The birth of Dolly the sheep in 1987 was a scientific breakthrough, marking the first time that a mammal had been cloned. Dolly, in fact, was derived from an adult cell rather than from the fusion of an egg and a sperm. Overnight, the hypothetical notion of human reproductive cloning was transformed into a real possibility – an idea that many individuals and organizations quickly moved to condemn.

The technique used to create Dolly, however – somatic cell nuclear transfer – also has potential applications for so-called 'therapeutic cloning,' which could provide remedies for many previously incurable diseases. But, like reproductive cloning, therapeutic cloning is a controversial issue with ethical implications.

Last September, against the background of a United Nations debate on whether to ban all human cloning, the InterAcademy Panel on International Issues (IAP) issued a statement signed by 66 national academies of science calling for a ban on reproductive cloning, but supporting research on therapeutic cloning.

IAP Enters Cloning Debate

The process behind the IAP statement, which was released to the world's media during three near-simultaneous press conferences held in Trieste, London and São Paulo on 22 September, began back in March.

As Yves Quéré, co-chair of the IAP, explained at a press conference held at the IAP secretariat in Trieste the same day as the Panel's statement on cloning was released: "We knew that the UN would be debating a ban on human cloning at the end of September and felt that the academies and the scientific community should present their views on the problem. A six-member group, convened by the UK's Royal Society with representatives from Australia, Brazil, France, Iran, India and the UK, prepared a draft statement and submitted it to the 13 members of the IAP executive committee. This statement was discussed, amended and agreed upon before it was sent to the 90 member academies of the IAP for their approval."

Although many academies of science do not meet on a regular basis and the document had to be released before the UN meeting, IAP co-chairs Quéré and Eduardo Krieger regard it as a great success that 66 academies have signed the document, representing more than 16,000 of the world's leading scientists.

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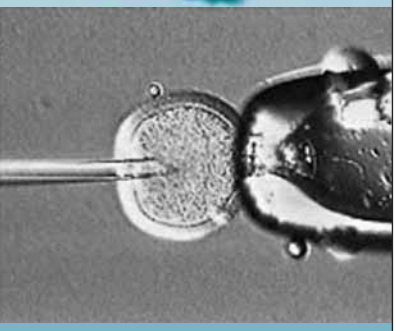


TWAS Executive Director Mohamed Hassan also pointed out at the Trieste press conference that more than 50 of the 66 signatories to the statement are from developing countries, including such regional academies as TWAS, the African Academy of Sciences and the Caribbean Academy of Sciences.

"Scientists in developing countries are very concerned that biotechnology research should not be held back," said Hassan. "In many developing countries, if cloning for research purposes is not allowed, it would compromise their participation in this exciting and potentially beneficial field."

CLONING

Cloning, or the production of (almost) genetically identical organisms, is a natural process. Identical twins are examples of clones, as both individuals are derived from the same fertilization event. At an early developmental stage, the young embryo splits in two, and both halves result in the formation of a complete individual. Taking a cutting from a plant, rooting it and growing a new plant from it is another example of cloning – in this case from adult plant cells.

As the first mammal cloned from adult cells, Dolly was unique, however. Chromosomes – the genetic material found in a cell's nucleus – were extracted from a cell taken from an adult sheep's mammary gland. This material was then injected into the nucleus of an unfertilized donor egg cell from which the original chromosomes had previously been removed. This new combination of egg cell with 'adult' chromosomes was allowed to multiply for a few days in a test tube before being implanted into the uterus of a surrogate mother sheep. Several months later, Dolly was born.

Since the birth of Dolly, many other mammal species, including mice, cattle and horses, have been successfully cloned using the same somatic cell nuclear transfer technique.

As the 66 IAP members pointed out in their statement supporting therapeutic cloning, however, a common feature of reproductive cloning in mammals has been the markedly higher than normal incidence of foetal disorders and loss throughout pregnancy, and of malformation and death among newborns.

"There is no reason to suppose this would be any different in humans," the academies concluded. "As a result, there would be a serious threat to the health of the cloned individual. Moreover, death of a foetus late in pregnancy could pose a serious threat to the health of the woman carrying it. Even on a purely scientific basis, therefore, it would be irresponsible for anyone to attempt human reproductive cloning."

Earlier this year, an independent, 'rogue' laboratory in the United States claimed to have produced the first cloned human baby. However, the group has yet to produce any scientific evidence of its achievement. This case highlights the need for international consensus on the issue. Apart from the health risks, there are also strong ethical, social and economic objections to the practice of reproductive human cloning, which has been said to "breach human rights and to violate the intrinsic dignity of all human beings." Indeed, many countries, including the United States and Germany, have already introduced bans on human reproductive cloning.

[CONTINUED PAGE 4]

THERAPEUTIC CLONING

Such bans introduced unilaterally by the USA, Germany and other countries also place restrictions on cloning for therapeutic purposes – a move supported by Costa Rica, Uganda and others, which have pushed for a global ban on all forms of cloning.

This, according to the IAP, would be a mistake because it prohibits a technique that could prove hugely beneficial to the health of millions of people around the world. Basically, therapeutic cloning, although still in its infancy, offers the potential to develop cures for many ailments that are, with current medical technologies, incurable.

Therapeutic cloning involves taking chromosomes from an adult cell and introducing them into an egg in the same way that Dolly was created. However, in this case, the resulting cell is never implanted into a uterus and is not allowed to develop into a young animal.

Instead, the cell is grown in a test tube for 5 to 6 days until it develops into a ball of about 100 cells known as a blastocyst. These cells, which have yet to differentiate into the cells that will eventually make up different tissues and organs, are known as stem cells. Scientists believe that such stem cells could be used to generate replacement cells and tissues to treat many diseases and conditions, including Parkinson's disease, leukaemia, stroke, diabetes, spinal cord injuries and such skin problems as those caused by severe burns.

Nuclear transfer cloning techniques also offer the prospect of providing patients with cell, tissue or organ transplants that are genetically compatible with the recipient, thus circumventing the problem of rejection. This potentially provides a greater supply of transplant material than can effectively be sourced by the organ donation system in use today.

Even so, it remains to be seen if cloning for therapeutic purposes will be clinically viable.

"Research into additional strategies to overcome immune rejection is therefore strongly to be encouraged," says the IAP statement. "Such research may require the use of human embryonic stem cells derived from early human embryos."

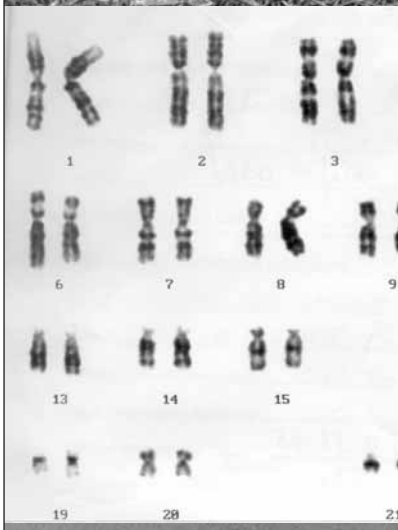
Critics of using stem cells from cloned human foetuses say that similar results could be obtained by using stem cells extracted from adult tissues. However, say the signatories to the IAP statement, scientific findings suggest that adult-derived stem cells would not be as versatile as embryo-derived cells and, therefore, research on both types of stem cell is vital to make a comprehensive evaluation of the prospects of stem cell therapy for the treatment of serious disease and injury.

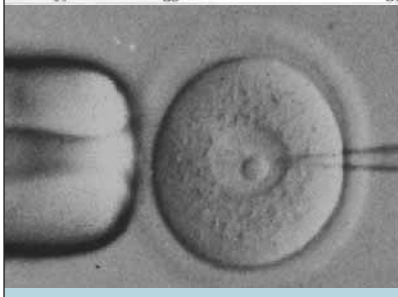
INTERNATIONAL DEBATE

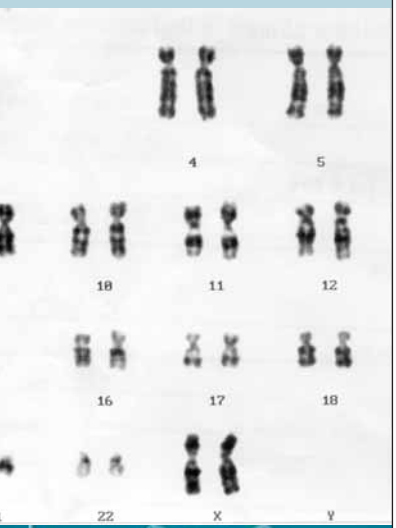
Beyond the unproven nature of the use of stem cells derived from cloned human embryos, many people are concerned about the practice of creating human embryos, although they are grown in test tubes for just a few days and would never be implanted in a uterus.

To some, the idea is ethically repugnant. Others contend that policing the production of embryos for stem cell research while banning the production of embryos for reproductive cloning would be too difficult and that legislation would be much clearer and easier to implement if there was a total ban on cloning.

In December 2001, France and Germany asked the United Nations to consider developing a binding treaty that would ban human reproductive cloning.







In autumn 2002, the UN delayed a decision about the scope of a treaty to ban human cloning. At least 75 countries supported the proposal by France and Germany to begin negotiations on a treaty that would ban reproductive cloning, to be followed by consideration of a treaty addressing cloning for research purposes. However, this was opposed by at least 35 countries, led by the United States and Spain, that called for both reproductive cloning and cloning for therapeutic or research purposes to be considered simultaneously.

Between 29 September and 3 October 2003, UN delegates returned to the negotiating table to debate a ban on human cloning. Against this backdrop, and concern that an opportunity would be lost for saving lives in both the developed and developing worlds, the IAP organized its petition in support of cloning for therapeutic and research purposes, while banning human cloning for reproductive purposes.

DELAYED OUTCOME

The most recent UN debate, like previous UN debates on the proposed ban on human cloning, was unable to reach a consensus. Instead, the delegates, adopting a motion put forward by Iran, narrowly decided to postpone further discussion and a decision for two years. The summary of the chairman of the UN working group (see *www.un.org/law/cloning*) spells out the dilemmas that make such decisions difficult to agree upon. However, among the seven points of his report are the words: "reference was made to recent statements, emanating from within the international scientific community, expressing support for a ban on human reproductive cloning, while allowing therapeutic cloning."

Although the final outcome of the debate has yet to be resolved (another UN debate will be convened in 2005), there is evidence that the voice of IAP, and the thousands of scientists it represents, has been heard at the highest levels. ■

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UPDATE

Since this article was written – and since the UN decided to postpone decision on cloning for two years – a number of nations, led by Costa Rica, attempted to have a second vote calling for a total ban on human cloning at the UN's General Assembly held in mid-December.
IAP immediately issued another statement to the UN and the world's press reiterating its support for a ban on human reproductive cloning while backing additional research into the potential of cloning for therapeutic purposes.

Costa Rica's motion was narrowly defeated, but a deal was reached whereby the UN will now re-open the cloning debate in one rather than two year's time. Thus, the global debate on cloning that the IAP has entered promises to remain at the forefront of science-related discussions in the years ahead.

IRAQ'S DESERT: CASUALTY OF WAR

FAROUK EL-BAZ (TWAS FELLOW 1985) DISCUSSES THE ENVIRONMENTAL CONSEQUENCES OF THE WAR IN IRAQ. DESERT SANDS, STRIPPED OF THEIR PROTECTIVE COVER, HAVE BEEN PLACED AT RISK.

The desert is the least understood of all of the Earth's land types. Many believe that it is a lifeless, static wasteland. In reality, seeds of life are always hidden beneath the sands awaiting a drop of rain.

Nevertheless, the desert surface is fragile. A single layer of gravel and pebbles shields the underlying soil from aggressive winds. Disturbing that layer causes the finest sand grains to be lifted into the air as dust. Larger grains accumulate into sand dunes, which continue to move as long as the wind blows.

During the recent war in Iraq, thousands of tanks and armoured personnel carriers sped in multiple lanes over the flat, seemingly-barren sands from Kuwait toward Baghdad. The race through the desert disrupted the natural stabilizing layer of surface pebbles and exposed the underlying fine-grained soil to the erosive action of the wind. Televized images of the military's deployment across the desert showed the results of this disruption: clouds of enveloping dust.

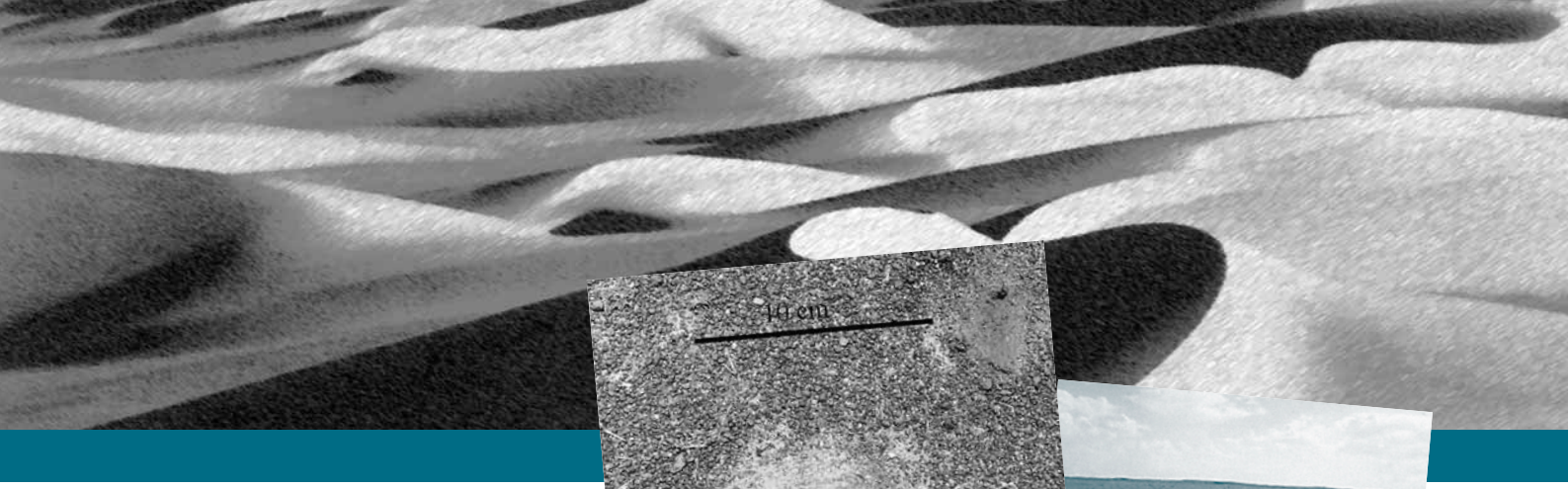
During the months that preceded the war, Iraqi military and US-led coalition forces alike spent much of their time digging trenches and pits or building protective banks and walls from sand. It is the thing to do for military forces in an open desert, usually to hide troops and equipment. In some cases, these activities are meant to keep the troops busy – and fit.

Scarring the terrain with these hollows and heaps also destroys the protective layer of pebbles and exposes the soil below to wind erosion. Surface irregularities represent impediments in the path of the wind, which acts to return the land to its original flatness – the path of least resistance.

The result is that the dust remains airborne, raising health and visibility hazards. The impediments also become the source of new sand dunes that encroach on roads, runways, farms and the occasional homes found in Bedouin communities.

There is a lesson in how the protective layer of pebbles formed in the first place. The terrain of Kuwait and southern Iraq was once a flat river delta fed by an ancient river that carried sediments over 850 kilometres from the Hijaz Mountains westward towards the Red Sea. When the river dried up 5,000 years ago, the wind began to segregate the delta's deposits.

The wind whirled particles with diameters less than 0.05 millimetres into the atmosphere as dust. Particles between 0.05 and 0.5 millimetres were winnowed out and accumulated into sand dunes. Grains from 0.5 to 2 millimetres rolled erratically on the surface. Gravel larger than 2 millimetres in diameter lagged behind to form a 'desert pavement' – a one-grain-thick layer



that has served as armour, protecting the underlying sediments from further wind erosion for thousands of years.

It took a vast amount of soil erosion and sorting to form that protective layer. It would require the same process and a similarly long period to regenerate the pavement layer.

My knowledge of this process is based on long-term field observations in desert areas in North Africa and the Arabian Peninsula, including a desert pavement of gravel formed in a windy environment south of the Kharga Oasis in the western desert of Egypt over a period of 25 years, and the partial development of a gravel layer, barely commenced after a four-year period, near the Jal Az-Zor escarpment in northern Kuwait.

I first encountered the environmental effects of the first Gulf War in April 1991. It was a mission on behalf of the Third World Academy of Sciences (TWAS), conducted with Mohamed Hassan, the Academy's Executive Director, that was designed to evaluate these effects. At that time, fires were still raging in more than 600 oil wells and the coastal water of the western Arabian Gulf was veneered by the largest oil spill in history. Recommendations regarding immediate actions and follow-up studies were conveyed to local officials in the Gulf Cooperation Council countries that we visited.

Then, in April 1992, on behalf of the World Bank, I organized a conference on the environmental consequences of that war that was hosted by the United Arab Emirates University in Al Ain. The meeting was followed by a field trip to Kuwait to study the environmental changes after the passage of one year.

The Kuwait Foundation for the Advancement of Sciences (KFAS) later asked me to organize a scientific evaluation of the short- and long-term impacts of the war on the desert surface of Kuwait. A research project was established and jointly conducted by the Boston University Center for Remote Sensing and the Kuwait Institute for Scientific Research (KISR).

The project entailed the assessment of environmental changes by comparing pre- and post-war satellite images. Changes detected based on these comparisons were checked in the field to confirm the satellite image interpretations. We determined that the desert pavement was disrupted in more than 20 percent of the land area of Kuwait.

The research report also dealt with the effects of blowing up the oil wells, which resulted in the formation of 240 'oil lakes' from seepages on the surface and the deposition of oil particles and soot that mixed with gravel and sand to form a layer of 'tarcrete' in the lee of the oil well fires.

Recommendations were made to: (1) pump the oil from the oil lakes and apply bioremediation to the underlying oil-soaked soils; and (2) leave the tarcrete layer intact as its removal would expose fine-grained soil to wind erosion, with the expectation that the tarcrete layer would be covered by windblown sand in due course – a recommendation that has since been justified.

More importantly, the major causes of the disruption of the desert surface by military action were identified. Destabilized areas of fine-grained soils were mapped and new sand dunes were identi-

[CONTINUED PAGE 8]

fied. In one area south of the Jal Az-Zor escarpment, 22 dunes formed in about eight months. In the open desert, many more new dunes formed and were continually pushed forward by the wind so that they covered roads, airports, military bases and farms.

Attempts to re-surface uncovered soil with a protective layer of gravel (to mimic the natural desert pavement) were carried out only on small pilot areas near important installations, such as military airports. However, the vast majority of the exposed fine-grained soil was left to the action of the wind resulting in the increase of dust storms in the region, and the formation of numerous 'marching' dunes.

I conveyed my fear of long-term environmental consequences to then US Ambassador to Kuwait, Edward Gnehm, who introduced me to General P. X. Kelley, commander of the US Marines in Kuwait. General Kelley noted that no one had brought this problem to his attention before 90 percent of the marines had returned home. He pointed out that they could have levelled the degraded land prior to their departure to limit the damaging environmental consequences, "while they had the equipment to do it." Had that been done, many of the problems would have been dramatically reduced.

A decade later, the present conflict has further disrupted the desert pavement in northern Kuwait and southern Iraq. As the military forces in Iraq have turned to post-war peace-keeping efforts, their work to maintain order within the cities should be extended to include restoring environmental order in the desert. Military personnel should be assigned to flatten the desert surface where it has been modified – and they should perform this task while they still have the heavy equipment there.

The current state of affairs – leaving wartime scars on the desert floor without post-war remediation (that could be accomplished by levelling the land surface) – means that the lessons from the first Gulf War remain unheeded. If the results of the second Gulf War in the desert of northern Kuwait and southern Iraq are ignored, the region's environment will be adversely affected for many years to come.

Farouk El-Baz

Restoring the land to the original flat contours would limit the long-term effects of wind erosion, and allow faster regeneration of the desert pavement. The restoration of the flat posture of the land is the only way to contain the damage to the environment and help the desert heal its war wounds. ■

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HELPING THOSE MOST IN NEED

LAST YEAR, TWAS LAUNCHED A NEW PROGRAMME DESIGNED TO BUILD RESEARCH CAPACITY IN THE WORLD'S LEAST DEVELOPED COUNTRIES. THE UNIVERSITY OF KHARTOUM'S CAMEL RESEARCH CENTRE – ONE OF THE GRANT RECIPIENTS – IS PUTTING THE MONEY TO GOOD USE TO IMPROVE THE HEALTH AND PRODUCTIVITY OF ONE OF SUDAN'S MOST ENDURING RESOURCES: CAMELS.

The United Nations Conference on Trade and Development (UNCTD) recognizes 49 countries as Least Developed Countries (LDCs), 34 of which are in Africa. Most LDCs have been poor for a long time and many have become even poorer over the past few decades.

Last year, to support science and technology development in these countries, TWAS launched the Science Development Initiative for LDCs. This new programme aims to build and sustain, over a long period, units of scientific excellence.

The long-term goal is to help LDCs train a critical mass of highly qualified scientists who will be empowered to address real-life problems facing their countries. Grants of up to US$30,000 a year for up to three years are available to research groups that are selected on the basis of merit.

By providing funds to cover the cost of new laboratory equipment and supplies, supporting training programmes for bright young students, and inviting experts from abroad to assist in teaching activities, the programme seeks to encourage scientific excellence in LDCs by assisting in the creation of a vibrant research environment. In addition to strengthening a country's science capacity, it is hoped that the programme will help counteract the brain drain, reducing the exodus of scientific talent from LDCs.

Research groups applying for the grants, which may be located within university departments or other institutions within an LDC, should already possess a high level of scientific competence. Applications are judged by internationally renowned experts, including TWAS members. The results of this peer review process are then examined by a technical committee appointed by TWAS which makes the final selection.

In 2002, the initiative's first year, 89 research groups applied for support, and six applicants were successful. Among these was the Camel Disease Research Group at the University of Khartoum's Camel Research Centre, Sudan.

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SUDAN'S CAMEL CLINIC

A TWAS SCIENCE DEVELOPMENT INITIATIVE FOR LDCS AT WORK.

For centuries, tradesmen and the indigenous peoples of North Africa and the Middle East have relied on their domesticated camels to serve as beasts of burden – a primary source of sturdy transportation in an isolated, often forbidding, environment.

Nomadic tribes such as the Tuaregs and Bedouins have also used these 'ships of the desert' to provide a variety of other resources, including milk, meat and hides. Camel hair, too, has been useful, often woven into blankets and pleated to make ropes.

Despite their many uses, since the advent of motor transport and air freight, and the decline of the nomadic life-style, camels were increasingly dismissed as relics of the past with minimal value in today's world.

However, since severe droughts hit parts of the region in the early 1980s, East Africa has witnessed a 'camel revival' of sorts. During this period of scant rainfall, camels proved their enduring value by emerging from the drought as the region's least affected domesticated animals.

Despite the recent ability of camels to show their worth, developments in camel husbandry have lagged behind advances made in other livestock sectors such as cattle and sheep. Responding to this shortcoming, scientists from the Camel Disease Research Group at the University of Khartoum's Camel Research Centre, Sudan, launched a programme to identify the major camel diseases and develop best practices for their diagnosis, control and cure.

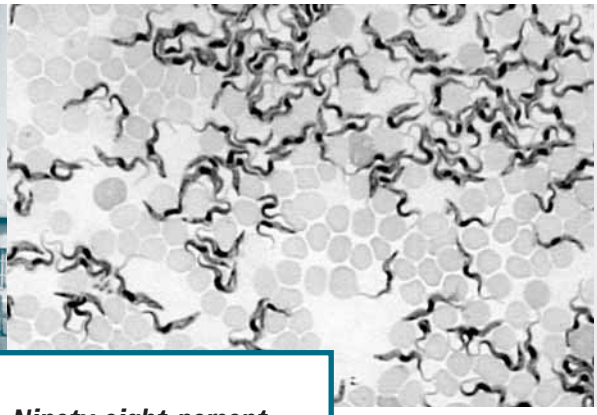
The world's camel population has been estimated at almost 19 million, more than 98 percent of which are found in developing countries. Sudan, with a population of about 3 million camels, has more than any other country except Somalia.

However, because of the nomadic way of life of many camel owners, studies on the effects of the parasites and diseases which afflict camels – and how these parasites and diseases may be either cured or controlled – have seldom been carried out. With the help of a US$20,000 award under TWAS's Science Development Initiative for LDCs, an award that could be renewed for two additional years, work by scientists from the University of Khartoum's Camel Disease Research Group is beginning to fill this information void.

As Hamid Suliman Abdalla, the project's lead scientist, explains: "The grant money has been used to set

up a field laboratory – a kind of 'camel clinic' – at Showak in eastern Sudan, 400 km northeast of Khartoum."

With two researchers, four technicians, a graduate student and two support staff on the job, and with Abdalla himself having made several 10-15-day trips to the laboratory, the research project is well underway. The initial phase of the project, in fact, has relied less on basic science and more on sociology.



Ninety-eight percent of the world's camel population is found in developing countries.

"The first thing we did," says Abdalla, "was to invite tribal leaders to a meeting in which we explained the purposes of our study," says Abdalla. "Together, we worked out how best to group the camel herds in the study area – comprising about 7,000 animals – and how best to follow the herds between one sample date and the next."

The project organizers discovered that the optimal method for tracking the herds had been used for aeons of time – simply follow their tracks in the sand. The organizers also reached agreements with the chiefs concerning the type of samples that are required for the parasitological analyses and the initial specimens have already been taken. By building confidence and trust, Abdalla and his colleagues were able to devise a roadmap for research that joined their university-based knowledge with the indigenous knowledge of those who have herded camels for untold generations.

Camels, like all animals – domestic or wild – have their own particular diseases. Camel pox, for example, is well known in Sudan and elsewhere. While scientists acknowledge that the camel pox virus is the closest known relation to the variola or human smallpox virus, it remains a virus of minor importance in camels and does not infect humans. Bacterial infections are common, too, and have been implicated in causing such diseases as 'calf diarrhoea' and mastitis, an infection of the udder that is also common in dairy cattle. Then there is the mysterious 'bent-neck' syndrome, a strange disease of unknown cause that prevents camels from lifting their heads, forcing them to almost drag them along the ground.

But it is the parasites – both internal and external – that are the focus of the Showak study. Among the internal parasites are various species of gastro-intestinal worms, and *Trypanosoma evansi*, a single-celled parasite that lives in the blood and causes 'gufar,' a disease similar to human sleeping sickness.

Because camels reproduce slowly – each female produces a calf perhaps only every other year – every birth is precious, not just as a miracle of life but for economic reasons as well. A major problem for camel herders, therefore, has been spontaneous abortion, which, in one study, was estimated to affect between 25 and 40 percent of pregnant camels. Although no single malady has been linked to spontaneous abortion, chronic infection with parasitic worms and *T. evansi* is suspected.

"We also hope to obtain kits for diagnosing another protozoan parasite, *Toxoplasma gondii*, that has been shown to cause abortions in other animals, including

[CONTINUED PAGE 12]

sheep and goats," says Abdalla. "This parasite has been extensively studied in many countries around the world, but its incidence in Sudan, especially in the camel herd, is so far unknown".

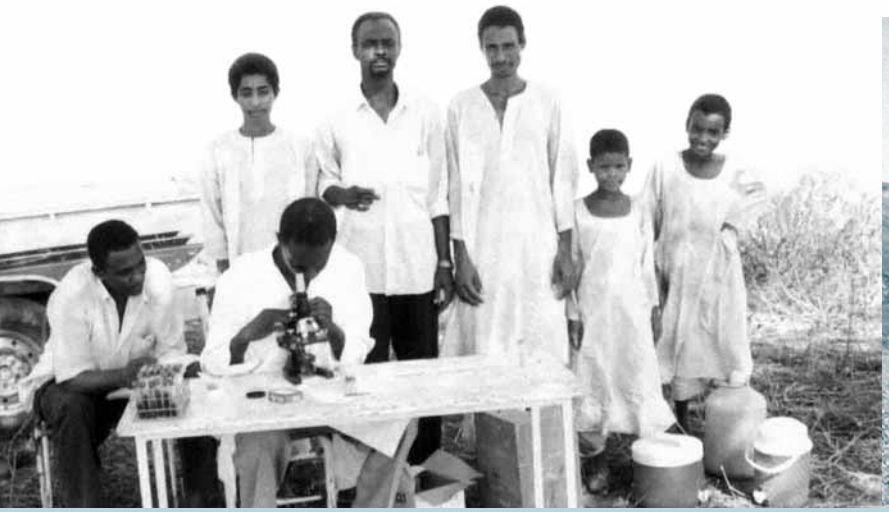
Among the external parasites covered in the Showak study is *Sarcoptes scabiei*, the mange-causing mite that spends its entire life burrowing in the skin of the host animal. Mange is very common in many camel herds. There are also ticks, which attach to the host for a few days to take a blood meal, and biting flies of the family Tabanidae, which includes the horse flies. As well as being a nuisance, by biting an infected camel and then feeding on the blood of a healthy animal, these flies transmit the sleeping-sickness-like gufar.

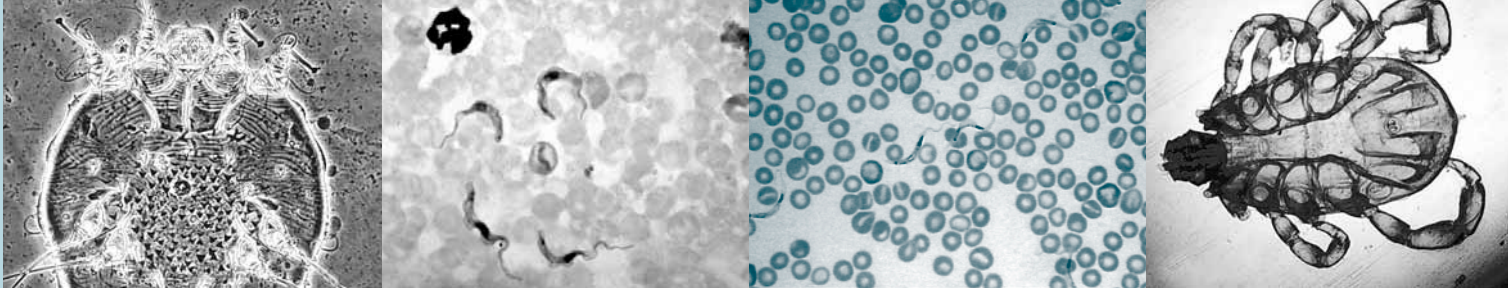
We hope to assist the people of Sudan by melding good science to vital local and regional needs.

Given the diversity of camel-infecting parasites and their different life-histories, it is no surprise that a wide range of laboratory apparatus is required for their detection and identification. Among the apparatus purchased by Abdalla for the field laboratory at Showak are such standard pieces of equipment as a pH meter, a bench-top centrifuge and an incubator. The laboratory is also now equipped with haemocytometers – essential pieces of equipment for counting blood cells, as well as the parasites present in a blood sample, and even the number of worm eggs extracted from camel dung. Microscopes, including phase-contrast microscopes that allow more detailed views of blood and tissue specimens, have also been bought.

"With all this new equipment in hand, we have recently started taking and preparing specimens," says Abdalla. "We have discovered a tremendous number of ticks and some surprisingly heavy infestations for which we have already begun treating some herds." In Africa, ticks are known to transmit several diseases to livestock, so this finding has meant that the boundaries of the Showak study have been expanded to search for diseases such as rickettsia. An earlier study in eastern Sudan also identified an ailment known as 'tick paralysis' as the cause of death for 23 percent of adult camels and 20 percent of calves.

"Beyond obtaining important scientific data on the incidence and importance of the different parasites in the Sudanese camel herd, we hope the treatments we have begun to apply against ticks will serve as one of the primary long-term benefits of this project," explains Abdalla. "Currently, the various parasites and diseases are not well known by the herdsmen and therefore their own treatments usually have little or no effect. Instead, we will begin to provide a sort of extension service, and once the nomadic herdsmen know we





are supplying good information, accurate diagnoses and effective treatments, the health and productivity of their camel herds should improve."

With the incidence of the various diseases and parasites expected to vary between different seasons and from year to year, such a project obviously has a long-term focus.

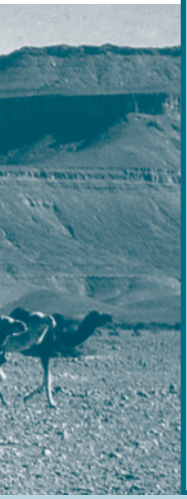
Thanks to the initial funding from the TWAS grant, the field laboratory in Showak is up and running. As part of their commitment for receiving the TWAS grant, Abdalla and his colleagues in Sudan are now putting together their end-of-year report – as are the five other Science Development Initiative for LDCs grant awardees. These reports will be assessed by an independent panel and a decision taken on whether an additional year of funding will be provided. The decision will be made by spring 2004 to ensure project continuity for those institutions receiving favourable reviews.

"We hope that we are using the TWAS grant not only to do good science, but also to provide direct benefits to the nomadic people of eastern Sudan, helping them maintain their traditional lifestyles," concludes Abdalla. "With TWAS's assistance, we hope to carry on our research and continue to assist both people and communities by melding good science to vital local and regional needs." ■

THE SIX SUCCESSFUL AWARDEES

The six successful awardees of the Science Development Initiative for LDCs were announced at TWAS's 8th General Conference and 13th General Meeting held in October 2002 in New Delhi, India. The other grant recipients are:

- ***Leishmaniasis Research Group**, Institute of Pathobiology, Addis Ababa University, Ethiopia – for studies on the diagnosis and treatment of leishmaniasis and schistosomiasis, two parasitic diseases prevalent in many Ethiopian communities.*
- ***Research Group in Electrochemistry and Polymer Science**, Laboratory of Physical and Organic Chemistry and Instrumental Analysis, Department of Chemistry, Faculty of Sciences and Techniques, University Cheikh Anta Diop, Dakar, Senegal – for studies on polymers with electricity conducting properties and their application in energy storage or as anti-corrosion coatings.*
- ***Physical and Applied Marine Sciences Section**, Institute of Marine Sciences, University of Dar es Salaam, Zanzibar, Tanzania – for studies of environmental changes in Tanzanian coastal waters and their implications for the conservation of coastal ecosystems and the sustainable use of marine resources.*
- ***Parasitology Group**, Med Biotech Laboratories, Kampala, Uganda – for efforts in mapping the extent of pyrethroid insecticide resistant* Anopheles *mosquitoes, the vectors of malaria. (For additional information on this research facility and its programmes, see article on pages 18-23).*
- ***Polymer Research Group**, Department of Chemistry, Faculty of Science, Sana'a University, Yemen – for studies on the synthesis and characterization of novel electricity conducting polymers and oligomers.*



SCIENTISTS ARE ELECTED AS MEMBERS OF TWAS SOLELY ON THE EXCELLENCE OF THEIR SCIENTIFIC ACHIEVEMENTS. TO BRING THE ACHIEVEMENTS OF THESE EMINENT RESEARCHERS TO AN AUDIENCE BEYOND THEIR FIELDS OF SPECIALIZATION, THE *TWAS NEWSLETTER* IS BEGINNING A SERIES OF MEMBER PROFILES. THE FIRST ARTICLE IN THIS SERIES HIGHLIGHTS THE WORK OF BRAZILIAN SÉRGIO FERREIRA, WHO WAS ELECTED TO THE ACADEMY IN 1993.

NO PAIN, NO GAIN

High blood pressure, or hypertension, has been called 'the silent killer'. Today, with modern anti-hypertension drugs, illnesses and deaths caused by high blood pressure – for example, heart attacks, brain haemorrhages and strokes – can be reduced. Throughout his career, Sérgio Ferreira (TWAS Fellow 1993) has been at the forefront of the development of such anti-hypertension drugs and, more recently, drugs countering inflammatory pain as well.

It is now 42 years since Sérgio Ferreira, a native of Brazil, graduated from the University of São Paolo's (USP) School of Medicine with a PhD in pharmacology. Early on in his research career he was fortunate to work with John Vane at the United Kingdom's Royal College of Surgeons. In 1982, Vane was awarded the Nobel Prize for medicine for his discovery of the mode of action of such anti-inflammatory compounds as aspirin. Research into the molecular pathways, chemical mediators and cellular responses that occur in reaction to so-called inflammatory hyperalgesia (i.e. pain) has continued to occupy Ferreira's investigations to this day. However, he is perhaps best known for his research in combating high blood pressure and the development of the first effective drug treatment for the condition.

In both these lines of work, Ferreira has identified novel drug compounds, not in the usual way, which involves screening thousands of potential candidate chemicals and hoping that one will have the desired effect. Instead, he has carefully elucidated how biochemical and physiological processes control basic physiopathological pathways.

BLOOD PRESSURE

A major cause of high blood pressure is a constriction of the small blood vessels. One way to counter this is to apply a 'vasodilator' – a chemical that works by expanding the blood vessels, or by preventing the body from releasing substances responsible for increasing blood pressure. Among the first endogenous vasodilators to be characterized was a molecule known as

Sérgio Ferreira

bradykinin, discovered by Mauricio Oscar Rocha e Silva at USP. Immediately after graduating, Ferreira worked with Rocha e Silva and soon made his first important discovery, the so-called 'bradykinin potentiating factor' (BPF).

The discovery was hailed as a triumph of interdisciplinary research, as BPF was isolated from the venom of a poisonous snake native to Brazil, *Bothrops jararaca* – the same venom that, when incubated with blood plasma, had allowed Rocha e Silva to discover bradykinin. Just as high blood pressure can kill, so can the shock of a sudden fall in blood pressure. It is this mechanism that is exploited by the jararaca snake to kill its prey.

Ferreira showed that, when applied together, bradykinin and BPF had a synergistic effect. That is, their combined vasodilation effect was greater than the sum of their individual effects. Indeed, on its own, BPF had no effect, implying that it acted by protecting bradykinin, which otherwise has an extremely short life in the blood system as it is destroyed by an enzyme.

In fact, Ferreira went on to demonstrate that the bradykinin-inactivating enzyme that is blocked by BPF also promotes the conversion of angiotensin from its pro-active form, angiotensin I, to angiotensin II – a potent vasoconstrictor, excess levels of which have been implicated as a major cause of hypertension.

"We had discovered a dual role for BPF," explains Ferreira. "It not only boosts the activity of the hypotensive agent bradykinin, but it also inhibits the conversion of angiotensin, thus preventing its hypertensive role."

Then came Ferreira's big breakthrough. BPF extracted from the snake venom is made from a mixture of peptides, or short chains of amino acids – the building blocks of proteins. Ferreira isolated a series of short peptides from this mixture. "We synthesized the shortest peptide, just five amino acids long," says Ferreira, "and demonstrated that it could be used to control hypertension in animal models."

A second breakthrough was made by scientists working for a commercial company, Squibb, who selected and attached another molecule to one of the five amino acids in the BPF peptide. The attached molecule acted by inhibiting the active site of the angiotensin converting enzyme. After a series of clinical trials, this new compound became a commercial product, known as captopril, the first of a new class of highly effective anti-hypertensive drugs.

"Unfortunately, in spite of our contribution to the discovery of BPF and being the first to understand its usefulness in the control of blood pressure, this work was not a candidate for patenting because Brazilian and international patent laws do not allow the patenting of natural products," explains Ferreira, who would learn from this experience and apply the lesson to his future research discoveries.

INFLAMMATION AND PAIN

Ferreira's second line of research has involved working out the cellular and chemical processes that take place during the process of inflammation.

The roots to this line of work lie in the early 1970s when Ferreira spent five years collabo-

rating with John Vane at the UK's Royal College of Surgeons and Wellcome Trust. As part of Vane's research group, Ferreira participated in the discovery that aspirin-like drugs inhibit the synthesis of prostaglandins. These hormone-like chemicals that are released by damaged cells act by sensitizing the body's pain receptors.

"Identifying the chain of events leading to the sensation of pain – and the discovery of methods to counter them – has been the objective of my research for the past 30 years," says Ferreira.

In 1980, for example, Ferreira worked out the mechanism by which morphine and other opiates relieve pain in the peripheral nervous system. These well-known pain-relievers have been used for hundreds of years but, despite their usefulness, they also induce dependence, causing patients to become addicts.

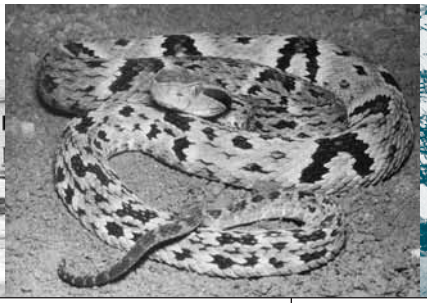
Ferreira's analysis of the mode of action of opiates, however, has led to the suggestion that a new class of analgesics could be developed by tinkering with their molecular structure and preventing them from crossing the blood-brain barrier.

"The idea is to knock out their ability to enter the brain while retaining their pain-relieving properties," explains Ferreira. "Such compounds would be selective peripheral analgesics devoid of any side-effects in the central nervous system. Some compounds with these properties are now undergoing tests as potential drugs."

More recently, Ferreira has also managed to tie in his research on high blood pressure with his studies on the inflammatory response. Cytokines are small, hormone-like proteins that are released by cells to communicate messages to other cells. The release takes place early in the inflammatory response and causes a cascade of other cytokines and physiopathological reactions, including endotoxaemia caused, for example, by bacterial infection. In particular, Ferreira has identified a cascade of cytokines, starting with one known as TNF-Alfa, that is stimulated by the vasodilator, bradykinin. This cascade culminates in the release of an interleukin, IL-1ß, that induces the liberation of prostaglandins, which are ultimately responsible for inflammatory hyperalgesia, or excessive sensibility to pain.

"We have now developed a three-amino acid active compound known as P7 that we have patented. This peptide is an antagonist of IL-1ß and is serving as a prototype for developing new IL-1ß antagonists. This type of drug will not have the same side-effect problems as aspirin-like drugs – for example, stomach pain and heart burn – and will be very useful in improving the quality of life in old age," claims Ferreira.

Although P7 has been patented by USP, many years of research and investment will be necessary for this prototype to begin providing an economic return to the university.


"In fact, I would prefer that, if a drug does come from this work, instead of representing a way for the university to make financial gains, it should benefit the poor people of the world who would not have to pay higher prices to cover, in part, the cost of royalties," says Ferreira. "One should realize that discoveries made in universities are always financed by people working in the country where these discoveries are made. A nation's workers should be able to profit from such discoveries without new hidden taxes being levied on them in the form of royalties."

REWARDS

Indeed, pharmaceutical companies and other researchers are increasingly 'prospecting' the South's wealth of biodiversity for new drugs and other useful compounds. (The discovery of BPF in *Bothrops jararaca* snake venom that led to the development of a new class of anti-hypertension drugs highlights the returns that can be made.) Because of international patent laws, the money earned by patents derived from Ferreira's work did not feed back into the university's research programmes. South American scientists therefore, like their colleagues in the North, are learning to patent their discoveries.

"But this is meaningless if the undeveloped countries do not adopt an aggressive policy of developing drugs and medicines based on their culture and the work of their own scientists," cautions Ferreira. "It is also ridiculous to believe that multinational companies will stimulate the formation of national industries capable of using national inventiveness that would allow any kind of market competition."

In this era of genomics, proteomics, metabolomics – techniques that allow the entire contents of cells to be analysed – potentially useful chemicals are being discovered every day. However, what makes Ferreira's work unique is that he questions the automated screening technologies associated with these new trends in biological research.

"Without a meaningful hypothesis it is impossible to unravel cellular pathways," he warns. "However, genomics and proteomics are fantastic instruments by which to gain basic information that will allow pharmacologists working to understand the peculiarities of a physiopathological process to propose new drug targets. With new techniques for molecular design and faster processes for synthesising drugs, pharmacologists have now multiplied their chances for success."

Ferreira's research career spans more than 40 years, and he has published some 250 peer-reviewed papers (including five in *Nature*). He has also trained more than 30 students to master's and doctoral levels, and was the founder of the *Brazilian Journal of Biological and Medical Sciences* (the journal with the highest impact factor in Latin America). He helped launch the Brazilian Society of Pharmacology and the Brazilian Society for the Study of Pain. As Director of the National Institute for Drug Control and President of the Brazilian Society for the Advancement of Science, Ferreira has participated directly in Brazil's public health and science policy arenas.

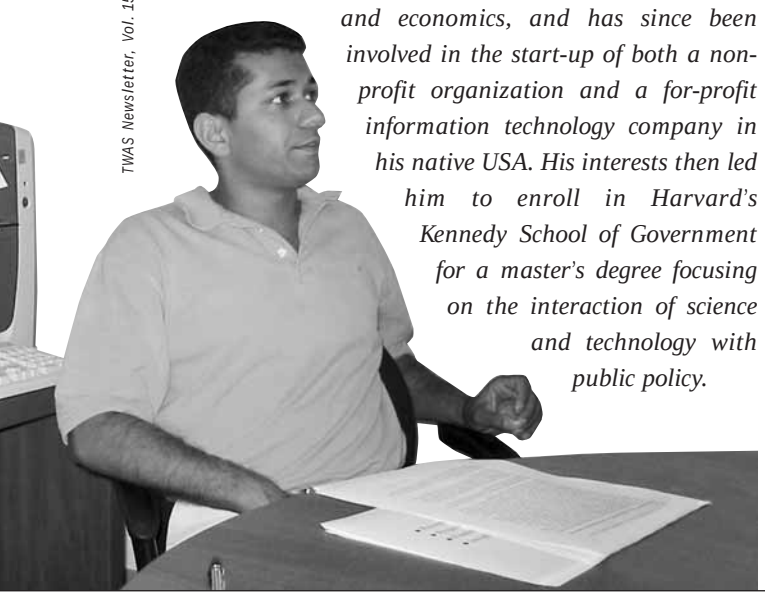
During a lifetime of research, Ferreira has received a host of accolades, including election to the US National Academy of Sciences. He also received the 1983 Ciba Award for Hypertension, the 1990 TWAS Award in Basic Medical Science and, most recently, the 1999 *Premio México de Ciencia y Tecnología*. ■

SUMMER STUDIES

THIS SUMMER, INDER SINGH, A MASTER'S DEGREE STUDENT AT HARVARD UNIVERSITY'S KENNEDY SCHOOL OF GOVERNMENT, BECAME TWAS'S FIRST INTERN. AS PART OF THE TWAS/ISTS (INITIATIVE ON SCIENCE AND TECHNOLOGY FOR SUSTAINABILITY) PROJECT, HE SPENT HIS SUMMER IN UGANDA AND TRIESTE LEARNING ABOUT THE OPPORTUNITIES AND OBSTACLES FOR INSTITUTIONAL DEVELOPMENT IN THE SOUTH.

When William Clark of Harvard University's Kennedy School of Government visited TWAS in 1998 to meet with Mohamed Hassan, TWAS's Executive Director, neither one was quite sure where their discussions would lead. In fact, the meeting eventually led to TWAS's participation, beginning in 2001, in the Initiative on Science and Technology for Sustainability (ISTS) project. This summer, the collaborative programme funded its first internship.

The intern, Inder Singh, was educated in engineering and economics, and has since been involved in the start-up of both a non-profit organization and a for-profit information technology company in his native USA. His interests then led him to enroll in Harvard's Kennedy School of Government for a master's degree focusing on the interaction of science and technology with public policy.



During his internship, Singh spent five weeks at the Med Biotech Laboratories in Kampala, Uganda, run by Thomas Egwang (TWAS Fellow 1997), followed by five weeks at TWAS headquarters in Trieste. While in Uganda, Singh conducted interviews with health policy officials, biomedical researchers and medical practitioners to try to understand how scientific knowledge surrounding malaria is being incorporated into policy and practice.

As Singh explains: "The internship was a great opportunity. I was able to work in a developing country, have access to senior officials, and wrestle with issues that interested me: How do you build organizations that can rapidly and effectively use science and technology to achieve positive social outcomes, and what types of strategies are applicable and effective in least developed countries?"

While in Trieste, Singh spent time writing up his findings for the following article.

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BATTLING MALARIA IN UGANDA

CONNECTING BIOMEDICAL RESEARCH AND HEALTHCARE POLICIES

Each year, one million people die of malaria. Over 90 percent of these deaths occur in sub-Saharan Africa. Part of the reason for this lopsided statistic is that the most virulent of the four malaria species, *Plasmodium falciparum* (which is fatal in about 1 percent of cases) is endemic to the region.

Millions of others living in sub-Saharan Africa are infected with more chronic forms of malaria and suffer from recurring bouts of malarial fever. Indeed, as malaria causes anaemia and mental retardation, it can seriously impair the learning ability of some African schoolchildren. Malaria is also estimated to cause over half of the person-hours lost in agricultural enterprizes, causing additional hardship for families that are already living a subsistence lifestyle.

Apart from the complex biology of the *Plasmodium* parasite and its mosquito vectors, Africa's malaria problem also lies with medical research infrastructures that, in many cases, fail to provide scientists with the equipment and materials necessary for their work, and public health systems that do not have sufficient resources to marshal an effective response against the disease.

As the harbinger of disease and death, the pervasive malaria parasites tear at the fabric of many countries, reducing their ability to deal with critical development issues. To complicate the issue, fighting malaria has become more difficult during the last decade as the parasites have developed resistance to some widely used drugs.

Thomas Egwang

Thomas Egwang (TWAS Fellow 1997), founder and director general of Med Biotech Laboratories (MBL) in Kampala, Uganda, is leading a multi-disciplinary research agenda that he hopes will help Uganda address its malaria problems.

Malaria tears at the fabric of many countries, reducing their ability to deal with critical development issues.

Meanwhile, Z.M. Nyiira, executive secretary of the Uganda National Council for Science and Technology (UNCST), has been wrestling with the issue of how best to channel research results to address the country's priority issues – including malaria. Lessons learned in establishing and managing these two institutions provide insights into how to build research and science policy institutions that can operate effectively in a developing country.

GETTING STARTED

Trained in parasitology and immunology in Canada, Egwang was a visiting scientist at the University of California, Berkeley, USA, from 1986 to 1987. Although he was offered a tenure track position in the United States, he opted to return to Africa to assume the position of research director at the *Centre Internationale de Recherches Medicales de Franceville* (CIRMF) in Gabon,

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FROM THE FOUR CORNERS OF THE WORLD

This summer, the TWAS/ISTS Project also collaborated with the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, near Vienna, Austria, in organizing a Young Scientists Summer Programme (YSSP). The IIASA project, now in its 25th year, received applications from almost 100 hopeful young scientists from developing countries. Under the direction of IIASA's Jill Jäger, three successful students visited IIASA from 2 June to 29 August to interact with top researchers and complete reports discussing applications of science and technology for sustainable development. These three students also spent two days at Trieste where they linked up with TWAS/ISTS Project intern, Inder Singh (see main article), to discuss their case studies with TWAS staff. The three IIASA students were:

• ***Juan Bernardo Moreno Cruz*** *(Colombia), who analysed Colombia's current energy industry, including government policies and management. Based on his findings, he suggests that various links between stakeholders, including nongovernmental organizations, be established to enable government bodies to receive unbiased feedback from diverse sources.*

• ***Sharda Mahabir*** *(Trinidad and Tobago), who analysed river water, sediments and aquatic insects and fish for the presence of heavy metal and other pollutants. She is now trying to link the distribution of these pollutants to land-use practices, industrial sites and urban development. As part of her PhD studies, she has also helped raise public awareness of safe drinking water-related issues.*

• ***Riziki Shemdoe*** *(Tanzania), who is studying the effects of land-use changes on the on the distribution and incidence of bubonic plague, a disease spread by the fleas of rats, and possibly other wild rodent species, in rural areas of Tanzania.*

where he was given the task of establishing a new laboratory.

"I was actually inspired by a US biotechnology company," explains Egwang, "and became convinced that Africa's nongovernmental sector could likewise play a significant role in biomedical research and training, alongside such traditional government institutions as ministries and universities."

When he returned to his native Uganda in 1995, that idea crystallized into the MBL – the first non-government-affiliated research laboratory in the country to be established by a private citizen. This pioneering move, which has drawn admiration from colleagues in both government and research, was helped by initial funding from the World Health Organization (WHO).

One of Egwang's earliest tasks was to set up the institute's governance structures. These structures have proven essential for building and maintaining a network of people with whom Egwang could collaborate scientifically and who would support the MBL in subtle but useful ways. Positions on two advisory councils – the scientific advisory council and the ethics committee – were filled by a mix of eminent local scientists and prominent policy makers.

These individuals, including Nyiira, have provided both guidance and support. For example, when the MBL ran into difficulties with a research grant because the awarding agency did not recognize it as an established institute with the necessary administrative infrastructure to receive funding, UNCST was on hand to sign the contract and secure funding on its behalf.

MULTIDISCIPLINARY APPROACH

Today, with a staff of 10 and several international collaborators, the MBL is carrying out research on several aspects of Uganda's malaria and mosquito problems. Among the research projects currently underway are efforts to determine the distribution and incidence of pyrethroid insecticide resistance of malaria's mosquito vectors (a project funded by TWAS under its Science Development Initiative for Least Developed Countries – see article on page 9 for further details). There are also efforts to map the incidence of anti-malarial drug resistance of the *Plasmodium* parasites, to control the mosquito vectors, and to develop an effective vaccine.

As well as receiving capacity building grants from organizations such as TWAS and WHO, Egwang has developed several collaborative research projects with institutes in the North. He believes that such projects, if structured properly, can result in a win-win situation for a both parties.

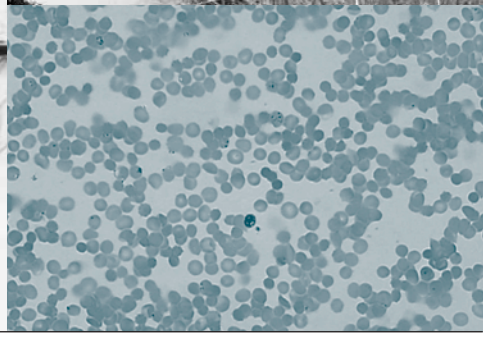
In the case of the MBL, for example, training opportunities for key personnel have helped advance the research programmes. "Unfortunately," says Egwang, "many African scientists remain passive participants in research, sometimes acting only as conduits for the collection of specimens." In contrast, Egwang is a firm believer that science relevant to the South must be conducted by scientists in the South. "We can no longer afford to remain on the sidelines," he asserts, "because, if we do, it is unlikely that suitable technologies will be used to address issues of importance to us."

"Many African scientists remain passive participants in research, sometimes acting only as conduits for specimens."

Among the various North-South research projects being carried out at the MBL is one in collaboration with Steven Lindsay of the University of Durham, UK. Lindsay is an early proponent of insecticide treated bed nets, a tried-and-tested technique of preventing mosquitoes from biting people, especially children, while they sleep. Lindsay and Egwang are performing applied research on the environmental control of malaria in Kampala and Jinja, two of Uganda's major cities, trying to understand and develop the best techniques to control mosquitoes. One idea currently being investigated is to enhance the populations of certain fish that eat mosquito larvae in ponds and brick pits where mosquitoes breed.

Also, in collaboration with the University of Osaka, Japan, malarial vaccine studies are now yielding promising results. So much so that the MBL is seeking funds to carry out phase I trials for a candidate vaccine being manufactured by the Japanese group. The funds would be used to develop a clinic in the Apac district of northern Uganda, Egwang's home town and an area with a high incidence of malaria.

Not all the MBL's research programmes rely on partners from the North. One in-house project pursued in collaboration with Uganda's Ministry of Health involved an analysis of anti-malarial drug resistance.



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Z.M. Nyiira

"The study," explains Egwang, "concluded that a traditional treatment for malaria, the combination of the drugs chloroquine and sulphadoxine-pyrimethamine (SP), is no more effective than SP alone. This implies that resistance to chloroquine has become so great that it essentially ineffective as a treatment for malaria in Uganda." The project did reveal, however, that other drug combinations, such as SP and another anti-malarial, amodiaquine, are effective – results that have implications for Uganda's future anti-malarial drug policy.

FROM RESEARCH TO POLICY

Egwang hopes that MBL's malaria research will have an impact in Uganda, particularly on health policy. His growing interest in the policy relevance of his research has been fostered by his personal relationships with policy makers, particularly Nyiira. This interest is also a primary reason for the MBL shifting its focus in the past few years to more applied research projects, such as the drug resistance studies that may yet have an impact on national anti-malaria drug policy.

Egwang admits, however, that his involvement in health policy issues does not draw on his best talents and that he would prefer to leave the process to others. "I am a scientist first and foremost," he confirms.

That's where UNCST comes into play. UNCST, by virtue of its mandate, is concerned with policy. Seven boards oversee the management of research agendas and priorities in various sectors, including the biomedical sciences.

With regard to malaria, UNCST encourages research into innovative ways of controlling malaria. As Nyiira explains: "UNCST has put together a multi-disciplinary team of university researchers and public health officials in the ministries of agriculture and health, as well as independent scientists and traditional medicine practitioners working at the grassroots level."

Science policy analysts have come to call institutions like UNCST "boundary organizations." As William Clark, of Harvard University's Kennedy School of Government and a member of ISTS, explains: "Boundary organizations are institutions that straddle the shifting divide between politics and science. They draw their incentives from both domains and facilitate the transfer of useful knowledge between science and policy."

Addressing Uganda's malaria problem poses challenges at various levels – institutional, district and national.

In this regard, UNCST is performing a vitally important role that may otherwise go unattended. Connecting biomedical researchers with health policy makers and medical practitioners ensures that both policy and practice reflect the best of what is known about malaria prevention and treatment in Uganda. Egwang and his colleagues agree that the role of UNCST in aligning the agenda of researchers, policy makers, and health practitioners will be critical if Uganda is to successfully address its malaria problems.

CHALLENGES AHEAD

Addressing Uganda's malaria problem poses challenges at various levels – institutional, district and

national. Key players such as Egwang and Nyiira readily acknowledge that success in all these areas can only be achieved by overcoming the challenges of limited budgets and resources.

As a research institution, MBL faces two particular challenges. First, it currently has no researchers with a PhD on its staff, although three students should receive their doctorates within the next year. A priority for Egwang, therefore, is to recruit or train more senior scientists to ensure the viability and prowess of its future research activities. Egwang must also balance his research efforts with other obligations, including the never-ending search for funding, laboratory administration, and his involvement with such organizations as UNCST, WHO and TWAS that have helped contribute to the MBL's success.

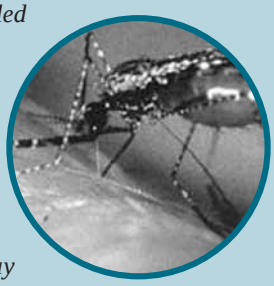
For Nyiira, securing the commitment of researchers, public health officials, and practitioners to a collaborative strategy poses a great challenge. With retirement approaching, Nyiira, must also ensure that there is a seamless transfer of the council's management to a new group of individuals who have the respect of all stakeholders.

Overcoming Uganda's malaria problem will require research for the monitoring of drug resistance, the development of effective vaccines, and an understanding of the environmental factors that contribute to the reduction of vector populations. It will also require an effective strategy to channel such scientific and technological advances into successful policies and practices.

Well-formulated policies, and their effective implementation, are a challenge in any context, whether in Europe, the USA or Africa. In Uganda, they will be critical in the fight against malaria.

But while resources are limited, the players are in place. What is needed now is a coordinated effort between these players – researchers, policy makers and practitioners – to pursue the *best* research agenda and effectively implement the *best* policies and practices, based on the *best* scientific advice. Uganda's long-term success in addressing its malaria problem will depend on such integrated action. ■

MALARIA *is caused by any one of four species of a closely-related group of single-celled parasites:* Plasmodium falciparum, P. malariae, P. ovale *and* P. vivax. *They are all transmitted by* Anopheles *species of mosquito that inject the parasites into a host when taking a blood meal. The parasites spend a few days developing and reproducing in the liver before being released once more into the blood. They then enter the red blood cells and begin another cycle of reproduction, the duration of which depends on the species present.* P. vivax, *for example, releases a new wave of parasites into the blood every third day and fevers, therefore, rise and fall on a three-day cycle.* P. falciparum, *the most feared of the four species, has more erratic cycles, and causes red blood cells to clump together – a property that is particularly hazardous in the narrow capillaries of the brain. Whenever the parasites are released into the blood, they can be picked up by another mosquito and later transmitted to another person.*



In many developing countries, including Uganda, the emergence of the HIV/AIDS epidemic in the 1980s meant that critical health-care expenditure was directed away from malaria and mosquito control. Uganda, however, has been particularly successful at controlling AIDS, reducing its prevalence from a high of 18 percent of the population to 6.5 percent today. Although this meant that research into malaria slowed to a trickle, it has also given today's researchers hope that the successful HIV/AIDS control model can be adapted to the fight against malaria. With the World Health Organization recently creating a US$15 billion Global Fund to Fight AIDS, Tuberculosis, and Malaria, malaria has re-emerged as a priority issue for sub-Saharan Africa. As the article above explains, however, whether malaria can finally be beaten will take more than just money and first-class research. It will require first-class institutions in Africa and other affected areas staffed by skilled and dedicated personnel too.

PROMOTING LIFE SCIENCES IN THE DEVELOPING WORLD

A RECENT WORKSHOP CO-SPONSORED BY TWAS AND A HOST OF OTHER INSTITUTIONS EXAMINED WAYS TO BOLSTER LIFE SCIENCES RESEARCH IN THE DEVELOPING WORLD.

When a student recently asked Nobel Laureate Sydney Brenner (Physiology or Medicine 2002) what ethical standards should be adopted by his colleagues, he had this answer: "Tell the truth and stand up for humanity."

A recent workshop held in Trieste to explore strategies for promoting life sciences in developing countries had this inadvertent response to Brenner's observations: the truth is elusive and standing up for humanity is no easy task.

The workshop, sponsored jointly by the Human Frontier Science Program (HFSP), the European Molecular Biology Organization (EMBO), the Wellcome Trust, and the Third World Academy of Sciences (TWAS), was attended by more than 40 people from 14 countries.

Among those participating were representatives of such funding agencies as the UK Department for International Development (DFID), the Howard Hughes Medical Institute and the Rockefeller Foundation; such national science foundations as the US National Science Foundation, the German Research Foundation (DGF) and the National Natural Science Foundation of China; and such research institutes as the US National Institutes of Health, the Jawaharlal Nehru Centre for Advanced Scientific Advance in India and the Pasteur Institute in France. HFSP Secretary General, Nobel Laureate Torsten Wiesel (Physiology or Medicine 1981), presided over the event.

As EMBO's Alexandra Moreno Borchart, who prepared the background report for the meeting, noted in her presentation to workshop attendees, the truth is elusive because gaining statistical information on the state of the life sciences, particularly in developing countries, is difficult. Data collection efforts often are incomplete and between-country comparisons, especially over time, are difficult because national statistics

have not been collected in a consistent manner – either from one country to the next or from one year to another.

Standing up for humanity is equally challenging because, as experience shows, translating laboratory advances into effective public health strategies, especially in the developing world, has often proven illusive. Well-intentioned initiatives, moreover, have been hampered by the emergence of such new diseases as AIDS or the resurgence of such long-standing diseases as malaria and tuberculosis.

Borchart's overview focused on 31 resource-constrained countries in five different regions: Africa, Asia, Eastern Europe, Latin America and the Middle East. The state of science – particularly the life sciences – in each of these countries was examined through the lens of several different statistical criteria: for example, the human and financial resources invested in such research, the number of articles that researchers in each country had published in peer-reviewed journals, and the number of patents that entrepreneurs in each country had received.

Research and development in the least developed countries relies almost exclusively on external funding.

The snapshot depicted by the report is highlighted by these factors:

• Developed countries spend on average 2.4 percent of their gross domestic product (GDP) on research and development (R&D), while developing countries spend less than 1 percent.

• Large disparities in R&D expenditures exist both between and within developing countries. South Africa, for example, spends nine times more on R&D than Uganda, while, nearly 10 years after the demise of apartheid, more than 90 percent of all international patents in South Africa continue to be awarded to formerly all-white institutions.

• Developing countries account for nearly 80 percent of the world's population, but are home to less than 30 percent of the total number of researchers in the world.

• R&D in the least developed countries depends almost exclusively on external sources of funding. More than 90 percent of the funding for R&D in Uganda, for example, comes from abroad.

• Successful efforts to bolster science in the developing world need not follow a single path. Examples from China, in which government commitment has played a prominent role; Chile, whose efforts in science have received a boost from the World Bank's Millennium Science Initiative; and Uganda, where a private initiative led by one individual has sparked the creation of an international centre in medical biotechnology (see pages 19-23), suggest that excellence in the life sciences can be achieved using diverse strategies. The fundamental challenge is to devise a plan that is compatible with a nation's or region's political makeup, economic circumstances and cultural values.

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• Contemporary research in the life sciences, whose origins are rooted to the historic discovery of the DNA double helix 50 years ago, has eclipsed physics as the most glamorous field of science. Ever-expanding interest in this field has been expressed in a number of ways throughout the developing world, including increased funding from international donors; enhanced national investments in the development of biotechnology; and the creation of such regional networks as the Latin American Network of Biological Sciences (RELAB), the Asia-Pacific International Molecular Biological Network (A-IMBN), and the East Africa Regional Programme and Regional Network for Biotechnology, Biosafety and Biotechnology Development (BIO-EARN).

• The global medical community has focused increasing attention on public health crises caused by such infectious diseases as AIDS, malaria and tuberculosis in developing countries. These efforts, participants agreed, should not be curbed. After all, 3,000 children in sub-Saharan Africa die each day from malaria and more than 10 percent of the adult populations of Mozambique, South Africa and Tanzania have been infected by HIV. However, an increasing number of deaths in developing countries are due to chronic, not infectious, diseases – for example, cancer, diabetes and cardiovascular ailments. A growing convergence between the disease profiles of the North and South (by 2030, more than 70 percent of all incidences of cancer are expected to occur in the developing world) suggests that the 'disease divide' is likely to narrow in the decades ahead.

THE ORGANIZERS

The 'Promoting the Life Sciences in Developing Countries' workshop was a collaborative effort. Together with TWAS, three other organizations were involved:

• ***European Molecular Biology Organization** (EMBO). Created over 40 years ago by research scientists seeking to promote what was then a new frontier in biological research – molecular biology. Each year, EMBO supports more than 300 postdoctoral fellowships, 200 short research visits and 40 practical courses and workshops. Though the organization's activities are mainly based in Europe, it has recently expanded its programmes to include scientists worldwide. (www.embo.org)*

• ***Human Frontier Science Program** (HFSP). Established in 1989, member countries now include Canada, France, Germany, Italy, Japan, Switzerland, the United Kingdom, the United States and the European Union. HFSP supports collaborative research in biological sciences and, since 1990, has awarded nearly 600 research grants and over 1,800 long-term fellowships. HFSP gives special emphasis to the support and training of young scientists. (www.hfsp.org)*

• ***The Wellcome Trust**. Established in 1936 'to foster and promote research with the aim of improving human and animal health', the Trust is now one of the world's largest funders of biomedical research. Although much of its funding goes to universities in the UK, the Trust also runs research centres in Africa and southeast Asia. A large international funding programme includes programmes for researchers from developing and restructuring countries to collaborate with colleagues in the UK. (www.wellcome.ac.uk)*

• Finally, participants concurred that life sciences research must focus not just on basic science but on the translation of that science into such areas as food security, biodiversity conservation and the protection of safe drinking water supplies. Successful translation of research results from the laboratory to society would not only put science to work in addressing critical global problems but would also help increase public support for scientific research.

Despite increasing public interest, research in the life sciences faces a series of problems shared by research in many other scientific fields.

For example, while funding on average has increased over the past decades, it still remains inadequate in many countries, particularly in the world's least developed countries. Moreover, too many developing countries remain dependent on outside donors to sustain their research agendas. While such funding helps to nurture international standards in underfunded and understaffed scientific institutions, it nevertheless distances the research community from national budgetary arrangements, making it more difficult for their efforts to be fully integrated into a nation's broadbased economic development strategies.

At the same time, more attractive salaries in other fields have handicapped efforts to draw talented young students into the life sciences, causing a deficit in human resources that has been exacerbated by the brain drain phenomenon. And, while institutional networking has improved over the past several years, many life scientists in the developing world continue to work in isolation, separated from both their colleagues and from the private sector where research findings could be used to address critical food security, public health and environmental concerns.

Successful translation of research results from the laboratory to society would help increase public support for scientific research.

The Trieste workshop was a follow-up to a similar 'brainstorming' effort held in Strasbourg, France, from 29-30 November 2001. While the Strasbourg event focused on strategies for broadening career opportunities in the natural sciences both in the North and South, the event in Trieste sought to explore ideas for strengthening the status of the life sciences in developing countries. Although no precise blueprint for action emerged from the discussions, participants agreed that a successful strategy would likely include the following provisions:

• *Greater commitment on the part of governments in developing countries to support the life sciences*. China, where investments in the life sciences now account for just under 20 percent of the nation's rapidly growing R&D expenditures, offers one example of the dramatic impact that such a concerted effort can have on a nation's scientific output in this field – even when other scientific disciplines (for example, physics and

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mathematics) continue to dominate the research agenda.

• *Expansion of international exchange programmes fostered through an increasing number of lectureships, fellowships, and joint institutional research projects underwritten by both bilateral and multilateral agreements*. Such efforts, participants noted, would not only help to improve the state of the life sciences in developing countries but would also have a positive impact on what one participant called the "inverse information gap" in the North, where the scientific community often remains unaware of the excellent life sciences research taking place in the South.

• *Improvements in public understanding of the potential benefits of life sciences and the challenges – both scientific and ethical – that are confronting researchers*. Such endeavours, participants noted, are critical for the life sciences community which, in most countries, continues to depend on the public sector – particularly national governments – for major portions of its funding. Participants agreed that scientists, not the public, should shoulder the major responsibility for providing this education and that the purpose of such initiatives should not be to make citizens 'junior scientists' but to provide useful information that allows people to judge for themselves the risks and benefits of pursuing life science research projects.

• *Strengthening of links among universities, national research centres and the private sector*. While such efforts would be difficult to pursue in many developing countries because of the small number of private firms, participants largely agreed that greater interaction with the private sector could provide research communities in the North and South with larger sources of capital and greater access to markets. For these efforts to succeed in broad societal terms, issues related to intellectual property rights and the equitable sharing of profits would have to be addressed. These efforts, they added, should not compromise the historic role of universities as institutions that nurture the free and unrestricted flow of information.

Greater interaction with the private sector could provide research communities with larger sources of capital.

Over the past half century, rapid advances in the life sciences, combined with their dramatic impact on medicine, public health, agriculture and the environment, have transformed this once obscure field into the 'science of all sciences,' occupying a space in the public's imagination that was once reserved for nuclear physics. As a result, life scientists and medical researchers have a real opportunity to contribute to the evolving relationship between science and society in the 21st century – by making their research more interdisciplinary and international as well as more tightly focused on critical social, health and environmental problems.

It is a formidable challenge fraught with both risks and opportunities. Do life scientists want to assume responsibility for such a challenge? Are the institutions in the field ready to tackle the complex issues that they must if they hope to address such concerns? What can – and should – donors and research centres do to assist such efforts? What role can – and should – the developing world play in the broad agenda that now lies before the life sciences?

These are the kind of questions that were raised during the course of the two-day discussion that took place in Trieste. A report detailing the full discussion will be prepared over the next few months and a consortium will likely be forged with this goal in mind: to keep the discussion going because the issues are too difficult and too important to ignore. More specifically, efforts will be made to distil the best capacity building strategies available – many of which were presented at this workshop – for addressing the critical issues that now confront life sciences research, particularly in the developing world.

To advance these goals, the consortium will indeed seek to heed Sydney Brenner's dictum: to tell the truth and help humanity. ■

TWINNED JOURNALS

During the workshop, Gerald Keusch of the Fogarty International Center of the US National Institutes of Health described a novel mechanism for assisting researchers in developing countries in gaining access to scientific literature from the North while boosting the quality of their own journals.

The idea is to 'twin' journals published in developing countries with those from a developed country. In a pilot scheme, the Medical Journal of Ghana, Mali Medicine, *the* Malawi Medical Journal *and* African Health Sciences *from Uganda are being twinned with such high-profile medical journals as the* Journal of the American Medical Association, *the* American Journal of Public Health, Environmental Health Perspectives, *the* British Medical Journal *and* The Lancet.

"For a relatively small amount of money we can help to educate editors – who are often heads of learned societies with no professional editing experience – improve the business plan and sustainability of their journal, and promote parallel publishing," explained Keusch. Parallel publishing means that certain papers from the Journal of the American Medical Association, *for example, would also be published in the African journals. Meanwhile, strong papers with international relevance from African authors could be published in the twinned international journals, with perhaps a related paper containing more locally relevant information printed in the African journal.*

BORLAUG PROMOTES BIOTECH

• **Norman Borlaug** (TWAS Associate Fellow 1985 and Nobel Peace Prize Laureate 1970) gave the keynote address at the Ministerial Conference and Expo on Agricultural Science and Technology held in Sacramento, California, from 23-25 June. The conference focused on the critical role that science and technology, including biotechnology, can play in raising agricultural productivity in developing countries. Sponsored by the US Department of State, the US Department of Agriculture (USDA) and the US Agency for International Development (USAID), the meeting was attended by representatives from 115 countries and 13 international organizations. In his address, Borlaug stressed that Africa, because of its problems with declining soil fertility, its slow uptake of new technologies, its poor health and education services and its high population growth, is the region that presents the greatest food security concerns. Efforts to reduce the chronic hunger that affects the continent should be accelerated, said Borlaug, to avoid an unprecedented humanitarian crisis. However, Borlaug also maintained that: "The world has the technology, either available or well advanced in the research pipeline, to feed 10 billion people." Continued research and development of technology, especially biotechnology, is critical to meeting this challenge, he added.

Norman Borlaug

PRIZE FOR TWOWS AWARDEE

• **Fernande Fotsa-Ngaffo**, who has been awarded a fellowship by the Third World Organization for Women in Science (TWOWS), has received South Africa's First Young Women in Science Award. The prize, awarded in the presence of Adi Patterson, South Africa's deputy minister and deputy director general of the Department of Arts, Culture, Science and Technology, includes a gold medal and 100,000 rands (US$14,000). Cameroon-born Fotsa-Ngaffo, who has a master's degree in physics, was awarded the TWOWS fellowship in 2002, which enabled her to travel to the Material Physics Institute, University of the Witwatersrand, Johannesburg, South Africa. There, under the supervision of Malik Maaza, she is carrying out research for her PhD into the potential of titanium dioxide nanocrystals to improve the energy efficiency of solar cells. Ngaffo, who plans to receive her doctorate by 2006, also received the Best Young Women in Science Award for her presentation during the International Conference on Optic and Laser Applications held in Windhoek, Namibia, 10-14 August. The conference was co-organized by University of Witwatersrand, the University of Namibia, the International Centre for Theoretical Physics (ICTP) and the International Union of Pure and Applied Physicists (IUPAP).

Fernande Fotsa-Ngaffo

AIMS FOR AFRICA

• The African Institute for Mathematical Sciences (AIMS) has been established in Cape Town, South Africa, with the goal of strengthening scientific and technological capacity across the continent. AIMS is a collaborative project between three South African universities, Cape Town, Stellenbosch and the Western Cape, as well as the University of Cambridge, UK, the University of Oxford, UK, and the University of Paris-Sud-XI, France. The institute is located in Muizenburg, Cape Town, in a former art-deco hotel that has been donated to the project. To date, over US$1.3 million has been secured. It is estimated that US$2 million will be required to cover operational costs for the first three years. AIMS will initially focus on a one-year postgraduate diploma course designed to develop strong mathematical and computing problem-solving skills. Courses, which include quantum physics, epidemiological modelling and financial mathematics, will be taught by eminent lecturers from Africa, the three collaborating European universities and elsewhere. Students with degrees in mathematics, science or engi-

neering are now being recruited from across Africa. For its first course, which began last September, AIMS received over 80 applications and accepted 30 students from 15 countries, including seven women. For further information see *www.aimsforafrica.org*.

DECLARATION ON FOOD PRODUCTION

• Delegates at the congress 'In the Wake of the Double Helix: From the Green Revolution to the Gene Revolution', held in Bologna, Italy, from May 28 to 31, signed a statement on securing global food production. Among the signatories were Nobel Peace Prize Laureate **Norman Borlaug** (TWAS Associate Fellow 1985), and World Food Prize Laureates **M.S. Swaminathan** (TWAS Founding Fellow) and **Gurdev Khush** (TWAS Fellow 1989). The statement supports a multidisciplinary approach for achieving a much-needed increase in food production by sustainable and environmentally sound practices. The scientists agreed that there should be:

Gurdev Khush

• Publicly funded research programmes to improve knowledge of the genomics of crop plants, accompanied by policies to ensure fair access to genetic resources for humanitarian purposes.

• Better recognition that genes found in domesticated crops, other plants and other living entities are the source for the improvement and protection of crops in sustainable and environmentally sound ways.

• Support for internationally coordinated research in the public and private sectors, both in the developed and developing nations.

• Support for capacity building in biotechnology and other modern crop improvement methods in developing countries and the establishment of an appropriate regulatory framework for evaluating new traits in crop varieties.

• Streamlining of the regulatory processes to prevent unnecessary delays in the introduction of crop plants with valuable traits that can save lives and alleviate devastating human diseases.

• Re-examination of intellectual property rights, in particular those that impact on biotechnologies, to ensure that the public good and international humanitarian purposes are well served.

M.S. Swaminathan

ICTI CENTRE FOUNDED

• Last February, Mining Italia (a multinational mining company operating in America, Africa and Europe) founded the International Centre for Technology and Innovation (ICTI) following an agreement with eminent scientists and in the presence of representatives from five Italian government ministries. The principal function of the new centre is "to promote the progress of applied sciences and innovative technologies considering the needs of developing countries with particular attention to mining and environmental sectors, facilitating contacts among scientists and experts from all over the world, especially from developing countries." Among the members of ICTI's scientific council are **Adnan Badran** (TWAS Fellow 1991), **Arturo Falaschi** (TWAS Associate Fellow 1996), **Swadesh Mahajan** (TWAS Fellow 1991), **Federico Mayor** (TWAS Associate Fellow 1991) and **Antonio Zichichi** (TWAS Associate Fellow 1986). The centre, with an annual budget of € 50 million, has laboratory and office space at the University of Calabria, Italy, from where it will organize workshops, seminars and conferences and carry out long-term research programmes. Its first major event, the International Conference on Frontiers in Science and Technology for Innovation, was held from 24-28 November 2003.

NEW ONLINE JOURNAL ACCESS

• A new website has been launched that allows free or low-cost access for scientists in developing countries to more than 400 food, nutrition and agriculture journals. Known as AGORA (Access to Global Online Research in Agriculture), the site is funded by the FAO. See *www.aginternetwork.org/en/*.

WHAT'S TWAS?

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

TWAS has 710 members from 81 countries, 66 of which are developing countries. A Council of 13 members is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat, headed by the Executive Director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. UNESCO is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of Italy.

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 scholarship.

TWAS was instrumental in the establishment in 1988 of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of 160 scientific organizations from Third World countries, whose goal is to assist in building political and scientific leadership for science-based economic development in the South and to promote sustainable development through broad-based partnerships in science and technology. ···⁘ **www.twnso.org**

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2000 women scientists from 87 Third World countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. ···⁘ **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 90 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. ···⁘ **www.interacademies.net**

WANT TO KNOW MORE?

TWAS offers scientists in the Third World a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS web-pages! Our main page is at:
www.twas.org

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes:
www.twas.org/Fellowships.html
www.twas.org/AssocRules.html

GRANTS

Seeking funding for your research project? Take a look at the TWAS Research Grants:
www.twas.org/RG_form.html
TWNSO runs a similar scheme, for projects carried out in collaboration with institutions in other countries in the South:
www.twnso.org/TWNSO_RG.html

EQUIPMENT

But that's not all TWAS has to offer. For instance, do you need a minor spare part for some of your laboratory equipment, no big deal, really, but you just can't get it anywhere locally? Well, TWAS can help:
www.twas.org/SP_form.html

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Examine the Visiting Scientist Programme, then:
www.twas.org/vis_sci.html

CONFERENCES

You're organizing a scientific conference and would like to involve young scientists from the region? You may find what you are looking for here:
www.twas.org/SM_form.html