

# **The Rolex Awards For Enterprise Fact Sheet**

## **Programme Overview**

The Rolex Awards for Enterprise were created to foster a spirit of enterprise and advance human knowledge and well-being around the globe. They support pioneering work in five areas: science and medicine; technology and innovation; exploration and discovery; the environment; and cultural heritage. In each series, ten Awards are presented to visionary men and women whose groundbreaking projects benefit their fields of endeavour, their communities and the wider world.

Winners are innovators who typically work outside the mainstream and often have limited access to traditional funding. Rather than reward past achievements, the Rolex Awards provide financial assistance and recognition to individuals embarking on new ventures or carrying out ongoing projects. Grants of \$100,000 are awarded to five Laureates and \$50,000 to five Associate Laureates in each series. These grants must be used to complete their projects. All ten also receive a Rolex chronometer.

In the 32 years since the Awards for Enterprise were founded, Rolex has inspired the work of a global network of visionaries. Chosen by a committee of specialists who themselves embody the spirit of enterprise that the Awards seek to promote, these past and current Laureates are helping to improve the human condition.

## **Selection Process**

The Selection Committee is an independent, voluntary jury of international experts from a range of disciplines. Chaired by Rolex CEO Patrick Heiniger, a new jury is convened for each series, for which Rolex receives roughly 1,500 applications from more than 120 countries. The projects submitted are analysed over a ten-month period by a team of scientific researchers at Rolex before being presented to the Selection Committee.

Projects are judged on their feasibility, originality, potential for sustained impact and, above all, on the candidates' spirit of enterprise. The Awards are open to anyone of any age, nationality or background. Applicants must show how they will turn an original idea into a functioning project, and how, through initiative and ingenuity, their projects will benefit mankind.

### **History of the Rolex Awards**

The Rolex Awards for Enterprise were initiated in 1976 by the late André J. Heiniger, former chairman of Rolex, to commemorate the 50th anniversary of the Oyster chronometer, the world's first waterproof watch. Since then, 110 Rolex Awards for Enterprise have been presented, honouring pioneers from 38 countries with projects in over 60 countries. Winning projects have helped to: protect rare and endangered species, from the tiny seahorse to the giant whale shark, and habitats, from the Amazon rainforest to coastal ecosystems in Thailand; revive time-honoured practices, from agriculture in the Andes and Africa, to traditional healing in the Himalayas; preserve and document ancient customs from Turkmenistan to Bolivia; record traditional cultural expression, from Mexican folk music to vanishing whistled and drummed languages; provide safe, affordable water, shelter, food and medicine in developing countries; and introduce revolutionary, technological and scientific inventions from low-powered lighting system for use in isolated regions to a device that analyses animal behaviour in the wild.

### **Rolex Philanthropy**

Since it was founded a century ago, Rolex has championed individual excellence and achievement in all its activities. In the 1950s, the company began assuring the reliability of its watches by asking leaders in sports and exploration to test them under extreme conditions – from the summit of Mount Everest to 10,000 metres underwater. During the past three decades, the company has continued to recognize excellence through two unique philanthropic programmes: from 1976, the Rolex Awards for Enterprise, and, from 2002, the Rolex Mentor and Protégé Arts Initiative, a global programme that pairs emerging artists with masters in dance, film, literature, music, theatre and the visual arts for a year of intensive collaboration. Building on a legacy of supporting culture that dates back to the 1970s, when the company established unique relationships with many of the greatest living artists, Rolex launched the Arts Initiative to help ensure that artistic excellence is passed on to the next generation. Unparalleled in its artistic and geographic reach – over 200 notable talents from 39 countries have participated since its beginnings – the multidisciplinary initiative is currently in its fourth cycle.

By fostering innovation in science, exploration, conservation and the arts, both the Rolex Awards and the Rolex Arts Initiative advance the work of individuals who exemplify the vision, ingenuity and excellence that define the Rolex brand.

## **The 2008 Laureates**

### **Talal Akasheh – Jordan**

Conserve ancient Petra from the ravages of time and tourism

### **Tim Bauer – United States**

Reduce pollution from motorized tricycles in Asian cities

### **Andrew McGonigle – United Kingdom**

Predict volcano eruptions using a remote-controlled helicopter

### **Andrew Muir – South Africa**

Provide training and jobs to young people orphaned by Aids

### **Elsa Zaldívar – Paraguay**

Combine loofah and plastic waste to make low-cost housing

# **Conserve ancient Petra from the ravages of time and tourism**

## **Talal Akasheh – Jordan**

### **BIRTH**

20 March 1947; Amman, Jordan

### **PROFESSION/JOB**

Professor of chemistry with expertise in archaeological conservation

### **PROJECT LOCATION**

Petra, Jordan

### **SUMMARY**

Petra, a 2,500-year-old city in Jordan, is one of the world's most revered cultural sites. But time and tourism are taking their toll of its monuments, carved into sandstone cliffs. Chemistry professor Talal Akasheh, who has devoted 26 years to documenting Petra scientifically, is set to complete a knowledge system that will underpin the city's future conservation.

57 words/366 characters

### **ADDRESS**

Department of Chemistry

Hashemite University

Zarqua

Jordan 13115

Tel: +962 5 3903333 ext. 4910

Email: takasheh@hu.edu.jo

Like a city carved from a sunrise, Petra rests among the desert sands, recalling the genius of creators long lost in time. Yet the very beauty that adorns it is also, slowly, devouring it.

The chemistry that decks Petra's ancient sandstone monuments in red, sulphur and orange hues is also secretly, grain by grain, dissolving this ancient wonder. Bone-stripping desert winds, rain and flash floods, scorching sun, teeming tourists and modern development add their weight to the erosion. Against these irresistible natural and human forces stand the resolution and skill of Talal Akasheh, a man determined to help save Petra for future generations.

Since he first beheld Petra as a young scientist, the soft-spoken professor of chemistry from Jordan's Hashemite University has dedicated 26 of his 61 years to conserving the ancient city. As he marvelled at the magnificence of its 2,000-year-old monuments carved from the living rock by a forgotten people, he also noted with distress the ravages of time. "I was astonished by the beauty of the site, its geology, its architecture. But I also saw many signs of deterioration. I felt something should be done about it," he explains. "It is a place alive with history – including the history of my own family, originally from Petra. I could not look at such beauty without saying: 'Maybe I can help. Maybe not a lot, but perhaps a little, I can help'." With quiet persistence, scientific meticulousness and inspired leadership, Akasheh has helped piece together the knowledge system that may yet help protect Petra, or at least delay its complete destruction for as long as possible.

The city of Petra was born 2,500 years ago in a giant bowl hollowed over aeons into the sandstone tableland by wind and water to form a perfect natural stronghold for a desert tribe, the Nabataeans, who lived by raiding caravans on the trade routes that criss-crossed the region. In time they grew wealthy and settled to a more cultured existence, crafting majestic tombs, elegant temples and theatres from the timeless cliffs that enfold the hidden site. They built a sophisticated system of dams, cisterns, pipes and channels to guard it from sudden floods. Later, the Romans added to the city. At its peak Petra may have sheltered 25,000 citizens. Named Rekem in the Dead Sea Scrolls, it had a profound influence on regional culture and politics, but, from the 3rd century on, natural disasters and political tides gradually eclipsed it until it was eventually abandoned and erased from the memory of all but local Bedouin.

In 1812, gleaned rumours of a "lost city" in the desert, Swiss explorer Johann Ludwig Burckhardt rediscovered Petra and proclaimed its marvels to the European public. English poet John Burgon famously celebrated it as "a rose-red city, half as old as time". Approached through a dark and sinuous gorge called the Siq, the site opens out into a breathtaking vista of more than 500 facades of tombs and as many as 3,000 features, over which The Treasury – a royal mausoleum – towers with grandeur. Visitors, particularly in recent decades, have flocked to view these wonders in tens of thousands, providing vital income to Jordan – but also posing a new threat to the ancient city. Added to UNESCO's World Heritage List in 1985, Petra has been listed, by the World Monuments Fund, among the annual 100 most endangered sites four times in the past 12 years.

From his first visit to the site, Talal Akasheh was not only moved by its beauty – as a scientist, he was eager to understand the chemistry of the weathering that is destroying Petra and to use his training to help arrest it. The vivid colours that lend the city its mystique in fact reflect the chemical processes caused by water within the rock itself: “Water is the most important element. It gets into the pores of the rock, evaporates and condenses, dissolving the minerals, depositing their crystals which then grow and crack the rock into finer particles. It is a very complex process and the flow of water leaves traces that form these beautiful colours on the surface.”

In 1984, he obtained a Unesco grant to work with German experts to decipher and remedy these destructive processes. After working for years at the site, he began to absorb the enormity of the challenge – and the many skills it would demand. Early attempts to patch up monuments had failed. Akasheh decided it was vital to document everything known about Petra before proceeding to protect or restore it. Gradually he began to combine the work of archaeologists and geologists, hydrologists, chemists, engineers, architects and planners into a database and geo-archaeological information system (GIS), with maps and minute details of the site, its physical characteristics, the monuments, their condition and the surrounding modern development.

Today the GIS provides managers of the archaeological park with essential knowledge they need to plan, care for and restore the site and its surrounding region. It offers archaeologists and architects a new way to analyse the monuments and their architecture – and visitors with a safer, more informative experience.

However, the threats facing Petra are pervasive. Akasheh has examined them all: there is the long, slow, chemical disintegration driven by moisture and the airborne salts from the Dead Sea, the rare, fierce downpours, changes to the water table and the sand-blast of desert winds. There is constant abrasion from the hands and feet of tourists and guides, the vandalism of tomb-robbers, urban encroachment, the visual canker of modern development and loss of vegetation from the landscape. There is the snake-like spread of tarmac roads and the acidic fumes of traffic. “I had an ulterior motive for wanting to conserve Petra,” Akasheh admits, referring to his fascination with the site. “Every time I go back there I find new things to marvel at, features to admire. I am myself a tourist. And tourism is the bread and butter of this part of Jordan. But it must be carefully planned. The GIS is the foundation, a first step, in this process.”

Learning the specialist skills to create the database was no simple matter. Meticulously, doggedly, Dr Akasheh applied himself to mastering them. By 2002, the Petra GIS, the first of its kind in Jordan, was in action, acclaimed by colleagues and put to practical use by Jordan’s Ministry of Tourism and Antiquities to plan and manage the site. Like the desert itself, funding was erratic, downpours were followed by long periods of scarcity through which the work progressed hand-to-mouth, often consuming Akasheh’s own resources. Yet he persisted. By 2008, the GIS’s 10-gigabyte memory collated 2,000 monuments and features, mapped Petra itself, the nearby tourist town of Wadi Musa and the Bedouin settlement of Um Sayhoun. At the same time, he also sought new ways to conserve the monuments and explored the exquisite Nabataean pottery.

Aqel Biltaji, former Jordanian Minister for Tourism and Antiquities, says: "Dr Akasheh's work is a perfect example of the use of science and technology in the service of sustainable tourism....Jordan lays great importance on tourism development, but is very keen to ensure the protection of the site. Dr Akasheh's work...could be among the first and most effective efforts towards achieving this goal."

Still, the GIS covers only part of the site – and it is for this vital completion phase that Talal Akasheh has been given a Rolex Award. Over three years, he plans to devote the prize funds to the inclusion of up to 1,000 further possible archaeological features in the database, half within Petra and the rest – possibly including a collection of watchtowers in a rural-suburban agricultural area filled with dams and water-management systems – outside. Study will be made of the flash floods that ravage the site, with a view to possibly restoring the 2,000-year-old Nabataean drainage system. Ground-penetrating radar will be used to prospect the surrounding terrain for hidden tombs and other archaeological mysteries. X-ray fluoroscopy and other advanced techniques will be deployed to study the weathering chemistry of the monuments, to identify those in most urgent need of conservation. The GIS has already yielded a wonderfully detailed tourist map, and may make possible virtual visits to the city from anywhere on earth, via the internet.

"The area around the city is covered with ancient farm terraces and dams, interesting graves, stone rubble pointing to possible defensive structures on the high ground, and other features," Akasheh explains. "If we leave it to the developers, we will never know what was there."

Among the world's fabled lost cities, Petra mysterious glory stands as a beacon of human achievement. It has withstood the abrasion of time for over two millennia, but how long it endures depends on how it is cared for today. Eventually, Akasheh acknowledges, it must return to the desert sands: "Already monuments have disappeared, and some are more affected than others. But it is still worthwhile. It is natural for man to look at his past and to respect it. To want it to last as long as possible. And good documentation of the site keeps its memory safe, even after it is long gone".



#### AN INTERVIEW WITH TALAL AKASHEH

**What is the link between your professional career as a chemist and your involvement in a cultural heritage project?**

My specialty in chemistry was the advanced reactions and physical processes caused by light – so it had very little to do with the weathering of the monuments. The geological, physical, chemical and biological processes were out of my scope at the time, and I had to learn those things. Slowly I decided we needed to create an information system. The site required integrated management, multidisciplinary action

and so on, and this led me into another area – how to create a database using new digital technologies. I went into GIS very slowly, really. Sometimes you are not sure where you are getting with this new knowledge. And, you know, in time it worked.

**What have been the greatest obstacles you have had to face?**

In the first place, just learning the necessary skills was quite challenging. Then, convincing people of the importance of this work. It takes a lot of communication to get people to back you and to understand what you are trying to do. This takes up a lot of your life; you have to give up many things. Sometimes, too, you'd go on a course [of investigation] only to find it wasn't useful or beneficial – but it is part of the process. Research is like that. Sometimes. Raising funds takes the better part of your efforts and time, and remains a problem.

**What do you see as the main impact of the project, for Petra and other cultural heritage sites?**

Many sites all over the world have been subjected to the same kind of study. I think the biggest impact is in Jordan, as a foundation for planning, for conservation and management. This really is the first GIS for a site in Jordan, and it is designed with a view to create a foundation for the conservation of Petra. It can be a model to be employed for other sites in Jordan as well as outside. At the same time, anything you do can have a scientific impact in other places. You find other people would like to do something similar to what you have done. They get an idea from you to improve their system – or you get an idea from theirs. Now we are considering creating virtual reality – our GIS can be used to enhance this. We have already covered a few monuments. Eventually, with the right resources, we hope to cover the whole city.

**In what way is Petra unique, or different from other ancient sites?**

Petra hosts the largest number of rock-carved monuments in the world. However, in addition to the finest man-made art and architecture, nature has also used its tools to carve the most breathtaking geologic formations. Man and nature have collaborated in the creation of this fantastic site, with the visual and artistic riches that tourists enjoy today. It is also a perfect example of how ancient man was able to work in harmony with nature, harnessing its resources and scarce water for sustainable development. It is not surprising that Petra recently won the title [in an Internet poll in 2007] of one of the "Seven New Wonders of the World".

## **Reduce pollution from motorized tricycles in Asian cities**

### **Tim Bauer – United States**

#### **BIRTH**

28 December 1976; Annapolis, Maryland, United States

#### **PROFESSION/JOB**

Mechanical engineer, co-founder and Vice-President of Operations at Envirofit International

#### **PROJECT LOCATION**

Vigan and Puerto Princesa, Philippines, and later in other Asian cities

#### **SUMMARY**

In Asia, the ubiquitous motorised tricycle with its two-stroke engine is a major cause of air pollution. Working in the Philippines, American mechanical engineer Tim Bauer and his team have developed a kit to reconfigure these machines, drastically reducing their noxious emissions. He now plans to install thousands of kits, greatly improving air quality and providing tricycle drivers with a way to boost their income.

#### **ADDRESS**

Envirofit International  
P.O. Box 886  
Fort Collins, Colorado 80524  
United States  
Tel: +1 970 491 4788  
Email: [Tim.Bauer@envirofit.org](mailto:Tim.Bauer@envirofit.org)  
Website: [envirofit.org](http://envirofit.org)

Every day at dawn, Angel Raqueno gets on his motorised tricycle with its shaky side-car and criss-crosses the narrow paved streets of Vigan, a small, picturesque tourist city 400 kilometres north of Manila, capital of the Philippines. Long ago, he had begun studying electronics, but he gave it up to take up taxi-driving to support his family. For the past 18 years, he has driven passengers through the city's 39 *barangays* (districts) ten hours a day, six days a week. But, for Raqueno, worse than the long hours on the road is the blueish smoke emitted by the 3,000 other tricycles providing transport for tourists and locals around this 16th-century architectural gem: if you are stuck in traffic behind one of these vehicles, the air is almost unbreathable.

According to the *2006 Philippine Environment Monitor* published by the World Bank, atmospheric pollution causes 15,000 deaths in the country every year. Related health costs represent US\$19 million a year, and loss of earnings amount to \$134 million. The World Health Organization reports that atmospheric pollution across Asia is responsible for 537,000 deaths a year. The transport sector contributes significantly to this: most of the 100 million tricycles, tuk-tuks, auto-rickshaws and trishaws – symbols of tourism and urban mobility – that clog up Asian cities from New Delhi to Manila are equipped with two-stroke engines – each of them causing as much pollution as 50 cars.

Tim Bauer decided that the solution could be found at the heart of the problem. Since 2006, this 31-year-old American mechanical engineer has been distributing a kit that makes it easy to transform the engines on these vehicles into direct fuel-injection mechanisms, thereby reducing the pollution they produce. Carrying out tests in a laboratory and in Filipino garages for many months, it took him and his team every ounce of ingenuity they could muster to disentangle all the technical, economic and socio-cultural intricacies. The result has earned Tim Bauer a Rolex Award.

In the Philippines, about 1.8 million tricycle drivers have to face appalling traffic conditions for long hours every day in order to transport their passengers on congested thoroughfares, roads flooded by torrential rain or riddled with deep potholes. When neither cars nor buses can get through, a tricycle will always find a way. These all-purpose vehicles provide cheap transport for tourists, but, on a far larger scale, to thousands of people who use them to earn a living, get to work, school, the market or church. "They play an essential role in the social and economic fabric," Bauer says. "But their impact on public health is disastrous."

In Europe and the United States, two-stroke engines are relegated to powered grass trimmers and chainsaws. But in the Philippines they are used on 94 per cent of motorcycles; in India, Pakistan and Thailand, the figure is between 50 and 90 per cent. For Tim Bauer, it is easy to see why: "A two-stroke engine is a beautiful thing. It's reliable, robust, powerful and so simple that drivers can repair it themselves, which is very important for people who earn only about \$5 daily. But there's a problem: up to 40 per cent of the fuel and oil exit the engine unburned." This leads to substantial emissions of oxides of carbon, nitrogen and sulphur, hydrocarbons and fine dust, making them one of the main sources of air pollution in the Philippines archipelago.

In 2003, the Filipino government tried to phase out these vehicles and replace them with motorcycles with four-stroke engines, which are less polluting, but cost about \$1,500, the equivalent of a tricycle driver's annual income. The authorities were forced

to back down when faced with a general outcry from drivers and the vast network of mechanics and sellers of spare parts depending on them. "The challenge was to find a solution that would allow the drivers to keep their means of subsistence," says Bauer. "The constraint was thus to keep the two-stroke and start from it."

The direct injection kit began to take shape in 2000, in the Engines and Energy Conservation Lab – a spin-off of Colorado State University (USA) directed by Professor Bryan Willson – which Tim Bauer joined in 1997 during his mechanical engineering studies. Bauer, then aged 24, and his colleague Nathan Lorenz were leading a team of students in a research project on the application of direct injection to the snowmobiles of Yellowstone National Park. Bauer immediately saw the potential of this technology for reducing polluting emissions and, at the end of his studies in 2004, instead of applying for a more lucrative job in the aerospace industry, he and Lorenz decided to do their utmost to develop a commercially viable product and make it widely available in Asia.

But getting from North American snowmobiles to Filipino tricycles required inventiveness and global awareness. "I became aware of air pollution at an early age," Bauer remembers. "I lived for some time in Saudi Arabia as a kid, and from there I visited Bangkok and Hong Kong with my parents. This is where I saw and felt two-stroke pollution for the first time. It made a lasting impression on me."

The "retrofit" consists of a simple but effective mechanical change. "In a two-stroke, when the piston goes down it uncovers both the exhaust port, where the combustion products are forced, and the fuel and oil intake port. This means that a lot of the oil and fuel mixture is directly washed out in the exhaust stream," explains Tim Bauer. "In a direct-injection system, fuel is injected into the cylinder later in the cycle, when the exhaust port is closed by the piston, thus greatly reducing the amount of unburned fuel that is allowed to escape."

The kit can be installed in two to four hours and reduces particulate emissions by roughly 70 per cent and emissions of carbon monoxide (CO) by 76 per cent, hydrocarbons by 89 per cent and carbon dioxide (CO<sub>2</sub>) by 35 per cent. The kit also eliminates the blueish smoke in the exhaust, and oil consumption is reduced by 50 per cent and petrol consumption by 35 per cent – the equivalent of around 450 litres of petrol a year per kit. This makes the engine cleaner than a simple carburetted four-stroke, and for the driver it means a saving of around \$3 a day or over \$1,000 a year, almost doubling his salary. This extra income is put to use straight away. "Drivers often give the money to their wife for her to invest – many families have a small convenience store. Or they use it to pay for their children's schooling or studies," says Tim Bauer.

To keep down the cost of manufacturing the kit – currently \$350 – Tim Bauer and Nathan Lorenz used off-the-shelf components: "We have simply adapted as many components as possible from an existing direct-injection system and developed other components (i.e. custom cylinder head, wiring harness, bracketry, etc) that could be used on the most popular motorcycle models in Asia. One-third of the 30 parts of the kit are produced in the Philippines."

In October 2003, in order to further develop, commercialize and distribute the kit, Bauer and three of his colleagues founded a non-profit organization, Envirofit, which now has over 20 employees, half of them based in the Philippines. In December 2005, Envirofit signed a Memorandum of Understanding with Vigan City Council, thereby gaining its official support. The following year, it published a troubleshooting manual, translated into Tagalog, one of the main languages of the Philippines, and Ilocano, the language spoken in Vigan. Bauer, who travels to the Philippines five times a year, has also organized about 15 training workshops and seminars in Vigan and Puerto Princesa, two seaside tourist cities with no major industry, where tricycles contribute significantly to atmospheric pollution. Twenty or more drivers and mechanics have attended each workshop so far. "We have developed the kit so it is easy to install, even by non-certified mechanics," Bauer explains. "But we had to convince them that the common idea, according to which the more visible smoke you have, the more powerful your engine is, is wrong. As there is no smoke with the kit, they thought that we were hiding it with some kind of chemicals!"

However, purchasing the kit represents a major investment for a tricycle driver. So Bauer and his team launched a microcredit programme, in collaboration with the Nueva Segovia cooperative bank, which collects repayments on the loans. "Microcredit is essential to ensure a sustainable impact to our action. Drivers earn money daily, so it's easy for them to pay back their loan and 90 per cent of them do it in less than a year."

To date, over 230 drivers in Vigan and Puerto Princesa have fitted their taxis with a kit and have driven a total of 4.5 million kilometres. With the funds from his Rolex Award, Bauer now wants to further develop the market in these cities and surrounding regions as a stepping stone to distributing the kit more widely in the Philippines and beyond, particularly Pakistan, India, Indonesia and Sri Lanka where millions of autorickshaws could easily be retrofitted.

Besides the kit, Vigan City Council is exploring other forms of technology to solve its pollution problem, such as tricycles powered by electricity or natural gas. For the moment, however, their price is prohibitive and, according to Bauer, if implemented incorrectly, can potentially shift the problem elsewhere: "Two-strokes can have a lifetime of up to 20 or 30 years. If they're banished from the cities, they'll continue to be driven in more disadvantaged, outlying areas. Our retrofit kit makes it possible to reduce the environmental impact of the millions of two-strokes currently in use, and that will still be used for many years."

Amory Lovins, a world expert on energy resources, agrees: "Envirofit has devised a practical and affordable way...to fix two-stroke vehicles in Asia. This is the here-and-now solution to go with."

"These drivers are at the base of the economic pyramid, and these tricycles are a testament to their ingenuity and work ethic," says Tim Bauer. "At the end of the day, we can improve their lives with a cylinder head, a few brackets, and, of course, hard work. This is our best reward."



## AN INTERVIEW WITH TIM BAUER

### **Why did you decide to concentrate particularly on two-stroke engines?**

It's powerful, simple, reliable and robust, and spare parts are easy to find. It also has a long lifetime: the oldest we worked on was 32 years old. But there's a deficit in design: it's very polluting. They could be some of the cleanest engines if designed correctly, e.g. with direct injection. There are millions of them out there. As an engineer, I had to try to enhance them.

### **What were you aiming for when you developed the kit?**

There were several key constraints. It had to substantially reduce emissions without impairing the engine's performance, which is appreciated by its users. It had to be installed without machining the engine crankcase, and with only a basic tool set. Of course, it also had to be affordable for Filipino tricycle drivers.

### **What made you choose Vigan and Puerto Princesa as the cities to test the kit in?**

Vigan was designated as a UNESCO World Heritage Site in 1999. The city depends on its tourist economy, but the local environment, the historic architecture and the residents' health are under siege from air pollution. As the city lacks any significant industry, its air quality problems can be traced to its fleet of 3,000 tricycles. The same applies to Puerto Princesa, one of the main tourism capitals of the Philippines, with a two-stroke fleet of over 2,000. Thus, the retrofit kit could literally clean the air in those cities. This will serve as a useful public relations boost for the kit and allow both regional and national expansion, and beyond.

### **Envirofit is a non-profit organisation, which receives no direct funding from the University of Colorado. What is your strategy for achieving sustainability?**

To reach sustainability, you have to be commercially driven. If you're not, you're not holding the bar high enough for yourself to make an impact. And at the end of the day, we're out there to make an impact that is sustainable. It's not just for a couple of years and then going away, it's not "hit-and-run" development. Our ultimate measure of success is "people, planet, profit": we aim to increase incomes to achieve sustainable health improvements.

# **Predict volcano eruptions using a remote-controlled helicopter**

**Andrew McGonigle – United Kingdom**

## **BIRTH**

11 November 1973; Edinburgh, Scotland

## **PROFESSION/JOB**

Senior research scientist with expertise in physics and volcanology

## **PROJECT LOCATION**

Mt. Etna and Mt. Stromboli, Italy

## **SUMMARY**

Many millions of people around the world live in the shadow of an active volcano, at risk of sudden death. Scottish physicist Andrew McGonigle is developing a reliable way to predict eruptions, using an unmanned, small-scale helicopter to measure gases that escape from the volcanic vent. His combination of science and advanced technology has the potential to save thousands of lives.

## **ADDRESS**

Department of Geography

University of Sheffield

Sheffield

Yorkshire S10 2TN

United Kingdom

Tel: +44 114 222 7961

Email: [a.mcgonigle@shef.ac.uk](mailto:a.mcgonigle@shef.ac.uk)

The ancient Romans named the mouth of Hell *Avernus* – “birdless” – because of the deadly volcanic exhalations that killed every creature flying over it. Now, a small, man-made bird will approach the vents leading to the underworld, to sample their lethal breath. The knowledge it gathers could help save thousands of lives.

In 2009, Scottish physicist Andrew McGonigle will fly his remote-controlled, two-metre-long helicopter towards the fiery mouths of Italian volcanoes Etna and Stromboli to inquire of them when they are likely to erupt.

Volcanoes loom large in the human imagination, not only for their vast bulk and fearsome destructive powers, but also for their unpredictability. Their flair for unheralded catastrophe has awed poets, painters, storytellers and scientists alike for generations. Today hundreds of millions of people in many countries dwell in their shadows. Volcanoes present not only a risk to human life, but also a major inconvenience to national and municipal governments – a false alert to evacuate a city can cause unnecessary alarm and much expense; failure to warn citizens in the case of an eruption has far more devastating consequences.

But if Andrew McGonigle’s brilliant fusion of high science and smart technology succeeds and is used in conjunction with other measurements specific to each volcano, the fear of sudden volcanic death, which has accompanied humanity since its dawn, will be greatly reduced. Those who live around the 550 volcanoes that have been active at some point over the centuries may receive weeks, even months of warning of an impending eruption.

Researchers have sought ways to predict eruptions for more than a century, a task that sometimes required them to get dangerously close to the volcanoes. While techniques have improved, adequate forewarning remains elusive in many cases. When Mt. Tambora erupted in Indonesia in 1815, it claimed over 70,000 lives. In 1902, Mt. Pelee in Martinique left 31,000 dead and, in 1985, Nevado del Ruiz took 25,000 lives, while Laki killed a quarter of Iceland’s population in 1783-84. Yet, in 1991, thanks to measurements of gas emissions, a few days’ warning that Mt. Pinatubo in the Philippines was primed to erupt enabled 300,000 people to flee, leaving just 875 casualties. But the gas-based conditions that enabled the forecasting of this eruption are rare: many of the world’s volcanoes remain enigmatic and, in the 20th century alone, killed 100,000 people.

One clue to the impending explosion is the release of gases from the magma as it rises towards the surface: sulphur dioxide (SO<sub>2</sub>), as well as super-heated steam, and carbon dioxide (CO<sub>2</sub>) are the main messengers, bubbling out of the molten rock as the pressure that imprisons them drops. “It’s like popping the cork on a bottle of champagne, allowing the bubbles to escape,” McGonigle explains.

SO<sub>2</sub> is easily detected – but it dissolves in groundwater and is often not released in time to be a reliable indicator of an eruption. The best indicator of all is CO<sub>2</sub>, which escapes from the magma much earlier, when it is still 10 kilometres deep in the throat of the volcano. Once it reaches the surface, however, volcanic CO<sub>2</sub> is indistinguishable from atmospheric CO<sub>2</sub> and – until now – measuring methods were not sensitive enough to detect the presence of significant volcanic CO<sub>2</sub>. Volcanologists have tried setting their

instruments inside the crater, but this method is very hazardous. McGonigle discovered that a better method was to position the instruments below and briefly through the plume of gas as it spewed from the volcano's mouth and floated downwind, high above the ground.

McGonigle, who is 35 years old, grew up in Edinburgh, a fountainhead of the earth sciences for two centuries. On cross-country runs and camping expeditions, he skirted extinct volcanoes and explored the rugged, primordial geology of the Scottish Highlands. But his first love was physics: "I wanted first to understand how the universe worked, through the most fundamental of sciences – although my real passion is to use that understanding to come up with simple, elegant solutions to real problems."

As a scientist, McGonigle has specialized for a decade in the study of air pollution and volcanic gases using lasers and other sensing devices. Among his adaptations for volcanology is a miniaturized spectrometer, far smaller and less expensive than normal instruments and now in standard use around the world. He has clambered over 15 of the world's 60 active volcanoes, and analysed the gas signatures of many more. His research has proved seminal, yielding 42 scientific papers that have profoundly influenced volcanology in particular, as well as other areas of research. But it was the coupling of this science with the emerging technology of remote-controlled aircraft that was the stroke of genius, leading to his selection for a Rolex Award.

In 2005, a colleague at Sheffield University, Dr Andy Hodson, began testing a remote-controlled helicopter for studying glaciers, covering a far larger area, more safely and less arduously than on foot. This inspired McGonigle to develop a similar approach for sampling the gases from volcanoes. He rang a model shop, where the obliging manager ran a quick test and told him, yes, a remote-controlled helicopter could carry a payload up to 3 kilos – enough for the sophisticated sensors needed to take the measurements.

McGonigle teamed up with David Fisher, remote-controlled helicopter champion of Great Britain, and they installed the instruments on a small chopper. To their dismay, the onboard computer that analysed the data failed repeatedly. Eventually they tracked the fault to the massive vibration caused by the helicopter engine – a problem solved with true inventiveness using foam rubber, elastic bands and a US\$10 plastic stool. "For me, the biggest breakthrough was getting it all to work on the test flight. I was almost in tears," McGonigle recalls.

In March 2007, with the help of David Fisher and Professor Alessandro Aiuppa, of the Italian National Institute of Geophysics and Volcanology, the prototype helicopter, AEROVOLC I, took to the skies near the fuming vent of Vulcano, a modest cone near Sicily that has lent its name to the entire volcano tribe. It worked perfectly – over the ensuing days the instruments recorded SO<sub>2</sub>, CO<sub>2</sub> and wind speed, enabling the scientists to calculate the flow of gases from the volcano. "It was just amazing. There was ecstasy in the camp. We had clear proof that the concept worked – and that it may be possible to predict from weeks to months ahead whether an eruption is developing, from the flow of CO<sub>2</sub>," says McGonigle. Professor Aiuppa adds: "These measurements could provide us with the earliest and most direct possible indicator of a

forthcoming eruption. McGonigle's idea is innovative and should represent a major breakthrough in modern volcanology."

The method requires the team to measure the flow of SO<sub>2</sub> from beneath, then fly the helicopter into the plume to measure total SO<sub>2</sub> and CO<sub>2</sub> and establish the wind speed, all with the aim of accurately calculating the flow rate of volcanic CO<sub>2</sub>. This provides clues to the state and position of the magma, deep in the volcano – advance notice that "something is going on". However, McGonigle cautions, each volcano is different – special knowledge of its unique "personality" must be added to the information about its gas emissions.

With the Rolex Award funds, McGonigle is purchasing a piece of high technology, a 14-kilo helicopter built by an American firm, which will be known as AEROVOLC II once he has equipped it with his specially tailored gas sensors and analytical software. In 2009, he will carry out further field trials on two of Italy's most famous but very different volcanoes, Mt. Stromboli and Mt. Etna: the former erupts every 10 minutes and the latter about once a year. Using GPS navigation and on-board robotics, the helicopter can take off, fly and land itself according to a pre-determined flight plan, enabling anyone with basic technical skills to operate it. Or, thanks to an onboard video camera, it can be guided manually at any stage of a flight extending up to around 20 kilometres. This makes the technology usable with minimal training by the staff at any volcano observatory in the world. Measurements can be taken safely, cheaply and frequently, even daily, replacing, for example, current piloted helicopter flights over volcanoes that are expensive and at times perilous.

"People are now interested in the prospect of using these kinds of aircraft for all sorts of monitoring and mapping, for anything that is remotely dangerous," McGonigle adds. The equipment costs about \$80,000, a fraction the price of other, less versatile approaches. Thus, for relatively modest costs, millions of people could receive the gift of time in which to save themselves from an impending eruption.

Combined with other forms of volcanic sensing, such as seismology and ground-deformation detection, Andrew McGonigle's innovative approach to gas sampling will provide far greater power and precision in predicting the unpredictable, the timing of a volcanic outbreak – and so protect countless people from an age-old, terrifying menace to humanity.



## AN INTERVIEW WITH ANDREW MCGONIGLE

### **How did you become interested in volcanoes?**

Even as a child, I was incredibly curious to know how the world works. In school I was really interested in physics and in geography too. There seemed no real way to marry them, so I decided to go with physics to understand the universe at its most

fundamental level. But, all along, I wanted somehow to get back into the earth and environmental sciences. Amazingly, a position came up at Cambridge, where Clive Oppenheimer was looking for a physicist to monitor volcanic gas plumes. And I haven't looked back since.

**How many volcanoes have you visited?**

I've worked on 15 volcanoes in Central America, the Caribbean, Papua New Guinea and Italy. I've also been involved in supplying instruments or with data analysis on many others. Among my experiences, visiting Herculaneum was very impressive. You have to physically climb down from the new city, Ercolano, near Naples, through the pyroclastic flow deposit, into the old Roman city below. That sandwich effect reminds you that history will be repeated at some point.

**What is the appeal of volcanoes?**

I find the whole scale of volcanoes absolutely awesome. They are these incredibly powerful phenomena that we cross at our peril. It is awe that drives you to be as far away from the volcano as possible whilst measuring. Volcanoes touch many aspects of society and art – they feature in poetry and in paintings like Edvard Munch's "The Scream", where the eerie red sky in the background is caused by the ash from Krakatoa.

**What will you do after this method of detecting eruptions is up and working?**

First we need to bed this method down, and mine the information it generates. Then we can combine this with all the other different signatures, such as seismic and ground deformation data. Fusing these together is so useful, as it reveals things you would not have seen before. That would be really valuable.

**What will be your next field of volcanic research or innovation?**

The other major technological project that I am working on concerns using ultraviolet cameras to measure SO<sub>2</sub> emission rates, at a completely unprecedented time resolution of one or more measurements per second. This will allow us to study rapid volcanic effects, such as the explosions, which occur on Stromboli every ten minutes or so, through the lens of gas flux data for the first time. Given that these eruptions are driven by pressurised gases, this should allow us far more direct insights into this behaviour than possible hitherto.

## **Provide training and jobs to young people orphaned by Aids**

### **Andrew Muir – South Africa**

#### **BIRTH**

6 November 1965; Cape Town, South Africa

#### **PROFESSION/JOB**

Executive director, the Wilderness Foundation; conservationist and humanitarian

#### **PROJECT LOCATION**

Eastern Cape Province, South Africa

#### **SUMMARY**

South African conservationist Andrew Muir is harnessing the healing powers of nature to help young people orphaned by HIV/Aids become independent citizens. Muir's Umzi Wethu programme provides vulnerable but motivated youths with vocational training and jobs in the burgeoning ecotourism industry, while immersing them in their country's rich natural heritage.

#### **ADDRESS**

The Wilderness Foundation  
11 Newington Road Central  
Port Elizabeth 6001  
South Africa  
Tel: +27 0 41 373 0293  
Email: [andrew@sa.wild.org](mailto:andrew@sa.wild.org)  
Website: [wildernessfoundation.org](http://wildernessfoundation.org)

Pakamisa Kolisi was just 13 years old when his mother died. At the time, he lived in a cardboard shack in the sprawling township of Zwide, just outside Port Elizabeth in South Africa's Eastern Cape Province. His father had abandoned him long before, so the mother's death meant Pakamisa was an orphan. His seven-year-old brother Mandilakhe now looked to Pakamisa for food and clothes, and to get him ready for school. For a while, Pakamisa was helped by his grandmother, but she too became frail and died. His future looked bleak, particularly as he lived in a township where most of the 35,000-plus inhabitants lived below the poverty line, were unemployed and lacked proper housing.

Pakamisa's story, sadly, is not an unusual one. South Africa has an estimated 88,000 child-headed households. As the nation continues to suffer the devastation of an Aids pandemic – South Africa has the biggest number of HIV/Aids infections of any country in the world, with 5.5 million people believed to be infected – the number of children with no parents is expected to increase significantly over the next decade. The death of a parent by HIV/Aids accounts for about half the country's estimated 2.2 million orphans. Traditional family structures are becoming overstretched, unable to cope with the overwhelming number of children with no adults to care for them.

In most developing countries, orphaned children are highly vulnerable. Not only have they lost the security and moral guidance that parents provide, they are also at risk, in poorer countries, of being denied shelter, food, clothing and health care. Many are unable to attend school as they have to look after younger siblings or contribute financially to the household. Understandably, such children often lapse into depression, develop a dependence on alcohol or drugs, or turn to crime or prostitution to survive. To escape such a cycle of poverty is virtually impossible.

What is remarkable about Pakamisa's story is that, today, at the age of 25, he is content. Thanks to the Umzi Wethu Training Academy for Displaced Youth, he has embarked on a career in the hospitality industry and is well on his way to becoming independent.

The brainchild of South African conservationist Andrew Muir, Umzi Wethu is a multifaceted intervention programme that targets orphans. Aged 42, Muir vividly recalls the day the seed was planted for Umzi Wethu: "I read a UN report back in 2004 that 80 per cent of the world's orphans live in sub-Saharan Africa. I was shocked. This is a massive issue, not only from a social perspective, but also from an environmental perspective. I understand the pressure this can have on the environment, particularly in very poor regions. Orphans are vulnerable, and generally have no other option than to use the resources readily available to them. This can lead to poaching, chopping down of trees for firewood and shelter, and the like.

"I also realised that conservationists as a collective have not come up with a solution, one that could make this crisis take a positive turn. Conservationists today need to be aware of the broader social context within which they operate. Gone are the days when we could simply put a fence around a protected area and ignore what was happening outside."

As executive director of the Wilderness Foundation South Africa (WFSA), a non-profit conservation organization that uses nature as a tool for social change, Muir is aware of the healing capacity of nature and the significant employment opportunities offered by ecotourism. Over the course of his career, he has created dozens of initiatives and events linking conservation causes with social development, and has raised over US\$26 million for conservation and social development programmes. Umzi Wethu, which means “our home” in Xhosa, one of South Africa’s 11 official languages, is Muir’s latest project, a holistic programme that aims to fulfil the potential of resilient, motivated youths like Pakamisa who have been displaced by HIV/Aids and poverty.

Muir primarily targets orphans from the most impoverished communities, providing a secure, nurturing place for day and residential students to develop. About 60 per cent of the youths attending Umzi Wethu are “Aids orphans” – individuals impacted by Aids but who are not necessarily infected by the virus – while the remaining intake comprises individuals living in child-headed households. Muir stresses that Umzi Wethu is neither an orphanage nor a state institution, but a training facility that teaches teenage orphans to be cooks or rangers, the two sectors in the ecotourism industry with the highest potential for income and management opportunities.

“We don’t choose individuals directly, but work with institutions who identify potential candidates and who can provide us with a case history. Over and above vocational tuition, Umzi Wethu also provides life skills training, wellness counselling, one-to-one mentoring and wilderness experience. I knew that the only way we could make Umzi Wethu work was by creating a comprehensive and long-lasting programme. After all, the vulnerability of these orphans has generally been 18 years in the making and will need something pretty intense and all-embracing to turn it around!”

As well as a year of training, Umzi Wethu provides guaranteed job placement with transitional support. As the costs of any programme like Umzi Wethu are substantial, Muir believes it is essential to select young people who have the aptitude and potential to see the programme through. “We need to be confident that our Umzi Wethu students will be able to stay in the jobs we secure for them – only then will the programme be successful from a socio-economic perspective. Essentially we are creating ambassadors for other vulnerable youths and orphans to look up to, and see a brighter outlook. Graduates from Umzi Wethu will serve as examples of opportunity and hope to both their own families and to the communities from which they come.”

South Africa’s Eastern Cape Province, where Muir piloted the Umzi Wethu programme, boasts remarkable natural diversity. Ironically, far more Western tourists have had more access to these wilderness areas than the people who live nearby. Muir believes that “the wilderness can heal and sustain the human psyche”. All Umzi Wethu students spend approximately one week every two months off-site at bush camp to experience, often for the first time, South Africa’s great wildlife and plant biodiversity. For a young orphan, used only to the muddy, littered streets of a shanty town to walk through the bush or next to a running river in a forest can be life-changing. And for this same young person to be surrounded by peers from a similar background, in a setting that is secure, with boundaries of discipline set by a caring House Mother, will bring major psychological benefits. Add credible vocational training and you have the ingredients that make up Umzi Wethu, transforming such young people into effective, independent

citizens. This pioneering method of using conservation to rescue orphans and vulnerable youths from poverty and despair has won Andrew Muir a Rolex Award.

Initial studies and assessments by the Wilderness Foundation indicate that in South Africa alone more than 50,000 new jobs are being created every year in the conservation and tourism industries leading up to a major football event – the 2010 FIFA World Cup, which South Africa will host. The Eastern Cape is poised to reap the benefits of this upsurge in ecotourism, and two Umzi Wethu academies have been established there. The first, in Port Elizabeth, focuses on hospitality, while the second, located in Somerset East, close to three national parks, caters exclusively to the conservation and ranger trainees. Funds from Muir’s Rolex Award will help cover the costs associated with one intake of 20 students at the Somerset East academy. The success of the pilot programme at the two academies has been outstanding, as Muir proudly explains: “Eighty-five per cent of the 40 graduates have made the successful transition into employment, with some already having been promoted to junior managers.”

Umzi Wethu is, for Muir, also a means by which he can help heal the wounds left by apartheid. It was his exposure to the atrocities committed by the military in suppressing the anti-apartheid movement that flamed his desire to redress the long-standing racial injustices in South Africa. Conscripted into the South African Defence Force (SADF) in 1985, he was deployed into the townships to help quell the uprisings. “This marked a turning point in my life,” recalls Muir. “I witnessed some horrific things, and saw absolute anger and hatred in the eyes of the majority of our country’s citizens. I knew then that I had to try, in some way, to heal those wounds.”

In fact Muir’s experience in the army not only showed him the worst side of the country, but also its best. Having conscientiously objected to his duties, he was, after a period of incarceration, assigned a desk job. It was here that he conceived the idea of a 780-kilometre walk along the beach from Nature’s Valley, near Plettenberg Bay, to Cape Town to raise awareness about tuberculosis. Under the auspices of the SADF, Muir was joined by 13 of the country’s premier athletes on a walk that took 28 days. He says the experience transformed him, inspiring him to develop his philosophy of using nature for both social and environmental reform.

His deep commitment has won wide respect, as Dr Mamphela Ramphele, a leading intellectual and political figure, acknowledges: “Andrew is a man fired by the passion to be the best he can be in order to make the world he lives in a better place. He is a leader, teacher, mentor and bridge between young people and the world of adults; between black and white South Africans; and between urban development and the relatively unspoiled wilderness areas. He is able to move people beyond the limits they set themselves.”

Muir wants to create 10,000 jobs over the next 10 years. To achieve this, the Umzi Wethu model needs to be embraced throughout the Southern African region. “Umzi Wethu was never created as a one-off programme, but rather as a model that can be duplicated in other provinces and countries, and in other industries. My hope is that the Rolex Award will be the catalyst for rolling out this programme more widely, to benefit the millions of orphans living in Southern Africa.”

Pakamisa says Umzi Wethu has changed his life. With a job as a junior chef, he is better placed to look after his brother Mandilakhe. "I now know where I am going," he says. "My future is bright and secure, and I really believe that I can fulfil my dream to be a manager in a hotel. What I pray for is that my friends living in the township will also be able to share the Umzi experience, and be given the chance to live their dream."



## AN INTERVIEW WITH ANDREW MUIR

### **Can the Umzi Wethu programme help stem the tide of HIV/Aids and its devastating effects?**

Umzi not only trains and places vulnerable orphans into sustainable employment, but also places a lot of emphasis on wellness and HIV education and prevention. But for the programme to be truly successful, it needs to be duplicated in a wide range of organizations. If there were, for example, 100 Umzi Wethu academies in the areas worst hit by HIV/Aids graduating 50 students annually into jobs, these 5,000 previously vulnerable youths would have a positive socio-economic impact on approximately 50,000 individuals. This will begin to stem the tide!

### **HIV/Aids still has a huge stigma attached to it. Are children orphaned as a result of Aids subjected to increased discrimination compared with other orphans?**

The simple answer is yes. The challenge faced by many of our youths is that parents do not disclose their HIV-positive status, and seldom are people declared to have died of HIV/Aids. Even at our interview or screening stage, it is very difficult to determine who is an Aids orphan and who is not, as applicants do not willingly disclose that HIV/Aids was the cause of death of their parents. Programmes like Umzi will help lose the stigma and labels attached to HIV/Aids, and also help to sensitize would-be employers. About 60 per cent of all our learners are "Aids orphans" and 40 per cent are in child-headed households. All are highly vulnerable. It is also important to note that 70 per cent of all "Aids orphans" are not infected by the virus.

### **Umzi Wethu's vision is to place 10,000 vulnerable youths in jobs over the next 10 years. Is Umzi Wethu on track to achieve this goal?**

We are only on track if we achieve roll-out, in other words if we get other organizations to embrace this programme. For this to happen, people need to know what Umzi Wethu is all about – the coverage and attention Umzi Wethu will receive through the Rolex Award is a fantastic opportunity for this! The wonderful aspect of Umzi Wethu is that the model can be duplicated in other industries such as manufacturing, provided the core components remain the same – i.e. only the skills training component would change.

**How successful has your programme been to date?**

To date, we have an 85 per cent success rate of training and job placement. What we cannot predict nor necessarily prevent is when a student might make a bad decision, succumb to family pressure or otherwise default on the responsibilities that become obligations upon entering the Umzi Wethu programme. Our best way of dealing with this risk is to encourage students to develop close relationships, particularly with their Wellness Coordinator. Knowing the personal circumstances of each youth and his or her family helps Umzi management anticipate and mitigate potential risks.

**How does conservation help the wider community?**

Establishing private and public protected areas supports rural economic development as reserves hosting tourists need clean water, sanitation and electricity, as well as access by decent roads. The public provision of these services inevitably spills over to local communities. This new infrastructure creates many and varied employment opportunities.

**What are your plans to extend the Umzi Wethu concept throughout southern Africa and beyond)**

We are in the process of refining the model and pilot Umzi Wethu academies. Starting from the first quarter of 2009, we will begin a series of roll-out workshops. Several organizations have already expressed interest in establishing Umzi Wethu academies associated to ecotourism developments in other game reserve areas of South Africa, Mozambique and Namibia. We will also take advantage of large-scale networking opportunities offered by conservation and social development, particularly HIV/Aids-related conferences and meetings.

## **Combine loofah and plastic waste to make low-cost housing**

### **Elsa Zaldívar – Paraguay**

#### **BIRTH**

11 June 1960; Asunción, Paraguay

#### **PROFESSION/JOB**

Social communicator and consultant on rural development, executive director of Base Educación, Comunicación, and Tecnología Alternativa (Base ECTA)

#### **PROJECT LOCATION**

Paraguay

#### **SUMMARY**

Elsa Zaldívar takes leftover pieces of a vegetable sponge and mixes them with other vegetable matter and recycled plastic to form strong, lightweight panels that can easily be assembled into simple structures, including houses. Her technological, eco-friendly solution to her nation's housing shortage will help save what remains of Paraguay's rapidly diminishing forests.

#### **ADDRESS**

Defensores del Chaco 350  
San Lorenzo, Paraguay 2140  
Tel: +595 21 580 239  
Email: basedir@basecta.org.py

In the poverty-stricken countryside of Paraguay, a landlocked country in the heart of South America, an innovative social activist has found a new use for an old vegetable. Elsa Zaldívar, whose longstanding commitment to helping the poor while protecting the environment has won her deep respect in her native land, has found a way to mix loofah – a cucumber-like vegetable that is dried to yield a scratchy sponge for use as abrasive skin scrubber – with other vegetable matter like husks from corn and caranday palm trees, along with recycled plastic, to form strong, lightweight panels. These can be used to create furniture and construct houses, insulating them from temperature and noise. About 300,000 Paraguayan families do not have adequate housing.

Elsa Zaldívar was born in Asunción, the nation's capital, in 1960, during the repressive 35-year rule of President Alfredo Stroessner. Her mother was an entertainer and her father a committed political leader fiercely opposed to the military dictatorship. Zaldívar inherited their passion for change and became involved in social programmes, working with poor people in her neighbourhood. She took a degree in communications and, from 1992, ran a rural development programme in Caaguazú, a region that had experienced severe deforestation for more than four decades. Her work quickly showed her how making a simple change can transform people's lives.

"We carried out a project with women to construct toilets, and we built stoves for them to cook on," she explains. "It was impressive how these simple acts changed the women's lives. They told me: 'Now we feel like we're people with dignity.' That's the result of simply having a bathroom inside or close to the house rather than 100 metres away, and being able to cook on a stove rather than stooped over a fire on the ground."

Zaldívar decided that the most effective way to improve the lives of rural women was by increasing their earning capacity. The area's economy had declined with the collapse of cotton and increasing cultivation of soya, an environmentally disastrous crop that had left soils contaminated and forced families off the land, leaving them without employment. Zaldívar took an interest in loofah, a plant that grows easily in the region, but which had fallen out of favour. She persuaded local women in Caaguazú to consider it as a means of generating income.

When harvested before it completely ripens, loofah can be eaten. But Zaldívar's women let the plant ripen and dry out, then process it until only a fibrous sponge remained. Their hard work, along with the ecological methods they used and the quality of the fibre they produced, gave the product a competitive advantage over plantation-grown loofahs from China and other countries. The women organized themselves in a cooperative and sold their loofah sponges as cosmetic products. They used loofah to manufacture mats, slippers, insoles and a variety of other products that were exported to markets as far away as Europe. The women's earnings grew, and the successful enterprise drew praise from environmentalists and others. Eventually it even won the respect of the local men who had initially laughed at the project as a women's idea that had no chance of succeeding.

Zaldívar wrote a manual about growing loofah to spread the word to other regions. She was awarded an Ashoka Fellowship in 2001 to continue her efforts to empower rural women to make products from loofah products and to set up a micro-enterprise.

Yet Zaldívar was not fully satisfied with the cooperative's success. Even with the women's efforts to grow the high-standard vegetables, roughly one-third of the loofahs they cultivated were of inferior quality and could not be exported. And another 30 per cent of the sponge material destined for the finished products was trimmed off during manufacture. Determined to find a market for the loofah waste, Zaldívar teamed up with Pedro Padrós, an industrial engineer, to search for a way to use the vegetable material to construct inexpensive panels for walls and roofing for building houses. She had realized that if the first step to improving the lives of the poor was increasing their income, the next was to help them find decent housing, which would dramatically raise their living standards. Zaldívar was highly enthusiastic. But, disappointingly, initial efforts to mix loofah with different types of glues did not produce the desired result, mainly because of the high costs involved.

Then Padrós got the idea of using plastic waste with the loofah. He invented a machine that melted a mixture of three types of recycled plastic and combined the resulting liquid with loofah and other vegetable fibres, such as cotton netting and chopped corn husks. After hundreds of trials, the results began to produce a working product. With help from Paraguay's environment ministry, Base ECTA (a non-profit organization headed by Zaldívar) obtained a grant from the Inter-American Development Bank to construct the prototype of a machine to produce the panels.

Combining a melting unit, mixer, extruder and cutting unit, the machine can produce – in an hour – a half-metre-wide panel 120 metres long. Depending on the exact mix of plastics and fibres, as well as the thickness of the panel, the composite can have varying amounts of flexibility, weight and insulating qualities, making it adaptable to a variety of construction needs. Colouring can be included in the panel's plastic mix at the time of fabrication, so there is no need to paint the walls after construction, saving homeowners time and money. Padrós says a panel of even greater strength can be created by using a honeycomb or earthen filler, as well as vegetable matter, to create a sandwich of two panels.

The composite panels are easier to handle than lumber or brick, and much better than conventional materials in an earthquake or other natural catastrophe. Combined with special metal connectors, "it will bend but not break", Padrós says. And if a house does collapse, he says, someone is much more likely to survive if the walls are lighter in weight than conventional materials. And using the panels will help spare the nation's forests. "Because we're using fibres that are completely renewable, we can stop using lumber for construction. That's very important in Paraguay because we've already reduced our original forest to less than ten per cent of Paraguay's territory," Zaldívar points out. "We're running out of trees."

As Padrós has refined the design of the panels, improvements have brought the cost down. The panels initially cost about US\$6 per square metre to produce, but the cost has already dropped to less than half that figure, making it competitive with existing construction materials, such as wood. Zaldívar predicts the price will continue to fall as experiments continue. She is also involved in discussions with several companies interested in using the panels commercially, but her main aim is to make the material available at low cost to those who need them most.

By supplementing the panels with other locally obtained materials such as bamboo and adobe, Zaldívar believes rural families should be able to build their own simple house in just three to four days. Even urban residents, who often have access to subsidized credit and other government assistance, will be able to use the panels in constructing decent housing.

The project's success derives from the unique combination of Padrós' engineering skills with Zaldívar's genius in creating an integrated system of cultivation, recycling, production and distribution. In addition to the loofah producers, Zaldívar is working with recyclers in urban areas in order to guarantee a flow of appropriate plastic, and with groups of women to provide the tonnes of corn and palm husks, for example, that will be needed – all materials that would otherwise end up in landfills.

Padrós says the panels are designed so that they will not generate any waste – should they wear out or break, they can be ground up and recycled into new panels. The process could be repeated several times until the composite becomes too rich in vegetable fibres, but Padrós says the mixture can then be used as a high-energy fuel. That means the recycled plastics used in the initial mix must be carefully selected to insure that they can be burned without producing toxic fumes.

Paraguayans are greeting news of the panels with excitement. Gustavo Candia, a Paraguayan consultant on good government and poverty reduction for the German development organization Gesellschaft für Technische Zusammenarbeit (GTZ), says that Zaldívar's initiative allows "primary producers to participate in adding value to their products", a distinct achievement for poor rural farmers. Zaldívar's reputation as an innovator is well deserved, he believes. "With this project, Elsa reaffirms that with persistence and reflection, you can create socio-economic impact in sectors that have generally been excluded from progress," Candia said.

As Zaldívar and Padrós finish testing the improved panel-making machine, the Rolex Award will finance a promotion centre near Asunción and the construction of three model houses where the panels' versatility will be displayed for both urban and rural audiences, as well as funding the production of a video that will be used to describe the project to people interested in using similar techniques in other countries.

Zaldívar's initial focus for providing low-cost housing remains Paraguay's deforested countryside. "We want to find sustainable housing alternatives for the poor, while also discovering new markets for their agricultural products, particularly the loofah. This is a perfect combination," she says.



## AN INTERVIEW WITH ELSA ZALDÍVAR

### **What kind of obstacles have you had to confront in your work?**

In the time of [Alfredo] Stroessner [president of Paraguay from 1954 until 1989], it was very difficult to work freely. We had to do everything while in hiding or wearing disguises. Any kind of social action was considered subversive.

### **You have spent your adult life helping the rural residents of your country. Was there a key moment in your life that inspired you to do this?**

My father was a politician and my mother was an entertainer. Their seven children were born at a time when creativity and freedom of expression were not permitted. They taught us to challenge these restrictions by fighting for democracy and freedom in Paraguay. At the age of 18, I had an opportunity to be part of the Christian Youth Association and begin to learn about development work. It's there that I began to work with needy and impoverished communities.

### **What's the relationship between decent housing and democracy?**

To have a decent home liberates people. They realize they can live in another manner, more freely, and move forward in other parts of their lives.

### **What impact will your project have on the environment?**

This project has many different kinds of impact on the environment. Most significantly, we'll recycle the mountain of garbage generated by plastics. And because we're using fibres that are completely renewable, we create jobs and stop using lumber for construction. That's very important in Paraguay because we've already reduced our original forest to less than ten per cent of the national territory. Four whole trees are destroyed to bake 10,000 bricks to build houses. We're running out of forest.

## **The 2008 Associate Laureates**

### **Alexis Belonio – Philippines**

Turn rice husks into cheap, clean energy for cooking

### **Arturo González – Mexico**

Explore submerged caves to discover and study remains from the Ice Age

### **Rodrigo Medellín – Mexico**

Save endemic and endangered bats through habitat protection and education

### **Moji Riba – India**

Safeguard the heritage of the people of Arunachal Pradesh

### **Romulus Whitaker – India**

Establish a network of rainforest research stations across India

## **Turn rice husks into cheap, clean energy for cooking**

### **Alexis Belonio – Philippines**

#### **BIRTH**

1 January 1960; Cabanatuan City, Philippines

#### **PROFESSION/JOB**

Associate Professor of Agricultural Engineering

#### **PROJECT LOCATION**

Iloilo City, Philippines, and abroad

#### **SUMMARY**

His fertile mind teeming with inventions to make life better and save energy, Alexis Belonio has produced a simple, gas-fired stove powered by rice husks, one of Asia's most abundant farm wastes. He is ready to share his low-cost invention, which reduces fuel costs and minimizes greenhouse gas emissions, with millions of families in the Philippines and abroad.

#### **ADDRESS**

Appropriate Technology Centre

College of Agriculture

Central Philippine University

Iloilo City

Philippines 5000

Tel: +63 33 329 1971

Email: [atbelonio@yahoo.com](mailto:atbelonio@yahoo.com) and [cpu\\_aprotech@yahoo.com](mailto:cpu_aprotech@yahoo.com)

The clear, blue flame emanating from the burner of the humble, metal cooking stove is a luminous sign of hope for hundreds of millions of poor farming families. And yet inventor Alexis Belonio was initially blithely unaware that he had achieved what leading experts had declared could not be done: turn agricultural waste into purified gas for domestic cooking in a top-lit, updraft, biomass gas stove.

In the many countries where rice is the staple food, small changes to the use of this grain can make a profound difference. The world's annual 650-million-tonne rice crop provides sustenance three times a day for two billion people, mainly in developing countries in the tropics. For these people, this stuff of life is indispensable, but to cook the rice they need gas or kerosene, fossil fuels that come at an increasingly unaffordable cost and with often negative consequences on health and climate.

But there is another side to rice: the huge piles of inedible husks that are often found rotting beside roads or smouldering in fields, millions of tonnes of potential energy, mostly going to waste. For Belonio, a 48-year-old associate professor of agricultural engineering in the Philippines and inventor of over 30 devices to help farmers, many of them poor, finding uses for this neglected abundance became an obsession.

Cookers fuelled by rice husks have been used before, but they are sooty and unhealthy; nor can they generate enough heat to cook food quickly. Belonio believed that if he could convert the rice husks to gas, it would provide a much hotter, cleaner flame to cook on. Gasification has been regularly re-invented for many purposes over the past 150 years, including for several types of stoves, but few applications have promised to benefit so many people, so simply and so cheaply.

Drawing the concept from a technical workshop on wood gasification at the Asian Institute of Technology, in Thailand, then working alone and with his own resources, he designed a simple, top-lit stove with a small fan at the base supplying an updraft of air. In Belonio's design, a stream of oxygen converts the burning rice husk fuel to a combustible blend of hydrogen, carbon monoxide and methane gases, yielding a hot, blue flame similar to that produced by burning natural gas. At first, says Emeritus Professor Paul S. Anderson, of Illinois State University, Belonio "was unaware that what he was trying to do had been deemed...as not being possible. He did not even know he should have been highly surprised that he succeeded!" Belonio says simply: "It is a God-given technology. I wish to share it with people all around the world."

But there was a setback. Belonio's early stoves, made in the Philippines, sold at US\$100, too expensive for a poor family to afford. Further research and development conducted in Indonesia significantly reduced the retail price of the stove to only \$25. This was achieved by simplifying the design of the stove in terms of operation, materials and fabrication. Thousands of cookers are now being manufactured by companies cooperating with Belonio in the Philippines, Indonesia and Cambodia. By exploiting a freely available waste product at a time of soaring energy prices, the stoves can save a family of rice farmers about \$150 a year in fuel bills, a huge benefit for families that live on \$2 or \$3 a day.

The potential benefits are prodigious. A tonne of rice husks contains the same energy as 415 litres of petrol or 378 litres of kerosene. A few handfuls of rice husks can boil

water in six to nine minutes. Best of all, the husks are usually free, either on the farm or from the waste dumps that surround rice mills. Furthermore, by being far more efficient than ordinary cookers, Belonio's stoves reduce greenhouse gas emissions and eliminate toxic fumes inside houses. Even the char left after burning can be recycled to improve farm soils or to form bio-coal briquettes.

Belonio has recently scaled up the principle of his domestic stove to create a whole family of new technologies: dual-reactor and continuous-flow gasifiers for grain dryers, bakery ovens, commercial kitchen stoves, and small power-generating plants. His latest invention, a "super-gasifier", is a powerful rice-husk stove driven by injecting superheated steam, which, he says, is ideal for cottage industries. "I was very surprised at how well it worked. That was a great moment." His technologies are proven, reliable and inexpensive. In addition to rice husks, they can use other biomass such as coconut husk, corn cobs and sugarcane bagasse, instead of fossil fuels or timber from fast-vanishing rainforests.

Belonio's ambition now is to spread the word about his inventions and to share the know-how, in the Philippines and around the world. He has already published a handbook on building the rice-husk gas stove, which is available for free on the World Wide Web. With funds from his Rolex Award, Belonio plans to set up a demonstration centre in Iloilo, in the Philippines, to disseminate free information and to provide training and technical advice. He will also research new inventions, such as a large-scale, rice-husk-fuelled gasifier and a gas-turbine power-generating plant for supplying electrical energy to rice mills and for lighting remote villages. He even envisions storing gas from rice husks to run farm machinery.

Professor Anderson says of this keen inventor: "Alexis's accomplishments are founded upon his personal drive and the use of his personal resources. Establishing a centre dealing with rice husks is a worthy goal that will eventually benefit millions of people in many countries." With tireless dedication, practical focus and technical insight, Alexis Belonio is continuing his quest to convert overlooked energy sources to ensure that families in many developing countries can prepare meals more cleanly and efficiently, at the least cost possible to the environment and to themselves.



## AN INTERVIEW WITH ALEXIS BELONIO

### **Why did you focus on rice husks, a product most people regard as waste?**

The world produces over 115 million metric tonnes of rice husks each year. The husks are so abundant. Even though there are other technologies that utilize rice husk for various purposes, using them for cooking and other related applications can save a great deal of energy as well as money. In Indonesia, for example, rice husks could reduce the domestic use of LPG [liquefied petroleum gas] by 37 per cent. In the Philippines, we have around two million tonnes of rice husks available each year. A

typical family of rice farmers produces 2 to 3 tonnes of such husks a year – more than enough for their domestic cooking needs, leaving a surplus that they or the rice mill could sell as fuel.

**The experts said it was impossible. How did you do it?**

Actually, I was surprised my stove worked so well. I was just experimenting, testing, but I did not have the instruments to analyse the gas. It gave me great pleasure when I saw the flame turn blue – very blue – which was a sign it contained the right sort of gas, one that would produce greater heat, though not as much as LPG. People had tried for so many years to achieve this, but could not produce a stove that worked.

**What will you do with the technology now?**

I will spend the Rolex Award money on promoting and sharing the technology with others for free, as widely as I can. I will focus on disseminating it throughout the world. I will produce more publications to show people how to do it.

**What is your next project?**

I am pursuing the construction of a small-scale power-generation plant that will provide electricity for farms of a few hectares in remote villages comprising steam-injection technology coupled to a gas turbine and using rice husks, wood waste or other forms of biomass as fuel.

## **Explore submerged caves to discover and study remains from the Ice Age**

### **Arturo González – Mexico**

#### **BIRTH**

20 October 1964; Mexico City, Mexico

#### **PROFESSION/JOB**

Biologist, underwater archaeologist

#### **PROJECT LOCATION**

Yucatán Peninsula, Mexico

#### **SUMMARY**

Far beneath the Maya ruins and jungle covering Mexico's Yucatán Peninsula, biologist and underwater archaeologist Arturo González has struggled through flooded labyrinths to recover evidence humans lived in the region before the end of the last Ice Age sent sea levels rising, inundating the caves. His commitment to bringing the truth to the surface is yielding new insights into prehistoric life.

#### **ADDRESS**

Calzada Antonio Narro 931-1

Saltillo, Coahuila 25000

Mexico

Tel: +52 844 410 06 73

Email: arteconciencia@yahoo.com

Mexico's Yucatán Peninsula is a relatively flat landscape where no rivers flow for the rain sinks quickly into the limestone and runs unseen to the sea. The ground is pocked by vine-draped sinkholes – *cenotes*, as they are called locally – where the roofs of underground caverns have collapsed. For centuries these openings have provided inhabitants with access to fresh water, and the inaccessibility of the deep caves beneath the openings have long beckoned the adventurous, though physical challenges limited how far they could go. In recent years, however, technological developments in underwater equipment have made it easier for divers to go farther into the networks of dark tunnels branching out from the submerged caves, and reports began to emerge about this dark underworld and its store of human and animal remains.

Arturo González, a Mexican biologist and underwater archaeologist working with the Instituto Nacional de Antropología e Historia, decided to launch a systematic examination of the flooded caverns in 1999. He worked together with a team of specialists including cave divers, archaeologists, palaeontologists and photographers, who would face technically difficult and physically challenging dives of up to six hours. The multidisciplinary team excavated three human skeletons from the depths, then carefully studied and analysed them. What they found startled the scientific community.

The skeletons are possibly older than any other human remains in the Americas. One in particular has been estimated by three foreign laboratories to be more than 11,600 years old. Furthermore, the skeletons bear no resemblance to the Maya who came to dominate the region thousands of years later, and whose remains and artefacts are found near the openings of the *cenotes*. If anything, according to González, the newly discovered skeletons have a cranial morphology resembling that of people in eastern Asia. The findings are forcing the scientific community to reassess its theories about when and how early humans travelled to the Americas.

"What we've discovered is a piece in the puzzle of human evolution," says 44-year-old González, who has been director of the Museum of the Desert in the northern Mexican city of Saltillo since 2002. "But there are a lot of other pieces missing from the puzzle. We have one important piece, but it doesn't match any other existing part in a way that would help us understand how early humans colonized the Americas."

González first learned scuba diving as part of his university studies on biology, but it was a National Geographic documentary about the discovery, by underwater explorer James Coke, of an ancient fireplace 30 metres below the surface that inspired him. "For me this was unbelievable," says González. "Caves have always interested me, this space below the ground that for many indigenous groups signifies the mother's womb. When I saw this documentary about fire pits under the water, I began to travel to these areas to explore them. We got to know James Coke, a pioneer in the exploration of these spaces, and he alerted us to other discoveries he'd made. Thanks to him we began to form a project that since 1999 has been making important discoveries about the ancient history of the Americas."

Cave divers and speleologists have been exploring Yucatán's submerged cave systems since the 1980s, collecting geological, archaeological and palaeontological evidence that is now crucial to González. Deep in the caverns, González and his colleagues retrieved fossils that are between 10,000 and 60,000 years old, including those of

extinct camelids, giant armadillos and horses. All are from the Pleistocene Epoch, when the Yucatán was covered not with low forests but with dry grasslands. In at least one submerged cave north of Tulum, near the Caribbean coast, the divers found another ancient fireplace, whose carbon traces of partially burned camelid bones suggest that the prehistoric humans there survived in part on the meat of an animal whose species disappeared at the end of the Pleistocene.

When prehistoric people were cooking camelid meat, the sea level was more than 100 metres below where it is today. González believes these people may have used the caves not only as rudimentary kitchens, but also as pathways to water sources. There is also strong evidence that dead bodies were placed in special caves far below the ground, perhaps to protect them from natural predators. But then a massive shift in global climate produced rapid rises in the sea level, as well as the intricately linked water table inland, and the burial sites and kitchens were all flooded – to remain unseen until cave divers discovered them millennia later.

Funds from the Rolex Award will allow González to field a team for at least another year of research; the group intends to focus on the Chan Hol cave, where a fourth skeleton has been discovered, but not yet removed or analysed. The more skeletons examined, González says, the more comparisons can be made to similar human remains in other parts of the world – perhaps even putting more pieces into the puzzle of human evolution. Beyond that, González says he and his colleagues will focus on trying to understand the lives of these ancient people, especially how they used different caves for different purposes – clues that will lead researchers to move beyond the bones and toward a better understanding of prehistoric life.

These findings have greatly increased interest in the *cenotes*, leading González and his colleagues to work with residents of local villages to protect the rare treasures from damage and looting. They have also encouraged the villagers to speak out against the contamination of the underground waters by unrestrained tourist development along the so-called Mayan Riviera. Cenotes hold vital freshwater reserves, yet millions of litres of water are pumped from these aquifers every day, far exceeding their natural regeneration rate in some parts of the peninsula. In remote areas, *cenotes* are sometimes used as waste dumps that spread organic and chemical pollution.

As knowledge of the past increases, the challenge of getting in and out of the twisting labyrinths remains a dangerous pursuit in the name of science and discovery. With complicated logistics and multiple equipment combinations to minimize the risks, the long and disorienting trips underwater remain physically and emotionally grueling. A typical underwater expedition can take six hours, including the first hour to reach the cave of interest, an hour to carry out research, and then, given the need for decompression stops along the way, a four-hour return trip to the surface. Fortunately, the scientists are assisted with this aspect of their work by a small cadre of highly trained, professional divers whose knowledge of the systems is a precious resource.

Many years of work still lies ahead for González in what, according to Prof. Wolfgang Stinnesbeck, specialist of Mexican geology and palaeontology at the University of Heidelberg, “is certainly one of the most fascinating and outstanding research projects in modern geosciences and has already delivered an impressive number of outstanding

results". And it's a race against time given the Yucatán's burgeoning tourist development. Yet for González, the risks the divers take as they plunge into the watery windows on the past are worth the challenge.

"As an inhabitant of the Americas, I'm interested in knowing who these people were, where they came from, and when their first steps in the Americas occurred," he explains. "In these sites, we can find the archaeological contexts just about as they were left by the people of the Ice Age. It's a great treasure and it's my passion to get there and discover them, and be able to interpret them in order to share a new understanding of the history of humanity."



## AN INTERVIEW WITH ARTURO GONZÁLEZ

### **What's the biggest challenge you've faced?**

The worst problem to solve has been the bureaucracy at every level – federal, state, municipal, and at the level of the local community. So we have to work with all these to explain our work, and that takes a lot of time, time that we could use for investigation.

### **How have you encouraged local communities to protect the caves?**

The inhabitants of the small communities charge a fee to dive in these systems, and that's income for them that they've never had before. We've done a lot of work to help them understand the importance of protecting and caring for these spaces, as they are the ones who explain to their children and to tourists who enter that they should not touch the stalagmites and stalactites, so that we can go on putting together the information from these sites.

### **While diving, have you ever got lost in the chaotic labyrinth of underwater caves?**

I haven't been lost, but I have got stuck. When you're stuck in a narrow passage, with no visibility, as the minutes go by and you can't move, that's when panic sets in. It's the strongest panic I've felt in my life. It's indescribable.

### **In that moment, what do you do?**

One of the most important rules in cave diving is that when you have a problem – you lose your guideline or drop your lamp, there's a rock fall, whatever phenomenon that causes you to feel that natural response of wanting to move quickly to get out of that danger – the rule is: "Stop, think and act." You've got to stop all activity and put your mind in order before you act. It's a very valuable rule to avoid dying in these cave systems.

# **Save endemic and endangered bats through habitat protection and education**

## **Rodrigo Medellín – Mexico**

### **BIRTH**

23 December 1957; Mexico City, Mexico

### **PROFESSION/JOB**

Research Professor, Institute of Ecology, National Autonomous University of Mexico

### **PROJECT LOCATION**

Mexico

### **SUMMARY**

Superior pollinators and insect predators, bats are, with a few exceptions, valuable assets to mankind. Yet these flying mammals are reviled and killed. Rodrigo Medellín's passionate advocacy of bats through conservation and education is dispelling harmful myths and bringing about harmony between these animals and their human neighbours.

### **ADDRESS**

Inst. of Ecology, Natl Autonomous University of Mexico

Circuito Exterior sin numero, Ciudad Universitaria

UNAM

DF 04510, Mexico

Tel: +52 55 5622 9042

Email: medellin@miranda.ecologia.unam.mx

Once worshipped as deities, bats held a place of honour in the rich cultural landscape of the Maya civilisation. But these remarkable animals – in some areas of the world a keystone species critical for healthy ecosystems – have suffered from centuries of misconceptions and folklore that portray them as sinister, disease-carrying, blood-sucking demons. Through ignorance and fear, humans wipe out entire colonies of bats through pesticides, encroachment or by mining, burning or dynamiting the caves where they roost.

Severely under-studied, omitted from conservation plans, bats are among the world's most rapidly declining mammal species. A total of 1,116 species of bats exist worldwide, and are found everywhere except polar regions and desert extremes. Eighty-five species are endangered, and in many cases, the main threat to them stems from mankind's fear and hatred.

For Rodrigo Medellín, however, bats are nothing less than astonishing. Mexico's foremost authority on bats and an ardent conservationist determined to change their image, he is Professor of Ecology at the National Autonomous University Of Mexico (UNAM), where he has devoted over 30 years to creating awareness of the invaluable role they play in keeping ecosystems and lucrative agricultural crops healthy.

Medellín was 12 years old when he first encountered bats in a hot, damp cavern teeming with life. Vampire bats hung in one corner and nectar-feeding bats mated in another. Insects burrowed into mounds of bat guano, while a snake hunted sleeping bats. "It was incredible. Surrounded by life, I couldn't find a single spot on which to focus," he says. Discovering this wealth of biodiversity in that single location was a pivotal moment in his decision to study one of the most ecologically diverse mammals in the world and to correct the many misconceptions about them.

Bats are natural controllers of night-flying insect pests and consume almost the equivalent of their weight in mosquitoes and crop pests each night. Corn earworm moths cost farmers billions of dollars annually, yet in one night, a million Mexican free-tailed bats (*Tadarida brasiliensis*) can destroy ten tonnes of moths.

Across Mexico's lush rainforests, sprawling savannahs and vast deserts, bats pollinate flowers of many hundreds of species, such as columnar cacti and agaves (a vital ingredient in the production of tequila), and disperse seeds of many species that promote forest restoration. In fact, bats distribute up to five times more seeds per square metre than birds, and can account for up to 95 per cent of forest regrowth. Mexico, renowned for its extraordinary biological diversity, boasts an astonishing variety of bats – Medellín estimates that his country has about 138 species, of which 19 are officially threatened or endangered.

Three of Mexico's bat species feed on the blood of higher vertebrates, and there have been reports of the common vampire bat, *Desmodus rotundus*, attacking humans. But, Medellín says, "in Mexico, this is a very rare occurrence. The risks to humans are extremely low. In fact, virtually all bats are completely harmless, and 100 per cent beneficial, even crucial to ecosystems and humans.

With the benefits brought by so many bat species so high, and the risks to humans from a handful of species so low, Medellín saw the significant decline in the population of his country's 10 major bat colonies as a call to action. In 1994, he founded the Program for the Conservation of Bats of Mexico, in partnership with his university and Bat Conservation International. Under his direction, a comprehensive strategy was established, based on research, education and conservation.

Today, Medellín and his 30-member team, drawn from master's and Ph.D. students, identify priority sites among Mexico's estimated 30,000 caves, and then develop management and recovery programmes for threatened species. Ranchers, for instance, believing them to be vampire bats that prey on their cattle mistakenly destroy thousands of beneficial bats; Medellín and his team defuse the problem by teaching them vampire-bat control strategies. As part of the programme, educational materials are made available, community workshops held regularly and an accurate picture of bats and their usefulness is presented via nationwide media exposure, including an award-winning radio show that reaches millions of listeners. "Adventures in Flight" is a series of 15-minute broadcasts, aimed mainly at children, with each programme covering an aspect of bat biology or conservation.

Medellín's overall strategy has proved highly effective, becoming a model for similar initiatives in Bolivia, Costa Rica, Guatemala and elsewhere. He believes that if young people do not change their attitudes, bats are doomed. His teams work with schools and communities located near habitats for threatened bat species. Games, toys and storybooks are used to enlighten children. "We've reached well over 200,000 people, at least half of them children," Medellín says, adding that thanks to radio programmes, coverage on television and articles in the press, millions of people now have access to accurate information about bats.

One striking example of the strategy's success occurred in 1996, soon after Medellín and his team worked with a school near Monterrey in northern Mexico. Rumours began to circulate that a livestock-killing creature, the Chupacabras, lurked in the famous Cueva de la Boca caves, home to the world's largest Mexican free-tailed bat population. Locals threatened to burn the cave until schoolchildren – newly informed about bats by Medellín's team – intervened and explained their benefits. Local people grew to appreciate the Mexican free-tailed bat, and its population increased from a low of 100,000 in 1991 to 2.5 million by 2001. "To this day, the cave remains protected and cherished," says Medellín.

He explains that one major challenge of his work is convincing those funding conservation that bats are worth supporting. "This is a constant battle because most donors focus on charismatic species such as big carnivores or birds. Patience and education are needed, we have to explain to donors the importance of investing in bat conservation."

The funds from Medellín's Rolex Award will be a welcome boost, allowing him and his team to work in ten states, selecting ten new priority caves beyond the 25 that had been previously identified as needing conservation. They will also focus on five endangered species, including the flat-headed bat (*Myotis planiceps*). Declared extinct

by the World Conservation Union (IUCN) in 1996, this tiny animal – at 3 grams, one of the world’s smallest bats – was rediscovered by Medellín and his associates in 2004.

Deeply committed to safeguarding not only bats but all of Mexico’s wildlife, Medellín is extending his work to other species, including the pronghorn antelope, bighorn sheep, black bears and the first-ever nationwide population estimates of jaguars in Mexico. In demand at conferences and universities worldwide as a speaker and educator, Medellín has become a potent force in changing negative perceptions and restoring pride in one of Mexico’s most unusual animals, earning along the way several major honours, including the Whitley Award.

“Rodrigo is brilliant, and...because of his intellect, passion, commitment and humour, he is able to convince people from all walks of life of the importance of bat populations, and their need to get informed and involved in their conservation,” says Dr Mary C. Pearl, president of the Wildlife Trust, in New York.

For Medellín, the words of a young boy are the best validation of his work. A few years ago, he says, “after my education team had already worked in a cave in western Mexico, I arrived at the cave incognito with some donors. As we got out of our vehicles, a child no older than nine approached us and offered to tell us about the importance of the bats that lived in that cave if we gave him a peso. I immediately gave him a couple of coins and he proceeded to tell us all about bats and their pest control, pollination, and seed dispersal services. I could not have been happier!”



#### INTERVIEW WITH RODRIGO MEDELLÍN

**What made you decide from an early age to devote your life to such a maligned species as bats?**

I realized that bat biology is as diverse as that of any group of species in the world, that I would never grow weary of learning about them or researching them. This is not work, it’s a passion for me.

**What would you consider as a life-changing moment in your career?**

Entering that first hot cavern at age 12 in the Mexican tropics, I thought to myself: this is an entirely unknown universe –and hardly anybody is working on it! This is my chance to work protecting and studying these misunderstood animals. My fate was sealed then.

**What have been your toughest challenges over the span of your career?**

Trying to change the negative image that bats have in Mexico; you realize you have to change the minds of 100 million people if you want to have an impact. We realized we could do it one step at a time.

**What do you foresee as the most important impact of your project?**

New data will be produced that will justify the creation of protected areas. My dream is that the government takes bats and other wildlife into account as an integral part of their assets. Society is catching up rapidly on the importance of bats for their well-being, so I believe we are winning the war.

**What is your favourite bat?**

Mexico's largest and rarely seen Linnaeus' false vampire bat (*Vampyrum spectrum*), which has a metre-long wingspan and lives in remote rainforests. I've only seen it four times in my life. Each time was a big adrenaline kick. My whole body was shaking.

## **Safeguard the heritage of the people of Arunachal Pradesh**

### **Moji Riba – India**

#### **BIRTH**

18 April 1972; Ziro, Arunachal Pradesh, India

#### **PROFESSION/JOB**

Film-maker and cultural activist; executive Director, Centre for Cultural Research and Documentation

#### **PROJECT LOCATION**

Arunachal Pradesh, India

#### **SUMMARY**

The ancient tribal cultures of India's Arunachal Pradesh state are succumbing to the influences of the modern world. Determined not to let this remote part of the world's heritage slip away, Moji Riba has devised an ambitious plan to involve young people in documenting the state's beliefs and customs and help this rich culture live on.

#### **ADDRESS**

Centre for Cultural Research & Documentation

1st Floor, Takar Complex

Naharlagun 791 110

Arunachal Pradesh

India

Tel: +91 360 224 7201

Email: [mojiriba@hotmail.com](mailto:mojiriba@hotmail.com)

Website: [ccrd.in](http://ccrd.in)

Nestled in the Himalayan foothills in the extreme north-east of India is Arunachal Pradesh, an isolated remote and sparsely populated state that is home to an astonishing diversity of ethnic societies. Few regions of the world can match the wide range of languages and religion, diet and dress enclosed within the state's 83,700 square kilometres. A million inhabitants are divided into 26 major tribal communities, each with its own distinctive dialect, lifestyle, faith, traditional practices and social mores, living side by side with about 30 smaller communities. In the far west live the Sherdukpen and Monpa tribes, practitioners of the ritualistic Tibetan form of Buddhism, adept in mask-making and pantomime dances. The Adi and Nyishi people live in the state's heartland and worship their gods at elaborate altars crafted out of bamboo and cane. In the extreme south-east of the state, the Wanchos are known for the quality of wood carvings they create. In the east of the region, the Idus are expert textile-weavers and their costumes are a rich tapestry of hues and designs, while the Apatani are famous for their basket-weaving, their strong village institutions and social networks. The Simong, who inhabit the forbidding northern uplands, climb up mountain peaks to perform their rituals and collect poisonous aconite plants to use on their arrow-tips for hunting.

For 36-year-old film-maker Moji Riba, the cultural richness of Arunachal, his home state, is "like a wonderful shawl woven in a myriad of colours and patterns". Situated far east of the bulk of India, the state has borders with Tibet (China), Myanmar and Bhutan, but it is isolated by high mountains and dense forests, and regulated by a strict tribal protection policy that requires even Indian citizens to have a special permit to enter the region. As a result, the ethnic groups of Arunachal were, until recently, shielded from external influence. "The Arunachali have evolved an enviable understanding of their immediate environment, finding imaginative ways of survival in their rugged homeland," Riba explains. "Over time, they have devised a bold celebration of the pageantry and patterns of everyday life. There is much to learn from their contributions to folklore, arts and crafts and philosophy."

Today, however, economic development, improved means of communication, the exodus of the young and the gradual renunciation of animist beliefs for mainstream religions threaten Arunachal's colourful traditions. "It is not my place to denounce this change or to counter it," says Riba. "But, as the older generation holds the last link to the storehouse of indigenous knowledge systems, we are at risk of losing out on an entire value system, and very soon." The risk of many of these cultures disappearing in a generation is particularly great as almost the entire body of local wisdom – from religious chants to tribe histories, from love songs to agricultural rituals – exist today only in the oral tradition. The death of every older person in a village means the loss of part of the local heritage.

This realization led Riba, who holds a master's degree in mass communications, to set up the Centre for Cultural Research & Documentation (CCRD) in 1997 in Itanagar, the capital city of Arunachal. Over the past decade, a team working at the centre has made 35 documentaries for national television stations and for government and non-governmental agencies. But the centre is more than just an archive or library, it is also a platform offering the tribal people an opportunity to voice their concerns and share experiences. In 2004, Riba was instrumental in creating the diploma in mass communications at Itanagar's Rajiv Gandhi University, again to augment understanding

of cultural values and local customs. He currently juggles his time as head of the university's communications department with running the centre.

But the unprecedented rate at which cultural change is taking place is simply "too large, too rapid and too overwhelming" for the team to capture through standard methods. Riba's solution is the Mountain Eye Project, an unconventional and ambitious initiative that aims to create a cinematic time capsule documenting a year in the life of 15 different ethnic groups. Riba will select and train young people from each community to do the filming. This gives him access to enough film-makers – a resource he lacked at the cultural research centre – as well as access to people with an intimate understanding of village life. Beginning in early 2009, these novice film-makers will capture a broad range of the tribes' oral histories, as well as the rituals, ceremonies and festivals that take place over a year in their villages. Riba expects to collect about 300 hours of film per village, all of which will be recorded and archived in the native languages. He believes that the resulting 4,000-plus hours of video will provide an invaluable record of life as it has been lived in his state for centuries. The project will also engage scholars belonging to the 15 tribes from the University at Itanagar to analyse and translate this vast amount of data and organize it in a publicly accessible database.

Riba is philosophical about the inevitable limits on what can be saved for the future. "While there is unquestionably a need for the documentation of customs and beliefs," he says, "we also understand that all this documentation and the outreach activities will not ensure that these customs continue to be practised in their original forms – it would be unrealistic to even expect it to do so. The forces of change are larger than what we can take on. We are instead trying to create a space where they will continue to live in some form or the other: some definitely in their practice like the singing of songs, the telling of folktales and the fun of the folk dances; others, like the Apatani nose piercing or the Wancho tattoos and the war rituals, to be understood and valued for what they would have meant to our people in another time and age. "I like to think of our heritage as an elastic band. I want to stretch this as much into the future generations as we can – till it reaches its edge and snaps. Each day I wake up and hope that this never happens. But that is sadly a finality we have to stare at – unless of course, there is a revolution of some kind!"

Each video volunteer will also produce a film based on a particular aspect of their village that moved them. These short films will be the cornerstone of an outreach programme, to be held initially at Itanagar's Jawaharlal Nehru State Museum. A series of interactive workshops will take place where the films will be shown alongside traditional artistic activities such as mask-making, painting, storytelling and participatory games using local languages. Cultural heritage activity clubs will be launched in participating schools and colleges. Students will be encouraged to create information posters about various tribes and undertake field trips to the State Museum. Schools will hold events where students from different tribes can meet and exchange cultural experiences.

"It is my hope these outreach activities will inculcate in children and youth an appreciation of their traditional heritage, and help them make sense of their ancestry, their identity," reasons Riba. The films will then be screened in New Delhi, giving the

novice film-makers an opportunity to present their work to a large audience in a country where cinema is one of the most popular forms of entertainment.

Ultimately, Riba hopes to draw attention to this part of the world, enhance the centre's visibility and encourage support from other sources. To get the project off the ground, he needs to purchase video equipment – each video volunteer will be equipped with a complete digital video documentation unit – and fund training. He explains that the funds from his Rolex Award will be used as seed money, launching the project and encouraging other donors to give support. “The scale of the project is large, it's almost like working against the clock to try and get as much done within a limited time frame in a vast area. Therefore, the resources needed are also relatively large. “There is a crying need to fill the vacuum that exists in providing a platform for issues like the promotion of the indigenous languages, the ideal of tribal identities as a common shared heritage and the use of heritage education to enable the future generations to share, realize and respect the diversities in culture,” says Riba.

Professor Kambeyanda Belliappa, of Rajiv Gandhi University, needs no convincing about the far-reaching implications of Mountain Eye: “This is a path-breaking project, for it views the folklore and cultural heritage of the tribal groups in Arunachal Pradesh not as mummified objects to be confined to museums, but as a living thing that needs not only to be documented but also passed on to the next generation.”

Riba is naturally eager to preserve his own family's heritage (part of the Galo ethnic group), as well as the many other cultures of Arunachal Pradesh. Like many young Arunachali, he speaks – and thinks – in English, deemed the language of opportunity in India, and also the language of instruction at his school and at university. But he vividly recalls his father's funeral in 2000, where he felt more like a bystander than a participant while his relatives embraced his father's body and sang a lament for him, an *ane-naenam*. It pained him that he could not understand the eulogies they were offering his father or the memories of him that were being shared. “I could not even thank the people that sang them,” he concedes. “Indigenous languages have been caught in the crossfire between English and Hindi, the national language of India. Today, I am making a concerted effort to learn my mother tongue, the Galo language, and to encourage my boys – nine-year-old Jiri and Jili, aged three – also to learn it. Language is a significant part of our culture, our heritage, and we cannot afford to let it die. In today's era of globalization, where everybody is encouraged to be the same as everybody else, language is one of the only things we have left to distinguish ourselves. Mountain Eye will help preserve these languages and hopefully encourage the audience to bridge the divide between modern society and their tribal identity, inspiring them to be in touch with their roots.”

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## AN INTERVIEW WITH MOJI RIBA

**It takes an inordinate spirit of enterprise to juggle your many responsibilities, from your work at the Rajiv Gandhi University to the leadership of the CCRD, and now this new project. Can you comment on the inner reserves required to carry this out?**

Juggling my time between the university, the CCRD and my family can be very difficult. At times I want to pull my hair out. But I could not let either of them go. I started the CCRD because that is what moves me. My work at the university offers me a window through which I can observe, and hopefully influence, the youth of today. I hope to encourage the young people to embrace their heritage, to value their traditions, to learn their mother tongue, and to simply go back to their village regularly. As exhausting as it is, at the end of the day, I sleep easy.

**What is the biggest change you have observed in Arunachal Pradesh?**

One of the most dramatic changes that have taken place is undoubtedly the decay of the indigenous languages as fewer and fewer people speak them. Each language carries with it an unspoken network of cultural values which, though operating on a subliminal level, are nonetheless a major force in the shaping of each person's self-awareness and identity. Normally, these values are absorbed along with the mother tongue, but today, with the Hindi-isation of Arunachal languages, culture and language have become separated. As a result, many young people are trying to walk in two worlds with only one language, a language that is not their mother tongue.

**Can you briefly comment on how you chose the 15 tribes to represent and, among them, the individuals selected to document their respective cultures?**

The number 15 is not an academic number, but rather a number we felt would be practical and representative. The tribes selected represent the geographic spread of the region, and also best symbolize the cultural characteristics of their immediate area. The Mountain Eye Project is an evolving model which we continually revise to suit the circumstances. With regards to how we are selecting the individuals, a lot of time and effort is going into this process. We appreciate that most will not be well educated, but they must have what I call "street smartness". They must have the aptitude and understanding of what we are trying to achieve, they must be residents of that village, and they need to demonstrate the capacity and willingness to learn.

# **Establish a network of rainforest research stations across India**

## **Romulus Whitaker – India**

### **BIRTH**

23 May 1943; New York City, United States

### **PROFESSION/JOB**

Wildlife management consultant, film-maker, team leader Agumbe Rainforest Research Station, Andaman and Nicobar Islands Research Station

### **PROJECT LOCATION**

Indian subcontinent, Andaman and Nicobar Islands

### **SUMMARY**

Over the course of his unconventional life – from being an American boy raised in India's wild places to achieving scientific renown – Romulus Whitaker has gone from conserving reptiles to saving rainforests. His planned network of research stations will build on the surprisingly limited knowledge of India's rainforests and demonstrate the importance of their water supplies to hundreds of millions of people.

### **ADDRESS**

Agumbe Rainforest Research Station

Suralihalla

Agumbe Village, Karnataka

577411, India

Tel: +91 8181 223081

Email: kingcobra@gmail.com

Website: draco-india.com

Romulus Whitaker seems an unlikely name for an Indian citizen who is also a reptile expert and environment film-maker. But the combination of a foreign name, mildly Viking looks inherited from his Swedish mother, an unexpected fluency in local Indian dialects and a thoroughly irreverent attitude has marked this American-born, 65-year-old Indian citizen out as a highly unconventional yet effective conservationist in a country far from his birthplace.

Whatever his ancestry and skills, what drives him is a boundless enthusiasm for the wonders of nature, and a determination to save them. "It is fascination with the endless natural mysteries, questions on why critters do what they do, and empathy and sympathy in the face of the destruction all around," he explains from his base in the southern Indian state of Tamil Nadu. "I haven't had to do a nine-to-five job ever in my life, and that is a very envious situation to be in if you like the wild. Life has been much like a river in that it picks you up and carries you along. I have got into things as they come towards me."

This seemingly relaxed attitude belies the original thinking and careful and considered planning behind his many projects for wildlife, for forests and for the people living in them. His current ambition, for which he has been selected as an Associate Laureate in the 2008 Rolex Awards, is to create a network of rainforest research stations throughout India, part of a vision he has been elaborating in his mind for many years. "The idea of the rainforest research stations has been with me absolutely forever, but I didn't have the wherewithal to do anything about it. Then all these things started falling into place over the last few years. My mother died and she left some money, enough to buy this block of land [at Agumbe, in southern India] we had talked about before her death. Then the Whitley Award for Nature came along and helped set up the Agumbe Rainforest Research Station and get it working really well."

A mother's tolerance for a small boy's fascination with snakes – first in upstate New York and then among India's much more venomous varieties – became the basis of a notable career in herpetology for Whitaker. Author of eight books and over 150 articles, he served in key reptile posts and has inspired many with 23 acclaimed environmental documentaries, such as the National Geographic film King Cobra. In 1984, for his project to help the indigenous Irula people of Tamil Nadu make the transition from their old trade (catching snakes for the now-banned skin trade) to collecting snake venom to produce life-saving antivenom serum, he received an Honourable Mention in the Rolex Awards for Enterprise.

Whitaker realized long ago that snakes and the other species he loves cannot survive without their habitats. So, like many others, he has evolved from naturalist to conservationist. "A lot of us get wrapped up in our own little special animal and then we wake up and start thinking it has got to be habitat and it has to be eco-development that involves people and, now, in my case, it has crystallized into the whole idea of water resources.

"India has a history of droughts, floods and famines," Whitaker explains. "Food production has been successfully tackled and dealt with, but we are now faced with a water shortage that will dwarf any of the past problems faced by the people. Thanks to forest clearance and ill-advised dam projects, rivers are drying up, ground water

reserves are being used up faster than they can be replenished and pollution is hitting most of our sources of drinking water. These are the obvious problems, but there are other, possibly much more serious threats facing our water regimes including climate change, which we must tackle on a war footing.”

Ironically the water that Whitaker is intent on saving is – in the form of rain – one of the major obstacles to conservation research in many parts of India. Despite being recognized worldwide as biodiversity hotspots, relatively little is known about India’s dwindling rainforests and the many species for which they are home. But monsoon downpours make it near-impossible for researchers to operate at the very time the most scientifically interesting events are occurring in the landscape and the lives of its inhabitants. At Agumbe, where Whitaker caught his first king cobra back in 1971, annual rainfall of 10 metres or so condemns outsiders not just to swarms of leeches, along with wet clothes and tents, but also to guaranteed malfunction in all the equipment bound up in recording, communicating and calculating.

Whitaker’s base at Agumbe, constructed in 2005, and now a fully functioning research, conservation and education centre, is the first of seven research stations that will connect key remaining rainforest strongholds throughout India. Sita Nadi, a river that has its source near the Agumbe Station, is a major focus for Whitaker and his team, who have started a small but ambitious plan to clean up and maintain the integrity of the river, using a three-pronged approach: evaluating the problems, involving the people and implementing a practical action plan. Whitaker cannot emphasize enough the importance of the region’s rainforests for water resources. “The rainforests of India are the origin of all the major rivers in the south and the north-east,” he points out. “The rivers in the Western Ghats [in India’s south] provide the water for 350 to 400 million people, about a third of India’s population.”

The Agumbe station itself consists of living and working quarters purpose-built to function during the monsoon and to be self-sufficient in renewable energy. It is strategically located on about three hectares of land adjacent to a wildlife sanctuary and a national park so that field scientists have easy access to the forest. The base has hosted dozens of Indian researchers, journalists and naturalists. But the station’s mission extends beyond science. It is a springboard for local conservation, including the sustainable use of minor forest produce and medicinal plants. The station has educated hundreds of school children about the forest. “Children are a bit shaky about going into the forest at first, but fascination with what we show them soon gets them hooked,” Whitaker says.

The network of seven stations will produce vital information, building on discoveries by Whitaker’s colleagues of over 100 new species of frogs in the last decade, and the study of crabs that live in trees. The network will allow immediate exchange of expertise and research, creation of a comprehensive biodiversity database, and expanded mobile educational programmes. Five of the stations in the network, including Agumbe, will be located in the states that span the Western Ghats. A sixth station will be located in the far north-eastern state of Assam, a vital haven for large numbers of migratory birds and endangered mammals. The seventh station is in the Andaman and Nicobar Islands, 350 tropical islands situated 1,200 kilometres from the Indian mainland in the Bay of Bengal.

Six of the seven stations already exist in various stages of development and now need vital new laboratory equipment and in some cases physical expansion to bring them up to speed for the network. Whitaker will use the Rolex award to help make this happen. Only one station, near the Kalakkadu/Mundanthorai Tiger Reserve in the southern tip of India, needs to be built from the ground up. The Rolex funds will also be used to fit out the bases with automatic weather stations. "Climate change is tightly linked with the future of water resources and we need to be monitoring it now," he says.

All those who know Whitaker's work agree his ability to implement environmental projects is considerable. "Rom Whitaker is passionate about conservation and he is an intrepid fieldworker," says S. Theodore Baskaran, honorary wildlife warden and former Postmaster General of Tamil Nadu. "As an institution-builder, Rom is unfazed by any hurdle he might face in his work."

Whitaker puts his trust not just in his own skills, but also in the aspirations of younger generations: "We are doing a lot of work with young people, bringing them to the forest and showing them what happens here and why it matters. It can be very difficult to change adult attitudes, but with the young, it is easier to get across the knowledge that what we are doing to the forests we are doing to ourselves."



## AN INTERVIEW WITH ROMULUS WHITAKER

### **Why were you originally so interested in snakes?**

It started at the tender age of four or five years, so my mother told me. I was interested in all sorts of small animal life, not to mention bigger ones like dinosaurs, introduced to me by her at the American Museum of Natural History, but somehow snakes were always No. 1.

### **How did your goals go so far beyond snakes?**

Coming to India to live at age seven – when my Indian step-father moved the family – opened up a whole world of natural wonders to me. Having a mother who encouraged my wild ideas, a series of wonderful accidents – or intelligent design from Mother Nature herself, perhaps – put me into places in India and around the world that just kept me climbing higher.

### **What was it like to move to India at age seven?**

It was magical to be in India for a young boy who grew up in the countryside of New York state. To move to the land of snakes and snake-charmers was an unparalleled experience for a young naturalist.

**Do conservationists in India face particular difficulties that their counterparts in other countries do not have to deal with? How do you overcome them?**

In talking with colleagues the world over we all face similar difficulties and all tell each other how much worse it is in our respective areas. The difficulty here in India is that the problems are multiplied by the multitudes of hungry people who want a bite of the earth, often just to survive, and, on top of them, the well fed people who just want more of everything and treat jungles and wild places as trash heaps that need "developing".