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ROMAIN MURENZI, A KEY ARCHITECT OF RWANDA'S SUCCESSFUL EFFORTS TO DEVISE A BLUEPRINT FOR SCIENCE-BASED SUSTAINABLE DEVELOPMENT AFTER YEARS OF CIVIL WAR AND GENOCIDE, HAS BEEN APPOINTED THE NEW EXECUTIVE DIRECTOR OF TWAS. HE REPLACES THE ACADEMY'S LONG-TIME EXECUTIVE DIRECTOR, MOHAMED H.A. HASSAN, WHO IS RETIRING.

Romain Murenzi appointed TWAS executive director

Romain Murenzi, who was born in Rwanda and raised in Burundi, earned a bachelor's degree in mathematics from the University of Burundi (1982), and a master's degree (1986) and doctorate degree (1990) in physics from the Catholic University of Louvain in Belgium.

In 1990, he was named a postdoctoral researcher at the European Center for Advanced Training and Research in Scientific Computation (CERFACS) in Toulouse, France. Two years later, he moved to the United States to become a principal investigator at the Clark Atlanta University Center for Theoretical Studies of Physical Systems in Georgia. In 1993, he was named an associate professor of physics and, in 1999, he was selected chair of the physics department. One year later, he became a full professor. His research has focused on applications of multi-dimensional continuous wavelet transforms to quantum mechanics and image and video processing.

In 2001, Rwanda's President Paul Kagame appointed Murenzi minister of education, science, technology and scientific research, and, in 2006, minister of science, technology and information and communication technologies. As minister, Murenzi contributed to the expansion and modernization of Rwanda's education system and the building of the country's scientific and technological capacity.

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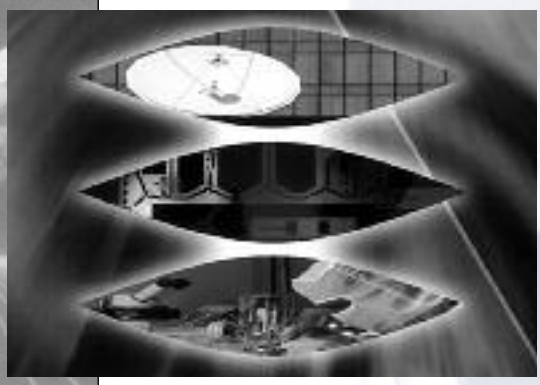


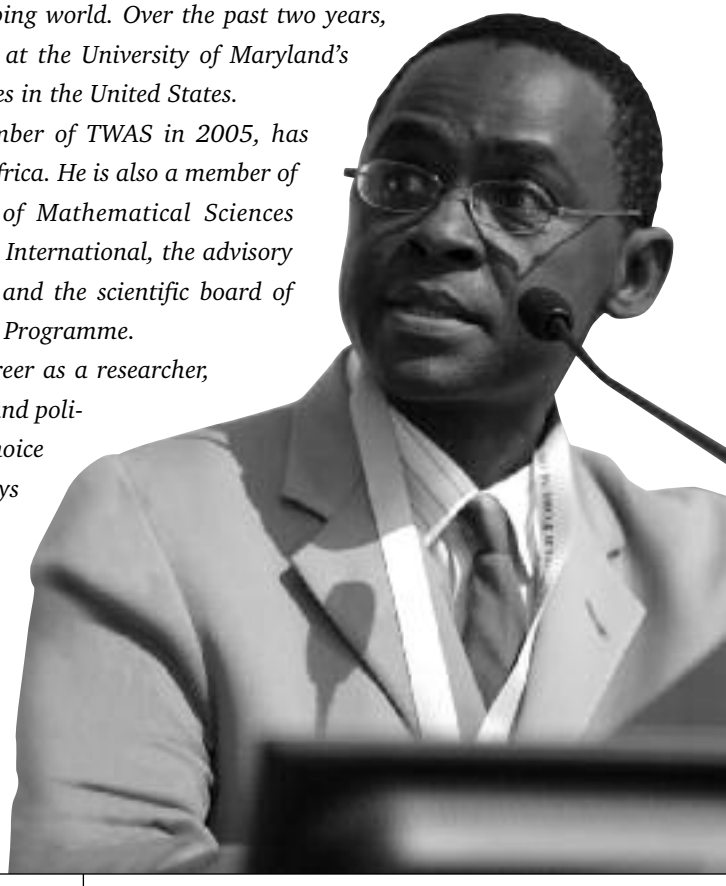
Over the past decade, Rwanda has overcome its war-torn past to become a model for science-based development in sub-Saharan Africa. Rwanda now spends 1.6% of its gross domestic product (GDP) on science and technology, a level that is expected to rise to 3% over the next five years. Its national economy, moreover, grew at an annual rate of nearly 7% a year between 1998 and 2008. More than 95% of its 2.5 million school-age children are now enrolled in elementary school.

Murenzi has travelled extensively both as a researcher and public official, forging partnerships in the areas of education, science and technology. He has worked with universities, research centres and ministries worldwide.

In 2009, Murenzi left Rwanda to become a senior scholar at AAAS in Washington, DC. In July 2010, he was named director of the AAAS Center for Science, Technology and Sustainable Development. As part of AAAS's International Office, the centre examines issues related to science-based sustainable development, especially in the developing world. Over the past two years, he has also been a visiting professor at the University of Maryland's Institute of Advanced Computer Studies in the United States.

Murenzi, who was elected a member of TWAS in 2005, has served as vice president of TWAS for Africa. He is also a member of the board of the African Institute of Mathematical Sciences (AIMS) and Dian Fossey Gorilla Fund International, the advisory board of Scientists Without Borders, and the scientific board of UNESCO's International Basic Science Programme.

"Professor Murenzi's successful career as a researcher, teacher and high-level administrator and policy official makes him an excellent choice for the executive director of TWAS," says the Academy's president Jacob Palis. "We believe that Professor Murenzi has the skills and experience to lead the secretariat in the years ahead as TWAS seeks to expand its efforts to build scientific and technological capacity in all developing countries." ■



THROUGH THE YEARS AT TWAS

MOHAMED H.A. HASSAN, TWAS'S LONG-TIME EXECUTIVE DIRECTOR, RETIRED AT THE END OF MARCH. ROMAIN MURENZI (TWAS FELLOW 2005), THE FORMER MINISTER OF SCIENCE AND TECHNOLOGY IN RWANDA, WILL REPLACE HIM. IN THE FOLLOWING ARTICLE, HASSAN LOOKS BACK AT HIS 25-YEAR CAREER WITH TWAS. HE ALSO OUTLINES SOME OF THE MAJOR CHALLENGES THAT HE BELIEVES THE ACADEMY WILL FACE IN THE YEARS AHEAD.

As I think about my tenure as TWAS executive director, I find it hard to believe that my first trip to Trieste took place in 1974. At the time, I was travelling across Europe. I had just earned a doctorate degree in mathematics from the University of Oxford in the UK and I had just begun my career as a lecturer in mathematics at the University of Khartoum.

I was also assisting my father who owned (and still owns) a number of businesses in Sudan that depend on suppliers in Europe. It was business, not science, which prompted my journey.

My side trip to Trieste, a beautiful port city nestled against the Adriatic Sea in the northeastern corner of Italy was, in fact, just that. The trip was not essential but instead driven by curiosity. I dearly wanted to see the International Centre for Theoretical Physics (ICTP). Launched in 1964, ICTP had emerged as an intellectual oasis for scientists from across the developing world. I also hoped to speak to the Nobel Laureate Abdus Salam, ICTP's founding director and an iconic figure in science, especially in the South.

To my delight, I was able to do both. As I boarded the train to head to the airport and to begin my journey back home to Sudan, I gazed out the window at the city and the sea. I remember thinking that I won't soon forget this wonderful experience. I cherished the moment.

In 1976, I returned to Trieste as an ICTP Associate. In 1983, Salam

asked me to work with him in helping to launch TWAS. I seized the opportunity. I was young, eager and perhaps a bit naive. I thought I would go to Trieste for a year or two to see what would happen. I had no idea that TWAS would become my life's work.

Today, as I look across the ICTP campus from my hillside office and down to the sea below, I see many changes. There is the expansion of ICTP itself, which now attracts more than 5,000 scientists each year to attend research and training courses, workshops and seminars at its facilities in Trieste. There is the addition of the Fermi Building, which serves as the home of TWAS. And there is TWAS itself, which now has nearly 1,000 members and oversees a broad range of programmes that are intended to honour and promote science in the South.

But as much as TWAS has changed, the world of science in the developing world has changed even more. When TWAS first became operational in 1985, China was just opening its doors to the outside world, India was experiencing slow economic growth that was failing to keep pace with the needs and aspirations of its people, Brazil remained under the authoritarian hand of a military government and South Africa was shackled by apartheid.

Today, each of these countries is recognized as an emerging economic power with broad areas of scientific excellence that increasingly compare to the level of competence found among developed countries. Other developing countries, including Chile, Malaysia, Mexico and Turkey, to name just a few, have also placed science at the centre of their development efforts – with encouraging and, in some cases, even remarkable, results. From this perspective, the future of the developing world looks bright.

I often think about those early years: the writing of the statutes for TWAS, the organization of the foundation meeting with the academy's first 42 members in 1983, and the writing of letters to potential donors.

I remember trying to enlarge the pool of potential candidates for TWAS membership by speaking with newly elected TWAS members about colleagues whom they knew to be outstanding scientists; by reviewing the roster of scientists elected to science academies in the North who came from the developing world; and by identifying prominent scientists who travelled to ICTP to participate in the Centre's research and training activities.

I remember the joy and satisfaction that everyone associated with the academy felt in 1985 when the Italian government announced that it would provide TWAS with an annual grant of USD1.5 million – a generous contribution that ensured the academy's long-term survival and that enabled TWAS to launch its research grants, fellowships and prize programmes in earnest.

I remember witnessing similar expressions of pride and enthusiasm in 2004 when the Italian government passed a parliamentary law that transformed the funds that Italy gave to TWAS from a "voluntary" to a "permanent" contribution that would no longer be subject to yearly reviews. I learned about this good news the same day that China's President Hu Jintao spoke to more than 3,000 people attending the opening ceremony of the TWAS 20th anniversary conference in the Great Hall of the People in Beijing. The Italian government's decision to provide TWAS with a permanent source of funding, combined with President Hu's high praise for the accomplishments of TWAS that he presented to such a large and distinguished audience, made this one of the most memorable days in the academy's history.

I think about other turning points too that may have been less dramatic but no less important to the success of TWAS. I recall, for example, the academy's decision to focus on South-South collaboration in science at a time when developing countries looked exclusively to

the North to build their scientific capacity.

TWAS's emphasis on South-South collaboration may have failed to pay significant dividends in the short term (at the time, there were simply too few scientists and too few scientific institutions of excellence in the developing world to forge meaningful collaborations).

Yet, over the long term, TWAS's early call for scientific partnerships and exchanges among developing countries gave the academy lasting credibility as one of the world's strongest and most forthright "voices for science in the South." This has generated untold benefits not only for TWAS but, more importantly, for science in the developing world.

Indeed South-South collaboration in science has both deepened and accelerated over the past two decades as scientific capacity has become stronger in a broad range of fields. The trend has spread across the South, creating fertile ground for fellowships, grants and joint research programmes among developing countries.

Then there's the decision by the governments of Brazil, China and India, in 2004, to collaborate with TWAS in funding fellowships for postgraduate and postdoctorate students from the developing world to study in centres of excellence in their countries. Today, the TWAS South-South fellowship programme, which has since been joined by a number of other countries including Kenya, Malaysia, Mexico, Pakistan and Thailand, now offers more than 350 fellowships each year. It is the largest South-South postgraduate and postdoctoral fellowship programme in the world.

There's also the family of like-minded institutions that have joined TWAS over the years to make Trieste their home. For example, the Third World Organization for Women in Science (TWOWS, which has recently been renamed the Organization for Women in Science for the Developing World or OWSDW). The organization, which was launched with the help of TWAS in 1988 and which the academy has supported ever since, remained active but largely in a steady state for many years.

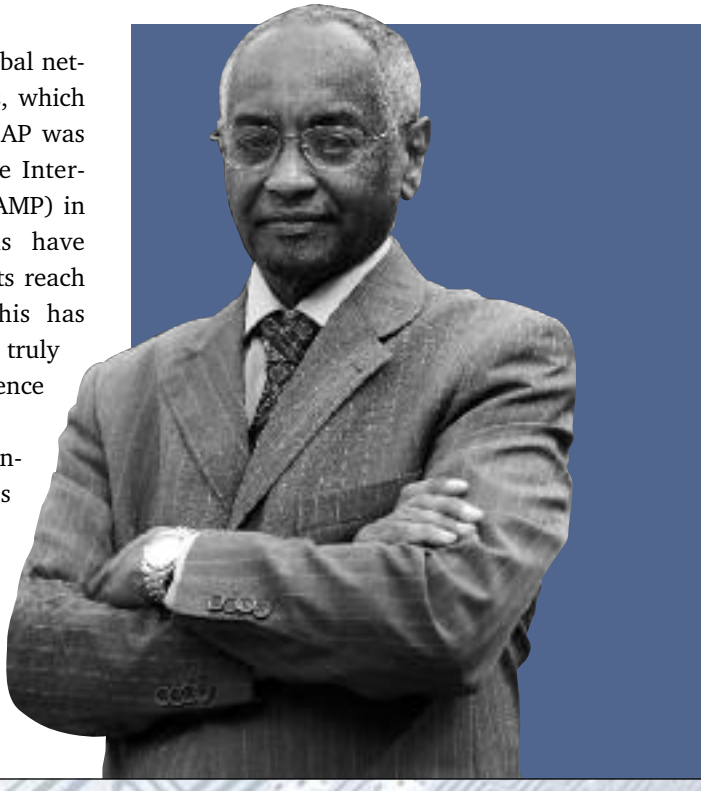
However, OWSDW has recently taken important steps to raise its profile and increase its level of activities. There are now more than 5,000 women scientists who belong to OWSDW. That makes it the world's largest organization of women scientists.

There's also IAP, the global network of science academies, which came to Trieste in 2000. IAP was subsequently joined by the Inter-Academy Medical Panel (IAMP) in 2005. Both organizations have allowed TWAS to extend its reach from South to North. This has helped give the academy a truly global presence in both science and science policy.

Over the past quarter century, a great deal of progress has undoubtedly been made in building scientific capacity in the South. Yet, it is equally true that more work needs to be done if the goal of having "good science in all countries," as TWAS president Jacob Palis likes to say, is to be achieved.

I am, of course, proud of the contributions that TWAS has made to this effort. But I also know that my successor, Romain Murenzi, will continue to face a broad range of challenges that are no less daunting than those that the academy has confronted in the past.

As the *UNESCO Science Report 2010* noted, the North-South gap in scientific capacity, at least in aggregate terms, is slowly closing. From 2003 to 2007, the share of scientific articles published by scientists from developing countries in peer-reviewed scientific journals has climbed from 20% to 25%. This is undoubtedly welcome news. It speaks to a more equitable world and to a world with a larger, more diverse, scientific pool of expertise.



But a closer look at the statistics reveals a less glowing portrait of the state of science in the developing world. An estimated 80% of the increase in publications in peer-reviewed journals authored by scientists in the South comes from just a handful of countries: Brazil, China, India, Malaysia, Mexico, South Africa and Turkey. China alone is responsible for one-third of the developing world's scientific output.

TWAS, in fact, has identified some 80 developing countries that continue to lag far behind the rest of the world in their scientific capacity and output – so-called "scientifically lagging" countries. With a collective population of 1.6 billion people, these countries account for less than 1% of the world's scientific publications.

Thus, for all of the progress that has been made, we have, in a sense, traded a North-South divide in science and technology for a South-South divide.

And what is true of science, not surprisingly, is also true of economic development. Again, much attention has been focused on the rapid pace of growth now being experienced by emerging economies. This is indeed welcome news. China's 10% annual growth rate over the past 25 years has lifted some 600 million people out of poverty, marking the most rapid pace of poverty alleviation in the history of humankind. Just last year, China's economy leaped passed Japan to become the world's second largest economy. India, which has experienced annual growth rates ranging from 5% to 10% over the past two decades, now has more than 300 million people who enjoy middle-class income status. The annual per-capita gross domestic product (GDP) in Brazil, meanwhile, climbed from USD8,700 in 2005 to USD11,200 in 2010.

Science and technology has played a prominent role in the economic success of each of these countries, a role well recognized by the political leadership. Brazil now spends more than 1% of its gross domestic product on science and technology; China spends 1.5%; and India about 1%.

But again a closer look reveals a much more complicated picture in which the bright colours of hope are mixed with darker hues of grey. For example, the average expenditures on science and technology among sub-Saharan Africa's 48 countries are well below 0.5%. In Burkina Faso, Congo, Lesotho and Zambia, it is lower than 0.1%. Low percentages also prevail in countries with predominantly Muslim populations.

But equally disturbing, as overall economic growth of many developing countries has increased, so too has economic inequity. India, for instance, has more people living in extreme poverty – on less than USD2 a day – than all of sub-Saharan Africa. In China, income inequality has increased dramatically even as the country has quadrupled its GDP over the past decade.

TWAS has always supported efforts to build scientific and technological capacity in developing countries as a necessary prerequisite for improving global social and economic well-being. But, at the same time, it has always been keenly aware of the modest contributions it can make to this effort. TWAS, after all, is a small organization with a small staff and limited budget.

The same sense of reality will undoubtedly guide the agenda of the new executive director as he takes over the reins of the organization. However, I would like to offer some suggestions, many of which have been outlined in the academy's strategic plan for 2010 - 2014, that could help TWAS remain a key player in global efforts to continue to strengthen scientific capacity in developing countries.

First, I think it is important to decentralize TWAS activities, largely by extending greater responsibility to the academy's regional offices.

It is unlikely that the core operating budget for the TWAS secretariat will increase in the future. Therefore the regional offices will need to shoulder greater responsibility for the administration of prizes, fellowships and research grants, especially as these efforts continue to expand. Indeed this trend has been unfolding for the past several years with the help of the secretariat. Such efforts, moreover, should not be viewed solely as an economic measure. Decentralizing the academy's activities reflects the growing strength of science in the developing world and the ability of neighbouring countries within the same region to pursue activities that are mutually reinforcing and beneficial.

Second, TWAS should seek to build upon its successful postgraduate fellowship programmes. These programmes currently offer 350 fellowships each year. However, less than half – some 160 fellowships – are actually awarded. It costs the academy about USD350,000 a year to cover the transportation costs for grant recipients and to administer the programme. This investment, in turn, leverages an estimated USD2.5 million from the host countries to cover tuition, housing and living costs.

If the academy were able to identify worthy candidates for each of the 300 fellowships that are currently available, the costs for TWAS would increase nearly threefold, reaching over USD1 million dollars. For the host countries, the costs would rise to more than USD5 million. There's no doubt that, if we could heighten awareness among students across the developing world, sufficient demand exists for these fellowships.

The question, then, is this: How can we secure the money we need to manage a possible three-fold increase in the number of awardees. The answer lies in launching an extensive fund-raising campaign highlighting how this programme could help ensure the next generation of well-trained scientists in the developing countries. Few issues are so critical to the future well-being of the South.

Third, TWAS should seek to reach its USD25 million target for the academy's endowment fund. The fund currently stands at USD15 million and has been growing slowly largely as a result of the earnings that are being generated by the principal. The academy should reinvigorate its endowment fund campaign to help ensure that the USD25 million goal is met by 2020. As has been the case since the endowment fund was created in 1993, all contributions should come from developing countries and TWAS members.

Fourth, TWAS should seek to strengthen its position as one of the key voices for science in the South. To accomplish this goal, the acad-

emy should begin publishing at least one policy brief on a science-based issue of importance to the developing world each year. The briefs should examine these issues from the perspective of scientific communities in the South. In a similar vein, the academy should continue to encourage the development of the Consortium on Science, Technology and Innovation for the South (COSTIS), which UNESCO has agreed to host in partnership with the Paris office of the G77 + China. COSTIS holds great promise in forging close ties between science policymakers and the scientific community.

And fifth, TWAS should engage in a comprehensive study on how it can best position itself to meet the challenges posed by the rapid – indeed breathtaking – changes now taking place in science and society not only in the developing world but throughout the entire world.

As stated earlier, a much more complicated mosaic is emerging due to the progress that has been made in building scientific capacity in the developing world. The North-South divide in science and technology is narrowing. Yet, at the same time, domestic divides in education and economic well-being are widening in both developed and developing countries. Broad global problems such as climate change, the spread of infectious diseases, food and energy security and the loss of biodiversity not only need to draw on the knowledge and creativity of the global scientific community but also must be addressed in their global, national and local contexts. This will require training a new generation of scientists who are well versed not only in broad international scientific issues but also on how these issues are playing out in their own regions, countries and communities.

Therefore, if I could convey just one thing to the academy's new executive director, it would be this: Do not allow TWAS's reputation for promoting scientific excellence and its abiding concern for improving the economic and social well-being of the people of the developing world through science, to be compromised. It has been the academy's ability to serve as a beacon of excellence, helping to guide the developing world to a better future, that accounts for TWAS's success.

No organization owes its accomplishments to just one individual or even group of individuals. And so it is with TWAS. Whatever contributions the academy has made to science and society in the developing world have been due to a number of distinct, yet integrated, pillars of strengths to which I owe an enormous debt of gratitude: The academy's members, the academy's staff and the academy's leadership, led by TWAS's remarkable presidents: Abdus Salam, Jose Vargas, CNR Rao and, currently, Jacob Palis. I am also indebted to the academy's dedicated staff, many of whom have worked for the academy as long as I have. As TWAS's executive director, I have been the primary point of contact for the academy's many partners. But it is the work behind the scenes, done by the staff, which accounts for much of TWAS's success.

I have no doubt that my worthy successor, Romain Murenzi, will find a great deal of support in his efforts to move TWAS forward as it seeks to attain even greater success in the years ahead.

And, as for me, I am sure that I will continue to observe TWAS in the years ahead. Indeed don't be surprised if I turn up from time to time to participate in TWAS meetings and join in the discussions.

Let me conclude by offering my sincere thanks for allowing me to serve such a magnificent organization that has fulfilled so much of its promise, yet promises so much more. It's been the journey of a lifetime that has bestowed rich personal rewards and a sense of satisfaction for which I will be forever grateful. ■

Mohamed H.A. Hassan
Executive Director
TWAS, the academy of sciences for the developing world
Trieste, Italy

TWAS IN INDIA

THE TWAS 21ST GENERAL MEETING WAS HELD IN HYDERABAD, INDIA, FROM 19 TO 22 OCTOBER 2010. THE EVENT, WHICH INCLUDED MORE THAN 350 SCIENTISTS FROM OVER 50 COUNTRIES, TOOK PLACE IN A CONFERENCE COMPLEX OVERLOOKING THE CAPITAL CITY OF THE STATE OF ANDHRA PRADESH. THE HILLTOP PANORAMA, WITH ITS CONTRASTING VIEWS OF HYDERABAD'S GROWING PROSPERITY AND ENTRENCHED POVERTY, OFFERED A TELLING 360° PORTRAIT OF THE HOPE AND CHALLENGES FACING INDIA TODAY.

Hyderabad, the country's sixth largest city, embodies many of the characteristics of modern India. The city is big, it is growing, it is diverse, it is optimistic and it has fully embraced science and technology as part of a broader effort to achieve rapid and sustained economic growth. In fact, Hyderabad, or "Cyberabad" as some have nicknamed the city, has emerged as one of India's major science and technology hubs, a growing rival to Bangalore, India's 'Silicon Valley' to the south, especially in the field of biotechnology. Indeed Hyderabad's recent success shows that science- and technology-based growth in India is not confined to a few isolated areas but is now a nationwide phenomenon. Both the city and the country carry important lessons for much of the developing world.

When TWAS held its 13th General Meeting in New Delhi in 2002, India's decade-long efforts to develop a broad-based strategy for science-based development were first gaining traction at home and increasing visibility abroad. The impacts of India's efforts were clearly visible, yet narrowly confined to select areas in select cities. These special places offered beacons of hope for a better future even as they stood in stark – indeed startling – contrast to their surroundings, which were often cast in dark shadows of poverty and despair.

Upon TWAS's return to India in 2010 for its 21st General Meeting, the country's shimmering future was on full display, most notably in the ceaseless construction and buoyant optimism that is evident everywhere you look. India, of course, continues to face many challenges. Yet there is now growing confidence – and, more importantly, growing evidence – that these challenges can and will be met.

This was the uplifting atmosphere that surrounded the discussions at the TWAS conference in Hyderabad. In less than a decade, the hints of hope infusing the academy's conference in New Delhi in 2002 had been transformed into clarion calls heralding a better future

not just in India but also throughout the developing world – a future that will be propelled forward by increased knowledge and widespread applications of science and technology.

Conference highlights included:

- The opening address by Prime Minister Manmohan Singh in which he lauded the rapid growth of scientific capacity in the South. Until recently, he observed, science and technology "was the preserve of the developed world." But "the barriers to the development and the obstacles to the diffusion of science and knowledge," he noted, "are breaking down." The Minister cautioned, however, that "developing countries should not follow the same path to development as developed countries." Instead, he urged developing countries to devise a "more sustainable way of developing their societies and economies without injuring or destroying the natural beauty of Mother Earth." Such an effort, he asserted, can only be charted by advances in scientific knowledge. (For the full text of Prime Minister Singh's speech, see "Empires of the Mind," p. 20)

> ***Barriers to the diffusion of science and knowledge are breaking down.***

- Brief speeches by representatives of organizations that have graciously supported TWAS, including Immacolata Pannone, scientific expert, the Italian Ministry of Foreign Affairs; Fernando Quevedo, executive director, the Abdus Salam International Centre for Theoretical Physics (ICTP); AnnaKarin Jonsson Norling, policy specialist, the Swedish International Development Agency (Sida); and Anna Illy, the daughter of the late Ernesto Illy and vice-president of the Ernesto Illy Foundation.
- A ministerial roundtable focusing on scientific collaboration with Africa. The roundtable featured presentations by Shri Prithviraj Chaven, Minister of Science and Technology in India; Naledi Pandor, Minister of Science and Technology in South Africa; H.A.M. Dzinotyiweyi, Minister of Science and Technology in Zimbabwe; Jean Pierre Ezin, Commissioner of Human Resources, Science and Technology of the African Union; and Carlos Alberto Aragão de Carvalho, president, Brazilian National Council of Scientific and Technological Development (CNPq). The speakers not only conveyed a sense of pride, but also foresaw great promise in the progress of science-based sustainable development now taking place in a growing number of developing countries. In addition, they emphasized the importance of South-South cooperation in science and technology and examined how such collaboration could prove beneficial not just for emerging economies but, equally important, for least developed countries (LDCs). The speakers, in fact, also noted that many developing countries do not have the critical mass of scientists necessary to address their most pressing social and economic problems on their own. Yet, they maintained that through South-South collaboration

South-South cooperation in science and technology could prove beneficial for least developed countries.

they could marshal the knowledge and skills they would need to promote sustainable development within their own countries. Collaborative efforts, the speakers said, would also help to address critical global issues that have been historically neglected by developed countries, including effective treatments of tropical disease, strategies for producing higher yields for small landholders who rely on traditional farming practices, and improved programmes for mitigating the risks posed by natural hazards. TWAS, the speakers observed, could serve as an important catalyst in such efforts.

• The election into the Academy of 58 new members from 21 countries: 53 fellows and 5 associate fellows, including scientists from Ethiopia, Lebanon and Senegal. With the election of the class of 2010, TWAS's total membership has reached the 1,000 threshold.

• Conference symposia that ranged from 'Science in India' to 'Agriculture and Food Security' to 'Mitigation and Adaptation to Climate Change'. For the first time, TWAS also held a session on 'science with children', organized by TWAS's immediate past president, C.N.R. Rao, that was attended by some 150 secondary school students.

• The announcement that José Goldemberg, a professor at the Institute of Electronics and Energy at the University of São Paulo and former Federal Secretary of Science and Technology and Federal Secretary of Environment in Brazil, had won the Ernesto Illy Trieste Science Prize. Goldemberg was honoured "for his contributions to the development and modernization of the use of biomass as a sustainable energy source". The prize, sponsored by the Ernesto Illy Foundation, carries a cash prize of USD100,000. In his




speech to the conference participants, Goldemberg offered a strong defense for the cultivation of biofuel crops in such sugar-growing countries as his native Brazil where ethanol now constitutes nearly 20% of the fuel stock for transportation and one-third of the ethanol consumed worldwide. He contended that African countries such as Ghana, Mozambique and Tanzania with similar climates and soil conditions could – and should – replicate Brazil's success in biofuel production. Such initiatives, he said, would generate much-needed income for their economies while helping to curb the world's appetite for fossil fuels (for additional information about Goldemberg's research, see "Trieste Science Prize for 2010," p. 32).

- TWAS 2010 Medal Lectures by Silvia Torres-Peimbert, professor emeritus, *Instituto de Astronomia, Universidad Nacional Autonoma de Mexico*, Mexico City, Mexico, and winner of the 2010 L'Oreal-UNESCO Prize, who spoke about planetary nebulae that eject stellar matter into space, influencing the chemical composition of stars; Habib Firouzabadi, professor of chemistry, College of Sciences, Shiraz University, Iran, who talked about the growing number of organic reactions that have been induced using newly developed reagents and catalysts created in laboratories in both developed and developing countries; and M.K. Bhan, secretary to the government of India, Department of Biotechnology, New Delhi, who examined the health risks posed by zinc deficiencies in developing countries, especially for children.
- Presentations by 2009 TWAS prize winners, including in agricultural sciences: Huey-Lang Yang, distinguished professor at the Center of Biotechnology, National Cheng Kung University, Taiwan, China; in biology: Lin He, professor at Shanghai Jiao Tong University, China, and Partha P. Majumder, professor of eminence, Human Genetics Unit, Indian Statistical Institute, Kolkata, India; in chemistry: Swapan K. Ghosh, head, Theoretical Chemistry Section, Bhabha Atomic Research Centre, Mumbai, India, and Li-Jun Wan, professor, Institute of Chemistry, Chinese Academy of Sciences, Beijing, China; in earth sciences: Rafael Navarro-González, professor, Laboratory of Plasma Physics and Planetary Studies, Institute of Nuclear Sciences, National Autonomous University of Mexico, Mexico City; in engineering sciences: Liang-Gee Chen, distinguished professor, National Taiwan University, Taipei; in mathematics: Enrique Pujals, professor, Institute of Pure and Applied Mathematics (IMPA), Rio de Janeiro, Brazil; in medical sciences: Ricardo Gazzinelli, professor, Department of Biochemistry and Immunology, Federal University of Minas Gerais, Belo Horizonte, Brazil; and in physics: Nathan Berkovits, full professor, Institute of Theoretical Physics, *Universidade Estadual Paulista*, Sao Paulo, Brazil, and Hongjun Gao, deputy director, Institute of Physics, Chinese Academy of Sciences, Beijing, China. For additional information about the presentations, including the abstracts, contact info@twas.org.
- The announcement of the 2010 TWAS prize winners. The awardees will speak about their research at the next TWAS conference. The winners are in agricultural




sciences: Francisco Alfonso Larque-Saavedra, Centre of Scientific Investigation, Merida, Mexico, and Ibrokhim Abdurakhmonov, Center of Genomic Technologies, Academy of Sciences of Uzbekistan; in biology: Satyajit Mayor, National Centre for Biological Sciences, Tata Institute for Fundamental Research, Bangalore, India, and Soo-Chen Cheng, Institute of Molecular Biology, *Academia Sinica*, Taiwan; in chemistry: Dan Yang, Department of Chemistry, University of Hong Kong, and Santanu Bhattacharya, Department of Organic Chemistry, Indian Institute of Science, Bangalore, India; in earth sciences: Anil K. Gupta, Department of Geology and Geophysics, Indian Institute of Technology, and Alexander W.A. Kellner, Department of Geology and Paleontology, National Museum, Federal University of Rio de Janeiro, Brazil; in engineering sciences: Vivek Borkar, School of Technology and Computer Science, Tata Institute of Fundamental Research, Mumbai, India, and Edgar Zanotto, Vitreous Materials Laboratory, Federal University of São Carlos, Brazil; in mathematics: Manindra Agrawal, Department of Computer Science and Engineering, Indian Institute of Technology, Kanpur, India, and Carlos Gustavo Tamm de Araujo Moreira, Institute of Pure and Applied Mathematics, Rio de Janeiro, Brazil; in medical sciences: Gabriel Adrian Rabinovich, Institute of Biology and Experimental Medicine, Buenos Aires, Argentina; and in physics: Qi-Kun Xue, Department of Physics, Tsinghua University, Beijing, China.

- Invited lectures by Bengt Norden, professor of chemistry, University of Technology, Gothenburg, Sweden, who spoke about the role that optical spectroscopy can play in enhancing our understanding and applications on nanotechnology in both biological systems and synthetic materials; Luiz Davidovich, professor of physics, *Instituto de Fisica, Universidade Federal do Rio de Janiero*, Brazil, who explored the enormous intellectual challenges that scientists face in seeking to understand the quirky behaviour of subatomic particles operating in the quantum world and the reasons why such understanding may hold the key for unlocking not only the deepest secrets of the fundamental laws of physics but also for advancing such fields as quantum information that could lead to more efficient processing and transmission of information; Raghavendra Gadagkar, INSA S.N. Bose research professor and J.C. Bose National Fellow at the Indian Institute of Science in Bangalore, who examined the intricate and fascinating systems of the social organization of wasps that exhibit a strong "sense" of loyalty, obedience, resilience, and adaptability (see "The Social Life of Wasps," p. 25); K. Srinath Reddy, president, Public Health Foundation of India, New Delhi, India, who detailed the 'vast disparities' in health that exist not just between rich and poor countries but between rich and poor people in all countries. He observed that life expectancy at birth ranges from just over 40 in Lesotho to more than 80 in Japan and that disparities in infant mortality rates range from 160 deaths per 1,000 live births in Afghanistan to 3 per 1,000 live births in Singapore. To reduce these disparities, he called on

developing countries to increase the number of medical personnel and to place greater emphasis on primary health care (see "Health in Transition," p. 28); and Atta-ur-Rahman, coordinator general, COMSTECH, Islamabad, Pakistan, who urged developing countries to turn to knowledge, technology, innovation and enlightened leadership as the primary drivers of sustained economic growth.

- A symposium on Mitigation and Adaptation to Climate Change examined a broad range of technical and environmental issues related to one of the world's most critical and perplexing challenges. Jagadish Shukla (TWAS Associate Fellow 1995), George Mason University, Institute of Global Environment and Society, USA, highlighted the need to invest in a new generation of transnational interconnected computers that would allow for higher resolution regional and global climate models. Pauline Dube, University of Botswana, emphasized the need for policies designed to promote mitigation and adaptation, especially in poor countries. She based her argument on the fact that climate-change impacts have already begun and that poor people, who often depend on the natural resource base for their well being, are particularly vulnerable to the changes in weather and precipitation patterns taking place. Similarly, Adel El-Beltagy (TWAS Fellow 2005), Global Forum of Agricultural Research, Rome, Italy, contended that climate change disproportionately impacts the poor and presents a particular challenge for maintaining adequate food supplies in the face of higher temperatures and rising incidences of extreme heat, greater levels of precipitation and more severe storms, and increased episodes of flooding and drought. Carlos Nobre (TWAS Fellow 2006), Centre for Earth System at the National Space Research in Brazil, warned of the "savannization" of the Amazon due to forest clearing and climate change. He noted that 18% of the Amazon has already been deforested and that the pace of deforestation is accelerating. He issued an urgent call for Brazil to devise a strategy that would allow people to meet their basic needs without further depleting the country's natural base. B.N. Goswami (TWAS Fellow 2009), Indian Institute of Tropical Meteorology, observed that climate change is changing the global weather system and is having a dramatic effect on the intensity of monsoons in India. He noted that profound alterations in interactions between the ocean and the atmosphere and the warming of the Arctic, both due to climate change, have played a fundamental role in the mega droughts that have recently afflicted India.

There was broad acknowledgement that TWAS's fellowship programmes are working well.

- Lectures by the winners of the 2010 TWAS Regional Prizes, focusing on the critical issues of public understanding and popularization of science. The awards are given by the TWAS regional offices and include a




USD3,000 cash prize. For additional information, including the names of the award winners and a description of their work in promoting citizen appreciation of science, see tinyurl.com/2vgcjp4.

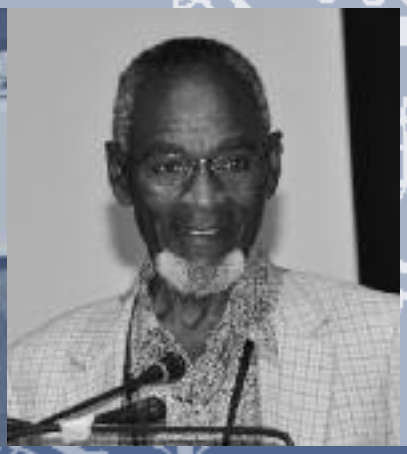
- Presentations by TWAS young affiliates in the fields of biological and physical science. There were 17 talks in all on topics ranging from malaria control in Nigeria to mitochondrial DNA diversity in Africa to quantum entanglement and molecular self-assembly of new polymer materials. Among the countries represented were Algeria, Botswana, Indonesia, Jamaica and Qatar. In addition, TWAS's regional offices announced the selection of 25 new young affiliates for 2010-2014. That brings the total number of TWAS young affiliates to 98.
- For the second consecutive year, events at the TWAS general meeting were the subject of a lively blog and stories posted on the news portal scidev.net (see www.scidev.net). This year the postings were made by journalist T.V. Padma, SciDev.Net's regional coordinator for South Asia. A feature article, examining the state of science in India, written by the TWAS editor, was also carried by SciDev.Net website. Twelve news stories were posted on the TWAS website (see *www.twas.org*). The number of visitors to the TWAS website tripled during the conference.
- The official announcement that TWAS's long-standing executive director, Mohamed H.A. Hassan, would be retiring in spring 2011 after having adeptly guided the Academy since its inception more than a quarter century ago.

There is growing appreciation for the success of TWAS's five regional offices.

India enjoys a long and rich tradition in science and technology. It's where the concept of zero was created. It's where many of the principles of astronomy were first introduced. It's where the deeply rooted traditions of scholarship and science remained firmly in place despite centuries of poverty and often-oppressive rule by foreign powers. And it's where a newly independent India, created in 1947, sought to revive and nurture the country's intellectual and scientific roots despite the enormous social and economic problems that the nation faced. Indeed, over its long history, India has never lost its reverence for learning even in times of despair.

In the past, mathematics, astronomy and geography marked the strengths of India's scholarly and scientific community. More recently, such fields as mining and metallurgy, information and communication technologies, agriculture and climatology, medicine and pharmaceuticals, and nuclear energy and space science have dominated the country's research agenda. These pursuits have earned India a growing international reputation in science, technology and increasingly innovation.

Ever since India liberalized its economy in 1991, there has been a companion revolution in science and technology. In fact, the two revolutions – one in eco-



nomic policies and performance, the other in science and technology capacity building and applications – have complemented and reinforced each other.

Today, India is on a path to becoming a global superpower. The same can be said of science. As Prime Minister Chavan noted just prior to the conference: "India is too big to be straight jacketed into a single policy for science and technology. It has a strong and diverse scientific research community and a growing array of scientific centres of scientific excellence; it has received consistent support from the government regardless of the party in power; and it has enjoyed moderate but steady progress in science-based development, which is increasing at an accelerated pace."

India, the Minister went on to say, "has been patient, optimistic and ethical" in its approach to both science and development, and it has been determined to invest in science and technology in ways designed to benefit all Indians even as it seeks to gain prominence in the international scientific community." (See "On the Future of Science in India," p. 23)

All of those trends and principles were on full display at the TWAS 21st General Assembly – both for the world to see and for others to learn from.

As for TWAS, the message was similarly upbeat yet replete with challenges – both old and new.

There was broad acknowledgement that TWAS's fellowship programmes are working well and are growing at a rapid pace, thanks in large measure to partnerships with others, including the governments of Brazil, China, Pakistan, Malaysia and Mexico. There is growing appreciation for the success of TWAS's five regional offices, which are assuming greater responsibility for TWAS activities, including the selection of TWAS Young Affiliates and the awarding of TWAS regional prizes.

There has been progress in reaching the Academy's hoped-for USD25 million endowment fund. The fund currently has more than USD15 million. There has been continual support from TWAS's major benefactors – the Swedish International Development Agency (Sida), the Kuwait Foundation for Science (KFAS) and, of course, the Italian government, which has served as the Academy's primary funder since TWAS's inception.

In addition, there is an expanding list of partners that now collaborate with TWAS, including Illycafè, Microsoft Research, the International Science, Technology and Innovation Centre for South-South Cooperation (ISTIC), International Centre of Insect Physiology and Ecology (ICIPE), the African Union, BioVision and Lilly. There is the growing global presence of Trieste-based international organizations that work closely with TWAS – most notably, the Abdus Salam International Centre for Theoretical Physics (ICTP); IAP, the global network of science academies; the Organization for Women in Science for the Developing World (OWSDW); and the InterAcademy Medical Panel (IAMP). And there is increasing recognition in both the scientific and economic development communities of the important role that TWAS plays in helping to build scientific and technological capacity in the developing world.

Yet, despite the progress that has been made, daunting problems persist. As UNESCO's *2010 Science Report* shows, the welcome increase in scientific prowess in the South, whether measured in terms of the rising number of scientists, publications, patents or the production science-based goods and delivery of science-based services, has been led and, in many cases, continues to be dominated by just a few emerging economies – notably, Brazil, China, India, Mexico, South Africa and Turkey. While the share of articles published in peer-reviewed international journals by scientists in developing countries rose from 18% in 2003 to 25% in 2007, scientists in just six countries accounted for more than 85% of these articles. Surveys suggest that there are some 80 countries where science and technology plays virtually no role in the economy. Not surprisingly, these are among the world's poorest countries.

The dream of TWAS is to achieve good science in all countries.

"The dream of TWAS," Jacob Palis, the Academy's President, noted in a presentation given at the opening ceremony of the 21st General Meeting, "is to achieve good science in all countries." From this perspective, TWAS still has a great deal of work to do.

The Academy, which has both witnessed and participated in the enormous changes in global science that have taken place over the past quarter century, is well placed to serve as an important player in efforts to meet the challenges that lie ahead.

Thus what is true for India, in many ways, is also true for TWAS. The path to success has been long and arduous with many twists and turns. Much progress has been made and there is good reason to believe that much more can be achieved. Yet there is a long way to go before the journey will be complete, and there are many obstacles that continue to stand in the way of success.

However, discussions in India showed, there are increasing expectations that rapid advances in scientific capacity building and science-based development across the developing world are now possible. The key to future progress is no secret. It lies in unwavering national commitment, sustained financial support and the promotion of openness and scientific exchange – a formula for success that has served India well over the past several decades and that could provide a useful template for others. The even better news is that India is just one of a growing number of developing countries that have been able to chart a successful path for science-based development. That means developing countries now have a number of models to examine and the luxury of choosing elements from each that best suit their circumstances and goals.

As many of the participants noted during the course of the conference: When it comes to science and technology, all developing countries are moving ahead. But as the conference participants also noted: Some countries are moving much faster than others.

A primary goal of TWAS over the next several years will be to help accelerate the pace of change in 'scientifically lagging' countries so that a true global community of science can be built for the benefit of all.

That goal is in many ways no different than the one that led to the creation of TWAS more than a quarter century ago. The difference today is that there is every reason to believe we are no longer at the beginning of the journey. Instead we are midway through the course with our eyes tightly fixed on the path ahead.

This doesn't mean that we are about to usher in a new world marked by peace and prosperity. To the contrary, poverty will persist, tensions will flare and science will find its way to some places but not to others, bringing both elation and concern.

What it does mean, however, is that the long-standing era defined by a North-South gap in scientific capacity is coming to an end and that a new era marked by less clearly defined lines of demarcation between scientifically-advanced and scientifically-lagging countries is about to unfold. Such a paradigm shift will have profound implications not only for international science but for international development and diplomacy. TWAS plans to be there every step of the way providing assistance when and where it can and encouraging others to join in efforts to embrace science as a primary tool for building a more prosperous and peaceful world. ■

EMPIRES OF THE MIND

INDIA'S PRIME MINISTER MANMOHAN SINGH DESCRIBES HOW SCIENCE HAS BECOME A KEY DRIVER OF GLOBAL DISCUSSIONS DEVOTED TO CRITICAL SOCIAL AND ECONOMIC ISSUES, AND HOW SOUTH-SOUTH COOPERATION IN SCIENCE CAN HELP BUILD PROSPEROUS AND SUSTAINABLE SOCIETIES IN THE DEVELOPING WORLD. THE ARTICLE IS BASED ON HIS ADDRESS TO PARTICIPANTS ATTENDING THE TWAS 21ST GENERAL ASSEMBLY IN HYDERABAD, INDIA, HELD LAST AUTUMN.

Abdus Salam had great faith in the potential of scientists of the developing world and also in the essential unity of scientific purpose in advancing human civilization. It was this vision that led him to establish TWAS in 1983.

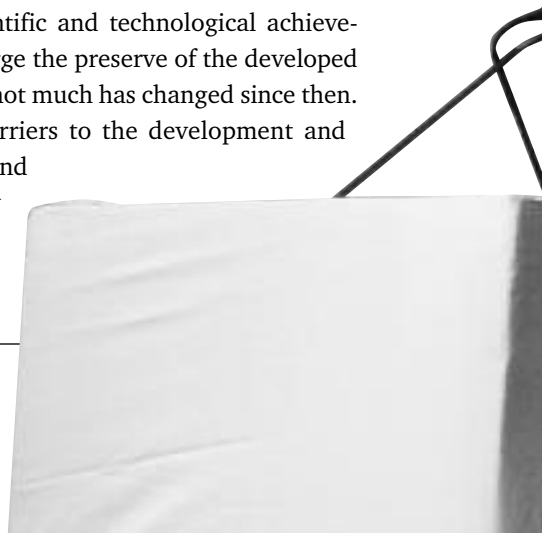
In fact, no one believed more fervently in Winston Churchill's prophesy concerning 'empires of the mind' than Salam, a Nobel Laureate in physics in 1979 and one of the most outstanding scientists of his generation.

> ***"The empires of the future are going to be the empires of the mind."***
> *Sir Winston Churchill*
> *Harvard University, Boston, Massachusetts, USA, 1943*

I had the great privilege of knowing Salam for more than four decades. Our relationship dates back to the 1950s when I was an undergraduate at St. John's College, Cambridge, UK, and he was a fellow at St. John's College.

I subsequently worked closely with Salam in writing the seminal report of the South Commission, *The Challenge to the South*. During the project, which was headed by Julius Nyerere, the former President of Tanzania, I had an opportunity to visit with Salam several times. The scope of his wisdom, experience and knowledge was phenomenal. We should pay homage to this great leader of science and revered scientist who showed us the path to cooperation and collaboration that will and can benefit us all.

At that time, scientific and technological achievements were by and large the preserve of the developed world. It may be that not much has changed since then. But the walls and barriers to the development and diffusion of science and knowledge are now breaking down. Communication and glob-



alization are enabling developing countries to aspire for cutting-edge scientific achievement and progress like never before.

I believe that it is not beyond our collective imagination to create "empires of knowledge" in the developing world. For that to happen, however, we need many more visionaries like Salam – great scientists, inspiring leaders and strong institution builders.

Developing countries face similar challenges, whether it is in combating tropical diseases, transforming traditional agriculture, or predicting and tackling natural disasters.

The problems of underdevelopment do not receive adequate attention in advanced industrialized countries. Nor should we expect others to solve our problems for us. I believe that we can and should make a renewed and determined effort to quicken the pace of developing scientific knowledge and applications that are relevant to our own needs and circumstances.

Each of our countries needs to put science on a pedestal.

PATHS TO SUSTAINABILITY

We have seen how the path of development followed by the industrialized countries has the potential to threaten our existence and way of life.

I have therefore wondered whether there is an alternative and a more sustainable way of developing our societies and economies without injuring and destroying the natural bounty of Mother Earth.

If we can find such a path – that does not unduly constrain our ability to deal effectively and quickly with basic challenges of development – then we should follow it in our enlightened self-interest.

I believe that only science can provide us with these answers.

The developing world is constrained by the lack of well-organised systems and critical mass of expertise in its scientific establishments. There are shortages of skilled scientific manpower and research facilities.

That is why collaboration among our scientific communities is so very important for each one of our countries. The problems we cannot solve individually, perhaps we can solve by working together and pooling our knowledge, wisdom and experience.

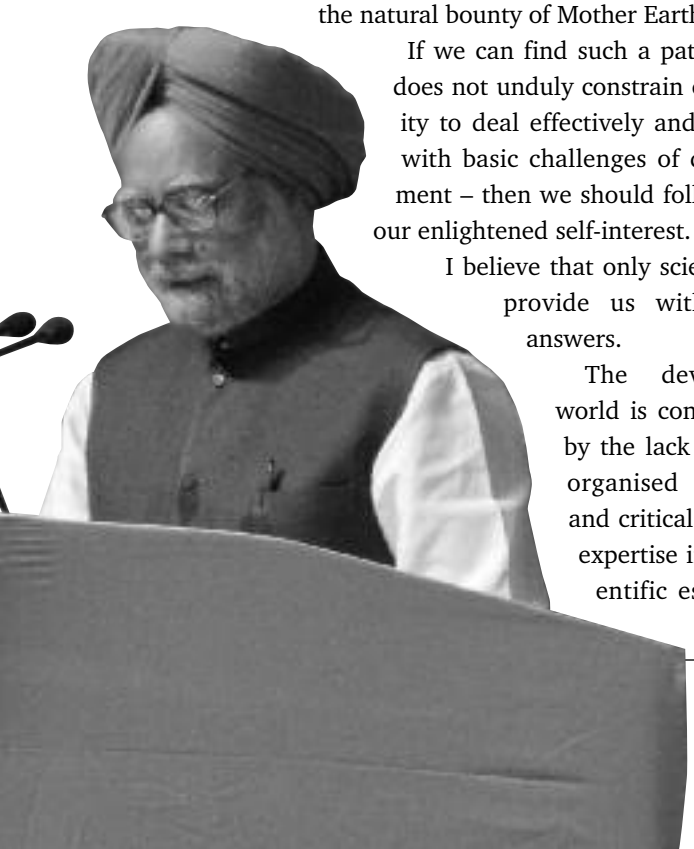
SCIENCE ON A PEDESTAL

Each of our countries needs to put science on a pedestal. We need to invest in science. We need to invest in scientific infrastructure – in our schools and laboratories. We need to promote a system that rewards innovation, creativity and excellence. We need to inculcate what Jawaharlal Nehru often talked about – a scientific bent of mind in our children. We need to nurture inquisitiveness and a questioning mind. We need to change our pedagogical methods that emphasize memory rather than inquiry.

In India, we have increased the expenditure on science and technology as a proportion of our gross domestic product. But we must do much more. We are investing a lot of resources in both basic and higher education. For the last 50 years, we had seven Indian Institutes of Technology (IIT) and one Indian Institute of Science (IIS). In the past five years, we have established eight more IITs and five Indian Institutes of Science Education and Research.

An important issue that sometimes bedevils collaboration on research with relatively immediate commercial applications is the sharing of intellectual property rights. We need to address this problem head on.

One approach being tried now is an application of ideas from the open source movement in software. The Council for Scientific and Industrial Research (CSIR) in India has launched an Open Source Drug Discovery project that facilitates collaboration by providing a platform for the mutual sharing of research results that may be used freely by any participant. The government of India has committed some USD40 million to this project. An equivalent level of funding will be sought from international agencies and philanthropists. The project has already made available the complete sequencing of the *Mycobacterium tuberculosis* genome.



Science is increasingly becoming a key driver that guides global policy discourse and action in such areas as climate change and the management of biodiversity. The work done by the Intergovernmental Panel on Climate Change (IPCC) and the International Union for Conservation of Nature (IUCN) is of critical importance to the future of humankind. The impact of climate change, for example, is most devastating in the developing world.

Scientists from the advanced countries dominate many of these scientific processes. The concerns of developing countries need to be voiced more forcefully in these processes. Governments in the South are trying to create greater synergy and coherence in policies among developing countries, but these efforts must be backed by solid scientific and technical inputs.

PROGRESS TOGETHER

TWAS can play a very important role in providing a space where scientific collaboration on such critical areas as climate change can be facilitated.

India has been a strong advocate of South-South cooperation. The India-Brazil-South Africa Forum (IBSA) provides a unique framework of cooperation among three major democracies from three different continents. Under the IBSA framework, there has been a series of collaborative activities in science and technology, including in ocean research, space sciences, biotechnology, agriculture, health, climate change, nanotechnology and Antarctica.

In partnership with Africa, India has ushered in far-reaching initiatives to strengthen our development partnership following the India-Africa Forum Summit held in New Delhi in 2008, which included discussions on collaboration in science and technology.

India has offered more than 400 scholarships through a fellowship named after the Indian Nobel Laureate C.V. Raman that will provide support to African researchers and postdoctoral fellows in science. To strengthen the institutional framework in science and technology, India has offered to strengthen three research centres in Africa engaged in activities that have cross-cutting impact across the African continent.

These initiatives can and should be expanded and multiplied across the developing world. I hope that TWAS can be the instrument to catalyse such partnerships not only between individual scientists but also between the scientific institutions. India is ready to do more in this direction.

India has been a partner and member of TWAS from its inception and has offered collaboration, capacity building and knowledge-sharing programmes. We wish to expand this cooperation.

With these words, it gives me great pleasure to inaugurate the 2010 General Meeting of the Academy of Sciences for the Developing World. ■

Manmohan Singh
Prime Minister of India

SPEAKING ABOUT SCIENCE

Hyderabad, India. *What follows is a series of news articles based on discussions that took place during TWAS's 21st General Meeting.*

ON THE FUTURE OF SCIENCE IN INDIA

"India's too big to be straight-jacketed into a single framework for science and technology," says Prithviraj Chavan, India's Minister of Science and Technology and Earth Sciences.

"Some areas of S&T will continue to develop at a steady pace, while other areas will experience accelerated growth – at times leading to the discovery of 'leapfrog' technologies that will have a dramatic impact on the economy." The Minister made his remarks in an interview with the TWAS editor on the eve of the TWAS 21st General Meeting in Hyderabad.

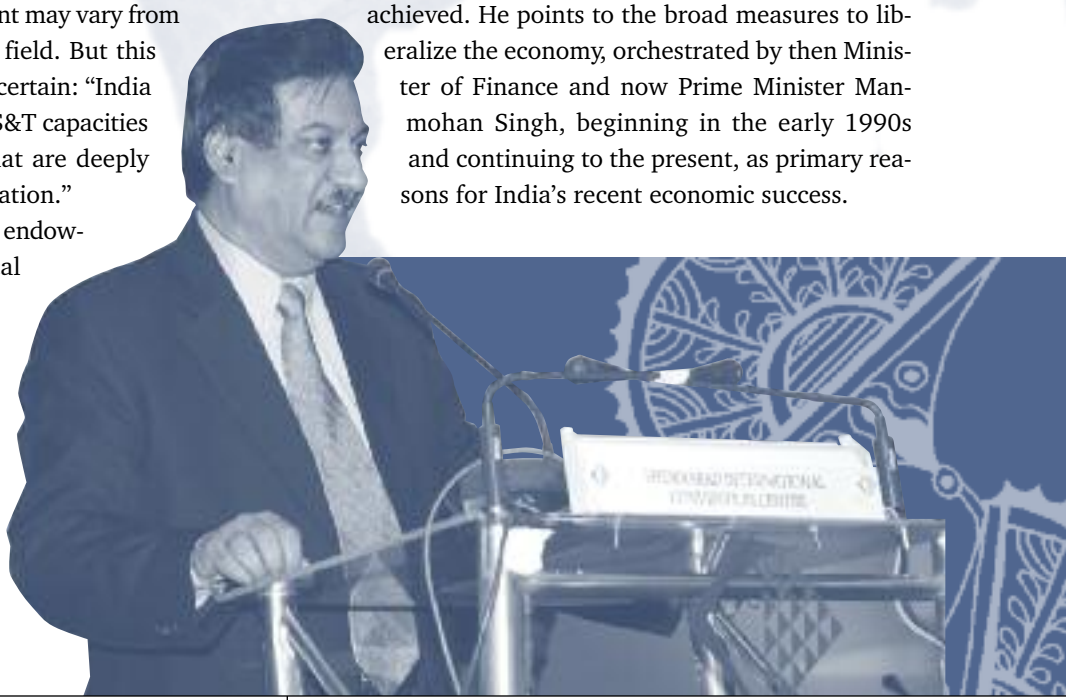
The pace of S&T development may vary from year to year and from field to field. But this much, the Minister believes, is certain: "India will continue to strengthen its S&T capacities by drawing upon traditions that are deeply rooted in its society and civilization."

He points to India's "natural endowments" in such highly analytical fields as mathematics and astronomy, which date back hundreds and, in some cases, thousands of years. He refers to a long list of eminent scientists, including C.V. Raman, J.C. and S.N. Bose, M. Saha and K.S. Krishnan. And he cites the willingness – indeed eagerness – of India's first Prime Minister Jawaharlal Nehru to invest in science and technology following independence as a compelling example of an unwavering national commitment to S&T "even when the country was seemingly too poor to do so."

Successive governments have embraced similar strategies.

India's persistence in building its S&T capacity is now paying big dividends for the economy. Between 1991 and 2004, the country's gross domestic product grew by about 7% a year. Since 2004, except for a sharp downturn that accompanied the global economic crisis in late 2008, the rate of annual growth has accelerated to about 9%.

The Minister readily acknowledges that other factors have played a central role in the progress that has been achieved. He points to the broad measures to liberalize the economy, orchestrated by then Minister of Finance and now Prime Minister Manmohan Singh, beginning in the early 1990s and continuing to the present, as primary reasons for India's recent economic success.



But Chavan is quick to add that one of the most critical drivers behind India's economic growth has been the country's growing capacity in S&T. Prime Minister Singh, for example, has also called for a doubling of public investments in research and development (R&D) and the creation of a vastly expanded network of S&T institutions.

"The first significant impact of S&T on the economy took place in the agricultural sector during the 1960s with the Green Revolution," Chavan notes. "This not only allowed India to gain self-sufficiency in feeding its people but also galvanized public support for S&T."

The second significant impact occurred with the growth of defence-related R&D in the 1970s and 1980s. "Investments in defence-related R&D," he says, "helped expand a number of sectors ranging from food processing to space science."

The third significant impact, he says, occurred with the liberalization of the economy in the 1990s. This not only helped to open S&T in India to both international collaboration and competition. It also helped to spur economic growth. "Increased wealth," Chavan observes, "has generated larger investments in S&T."

Today, India is recognized for S&T excellence in a growing number of areas, including information and communication technologies, biotechnology, pharmaceuticals, space science and nanotechnology. A large pool of scientists and technologists supports these and other fields – for example, India graduates some 700,000 engineers each year.

Progress is undeniable. But the Minister would be the first to admit that serious challenges remain.

India, he says, must continue to increase its investment in S&T. "We now spend about 1% of our GDP on R&D. I hope we can raise this figure to 2% in the years ahead." He also observes that 75% of the investment in R&D currently comes from the public sector and only 25% from the private sector. "I hope that the private sector's share of expenditures will eventually reach 50%." Greater involvement of the private sector, he asserts, "will help expand the impact of S&T on the economy."

Most significantly, Chavan maintains, India must take steps to engage a larger portion of its population in the emerging knowledge-based S&T-based economy.

This goal, he says, needs to be pursued on a number of fronts. There must be continual efforts to improve the educational system. There must be ongoing initiatives to ensure that the benefits of S&T reach the poorest segments of society. And there must be persistent efforts to engage the public in meaningful discussions about the role of S&T in their communities and lives.

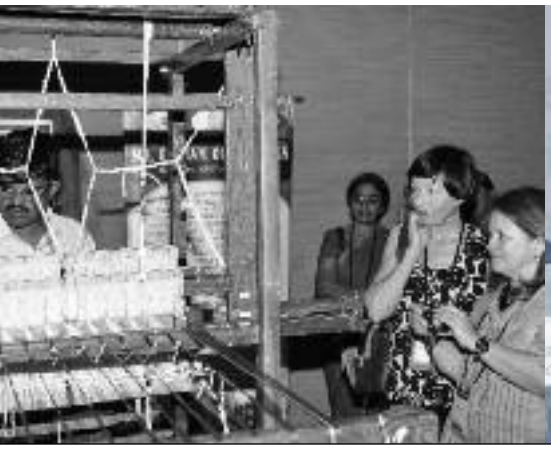
"The pace at which India has built its scientific and technological capacity may have been slower than some have wanted," Chavan acknowledges. But recent trends suggest that the country's S&T capacity, built on deeply rooted societal traditions and increasingly effective policies, is now growing at an ever-faster rate.

And that is a primary reason why Chavan believes that the progress India has made over the past several decades is just a prelude for better things to come. ■

CONDITIONS ON THE GROUND

Abdoulaye Mando sees the world from the ground up – a line of vision that is helping thousands of farmers in sub-Saharan Africa.

For his broad-ranging accomplishments as a senior soil scientist and programme leader at the International




Centre for Soil Fertility and Agricultural Development (IFDC) in Lomé, Togo, Mando has been elected as a member of TWAS. The induction ceremony for the "class" of 2009 took place at the 21st General Assembly in Hyderabad.

Mando studies soil conditions in Africa to develop the best management options for farmers.

His research not only involves investigations into such matters as soil nutrient levels and erosion rates, but also includes computer modelling to determine how certain measures might improve soil conditions and lead to higher yields.

Initiatives range from changes in farm practices – for example, a greater reliance on no-till and contour tilling – to purchases of new, higher yielding seed varieties. It's all part of what Mando and other agricultural experts call "integrated soil and water management." His research has led to some 12 book chapters and more than 30 articles published in peer-reviewed journals.

But Mando is interested in more than publications. At IFDC, he also leads efforts to coordinate programmes that put scientific knowledge to use on the ground to enhance crop yields. His activities take place not only in Togo but also in Burkina Faso, Benin, Mali, Niger, Nigeria and Uganda. The programmes are supported by the International Fund for Agricultural Development (IFAD), the Netherlands Directorate General for International Cooperation (DGIS) and the US Agency for International Development (USAID).

"Land holdings across the region," Mando says, "are small, ranging from less than one hectare in southern Togo to 5 to 10 hectares in northern Nigeria." Primary crops include maize, cassava, sorghum, rice and yam.

"My colleagues and I don't work directly with individual farmers," he explains. "Instead, we work through universities and research institutes. We have learned from experience that simply conveying our research findings and recommendations without adequate training and resources is ineffective."

That's why Mando and his colleagues have developed "innovation platforms" that draw on the knowledge and skills of a broad range of professionals, including policymakers, agricultural extension agents and business people.

"We need to involve policymakers to help ensure there is sufficient support from the political leaders," Mando explains. "We need to involve extension agents to help educate and train the farmers. And we need to involve the private sector to help foster the creation of markets where farmers can buy the seeds, chemicals and equipment they need to implement the integrated management strategies that we suggest they follow."

Conveying our research findings and recommendations without adequate training and resources is ineffective.

The broad reform efforts introduced by Mando and his colleagues have had a significant impact on farming across the region.

He notes that in the coastal savannah of Togo, maize yields have risen from 1 to 3 tonnes per hectare over the past three years, and cassava yields have jumped from 7 to 30 tonnes. In Nigeria, upland rice yields have increased from 1 to 3 tonnes during the same period.

"The good news is that small, incremental changes can make a big difference in the lives of rural people. Yet making change happen requires the creation of an enabling environment that promotes the broad use of scientific knowledge in ways that farmers can understand and embrace as their own." ■

THE SOCIAL LIFE OF WASPS

Raghavendra Gadagkar (TWAS Fellow 2000), INSA S.N. Bose research professor and J.C. Bose national fellow at the Indian Institute of Science in Bangalore, has been carefully watching the behaviour of wasps for more than 40 years. What began as a hobby in the 1970s eventually turned into a profession. Today, he is one the world's foremost "waspologists".

"There are many insects that have sophisticated social arrangements," Gadagkar says. "The best known

are honey bees. Residing in colonies with populations of more than 60,000, they live altruistic lives in the service of the queen."

"The social arrangements for wasps are different," he notes. "For example, unlike a queen honey bee, a queen wasp looks no different than her workers and drones. Moreover, unlike queens of other wasp species that will aggressively attack uncooperative members of the colony, the queen wasp in the species that I study, *Ropalidia marginata*, rarely rules by physical force – except at the beginning of her reign when she asserts her authority to show the others who is in charge. Subsequently, she uses pheromones to dictate behaviour." These are chemical secretions that elicit a desired social response among her subjects.

Life's building blocks can be found on Mars. Whether life ever existed is still an open question.

Gadagkar says that what he does is not that much different than what an anthropologist does. But instead of meticulously studying humans, he studies wasps to uncover patterns of behaviour that shed light on social interactions. He has spent much of his time studying the wasp species *Ropalidia marginata*, which lives in colonies with 40 to 50 members.

"There are thousands of species of wasps," he explains "Some species – solitary wasps – live alone. Others – social wasps – typically live in colonies that can reach populations of up to 100. The advantage of studying the *Ropalidia marginata* species is that it is large enough in size to observe group interaction but small enough to keep a careful watch on individual members."

Gadagkar and his students identify each wasp with "a dot of non-toxic paint" and they sometimes even give their wasps names. They not only intensely observe them in their nests, but also deliberately intervene to try to answer questions about their behaviour under specific situations.

For example, Gadagkar and his students have removed the queen wasp from the colony to see how the rest of the colony reacts. What they have discovered is that one wasp – "the wasp in waiting" – begins to act aggressively to exert her authority. The other members of the colony, meanwhile, continue to function normally and go about their daily chores.

For Gadagkar, this suggests that work within the nest is largely decentralized and self-organizing and that the worker wasps can function (but, of course, not reproduce) without a queen. Within a week, all is back in order, as the new queen wasp assumes the throne. There is no overt struggle for succession.

And what if the old queen wasp comes back? The new queen peacefully acknowledges the old queen's rightful place in the colony and returns to her previous social status as a worker bee.

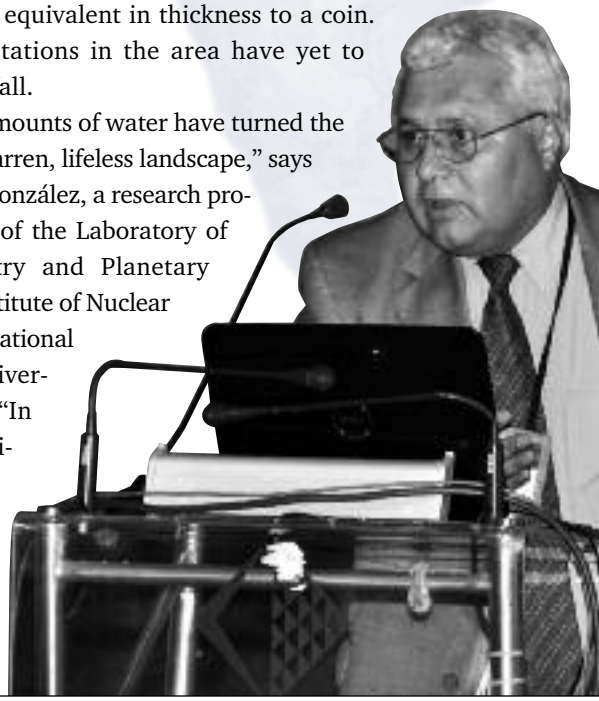
As part of a life-long scientific investigation into the social life of wasps, Gadagkar and his students have done a variety of other experiments – for example, they have moved and divided colonies, swapped queen wasps from one nest to another, introduced outside members into the colony and limited a colony's food supply.

It has been a fascinating adventure of discovery that he hopes places a mirror on our own human behaviour and encourages us to reflect on who we are, and how unique and superior we may – or may not – be after all. ■

MARS ON EARTH

The Atacama desert is a 1,500-kilometre-long wedge of land that stretches along the Pacific coast from southern Peru to northern Chile. It receives, on average, just one millimetre of rainfall each year – a level of precipitation that is equivalent in thickness to a coin. Some weather stations in the area have yet to receive any rainfall.

"Minuscule amounts of water have turned the Atacama into a barren, lifeless landscape," says Rafael Navarro-González, a research professor and head of the Laboratory of Plasma Chemistry and Planetary Studies at the Institute of Nuclear Research at the National Autonomous University of Mexico. "In terms of its environment and ecosystem, it is the closest place to Mars on Earth."



Navarro-González is the recipient of the 2009 TWAS prize in earth sciences. He spoke about his research at the TWAS meeting in Hyderabad.

The story begins with the twin Viking voyages to Mars undertaken by the US National Aeronautic and Space Administration (NASA) in the mid 1970s. "The missions," says Navarro-González, "were designed to collect images and soil samples from the surface of Mars for evidence of life in the past."

"NASA scientists," Navarro-González continues, "conducted experiments on the samples, seeking evidence of life revealed by the presence of photosynthesis, gas exchange, and the degradation of organic compounds in the soil.

"Proof of any of these processes," says Navarro-González, "would indicate that Mars was not lifeless."

"The initial investigations," Navarro-González notes, "achieved positive results. Yet, each of the findings hinted that living organisms might not have been responsible for these seemingly biological reactions."

For example, photosynthesis was taking place in darkness – something that could not happen among living organisms. Photosynthesis requires sunlight. In fact, 'photo' in Greek means light.

Gas exchanges of oxygen were also detected, notes Navarro-González. When water was added to the Martian soil, scientists detected a sharp rise in oxygen levels. But additional applications of water resulted in no further release of oxygen. Based on previous experiments with soil from other ecosystems, they had anticipated a slow upward rise in oxygen levels as the water was absorbed into the soil.

Laboratory analysis of possible soil degradation, moreover, showed that the "broth" of molecules in the soil was being consumed in a form that may have mimicked biological activity but in truth was due to chemical reactions.

The final and most important test, Navarro-González says, confirmed the suspicions of the researchers: "In their direct search for organics in the soil, they found none."

Absent the presence of organisms, the scientists decided that chemical reactions, not biological activities, accounted for the "appearance" of biological-like activity on Mars.

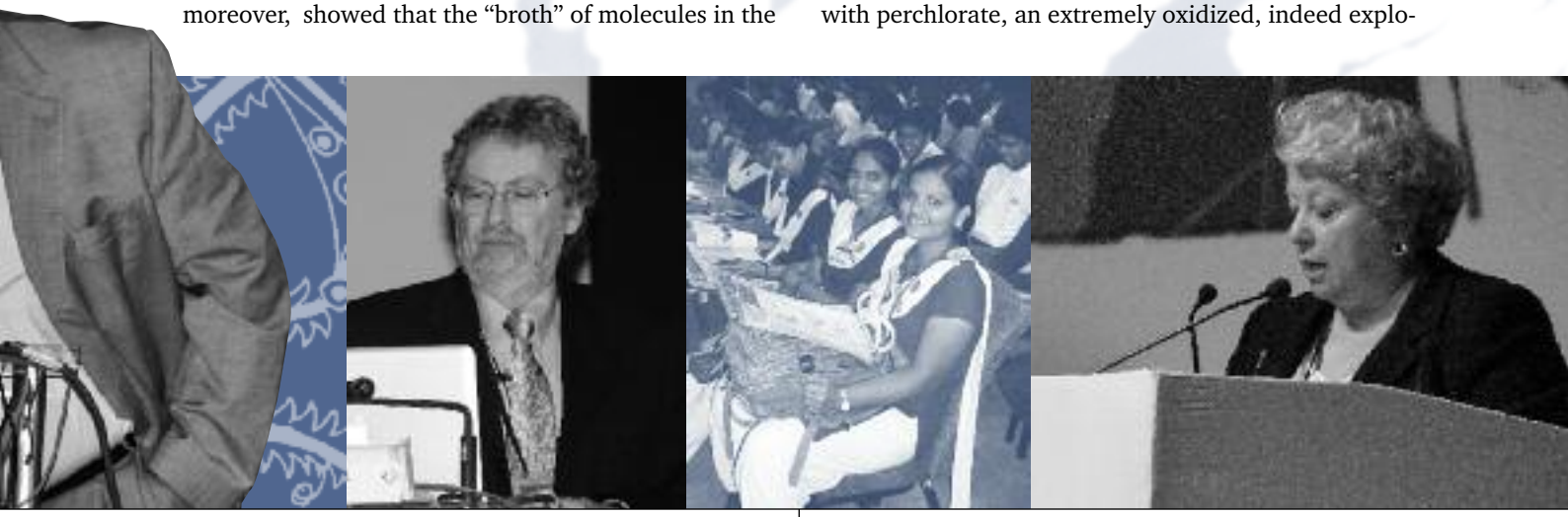
"The previous experiments," says Navarro-González, "had produced false positives."

And that's how the matter stood for more than a decade until scientists, in the 1980s, discovered rocks on Earth that they believed had originated on Mars. Extensive chemical analysis showed that the rocks had the same chemical composition and similar minerals to those found in the rocks analysed on Mars a decade earlier.

These findings, Navarro-González says, rekindled a new round of public interest in Mars. "There were even calls for a return to Mars," notes Navarro-González. "But a new mission would cost billions of dollars and take years, if not decades, to launch."

So, researchers did the next best thing. They decided to conduct experiments on soil and rock samples taken from the desert lands of Atacama, which, compared to Mars, was next door to their laboratories. Working with NASA, Navarro-González and his colleagues replicated the experiments of the 1970s "with, in a sense, the Earth's very own samples from Mars."

This time, however, they deliberately laced the soil with perchlorate, an extremely oxidized, indeed explo-



sive, salt. The use of perchlorate sparked a reaction that vaporized the soil, turning its trace elements of carbon dioxide into chloromethane and dichloromethane.

"These same hydrocarbons," says Navarro-González, "had been detected in the experiments done on soil samples from the Viking mission." But researchers had dismissed the findings believing that they were contaminants from cleaning fluids used to remove organics from the instruments at NASA's laboratories. "The contaminants were thought to have been released when the Viking Lander touched down on Mars and heated the soil," he explains.

"Our findings" – which will be published in the *Journal of Geophysical Research* – "clearly show that organics are present on Mars and that scientists working on soil samples from the Viking mission had simply misinterpreted the results." Mars, according to Navarro-González, has organics at levels 1,000 times higher than previously thought.

"Life's biological building blocks can indeed be found on Mars," concludes Navarro-González. "But whether life ever existed on the planet is still an open question."

For that, we may, in fact, have to return to Mars. But, thanks to recent investigations in the Atacama, we have reason to believe that the next expedition won't necessarily be returning to Earth disappointed. ■

HEALTH IN TRANSITION

"Global health is in a period of dramatic transition," says K. Srinath Reddy, president of the Public Health Foundation of India. And that transition is having a profound impact on health across the globe, especially in the developing world.

Reddy notes that developing countries "increasingly find themselves facing multiple disease burdens." On the one hand, they must grapple with infectious diseases associated with poverty – for example, bouts of acute diarrhoea, malaria and tuberculosis. On the other hand, they must increasingly deal with lifestyle diseases – for example, hypertension and cardiovascular disease, cancer and diabetes – that are often related to unhealthy diets and sedentary patterns of behaviour previously associated only with wealthy countries.

As Reddy observes, India, which still suffers high rates of infectious diseases, is now the global capital of diabetes. "An estimated 41 million Indians have diabetes," he says, "and that figure is expected to rise between 70 and 80 million people over the next few decades."

"Heart attacks are also on the rise in India," Reddy says. But in contrast to developed countries, where heart attacks first occur between the ages 60 and 70, in India and other developing countries heart attacks often strike in the late 40s or early 50s.

How can any country, Reddy asks, hope to build a prosperous society when a disproportionate number of its citizens are debilitated by illness and disease during the prime years of their work life? He cites a recent World Health Organization study which estimates that, between 2005 and 2015, developing countries will experience economic losses of more than USD235 billion due to heart ailments, strokes and diabetes.

If there is one word that describes the state of global health today, it is 'disparity'. For example, Reddy observes that there are disparities in life expectancy estimates at birth ranging from just over 40 in Lesotho to more than 80 in Japan. There are disparities in maternal mortality rates ranging from 2,000 deaths per 100,000 live births in Sierra Leone to 4 in Austria. And there are disparities in infant mortality rates, ranging from 160 deaths per 1,000 live births in Afghanistan to 3 in Singapore.

Disparities in critical health indicators, Reddy notes, just don't exist between devel-

oped and developing countries. They are present among developing countries too. For instance, the maternal mortality rate in India stands at 254 per 100,000 live births. In China, it is 54.

So, what can be done to improve global health and narrow health disparities between countries?

Reddy says that it is important for developing countries to address their chronic shortcomings in medical personnel. But it's not just personnel shortages or money that require the attention of policymakers. Reddy says there must also be a fundamental shift in thinking on how to train and employ health professionals.

"Greater emphasis must be placed on primary health care," he maintains, "and that means training greater numbers of general practitioners and fewer specialists." He also contends that "we must move health-care curricula beyond strictly confined professional tracts to channels that provide the knowledge and skills health-care professionals will need to 'fit the functions' that they will be asked to serve."

If there is one word that describes the state of global health today, it is 'disparity'.

He asserts that we must increase incentives for results-based rather than service-based health care. In addition, he maintains that we must develop comprehensive strategies to take advantage of new technologies, especially information and communication technologies, to improve the efficiency of health-care delivery. New fields of science, such as genomics, must be embraced not just by researchers, but also by clinicians. Yet, he also states that "we must carefully evaluate these technologies and fields" to ensure the investments are paying off in terms of better health.

Reddy observes that the 21st century will be the century of global health, and that this carries two important implications for health-care practices worldwide.

First, it means that a growing number of health issues will require a global response if we are to meet the challenges that these issues entail. These issues include the rapid transmission of new pathogens, fears of bioterrorism and the growing incidences of such non-communicable diseases as tobacco-related cancer, diabetes and obesity that are associated with unhealthy diets and lifestyles.

Second, Reddy notes that health is increasingly affected by trends that "are not often thought to be directly related to health", but that nevertheless have "profound impacts on whether people are able to live healthy lives." These trends include rapid urbanization and a sharp rise in air pollution levels in cities in the developing world, the spread of industrial agriculture which raises the prospects of more frequent occurrences of zootropic pandemics, and the spectre of global warming.

The 19th century, Reddy observes, was marked by the first significant advances in the practice of medicine and the 20th century by a rise in public health concerns.

The 21st century, in contrast, may be the century in which health issues are directly tied to broader currents in our global community, including efforts to combat global warming and devise effective measures for sustainable development.

To meet these complex challenges, Reddy concludes, "we must pursue strategies that have multiple, synergistic benefits for the economy, the environment and public health." ■




TWAS 21ST GENERAL MEETING

Hyderabad, India, 19-22 October 2010

TRIESTE SCIENCE PRIZE FOR 2010

JOSÉ GOLDEMBERG, A WORLD-RENOWNED ENERGY EXPERT WHO HELPED TO LAY THE FOUNDATION FOR BRAZIL'S BIOFUELS PROGRAMME AND SUBSEQUENTLY BECAME A LEADING ADVOCATE FOR THE ADOPTION OF "LEAPFROG" TECHNOLOGIES TO PROMOTE ECONOMIC DEVELOPMENT IN THE DEVELOPING WORLD, HAS WON THE 2010 ERNESTO ILLY TRIESTE SCIENCE PRIZE.

The Ernesto Illy Trieste Science Prize, co-sponsored by illycaffè, TWAS and the Ernesto Illy Foundation, is an annual prize given to a renowned researcher in a developing country or country with an emerging economy who has made significant contributions to science and scientific innovation. The prize, which in 2010 was given in the field of energy, includes a cash award of USD100,000.

This year's winner, José Goldemberg, a former Federal Secretary of Science and Technology and Minister of Education and professor at the University of São Paulo in, Brazil. The citation for the prize reads: "The Trieste Science Prize is given to José Goldemberg for his contributions to the development and modernization in the use of biomass as a sustainable energy resource."

In a seminal article published in *Science* magazine in 1978, Goldemberg and his colleagues presented compelling evidence showing that biofuels derived from sugarcane could reduce the use of fossil fuels in Brazil while rendering substantially less harm to the global environment.

"At the time," Goldemberg says, "efforts to develop biofuels in Brazil were justified largely on the basis of energy security. The prevailing thinking among government officials was that tapping larger quantities of domestic energy would reduce reliance on foreign sources of energy.

"The research that my colleagues and I conducted at the University of São Paulo added to the justification for biofuels by demonstrating that its production in Brazil would not only significantly decrease the use of fossil fuels, but also help curtail air pollution and greenhouse gas emissions."

Goldemberg's findings helped to bolster the Brazilian government's efforts to institute a biofuels programme in 1975 in response to the international oil crisis fuelled by the Arab oil embargo.



In the early 1970s, the Brazilian government's primary goal was to overcome possible supply disruptions from abroad by developing domestic sources of fuel. At the time, Brazil had virtually no domestic sources of oil. As a result, the embargo, put in place by the Arab oil-producing countries in October 1973 in response to US support for Israel during the Fourth Arab-Israeli War, led to fuel shortages that had a significant impact on the Brazilian – and indeed the global – economy.

When the embargo was lifted, the primary justification for the programme became less persuasive as worries about fuel disruptions faded. Fossil fuel proponents, who had expressed reservations about the programme from the very beginning, doubted its economic viability in light of the substantial government subsidies that were necessary for it to become operational. They also questioned whether biofuels, when accounting for the entire production and distribution cycle (from the tractors needed to cultivate the crops to the delivery of the fuel to petrol stations), actually represented a net plus in energy supplies for the country.

By verifying biofuel's "positive energy balance" and "adding an environmental dimension to the argument," Goldemberg strengthened support for Brazil's biofuels programme. His efforts played a critical role in helping to ensure the long-term viability of the initiative.

LIQUID SOLAR ENERGY

Goldemberg contended that biofuels, which he sometimes refers to as "liquid solar energy," was more than a hedge against an uncertain energy future. He has convincingly shown that a well-planned biofuels production system, based on sugarcane-based fuel crops, could substantially increase Brazil's energy supplies – and do so in a reliable way that would also be good for the environment. Because ethanol does not contain such impurities as sulphur oxides and particulates, it can help alleviate tropospheric air pollution, and because it curbs carbon emissions, it can help alleviate the impact that the transportation sector is having on global warming.

Today, Brazil produces more than 25 billion litres of sugarcane-based ethanol each year – a level of production that replaces 50% of the gasoline used in the country. More than 7 million flexible-fuel automobiles

ERNESTO ILLY TRIESTE SCIENCE PRIZE

Instituted in 2004 by TWAS and illycaffè and supported by the Ernesto Illy Foundation, the Ernesto Illy Trieste Science Prize is designed to bring recognition and distinction to the developing world's most eminent scientists.

The award, bestowed under the High Patronage of the Presidency of the Republic of Italy, is dedicated to Trieste, a city in northeast Italy that has made significant contributions to the promotion of science in the developing world and is home to the headquarters of TWAS. The prize is named for the long-time chairman of illycaffè, Ernesto Illy.

For further information, visit www.twas.org.

– capable of running on blends of ethanol and gasoline ranging from zero to 100% ethanol – now ply Brazil's streets and highways. That percentage is rising quickly as 95% of all new automobiles sold in Brazil today are flexible-fuel cars.

Given these trends, it should not be surprising to learn that ethanol production and distribution generates USD30 billion each year in revenues (about 5% of Brazil's gross domestic product) and accounts for one million jobs in Brazil.

PHYSICS TO FUELS

Trained as a physicist at the University of São Paulo, Goldemberg pursued postgraduate studies in Canada and the United States before returning to his alma mater in the mid-1950s, where he earned a PhD and subsequently became a full professor and the rector of the university.

In the early 1990s, he served as Brazil's Federal Secretary of Science and Technology and Minister of Education. In 1992, during his term as interim Federal Secretary of Environment, he was one of Brazil's highest-level representatives at the "Earth Summit" in Rio, a meeting that proved instrumental in setting the global environmental agenda in the late 20th and early 21st centuries. From 2002 to 2006, he was the Secretary of Environment in São Paulo, Brazil's most populous state and largest producer of biofuels.

Goldemberg's accomplishments in the policy arena have been matched by his extensive contributions to research and scholarship. In addition to his seminal articles on the environmental advantages of biofuels and his acclaimed publications on the relationship of energy to sustainable development in the developing world, in 2000, he was named lead author of the United Nations Development Programme's (UNDP) *World Energy Assessment*, and in 2007 he co-chaired the InterAcademy Council (IAC) study panel responsible for the report, *Lighting the Way: Towards a Sustainable Energy Future*.

In 2000, Goldemberg was awarded the Volvo Environment Prize and in 2008 the Asahi Glass Foundation's Blue Planet Prize. In 2007, *Time* magazine named him one of the "heroes of the environment".

ENERGY FOCUS

Goldemberg has spent his career bridging the world of research and policy, and has long been a passionate advocate for expanding the use of renewable energy, especially in developing countries. He contends that, by relying on renewable sources of energy, developing countries can "leapfrog" fossil-fuel-dependent devel-

ERNESTO ILLY FOUNDATION

Created by illycaffè and open to other supporting members – aims to develop and increase the rich heritage of ideas, projects and activities that Ernesto Illy left as his legacy. Its mission consists in fostering knowledge, ethics and sustainability not only as absolute values but also as business pursuits in ways that promote research as the principal way to attain the truth and human progress. The Foundation's activities mainly focus on ethics, sustainability, scientific research and coffee culture. Anna Rossi Illy, widow of the late Ernesto and honorary president of illycaffè, chairs the Foundation. See www.fondazionernestoilly.org/fondazione.

oped countries and "chart a more viable path for sustainable development."

He first outlined this paradigm for economic development in a book, *Energy for a Sustainable World*, which he co-authored with Thomas B. Johannsson, Amulya K.N. Reddy and Robert Williams in 1988. The book helped to redirect discussions on the relationship between energy and economic development by convincing policymakers of the important role that innovative technologies could play in providing plentiful yet environmentally sound supplies of energy to meet the developing world's growing energy needs.

While Goldemberg readily admits that economic progress is usually a story of incremental change, he maintains that there are times in history when nations and societies can jump ahead in dramatic ways that defy the linear "step-by-step" incremental advances that have often defined the pace of progress, especially for poor countries.

LOOK AND LEAP

Goldemberg didn't invent the term "leapfrogging". But the books and articles he wrote, both individually and in collaboration with others, helped to make the concept a commonly accepted part of discussions related to the complex relationship between science, technology and development.

"Leapfrogging" has taken on many different meanings. Today, it is sometimes used to describe rapid economic growth – as when journalists and scholars alike noted in August 2010 that China had "leapfrogged" past Japan to become the world's second largest economy.

But for Goldemberg, "leapfrogging" carries a very specific meaning. He is referring to the ability – indeed the necessity – for developing countries to embrace renewable energy as an effective way to bypass the fossil-fuel "energy pathways" that have propelled economic progress in the developed world.

The quest for energy in developing countries, Goldemberg has noted in his writings, is in part driven by demand. If developing countries are to successfully lift their populations from their chronic states of poverty, they will have to consume larger amounts of energy.

> ***The emergence of new energy technologies could allow developing countries to 'leapfrog' into the 21st century.***

No one, he adds, "can deny poor people their aspirations for a better a life." Yet, if developing countries embrace the same energy policies as developed countries, they will not only be placing additional pressure on finite fossil fuel reserves but also adding to the burden of global warming – an issue that first gained currency in the scientific community in the early 1980s.

Goldemberg has viewed the potential growth of renewable energy in developing countries as an opportunity as much as a challenge. That's because he firmly believes that the emergence of new energy technologies – for example, photovoltaics, storage batteries,

PREVIOUS WINNERS

The first Ernesto Illy Trieste Science Prize was awarded in 2005. Since then, it has been given annually in a variety of different of fields of science and technology. Previous winners are:

2009 in climate change and its impact on agriculture in developing countries

- ***Pram Kumar Aggarwal**, ICAR national professor at the Indian Agricultural Research Institute in New Delhi, India.*
- ***Carlos Clemente Cerri**, senior scientist at the Universidade de São Paulo, Brazil.*

2008 in earth, space, ocean and atmospheric sciences and engineering

- ***Beatriz Barbuy**, professor at the Institute of Astronomy, Geophysics and Atmospheric Sciences at the University of São Paulo (IAG/USP), Brazil, and vice-president of the International Astronomical Union (IAU).*
- ***Roddam Narasimha**, chairperson of the Engineering Mechanics Unit at the Jawaharlal Nehru Centre for Advanced Scientific Research, in Bangalore, India, and Pratt & Whitney professor of science and engineering at the University of Hyderabad, India.*

2007 in chemical sciences and agricultural sciences

- ***Goverdhan Mehta,** CSIR Bhatnagan fellow and honorary professor at the Department of Organic Chemistry at the Indian Institute of Science in Bangalore, and distinguished research professor at the University of Hyderabad, India.*
- ***Luis Rafael Herrera-Estrella**, director of the National Laboratory for Genomics of Biodiversity and professor of plant genetic engineering at the Centre of Research and Advanced Studies in Irapuato, Mexico.*

2006 in medical sciences and mathematics

- ***Chen Ding-Shinn**, dean of the National Taiwan University College of Medicine and chair of the Taiwanese government's Hepatitis Control Committee, Taiwan, China.*
- ***Rao Zihe**, professor at Tsinghua University and director of the Chinese Academy of Sciences' Institute of Biophysics, China.*
- ***Jacob Palis**, director-emeritus of the Institute of Pure and Applied Mathematics (IMPA) in Rio de Janeiro, Brazil.*
- ***C.S. Seshadri**, founding director, Chennai Mathematical Institute, India.*

2005 in biological sciences and physics and astrophysics

- ***Sergio Henrique Ferreira**, professor of pharmacology in the Faculty of Medicine at the University of São Paulo in Ribeirão Preto, Brazil.*
- ***T.V. Ramakrishnan**, distinguished associate in the Centre for Condensed Matter Theory at the Indian Institute of Science in Bangalore, and DAE Homi Bhabha professor of physics at Banaras Hindu University in Varanasi, India.*



solar, wind and, of course, biofuels – could allow developing countries to "leapfrog" into the 21st century without replicating the developed world's dependence on oil and gas – with all of the attendant problems related to security, air pollution, global warming and rising costs that this dependence entails. He also believes that support for renewable energy would spur other sectors of the economy and help to create both wealth and jobs.

Indeed Brazil's experience with biofuels over the past two decades has largely confirmed Goldemberg's forecasts. As he notes: "The production of biofuels in Brazil has led to the wide use of flexible-fuel engines and has stirred dramatic changes in Brazil's agriculture," making it more efficient and productive – for example, by introducing economies of scale and encouraging the use of cogeneration farm energy systems that draw on the burning of "waste" to supply both electricity and heat.

Brazil's biofuels programme, Goldemberg proclaims, "is now a mature and successful enterprise. Our experience has a great deal to teach other countries seeking new and innovative ways to align its energy and economic development policies."

Brazil's biofuels programme is now a mature and successful enterprise.

What Brazil has done, he adds, sheds a good deal of light on the role that government can play in supporting new technologies and launching new industries; it reveals how the relationship between the government and private sector can evolve (for the benefit of both) once the new technology and industry gains a foothold in the economy; it shows how synergies develop between various sectors of the economy; and it illustrates how success feeds upon itself to create a strong basis for innovate applications of technology. Perhaps, most importantly, he notes, it highlights the value of planning and persistence.

"Biofuels and other renewable sources of energy may represent 'leapfrog technologies,'" Goldemberg says. "But, as the experience in Brazil shows, the level of success depends on sound, adequately funded programmes for research, development and innovation that recognize long term problems require long-term solutions."

FOOD AND FUEL

In recent years, Goldemberg has been fully engaged in scientific discussions concerning biofuels' potential impact on food security and the conservation and preservation of forests and agricultural land. His studies have shown that only about one-half percent of the 1.5 billion hectares of arable land currently under cultivation is being used to grow fuel crops.

His studies have also shown that only a small amount of additional land will be needed to meet the projected demand for biofuels over the next decade (an estimated 4% of the total 440 million hectares of arable land that potentially remains available on a global scale). And, he adds, nearly all this land is in the developing world: 250 million hectares is in South America and another 180 million hectares is in Africa.

This, he says, offers an opportunity for agricultural expansion both for food and fuel crops that could provide a substantial boost to their economies.

Together with the development of second-generation technologies and access to marginal pasturelands, Goldemberg notes, there is good reason to believe that "additional lands could be cultivated for biofuels without jeopardizing global food security or placing other worthy environmental and land use goals at risk."

He nevertheless recognizes that Brazil enjoys unique characteristics, especially in its climate and soils, that facilitate the production of ethanol. He points to Brazil's "sugarcane" climate marked by high temperatures and high humidity. And he cites its broad savannas that cover more than 20% of the country's landmass – endless grasslands of untilled terrain that offer unrivalled opportunities for the cultivation of sugarcane. "These natural attributes," he acknowledges, "make it difficult to replicate Brazil's ethanol experience in other places."

Yet Goldemberg observes that there are places where sugarcane-based ethanol could expand "with good economic and environmental effects." He points to sub-Saharan Africa – most notably, the countries of Mozambique, South Africa and Tanzania – as potential candidates for large-scale ethanol production. The climate and soils in these countries, he says, are conducive to sugarcane production and there are substantial expanses of land that remain open and that are not likely to be used for food crops in the near future.

He also says that India has the potential to produce large amounts of sugarcane-based ethanol fuels. But, he adds, "India's tradition of small-scale farms may prove to be an obstacle to ethanol development there." That's because large farms seem to be the most efficient way to cultivate sugarcane for ethanol production. "The systems needed to grow sugarcane and the mechanized harvesting techniques that seem to be the most efficient way to gather the crop lend themselves to large-scale commercialized farms that can avail themselves of large-scale equipment."

Goldemberg would indeed welcome an increase in the production of ethanol crops, particularly sugarcane. In fact, he strongly believes that the development of substantial ethanol production in sub-Saharan Africa would have the same positive impact on the economy in Africa as it has had in Brazil.

Biofuels will be an essential component of our efforts to achieve sustainable economic growth.

NEXT GENERATION

Goldemberg admits that the long-term future of ethanol lies in the scientific community's ability to discover ways to process cellulosic materials – for example, plant stems, stalks, leaves, bark and even recyclable garbage – that have no nutritional value and are not part of our diet. This effort, which energy experts

have labelled "second generation" ethanol production, must be advanced in two stages, he says.

"The first stage involves advances in our existing scientific knowledge, while the second stage is marked by improvements in technology and production." The knowledge to break cellulosic material into sugars and turn them into ethanol exists but "advances in hydrolysis, molecular biology and engineering will help to make current production processes more efficient."

What are really needed are improved production techniques that will allow cellulosic-based ethanol processes to operate at an industrial scale. "For now," Goldemberg says, "cellulosic-based ethanol is too expensive to reach a mass market."

FUEL IN THE FUTURE

"Biofuels," Goldemberg notes, "were the primary source of energy from the dawn of civilization until the 19th century when their use was eclipsed, first by coal and then by oil and gas." Today, biofuels represent about 10% of primary energy consumption. Moreover, traditional sources of biofuels – wood, dung and discarded plant material – account for much of the biofuels used today.

Goldemberg maintains that 'new' biofuels created specifically to meet growing transportation needs by serving as a substitute for fossil fuels could account for just 50% of global energy used in transportation by 2050, but only if the right policies and incentives are put in place to boost production and tap all of the potential fuel stocks for this renewable source of energy.

Despite the relatively slow and halting development of renewables, including biofuels, over the past several decades, Goldemberg remains convinced that "in a world increasingly concerned about future energy supplies and the spectre of global warming, the continued development of biofuels – as well as other renewable sources of energy – will prove to be an essential component of our larger efforts to achieve sustainable economic growth without placing the global environment at risk."

It is a fitting tribute to Goldemberg's work in renewable energy, and especially in biofuels, that his broad-ranging accomplishments – both in science and policy – are now clearly on display across his native Brazil: in the cars that people drive, the cleaner air that they breathe, and in the growing economic prosperity that more and more of his fellow citizens enjoy. And he believes that a similar "sugarcane" climate and ecology in other countries, particularly in sub-Saharan Africa, would allow them to emulate Brazil's success.

Playing a key role in improving people's lives and helping to build a framework for a more sustainable future are indeed worthy reasons for awarding Goldemberg the 2010 Ernesto Illy Trieste Science Prize. As he noted in accepting the prize, the honour, which is based on evaluations by fellow researchers who served on the prize committee, represents a "source of recognition by colleagues that I will always cherish."

"For someone who has spent his career traversing the rarefied world of research and the real world of policy and economics, it is wonderful to be honoured for my efforts. I sincerely thank illycaffè for sponsoring such a special prize and for saying, in effect, that my research has made a difference." ■

SCIENTIFIC PUBLISHING

THE TWAS/BIOVISION.NXT 2010 MEETING, CO-SPONSORED BY TWAS AND BIBLIOTHECA ALEXANDRINA, EXAMINED HOW THE RAPID DISPERSION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IS RESHAPING SCIENTIFIC PUBLISHING AND, MORE SPECIFICALLY, WHAT THIS MIGHT MEAN FOR YOUNG SCIENTISTS IN THE DEVELOPING WORLD.

> ***The true sign of intelligence is not knowledge but imagination.***
>
> *Albert Einstein*

ICTs have generally had a positive impact on science in the developing world. Yet, when it comes to scientific publishing, serious problems persist.

Some of these problems predate the internet. For example, publishers have long displayed a bias, sometimes subtle and sometimes not, against articles submitted by scientists from developing countries. Such a bias has made it difficult for scientists in these countries to publish in international peer-reviewed journals.

Other problems, meanwhile, have only recently emerged with the rapid dispersion of electronic communications. These challenges include limited bandwidth, which impedes access to information on the internet, and the advent of authors' fees for articles, which creates financial barriers for scientists from poor countries who are seeking to publish in peer-reviewed journals using this business model.

The benefits that the global scientific community derives from ICTs are there for all to see – most notably, in the emergence of China, Brazil, India and other countries as significant players in global science. But so too are the risks, especially for scientists from the poorest countries in the developing world.

There's no doubt that ICTs have created unprecedented opportunities for scientists in the South to become fully active members of the global scientific community. Yet, the advent of ICTs also has raised the unwelcomed possibility of being left even farther behind. That's because scientists who cannot easily access the internet – either because of high costs or low bandwidth (or both) – are likely to find that their prospects to participate in global scientific discourse are further diminished.

One of the key areas where these ICT-instigated trends are unfolding most dramatically is in the world of

scientific publishing – the focal point of discussions at the TWAS/BioVision.NXT 2010 meeting held in Alexandria.

SPREADING THE NEWS

First the good news. ICTs have helped to increase access to scientific information and to strengthen collaboration, which are the lifeblood of learning and discovery. And ICTs have played a key role in the creation of entirely new fields of scientific inquiry – for example, bioinformatics – where the accumulation and exchange of enormous quantities of information is at the centre of advances in the field.

Relatedly, ICTs have also helped strengthen scientific capacity, especially in the developing world. Most notably, ICTs have played an instrumental role in increasing the number of countries that now enjoy expanding scientific capabilities.

No one denies the critical role that ICTs have played in the rapidly growing scientific capacities of Brazil, China, India and other countries. The information revolution has undoubtedly inspired dramatic changes in global science, helping to close the North-South divide in scientific and technological capacity.

ICTs have also raised global public awareness of the value of science, helping to transform science museums and science centres into dynamic fora where citizens, and especially young people, can enhance their understanding of science and its impact on their lives.

ICTs, in brief, can help bridge the gap between science and culture. In fact, as some observers in India and other developing countries have noted, ICTs can help transform cultural attitudes towards risks and rewards and, as a consequence, drive science-based innovation.

ICTs have helped to increase access to scientific information and to strengthen collaboration.

IT'S NOT ALL POSITIVE

Yet, like all revolutions, ICTs have proven to be a disruptive force that has not only radically transformed the scientific community but also displaced and reordered the intellectual tools that scientists use to share their findings and exchange information.

Perhaps no aspect of global science has been more affected by ICTs than scientific publishing, which has been the primary channel through which scientists

have communicated both with each other and the larger public ever since 1665 when the Royal Society published its inaugural edition of *Philosophical Transactions*, the world's first journal devoted exclusively to science.

"The challenges posed by ICTs apply to the full spectrum of individuals involved in science," notes Adel El Zaim, senior programme specialist, International Development Research Centre (IDRC) in Canada, speaking at the 2010 TWAS/BioVision.Nxt (TWAS/BVA.NXT) conference in Alexandria.

That means ICTs affect not only scientists but also science journalists, and not only universities and research centres but also libraries and publishers. It is an issue, he says, that cuts across both the developing and developed worlds. And it is one that brings scientists closer together to pursue collaborative projects, yet one that also runs the risk of creating even wider gaps among them.

Certain trends, El Zaim observes, are likely to accelerate in the future. In the scientific community, there has been a "move from paper to the internet," placing an even greater premium on the speed at which data and information is published and distributed, and raising questions about conventional methods of peer review. At the same time, ICTs have accelerated the movement from individual scientists to research teams by making it possible to process reams of information through scientific cyber-networks that are capable of exchanging information across the globe at lightning speed.

Such global scientific projects as the Large Hadron Collider (LHC), the world's most powerful accelerator, located at CERN, the European particles physics laboratory, near Geneva, Switzerland, have taken full advantage of the vast potential for collaboration created by ICTs to promote a truly international exchange of scientific information. To support and analyse LHC experiments, the LHC computing grid harnesses the computing power of more than 140 computer centres in 34 countries. Thanks to the participation of some thousands of scientists, the grid processes on average more than one million computations each day.

Yet, what does it mean for the long-standing principles of authorship and individual responsibility when some of the articles produced as a result of LHC-related research are bylined by hundreds of authors. Indeed, how does the enormous amount of information that is being generated change the very nature of the data collection and analysis? With so many information

providers and users, who exactly can lay claim to the findings? What, in fact, constitutes an original individual thought? Will future Nobel Prizes be shared by hundreds of scientists? Will future research failures be assigned to no one?

ICTs have not only recast the prevailing definition of peer-review, but have also diminished the prospects of some publications, most notably journals published by university departments and professional associations,

while strengthening others, especially high-profile publications such as *Nature* and *Science* magazines with long-standing reputations for excellence and widespread name recognition.

Even more importantly, the pace at which publishing is changing, says El Zaim, is causing scientists and scientific publishers alike to question the time-honoured edict: "publish or perish." Instead, El Zaim maintains that, given the rapid pace of change in the world of scientific publication, it may be appropriate to talk about the need to "adapt or disappear."

This much, El Zaim asserts, remains true, especially for developing countries: "Knowledge gained through scientific research can help alleviate poverty." As a result, he contends that "it is not only important to showcase knowledge in scientific literature (whether in print or on the internet), but also to utilize that knowledge to address critical social needs." In that sense, he notes, not much has changed at all. "Knowledge," he insists, "must be useful".

WHY PUBLISH?

As Erik Thulstrup (TWAS Associate Fellow 1994), professor of chemistry at Roskilde University in Denmark and a former science specialist at the World Bank, notes, "people publish for any number of reasons": to inform other researchers about their work; to gain respect and notoriety among peers and therefore to enhance their prospects for promotion and career advancement; to spur comments and criticisms from their colleagues to help improve their work; and to advance the frontiers of science. In most instances, the reasons that drive scientists to publish, ranging from the self-serving to the sublime, are intertwined and re-enforcing.

"Such motives," Thulstrup says, "have placed a premium on publishing in prestigious international journals." But prestigious international journals, as Thulstrup is quick to add, have traditionally favoured submissions from the scientists in developed countries. This has placed scientists from the South at a distinct disadvantage in the fiercely competitive fields in which they work.

"And," he says, "language barriers also pose continuous obstacles." English may be the universal language of science, but English is not the first language of the majority of scientists in the developing world. Those who cannot express themselves as fluently as others are unlikely to receive the same consideration regardless of the newness of their findings or the strength of their arguments.

People publish for any number of reasons, ranging from the self-serving to the sublime.

Yet, as other speakers suggest, there may, in fact, be a deeper challenge – one that has to do not only with bias in scientifically advanced countries but also with prevailing attitudes that remain stubbornly in place in scientifically-lagging countries. As El Zaim told participants, "a culture of scholarly and scientific writing and publishing does not exist in every country."

JOINING FORCES

With international peer-reviewed journals having such high barriers to entry, scientific communities in devel-

oping countries have often relied on local publications and university department journals to convey their findings and ideas. At times, these journals publish articles that focus on issues of vital concern to their societies, offering practical solutions to critical problems based on solid scientific evidence.

Yet, as Thulstrup also observes, many of these journals, particularly university department journals, have "extremely small and insulated readerships." In fact, he says, many of these journals are hardly read outside of the departments themselves. He also notes that "it is difficult to achieve good editorial quality or to publish in a timely fashion given the limited resources that are available to them."

Thulstrup recommends that those involved in publishing departmental journals should consider joining forces to produce a single national or regional journal in their respective fields. By pooling their resources, he contends, journal sponsors would not only save money but, more importantly, also improve the quality of the publications.

"This strategy," he observes, "was pursued with great success among four Nordic countries – Denmark, Finland, Norway and Sweden – in the 1960s and 1970s. "The effort," he says, "resulted in much fewer but stronger and better edited journals. A similar initiative, on a national scale, has been launched in Brazil." The consensus among observers is that these journals provide more readable information of higher quality and reach a much higher number of readers in their fields.

A critical challenge, says Thulstrup, is to convince editors, who often have "deep personal commitments to the journals they produce, that it is everyone's interests, including their own, to consolidate their efforts."

ON ETHICS

Lila Rosa Castellanos-Serra (TWAS Fellow 2000), a senior researcher at the Cuban Center for Genetic Engineering and Biotechnology (CIGB), raises another critical issue facing the rapidly changing world of scientific publishing today: the question of ethics. This sensitive topic encompasses a broad range of issues, including fair and equitable access to data, the transparent reporting of research results and the ability for others to confirm and replicate the findings.

Castellanos-Serra notes that these issues, which have become even more complicated with the development of electronic information, are important for all fields of science, including her own field of biomedicine, where critical matters of public health directly related to society's well-being are at stake.

With the unprecedented growth of biomedical data, she says, "we need to establish strict criteria on what constitutes good publishing practices."

"Greater access to information is a public good that carries enormous societal benefits," she notes. But, she adds, "the scientific community must develop strict guidelines to ensure that the information is reliable and based on solid scientific research".

Castellanos-Serra acknowledges that the number of articles authored by scientists in developing countries in peer-reviewed international journals "remains low." This is "certainly true for biomedical journals," she says, but "it extends to other scientific fields as well." Overall, scientists from developed countries constitute 80% of the authors in international peer-reviewed science journals.

Greater access to information is a public good that carries enormous societal benefits.

There are many reasons for this imbalance, she observes, including limited resources (which are becoming increasingly important with the rise of author-sponsored open-source publishing strategies) and insufficient time (due to heavy teaching responsibilities).

Other obstacles standing in the way of success are inadequate training and consequently deficient skills in data analyses and interpretation, limited outlets for the consumption of local knowledge, and too few innovative industries that draw on scientific findings to succeed and prosper.

Prabuddha Ganguli, chief executive officer, Vision-IPR, in India, echoes Castellanos-Serra's concerns by contending that developing countries need to nurture 'innovation ecosystems'. The goal, he says, should be to create an enduring 'culture of science' that acknowledges and rewards transparency, risk-taking and novel thinking, and that is willing to address large, complex issues that are at the heart of society's greatest challenges.

Ganguli goes on to say that despite the rapid proliferation of ICTs across the globe, scientists in many poor countries continue to have limited access to the most up-to-date information, especially in such fields as biotechnology and materials science, where discoveries can have direct economic payoffs. Such problems are not only related to limited bandwidth, which can be resolved through greater investments in ICT infrastructure, but are also due to the fact that scientific journals are no longer the sole source of valuable information for scientists, technologists, businesspeople and entrepreneurs.

Today, Ganguli asserts, "upwards of 60% of all research findings are first presented in patent applications" and not in the scientific literature. That percentage, he forecasts, is likely to rise as the commercialization of knowledge and efforts to protect proprietary information become increasingly important both in developed and developing countries.

WHITHER PUBLISHERS?

What are scientific publishers doing in response to the rapidly changing environment in which they operate? Several large-scale projects have been launched to take advantage of the unprecedented opportunities for the rapid, cost-effective distribution of information that is afforded by ICTs.

Carl Schwarz, publishing director for Elsevier's *Our Life Science Journals*, notes that his publishing company was one of the founding members of the *Research4Life* initiative that provides developing countries no- and low-cost access to reputable scientific publications in health, agriculture and the environment. The other founding members were the World Health Organization, the United Nations Environment Programme, the UN Food and Agricultural Organization (FAO) and Cornell University in the United States.

Under the initiative, researchers in countries where the average annual per capita income is USD1,250 can access the journals free of charge. Those in countries with annual per capita incomes between USD1,250 and USD3,500 are required to pay an annual fee of USD1,000. Meanwhile, researchers in countries with annual per capital incomes of more than USD3,500 are not eligible for the service and pay subscription fees set by the journal publisher. *Research4Life*'s Online Access to Research in the Environment (OARE) has more than 3,000 journals on its list. HINARI, which provides electronic access to research publications in biomedicine and health, currently has more than 7,000 journals.

Schwarz welcomes the opportunities afforded by electronic communications and open-access publishing. He maintains that the initiatives empower both scientists and people in developing countries with knowledge that would otherwise be unavailable in a timely fashion. This has been especially true for publications devoted to health issues. In 2006, he says, there were just 30 journals that freely provided authoritative information about medical issues of personal interest to patients and their families. "By 2008", he notes, "the number of open-access medical journals had increased nearly sevenfold to 200."

Yet, Schwarz also cautions, subscription-based scientific publishing has been around for more than 400 years" and has enjoyed a remarkable track record of success. "We should experiment," he says, "but we need to experiment carefully."

PERUSING THE FUTURE

"Information wants to be free" is an adage often cited by advocates of online publications. Yet, as many observers have also noted, "information is extremely valuable and good information does not come cheap."

Both the adage and the qualifying statement apply to all scientific publications, whether they continue to publish print copies and depend on subscribers and association membership dues for revenues, or turn to the newer forms of electronic communications and rely on authors' fees to cover expenses.

Consequently, the critical question is this: who pays?

For decades the answer has been subscribers, professional associations, foundations and even advertisers. But over the past decade a new business strategy has emerged: open-access publishers that call on the authors themselves to cover the costs of editing and distributing the article.

Open-access effort began with the launch of the *Public Library of Science* (PLoS) in 2000 through an initiative spearheaded in part by Harold Varmus, who then headed the US Institutes of Health. But the effort did not really get off the ground until the launch of *PLoS Biology*, which augmented revenues generated by authors' fees with a multi-million grant received from the Bill and Melinda Gates Foundation to ensure high-quality editorial oversight.

PLoS was motivated by the belief that public libraries should not have to purchase journal subscriptions that contained information which had been gathered through research supported by public funds. Proponents also believed that making scientific information freely available across the globe would "increase the accessibility and utility of the scientific literature" and enhance scientific productivity and collaboration.

Today, by some estimates more than 10% of peer-reviewed scientific journals are open-access publications, including six journals sponsored by *PLoS*. About 20% of all peer-reviewed articles in all disciplines are freely available online (many following a delay of six months to one year). In the United States and Europe, there is a movement afoot requiring scientists who receive grants from government agencies and foundations to devote a percentage of the funds they receive to open-access publications.

Articles published in open-source journals, it should be noted, are peer-reviewed. In this sense, access is freely open to readers but not to writers who must receive a "passing grade" from their colleagues for their work to be published. But critics have charged that marginal articles may sometimes be accepted to keep a sufficient amount of revenues flowing in.

Critics have also levelled charges that the journals have yet to prove they are economically viable over the long term, although *PLoS* is scheduled to generate a small profit this year. Another open-access initiative, BioMed Central, begun by UK entrepreneur Vitek Tracz in 2000 and purchased by Springer in 2008, now has a catalogue of more than 200 journals and is also profitable.

Then, there is the impact that these open-source journals are having on scientists from the developing world who often do not have sufficient funds to pay for the authors' fees.

Under such circumstances, does open access, in reality, mean closed access? For Ramy Aziz, a member of the editorial board of *PLoS One*, the answer is a resounding "no." He notes that more than half of the authors publishing in *PLoS One, PLoS*'s flagship publication, are not from the United States or Europe.

Open-access advocates, moreover, have responded to this authors' fee challenge by offering stair-stepped payment structures in which scientists from richer countries pay more than scientists from poorer countries, and where scientists from the poorest countries receive a fee waiver and pay nothing at all.

ACCESS FOR ALL?

What do the trends in scientific publishing mean for scientists, particularly, young scientists, from developing countries? In some ways, the challenges remain much the same. Scientists from the South remain woefully underrepresented among authors publishing in both print and online international peer-reviewed journals.

Thus it is important to continue to pursue efforts to raise the profile and enhance the writing and editorial skills of scientists from developing countries. Schwarz notes that Elsevier has made a concerted effort to increase the number of scientists from the South on the editorial boards of its journals and has strongly encouraged scientists from smaller, less prominent countries to submit articles to its journals.

Sioux Cumming, programme officer for INASP (International Network for the Availability of Scientific Publications) notes that her organization is engaged in a series of capacity building programmes for scientists from developing countries that are designed to help them "gain access" to international peer-reviewed journals. She says that INASP currently works with 22 partnering countries, both to enhance their scientists' ability to obtain research funding and to raise their profile.

The obstacles these scientists confront, Cumming maintains, are familiar to those who have examined the problem: brain drain that results in the country's best scientists living and working elsewhere; weak networks and poor connectivity; inferior communication skills and low visibility in the international scientific community; and a loss of hope bred by years of slow progress.

Electronic communications has changed how information is assembled and how research itself is done.

By helping potential authors hone their writing and editorial capabilities, providing training to improve their publications, launching online journals that welcome submissions from scientists from the developing world, and forging regional networks that encourage scientists and publishers to exchange ideas and learn from each others' experience, Cummings hopes that INASP will help to build a strong foundation for writing and publishing excellence in poor countries.

WHAT HASN'T CHANGED

The advent of electronic communications has not just accelerated the pace at which information is disseminated. In many ways, it has changed how information is assembled and how research itself is done.

Yet, as discussions at the 2010 session on BioVision.Nxt, illustrated, at a time of unprecedented change, this much remains constant:

- Publishing in prominent peer-reviewed journals is the key to academic success.
- English is the universal language of science and is likely to remain so for the foreseeable future.

• Quality information and good science writing – whether for a technical or general audience – is a labour intensive, costly enterprise.

The growing complexity and specialization of science has made it increasingly difficult for scientists to speak across disciplines, let alone to a broad public. ICTs have accelerated this trend by allowing information to be funnelled into ever-more narrow channels of communication. The result is the creation of vibrant yet small networks often blissfully divorced from others.

Ironically, the age of the internet and electronic communications, for all of its benefits, may be creating a cellular world of self-contained groups that not only separate scientists from society but also separate scientists in different fields from one another. For scientific publishers, this means they must cater to ever-smaller niches, which presents both intellectual and economic challenges.

Growing specialization has made it difficult for scientists to speak across disciplines.

As Gaell Mainguy, director of publications at the Institute Veolia Environment in France, asserts, ICTs often "work best for small communities of scientists and scholars that share an intense interest in a specific area of knowledge." He cites the Polymath Project that sought to find a simpler proof for the Hales-Jewett theorem.

Over a six-week period, beginning in late January 2009 when the call was first made to join the research effort, nearly 30 mathematicians sent some 800 comments. A solution was announced on 10 March, proving that collaborative, interactive discussions conducted by a small group of highly engaged experts could solve problems that had eluded individual scientists for a long time.

Yet, if the challenge had not been so tightly focused and the group of participants not so clearly delineated,

BIOVISION AND BIOVISION.NXT

BioVision *is an international platform for dialogue, debates and proposals concerning major issues in the life sciences. The signature event is the BioVision.Alexandria conference held in alternating years in Lyon, France, and Alexandria, Egypt. The Lyon meeting is organized by the* Fondation Scientifique de Lyon *(*www.fondation-scientifique-lyon.org*) in collaboration with the French Academy of Sciences (*www.academie-sciences.fr*). The Alexandria meeting is organized by the* Bibliotheca Alexandrina *(*www.bibalex.org*).*
BioVision.NXT is BioVision's fellowship programme for young scientists. Some 100 promising scientists are invited to attend and participate in the BioVision conference. Specific workshops and activities are organised for BioVision.NXT fellows that are designed to encourage them to get to know one another and to engage with more senior conference lecturers and participants. The class of 2009 welcomed 90 young leaders from 30 countries: 37% from Europe, 19% from America, 15% from Africa, 12% from Asia, and 10% from the Middle East. For more information, see www.biovision.org/bv2011/biovision-nxt-overview.html*. For additional information about BioVisionAlexandria, see* www.bibalex.org/bva2010/home/StaticPage.aspx?page=69*.*

Mainguy doubts that the result would have been as satisfactory. Indeed he warns that such intensity could reinforce the fragmentation of knowledge, transforming the age of information into an age characterized by small, specialized networks comprised of like-minded individuals.

KNOWLEDGE REVOLUTION

Despite all of these challenges, participants at the 2010 TWAS/BVA.NXT conference concluded that scientific publishing is likely to become even more edifying and vibrant than it has been in the past as the number of peer-reviewed articles by scientists in the developing countries continues to rise, reflecting the growing scientific capacity in the South.

As Mohamed Afzal, executive director of the *Eastern Mediterranean Health Journal*, noted, between 2002 and 2007 investments in research and development grew more than three times faster in developing countries compared to developed countries.

"Science,"' the famed economist Herbert Spencer observed, "is organized knowledge" and the best way to organize knowledge is by recording information in a systemic way so that others may learn, absorb and thoughtfully respond to new data and insights.

In this sense, electronic information is no different than the printed forms of information that have been produced for the past 400 years. Nor does it stray far from the reiterative process that has characterized scientific progress for centuries.

That's why in the midst of a communications revolution that shows no signs of slowing down, there is good reason to believe that conventional standards for review and excellence will continue to hold sway. At least, that is the hope of both the scientific community and society, regardless of how scientific publications are financed and distributed in the future.

Today, there are some 25,000 scholarly journals worldwide carrying 2.5 million articles each year. With scientific output doubling every 15 years, journals will remain at the centre of the global scientific enterprise.

Publishing will drive, as much as record, advances in research. And quality, timelines and cost will remain at the centre of the scientific publishing enterprise even as the means of communication undergoes wrenching changes that rival those which took place after the invention of the printing press in the 15th century.

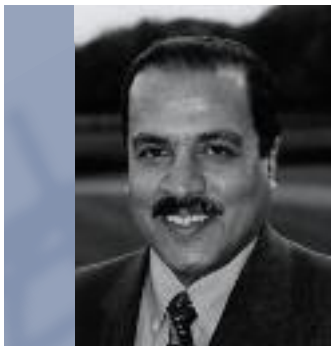
Is scientific publishing perishing? The answer is an obvious and resounding "no." In fact, you could argue that scientific publishing has never been more vibrant.

Is scientific publishing changing? The answer is an obvious and resounding "yes."

In the staid profession of publishing, which prides itself on following proven ways of operation, such change won't be easy. But it is inevitable. And if it takes place within the scientific community's abiding principles of excellence and transparency, science and society will both be better served by the new ways of communicating research findings. ■

KFAS DIRECTOR GENERAL

• **Ali A. Al-Shamlan** (TWAS Fellow 1987) is stepping down as director general of the Kuwait Foundation for the Advancement of Sciences (KFAS). In addition to his extensive accomplishments at KFAS, Al-Shamlan has contributed a great deal of his time and efforts to supporting TWAS activities. He served as TWAS vice president from 1992-98, TWAS



Ali A. Al-Shamlan

treasurer from 1999-2003 and a member of the TWAS council from 2004-09. Under Al-Shamlan's leadership, KFAS has been the primary sponsor of TWAS's flagship publication, the *TWAS Newsletter*, for many years. TWAS would like to express its deepest gratitude for Al-Shamlan's unwavering committment to and support for the academy. We wish him well in his future endeavours.

TWAS-ROLAC

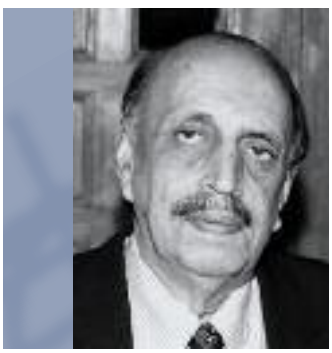
• **Antonio Carlos Campos de Carvalho** (TWAS Fellow 2003) has been appointed head of TWAS-ROLAC (Regional Office for Latin America and the Caribbean). Carvalho is a distinguished scientist in the medical and health sciences, and serves as scientific director of the National Cardiology Institute in Brazil and professor at the Federal University of Rio de Janeiro. He succeeds Marcelo

Antonio Carlos Campos de Carvalho

Viana (TWAS Fellow 1999), professor at the Institute of Pure and Applied Mathematics (IMPA), who ended his term in December 2010.

BIO-ASIA AWARD

• **Anwar Nasim** (TWAS Fellow 1987) has received the BioAsia-2011 Award for his outstanding work in biotechnology. Nasim, who is trained as a molecular geneticist, serves as science advisor to the Organization of Islamic Conference (OIC) Standing Committee on Scientific and Technological Cooperation (COMSTECH), in Islamabad, Pakistan. He is the founding president of the Federation of Asian Biotech Associations (FABA). The award ceremony, which took place on 24 February in Hyderabad, India, was attended by the governor of Andhra Pradesh. Nasim has previously been honoured with the Pride of Performance and Sitara-e-Imtiaz awards sponsored by the



Anwar Nasim

government of Pakistan. He is a fellow of the Pakistan Academy of Sciences and Islamic Academy of Science.

NEW AAS DIRECTOR

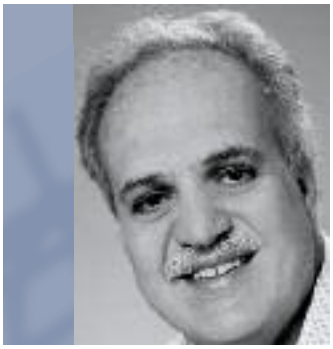
• **Berhanu Abegaz** (TWAS Fellow 1998) is the new executive director of the African Academy of Sciences in Nairobi, Kenya. He formerly served as professor of chemistry and coordinator of the Network for Analytical and Bioassay Services in Africa (NABSA) at the University of Botswana. At AAS, Abegaz will oversee pan-African programmes that recognize high scientific achieve-

Berhanu Abegaz

ment, support capacity building efforts in science, technology and innovation (STI) and promote quality scientific publishing.

NATIONAL R&D SECRETARY

• **Carlos Nobre** (TWAS Fellow 2006) has been appointed Brazil's National Secretary for R&D Policy and Programmes at the Ministry of Science and Technology. Nobre has worked for the National Institute for Space Research, Brazil, since 1983, where he has been involved in research that studied the local, regional and global impacts of Amazonian deforestation through observations and modeling. As national secretary, he will supervise national concerns regarding cli-


Carlos Nobre

mate change, biodiversity, meteorology, natural resources, global change and sustainability research. Nobre's first project will be to devise a plan for an early warning system for natural disasters in the wake of the January 2011 floods and landslides in Rio de Janiero that claimed almost 1,000 lives.

SERAGELDIN HONOURED

• **Ismail Serageldin** (TWAS Fellow 2001) has been elected as a foreign member of the Göteborg Royal Society of Arts and Sciences, Sweden. He has also been selected by the US National Academy of Sciences (NAS), in Washington DC, as the 2011 recipient of its most prestigious award, the Public Welfare Medal. Serageldin was chosen for his extensive involvement in initiatives to combat hunger in developing countries and in recognition of his tireless efforts to raise the profile of science in Arab and Muslim countries. Serageldin will be presented the medal on 1 May 2011 during NAS's 148th annual meeting. Serageldin is director of the *Bibliotheca Alexandrina* (BA).


Ismail Serageldin

ICSU-ROLAC

• **Manuel Limonta** (TWAS Fellow 1995) has been appointed the new director of the Regional Office for Latin America and the Caribbean of the International Council for Science (ICSU-ROLAC). He began his tenure on 1 January 2011. Limonta is head of biotechnology and science adviser at the National Institute of Haematology and professor at the Medical University of Havana in Cuba. He also served as the first director general of the Centre for Biological Research and the Centre for Genetic Engineering and Biotechnology in Cuba, and founded the centres for genetic engineering and biotechnology in the provinces of Camaguey and Sancti Spiritus.


Manuel Limonta

IN MEMORIAM

• **Wu Jieping** (TWAS Fellow 1992) died on 2 March 2011 at age 94. He was a senior academician at the Chinese Academy of Sciences and vice president of the Standing Committee of the National People's Congress from 1993-2003. Born in Changzhou City, Jiangsu Province, Wu obtained a doctorate in medicine at Peking Union Medical College and then served as professor of surgery at the Beijing Medical College, dean of the Beijing Second Medical College and a member of the World Health Organization (WHO) Scientific and Technical Advisory Group, Human Reproduction Special Programme. For his pioneering work in urinary surgery science and overall scientific achievements, he was given *La Grande Medaille de la Ville de Paris* and five national awards in China. He was honorary fellow of the American Urological Association, College of Surgeons of Hong Kong and the Royal College of Surgeons, Edinburgh.


Wu Jieping

WHAT'S TWAS?

TWAS, the academy of sciences for the developing world, 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 nearly 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.

In 1988, TWAS facilitated the establishment of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of some 150 scientific organizations in the South. In 2006, the foreign ministers of the Group of 77 and China endorsed the transformation of TWNSO into the Consortium on Science, Technology and Innovation for the South (COSTIS). COSTIS's goals are to help build political and scientific leadership in the South and to promote sustainable development through South-South and South-North partnerships in science and technology. ⋯⇢ **costis.g77.org**

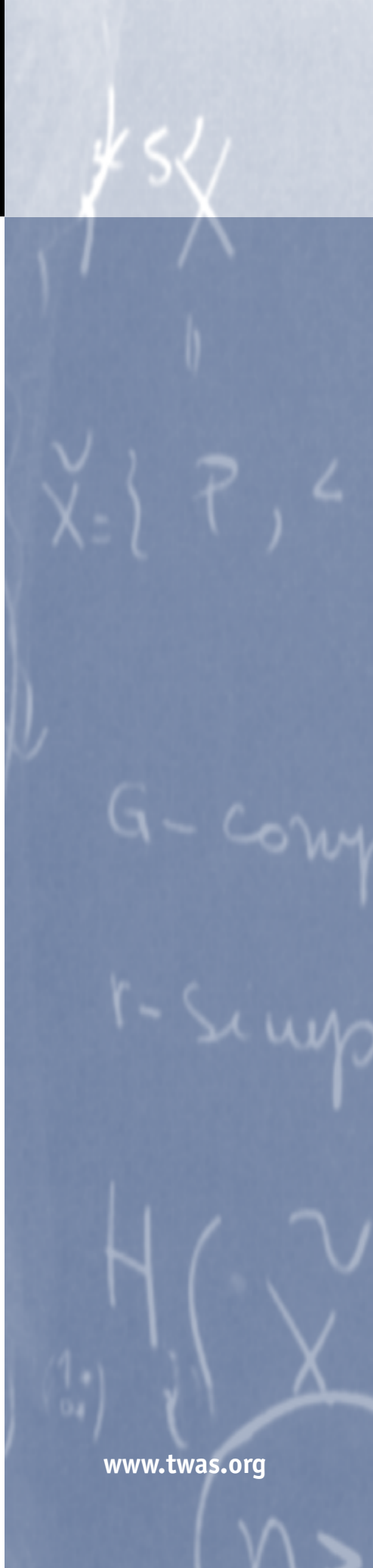
TWAS also played a key role in the establishment, in 1993, of the Organization for Women in Science for the Developing World (OWSDW, formerly the Third World Organization for Women in Science, TWOWS). Some 3,200 women scientists from more than 90 countries in the South are members of OWSDW, making it the largest organization of women scientists in the world. 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 OWSDW is hosted and assisted by TWAS.

⋯⇢ **www.twows.org**

Since 2000 TWAS has provided the secretariat for IAP, the global network of science academies. IAP, which was 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/iap**

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 69 members. ⋯⇢ **www.iamp-online.org**



www.twas.org