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Prof. Eugene Cloete Vice-Rector: Research and Innovation



foreword

Which this publication we wrap up the third year of New Voices in Science, a science communication competition that has become a highlight on the Stellenbosch University calendar.

This year the programme comprised three platforms for doctoral candidates to share their research beyond their academic disciplines. These pages showcase the finalists in the science writing and the brand new science photography category, while on 7 March 2014, twelve contenders vied to impress a record-size public audience with oral accounts of their research findings.

New Voices in Science has gathered considerable momentum since its inception in 2011. Initiatives such as New Voices in Social Science and the campus road show that takes our science 'Idols' to undergraduate students, reflect the growing appreciation among our researchers of the importance of science communication.

Researchers in a democratic society have an obligation to share their knowledge. As one of this year's participants noted, '...to communicate one's knowledge is to share the power of that knowledge'. I would venture to add that research only acquires real value and meaning once it has been shared.

I was also struck by another experience pointed out by these young researchers: Science communication makes for better science. It turns out that trying to explain one's science to the outside brings about new insights, fresh perspectives and improved scientific practice.

This year also saw higher levels of interest from the public and media. A number of participants' research found its way into the mainstream press or into industry publications. This confirms the changing role of science in our young democracy. People are no longer satisfied with being excluded and will be asking increasingly critical questions.

The stories and photographs in these pages depict the wonder of discovery – the wonder of what we find, but also of the human mind that finds it.

While it takes some getting used to, researchers should welcome any chance to engage with the public. They have a responsibility to protect the public from pseudo scientists who are only too happy to satisfy the public's curiosity or fuel pseudo-science debates in the media.

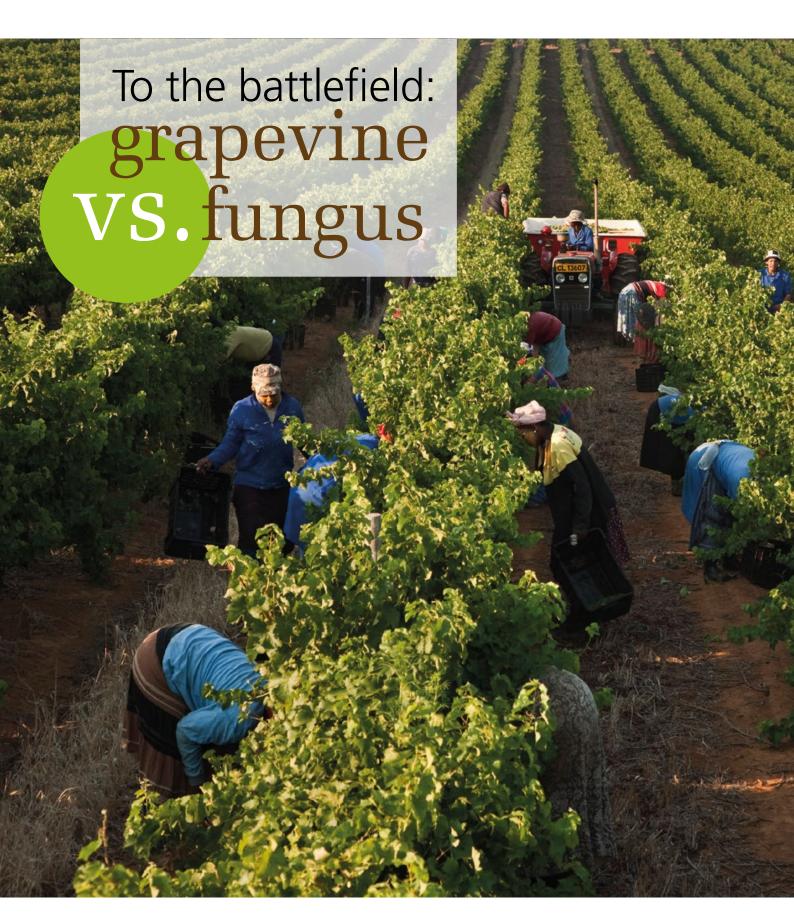
The public interest in *New Voices in Science* also highlights the fact that Stellenbosch University is doing relevant science. The topics in these articles range from helping teachers cope in gang-ridden schools to developing remarkable ways of reducing pollution. Some of the research reported on here will directly help our fruit, grape and ostrich industries; others have implications for health, or for economic and environmental stability. You will also find studies here that aim to deepen our understanding or change our perspectives on what it means to be human, on this continent and in this age. These are the studies that create the context for our applied research to thrive.

Above all, this publication highlights the wonder of science itself. The stories and photographs in these pages depict the wonder of discovery – the wonder of what we find, but also of the human mind that finds it. It celebrates the efforts of researchers to discover, and their efforts to share so freely. It celebrates the ability of science to still surprise us.

Prof. Eugene Cloete

Eugene Clork

Vice-Rector: Research and Innovation



Mukani Moyo, a molecular biologist, talks about the fight against a notorious grapevine fungus

The greater the effort, the greater the glory'. These were the words that keep me going when my PhD research at the Institute for Wine Biotechnology delivered some very surprising results. When you are nearing the end of your research, results that many could call 'inconsistent', are not always welcome. I remind myself that for the truly scientifically minded, a finding that does not make immediate sense can be as exciting as a breakthrough.

ierre Corneille once said

This particular surprise occurred on a mission to understand how grapevine plants defend themselves against a notorious fungus called Botrytis cinerea. This fungus causes grey mould rot on grapes, leading to huge losses in crop vields worldwide. B. cinerea poses a huge problem for South Africa where the wine industry contributes almost 10% to the annual GDP.

During plant infection, *B. cinerea* releases enzymes that eat through the cell walls of the grape, creating an entry point for more fungi. Once inside, the fungi feed from the plant's nutrient resources, ultimately destroying the plant tissue.

One of the defence mechanisms used by grapevine, is a group of enzymeinhibiting proteins that reduces the damage caused by the fungus, in some cases succeeding in resisting the infection altogether. The gene that is responsible for releasing the protective proteins in Vitis vinifera, the species of grape most commonly used in agriculture, has already been identified. Studies have confirmed this gene's defence role, through genetic modification of tobacco plants, which were shown to be more resistant to fungal infection than those which were not modified with the V. vinifera gene.

unmodified

modified with wild

Vitis vinifera

Despite having this defence, Vitis vinifera remains vulnerable to grey

mould rot infection. Other grapevine species such as wild vines have been found to be much better at fighting this fungus.

The grapevine molecular biology group in the Stellenbosch University Institute for Wine Biotechnology, therefore became interested in whether the defence genes of wild vines were perhaps more effective in producing proteins to efficiently suppress fungal enzymes. The research group isolated and characterised the genes and repeated the genetic modification experiment on tobacco plants, this time using the defence genes from the wild vines. As expected, the transgenic tobacco plants showed an even greater resistance to the *B. cinerea* fungus when compared to those that had been modified with the gene from

the grape species used for cultivation.

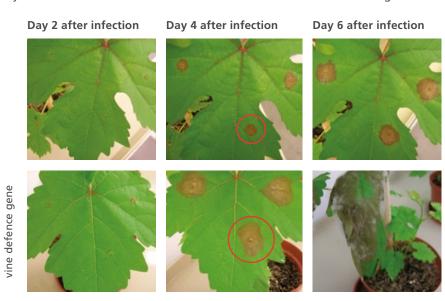
Armed with this knowledge, the next step seemed clear. What would happen if the *V. vinifera* vines were modified with the defence genes from the wild vines? Surprisingly, the transgenic V. vinifera plants became more susceptible to the fungus. No obvious explanation for this completely unexpected result has been found yet. Although a number of possible causes have been examined and ruled out, there is more to understand about fungal resistance and susceptibility in the grapevine plant than was thought.

The successfully genetically modified V. vinifera plants now provide the perfect opportunity for such further research into plant-fungus interaction at a molecular level. 🛥

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One of the defence mechanisms used by grapevine, is a group of enzymeinhibiting proteins that reduces the damage caused by the fungus, in some cases succeeding in resisting the infection altogether.

Unexpected results: Agricultural grapevine (V. vinifera), became more susceptible to grey mould rot infection when modified with the wild vine defence gene.





striking a South African chord

Hans Huyssen explains the complexities of music

ew musicians ever have the chance to collaborate with a philosopher. An artist's residency at STIAS afforded me such an opportunity, when I met the complexity philosopher Paul Cilliers in 2009. Our conversations about music and its many relational facets laid the foundation for a PhD study in musical composition from a complexity perspective.

Studies of complexity focus on the relations between components of systems, rather than on the components in isolation. It emphasises the interactions between these components and the systems that arise from such interactions. A system implies a certain quality of the whole that is not present in the individual components, nor predictable from their properties, but only emerges from their organisational relations.

This shift in emphasis is necessitated by the limitations of analytical studies of living beings, societies, languages, cultures and ecosystems. Dissecting a whole can lead to structural insights, but would never reveal the reason

for something to be alive and selfmaintaining.

Even this very brief introduction to systems thinking stirs up a number of musical implications. All the qualities of a system as a complex phenomenon apply to music. Music is an activity and an experience resulting from the intricate interactions of numerous physical constituents, seen in the coordinated energy applied to musical instruments; as well as the relation between a variety of role players, such as composers, performers, impresarios and listeners.

None of these elements can be taken away. In themselves they cannot guarantee the emergence of music, but as parts of a meaningful constellation they may contribute to something far exceeding their particular propensities.

What is there to be gained from this insight? I believe that findings from complexity studies can help to better understand, practice and teach music. New approaches and viable alternatives to our conventional perceptions and practices become possible.

We may learn from systems theory that the integrity of a complex system rests on its openness. This means that unless it is constantly regenerated from the outside, it stagnates and dies. Similarly, a system's identity is guaranteed by its ability to alter its organisation in response to changing conditions.

Yet, there are deeply ingrained divisions in the musical discipline, which assign the study and practice of different musical aspects to strictly separated areas of specialisation.

With respect to music, conventional wisdom tells us that cultural integrity is

A system implies a certain quality of the whole that is not present in the individual components, nor predictable from their properties, but only emerges from their organisational relations.

best safeguarded by closing it to outside influences, that stylistic and musical identity are best conserved by preventing changes and that musical autonomy arises from an artistic elevation beyond any context.

The framework offered by complexity theory can lead to a constructive engagement with important questions such as 'western' art and music in South Africa.

In a country where admitting to differences is difficult because the notion of difference is so often associated with conflict, violence and shame, the complexity approach offers a liberating perspective. In complexity theory, difference and diversity are enabling and enriching qualities. As Cilliers has summed it up: 'Difference is no problem, but the precondition for any interesting behaviour'.

If this assumption is correct, a complexity approach to music might help transform rigidly stagnated ideological positions and help South African musicians to develop strong, expressive, local musical voices.

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ur lives have been taken over by smart things – smart phones, smart televisions, even smart homes. And now research has shown that smart dirt is on the increase too. Smart dirt consists of germs that cling to surfaces and that have become resistant to the chemicals we use to get rid of them.

The accumulation of surface-adhering micro-organisms such as bacteria and algae is called bio-fouling. The fact that available chemical cleaners are no longer effective, impacts on almost all areas fundamental to human existence, including the water treatment industry, food industry and energy sectors.

Bio-fouling affects the filters in water treatment plants, reducing the quality of water and increasing operation costs. Food security is threatened when irrigation systems get worn out and production lines in industrial settings become plagued by the scourge of bio-fouling.

The energy sector, including Eskom, is also victim to this plague. Cooling water towers are constantly down due to heavy fouling, which reduces heat exchange efficiency. Repair costs run into millions and cooling tower lifetimes are severely shortened.

Fortunately, nature has also provided a solution to smart dirt's reign of terror. Researchers discovered that the marine red algae (*Delisea pulcra*), amidst other heavily fouled surfaces, remained untouched by ocean bacteria and barnacles. A closer look revealed that this marine plant contains substances called furanones that repel bacteria and all other forms of micro-organisms from their surface.

In a research project carried out in the Department of Chemistry and Polymer Science at Stellenbosch University, these furanones were prepared and tested on laboratory-scale water filters. The furanone-modified water filters did not only demonstrate self-cleaning behaviour (bacteria repelling), but also the ability to destroy the bacteria which attempted to stick to the filter surfaces. And since the furanone compound is chemically bound to the material, there is no risk of it leaking out to the environment.

This technology opens a lot of possibilities in the fight against surface bio-fouling. It can eliminate the use of chemical cleaners, which are dangerous for the environment and lead to antimicrobial resistance.

So, smart bugs, watch out. You might have won the battle, but the war against bio-fouling has just begun.

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Feeding off HUNGER

Collium Banda reinterprets the hope for heaven as a call to fight poverty



The seed of poverty thrives on the rich soils of Africa.

 \blacksquare he above words by the Zimbabwean theologian, Ezra Chitando, fittingly describe a deep-rooted irony afflicting the African continent. Africa's fertile soils produce little besides poverty, hunger and disease.

There is a bitter twist to Chitando's observation: In Zimbabwe the rich soils have not only grown poverty; there is an equally rapid growth in Christianity. So scandalous has this parallel growth of poverty and Christianity been that a media house recently taunted Bulawayo, the country's former industrial hub, with this news billboard: 'Bulawayo: From Industrial Hub to Church City' (Southern Eye, 21 July 2013). The billboard reflected the outrage of workers and business people at the rapid conversion of factories and office blocks into places of worship. This mocking of economics by religion has baffled the government and economists.

How should we understand the correlation between poverty and religion in Zimbabwe? While few would go as far as to say that the church actively causes poverty, there might well be a causal relationship in the opposite direction - more people are likely to seek solace in religion during times of hardship. And in a city where economic activity has literally been replaced by religious activity, one could reasonably argue that the church, inadvertently or not, plays a part in reinforcing and maintaining poverty.

Jürgen Moltmann, a German Protestant theologian, says in his many works on hope that churches can indeed be guilty of promoting poverty. This is when they interpret the Christian message of hope for a future heaven in a way that discourages the poor to deal with their poverty. In this matter the theologian is an unlikely supporter of Karl Marx, the communist philosopher, who criticised religion as a drug that blinded people to their hardships and killed their will

to fight their poverty. Marx found that religion kept the poor complacent and docile while the rich and powerful increased their wealth.

However, this is as far as Moltmann agrees with Marx. Moltmann believes in the importance of hope, but calls for an alternative interpretation of hope that enables churches to promote economic activity and to eradicate poverty. Moltmann pleads for an activist and revolutionary hope of heaven countering all structures that promote poverty in this present life.

Moltmann's theological thought can be summarised in three points. Firstly, God participates in the life of his people on earth. In the Israelites' journey out of their Egyptian slavery to liberation in Canaan, God did not just wait for them in the Promised Land; he joined in their journey. Jesus preached a message of the future, but he engaged the pain and suffering of the people he met.

Secondly, the Kingdom of God symbolises God's rule of justice, which promotes life. The request for the Kingdom of God to come in the Lord's prayer opposes all forces that bring death, including socio-economic issues.

Thirdly, the church in the Bible does not refer to a building, but a human network of worshippers.

Therefore, in Moltmann's analysis the church should not focus only on the future, but engage the context of this present life. It should not accept poverty here on earth, but work to transform this world to be like the awaited future. Rather than a place to go and pray for one's own salvation, the church should act as a community of people, interconnected by love and service to one another, to practically support the poor in their daily struggle for survival in this life.

Moltmann's analysis of the Christian hope for heaven means that one should not simply dismiss the role of the church in Zimbabwe. It challenges churches in Zimbabwe to stop soothing the poor with promises only. Churches can and should promote socio-economic change. Practically, this means working towards

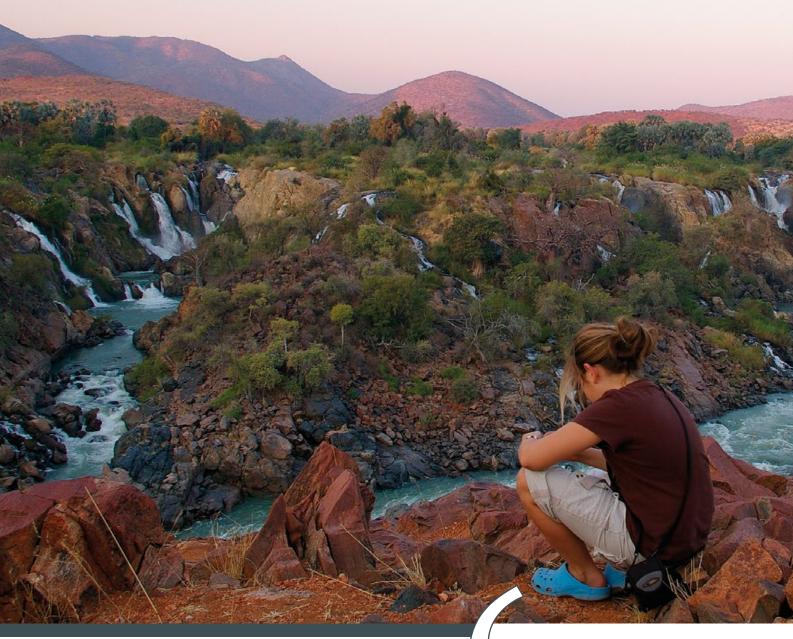
Churches should not simply feed off the poverty that seems to be growing in the rich soils of Africa, but should plant the seeds of socio-economic transformation and nurture them into life-giving prosperity for all.

the goodness of life here-and-now, and giving the poor the resources, skills and abilities to make money.

Theologians can also contribute through their study and reflection on their faith, their God and their people and share insights that make a difference in people's lives.

Churches should not simply feed off the poverty that seems to be growing in the rich soils of Africa, but plant the seeds of socio-economic transformation and nurture them into life giving prosperity for all.

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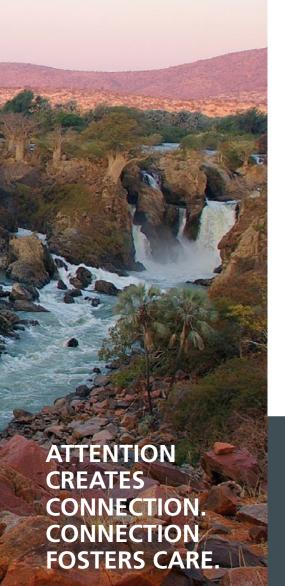


Nature needs our attention

The ability to focus attention on nature is vital for sustainability and human health and well-being, writes Matthew Zylstra

econnect with nature' is becoming a popular catchphrase. ► Ecotourism and wilderness retreats regularly offer jaded city dwellers the promise of an escape from the urban jungle. However, reconnecting implies something more than just a getaway. It suggests that we once had a deeper connection with nature that we can rediscover and when we do, we will be better for it.

There is growing evidence that regular contact with nature offers health benefits such as improved memory, concentration, sensory awareness, creativity, mood and social bonding. But researchers in the field of conservation psychology are now finding that human connections with nature can benefit the environment



to lower with each generation to the point that we may one day be unable to comprehend why a relationship with nature is important at all.

From the times of early civilisation, humans have been physically moving away from wilder nature; since the rise of the earliest forms of agriculture, through industrialisation, steady migration out of rural areas and growing separation from food sources, and the more recent scale and speed of urbanisation, globalised consumerism, instant gratification and technologydependent lifestyles. Partly fuelled by this physical separation, these trends have also damaged our psychological connection with nature. Together, these trends form a 'blind spot' in our consciousness since nature consistently falls outside of our everyday awareness.

Consciousness is shaped by our experiences. To avoid becoming overwhelmed, consciousness has a mechanism that allows us to wilfully direct our attention toward things which are of interest to us and to shut off or 'edit out' those things we consider unimportant to our immediate survival.

as well. A consciousness attuned to nature is thought to lead to increased stewardship of the environment. Awareness allows us to experience something deeply, which in turn cultivates emotional bonds that foster concern. Attention creates connection. Connection fosters care.

How have we disconnected from nature? In one sense, we can never fully disconnect, since we remain physically dependent on nature for food production, crop pollination, water purification, climate regulation and its many other 'free' services. But this is largely an indirect and passive connection, and most people are unaware of the contributions of nature to their lives. This awareness is likely to continue

The general lack of awareness about our dependence of nature is exacerbated by the attention-grabbing technological 'super-stimuli' of modern society. This fuels our inattention nature blindness and our disconnection.

Inattention nature blindness could explain the continued environmental degradation by humans, since we no longer notice ecological change.

Many well-meaning conservationists berate modern civilisation for destroying ecosystems and point out the negative social and economic consequences. Ironically, this often results in people 'switching-off' their attention. Research instead finds that focusing on 'love' rather than only 'loss' of nature is a more powerful and enduring motivation.

Conservation psychologists are therefore joining the call to reconnect with nature, not just through knowledge about nature (thinking) and experience in nature (doing), but through mindfully bringing nature into consciousness (being). This means having a sustained awareness of the interrelatedness between one's self with the rest of nature. This supports pro-social and pro-environmental behaviour.

Research is still on-going to identify which activities best support nature connection in various contexts. While there is no blueprint, it is evident from emerging research in South Africa that nature connection requires a combination of cognitive, emotional and experiential approaches.

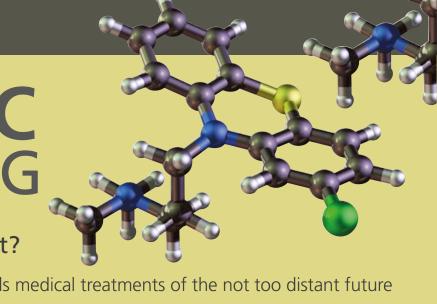
But people are encouraged to personally experiment with their own techniques. One effective exercise is to just sit quietly with an open mind in any (semi-) natural area and focus attention with all your senses awakened and alert. Nature connection is often best achieved through unstructured creative or playful activity, free from time constraint. Such activities aim to focus attention in a way that displaces artificial stimuli and is instead sustained by natural phenomena: that is, a shift from nature blindness to nature awareness.

Reconnecting to nature is more than only a physical escape to recharge your batteries. True connection with nature is an everyday awareness that holds the key to finding a more harmonious relationship with life on earth. It seems that feeling part of something greater than oneself motivates care and responsible action, as well as helping us lead happier and more fulfilling lives.

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GENETIC **PROFILING**

...a silver bullet for schizophrenia treatment?



Geneticist Britt Drögemöller reveals medical treatments of the not too distant future

magine a world where you are surrounded by terrifying voices **L** and people that exist only in your mind. Struggling from day to day in a dimension of the universe that leaves you running scared. Living in a reality that is disconnected from the world in which others live, where they stand and jeer from a distance.

Schizophrenic patients spend great parts of their lives in terrifying distorted realities. Antipsychotic medication reduces these debilitating symptoms. The right antipsychotic can free patients from daily distress and discrimination and allow them to live self-sufficient lives.

But current antipsychotic treatments are only effective in about half of schizophrenic patients and 70% experience encumbering side effects. These range from embarrassing uncontrolled movements to weight gain. In extreme cases, medication can lead to death.

Patients often go through months of trial-and-error before they find a suitable treatment combination. This, together with the upsetting side effects, leads to patients refusing to take their medication, hampering their recovery and affecting the progression of their illness.

Predicting how an individual patient is likely to respond to a particular antipsychotic, could address this dilemma. Researchers around the

There are 3 billion base pairs of DNA that lie in the cells of every human being. It is variations in the DNA sequence that makes each person unique from outward appearances to internal processes, including how the body responds to medication.

world have started looking at possible DNA variations linked to reactions to different types of medication for various other illnesses. Collaborative research between the departments of genetics and psychiatry at Stellenbosch University is the first to apply this strategy to antipsychotic treatment.

Determining the variants in the 20000 human genes of those that respond well and not so well to antipsychotics, generates a lot of data. Using computerbased analyses, the team was able to identify eleven genetic variants that were associated with non-response to antipsychotic treatment.

These variants affect the functions of genes involved in two different processes: firstly, the metabolism of a vitamin found in fruit and vegetables, and secondly, the transport of cells in the brain to areas where they can communicate with each other, so that we are able to interpret the world around us. The disruption of these two processes may play a role in the development of schizophrenia, as well as the way in which patients respond to antipsychotic treatment.

If future studies validate these results.

it could lead to more effective antipsychotics and predictive DNA tests to determine if patients contain genetic variants that will cause them to respond poorly to antipsychotic medication or experience side effects.

This predictive testing will allow schizophrenia patients to have easy access to optimal and customised antipsychotic treatments.

Imagine a world where treatment relieves, rather than adds to the distress of those suffering from schizophrenia. Where, instead of lengthy experimentation with various antipsychotics, a simple spittle test can indicate which medicine would work best for you.

Such tests are already available for certain other drugs. The era of personalised medicine is upon us, and in the not-too-distant future schizophrenia patients will be afforded the same benefits of optimal treatment. 🗬

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mericans are known for their patriotism. Such national pride expresses itself in a fierce loyalty to local brands. Indeed, for a long time the American car market was dominated by local brands like GM and Ford.

But when it comes to consumer behaviour, patriotism seems negotiable. As soon as US consumers were given the option of more efficient and costeffective Japanese brands, the patriotic Americans unceremoniously dumped their local products and switched to foreign brands. The car industry in North America has yet to regain its former glory.

The moral behind the story is that inefficient organisations may thrive in the absence of competition, but are in fact extremely vulnerable to collapse.

That is why productivity and efficiency analyses have become important measures for economists and policymakers. Not only is society burdened by the costs of inefficient systems, but the collapse of any industry has serious knock-on effects for the whole economy.

The sudden boom in the microfinance sector of Tanzania has therefore caught the attention of economists and policy-makers there. Saving and credit cooperatives, called SACCOs, have recorded an astounding growth rate of 565% in the past decade. Operating much like credit unions, SACCOs provide financial service to the poor and to those marginalised from the mainstream banking system.

The question is whether SACCOs represent a much-needed stimulus for economic growth in Tanzania, or whether their sudden boom is concealing inefficiencies that could soon lead to a spectacular implosion.

The risk of the latter is exacerbated by the fact that SACCOs operate in precisely those environments that conventional banks avoid, dealing in small transactions that carry much higher risks of default. They tend to be small scale operators with limited infrastructure and support. It is no wonder that there are concerns about whether SACCOs possess the

efficiencies and effectiveness to survive in a changing and increasingly competitive banking landscape.

Recent findings by researchers from the Faculty of Economic and Management Sciences at Stellenbosch University show that most SACCOs in Tanzania are indeed inefficient when compared to industry best practice. The research results are based on audited financial statements data from 103 Tanzanian saving and credit cooperatives.

Further analysis showed that these inefficiencies were related to scale rather than to technical inefficiencies such as poor management practices and business processes.

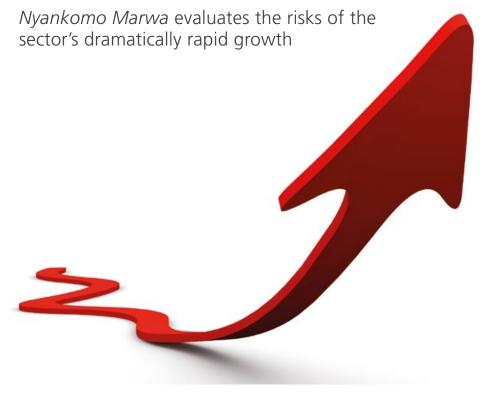
77% of all SACCOs studied were operating at suboptimal scale, in other words, they were too small (and in a few cases too large) and could improve their efficiency just by adjusting the size of their operation.

However, about half of the SACCOs studied also showed inefficiencies related to poor management of resources and high levels of waste.

Despite these gaps in efficiency, the micro-lending sector in Tanzania might be healthier than feared. Inefficiencies in the SACCOs studied could largely be attributed to economies of scales, which are much easier to address than technical inefficiencies. Even so, the study offers clear strategies that show which organisations would benefit most from which remedies.

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Boom or bust in the Tanzanian micro-financing sector





where Evergreen stayed while her mother was at work. When Evergreen was 12 years old, she told her mother what some of these men did to her. Her mother responded violently and accused Evergreen of lying. She told Evergreen that she would drown her if she ever heard her say such things again.

Some 40 years later, Evergreen, having been diagnosed with major depressive disorder, became one of the study participants in my doctoral research on depression in low-income South African women. In 2011, I sat with Evergreen for the first time and listened to her as she found the courage to give voice to the story she wasn't allowed to tell.

ajor depressive disorder is the single most commonly occurring mood disorder in the world and is believed to affect twice as many women as men. The World Health Organisation has projected that by the year 2030, depression will be the number one cause of disability worldwide, ahead of HIV/Aids, cardiovascular and chronic pulmonary diseases. Despite the magnitude of this global mental health problem, depression remains poorly understood. Part of the problem may lie in the way it is diagnosed and described in the medical literature.

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) is an international reference book which lists

the symptoms and diagnostic criteria for various mental disorders, such as depression. Used by mental healthcare professionals throughout the world, the DSM-5 can be considered a substantial part of the foundation of our understanding of all known mental disorders. Most importantly, that foundational understanding informs the diagnosis of various mental disorders and ultimately, their corresponding treatment.

This begs the question: Is the DSM-5 really the best way in which to understand, diagnose and treat depression? Some mental healthcare professionals argue that the medical model adopted by the DSM-5 might work well for physical diseases but not for mental

My findings indicated that there is indeed much more to the concept of depression than the DSM-5 suggests.

illnesses. In diagnosing a physical disease, one assumes that the cause of the illness (the pathogen) resides within the individual, and it is therefore understood and treated on an individual level. Critics contest that applying this view to depression (for example, to assume that a 'hormonal', 'personality' or 'chemical' problem within the individual has caused their depression) is parochial and therefore inappropriate. They argue that such individualistic and 'clinical' understandings of depression obscure any consideration of the interpersonal, political or otherwise external factors that can cause an individual emotional distress.

It was with these criticisms in mind that I set out to compare the DSM-5's understanding/portrayal of depression with that which was provided by women who had had a personal experience of depression. My findings indicated that there is indeed much more to the concept of depression than the DSM-5 suggests. That is, the subjective understandings of depression, as recounted by women who have personally experienced the phenomenon, connote a richness and complexity of knowledge that stands in contrast to the stark and clinical picture of depression that is usually presented by medical literature.

This is not to say that the DSM-5 is unhelpful in clinical practice. Rather, it is to say that we must remember that the DSM-5 only captures a *small part* of the experience of depression. Its understanding is partial: It does not show us the whole picture and should therefore be used with caution.

Of course, it may be more comfortable for us to think of depression as individually located and individually



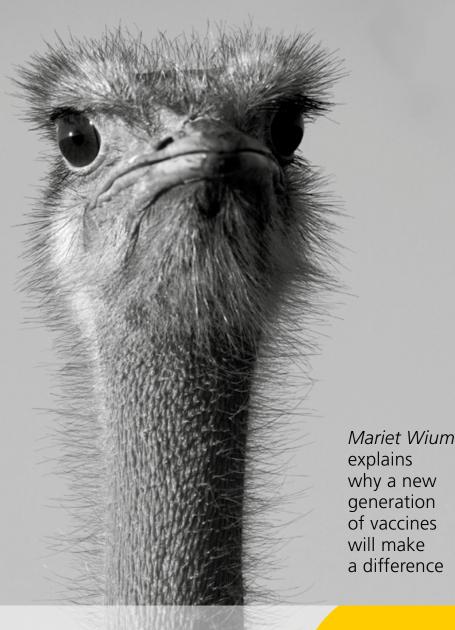
To consider Evergreen's misery in that way would be to disregard the deeply painful and damaging consequences of her abused childhood...

treated, but in truth, depression is seldom just a personality or hormonal problem. To consider Evergreen's misery in that way would be to disregard the deeply painful and damaging consequences of her abused childhood, her financially impoverished life and her unremitting daily hardships. If we do not acknowledge the profound effects of a person's political and social environments on their mental health.

we will never understand their problems sufficiently, and we will therefore never be able to develop truly effective treatment and prevention strategies.

Perhaps it is time to look beyond the clinical diagnosis and recognise the sad truth about depression. The sad truth is that it is usually not just a chemical imbalance or an individual's biological, cognitive or personality problem. More often than not, people are depressed because depressing things have happened to them.

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THE OSTRICH INDUSTRY WITH

he ostrich industry is of significant economic importance to South Africa. Ostrich meat is seen as a healthier alternative to other red meats such as beef, and South Africa is the world's largest supplier of ostrich meat. The industry provides work to more than 20 000 people in rural communities and generates a gross income of R1,2 billion a year in exports. But diseases affect commercial farming and lead to economic and livestock losses. One such disease-causing pathogen is the mycoplasma bacteria. Mycoplasma infects the mucosal membranes of the eyes, nose and respiratory track; and causes conjunctivitis, sinusitis and airsacculitis, which is infection of the airbags. Airbags act as additional lungs in birds to help with breathing.

Overall, birds infected with mycoplasma will have a decreased growth rate, low feather quality and infected young birds may even die. The meat of infected birds is also sometimes downgraded.

While mycoplasma infection in ostriches is currently treated with antibiotics, a preventative vaccine would be much more effective and economical. This is exactly the focus of the laboratory in the Department of Biochemistry at Stellenbosch University. If work done here is successful, the ostrich industry in South Africa could benefit from a new generation of so-called DNA vaccines.

While vaccines have helped in preventing diseases in large parts of the world, they do have some shortcomings. Traditionally, a vaccine contains a killed or weakened bacteria or virus that is responsible for the disease. Because it has been killed or weakened, the patient does not contract the disease. However, the killed pathogen used in the vaccine might not create a strong enough immune response, or regular vaccinations might be necessary to maintain immunity. There is also always the chance - although small that the weakened organism in the

How to make a DNA vaccine against ostrich mycoplasma:

To make the vaccine, we select one gene of the mycoplasma that is essential for its survival and insert it into a special DNA molecule that acts as a carrier of information.

This DNA vaccine consists of two halves.

The first half will allow the ostrich cell to read the gene information on the DNA vaccine. These parts of the vaccine translate the recipe for mycoplasma protein to 'ostrich'. When this DNA vaccine is administered to the ostrich, the ostrich's cells start to produce the mycoplasma protein from the gene.

The second half contains all the information necessary for the amplification of the vaccine in the laboratory. For this purpose, the DNA molecule is inserted into *E. coli* bacteria, which multiplies rapidly, resulting in many copies of the DNA vaccine. It is like printing many copies of the same recipe. This makes the vaccine more effective.

vaccine might return to its original potent form and make the person ill when administered.

New generation DNA vaccines address some of these shortcomings of traditional vaccines.

The design of a DNA vaccine for mycoplasma starts from the genome sequence of the mycoplasma bacteria, which contains genes that each code for a unique protein product. The genome

The industry provides work to more than 20 000 people in rural communities and generates a gross income of R1,2 billion a year in exports. But diseases affect commercial farming and lead to economic and livestock losses.

sequence is the collection of all the inheritable material within the cell. Although we do not understand everything yet, reading the genome along with research can tell us which genes are essential for mycoplasma to survive.

To make the vaccine, we select one gene that is essential for the mycoplasma's survival, and insert it into a special DNA molecule that acts as a carrier of the information.

When this DNA vaccine is administered to the ostrich, the ostrich's cells start producing the protein according to the inserted gene. But because the protein is foreign, the ostrich immune system will launch a response towards it and produce antibodies and T-cells. This will create memory that can be used to combat future mycoplasma infection.

DNA vaccines use the body's own mechanisms to prime the immune system. Unlike conventional vaccines, DNA vaccines cannot cause infections and are safe to use in immunocompromised old and young individuals. DNA vaccines also circumvent the use of dangerous bacteria within the development phase within the lab as well as during vaccine production.

In conclusion, DNA vaccines are a new technologically advancement that will contribute to the treatment of disease in the future.

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Where is the toilet please

Sheilla Simiyu shares her curiosity and insights into a private matter



It was a minute to the top of the hour. My friend Abby* and I had been keeping a close eye on the wall-clock hanging in the classroom. The school bell rang, and the classroom erupted. Huuurrraay! Home time! Everyone dashed for their schoolbags and pushed through the classroom door. Most of us headed straight to the school gate, but Abby turned the other way and headed for the toilet queue. This she did every day, and I would wait at least 20 minutes for her outside the school grounds. We walked together for the first part of our journey home, but just before the turnoff to my suburb, Abby would again turn the other way, towards the informal settlement where she lived. When we said goodbye, it seemed as though we were heading for different planets. I never asked about the toilet, but for me it came to represent all the mysteries of Abby's life outside of school.

♦ his was fifteen years ago in my home country, Kenya. Today, Abby lives in another town, and has probably forgotten these experiences. But these childhood memories stuck with me. I remain curious about the practicalities and intricacies of toilets in informal settlements. As a researcher in public and development management, I believe that openly exploring and sharing this hidden aspect of life in informal settlements would yield important and powerful insights.

From childhood memories I ask, 'Why did Abby and many others queue to use the toilet before walking home?' As a researcher I ask, 'Where are the toilets in Kenyan informal settlements?'

Majimaji*, is an informal settlement in Kenya where I went to get some answers to these questions. Walking through it, I experienced the residents' daily reality first-hand: solid waste everywhere, black smelly water flowing through shallow trenches in which children played oblivious to the danger; women cooking and selling delicacies beside stagnant raw sewage, and traders jostling to sell their wares. There was just too much of everything: noise, people, shacks with narrow alleys, and an overwhelming stench. In spite of this, people went about their business. I was in the heart and soul of an informal settlement. I gathered my courage and asked people to share with me their toilet experiences.

Brenda*, a single parent, lives in a single roomed 'house' with her four children. A dilapidated pit latrine structure serves her family and six other neighbours, also living in single roomed houses. She and her children do not use the toilet. Every morning she reminds her children to finish any toilet business at school. She uses the toilet at her work place. Brenda assures me that this system works well for them. I am reminded of Abby who had to queue to use the toilet at school. I glance at the toilet, and I understand why. It is dirty, almost full, smelly and the structure has large crevices through which everyone can see whoever is

inside relieving themselves. John* lives a short distance away from Brenda, also in a single roomed-house. There is no sign of any toilet nearby. His face droops when I asked him about it; and in an attempt to make me leave, assures me that he and his neighbours use a toilet a hundred metres away. We talk about general matters, including local football matches; but when I leave, he blurts out the truth, "We do not have a toilet. I irrigate the grass behind my house. When I need to empty solid stuff, I do it in a plastic bag, within the corners of my house. I then wrap it like a piece

of meat and fling it away."

I leave Majimaji with mixed emotions, unsure whether to empathise or commiserate, whether to be shocked or delighted that I found some answers to my curios question. A life without a toilet strikes me as impossible.

The health risks of poor sanitation are well known and many researchers, policy-makers, governments, and donors are working on ways to improve sanitation in informal settlements. But how many of us are aware of the practicalities of having to live, play, eat and sleep with no toilet close by?

This is just the beginning of my research. I have partly solved the childhood mystery that inspired it. But more importantly, these initial findings have allowed me to formulate more focused questions on how to provide residents of informal settlements with access to clean toilets.

*Names are fictitious

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Nuclear physicist Zina Ndlovu reveals toxic heavy metals in the air we breathe

¶ he world has finally woken up to the fact that we are slowly suffocating.

By 2050, more people on earth will die from air pollution than from poor sanitation and dirty drinking water. This is according to a recent study by the Organisation for Economic Cooperation and Development.

Air pollution has long been known to cause respiratory and heart disease. In 2012, the World Health Organisation (WHO) officially classified polluted air as carcinogenic and now regards it as the leading cause of lung cancer.

A recent link to bladder cancer has also been suggested by the WHO.

Increased industrialisation and urbanisation in developing countries has meant that worldwide levels of air pollution have risen significantly in recent years.

Since the establishment of air quality standards by the United Nations, South African air pollution studies have focused mainly on assessing concentrations of classical pollutants. These are the pollutants that typically reduce visibility, such as carbon monoxide, particulate matter and ozone.

But it is not only smog we should be worried about. The most dangerous kind of air pollution is completely invisible. Deceptively clean-looking city air carries invisible toxic particles that penetrate and spread through the body, precisely because they are so small. Heavy metals have been identified as the toxins most active and dangerous to human health, yet little attention has been paid to measuring the concentration levels of toxic trace elements in our air.

A research group from Stellenbosch University has initiated a novel way of revealing the completely invisible and highly toxic heavy metal trace elements emitted by cars, factories and the burning of household waste. This research collaboration between Stellenbosch University, iThemba LABS and scientists from the Joint Institute of Nuclear Research (IINR) in Russia, can now reveal the exact levels of toxic elements like copper, zinc, cobalt, vanadium, chromium in the Western Cape air.

The researchers use mosses and lichens as natural air filters to trap toxic trace elements. Like humans, plants 'breath-in' the air around them. Any trace elements that people are breathing in are also trapped by plants. Plant samples are placed inside a nuclear research reactor and bombarded with neutrons. The accumulated trace elements in the plants will become radioactive and start >

Air pollution exposed continued...

emitting gamma rays. Various elements will emit gamma rays with unique energies, so the gamma rays act like fingerprints to identify each element that is present in the sample. This process is called neutron activation analysis (NAA) and up to 65 trapped elements have been identified in plants. By looking at the peak intensity of the emitted gamma rays, indicated as spikes on a graph, the concentration level of each element can literally be seen.

A further advantage of NAA is that it uses factor analysis to link certain elements to specific sources, which is very useful in air quality control and management. The technology behind this process includes the IBR-2 pulsed fast nuclear research reactor from the JINR, followed by High Purity Germanium Detectors to detect and track the gamma rays and finally a gamma-ray spectroscopy software programme called Genie 2000, which displays the toxic trace elements. Intimidating as this might sound; the process is safe, environmentally friendly as well as relatively simple and cheap. Most importantly, it provides the most accurate picture yet of exact levels of toxic trace elements present in the air that we breathe.

The research team hopes that by making these invisible killers visible, environmental regulators, industry and the public will be pressed into long overdue action.

Environmental policy-makers will be able to enforce air quality standards. Industry will be compelled to invest in greener technologies. Last but not least, the public, becoming aware of their own steady suffocation, might be encouraged to find their own ways of reducing air-borne toxic trace elements through reducing waste and investing in non-motorised transport.

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Putting HOPE into ACTION

Barnabé Msabah shares his insights into refugee migrant survival

Incle Neville, who was to link me up with some of his friends, whispers in my ear, 'Let's go to Mogadishu!' We are sitting in a coffee shop in Bellville, so I am completely taken aback when he gets up and starts walking. The imaginary 'long walk to Mogadishu' turns out to be much shorter than expected. The 'Mogadishu' Uncle Neville was talking about is not the capital of Somalia, but a buzzing commercial hub right here in the heart of Bellville, Cape Town. Here, one finds rows of foreign-owned shops and supermarkets, predominantly Somali. Food and household goods are displayed on giant shelves or spread out in front of tiny makeshift stalls, some of which



difficult circumstances they face here. In South Africa, refugees have freedom of movement and enjoy basic civil rights such as studying and seeking employment.

Even so, as I listen to the stories of incredible hardship and heartbreak told by refugees, the *joie de vivre* and high-spiritedness of Mogadishu becomes harder to explain. Attempting to make sense of this, my research focused on what other scholars have labelled 'the transformative role of hope' in the lives of humans. I found that it is hope that allows refugees to endure their hardships and overcome challenges with courage, resilience and resourcefulness.

Consider the fact that the life of a refugee is a life of constant waiting. Refugees live in limbo as they do not belong to their country of origin or their country of asylum. They wait in long queues at the Department of Home Affairs, often for days, before being attended to. The waiting is hard physically and emotionally, as there is no guarantee that their hours of waiting will pay off.

Most of us find waiting in the most mundane circumstances almost unbearable. We feel powerless because

As other studies have pointed out, it is the very act of waiting that gives refugees meaning and purpose, because it carries the hope of a new identity and a new life.

boast hanging rails stacked with low-priced price clothing. From the shops comes the strong scent of burning *udi*, an incense, which mixes with the sounds of loud music and human voices. The vibe in Mogadishu is remarkable and reminds me of Kariakoo, the famous bazaar in Dar-es-Salaam, Tanzania.

It is my interest in the well-being of refugee migrants that brings me here. My PhD research in practical theology and missiology at Stellenbosch University has shown me that 'Mogadishu's' enthusiastic trading is typical of the refugee population. Most refugees are better off in their country of asylum than in the home countries, despite the often

the length and outcome of the wait is not within our control, and we often feel that our time is 'wasted' when we are required to wait.

As other studies have pointed out, it is the very act of waiting that gives refugees meaning and purpose, because it carries the hope of a new identity and a new life. For refugees, waiting does not always signal powerlessness. Hope is a coping mechanism that turns waiting into an act of resilience in their efforts to rebuild their lives, even when circumstances show that there are no rational grounds for it.

For example, it is hope that has allowed Bariani*, an asylum seeker from the DRC, to cope with his situation and survive. His asylum application was rejected in 2006, and to this day he is still waiting for the outcome of his appeal.

Nyabenda*, a young Burundian man in his late twenties and a university graduate, has been in South Africa for 12 years and the hope of building a productive and meaningful life made him pursue a BSc degree and a teaching qualification. Like so many refugees, Nyabenda has struggled to find a permanent job but survives on sporadic teaching contracts.

What I saw that day in 'Mogadishu' with Uncle Neville is hope put into action. Hope in action is what that turns powerlessness into strength, waiting into a socially productive phenomenon, helplessness into resourcefulness.

Prof. Russel Botman, Vice-Chancellor of SU where I am pursuing my studies, says that translating hope into action makes life meaningful and that it is a central part of what it means to be human. As a researcher, and as a refugee myself, I find myself agreeing with him.

*Names are fictitious

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Spend the day with marine biologist *Sara Andreotti*, as she reveals a different side to sharks

harks are almost universally reviled and loathed. Unlike lion and cobra which are also considered dangerous predators but are seen as essential for the healthy functioning of our ecosystems, sharks are still being wilfully or carelessly killed, to protect people in the sea. But sharks have the same balancing role for the oceans than a lion has for the bush. The difference is that we don't know as much about sharks as we know about land animals. It is partly this lack of knowledge that breeds our particular hostility towards sharks, as we tend to assign sharks evil motives and regard them as mindless killing machines with the sole purpose of attacking whatever humans they encounter.

I would like to re-introduce you to white sharks, as I know them. Forget the giant gaping robot used in Jaws. Forget the huge front-page headlines that follow every shark attack, and follow me on a boat. It is a small 6-metre boat, called little Pea, and we are chugging out to sea early in the morning at Gansbaai, South Africa's white shark cage-diving hotspot. Skippering the boat is my research partner, Michael Rutzen.

A few hundred meters off the coast, we put down anchor and wait. The air is chilly as the sun starts rising over the horizon – first red, then orange, pink and yellow. We wait in silence; the only sound is that of water gently splashing at starboard. We throw a mixture of sea water, fish oil and fish blood into the water. We watch the fish oil floating slowly in the current, towards Dyer Island. And we wait. The black arrow of dozens of cormorants rises from the island. And we wait some more.

After a few hours, a dark shadow appears, moving slowly, following the fish oil scent to the source. Finally, our first shark.

Careful and skittish, the shark starts to investigate the situation. It is looking for the fish it was smelling so clearly and does not seem to be too impressed by little Pea. On the boat however, the situation is less calm. I frantically grab and prepare the camera while Michael throws the tuna head, tied to a rope, into the water.

The shark is a female, about three to four metres long. She doesn't change her speed, even when she finally sees the fish she was looking for. She is still very cautious. More fish blood, more patience. She seems to relax a little but she doesn't try to get the fish, doesn't break the surface. She just investigates over and over, curiously looking at the boat and at us. From time to time, a big blue eye stares at us, almost asking what our intentions are. When she approaches, we start pulling the fish head. Finally, like a playful cat with a ball of wool, she starts following our fish head.

She finally breaks the surface with her dorsal fin. Holding my breath, I shoot with my camera – six snaps in quick succession. I got my photo of her dorsal fin. This is what we were looking for – a photo identification of this animal, a permanent fingerprint to recognise her next time.

Throughout the rest of the day, four more sharks visit our boat. I know these sharks already, as their dorsal fin IDs are captured in my catalogue of the white sharks of the South African coastline. When no more sharks appear, we pull anchor and head back to land, with a sense of emptiness. We won't be lucky enough to play with these magnificent creatures for much longer. Not if the situation does not change.

Every shark has a unique dorsal fin shape and pattern. For my PhD research, I have collected over 5 000 photos of white sharks' dorsal fins in the Gansbaai area. From these, we have identified only 426 individual sharks in what is considered one of the best white shark sighting spots in the world. New identifications of white sharks in my research slowed down drastically after about 400 sharks and now seem to have plateaued at a shockingly low number. The 426 sharks I have recorded, could represent close to the entire shark population of the South African coastline and probably even further afield. White sharks are not residential animals and the sharks spotted near Gansbaai continuously move around the coastline and between continents at a rapid pace.

A genetic variation analysis I have been conducting has confirmed that the shark population around the coast is likely to be less than 500. To put this number in perspective, there are 1600 giant pandas left in the wild.

At the current rate of culling [see shark facts], the population will not be able to recover quickly enough to sustain the population. The extinction of white sharks will result in a cascade of events that will negatively affect the whole ocean.

More attention should be paid to developing alternative ways of protecting ocean-goers as an ocean without sharks will be a giant lifeless pool, and we will lose the richness of a working ecosystem with its fascinating abundance of life. >



Shark facts

- White sharks have been patrolling South Africa's coastline for over 60 million years, but now they're facing extinction through direct human attack.
- White sharks are killed by humans for their jaws, trapped in anti-sharks nets or culled with baited hooks in attempts to protect beach-goers.
- In KwaZulu-Natal alone, approximately 1063 white sharks were reported to be entangled within anti-shark nets between 1978 and 2008.
- Sharks have been recorded moving to Australia and back within 90 days.

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Trauma tools help against **TEACHER BURN-OUT**

Sharon Johnson, a psychology researcher, gets powerful results through simple interventions

ore than 65% of high school educators report high levels of stress and burnout as a result of lack of discipline in schools. Despite this, educational workshops offering either physical, emotional or cognitive tools significantly improved teachers' coping skills as well as their interactions with learners.

This is one of the major findings of my recent doctorate in psychology, in which three interventions were used to measure and to reduce stress and burnout of teachers in four high schools on the Cape Flats in the Western Cape.

These teachers suffered from high levels of stress and burnout due to alarming incidents of social violence and lack of discipline among learners. They are often confronted with learners dying from fatal gunshots, assaults on headmasters and educators, racial outbreaks between Afrikaans and

Xhosa-speaking children, gang members with guns entering schools, bomb scares, fires disrupting classes and substance abuse among learners.

Uncertainty about their roles, work overload, and the unnecessary amount of red tape also triggered stress and burnout.

My study showed that the trauma prevalent in high-risk schools had a profound effect on teachers. They felt isolated, emotionally exhausted, physically tired, and unable to accomplish goals, with unmet needs. These are all well-known symptoms of burnout.

During the stress and burnout interventions, teachers were able to confront these unpleasant feelings and experiences. Diverse yet effective coping strategies offered practical tools and improved their self-efficacy.

Educators who attended at least one

of the three workshops all reported significantly reduced stress levels. Those who practised physical trauma release exercises or dealt with emotional healing, reported a reduction in learner burnout. They also had a better understanding of themselves.

Learner burnout was also reduced in the cognitive intervention, where teachers analysed their communication patterns, using self-tests and discussions to better understand their interactions with learners.

In the classroom, educators gained confidence to take control, were calmer and felt more relaxed with increased

There were also significant shifts in the understanding of classroom competency for educators, who took more responsibility for managing discipline, rather than seeing it exclusively as a learner problem. Teachers had a greater



understanding in the classroom about how to deal with learners and felt empowered by this new knowledge.

The interventions succeeded in helping teachers transfer what was learnt to everyday challenges in the classroom and in life.

Overall, educators recognised themselves as the ones who needed to take control of the class and relate positively to learners, rather than blaming the children for lack of discipline.

With learner discipline being the greatest stressor in high-risk schools, teachers need effective responses which do not exacerbate the violence and aggression present in gangland communities.

The positive mediation of educator stress and burnout could improve competence in the classrooms on the Cape Flats and help reverse the high drop-out rates of learners.

While the Department of Education does indeed recognise the daily challenges facing teachers and devise realistic, practical solutions for factors impeding educators from delivering quality teaching, it needs to address stress-inducing working conditions, such as large classes and inadequate resources.

It is not enough to be merely concerned by the plight of exhausted and demoralised teachers, or to introduce interventions which are not based on sound empirical research.

Positive action needs to be taken, analysing the effectiveness of different interventions on the coping strategies of teachers and assisting them to reach democratic, caring and social justice aims, particularly within challenging educational contexts such as public schools on the Cape Flats.

Practically, educators should be

afforded opportunities to exercise their right to be given an equal chance to voice their democratic concerns. Workshop interventions can provide tools to improve classroom competency and model compassion and care, which can be passed on to learners.

Reducing stress and burnout of educators is a vital key in unlocking the academic potential of our youth. Teachers as well as learners deserve a healthy classroom environment, conducive to learning and care. It is time to turn to the important task of empowering and healing our teachers.

Sharon Johnson graduated in December 2013 with a PhD in psychology from Stellenbosch University. Dr Johnson is now Head of the Department of Teaching and Learning at the South African College of Applied Psychology in Claremont. shajohnson@mweb.co.za



TAXI to Protea-ville

Natalie Theron, a conservation ecologist, uncovers a minute transport system important to protea pollination

group of researchers discovered that tiny mites travelling on birds and insects may be responsible for the pollination of protea flowers, rather than the birds and the bees themselves.

These tiny spider-like creatures, smaller than a sugar grain, were discovered by researchers from Stellenbosch University and the Agricultural Research Institute, when they were investigating a beetle thought to transport fungi within and between protea communities. They noticed that in fact it was the mites being transported by the beetles that were primarily responsible for fungal transport, through special fungal carry bags on their bodies.

This finding unlocked the door to an unexplored and almost invisible world. Soon eight different species of mites were discovered and evidence suggested a much more important role played by mites within the protea population

than initially assumed.

Specific mites were found to carry fungi that are known to cause disease within pine plantations. Some mites are thought to act as seed or plant protectors by excluding plant-eating arthropods. Others are believed to be flower cleaners by feeding on debris within the flowers and fruits.

It seems that nature has provided its own natural transport scheme within protea ecosystems.

Mites have been found on the flowers and fruits of proteas, on insects and quite recently on birds that are associated with these protea plants. Some mites have even been found to piggy back each other. Mites do not have the ability to move between flowers on their own and so they catch a ride on insects and birds to get where they need to go. It seems that nature has provided its own

natural transport scheme within protea ecosystems.

Further field and laboratory work will now focus on exactly how mites use birds to move between flowers, and on determining the precise influence of mite on protea pollination.

It would be a significant finding if these mites do play a role in protea pollination by not only dispersing pollen between plants but also depositing it inside the flowers. This will be of great importance for conservation management purposes, but also for researchers overlooking the influence that small and sometimes inconspicuous organisms might have on an ecosystem.

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t's a sweltering summers' day in Grabouw with the temperature L reaching 32 °C. Sweat runs down my face as I trudge along the rows of apple trees taking measurements of the exposed surfaces of apple fruit using a temperature gun. Suddenly a gentle breeze of wind blows and cools me down as the sweat evaporates, maintaining my body temperature at a steady 37 °C. I aim my temperature gun at the sun-exposed surface of a Granny Smith apple and it reads 50.1 °C. The surface of the fruit is starting to show the characteristic brown colour of a sunburnt fruit. What causes this? And why is the fruit not able to cool itself down?

As part of my PhD study I wanted to understand why this Granny Smith did not 'sweat' effectively enough to cool itself down. Like many in the apple growing sector, I wondered whether the answer to this question could hold the key to preventing sun damage in apples and its devastating effects on the industry.

Sun damage has been known to destroy up to 40% of the total South African apple yield. This translates into losses of around R500 million annually for the apple growing industry.

Consumers buy fruit based on how it looks. Unblemished fruit fetch high prices in the export market, while those with sun damage can only be sold locally or are only suitable for processing at much lower prices.

Before this study, three things were already known about sun damage in fruit. Firstly, it is normally associated with extreme fruit surface temperature (above 48 °C). Secondly, it is worse when trees are water stressed. Finally, sun damage normally appears in the later part of the season, in mature fruit. These three facts have led to the general assumption that sunburn damage is caused by reduced cooling of the fruit through evaporation, either because less water moves into the fruit from the water stressed tree, or because mature fruit might be less efficient at letting water through the skin.

The research project set out to test

Sunburnt **Granny Smiths** Giverson Mupambi investigated the causes of sun damage on fruit

these assumptions in Granny Smith apples which are highly susceptible to sunburn damage. The study found that as the fruit matured, less water vapour was released by the fruit as the skin of mature fruit was less permeable. Essentially the fruit 'sweated' less as it grew older.

Surprisingly though, this made very little difference to the fruit surface temperature. While the younger apple gave off more water for evaporation than the mature fruit, the amount was never enough to significantly affect the surface temperature of the fruit. In short, apples, unlike humans, do not 'sweat' very effectively.

This means that the link between sun damage, tree water stress and mature fruit has to be re-examined. Whatever the reason for the correlation, it is not the availability of water for evaporation and cooling, or even the amount actually released through the skin.

Though unexpected, this result is important in that it gives new direction to fruit sunburn research. Further research will most likely focus on the possible effects of water stress on the protective responses of the fruit, such as antioxidants within the fruit peel and the ability to re-emit the energy absorbed by chlorophyll molecules, as light, rather than as heat energy.

So I foresee more days in the orchards in Grabouw. There would be some comfort in the fact that unlike the apples around me, my body has a unique ability to keep its temperature constant. But as I brave the heat, I will probably be looking for clues to the fruit's own natural sun screening ability and how this might be reduced in water-stressed trees.

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ost people know the disappointment of biting into a crispy looking apple and ending up with a floury mouthful. Or the resentment when the brightest red tomatoes turn out to be tasteless.

All along the fruit supply chain people are desperate to find an accurate way of predicting the internal quality of fruit. Fruit suppliers are currently as dependent as consumers are on external clues. And while their methods may be more scientific, it still only tells them about the fruit's appearance. An example currently used in the industry is a test to gauge the reflection of light from a fruit surface, and grading apples according to their shine.

Suppliers are only too aware that consumer satisfaction will ultimately depend on qualities such as sweetness, acidity, juiciness and texture, especially if they feel that this is what they were promised.

The dilemma is of course that the only way to be sure how something tastes is to eat it, or at least to open it up and measure its sugar contents or acidity levels. This method, which is indeed used in fruit quality assurance, is time consuming, wasteful and because it relies on samples, still only offers probabilities rather than assurances about the rest of the harvest.

Researchers from the Department of Electrical and Electronic Engineering and the South African Research Chair in Postharvest Technology at Stellenbosch University (SU), are working on an interesting solution to this conundrum. They are developing Magnetic Resonance Imaging (MRI) technology for use in orchards and fruit sorting and grading lines. If successful, the adaptation could transform the fruit growing industry.

MRI is commonly known for its medical application in detecting injury or abnormalities in soft tissue, for example in brain imaging. Up to now it has been too expensive for industrial application. The SU research team hopes to create a low-cost imaging device for fruit that works at much lower magnetic fields.

In its medical application, a patient is placed in a machine that creates a very strong constant magnetic field. The machine works because of the way in which atoms, the smallest parts of any material including human cells, behave when exposed to a constant magnetic field.

The first thing to know about all atom nuclei is that they are magnetically charged themselves. Just like a compass needle that aligns itself to the north and south poles of the earth, the magnetic field produced by atoms will align itself to the direction of the magnetic field of the MRI machine.

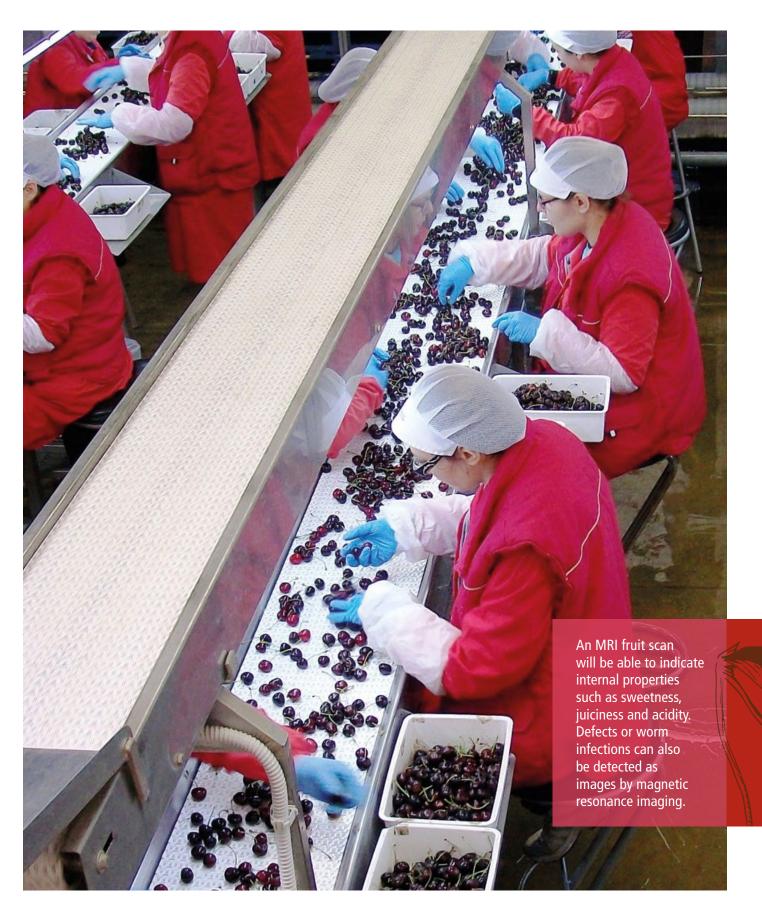
We can thus picture a patient, or a fruit in our case, as a bunch of virtual compass needles all aligning themselves to the larger constant magnetic field of the MRI. But this alignment does not yet tell us anything about the body inside the machine.

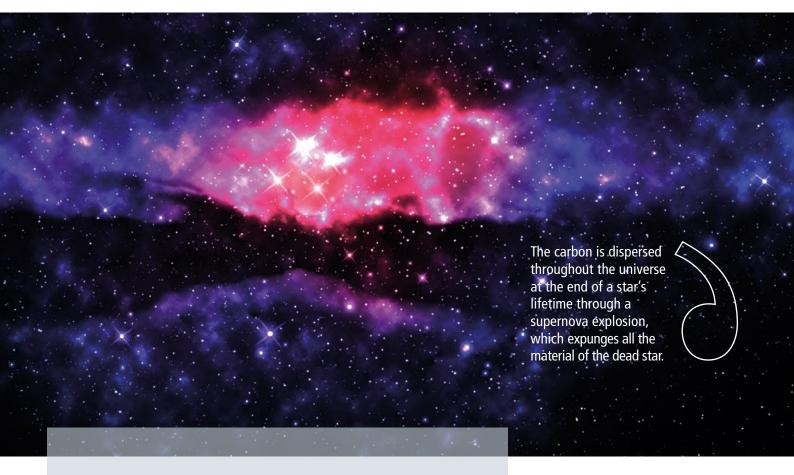
To trigger the measurements of interest, the machine generates a short disturbance to the aligned 'needles' so that the alignment is disrupted. What is measured is their reaction, as they try to line up with the magnetic field after the disturbance. How fast they realign depends on the internal properties the particular tissue that is being examined.

An MRI fruit scan will be able to indicate internal properties such as sweetness, juiciness and acidity. Defects or worm infections can also be detected.

It has been a challenge in the horticultural industry to find low-cost, user-friendly and effective equipment for non-destructively probing the internal quality of fruit and vegetables. Internal quality evaluation is not only necessary for grading and sorting, but also useful to ensure that the fruit is harvested at the appropriate time. This is important because it can prevent defects, like internal browning after harvest, and enhance the ripening process and shelf life of some fruits and vegetables. Internal quality-based non-destructive methods like infra-red spectroscopy are already used for sorting fruits, but this is still an expensive technology. The low-cost, low-field magnetic resonance spectroscopic techniques being developed by Stellenbosch University promises a viable alternative and has the potential to revolutionise quality control in the South African horticultural industry.

Frederic Isingizwe is completing his PhD studies in electronic engineering. He is attached to the Department of Electrical and Electronics in the Faculty of Engineering. 16197054@sun.ac.za or nijef58@gmail.com





WE ARE **STARDUST**

Cobus Swartz explains the significance of carbon

here is no form of life on earth that does not contain the element carbon. Carbon makes up most of our human DNA.

The physicist Fred Hoyle was one of the first to suggest that carbon, the 'element of life', is formed in the dying stages of a star's life. When the star eventually dies, it explodes, sending the carbon into the universe. In other words, that we are quite literally made of stardust.

The formation of carbon through what is now known as a Hoyle state is widely accepted today. However, the dominant thinking in 1954 when Hoyle first described this energy state, was that all the elements in existence, including carbon, were created during the Big Bang. Hoyle argued that there was simply too much carbon in the universe for this to be true. He postulated that

carbon is created through a particular energy state in carbon, which allows three helium nuclei to fuse into carbon. In 1957, this was indeed observed during an experiment at Caltech and today it is widely accepted that the Hoyle state is how most carbon is formed.

This Hoyle state occurs in dying stars. When a star collapses after the hydrogen-burning phase, temperatures and pressures become extreme; high enough that three helium nuclei contain enough energy to form carbon. This is known as the helium-burning phase. The carbon is dispersed throughout the universe at the end of a star's lifetime through a supernova explosion, which expunges all the material of the dead star.

More recently, researchers have discovered another Hoyle-like state which exists at a higher energy state than the Hoyle state and also allows

for three helium nuclei to fuse into carbon. This discovery was made by two separate and independent research groups, one based in Osaka in Japan in 2004, and the other by a research collaboration between researchers from Stellenbosch University, iThemba LABS and the University of Birmingham in 2009. These recent measurements suggest an additional gateway for carbon formation in stars, further explaining the abundance of carbon in the universe.

It is interesting to think that our own sun will one day go through a helium-burning phase and create its own carbon gift to the universe.

We are stardust. Each one of us made from matter which was forged in the fiery furnaces of ancient dying stars, and sent into the universe by their mighty death knells. 🗬

Jacobus Swartz graduated in April 2014 with a PhD in nuclear physics. He is now a postdoctoral research fellow at KU Leuven in Belgium. cobus.swartz@gmail.com

Sharing thoughts on science communication

Participants in the New Voices Programme had the opportunity to develop their science communication skills through workshops, auditions, coaching and lots of practice and rewrites. We asked them to share the highlights of their journey together.



Collium Banda

Full time PhD student in the Department of Systematic Theology and Ecclesiology, Faculty of Theology collium@gmail.com

...gathering of scientific data [becomes] profitable when the findings are communicated to the public in clear, logic and simple terms... It is critical for researchers to develop science communication skills."



Tandeka Magcwebeba

Postdoctoral fellow at the Department of Biochemistry, Faculty of Science tmagcwebeba@sun.ac.za

"The workshops broke the mental barrier that I had of seeing the audience as a group of critics that were ready to crucify me and helped me see them a group of people who are interested to hear about the research that I have done."



Mukani Moyo

Full time PhD student at the Institute for Wine Biotechnology, Faculty of AgriSciences Mukani@sun.ac.za

"New Voices in Science helped me to look at my research through other people's eyes. ... I now consider what impact it has on the 'man on the street'."



Sheillah Simiyu

PhD student at the School of Public Leadership, Faculty of Economics and Management Science

Sheillahshie@gmail.com or 18636209@gmail.com

"Scientists research real issues, which affect real people who live in a real world; yet many of them speak in a scientific language which is not understood by everyone. One way of sharing scientific research is speaking about it ... simply and plainly."



Hans Huyssen

Composer, cellist and conductor, part-time lecturer at UCT, PhD student at SU hans@huvssen.de

"The intelligibility [of research] is not only about explaining to the outside what one is doing, but becomes an important check on one's own grasp and understanding. I have come to realise that good communication is no optional luxury, serving only the outside world. Clear communication makes for better science and art."



Matthew Zylstra

PhD graduate, Department of Conservation Ecology and Entomology, Faculty of AgricSciences matt@earthcollective.net or

mattzylstra@yahoo.com

"To actively communicate one's knowledge is to also share the power of that knowledge. It is my hope that

Matthew Zylstra continued...

with every year that New Voices runs, a growing cohort of scientists may begin to initiate a paradigm shift for rethinking science's role in present-day society."



Nonjabulo Prudence Gule Researcher at the Department of Chemistry and Polymer Science, Faculty of Science njabu@sun.ac.za

"Communicating your science in a way that my own family in rural Swaziland can understand, has been the most fulfilling thing about New Voices. **Developing science communication** skills opens your world to so many possibilities and actually shows you how interesting and necessary your research is."



Frederic Isingizwe

Full time PhD student at the Department of Electrical and Electronic Engineering, Faculty of Engineering nijef58@gmail.com

"I have learned that when presenting, it is all about the audience: the message is to be kept explicitly clear and simple to understand, maybe put in a familiar context, or using stimulating real life examples that keep the audience captivated."



Lorraine Amollo Ambole

Full time PhD student in the School of Public Leadership, SU, and tutorial fellow at the School of the Arts and Design, University of Nairobi amollo.lorraine@gmail.com

"Unfortunately, the days of the ivory tower are numbered! We researchers need to learn how to speak about our research in a way that is understandable, fun and effective. Participating in New Voices taught me so much about how to package my message."



Giverson Mupambi

Full time PhD student at the Department of Horticultural Science, Faculty of AgriSciences giverson@sun.ac.za

"The highlight of the whole process was looking at the finished article and realising how much my creative writing ability came along. I have learned how to engage and communicate with the general public about my work in manner that still stresses the importance of the work but is not too scientific."



Sharon Johnson

Sharon Johnson graduated in December 2013 with a PhD in psychology. She is now Head of the Department of Teaching and Learning at the South African College of Applied Psychology shajohnson@mweb.co.za

"Scientists tend to retire behind their computer screens and not communicate their knowledge, not realising that the world will benefit from their talents and hard work. It is important to put yourself out there to not only spread the importance of your work, but to develop your own confidence and skills."



Britt Drögemöller

Full time postdoctoral fellow at the Department of Genetics, Faculty of Science brittdrogemoller@gmail.com

"New Voices [taught me] how to simplify my research in a way that is accessible to a larger audience. Along the way, I learnt the importance of connecting with my audience and relaxing while sharing my work with others. In addition ... I was allowed the opportunity to network with some bright young researchers."



Carla Dukas

Clinical psychologist (PhD) and manager of Welgevallen Community Psychology Clinic at Stellenbosch University carladukas@sun.ac.za

"New Voices ... helped me to talk more confidently about my research topic and to do so in ways that were interesting to people from a variety of different social and professional fields. This was wonderfully demonstrated by the amount of audience participation and questions I received at the public presentation event."



Sara Andreotti

Full time PhD student at the Department of Botany and Zoology, Faculty of Science andreottisara@gmail.com

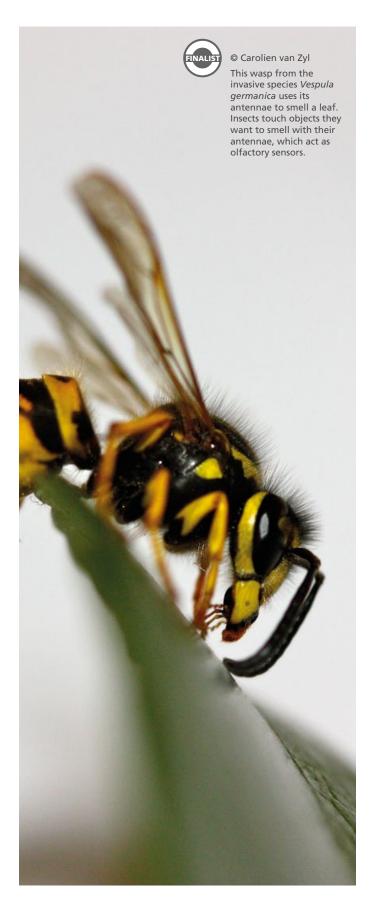
"I was glad to have the opportunity to meet PhD students from other faculties and to gain insight in the different approaches to science from the other fields. By only interacting with scientists in the same field, we tend to fail miserably when trying to communicate our science."



Natalie Theron

Full time student at the Department of Conservation Ecology and Entomology, Faculty of AgriSciences natz@sun.ac.za

"After New Voices I realised just how important science communication is, not just for my research, but for me as student and researcher. I would encourage all PhD students to take part in New Voices and even all academics to develop their science communication skills. Just do it, you have nothing to lose but loads to gain."



The 2014 New Voices in Science competition introduced a science photography category. Researchers could submit photographs that captured something meaningful, beautiful or exciting about their science subjects, their science practice or the role of science in society. Here are the finalists and winner of this year's competition.

A selection from our winner...









WINNER Sara Andreotti

The amazing photographs accompanying her article on pages 20 and 21 were also taken by her.

Full time PhD student at the Department of Botany and Zoology, Faculty of Science. Sara Andreotti was the winner in the photography competition.

andreottisara@gmail.com



A selection from our finalists...



Carolien van Zyl **Finalist**

An adult wasp Polistes dominula regurgitates nectar to feed its larvae. Polistes dominula is an invasive wasp species.

Full time student at the Department of Conservation Ecology and Entomology, Faculty of AgriSciences

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Matthew Zylstra Finalist

Matt's 'Child and Mantis' was chosen as our front page picture for this publication. It beautifully captures the observer and the observed, while the relationship and power dynamics between these two remain open to interpretation.

Graduated April 2014 from the Department of Conservation Ecology and Entomology, Faculty of AgriSciences.

matt@earthcollective.net

Natalie Theron Finalist

Natalie's pictures often focus on the tiny details in our natural surrounds. Given her research subject, this comes as no surprise. Can you spot the mite hiding in the protea, above?

Full time student at the Department of Conservation Ecology and Entomology in the Faculty of AgriSciences.

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