Prize winner **Segenet Kelemu** has been appointed the new director general of the International Centre of Insect Physiology and Ecology (*icipe*), a Kenyan research institution that collaborates with TWAS in its fellowship programme and associateships. She is the fourth chief executive officer, and the first woman, to lead *icipe*.

Kelemu was previously the director of biosciences for eastern and central Africa for the International Livestock Research Institute and the vice president of programmes at the Alliance for a Green Revolution in Africa. She has also been a senior scientist and later the leader of crop and agro-ecosystem health management at the International Centre for Tropical Agriculture in Cali, Colombia. She won the 2011 TWAS Prize for Agricultural Sciences jointly with *icipe* scientist Zeyaur Khan.

Based in Nairobi, Kenya, *icipe* conducts research and assists rural and urban communities in Africa to implement strategies that are environmentally safe, affordable and accessible, for the control of crop pests and disease vectors, and the exploitation of useful insects.

KLAUS KRICKEBERG HONOURED

• TWAS Fellow **Klaus Krickeberg**, elected in 1994, has received the Doctor Honoris Causa from Vietnam National University in Ho Chi Minh City.

Krickeberg, a German mathematician living in France, has worked extensively in both Latin America and Southeast Asia in mathematical statistics and public health. He has dedicated much of his life and career to developing Vietnam's health sector and in the past has received the Medal of Merit from the Vietnamese Ministry of Health.

The honorary degree recognizes Krickeberg's "contributions to the construction of Vietnam in the last 50 years, in particular research, teaching and application of the statistical sciences, to consolidating Public Health and to developing the friendship between the people of Vietnam, France and Germany."

IN MEMORIAM

• **Lawrence A. Wilson**, professor emeritus of the Department of Food Production at University of West Indies (UWI) St. Augustine, Republic of Trinidad and Tobago (T&T), the president of the Association of Professional Agricultural Scientists of T&T, passed away 2 December 2013. He was a TWAS Fellow, elected in 1991.

A native of T&T, Wilson earned a PhD in plant physiology from the University of Bristol (UK), in 1964. Then he served in the Ministry of Agriculture Central Experiment Station (1964-1967), and carried out studies on mineral nutrition and tree crops.

As a lecturer in the Department of Biological Sciences at UWI (1967-1975) he led the Root Crop Programme, studying early plant growth and tuberization methods for the selection of better cultivars. His results were described in over 70 publications.

He later served as head of the UWI Department of Biology and as dean of the Faculty of Agriculture. There he established postgraduate and training programmes in food nutrition and a distance education teaching programme.

Wilson also served on many regional and national boards, including the International Institute of Tropical Agriculture, and on editorial boards of international scientific publications.

WHAT'S TWAS?

The World Academy of Sciences for the advancement of science in developing countries (TWAS) is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded as the Third World Academy of Sciences by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam of Pakistan in 1983, TWAS was officially launched in Trieste, Italy, in 1985, by the Secretary General of the United Nations.

TWAS has more than 1,000 members from 90 countries, 73 of which are developing countries. A 13-member council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a secretariat, headed by an executive director and located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Italian government.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North cooperation between individuals and centres of science and scholarship.

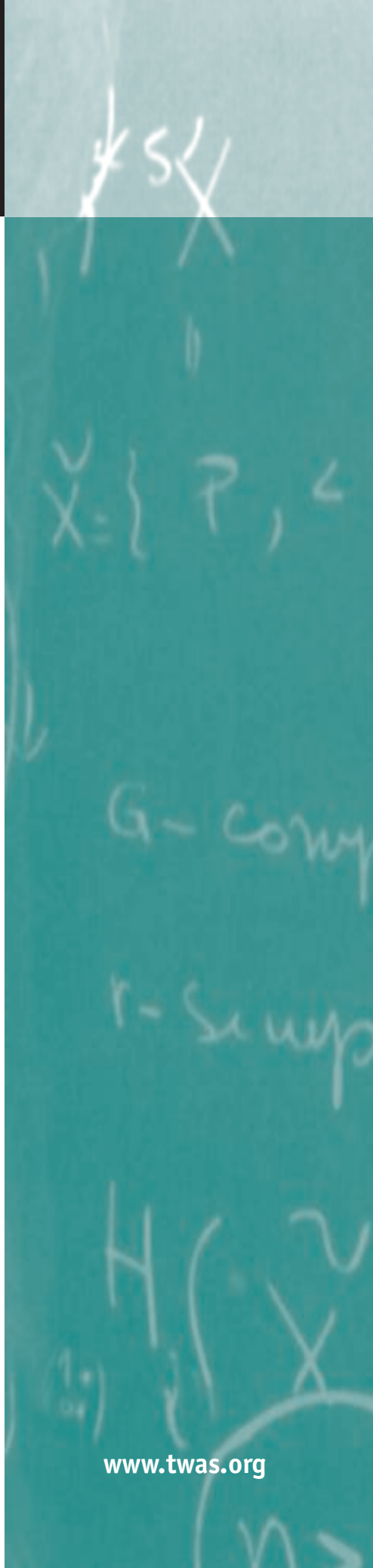
TWAS played a key role in the establishment, in 1993, of the Organization for Women in Science for the Developing World (OWSD, formerly the Third World Organization for Women in Science, TWOWS). More than 3,850 women scientists from 95 developing countries and 28 developed countries are members of OWSD, making it the largest organization of women scientists in the world. Membership also includes nearly 100 men from 31 developing countries and two developed countries. Its main objectives are to promote the leadership of women in science and technology in the South and to strengthen the participation of women in science-based development and decision-making. The secretariat of OWSD is hosted and assisted by TWAS.

www.owsd.net

Since 2000 TWAS has provided the secretariat for IAP, the global network of science academies. IAP, established in 1993 as the 'InterAcademy Panel on international issues', unites more than 100 science academies worldwide; provides high-quality independent information and advice on science and development to policymakers and the public; supports programmes on scientific capacity building, education and communication; and leads efforts to expand international science cooperation.

www.interacademies.net

Since 2004 TWAS has also hosted the secretariat of the InterAcademy Medical Panel (IAMP), an association of the world's medical academies and medical divisions of science academies. IAMP is committed to improving human health worldwide through the coordinated action of its 70 members. **www.iamp-online.org**



www.twas.org