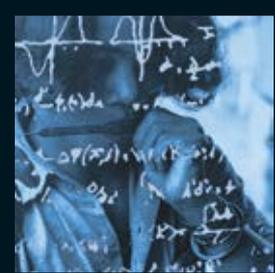


asia research news 2016

A ResearchSEA publication to highlight research in Asia

Beyond the Milky Way: finding exploding stars



MATHEMATICS PRESERVES
INDIGENOUS MUSIC

CELL FUSION IMPROVES
AGRICULTURE

WHISKERS INSPIRE
NAVIGATION TECHNOLOGY

MAPPING DEFECTS
IN SUPERMATERIALS

Harness the power of



Credit: (Background Image) Warakorn Harmpasop*



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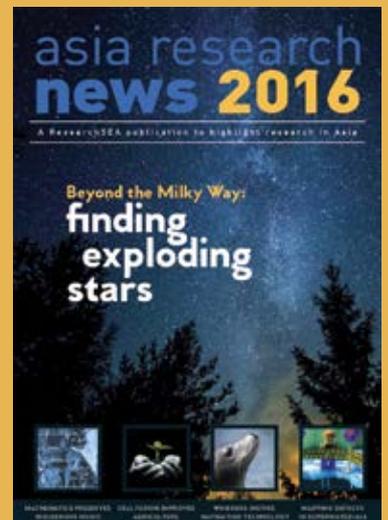
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Richard Stone oversees Science magazine's international news coverage. The two-time Fulbright Scholar opened Science's Asia

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Welcome to the 2016 edition of Asia Research News.

In the 8th issue of our magazine, Asia Research News highlights compelling research by our partner institutions and those working with partners in Asia. From fluorescent quantum dots that show where drugs end up in cells to the detection of exploding stars from beyond our Milky Way, this issue showcases exciting discoveries across a broad range of scientific disciplines.

Our people section profiles, among other things, efforts underway to help governments avoid the creation of digital sweatshops, bring sexual violence out of the shadows in South Asia, eliminate child labour in Burma, and explore the diversity of burial practices over the past 10,000 years in the Philippines.

In our technology, materials and energy pages, read about singalong software that can improve the quality of anyone's voice, graphene-based nanolubricants, a super glue that forms strong bonds in response to an electric current, efforts to turn sewage sludge into concrete, and a system for capturing the heat lost from industrial processes.

Our climate change and environment sections discuss how global warming could affect Asian coastlines, whether a Malaysian carbon tax could pave the way toward a more sustainable energy future, the use of remote sensing data for mangrove conservation, and how a newly discovered ant species gangs up on insects that are ten times larger.

How can nanotechnology extend the shelf life of fresh fruit? How do plants ensure the success of fertilisation? And can Japanese researchers grow sweeter tomatoes? Find out more in our food section.

Finally, our health section highlights many recent breakthroughs including advances in the delivery of anticancer drugs, a bacteria-repelling biomaterial that could increase the success of medical implants, a non-invasive method for diagnosing fetal abnormalities, and a link between digestive infections and the severity of Parkinson's symptoms.

Happy reading and we welcome your feedback. If you have exciting research to share, please contact Magdeline Pokar at m.pokar@researchsea.com.



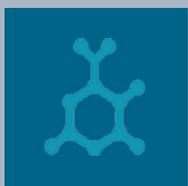
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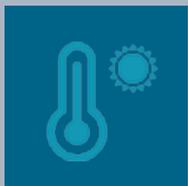
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REACHING OUT TO STARS BEYOND OUR GALAXY

Schematic of the
Super-Kamiokande,
Japan's largest
neutrino detector.



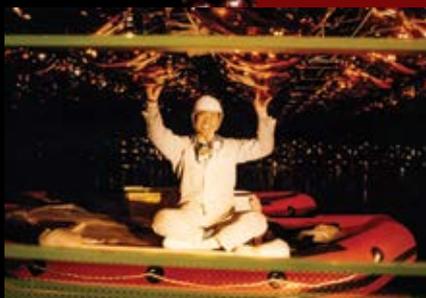
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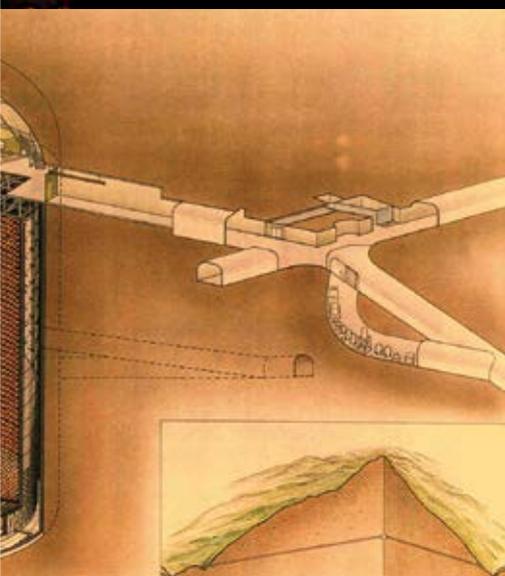
Did you know?

Super-Kamiokande is a gigantic detector located one kilometre beneath Mount Ikenoyama, inside an old mining tunnel in Kamioka, central Japan. The pure water inside the giant 50,000-ton tank acts as a target for a range of particles being studied today including neutrinos, leftover particles from supernovae, resulting in a tiny light flash that is picked up by sensitive phototubes lining the walls. In 1987, Kamiokande, the original experiment in the same mine, recorded the first supernova neutrinos. The experiment was headed by University of Tokyo special university professor emeritus Masatoshi Koshihira, who was awarded a Nobel Prize in Physics in 2002. In 1998, Kamiokande and Super-Kamiokande proved neutrinos have mass, resulting in the 2015 Nobel Prize in Physics for Takaaki Kajita, who had been a graduate student of Dr Koshihira.

**Professor
Takaaki
Kajita**



Credit: Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo



An international team of researchers in Japan is getting ready to power up a 50,000-ton neutrino detector by adding a single metal, which will turn it into the world's first detector capable of analysing exploding stars beyond the immediate neighbourhood of the Milky Way.

Neutrinos are relics from supernovae, or exploding stars. They are so tiny and interact so weakly that every second, trillions of them manage to pass through human bodies without anyone noticing. Studying them can reveal details about how stars in the universe, like our sun, work.

The problem is that all supernova neutrinos that have been detected to-date have come from the immediate vicinity of our galaxy. No one knows whether neutrinos from older galaxies far outside ours act the same way as neutrinos close to Earth, or whether there is a completely new class of tiny particles yet to be discovered.

Experimental physicist Mark Vagins of the Kavli Institute for the Physics and Mathematics of the Universe and Ohio State University theorist John Beacom wanted to see if it were possible to improve Japan's largest neutrino detector, Super-Kamiokande. One of their ideas was to add the rare-earth metal gadolinium to the detector's water tank, taking advantage of the gadolinium nuclei's ability to capture neutrons. If a neutron released from a neutrino interaction were nearby, it would be absorbed by the gadolinium, which would release the extra energy by creating a flash of

light: a signal that could be detected by the equipment. But before any tests could be run, the two researchers needed to find out if their idea made scientific sense and predict what complications they might need to overcome.

First, water inside the detector would need to be transparent. Neutrinos interact with water, creating tiny flashes of light that are picked up by the photomultiplier tubes lining the walls of the tank. If gadolinium made the water murky, it would prevent the phototubes from detecting any light.

Second, the gadolinium needed to be uniformly spread within the tank so it could be close enough to a neutrino-water interaction to magnify its signal.

"These two criteria, uniformity and transparency, mean the gadolinium must be induced to dissolve," says Dr Vagins. "We've spent over ten years figuring out how to do it."

In July 2015, Dr Vagins announced at an international conference in Tokyo that he had developed the necessary technology and will now start plans to enrich Super-Kamiokande with gadolinium.

Gadolinium is a by-product of the extraction of other rare earth metals, some of which are used to produce the colours in flat-screen TVs. This makes gadolinium affordable so that Dr Vagins and his team will be able to purchase the 100 tons needed to help Super-Kamiokande detect neutrinos from distant supernovae.

The latest results from an underground detector in Japan looking for dark matter have reignited the debate about its identity.

No one has ever seen dark matter. But scientists know it exists because, by doing the math, they have found there is a larger than expected amount of gravity keeping the universe and everything inside it together. The most likely explanation is the existence of invisible matter that has not yet been detected.

Yoichiro Suzuki, a principal investigator at the Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU), has led the development and use of XMASS (xenon detector for weakly interacting massive particles). This is one of a handful of detectors in the world built to detect weakly interacting massive particle (WIMP) signals, a popular theoretical notion that predicts the nature of dark matter.

UNCOVERING DARK MATTER IS POSSIBLE, BUT NOT SIMPLE

XMASS is able to collect highly accurate statistical data. It is unique because it is the first dark matter detector to be placed inside a water tank, where water acts as a shield against subatomic particles such as high-energy muons and other interferences from the atmosphere. If a WIMP collides with atomic nuclei inside the 800-kilogram liquid xenon detector, its interaction is picked up by XMASS as a signal.

"Using different technology than other xenon detectors, XMASS may see signals that other experiments cannot observe," says Dr Suzuki.

In September 2015, XMASS researchers announced their latest results after 16 months of recording data. Their findings did not produce convincing evidence in line with another underground project, the DAMA-LIBRA experiment in Italy, which claimed it had discovered dark matter. Previously, DAMA-LIBRA researchers announced they had found evidence of annual modulation: seasonal fluctuations in dark matter signals as the earth moves through a band of dark matter particles while circling the sun.

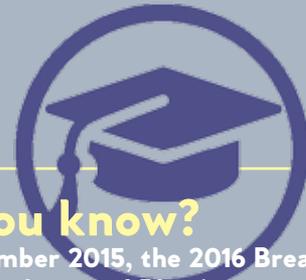
While XMASS found a weak modulation effect, the team says the result could be explained by background fluctuation. But no one will know for certain what these fluctuations actually represent until more data is taken.

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Did you know?

In November 2015, the 2016 Breakthrough Prize in Fundamental Physics was awarded to seven scientists representing five neutrino research projects around the world, including Kavli IPMU Project Professor Yoichiro Suzuki and the 2015 Nobel Laureate and Institute for Cosmic Ray Research Director Takaaki Kajita. These two have worked together as members of the Super-Kamiokande research team.



Did you know?

XMASS is an 800kg dark matter detector located one kilometre inside an old mine at the University of Tokyo's Kamioka Observatory in central Japan. Its isolated location keeps out cosmic rays, which create too much noise for researchers trying to see the liquid xenon inside the detector interact with WIMPs. The XMASS project is a collaboration between 12 institutions in Japan and Korea. It is currently operated by the University of Tokyo Institute for Cosmic Ray Research.

DECODING LIGHT FOR CLUES ABOUT DARK MATTER

An international team of researchers is developing an instrument that will decode the light of the night sky to understand the nature of dark matter.

The Prime Focus Spectrograph (PFS), which will be mounted on the 8.2-metre Subaru Telescope in Hawaii, splits up the light from celestial objects, such as stars and galaxies, into various wavelengths. The emerging data set is called a "spectrum". From this, scientists can obtain clues of any celestial object's motion.

This is important to scientists because dark matter, the mysterious force keeping our universe together, affects the direction and speed at which stars move. By looking at how a million stars move, scientists can create a map of where dark matter is and how it behaves. The project is an initiative of the Kavli Institute for the Physics and Mathematics of the Universe.

While conventional spectroscopy techniques can only observe a handful of objects at one time, PFS will make it possible to collect spectra from up to 2,400 objects at the same time. This will effectively make a "census" of the universe much more quickly than before, and will be crucial for any measurements and analyses needing large statistics.

Although spectroscopy has been used since Newton's days to study the characteristics of stars and galaxies, PFS will be able to analyse a large amount of light in the night sky collected by the Subaru Telescope's 8.2m primary mirror, enabling scientists to look at the universe in great depth. Subaru will also be able to make sharp images of objects more than ten billion light years away, adding to the amount of information PFS can provide.

Sub-components and sub-systems of the PFS instrument are now being built, assembled and tested in the U.S., France, Brazil and Taiwan. They will be shipped to the Subaru Telescope in Hawaii by 2018. After the system integration and tests on the telescope, the PFS is expected to be ready for science operations in 2019.

The Prime Focus Spectrograph will be mounted on the 8.2-metre Subaru Telescope in Hawaii.

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Credit: Kavli IPMU, NAOJ, Studio LINDA

PRESERVING INDIGENOUS MUSIC WITH MATHEMATICS

Mathematical algorithms may soon help to analyse, organise, understand and sift through large collections of indigenous Philippine music.

Researchers from the University of the Philippines Diliman (UPD) are sifting through digital audio tracks of ethnic Philippine music, using and further developing their algorithms to isolate voice, percussion and instruments from each other.

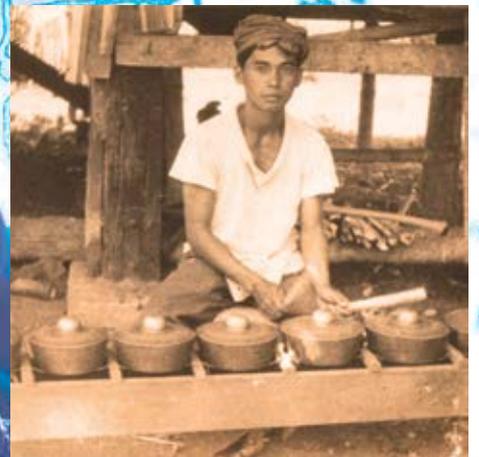
They hope their pioneering research will lay the groundwork for the preservation of Philippine indigenous music, which has been losing listeners and contributors for years.

The project is a collaboration between researchers from the Center of Ethnomusicology and the Electrical and Electronics Engineering Institute at UPD.

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This research could help lay the groundwork for the preservation of Philippine indigenous music.

Led by a feminist network based in India, researchers and advocates across South Asia are building the case for new legal and medical responses to sexual violence, while empowering victims to speak out.

For countries in South Asia that have endured conflict, acknowledging the violence and the suffering of victims is an important step in overcoming past grievances. Yet the blight of sexual violence in the region remains taboo, limiting restitution for victims and allowing perpetrators to avoid punishment.

With support from Canada's International Development Research Centre (IDRC), researchers and advocates in five countries – Bangladesh, India, Nepal, Pakistan and Sri Lanka – have made important strides toward ending the silence and impunity that surrounds the issue.

Led by Zubaan, a feminist network based in India, researchers have helped to build the case for new legal and medical responses to sexual violence, while empowering victims to speak out. The project has generated more than 50 research papers, two books and extensive media coverage. At the same time, it is building a new cadre of young researchers and activists who can play a meaningful role in the dialogue on peace and justice in South Asia so that these hidden

crimes are acknowledged. More than 85% of the several dozen researchers involved are under 40.

In India, team members provided crucial inputs to the Justice Verma Committee Report on Amendments to Criminal Law, a review process launched after a vicious gang rape and murder in Delhi in 2012. Among its recommendations, the report proposed expanding the definitions of rape and sexual assault; removing, for example, an exemption that prevented prosecution for rape within marriage. It called for domestic workers to be covered by new legislation on sexual harassment in the workplace, stiffer punishment for acid attacks and compensation for victims.

In one crucial area in particular, the team's work with the committee has translated into new legislation that will strengthen the prosecution of sexual assault and harassment. Research on medical and forensic protocols has fed directly into new guidelines issued in March 2014 by the Ministry of Health and Family Welfare. These guidelines aim to reduce the trauma for victims, while increasing the likelihood that vital and usable criminal evidence will be collected. The new measures – which the World Health Organization has lauded as “a positive way forward [...] providing empathetic support and rebuilding lives after assault” – have been widely shared and are now a touchstone for other countries in South Asia.

Another partner in the research effort, the Bangladesh Legal Aid and Services Trust (BLAST), successfully petitioned the Supreme Court of Bangladesh to urge the adoption of standardised protocols to deal with victims and survivors of sexual violence. BLAST is now working with a subcommittee that has been commissioned to draft guidelines.

BRINGING SEXUAL VIOLENCE OUT OF THE SHADOWS



Ahmedabad, India

Overall, the research points to essential transformations needed to end the silence on sexual violence including:

- **Identifying sexual assault as a major problem and an impediment to development.**
- **Making it visible through the media and in public discourse.**
- **Ensuring reasonable provisions in the law to protect women.**

Over the next year, efforts will focus on making research findings more visible, with a series of briefs, media outreach, four more books, and other publications and events planned. As the team takes aim against the culture of impunity, it will ensure sexual violence is high on the agenda as regional policymakers work toward post-conflict transitions in South Asia.

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CONNECTING WOMEN ENTREPRENEURS TO GLOBAL OPPORTUNITIES

Mumbai, India



Credit: Steve Evans/flickr

In India, a non-profit organisation is enhancing the links between women-owned businesses and global supply chains. The aim is to eventually roll out a data platform that serves and promotes women entrepreneurs from 17 other countries.

Across South Asia, women are far less likely to be employed than men, with less than a third of women holding or looking for a job, compared with 80% of men. According to the International Labour Organization, women's labour force participation rates in India actually declined in recent years, from about 37% in 2004-05 to 31% seven years later.

As in many developing countries, Indians who are employed are more likely to work in the informal sector, where income is low and benefits and protections scarcely exist. Empowering more women to succeed as entrepreneurs is one way to address the persistent gender gap in employment and incomes.

WEConnect International is a non-profit organisation that connects women-owned businesses with international buyers, tapping a growing number of multinational firms that have committed to using their purchasing power to support women's economic empowerment. The organisation has already played a key role in promoting women entrepreneurs in nearly 20 major markets. In India, it identifies, educates, registers and certifies enterprises that are at least 51% owned, managed and controlled by one or more women. WEConnect provides direct support to small businesses operated by women through its eNetwork, outreach events, training, networking and mentoring.

"There are so many opportunities for women entrepreneurs and business owners around the world," says

Elizabeth Vazquez, CEO and co-founder of WEConnect, "if only we can find these women and give them access to knowledge and the networks to expand their businesses from a start-up in the informal sector into something where they can create jobs for others and for their communities."

To strengthen WEConnect's data gathering and analysis on female-owned enterprises in India, Canada's International Development Research Centre is supporting the organisation's efforts to enhance women's links to global supply chains. In a pilot initiative, WEConnect will strengthen its global brokering model with a searchable database, initially serving more than 500 micro- to medium-sized businesses in India, owned and managed by women. The IDRC support "will help build the ecosystem that women-owned businesses require for sustainable and inclusive growth," Vazquez says. The aim is to eventually roll out a data platform that serves and promotes women entrepreneurs from 17 other countries.

Besides generating opportunities for women entrepreneurs, the project will produce new data and knowledge about women's economic empowerment and women's business growth in India. It will strengthen research capacities, foster peer exchange, and build a supply chain brokerage model that empowers women and can be duplicated around the world.

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Researchers in Burma are working with representatives from government, civil society and the private sector to find solutions for eliminating child labour and introducing other overdue labour reforms.

Burma, one of Asia's least developed countries, has undergone a dramatic series of political and economic shifts since the end of military rule in 2011. The country has recently introduced a range of labour market reforms as it attempts to tackle poverty and spur growth by expanding its manufacturing sector and attracting foreign investment.

Reforms are long overdue for Burmese workers. For decades, the country was known for its human rights abuses, including forced labour and human trafficking. The reform process, intended to pave the way for unions, new minimum wage rules and social security measures, has been slow and contentious. But two years after the government set up a joint committee to review minimum wages, a new minimum wage — set at K3600 (US\$2.80) — came into effect on September 1, 2015.

New research on labour market reforms led by Burma's Centre for Economic and Social Development (CESD) aims to help the country navigate its difficult transition toward greater prosperity and openness. A key challenge will be to balance improvements in wages and working conditions against industry's need to retain a competitive edge.

According to Zaw Oo, executive director of CESD, Burma's economy can only avoid a low-wage trap by enhancing skills and productivity hand-in-hand with better working conditions. "We are trying to ensure workers and employers have a more constructive relationship and work with government to improve skills, productivity and management practices so that we are not bound to low-end manufacturing in the textile and garment sector, but can move up the value chain to more advanced production."

Working with representatives from government, civil society and the private sector, researchers will survey employers and employees in labour-intensive industries. This will provide a foundation for analysing the needs and drivers behind productivity, social security and wages. The team is also reviewing labour-related laws and regulations, and available labour market data. The project aims to provide Burma's decision-makers with evidence to inform ongoing reforms. It also hopes to strengthen Burmese capacities, giving national researchers international exposure and providing training to help government officials apply evidence in weighing policy options.

Child labour remains rampant in Burma. According to the 2014 Maplecroft Child Labour Index, Burma ranked third out of 197 countries for the prevalence of child labour. Poverty and the need to contribute to family income force children as young as 12 into the workforce, and only half of all students progress to secondary school. Not only does child labour violate children's rights and undermine the development of human capital, it also risks the reputation of Burmese industries within global supply chains.

GETTING IT RIGHT ON LABOUR REFORMS IN BURMA

Business for Social Responsibility (BSR), a global non-profit network, has found that international garment sector buyers in other countries can play a significant role in eradicating child labour. Given that Burma's garment sector is small but growing, the country has a unique opportunity to address the challenge of eradicating child

labour head-on, rather than face possible boycotts down the road. To date, BSR Hong Kong has convened a group of responsible brands seeking to tackle child labour through the Myanmar Responsible Sourcing Working Group.

With support from Canada's International Development Research Centre, BSR is now conducting research that will strengthen the search for collaborative solutions. In 2016, it will develop and share a research brief for Burmese and international audiences and a report mapping organisations that

can help eradicate child labour. The brief will identify next steps for tackling the challenge at the factory level and among civil society groups, helping them advocate for measures to keep Burma's children in school.



Intha women on the move for work in Burma's Nyaung Shwe town, Shan state.

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An international research team is investigating who benefits from the globalisation of online work, hoping to identify how government policies can help to avoid the creation of digital sweatshops.

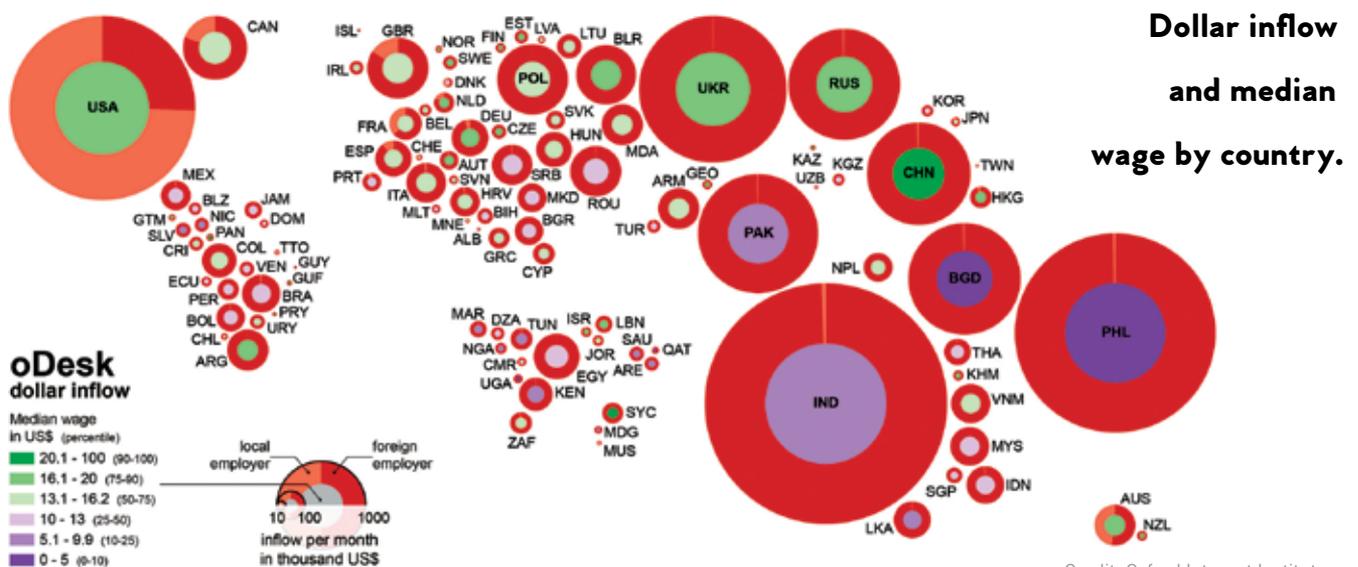
EXPLORING THE GLOBAL FLOW OF DIGITAL LABOUR

Just as online platforms such as Facebook and Twitter have rewired our social connections, a wave of digital service platforms is transforming the world of

possible ways that government policies might help youth and other vulnerable groups to benefit.

The research involves analysing data from leading microwork businesses, surveys of 2,000 contract service providers, and interviews with hundreds of digital freelancers. In South-East Asia, fieldwork is taking place in Malaysia, the Philippines and Vietnam.

Initial analysis of six months of data from oDesk – one of the world's largest microwork platforms with 4.5 million registered workers, and now part of Upwork – reveals the geographic divide. The bulk of demand for online labour is coming from wealthy countries, with most of the work carried out in low-income countries. Among



work. Through websites such as Upwork and Freelancer, service providers and buyers are connecting across the planet, negotiating millions of small contracts. This competitive “microwork” market covers pretty much any discrete task that can be done via the Internet, such as medical transcription, copywriting, web design and moderating social media sites.

In theory, microwork offers a wealth of opportunity for people in low-income regions. Countries such as India and the Philippines have already seen tremendous growth in the virtual service economy. But with no guaranteed hours or wages and few social protections, digital workers have little security. And as more and more companies turn to virtual outsourcing, stable jobs may disappear to be replaced by freelance contracts awarded to the lowest bidder.

“Is this a way to address unemployment in big swathes of the world or is it just creating digital sweatshops?” asks Mark Graham, a researcher and professor at the Oxford Internet Institute (OII). In partnership with a team from the University of Pretoria in South Africa, Dr Graham and colleagues at OII are leading a three-year study, supported by Canada’s International Development Research Centre, to look at how virtual production networks in Africa and South-East Asia are structured. They are examining who benefits, how they benefit, and

the 20 countries with the highest labour demand, only Malaysia (ranked 15th) and India (ranked 19th) are low income. Labour “sellers,” on the other hand, are mainly in emerging economies, with India and the Philippines providing much of the microwork sourced through oDesk. Wages also differ widely from North to South.

“The issue is not just a global race to the bottom, which in some ways seems to be occurring, but that there are different price floors for wages in different parts of the world and wage penalties associated with being affiliated with some countries,” says Dr Graham.

The team now aims to address many of the questions raised by its initial mappings, including what lies behind these patterns in the flow and compensation for digital work. Findings will ultimately be available through journal articles and an open data platform, and will feed into debates on what protections and rewards workers might expect in a fast-evolving digital labour market.

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**A filed incisor
found at
Pasimbahan Cave**



Excavators from the University of the Philippines recover bone fragments.

EXPLORING THE PREHISTORY OF PALAWAN ISLAND THROUGH HUMAN REMAINS

Researchers are excavating human remains from caves in Palawan Island in the Philippines to learn more about the diversity of burial and other cultural practices over the past 10,000 years.

Since 2004, archaeologists from the University of the Philippines Diliman (UPD) have systematically excavated and processed human remains from caves in northern Palawan Province. So far, this work has yielded numerous human skeletal materials ranging in age from the late Palaeolithic (9,000 Before Present), through the Neolithic (~4,000 BP) and Metal Periods (~1,000 BP), to the late millennium.

Skeletal remains have been found in diverse burial modes. Human skeletons from the late millennium were buried as whole bodies, lying on their backs and directed towards the cave mouth. Remains from the Metal Periods were found dispersed within a layer, possibly because of disturbances by subsequent burials or re-burying performed at later stages. However, two complete skeletons dating to the Neolithic were found covered with large rocks.

The remains found at the late Palaeolithic level were cremated and deposited as piles of bone fragments, says project leader Victor J. Paz of UPD's Archaeological Studies Program.

Next on the team's agenda is to describe the human remains in more detail, including age-at-death, sex, disease, cultural modifications (such as intentional changes in the skeleton or dentition) and other parameters. "Describing these variables will help us understand the diversity of mortuary practices," says Dr Paz. This research will also provide data for comparison with findings from other archaeological sites in South-East Asia, thereby contributing to an understanding of cultural diffusion within the region.

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A researcher at the University of the Philippines Diliman (UPD) is studying the ancient Japanese culture of “ama” — women who traditionally free-dive in the sea in search of seaweed, lobsters, snail “turbo” shells and, in the distant past, pearls — and its potential connections to Philippine maritime cultures.

Cynthia Neri Zayas from the Center for International Studies at UPD is exploring the ten-year diary of a contemporary Japanese ama named Yamashita-san, who lives in the village of Goza in south-western Japan.

Still in the first phases of her work, Professor Zayas has found several similarities between Japan’s ama culture and the Philippines’ fishing culture. Families in both cultures tend to be led by a matriarch who plays a



Credit: Itoh Mutsuko

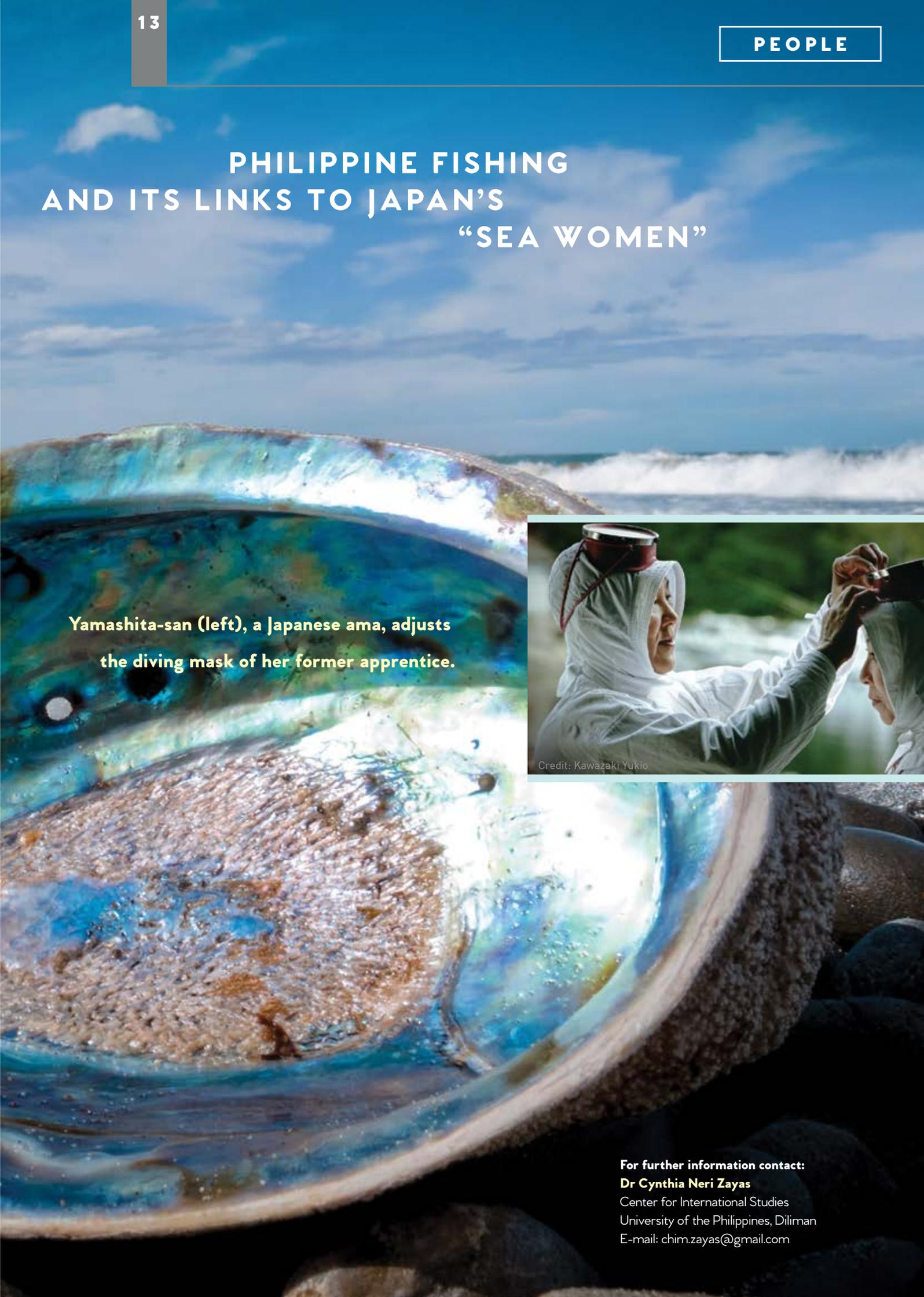
Warming up before a dive.

significant role in supporting the family’s livelihood. Japan’s sea women and Philippine fishers also tend to wander on a seasonal basis to find work away from home. Both cultures give prominence to the shells of “abalones”; a kind of sea snail. The Japanese use them for offerings and in the Philippines they are used as good luck charms.

Dr Zayas also found a connection between the architecture of the Ise Shrine in Japan, which is strongly linked to the ama culture and is built on top of pillars, and traditional raised homes along the coasts of the Philippines.

Dr Zayas hopes her work will add to efforts calling for the ama culture to be listed in the registry of UNESCO World Heritage.

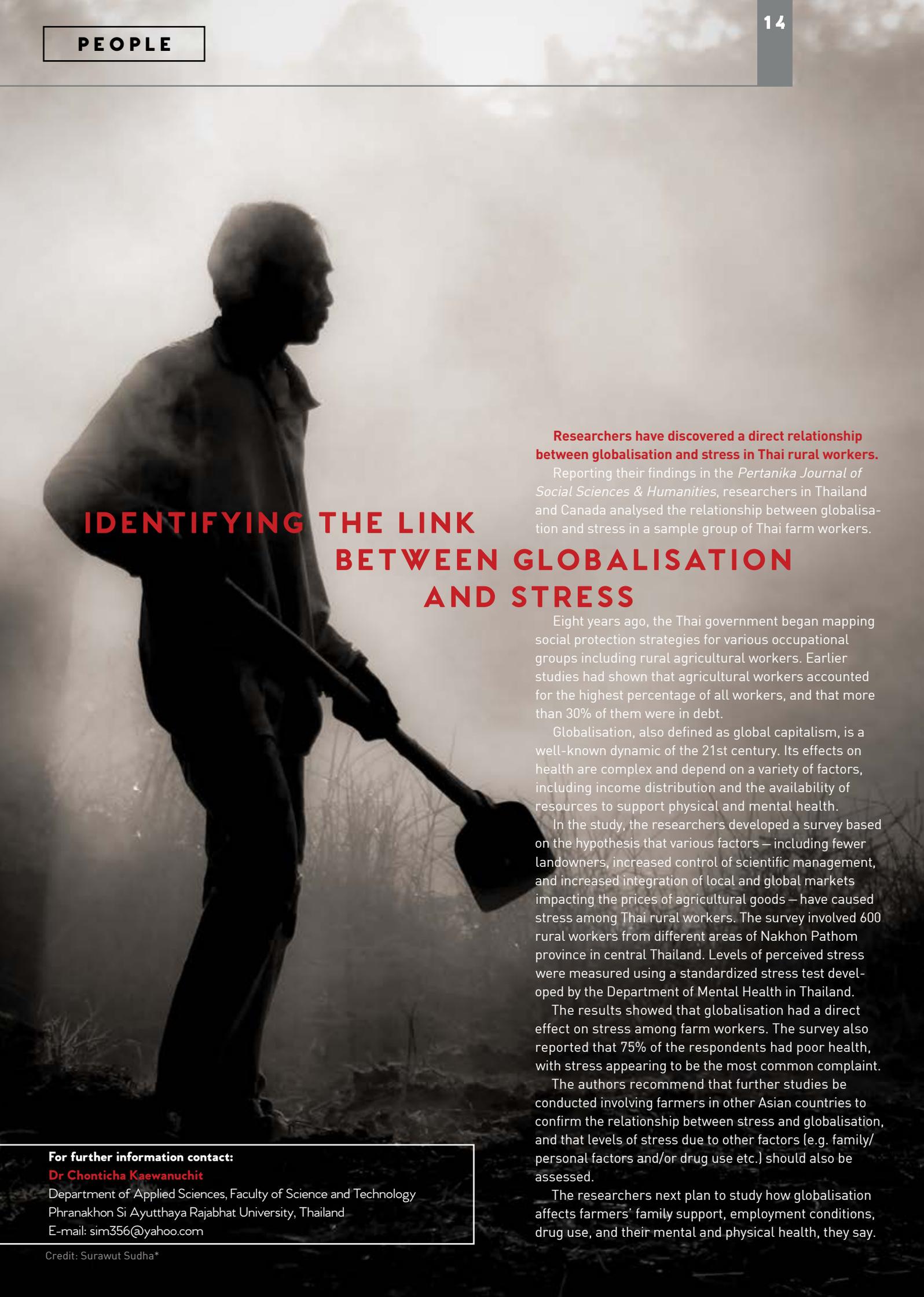
PHILIPPINE FISHING AND ITS LINKS TO JAPAN'S “SEA WOMEN”



Yamashita-san (left), a Japanese ama, adjusts the diving mask of her former apprentice.



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IDENTIFYING THE LINK BETWEEN GLOBALISATION AND STRESS

Researchers have discovered a direct relationship between globalisation and stress in Thai rural workers.

Reporting their findings in the *Pertanika Journal of Social Sciences & Humanities*, researchers in Thailand and Canada analysed the relationship between globalisation and stress in a sample group of Thai farm workers.

Eight years ago, the Thai government began mapping social protection strategies for various occupational groups including rural agricultural workers. Earlier studies had shown that agricultural workers accounted for the highest percentage of all workers, and that more than 30% of them were in debt.

Globalisation, also defined as global capitalism, is a well-known dynamic of the 21st century. Its effects on health are complex and depend on a variety of factors, including income distribution and the availability of resources to support physical and mental health.

In the study, the researchers developed a survey based on the hypothesis that various factors – including fewer landowners, increased control of scientific management, and increased integration of local and global markets impacting the prices of agricultural goods – have caused stress among Thai rural workers. The survey involved 600 rural workers from different areas of Nakhon Pathom province in central Thailand. Levels of perceived stress were measured using a standardized stress test developed by the Department of Mental Health in Thailand.

The results showed that globalisation had a direct effect on stress among farm workers. The survey also reported that 75% of the respondents had poor health, with stress appearing to be the most common complaint.

The authors recommend that further studies be conducted involving farmers in other Asian countries to confirm the relationship between stress and globalisation, and that levels of stress due to other factors (e.g. family/personal factors and/or drug use etc.) should also be assessed.

The researchers next plan to study how globalisation affects farmers' family support, employment conditions, drug use, and their mental and physical health, they say.

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Loving-kindness meditation, which aims to foster acceptance of oneself and others, involves repeated recitation of well-wishing phrases.

COMPASSION MEDITATION ENHANCES QUALITY-OF-LIFE PERCEPTIONS

An international research team has found that meditating could promote psychological well-being in young adults.

People are usually consistent in the way they perceive the quality of their lives – their subjective well-being – at any particular moment in time. Theorists suggest a probable substantial genetic basis to the way this happens. Research has often looked at how subjective well-being is influenced by personality and environment, but little is known about the efficacy of interventions to enhance it.

A team of researchers in Malaysia, the U.K. and the U.S. have found that a kind of meditation, called loving-kindness meditation, enhances psychological well-being by eliciting positive emotional responses in young adults.

Loving-kindness meditation aims to foster acceptance of oneself and others and involves repeated recitation of well-wishing phrases like, “May I (or someone else) be happy.”

The researchers, led by Dr Ahmed Dahir Mohamed, a neuroscientist at The University of Nottingham Malaysia Campus, asked 30 young, healthy and “neurologically typical” adults (i.e. those with no known neurological disorder) who were new to meditation and mindfulness training to practice loving-kindness meditation for 20 minutes a day for two weeks. The team asked participants to respond to five types of questionnaires on the first and last days of the training period to see if there were significant differences between their pre- and post-meditation scores.

The results showed a significant increase in the participants’ subjective reports of mindfulness, happiness, hopefulness and gratitude. The outcomes support previous studies that suggest short-term loving-kindness

meditation training has positive effects on young adults. However, in order to rule out the possibility that these positive effects were due to other experiment-related factors, the researchers recommend future studies should use control groups, such as a relaxation control group.

Dr Mohamed and his colleagues think that practicing loving-kindness meditation for longer periods might enable young adults to build their own positive psychological well-being and to extend these effects to others. Ultimately, it could help promote social interactions that further strengthen subjective well-being.

The team recommends future research should investigate the effects of loving-kindness meditation on the neurological system and if internal changes are related to subjective reports of positive emotions. Research should also investigate whether this form of meditation can affect different patient groups, as some reports suggest that subjective well-being could be associated with reductions in stress-related cortisol responses.

Dr Mohamed and his colleagues are now using electroencephalography measures to understand the relationship between brain changes due to meditation and the significant increase in the participants’ subjective well-being reports.

The results showed a significant increase in the participants’ subjective reports of mindfulness, happiness, hopefulness and gratitude.

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Researchers in Singapore are using “nanoantennae” to manipulate light beams. This may open the door to the development of new light-based technologies.

Complete control of some of the key properties of light waves — namely their polarisation and phase — at the nanoscale is of major interest for light-based technologies such as display screens, and in energy harvesting and data transmission. It would allow, for example, the miniaturization of traditional optical components, such as lenses, polarizers or beam-splitters, to nanoscale sizes. At the same time, it could dramatically increase their performance and resolution.

A novel approach to control the propagation of light at the nanoscale involves the use of so-called metasurfaces. A metasurface is a two-dimensional arrangement of nanosized particles called nanoantennae. Their geometries and material properties are cleverly designed to interact with light in a determined way. By engineering such metasurfaces, it is possible to modify the overall path of the light and, for example, make it bend or focus



Did you know?

The polarisation of light refers to the orientation of the electric field in a light wave, while the phase of light refers to the specific state of a light wave.

record efficiencies of about 50%: a level that could be further increased by optimising the system.

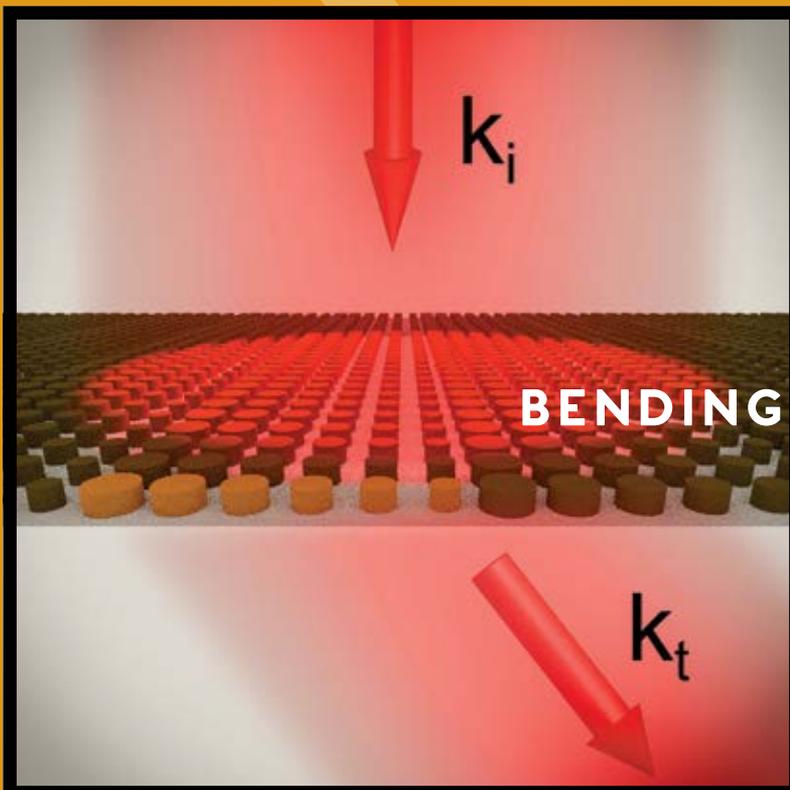
When metals were used to design nanoantennae, they caused strong reflections of light making them unsuitable for devices that transmit data. Heating induced in the metals also resulted in additional losses in the device, a serious drawback for real-world applications that require high efficiency. Silicon, as a semiconducting material, overcomes these issues, the A*STAR researchers found.

BENDING LIGHT WITH SILICON NANOPARTICLES

While the team’s future research will focus on creating switchable or reconfigurable devices, together with new materials in different spectral regions, the technological challenge will be to develop fully viable ultra-flat optical devices for commercial uses.

at a certain point of space, similar to what conventional prisms or lenses do. In the case of metasurfaces, this happens at distances that are 1,000 times smaller than the diameter of a human hair.

Researchers at the Agency for Science, Technology and Research (A*STAR) in Singapore have demonstrated that using silicon nanoparticles as nanoantennae, in place of metals used in previous research, allows full control of an incoming light beam while keeping it essentially transparent, allowing transmission rates above 85%. By controlling the spatial distribution of the silicon nanoparticles, they were able to bend a light beam with



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Researchers have developed artificial whiskers that allow robots to “see” their surroundings in dark and murky places by analysing the way the whiskers respond to water and air flow.

Many animals rely on their whiskers to paint a picture of their surrounding environment when vision or hearing is limited. For example, rats get a sense of their surrounding environment by brushing their whiskers against surfaces. Seals can judge water current conditions by how water flows through their whiskers.

In a recently published study in the IOP Publishing journal *Bioinspiration and Biomimetics*, researchers from Singapore and the U.S. describe a whisker array they developed using five super-elastic metal alloy wires covered in plastic straws. A

ANIMAL-INSPIRED WHISKERS KEY TO NEW NAVIGATION TECHNOLOGY

strain gauge located at the bottom of the array records any movement the whiskers make. These signals are accumulated to create an image of the gas or fluid brushing past it.

Making artificial whiskers that interpret delicate movements, called vibrissal sensing, has only become possible in the last 15 years, following advances in understanding the brain’s neural processing of vibrissal signals.

Lead author Cagdas Tuna of the University of Illinois’ Advanced Digital Sciences Center in Singapore believes artificial whiskers might eventually be used in robotics as an alternative to conventional vision, radar or sonar systems. His team is currently working on improving its image model so it can keep up with interpreting quick changes in flow patterns or moving objects.

“I believe if we can mimic some of the active strategies animals use to survive in their environment, we can actually further increase the sensing capabilities of the whisker system,” he says.

Currently, the whiskers developed in this study can only form two-dimensional images. Creating three-dimensional images would require a more sophisticated mathematical model to interpret the signals coming in, as well as improving the whisker sensors, making them smaller and more flexible. Not only this, but because humans have only begun to understand how animals in the wild use their whiskers to read their environment, it is important to continue research to find out how animals such as seals actively process vibrissal signals in their brains in different situations, and to understand how their whiskers are designed to do so.

Experimental setup for airflow imaging tests: the rods are the engineered whiskers and a hair dryer is used as the airflow source.



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Credit: Kjersti Jorgensen*

Credit (inset pictures): Illinois at Singapore, Advanced Digital Sciences Center

A Singapore research team is harnessing advanced fibre-sensor technologies to increase productivity and process safety in the waste oil recycling process.

Worldwide, the disposal of used industrial and non-industrial lubricants generates over 40 million tons of waste oil annually. Less than 50% of this waste is systematically collected for proper disposal or recycling, with the remainder posing a serious threat to pollution of global air and water resources if inappropriately handled. Although recycled waste oil is sold mainly as ship fuel, burning it pollutes the environment because of its relatively high sulphur content.

Waste oil is recycled by means of a thermo-chemical process into water, carbon and diesel fuel. The process is conducted in an oxygen-free enclosure and involves temperatures higher than 300°C. Although no emissions are released into the atmosphere, the process is time consuming and requires considerable effort to monitor. Also, the acquisition of critical and accurate data such as temperature and pressure is a challenge, as the use of conventional electrical sensors within the process environment invariably poses a safety concern.

Scientists at Nanyang Technological University in Singapore are working closely with Trans Research Pte Ltd., the R&D arm of Trans Petroleum Pte Ltd. and SK Envirotech Pte Ltd., to develop advanced optical fibre

sensors that can withstand the high temperatures essential to the thermo-chemical process without compromising data accuracy and integrity. They are also developing technologies that will reduce sulphur content in waste oil to reduce the environmental impact when the recycled product is used as ship or diesel fuel.

The team has two optical fibre sensors in the pipeline. One sensor incorporates an interferometer in a highly germanium-doped fibre and has shown high sensitivity to monitoring temperature. When used in combination with a more conventional type of fibre, it can simultaneously measure temperature and strain. Another sensor being developed is made of photonic-crystal fibres used together with "SERS-sensing" applications, which can detect and discern various compounds in a mixture. Together, the team's sensors can be used for high-accuracy, real-time measurements of temperature, pressure, vibration, bending, rotation, strain and humidity in waste oil recycling systems.

The team has set up a joint research program between academia and industry for the development and implementation of state-of-the-art technologies to enable the effective and efficient conversion of waste oil into a fuel that meets current and future environmental standards.

OPTICAL FIBRE MONITORING KEY TO WASTE OIL RECYCLING

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AUTOMATIC DEBUGGING OF SOFTWARE

Researchers in Singapore have developed an adaptable, automated approach for debugging software that combines the elements of previous solutions.

Computer programs often contain defects, or bugs, that need to be found and repaired. This manual “debugging” usually requires valuable time and resources. To help developers debug more efficiently, automated debugging solutions have been proposed. One approach goes through information available in bug reports. Another goes through information collected by running a set of test cases. Until now, explains David Lo from Singapore Management University’s (SMU) School of Information Systems, there has been a “missing link” that prevents these information gathering threads from being combined.

Dr Lo, together with colleagues from SMU, has developed an automated debugging approach called Adaptive Multimodal Bug Localisation (AML). AML gleans debugging hints from both bug reports and test cases, and then performs a statistical analysis to pinpoint program elements that are likely to contain bugs.

“While most past studies only demonstrate the applicability of similar solutions for small programs and “artificial bugs” [bugs that are intentionally inserted into a program for testing purposes], our approach can automate the debugging process for many real bugs that impact large programs,” Dr Lo explains. AML has been successfully evaluated on programs with more than 300,000 lines of code. By automatically identifying buggy code, developers can save time and redirect their debugging effort to designing new software features for clients.

Dr Lo and his colleagues are now planning to contact several industry partners to take AML one step closer toward integration as a software development tool.

Dr Lo’s future plans involve developing an Internet-scale software analytics solution. This would involve analysing massive amounts of data that passively exist in countless repositories on the Internet in order to transform manual, pain-staking and error-prone software engineering tasks into automated activities that can be performed efficiently and reliably. This is done, says Dr Lo, by harvesting the wisdom of the masses — accumulated through years of effort by thousands of software developers — hidden in these passive, distributed and diversified data sources.

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New singalong software brings sweet melody to any cacophonous cry.

Whether you give it your best effort or your worst, voice synthesis software developed at Singapore's Agency for Science, Technology and Research (A*STAR) will make you sound like the melodious singer you've always wanted to be. Called I2R Speech2Singing, this software is the first to deliver high-quality singing automatically, while still preserving the original character of your natural voice.

"Many people like singing but they lack the skills to do so," says Minghui Dong, the project leader at A*STAR's Institute for Infocomm Research (I2R). "We want to use our technology to help the average person sing well."

Speech consists of three key elements: content, prosody and timbre. Content is conveyed using words; prosody, or melody in the case of singing, is expressed through rhythm and pitch; and timbre is the distinctive quality that makes a banjo sound different from a trumpet and one singer's voice different from another's. I2R Speech2Singing works by polishing melody while retaining the original content and timbre of a sound.

Existing technologies that focus on correcting melody try to align off-tune sounds to the closest note on the musical scale or to the exact note in the original score. The former works well for professional singers who may be only slightly out of tune but cannot fix those who are singing drastically off-key or simply reading out loud. The latter is better at correcting discordant tunes but ignores many other aspects of melody such as vibrato and vowel stretching.

I2R Speech2Singing uses recordings by professional singers as templates to correct the melody of a singing voice or to convert a speaking voice into a singing one. The software detects the timing of each phonetic sound using speech recognition technology and then stretches or compresses the duration of the signal using voice conversion technology to match the rhythm to that of a professional singer. A speech synthesizer then combines the time-corrected voice with pitch data and background music to produce a beautiful solo.

"When we compared the output with other currently available applications, we realized that our software generated a much better voice quality," says Dr Dong.

Singaporeans were first introduced to the software in 2013 through "Sing for Singapore", part of the official mobile app of National Day Parade 2013. And in 2014, I2R Speech2Singing won the award for best Show & Tell contribution at INTERSPEECH, a major global venue for research on the science and technology of speech communication.

Dr Dong and his team are now developing a solution to quickly add songs into the software so that large-scale song databases can be easily built.

SPEAKING IN SONG

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Scientists in Korea have developed wearable, graphene-coated fabrics that can detect dangerous gases present in the air, alerting the wearer by turning on an LED light.

The researchers, from the Electronics and Telecommunications Research Institute and Konkuk University in the Republic of Korea, coated cotton and polyester yarn with a nanoglue called bovine serum albumin (BSA). The yarns were then wrapped in graphene oxide sheets.

Graphene is an incredibly strong one-atom-thick layer of carbon that is known for its excellent conductive properties of heat and electricity. The graphene sheets stuck very well to the nanoglue: so much so that further testing showed the fabrics retained their electrical

conducting properties after 1,000 consecutive cycles of bending and straightening and ten washing tests

with various chemical detergents. Finally, the graphene oxide yarns were exposed to a chemical reduction process, which involves the gaining of electrons.

The reduced-graphene-oxide-coated materials were found to be particularly sensitive to detecting nitrogen dioxide, a pollutant gas commonly found in vehicle exhaust that also results from fossil fuel combustion. Prolonged exposure to nitrogen dioxide can be dangerous to human health, causing many respiratory-related illnesses. Exposure of these specially-treated fabrics to nitrogen dioxide led to a change in the electrical resistance of the reduced graphene oxide.

The fabrics were so sensitive that 30 minutes of exposure to 0.25 parts per million of nitrogen dioxide (just under five times above the acceptable standard set by the U.S. Environmental Protection Agency) elicited a response. The fabrics were three times as sensitive to nitrogen dioxide in air compared to another reduced graphene oxide sensor previously prepared on a flat material.

The new technology, according to the researchers, can be immediately adopted in related industries because the coating process is a simple one, making it suitable for mass production. It would allow outdoor wearers to receive relevant information about air quality. The materials could also be incorporated with air-purifying filters to act as “smart filters” that can both detect and filter harmful gas from air.

“This sensor can bring a significant change to our daily life since it was developed with flexible and widely used fibres, unlike the gas sensors invariably developed with the existing solid substrates,” says Dr Hyung-Kun Lee, who led this research initiative. The study was published in *Scientific Reports*.

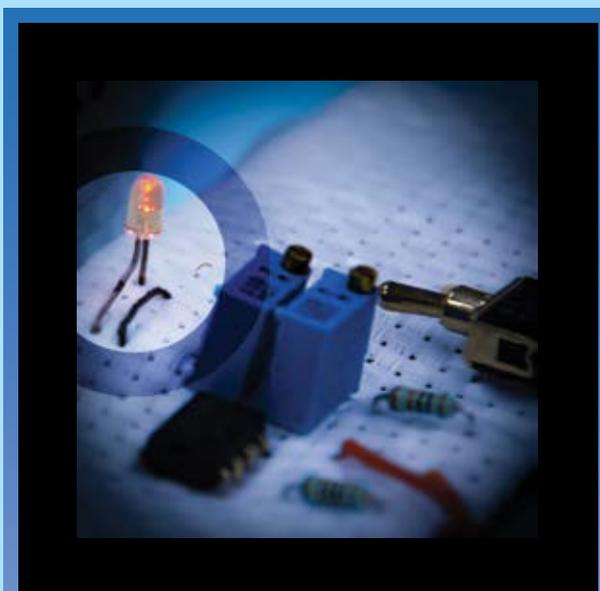
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NEW GRAPHENE-COATED “E-FABRICS” DETECT NOXIOUS GASES



Credit: Electronics and Telecommunications Research Institute

When the graphene-coated fabrics detect dangerous gases, they transmit an electric signal, turning on an LED light.



Dr Terry Steele (right) and his student Gao Feng have developed a glue that hardens in response to a small electric current.

Credit: Nanyang Technological University

A new glue that forms a strong bond when activated by low voltage electricity may be the first of its kind.

Researchers at Nanyang Technological University in Singapore believe the adhesive may be a game-changer in manufacturing fields as diverse as biological implants and automobiles.

The new adhesive is a liquid gel that “cures” to form a polymer bond when a voltage of less than two volts is passed through it. Curing is the amount of time it takes

NEW GLUE INSTANTLY HARDENS WITH ELECTRIC CURRENT

for a glue to reach full strength after it dries. The glue stops curing as soon as the current is turned off. Users can fine-tune the bond’s strength and flexibility by varying the current’s voltage and duration.

The bonding agent is a water-soluble, low-viscosity flowing liquid that allows users to coat and exactly position the materials to be joined. Applying voltage to the gel then rapidly cures it to a strong bond with high elasticity and high shear strength.

Currently available quick-curing adhesives used in industry are activated by light, heat or chemical catalysts, each of which limits uses to particular materials and

appropriate environments. Light-activated adhesives, for example, are only suited to materials that are somewhat transparent, while thermosetting can only be used with components that can tolerate heat.

Such quick-curing adhesives are used widely in the manufacture of medical devices, automobiles and other consumer goods, where they are favoured over more labour-intensive, heavier mechanical fasteners such as rivets, screws or bolts, which weaken the materials to be fixed. However, there has been little innovation in the field for decades.

Potential uses for electro-cured adhesives include biological devices for which photo- or thermo-setting glues are problematic, such as bioelectronics or polymer electronics designed for attachment to living tissue. The adhesive can be tuned to handle certain vibration frequencies or to match the firmness and flexibility of the soft tissue to which it will be attached.

In addition to biomedical uses, the new adhesive could make automotive assembly lines more efficient, since photo- and thermo-setting glues require costly, high-maintenance hardware.

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Russian scientists have developed a technique that allows them to visualize defects on the surface of graphene. The technique may ultimately help scientists develop a better understanding of graphene's properties in order to find novel applications for this supermaterial.

The technique, developed by researchers at the Zelinsky Institute of Organic Chemistry in a collaborative project, employs the metal palladium, which interacts with "carbon reactivity centres" found on graphene. Graphene is an incredibly strong one-atom-thick layer of carbon, touted to be an excellent conductor of heat and electricity. Several types of defects on graphene surfaces are known to increase the reactivity of its carbon atoms: i.e. their ability to form chemical bonds. If researchers can locate these defects and manipulate them, they will be able to maximize the use of graphene's properties. For example, locating and removing defects is important for applications that require perfectly smooth graphene. In other applications, such as in catalysis and certain biomedical materials, some defects are actually beneficial because they allow the incorporation of additional elements, such as metals, into the graphene.

When the palladium complex $\text{Pd}_2(\text{dba})_3$ is dissolved in chloroform, it forms a dark red solution under normal circumstances. But when graphene or another carbon material is added to the solution, the palladium is completely consumed. As a result, the solution turns from dark red to colourless.

Using advanced imaging techniques, the researchers found that the palladium clusters selectively attach to graphene's surface according to specific patterns, depending on how reactive the carbon centres are. Individual palladium particles settle onto point defects, local

accumulations of particles are present on larger defects, and short chains outline linear defects.

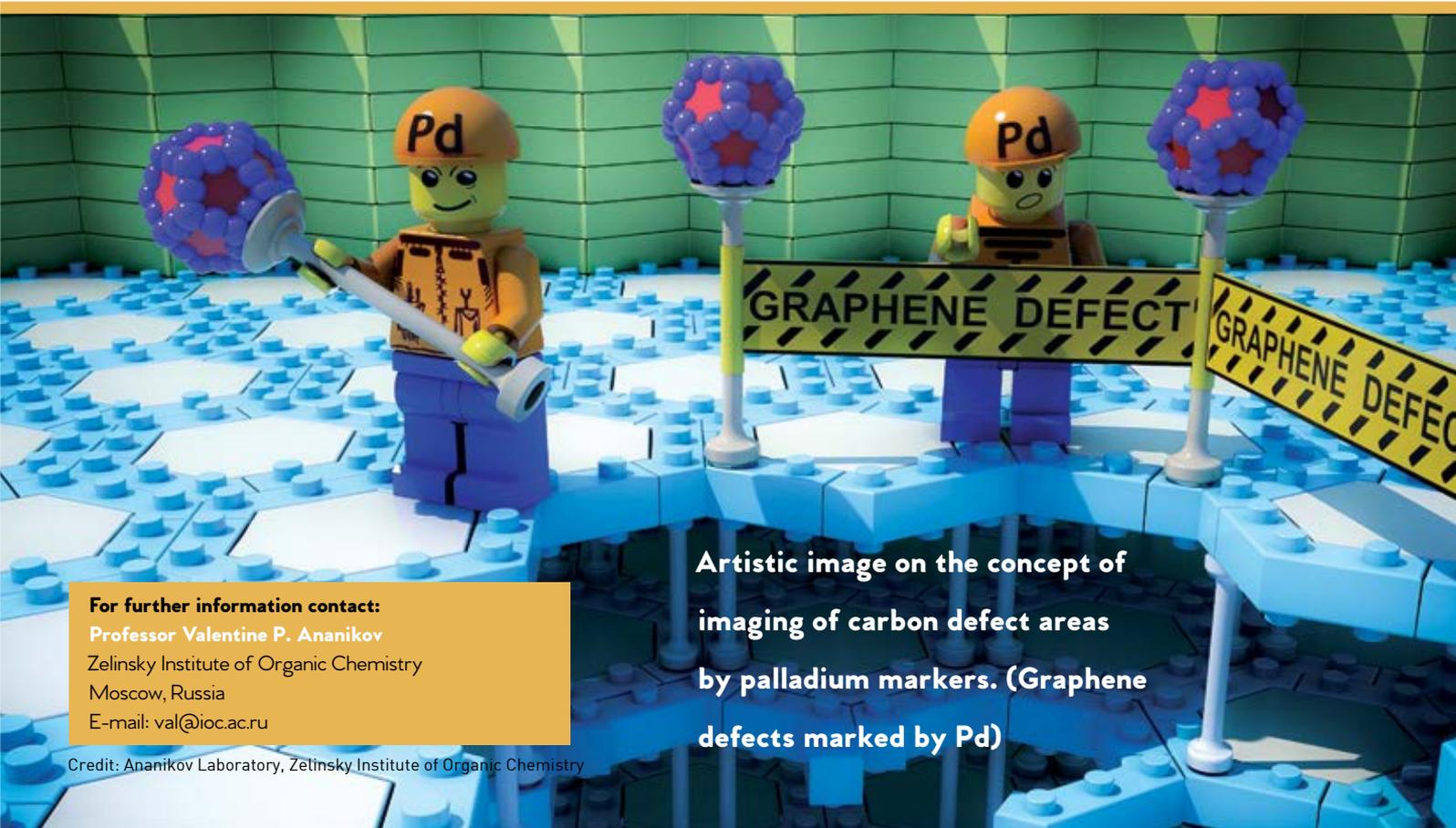
These defects are normally invisible under an electron microscope. The palladium particles act like a contrast agent, allowing the spatial imaging of the chemical reactivity, and thus the defects, of graphene layers.

"Metal mapping of carbon materials provides unique insights and reveals hidden information about fascinating properties at the molecular level," says project leader Professor Valentine Ananikov.

MAPPING THE DEFECTS OF A SUPERMATERIAL

The team's findings indicate that using palladium markers, more than 2,000 surface defects, or reactivity centres, on graphene can be individually located, per square micrometre of surface area. The researchers say that the unexpected capacity of graphene to accommodate so many reactivity centres challenges scientists to re-examine their understanding of the electronic and structural properties of carbon materials.

Now that the researchers have learned how to recognise and characterise the defects, their next step is to develop a technique to control them. Some defects possess a dynamic nature and have the ability to "migrate" over graphene's surface. If the researchers can control this migration, they will have a unique opportunity to form materials with customised properties. This is an outstanding direction for future studies, they say.



Artistic image on the concept of imaging of carbon defect areas by palladium markers. (Graphene defects marked by Pd)

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GRAPHENE-BASED NANOLUBRICANTS COULD GREASE AUTOMOTIVE INDUSTRY'S FUTURE

Malaysian scientists are studying the use of graphene “nanoflakes” to create a new generation of enhanced lubricants for the automotive industry.

Recent research has shown that adding nanoparticles to liquids significantly enhances some of their properties. “Nanofluids” have been synthesised using carbon nanotubes and various metallic, oxide and ceramic nanoparticles. Adding nanoparticles to lubricants enhances their ability to conduct heat, lubricate and protect from wear-and-tear. These are important properties in the automotive industry, as better lubricants result in reduced engine wear, lower noise, and better and longer engine performance.

So far, nanofluids employing carbon nanotubes have shown the best results. Now, a team of Malaysian scientists from the University of Nottingham Malaysia Campus and Taylor’s University are examining the effects of adding graphene nanoflakes to various commercially available

lubricants. Graphene is an incredibly strong one-atom-thick layer of carbon with excellent thermal and electrical conductivity, and properties for reducing wear and friction.

The team found that adding just 0.01% graphene nanoflakes compared to the total mass of lubricant improved its thermal conductivity by 17%, with almost no

changes in viscosity. The enhancement of the lubricant’s thermal properties generally varied according to the size, concentration and heating rates of the graphene nanoflakes used. The researchers believe that the enhanced thermal properties are due to graphene’s large surface area, even distribution and Brownian motion – the erratic random movement of its molecules due to collisions with other molecules. Improved thermal conduction means the lubricant is better able to carry heat away from an engine.

Abdul Khaliq Rasheed of the University of Nottingham Malaysia Campus is optimistic that graphene nanolubricants could last approximately 20% longer than the currently available 5,000 and 10,000 km motor oils. They may even cost less, because adding nanoparticles could reduce the amounts of other additives currently required. They could also protect engines better than currently available lubricants because they reduce friction. The main challenge for researchers now is to develop a complete nanoparticle-based formula that measures up to industry standards, he says.

Dr Mohammad Khalid, the principal researcher of this project, believes that the commercialization of the nanolubricants is not far away, as many companies have shown interest in developing them. In the future, he plans to investigate graphene’s impact on automotive coolants and electronic cooling.

Adding nanoparticles to lubricants enhances their ability to conduct heat, lubricate and protect from wear-and-tear.

Currently available motor oils provide protection for 5,000-10,000 km.

Graphene nanolubricants last 20% longer.

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Scientists in Japan have successfully recorded the atomic bonds between diamond and cubic boron nitride: the hardest known materials on earth. This feat could ultimately lead to the design of new types of semiconductors.

Diamond is the hardest material in existence but is useless for cutting steel because it reacts with iron, from which steel is made, at high temperatures. Cubic boron nitride, a synthetic material, is the second hardest substance after diamond but is chemically stable against iron at high temperatures. If desirable composites of diamond and cubic boron nitride crystals could be obtained, a unique machining tool could be developed for work on hard rock and substances that contain iron. Also, a better understanding of the bonds formed between these two unique semiconducting materials could lead to the development of new types of semiconductors. The nature of these bonds was previously unknown.

Reporting their findings in *Nature Communications Online*, a team of researchers at Tohoku University, the National Institute for Materials Science and the Japan Fine Ceramics Center imaged bonded diamond and boron nitride, both crystalline materials, using a super-high-resolution scanning electron microscope. The team then subjected those observations to extensive theoretical calculations.

When the researchers analysed the atomic bonds, they found that the connections between the two materials had a regularly patterned atomic structure. Strangely enough, it was only by tracking pattern irregularities — certain types of crystal lattice defects formed in the boundary layer between the two materials — that the researchers were able to calculate the main pattern.

The team is conducting research to further understand the nature of the diamond/cubic boron nitride bond. They aim to be able to control the way lattice defects form in crystal layers between diamond and boron nitride. This would ultimately propel the research and development of novel functional materials with unique properties.

Diamond is the hardest material in existence but is useless for cutting steel because it reacts with iron, from which steel is made, at high temperatures.

Cubic boron nitride, a synthetic material, is the second hardest substance after diamond but is chemically stable against iron at high temperatures.

MAP OF DIAMOND-BORON BOND PAVES WAY FOR NEW MATERIALS

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Researchers in Malaysia have discovered that dried sewage sludge could be recycled by adding it to cement to make concrete.

Disposing sludge left over from treating sewage water is a major challenge for wastewater plants in Malaysia. While studies show that the volume of sludge is expected to rise, disposal options are limited due to strict environmental regulations, including a ban on burying sludge in soil due to its high heavy metal content. Meanwhile, the construction sector seeks economic and ecological cement replacement materials in order to meet an increasing demand for concrete.

In a study published in the *Pertanika Journal of Science and Technology*, researchers from Universiti Teknologi MARA investigated the potential to replace various quantities of cement with processed sewage sludge to create a concrete mixture.

TURNING SEWAGE SLUDGE INTO CONCRETE

The researchers first produced domestic waste sludge powder (DWSP). They dried and burnt wet sludge cake to remove moisture, and then ground and sieved the dried sludge cake to make DWSP. Using varying proportions of DWSP (3, 5, 7, 10 and 15%), the researchers mixed the material with cement to produce normal strength and two higher strength grades of concrete. They then compared each DWSP concrete mixture with normal concrete in terms of their compressive strength, water absorption, water permeability and permeability to salt.

Overall, the researchers found that while DWSP has a potential role in the manufacture of concrete, the performance of DWSP concrete blends tends to decline with increasing concentrations of DWSP. For example, the compressive strengths of DWSP concrete generally decreased as the proportion of DWSP increased in concrete mix. Also, both water absorption and water permeability increased as the percentage of DWSP increased. However, resistance to salt increased for concretes containing up to 15% DWSP.

“Overall, there is potential for using DWSP as a partial cement replacement,” the researchers say. “However, more detailed research should be conducted to yield better quality powder.”

Next, the team will work on improving the quality of DWSP, based on previous research which showed that good quality DWSP can be produced when higher temperatures are used to incinerate the sludge. They are currently studying the effect of a range of incineration temperatures, i.e. from 600°C to 1000°C. To evaluate the quality of the DWSP after incineration, they will mix it with cement at various concentrations and then measure the strength and durability of the mortar or concrete that are subsequently formed.

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The construction sector seeks economic and ecological cement replacement materials in order to meet an increasing demand for concrete.

COULD INDIGENOUS KNOWLEDGE SYSTEMS COMBAT CLIMATE CHANGE?

As the global scientific community combines technology and brains to track climate change patterns and effects, indigenous populations have been noting these changes in a landscape they know intimately.

In the Philippines and Indonesia, scientists and non-governmental organisations are working with indigenous communities to map territories for future research and for hazard mapping during times of natural disasters.

In India, farmers in arid and semi-arid regions rotate crops and change the dates for sowing seeds based on climate conditions. In the Koli community of Mumbai, they change their fish catch patterns to enhance the avail-

be able to monitor, evaluate and read the signs ... of how we are adapting to climate change," explains Anne Poelina, managing director of Madjulla Inc., an indigenous non-governmental community development organisation based in Australia.

In order to best utilise indigenous resources for addressing climate change issues, respect, trust and mutually beneficial partnerships must be built, says Manja Bayan from the Indigenous Peoples Rights Monitor, Office of the High Commissioner for Human Rights. This requires that scientists and policy-makers make an effort to develop skills for working effectively in indigenous communities.

In the Koli community of Mumbai, people are changing their fish catch patterns to enhance the availability of fish in the future.

ability of fish in the future. This is part of the Navdanya programme, which promotes biodiversity conservation with the help of local tribal people. Among its activities, the programme maintains and engages with religious and tribal traditions such as rainwater harvesting, growing medicinal plants and maintaining biodiversity by conserving varietal flora and fauna.

"Indigenous peoples across the globe have been confronting climate change and variability on a regular basis due to their heavy dependence on natural resources for their livelihoods," says Vijaya Gupta from the National Institute of Industrial Engineering in Mumbai.

The unique knowledge systems held by indigenous populations can play an important role in monitoring small climatic changes and events that might go unnoticed by scientific tracking.

During the July 2015 climate change conference in Paris, scientists called on the global research community to seize the opportunity to collaborate with indigenous populations that are often taken for granted.

"Indigenous people are living on the land so they are being exposed to ecological changes. [Thus], they would

According to Bayan, there are several challenges in this collaboration. "Western science always looks for the kind of validation that is objective, yet for indigenous people it's not just about the objective things. You also have to look at the spiritual foundation," she explains.

Indigenous peoples across the globe have been confronting climate change and variability on a regular basis due to their heavy dependence on natural resources for their livelihoods.

2007 to 2010, four annual indigenous student videoconferences were held.

Participants from two American Indian nations and two Siberian communities discussed climate change issues and related impacts on their communities. Their concerns were highlighted in the 2010 "Redstone Statement," a product of the international summit on indigenous environmental philosophy held in the United States.

Some moves are being made. According to Jonathan Hook of the Cherokee Nation in the U.S., a growing call for collaboration with indigenous peoples has led to requests for mutual dialogue. From

Credit: Anand Morabad*

Asian countries have begun the long road toward clean energy. The challenges, however, are immense.

China, which accounts for almost half of global coal use, has been making big strides in reducing its carbon emissions by installing solar, wind and other renewable technologies.

China's wind turbines alone are expected to produce nearly 2.5 times the entire power-generating capacity of the U.K. by 2020, according to Xin Li, a fellow at the Oxford Institute for Energy Studies.

To support its economic growth, however, China will still need the cheapest large-scale source of energy available regardless of the impacts on climate. Unfortunately, this is usually coal.

The government of India has also started talking about carbon prices, carbon taxes and building up a national clean energy fund, which will not be an easy feat. Coal provides the overwhelming majority of India's energy.

"We need to leave three quarters of the coal reserves in the ground, which is not going to be easy because there's so much capital embedded in it," says Joyashree Roy, professor of economics at Jadavpur University.

Outside of China, India, Japan and South Korea, renewable power capacity in Asia is expanding at about 5% per year. But because it starts from such a low base, clean sources will provide only about 3% of the region's electricity by 2040.

Over the past year or so, the number of countries signalling their support for a long-term vision on climate change has risen dramatically. This has led to more investment in research and development, more research and more strides toward policy actions that aim

Outside of China, India, Japan and South Korea, renewable power capacity in Asia is expanding at about 5% per year but will provide only about 3% of the region's electricity by 2040.

to create a carbon neutral world. Some nations, such as China, have set long-term targets, ranging from 100% renewable energy by 2050 to absolute emissions reductions; 65% in China's case. With

these pledges come a slew of new technologies and innovations aimed at achieving the ambitious targets.

While a dramatic reduction in carbon emissions and boosting energy efficiency are possible, it's going to be a long, hard road to achieve these targets and even longer before we feel the impacts of these new technologies.

One target of the Conference of Parties 21 (COP21) on climate change held in December 2015 is to keep average

global temperature increases well below 2°C this century. This will require a carbon budget that limits future carbon dioxide emissions up to the year 2050 to about 900 billion tons, or roughly 20 times the world's combined annual emissions in 2014. In order to achieve this, renewable and clean energy sources will have to become a vital part of the energy mix.

Even if governments achieve their goals for curbing global warming, sea levels are predicted to rise by at least six metres in the centuries after 2100, swamping low-lying coastal areas such as Bangladesh.

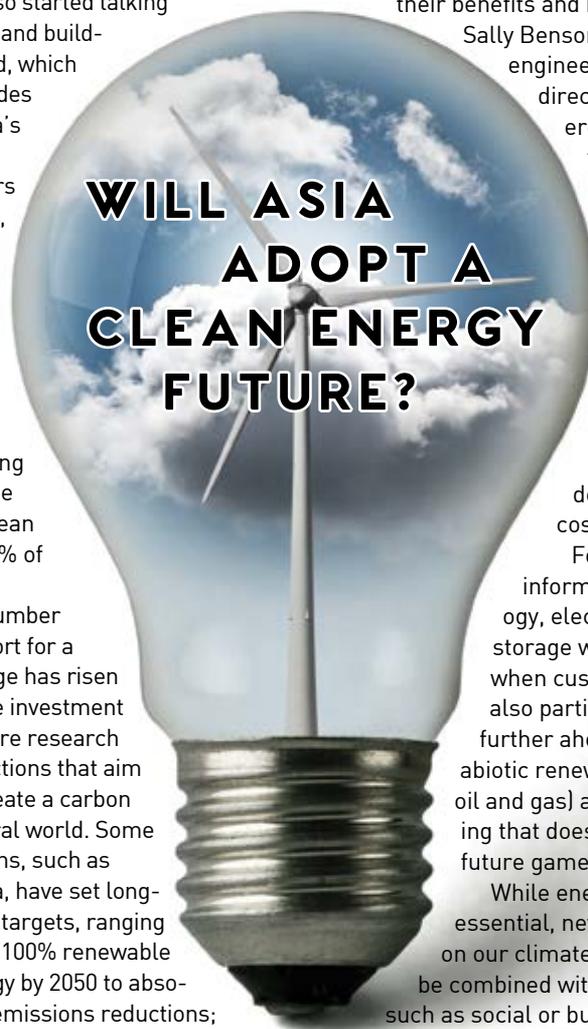
Discussions at a Paris event that preceded COP21 in July 2015, "Our Common Future under Climate Change" (CFCC), dissected various energy innovations, considering their benefits and hindrances. In her keynote speech,

Sally Benson, professor of energy resources engineering at Stanford University and a director of the Global Climate and Energy Project, outlined the direction of future innovations and technology.

"First, we need to decrease reliance on depletable energy resources. Second, we need to increase utilisation of local resources, improving energy security. We [also] need to radically reduce energy intensity and radically reduce carbon necessity. In order to do this, we need new technologies that can be deployed at a large scale and low cost," she explains.

For the near future, she says information technology, energy technology, electric cars and grid-scale energy storage will be game changers in a period when customers will not only consume but also participate in energy systems. Looking further ahead, carbon capture and storage, abiotic renewable fuels (inorganically derived oil and gas) and passive radiative cooling (cooling that doesn't require electricity) will be the future game changers, Dr Benson says.

While energy technology innovation will be essential, new technology is unlikely to deliver on our climate targets on its own and needs to be combined with non-technological innovations, such as social or business model innovations. Frank Geels, professor of system innovation and sustainability at the University of Manchester, emphasized the importance of citizens taking climate change into their own hands. The government of Singapore, for example, has been encouraging citizens to educate themselves and make climate-conscious decisions, such as buying electric cars, rather than relying too much on government regulations or market tools like carbon pricing.



Credit: fbmadeira*

China's wind turbines are expected to produce nearly 2.5 times the entire power-generating capacity of the United Kingdom by 2020.

It's not just a coincidence that extreme weather events have been happening more frequently.

ASIA'S COASTS TO EXPERIENCE MOST EXTREME WEATHER

Over the next 50 years, people living at low altitudes in developing countries, particularly those in coastal Asia, will suffer the most from extreme weather patterns, according to researchers.

Unbearable heat waves, typhoons of unprecedented speeds and flash floods have been an increasing occurrence globally. It's not just a coincidence that these extreme weather events have been happening more frequently, said researchers at the Our Common Future under Climate Change conference.

Hundreds of millions of people will be affected by coastal flooding and land loss as global temperatures rise, icecaps melt and sea levels rise. Cities will also suffer from heat stress, extreme precipitation, inland and coastal flooding, as well as drought and water scarcity, according to the report "Climate Change 2014: Impacts, Adaptation and Vulnerability".

Historical climate projections for the Indian subcontinent suggest an overall increase in temperature by two degrees, which has resulted in a noticeable rise in heat waves and hot days.

Sumetee Pahwa Gajjar, who leads climate change research at the Indian Institute for Human Settlements, has conducted a regional diagnostic study for the critical risks and impacts of climate change in the semi-arid regions of Maharashtra, Karnatak and Tamil Nadu states in south-western and peninsular India. She found that rising occurrences of heat waves and hot days affected the health sector, mainly due to an increased outbreak of diseases and increased risk of heat stress. They also placed a big strain on the agricultural sector as well as on livestock and fisheries.

Francis Zwiers, director of the Pacific Climate Consortium, says human actions, such as the burning of fossil fuels, have increased the odds of extreme weather occurrences.

Events that used to happen every 25 years now happen every 15, he explains. One example is the European heat wave of 2003, during which 35,000 people died. It

was the most extreme event of its kind since 1500 AD. In May 2015, India was struck by a severe heat wave that killed more than 2,500 people.

While it is all very new, research is examining weather models for future climates to show the probability of extreme events.

A recent study published in June 2015 in *Nature Climate Change* used 25 climate computer models to test the connection between global warming and extreme weather occurrences. It found that man-made global warming is responsible for about 75% of all hot-temperature extremes worldwide in the past 100 years and for about 18% of heavy rainfall. The study said climate change will cause higher percentages of extreme weather in future decades. For example, by the middle of this century, if temperatures continue to rise, about 95% of all heat waves and around 40% of precipitation extremes will be due to human influence.

Past research from the United Nations' Intergovernmental Panel on Climate Change has also shown that heat waves and heavy precipitation can be attributed in some part to global warming.

However, it is hard to confirm a distinct correlation. Climate systems are very complex and natural variability makes it difficult to separate out human influence on extreme weather events from other factors. In addition, extreme weather is relatively rare and it can take a long time to identify significant trends.

Adaptation has proven hard, especially in poverty stricken regions.

"Barriers to adaptation arise from resource-intensive development pathways, flawed governance mechanisms, inadequate information and socio-cultural characteristics," says India's Sumetee Pahwa Gajjar.

Hundreds of millions of people will be affected by coastal flooding and land loss as global temperatures rise, icecaps melt and sea levels rise.

PARTS OF PHILIPPINES MAY SUBMERGE DUE TO GLOBAL WARMING

Sea levels could rise by a maximum of 190 centimetres (higher than the average person) by the end of the century. Low-lying coastal communities are most at risk.

More than 167,000 hectares of coastland — about 0.6% of the country's total area — are projected to go underwater in the Philippines, especially in low-lying island communities, according to research by the University of the Philippines.

Low-lying countries with an abundance of coastlines are at significant risk from rising sea levels resulting from global warming. According to data by the World Meteorological Organisation, the water levels around the Philippines are rising at a rate almost three times the global average due partly to the influence of the trade winds pushing ocean currents.

On average, sea levels around the world rise 3.1 centimetres every ten years. Water levels in the Philippines are projected to rise between 7.6 and 10.2 centimetres each decade.

The Philippines government has been forced to take this into consideration. The Department of Environment and National Resources has its own climate change office, which has set up various programs to educate communities in high-risk areas. One program, for example, teaches communities to adapt to rising sea levels by ensuring that public spaces, such as community halls and schools, are not built near the coast.

But soon, adaptation on a local level won't be enough. Policy makers need to convince governments to curb their emissions on a global level.

Speaking at the CFCC conference in Paris, J.P. Gattuso, senior research scientist at France's CNRS Laboratory of Oceanography in Villefranche, said the discussion of warming oceans rarely featured in previous climate change discussions.

"The ocean moderates climate change at the cost of profound alterations to its physics, chemistry, ecology and services," said Dr Gattuso. "However, despite the ocean's critical role in global ecosystem processes and services, international climate negotiations have only minimally touched on ocean impacts. Any new climate regime that

fails to minimize ocean impacts will be incomplete and inadequate," he said.

But this is changing. The Intergovernmental Panel on Climate Change's Fifth Assessment Report 2013 indicated that if emissions continue on their current trend, we could face a "significant increase" in sea level extremes with risks of coastal flooding.

Published in October 2014, a study in *Environmental Research Letters* paints an even scarier picture. Sea levels could rise by a maximum of 190 centimetres (higher than the average person) by the end of the century. Low-lying coastal communities, such as in Bangladesh, could be most at risk.

Research in the journal *Science* released during the CFCC conference also emphasizes the importance that research address the effects of rising sea levels.

In the *Science* study, researchers compared the fate of the oceans under two scenarios: one a business-as-usual approach and the other involving drastic cuts in emissions.

Their analyses showed that business-as-usual would have an enormous and effectively irreversible impact on ocean ecosystems and the services they provide, such as fisheries, by 2100.

"Our present climate is warming to a level associated with significant polar ice-sheet loss in the past. Studies such as these that improve our understanding of magnitudes of global sea-level rise due to polar ice-sheet loss are critical for society," stated Anders Carlson, co-author and associate professor of geology and geophysics at Oregon State University in the Intergovernmental Panel on Climate Change Fifth Assessment Report 2013.

This and the three preceding articles were written by Aya Lowe, a journalist for Channel NewsAsia in the Philippines. She attended the "Our Common Future under Climate Change" conference with sponsorship from the International Development Research Centre.

Researchers in Sri Lanka are strengthening the nation's capacity to detect and manage health issues linked to wildlife-human interactions.

Sri Lanka is a global biodiversity hot spot with many forms of wildlife found nowhere else on the planet. Unique subspecies such as the Sri Lankan leopard and the largest Asian elephant are an important tourist draw for a country finding its feet after decades of civil war.

While wildlife enriches daily life, strengthens ecosystems and attracts visitors, it can also damage crops and carry disease. Densely populated and rapidly changing places such as Sri Lanka – where human settlements, domestic animals and wildlife mingle closely – need effective ways to manage these benefits and risks. Recent epidemics have shown the critical role that wildlife health monitoring can play. But like many low- and middle-income countries, Sri Lanka lacks the needed infrastructure and expertise.

Since 2011, Sri Lanka has had its own national wildlife health centre, co-managed by three government agencies and the University of Peradeniya, and mentored by the Canadian Wildlife Health Cooperative. With support from Canada's International Development Research Centre, a four-year collaboration between the University of Peradeniya and the University of Saskatchewan now aims to build the expertise needed for a national program of research and surveillance to help detect and manage health issues linked to interactions between wildlife and humans.

Research co-leader Dr Ted Leighton stresses the need to go beyond cataloguing wildlife and disease. "The human and social dimensions of managing health issues at the human-wildlife interface are severely neglected," he says. "Finding pathogens is relatively easy. The key is knowing how to communicate, educate and motivate risk-reducing behavioural change in human communities at risk."

In a first phase of the research, the team identified six study sites where local communities live near protected

areas. The sites represent a range of wildlife habitats and agro-ecological conditions. Researchers worked with villagers – including indigenous Adivasi or Vedda communities – to explore their beliefs, perceptions and contact with wild animals and to identify related conflicts or health risks. These explorations showed that, while some misconceptions exist, villagers are quite knowledgeable about the risks of transmittable diseases such as rabies, leptospirosis and Japanese encephalitis. Some villages raised concerns that merit further investigation, such as abnormal jackal behaviour and cases of anaemic sambar deer.

The chief aim, however, is to build a critical mass of Sri Lankan scientists able to bridge animal and human health and development. According to Dr Oswin Perera, director of the Sri Lanka Wildlife Health Centre, "The project is making an important contribution to training, capacity building and networking among staff and students from the university and government agencies."

Graduate students in veterinary and social sciences are taking part in the research and gaining expertise in areas

WHERE HUMANS MEET WILDLIFE: MANAGING THE HEALTH RISKS

such as veterinary pathology, epidemiology and community dynamics. Government officials and field staff from the wildlife, veterinary, human health and administrative sectors are helping to set project priorities, taking part in research and incorporating their new capacity in wildlife health into their programs. While building expertise in Sri Lanka, the joint effort is developing organisational models and training and evaluation tools for wildlife health research that may help other countries grappling with emerging diseases and increasing land use conflicts.

Bathing elephants at Udawalawe National Park, Sri Lanka

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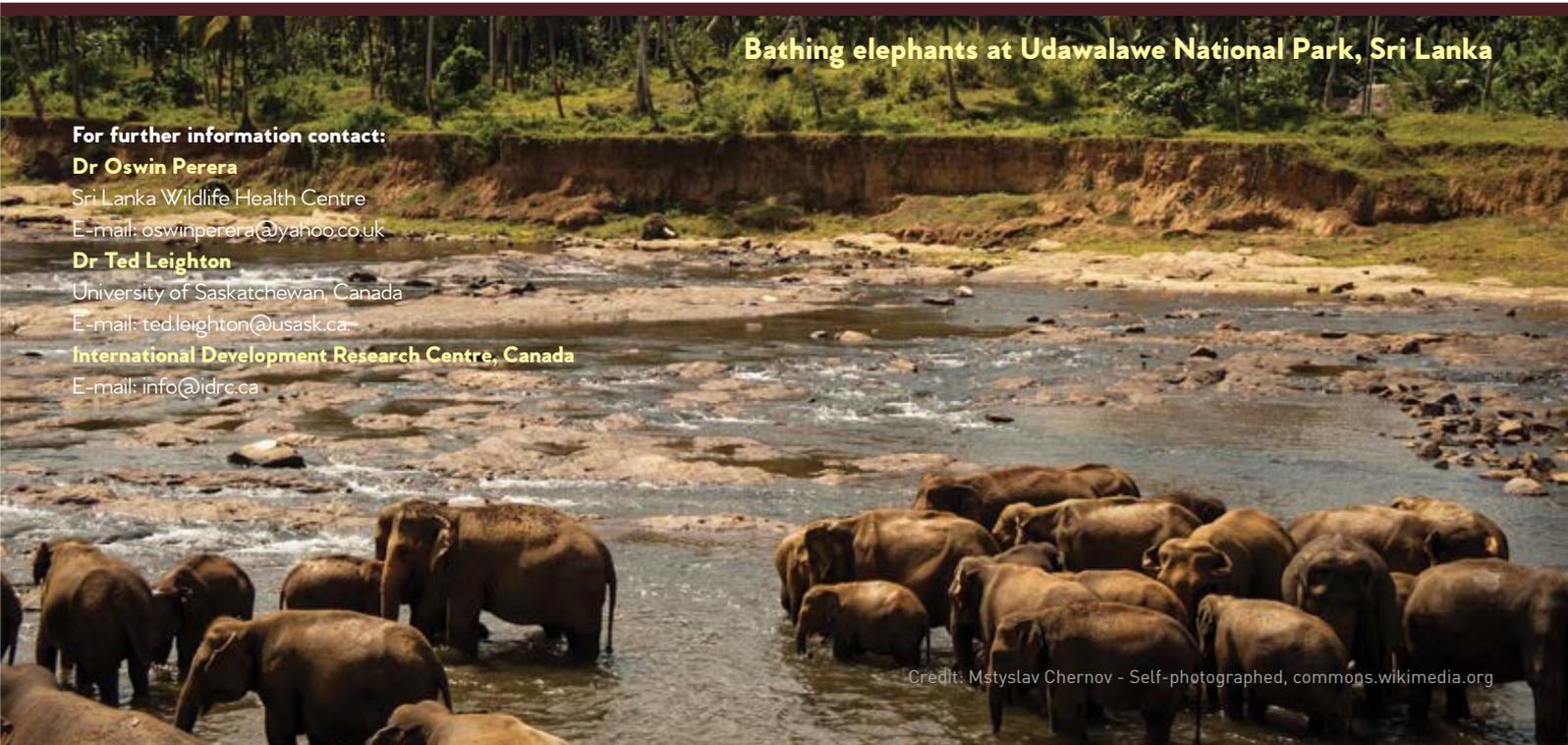
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MALAYSIAN CARBON TAX COULD PAVE WAY TO RENEWABLE ENERGY FUTURE

If Malaysia doesn't take action to control its carbon emissions through a carbon tax, the damage caused by climate change over a 95-year period could cost the country more than 40 trillion Malaysian ringgits (US\$9.1 trillion)

Temperatures in Malaysia are projected to rise between 0.8°C and 3.1°C by 2100. This rapid temperature rise and the resulting climate changes could degrade natural resources, damage infrastructure and threaten human health.

Researchers at the University of Malaya and Universiti Teknologi Malaysia analysed the costs of climate damage in Malaysia from 2010 to 2105 under two scenarios. In the first forecast, Malaysia takes no significant steps to control carbon emissions. In the second, the government gradually implements a tax on carbon emissions to help the country transition to renewable energy.

The team used a combination of data sources and climate modelling to conduct the analysis. They found that, with no action, damages from rising carbon emissions could top US\$9 trillion.

The team then analysed what would happen if the government gradually implemented a carbon tax, starting at 145 Malaysian ringgits (MYR)/ton (or about US\$33/ton) of CO₂ in 2015, increasing to MYR249/ton in 2040 and then to MYR855/ton in 2060.

Assuming that industries respond to the tax by moving away from fossil fuels, the team found that this would

keep carbon levels in the atmosphere at 685 parts per million and limit temperature rises to 2.5°C by 2100. (In 2014, the average annual level of CO₂ in the atmosphere was about 399 parts per million.) While the cost of climatic damages would still continue to rise and peak in 2095, they are projected to fall sharply afterwards.

According to the study, the cumulative cost of climatic damage over the 95-year period could reach MYR40.1 trillion. This amount can be reduced to MYR5.3 trillion, which could be recovered from carbon tax revenues amounting to MYR9.5 trillion over the same time period. Also, the accumulated surplus of MYR4.2 trillion could be used to finance the development of environment-friendly technologies to replace fossil fuels.

While the research team notes long-range forecasts must continually be updated to improve accuracy, they say they are confident that "the optimal climate change policy examined in this study will eventually provide savings and at the same time substantially reduce the impact of climate damage in the long run."

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REMOTE SENSING MAPS THREATS TO MALAYSIA'S MANGROVES

Remote sensing data reveals land use and land cover changes over an 18-year period at one of the best-managed mangrove forests in the world.

Researchers from Universiti Kebangsaan Malaysia and Universiti Malaysia Terengganu combined data from three satellites with previously obtained ground data to investigate changes to the Matang Mangrove Forest between 1993 and 2011.

Malaysia's mangroves are the third largest in the Asia-Pacific region. The Matang Mangrove Forest, covering 40,000 hectares of land on the western coast of peninsular Malaysia, is considered one of the best-managed mangrove forests in the world. It became fully protected in 1906.

Mangrove forests grow along sheltered coastlines and form a very unique and productive ecosystem. Unlike other forests, they grow in saline soil and brackish water and are periodically exposed to fresh and saltwater.

The scientists aimed to map the changes happening in Matang Mangrove Forest to determine what factors might be threatening it.

They found that the forest showed changes to about 8,000 hectares of its area between 1993 and 2011 due to erosion, conversion to dryland forest, agriculture and construction of shrimp ponds. Also, satellite images showed watery areas that were not yet planted with mangroves according to the Matang Mangrove Forest tree harvesting rotation system. This factor contributed to the large amount of changes seen in the forest. On the other hand, the forest also gained almost 3,000 hectares of newly planted mangroves.

This information, the researchers say, will be of added value to Malaysian authorities and other stakeholders in the Matang Mangrove Forest. The findings improve understanding of mangrove distribution and threats and can be helpful for management purposes.

The researchers recommend continuous monitoring using remote sensing data, since the forest covers an extensive area, making it difficult to monitor and manage. During future monitoring, they recommend using higher spatial resolution imagery to improve the accuracy of recognition of various species and the threats affecting them.

Covering 40,000 hectares of land on the western coast of peninsular Malaysia, the Matang Mangrove Forest is one of the best-managed mangrove forests in the world.

Mangrove forests grow along sheltered coastlines and form a unique and productive ecosystem.

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In hot climates, the right mix of ground cover, plant and tree foliage can noticeably improve local microclimates to make inner cities more liveable.

COMPUTER MODELS SHOW PARK MICROCLIMATES IMPROVE CITY LIFE

Computer modelling based on microclimate data from a Malaysian public park has shown how adding trees and grass can improve living conditions in dense city cores.

Most people appreciate urban parks for their aesthetic and social worth. In hot climates, the right mix of ground cover, plant and tree foliage can noticeably improve local microclimates to make inner cities more liveable, say researchers at the Universiti Teknologi MARA in Malaysia.

They placed portable weather stations in and around a lakeside park near the university to document the

model of the park yielded reduced temperatures and improved airflow, which the plants channelled through the park to create a more comfortable climate for humans.

Improved conditions were also elicited by increasing the ground cover vegetation, by planting cow grass, for example, and by increasing the numbers of mature trees such as the rain tree (*Samanea saman*), angkana (*Pterocarpus indicus*) and the yellow flame tree (*Peltophorum pterocarpum*).

The researchers say that, in addition to adding cooling shade to an area, trees shelter local wildlife, can help mitigate pollution, and can also reduce the energy



microclimate among its dense, mature plants. They then used the collected data to create computer models that demonstrate the effects of adding more trees and replacing all plants with ground cover.

The results of a simulated park with more trees showed, unsurprisingly, that the park's shady canopy harboured lower temperatures, slightly higher humidity and more airflow when compared with a simulated park with only ground cover. Using data modelling, the researchers were able to add about 80% more shade cover to the model to gain a significant increase in human comfort. They suggest further research should be done to gain a better understanding of the sizes and varieties of trees best suited to improve local conditions.

"The results showed that the density of the mature trees played an important role," say the researchers. They note that adding more, taller trees to the baseline

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Researchers have documented the first known instance of insects moving prey by forming chains.

In 2010, ant researchers Christian Peeters and Stéphane De Greef spotted chains of bluish ants dragging a huge millipede in Phnom Kulen National Park, Cambodia. Each ant bit on a constriction on the abdomen of the ant ahead of it, while the first ant bit tight on the millipede's antenna. Walking backwards, the ants heaved the millipede away.

Those ants belong to the genus *Leptogenys*. Dr Peeters, an expert in animal communications and evolutionary biology at the French National Centre for Scientific Research, knew the behaviour was unique.

Other ants form chains too. Weaver ants and army ants build chains to sew nests and cross waters respectively. But the bluish *Leptogenys* sp. ants are the first insects documented to move prey by making chains.

In 2014, Peeters and De Greef, an environmental engineer based in Cambodia who researches ants as a hobby, decided to better study the ants. They observed three *Leptogenys* colonies in Cambodia and published their findings in *Insectes Sociaux* in August 2015.

Peeters and De Greef observed that a *Leptogenys* sp. raid starts with one of its 14mm-long ants touching a 150mm-long, coiled-up millipede with its antennae. It then backs off slightly, facing the millipede, while the other ants encircle the millipede without attacking, demonstrating great restraint that suggests specialized adaptation. When the millipede uncoils, an ant bites its leg and the millipede snaps into a frenzy. Then all ants lunge forth, stinging the soft gaps between the millipede's legs. The millipede twists violently, hurling some ants off until, minutes later, it stops, probably paralysed by the ants' stings.

Now the ants move their hefty prize, dragging the millipede's legs and antennae. Chains form – linear, parallel, even branched – and the longest chain pulls the antennae.

Some ants walk ahead of the chains, presumably laying down chemical trails or clearing the path.

Although *Leptogenys* ants and millipedes coexist on other continents, self-assembling chains seem limited to South-East Asia.

The ant is a new species and is most closely related to *Leptogenys chalybaea*, another blue-metallic ant in Borneo, according to Koichi Arimoto, who studies *Leptogenys* ants at Kyushu University in Japan. Koichi is writing a paper to describe and name the ant. Although this new *Leptogenys* species appears to be distributed across Cambodia, Thailand and Vietnam, Koichi says that each population may be a different species.



***Leptogenys* ants assemble themselves into complex chains by grabbing each other by the gaster (abdomen) or thorax. This unique behaviour allows them to drag very large prey in a fast and efficient way.**

CHAINING UP TO MOVE A HEFTY MEAL



A closer look at this undescribed species of *Leptogenys*, showing its blue hue and the gastral constriction that plays a crucial role in the chain formation.

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EXHAUSTING OUR GREEN SHIPPING OPTIONS

Scientists in Singapore have developed a revolutionary emissions abatement system that removes pollutants from exhaust gas to help the international shipping industry meet ambitious emissions targets.

In 2013, the International Maritime Organization (IMO) introduced new regulations to reduce exhaust emissions attributed to the shipping industry. Shipping is responsible for around 90% of global trade and the effect of reducing emissions such as sulphur oxides (SO_x), nitrous oxides (NO_x), particulate matter and greenhouse gases such as carbon dioxide (CO₂) will have a huge impact on global totals.

Researchers from the Agency for Science, Technology and Research (A*STAR) Institute of High Performance Computing (IHPC) together with Sembcorp Marine Ltd and Ecospec Technology Pte Ltd have risen to the challenge of finding ways to meet the IMO's new emissions targets.

The team from Sembcorp Marine Ltd and Ecospec Technology Pte Ltd has developed an exhaust gas treatment system, called cSO_x, which removes SO_x and CO₂ from ships' diesel engine and boiler exhaust emissions. It uses ultra-low-frequency electromagnetic waves to treat seawater, thereby optimising the system's ability to absorb sulphur dioxide and CO₂.

Leveraging on the high performance computing capability of IHPC and its computational fluid dynamics (CFD) expertise, the team gained a better understanding of the flow of exhaust gases within the system and optimised the design without expensive and time-consuming physical experiments. Verification of the CFD analysis was carried out with site measurements, and this, in turn, enabled design improvements to be developed for better performance.

In early 2015, a memorandum of understanding was signed by IHPC, Sembcorp Marine Ltd and the University of Glasgow to collaborate to make ships more eco-friendly. Plans include designing vessels with improved hydrodynamics for better fuel efficiency and further enhancing the exhaust gas cleaning and ballast water treatment systems developed by Sembcorp Marine Ltd and Ecospec Technology Pte Ltd. Shipping is currently responsible for approximately three million tons of sulphur dioxide emissions, 4.5 million tons of nitrogen dioxide emissions and 900 million tons of greenhouse gas emissions yearly. Technology such as the cSO_x exhaust gas cleaning system may soon begin to reduce shipping emissions and give us hope for a more sustainable future.

Moving forward, the team plans to utilize the IHPC computational fluid dynamics model to evaluate the scaled-up cSO_x exhaust gas cleaning system's geometric parameters for better performance.

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Scientists have developed a novel system that recovers energy normally lost in industrial processes.

Each year, energy that equates to billions of barrels of oil is wasted as heat lost from machines and industrial processes. Recovering this energy could reduce energy costs. Scientists from Australia and Malaysia have developed a novel system that is designed to maximize such recovery.

Heat can be converted to electricity by devices called thermoelectric power generators (TEGs), which are made of thermoelectric materials that generate electricity when heat passes through them. Previous studies have attempted to use TEGs to recover energy from the heat generated by, for example, car engines, woodstoves and refrigerators. However, TEGs can only convert a small amount of the heat supplied to them, and the rest is emitted as heat from their "cold" side. No previous studies have attempted to recover energy from the waste heat that has already passed through TEGs. Researchers from Malaysia's Universiti Teknologi MARA and RMIT University in Australia set out to develop a system that can do this.

to eight TEGs via heat pipes. The researchers measured the amount of electricity produced by the TEGs and the amount of energy recovered from their cold side.

When two kilowatts of energy were supplied under normal circumstances to the novel system, they recovered approximately 1.35 kilowatts of heat: over 67% of the energy supplied. In addition, the TEGs generated 10.39 watts of electricity during the heat recovery process.

Both heat pipes and TEGs are passive devices that require no energy input besides the waste energy, and the findings demonstrate that these simple devices can be used to generate electricity and make energy recovery more efficient. The work could provide the basis for future development of larger-scale energy recovery systems.

ENERGY RECYCLING HEATS UP



The researchers designed a novel system in which a TEG was sandwiched between two heat pipes, which are devices that can efficiently transfer heat. One pipe delivered heat to the TEG and the other collected heat emitted from the other side.

The team built a small-scale version of their system to test in the lab before larger-scale versions are made for real-world applications. In this test system, the energy source was not heat wasted by machinery, but an electrical heater. Using a controlled heat source in this way ensured that the researchers knew how much energy entered the system. The supplied heat was transferred



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Researchers have found a way to recover energy from an outflow of seawater used for cooling a power plant in Malaysia.

RECOVERING ENERGY FROM POWER PLANTS

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Researchers are harnessing the energy of moving seawater that is being used to cool a power plant in Malaysia.

A team of scientists from Universiti Malaysia Sarawak has found a way to recover energy from an outflow of seawater used for cooling a power plant in Seijingkat, Malaysia. As the hot water flows from the plant, it creates an artificial waterfall. The team has developed and tested a hanging hydropower-generating system that was custom-designed for use at this sensitive site to recover energy from the artificial waterfall.

Unlike natural water systems such as rivers, the flow at this artificial site is unaffected by the weather, promising a consistent and reliable source of energy all year round.

The researchers first created a mathematical model of their system, which consisted of a water-powered turbine connected to a generator, to determine the energy output and consequent efficiency expected when the turbine turned at various speeds. They also took into consideration the unique challenges of the site before building the system. The hot seawater necessitated the use of marine-grade stainless steel in many parts of the system to avoid corrosion. Furthermore, the flow of water could not be stopped for installation, and measurements of performance had to be taken from a distance.

Despite these challenges, the team built and ran the system for a test period of three months. They measured the rotation speed of the turbine and compared this to the theoretical model to estimate its efficiency. They achieved a maximum efficiency of approximately 40%, approaching the theoretical limit of 50%. On the basis of their results, they also conducted an economical study of the system and determined that it would take a minimum of 4.2 years to recover the initial costs.

The researchers say that, while their system performed well, improvements could be made with further modelling of performance. Nevertheless, they conclude that their work demonstrates the feasibility of building custom-designed power-generating systems for challenging sites to produce local sources of renewable energy.



Photo courtesy of Universiti Malaysia Sarawak

Scientists in Korea have developed a new way of making fuel cell membranes using nanoscale fasteners, paving the way for lower-cost, higher-efficiency and more easily manufactured fuel cells.

The internal workings of fuel cells vary, but basically all types mix hydrogen and oxygen to produce a chemical reaction that delivers usable electricity and exhausts ordinary water as a by-product. One of the most efficient types is the proton exchange membrane (PEM) fuel cell, which operates at low enough temperatures to be used in homes and vehicles.

To generate electricity, PEM fuel cells rely on two chemical compartments separated by a permeable catalyst membrane. This membrane acts as an electrolyte; a negative electrode is bonded to one side of the membrane and a positive electrode is bonded to the other. The electrolyte membrane is often based on a polymer of perfluoro-sulfonic acid. Due to its high cost, however, a less expensive hydrocarbon-based electrolyte membrane has attracted interest in this technology sector.

Until now, the challenge in adopting such a hydrocarbon membrane has been that the interface between the electrode and hydrocarbon membrane is weak. This causes the membrane to delaminate relatively easily, falling apart and losing efficiency with use.

A combined team from the Korea Advanced Institute of Science and Technology and the Korea Research Institute of Chemical Technology has developed a new fastening system that bonds the two materials mechanically rather than chemically. This opens the way to the development of fuel cell membranes that are less expensive, easier to manufacture, stronger and more efficient.

The researchers achieved this by moulding a pattern of tiny cylindrical pillars on the face of the hydrocarbon membrane. The pillars protrude into a softened skin of the electrode with heat. The mechanical bond sets and strengthens as the material cools and absorbs water. The pillar-patterned hydrocarbon membrane is cast using silicone moulds.

The scientists say that the physically fastened bond is almost five times stronger and harder to separate than current bonds between the same layers. It also appears to offer a way to bond many types of hydrocarbon membranes that, until now, have been rejected because they couldn't be fastened robustly. This would make hydrocarbon membranes practical for a number of applications beyond fuel cells such as rechargeable "redox flow" batteries, they say.

The team is now developing a stronger and more scalable interlocking interface for their nanoscale fasteners.

The physically fastened bond is almost five times stronger and harder to separate than current bonds between the same layers.

Researchers have developed a new interlocking interface for more efficient fuel cell membranes.

MEMBRANE "NANO-FASTENERS" KEY TO NEXT-GENERATION FUEL CELLS

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Scanning electron

microscope image of

the interlocking structure

FINDING SUPERCONDUCTING NEEDLES IN THE METAL HAYSTACK

The discoverer of the first iron-based superconductor, one of *Science* magazine's 2008 runner-up breakthroughs of the year, now reports finding around 100 new superconducting materials.

First discovered in 1911, superconductivity is the ability of certain metals to conduct an electric current at zero resistance, resulting in no loss of energy. Superconductors could have a huge impact on future energy transmission, for example, since significant amounts of energy are currently lost in the process of transmitting electricity from power plants to their destinations.

There are so many superconductors that we [still] do not know. We hope there will be a room-temperature superconductor among them.

In 2010, Tokyo Institute of Technology materials scientist Hideo Hosono assembled a research team composed of over 40 researchers, who undertook a four-year

exploration of more than 1,000 materials to look for new superconductors. They found around 100 new superconducting materials and, in the process, published more than 330 original papers and applied for over 30 patents. An overview of their results recently appeared in the journal *Science and Technology of Advanced Materials* (STAM).

To date, superconductivity only happens in some materials at extremely low temperatures. The highest known temperature at which superconductivity occurs is about -135°C . The temperature of liquid nitrogen, by comparison, is -196°C . Researchers dream of finding materials with superconductive properties at room temperature: a feat that has eluded them so far. Materials that superconduct at or near room temperature would have the potential to be easily maintained in everyday environments.

While Dr Hosono's team did not discover any new superconductive materials at temperatures above those previously known, its findings are, nevertheless, significant. Dr Hosono gave his colleagues tremendous flexibility to search for new superconducting materials, believing that excellent solid state chemists would find new properties by serendipity. The results of this project have convinced him that there are many more superconducting materials left to discover.

"This project found around 100 kinds of new superconductors," says Dr Hosono. "[But] there are so many superconductors that we [still] do not know. We hope there will be a room-temperature superconductor among them," he adds.

Among the team's many successes in the project were the introduction of a new substance (a hydride ion) that induces iron-based superconductivity; the discovery of new cobalt- and titanium-based superconductors; and the design of electrical wires and tapes made from some of the superconducting materials, demonstrating their real-world applicability.

In its STAM paper, the team not only listed the superconducting materials found during the project, but also any materials that had no superconducting properties. "We believe that listing all materials examined, including both successes and failures, is meaningful for the people who work in this field," they write.

"Concentrated exploration for new superconductors under a clear and flexible policy may lead to unexpected discovery," says Dr Hosono.

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In 2008, Dr Hideo Hosono and colleagues published a paper in the journal *Nature*, detailing their discovery of iron-based superconductors. Previously, superconductivity was considered impossible in the presence of iron because its magnetism interferes with electric currents. The discovery of copper-based superconductors in the late 1980s had created tremendous excitement in the scientific community because of their superconducting properties at relatively higher temperatures than those previously known. However, the mechanism by which they became superconductive was a mystery.

Scientists hope that further studies on iron-based superconductors will provide new clues as to how high temperature superconductors work. “Ordinary” superconductors conduct electricity at temperatures below -243°C , while “high temperature” superconductors found to-date conduct at temperatures up to -135°C .

Levitation of a magnet on top of a superconductor

Did you know?

When certain materials are cooled to a critical temperature (with liquid nitrogen, for example), they become superconductors and their electrical resistance drops to zero. Superconductors also demonstrate another interesting property, called the Meissner effect. Magnetic fields cannot penetrate superconductors, resulting in the repulsion of magnets, causing them to levitate above them.



Malaysian researchers have concluded that mandatory labelling of genetically modified foods is justified, based on an extensive review of international scientific and legal frameworks related to genetically modified organisms (GMOs).

Genetically modified organisms may offer arguable societal and economic benefits, but some fear they may also pose hazards to humans, animals, plants and the environment.

So when Malaysia introduced mandatory labelling laws for GM foods, researchers at University Kebangsaan Malaysia (UKM) began to study whether such laws were

The UKM study found that not everyone is persuaded. Opponents worry that, with the potentially huge amounts of money at play, national scientific and legal frameworks may have been somehow tilted to be industry-friendly.

The research team argues that the “substantial equivalence” concept currently lacks adequate scientific backing. As long as safety remains incompletely proven, legislation should acknowledge potential hazards as well as perceived pluses, and set up ways to manage them.

While not writing off biotechnology or GM foods, the researchers say that, until more is known, it’s prudent to acknowledge and address uncertainties about their



STUDY WEIGHS PROS AND CONS OF GMO MANDATORY LABELLING

Credit: 06photo*

justified, using scientific, legal and policy documents in North America, the European Union and Asia. The study became an in-depth review of literature, legislation and labelling regimes worldwide.

Genetic modification – the ability to take genes from one species and splice them into another to create organisms with new properties – could be one of the biggest advances in recent science. Yet when debating whether GMOs are desirable, pro and con sides often speak past each other such that economic points “for” do little to address environmental points “against” and vice versa.

Under a concept known as “substantial equivalence”, GM food proponents say they are functionally the same and thus as safe as their natural counterparts, with no need for special labelling.

effects on people, animals and plants. Mandatory labelling fits within that approach, even if it adds costs. In the long-term, they say, it could prevent unexpected harm. In the meantime, it can educate consumers and allow those with religious, medical or social objections to avoid GMOs.

In that context, the team says Malaysia’s mandatory labelling legislation for GMOs is justified. As long as some producers or manufacturers fear negative consumer reactions to labelled GM products, voluntary labelling would be inconsistent at best. People have a right to know what kind of food they eat, concludes the team, and that justifies Malaysia’s GMO labelling laws.

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CELL FUSION DISCOVERY COULD IMPROVE AGRICULTURAL PRODUCTION

The research team's discovery could ultimately be useful for improving the success rate of plant fertilization in agricultural production.

An international research team has observed cell fusion in flowering plants for the first time in more than a century. The discovery demystifies how plants prevent the attraction of excessive pollen tubes after a successful fertilisation.

Reproduction of flowering plants occurs within a plant's ovule by the fertilisation of both the egg and a larger central cell by two sperm cells. Sperm cells are carried into the ovule by a pollen tube and discharged into one of two "synergid" cells located next to the egg cell. During this process, the synergid cell dies and degenerates, and the sperm cells migrate to the egg and central cell. Once fertilised, the egg cell becomes the embryo while the central cell becomes the endosperm that nourishes the embryo.

Earlier research found that the role of synergid cells is to attract or prevent pollen tubes from reaching a plant's ovule. If the initial fertilisation fails, the second synergid cell attracts a new pollen tube for another attempt of fertilisation. In the case of a successful fertilisation, the second synergid cell – also known as the persistent synergid cell – is inactivated to avoid multiple pollen tubes entering the ovule. This prevents more than one sperm cell from fertilising the same egg, creating a genetic imbalance. However, the mechanism behind synergid inactivation remained unknown.

Led by Daisuke Maruyama of Nagoya University's Institute of Transformative Bio-Molecules, a team of international researchers from Singapore, Germany, Saudi Arabia and Austria has discovered that, following fertilisation, the persistent synergid cell fuses with the endosperm, triggering its inactivation.

Cell-to-cell fusion in plants is rarely seen due to their relatively tough cell walls, according to the researchers. Their study is only the third report of plant cell fusion being observed and the first observation since the initial reports in the late 1800s.

Using live imaging techniques, the team found that cell fusion, which is induced by the fertilisation of the central cell, rapidly dilutes the contents of the persistent synergid cell. Meanwhile, fertilisation of the egg cell activates its "ethylene signalling" pathway, which degrades the nucleus of the persistent synergid cell. As a result, the persistent synergid cell completely loses its ability to attract pollen tubes.

Dr Maruyama says their discovery could ultimately be useful for improving the success rate of plant fertilisation in agricultural production, for example. Optimising the fusion of synergid cells with endosperm, he explains, would reduce the chance for multiple pollen tubes to be accidentally attracted following a successful fertilisation.

Next on the team's agenda is to explore molecules that are involved in the fusion of synergid cells and endosperm.

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Scientists at Taylor's University in Malaysia and the Chinese University of Hong Kong are undertaking interdisciplinary research to understand the food habits of the people of Hong Kong.

The project, called the Hong Kong food barometer, hopes to obtain data that will help describe how food habits vary according to social status, gender and ethnicity. It also aims to measure the frequency of eating out, the prevalence of using "convenience food" and how lifestyle choices correlate with obesity.

UNDERSTANDING FOOD CHOICES IN HONG KONG

The project is a follow-up of the Malaysian food barometer, which found, for example, that 38.5% of all Malaysian meals are consumed outside the home. This, the researchers say, is probably one of the highest rates of dining out in the world and raises concerns for diet management and higher risks of non-communicable diseases and obesity.

A further, larger follow-up to the Malaysian food barometer is expected in the near future, with the research team planning to compare food barometer data from Malaysia, Hong Kong and other South-East Asian countries.

For further information contact:

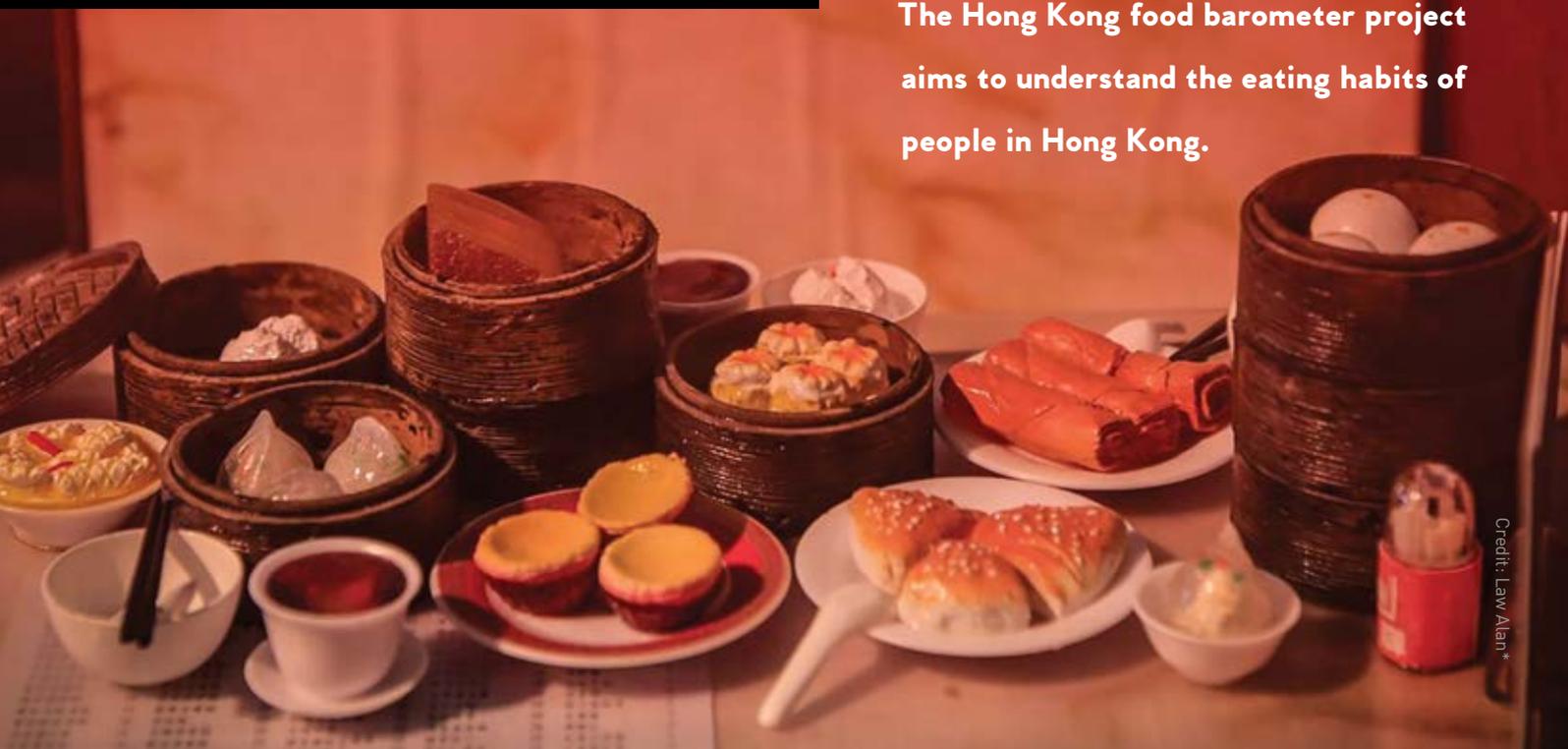
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The Hong Kong food barometer project aims to understand the eating habits of people in Hong Kong.



GROWING SWEET ON TOMATOES

Scientists from Tohoku University in Japan have developed a method to produce sweeter, well-growing tomatoes.

Previous research has shown that the sugar sucrose plays a role in controlling key fruit genes involved in sugar metabolism. Efforts to control these genes succeeded in increasing the sugar content in fruit but also resulted in stunted growth.

Researchers from Tohoku University in Japan used a bioinformatics search tool to find nucleotide sequences in the tomato genome similar to a known tobacco gene sequence that can be repressed by sucrose. When a special coding sequence on the tobacco gene, called a uORF, is removed and the main sequence is made to overexpress, the gene activates several other genes involved in sugar metabolism, ultimately increasing sucrose levels in tobacco leaves. When the uORF is not removed, an overexpressing gene will increase sucrose content in the tobacco leaves but only up to a point. The increased sucrose represses the uORF, which in turn represses the main part of the gene, limiting its ability to further increase the fruit's sucrose content.

Two genes with very similar sequences to the tobacco gene were identified in the tomato plant by the researchers' bioinformatics search and their uORFs were removed. The main gene sequence was placed under the control of another gene, called E8, to express the target gene. The modified DNA was then inserted into tomato plants. The resulting tomato lines were found to have 50% more sucrose than normal tomatoes and showed no growth retardation. In addition to sugar metabolism, the tomato gene also affects genes involved in amino acid metabolism. The researchers found that levels of several amino acids were higher in the transgenic tomatoes.

Based on their results, the team is now developing a new modified DNA sequence containing 2A11, which functions during more of the fruit's development than E8, they say.

The researchers think it is likely that most flowering plants, or angiosperms, contain similar sucrose-susceptible genes, making their "sweetening technology" widely applicable.

Researchers have developed new tomato lines that have 50% more sucrose than normal tomatoes.



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NANOTECH EXTENDS SHELF LIFE OF FRESH FRUIT

Credit: Inacio Pires*

An international research team is developing nanotechnology-based applications of hexanal, a natural plant extract that extends the storage life of harvested fruit.

Bananas, mangoes and papayas: these tender tropical fruits are in high demand in export markets and an important livelihood source for producers. But freshness is key because these fruits spoil quickly and damage easily. The challenge is especially daunting where refrigeration is lacking. Estimates suggest that up to 40% of produce in tropical countries is lost in post-harvest handling.

Breakthrough research by Canadian, Indian and Sri Lankan partners points to a promising innovation: nanotech applications of a natural plant extract called hexanal can be used to delay fruit ripening. Hexanal

inhibits a plant enzyme that is responsible for breaking cell membranes during a fruit's ripening process. In initial research in India and Sri Lanka, scientists used a hexanal-impregnated formula to test the product on mangoes. Spraying

orchards with a low concentration of the compound slowed fruit ripening by three weeks. The team is also developing "smart packaging" systems, made from materials such as banana fibre, that slowly release hexanal to extend storage life after fruit is harvested.

These applications can boost farmers' incomes. "Let's say a mango farmer sprays half or one third of the orchard with the formulation," explains Jay Subramanian, a professor at Canada's University of Guelph. "He gets that same mango production but spread out over a three-to four-week window instead of just one week, which causes a major rush and a glut in the market, leading to low prices." In field trials, farmers were able to earn up to 15% more for their crop. Once harvested, the sprayed mangoes remained fresh for up to 26 days in cold storage and 17 days at room temperature.

Researchers at the University of Guelph, India's Tamil Nadu Agricultural University and Sri Lanka's Industrial Technology Institute are building on this early success. Under a second phase of funding through the Canadian International Food Security Research Fund, a joint initiative of Canada's International Development Research Centre and Global Affairs Canada, they are taking their investigations beyond Asia.

Together with institutions in Kenya, Tanzania, and Trinidad and Tobago, they are looking at hexanal applications with other fruits under different growing conditions. The research teams are testing a variety of sprays, coatings and packaging on bananas, citrus, papayas and even some Canadian tender fruits and berries. Each fruit presents its own unique challenges, such as ripening along different timelines, requiring fine-tuning of the application process.

Biosafety testing shows promise. Already approved as a food additive in the United States, hexanal leaves no harmful residues. "It's a very natural compound," says Dr Subramanian. "In our academic research we have found that if you spray or dip the fruit with it, within 48 hours it's all gone; you can't find even a trace using a microscope."

A range of new materials is being developed, including wraps containing electro-spun or sprayed nanoparticles infused with hexanal for slow release of hexanal vapours. While exploring ways to delay ripening and improve shelf life, scientists are looking for opportunities to commercialise these technologies so they can be scaled up. The aim is to ensure the technology has a global reach and benefits low-income farmers, not just large producers.



Credit: Vijay Kutty/IDRC

**Spraying
hexanal
formula
on mango
trees**

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Apigenin is a naturally occurring “polyphenol” commonly found in vegetables.

Apigenin, a natural metabolite found in plants and vegetables, is poised to improve chemotherapy significantly.

Combining a new synthetic apigenin compound with existing anticancer drug treatments can reverse drug resistance, say researchers at The Hong Kong Polytechnic University (PolyU). The compound can also improve the absorption of cancer drugs in the digestive system, allowing patients to take some anticancer drugs orally rather than intravenously for the first time.

Chemotherapy treatments sometimes fail because of drug resistance. One common resistance mechanism takes the form of a “drug efflux”: a kind of internal pump

PLANT METABOLITE PROMISES MORE EFFECTIVE CHEMOTHERAPY

that helps cancer cells get rid of attacking drugs.

PolyU researchers studying efflux say they have found a way to stop this pump mechanism from expelling drugs by using a naturally occurring “polyphenol” called apigenin, which is commonly found in plants and vegetables. Plant polyphenols are metabolic by-products that help the growth and development of plants, commonly through protecting them from pests and pathogens.

The team chemically linked two apigenin compounds together, forming a dimer, which fits into the two similarly shaped halves of the pump. Using cell and animal studies, they demonstrated that the new apigenin dimer was highly effective in reversing cancer drug resistance by inhibiting the pump.

Based on this success, the PolyU team has developed a large compound library of improved apigenin dimers, each with a different structure. Significantly, they have found that some dimers can reverse the highest level of drug resistance found in cancer stem cells.

6 Drug resistance in cancer stem cells is one of the most difficult problems in effective chemotherapy.

“It is a breakthrough in tackling multidrug resistance in cancer,” says PolyU applied biologist Larry Chow. “Drug resistance in cancer stem cells is one of the most difficult problems in effective chemotherapy and we have found a way to reverse it using our new generation of dimers,” he says. The team’s work on treating cancer stem cells has not yet reached the stage of human clinical trials.

PolyU has patented the development of its synthetic apigenin and signed a licensing agreement with Kinex Pharmaceuticals, a U.S.-based global company specialising in cancer treatment. Kinex will be further developing the apigenin dimers for use in improving the oral bioavailability of cancer drugs.

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Researchers from Hong Kong and the U.S. have developed a new statistical and mapping method that could help identify drug targets for treating leukaemia.

In chronic myelogenous leukaemia (CML), too many stem cells in the bone marrow are transformed into a type of white blood cell called granulocytes, making less room for healthy white blood cells, red blood cells and platelets. CML occurs due to a chromosomal abnormality in which an abnormal gene is formed, called the BCR-ABL fusion gene. However, the development of CML is not fully understood, leading to limited treatment options.

The BCR-ABL gene activates enzyme pathways that disrupt protein synthesis and cause uncontrolled cell growth. A better understanding of these pathways and how they are activated could lead to the discovery of drug targets for CML.

Past research has shown that the expression of a protein-coding gene called NPM1 changes in tumour cells. NPM1 was found to respond to signals from enzyme pathways initiated by the BCR-ABL gene.

Benjamin Yung's research group at The Hong Kong Polytechnic University together with researchers from

The findings could help physicians develop more effective treatment strategies for chronic myelogenous leukaemia.

Harvard University in the U.S. and Queen Elizabeth Hospital in Hong Kong have developed a unique statistical and mapping strategy that identifies the relationships among

those genes that are involved in the development of CML.

Using their unique statistical approach, the researchers quantified and analysed publicly available gene expression data of nine CML patients and eight healthy volunteers. They created networking maps from the data to facilitate the visualization of the connections among genes. They compared NPM1 gene expressions with those from the BCR-ABL-initiated enzyme pathways in the CML patients and similar pathways that exist in healthy individuals. They also explored the role of NPM1 "doublets" — genes strongly co-expressed with NPM1 — in protein formation.

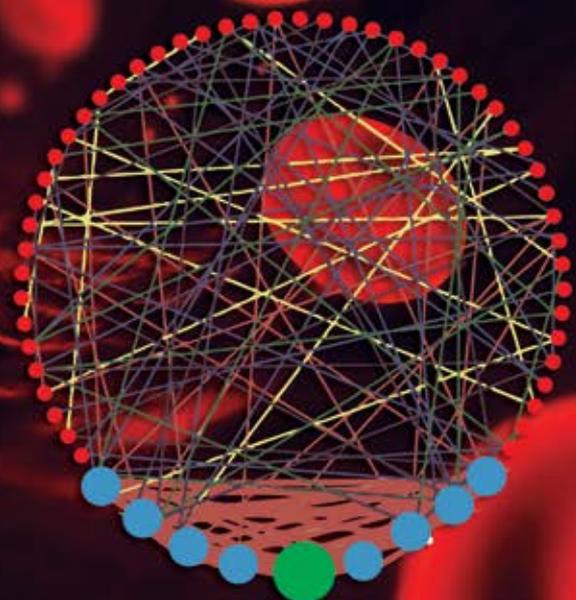
The researchers identified two sets of gene doublets that strongly co-expressed in CML patients but were not co-expressed in healthy individuals. These gene pairs may be related to CML development and thus could be an important target for drug research. They also found that NPM1 established ten gene-expressing pairs with BCR-ABL pathways in CML patients but only two pairs with similar pathways in healthy individuals, which may mean that NPM1 mediates the activation of other cellular proliferation pathways in CML. Finally, the researchers used a substance, called **resveratrol**, which is thought to have anti-cancer properties, on CML cells. Resveratrol caused a decrease in the expression of NPM1-related proteins and is thus a potential drug target for CML therapy.

The researchers' findings could help physicians develop more effective treatment strategies for CML. Their statistical and mapping strategy can also be used to diagnose and develop treatments for other diseases.

The researchers developed a map of the relationships among genes involved in the development of chronic myelogenous leukaemia (CML).

The points around the circumference represent genes, where green represents NPM1, blue represents NPM1 co-expressed genes, and the red points represent other NPM1-related genes.

IDENTIFYING DRUG TARGETS FOR LEUKAEMIA



- NPM1
- NPM1-coexpressed genes
- Other NPM1-related genes

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The most common male cancer in Asia is lung cancer. For Asian women, breast cancer is the most common, but cervical and liver cancers occur more frequently than in other regions of the world.

RESEARCH SHOWS HIGH CANCER DEATH RATES IN ASIA

Credit: Juan Gärtner*

Asia has one of the lowest overall cancer rates globally, but cancer patients are more likely to die there than most other regions.

While other studies have focused on specific cancers or countries, researchers at the University of Malaya in Kuala Lumpur collected statistics on cancer type, sex and income in 47 countries and synthesised the numbers into a cohesive picture of cancer in Asia.

Asia has about half the cancer incidence rate of North America (152.2 cases/100,000 person-years versus 315.6 cases/100,000 person-years). However, the ratio of cancer deaths to the number of new cancer cases in 2012 was much higher in Asia (0.66) than in North America (0.33). Only in Africa are cancer patients more likely to die (0.73).

Within Asia, there is great variation in cancer incidence and survival rates. Residents of the western and eastern regions are more likely to get cancer than people in the south-central and south-eastern regions. Researchers suspect differences in drinking and smoking habits play a key role.

However, cancer patients in poorer, less developed regions are less likely to survive than in richer, more developed areas due to lack of resources for screening and treatment.

Asia follows most global trends for common types of cancers, with some key differences. For example, the most common male cancer in Asia is lung cancer, while in the West it is prostate cancer. For Asian women, breast cancer is the most common, but cervical and liver cancers occur more frequently than in other regions.

Even though cervical cancer has a long latency period and effective screening methods, more women die from it in Asia than in the West. India alone accounts for 27% of global cervical cancer deaths, which may be due to the unavailability of screening.

The researchers used the latest cancer statistics in the GLOBOCAN 2012 database for this study, but note that more systematic and accurate data collection is necessary to track and manage the potential “cancer epidemic” in Asia as the population expands and develops.

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Researchers in Singapore and Hong Kong have created a novel, bacteria-repelling biomaterial that could increase the success of medical implants.

The new material is designed to help healthy cells “win the race” to a medical implant, beating off competition from bacterial cells and thus reducing the likelihood of the implant being rejected by the body.

The failure rate of certain medical implants is

The new material is designed to help healthy cells ‘win the race’ to a medical implant, beating off competition from bacterial cells.

high – around 40% for hip implants – due to the formation of thin films of microorganisms on an implant when it is first inserted into the body.

This prevents healthy cells from attaching and results

in the body eventually rejecting the implant, potentially leading to serious medical complications for patients.

Reporting their findings in the IOP Publishing journal *Biomedical Materials*, a team of researchers from the Agency for Science, Technology and Research in Singapore, Nanyang Technological University and City University of Hong Kong produced a material that not only repelled bacteria but also attracted healthy cells.

The base of the material was made of multiple layers of water-soluble macromolecules called polyelectrolytes, onto which specific bonding molecules, called ligands, were attached.

The team tested various concentrations of different ligands. They found that a naturally occurring protein building block called RGD was effective at inhibiting the attachment of bacterial cells and attracting healthy cells when it was attached to multilayers of certain polyelectrolytes. It surpassed collagen in this regard.

“The method we developed helped the host cells win the so-called ‘race-for-surface’ battle, forming a confluent layer on the implant surface which protects it from possible bacterial adhesion and colonisation,” explains the lead author, Vincent Chan of Nanyang Technological University.

Medical implants currently incorporate antibacterial silver coatings. “However, the total amount of silver used must be very carefully controlled because high concentrations could kill mammalian cells and become toxic to the human body,” says Professor Chan. By comparison, “the bio-selective coatings we’ve created do not have this problem, as the materials used are non-toxic and the environmentally sustainable preparation process uses water as a solvent.”

“At the moment this is just a proof-of-concept study, so there is still a long way to go before the coating can be used on implants in a clinical setting,” he adds. “In future studies we hope to improve the long-term stability of the coating.”

The failure rate of some medical implants is high – around 40% for hip implants – due to the formation of thin films of microorganisms.

ANTIBACTERIAL MEDICAL IMPLANTS

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Researchers in Malaysia and Japan have found that birdcages kept at home may be a breeding site for mosquitoes that transmit dengue virus to humans.

Bird keeping for personal or commercial purposes is as common in Malaysia as in the rest of South-East Asia. However, birdcages could provide an ideal environment for the development of mosquitoes that transmit dengue virus to humans.

Dengue fever is a debilitating and sometimes deadly disease caused by a virus transmitted by mosquitoes. Its symptoms include fever, headache, rash, muscle and joint pain, and sometimes severe bleeding.

Researchers have found that mosquito larvae can grow in bird faeces dropped into birdcage water bowls. Previous research found various developmental stages of the mosquito *Aedes albopictus* in the water containers of birdcages in rural homes of peninsular Malaysia. *Aedes albopictus* can transmit more than 20 diseases to humans, including dengue. Researchers were unsure, however, whether bird droppings contributed to the development and population maintenance of these mosquitoes.

Hamady Dieng of Universiti Malaysia Sarawak with colleagues from Malaysia and Japan found that *A. albopictus* can breed on bird faeces as effectively as when they are cultured under laboratory conditions with standard mosquito feed.

Dr Dieng and his colleagues collected mosquito samples from nine water containers in birdcages owned by residents of Penang State, Malaysia. The researchers divided hatched larvae into two high-density groups and two low-density groups (to check the impact of density on population growth), containing 80 and 40 larvae respectively. They then fed one set in each density group with standard larval food, which is commonly used to culture

mosquitoes in labs, and the other with bird faecal matter, made of powdered bird manure from spotted doves.

They found that larvae grown on standard larval food or bird faecal matter had similar mortality rates and developed into pupae and adults with similar success rates. Female mosquitoes from the low-density group fed on blood and produced eggs at similar levels regardless of the type of food given during the larval stage, suggesting they had an equal potential of spreading dengue virus to humans.

The research suggests that birdcages may have been producing dengue vectors for many years in the region. This knowledge could help the development of preventive measures against the disease.

Dr Dieng now plans to examine the capacity of fecal matter from cats and dogs to support the development of dengue mosquitoes.

The research suggests that birdcages may have been producing dengue vectors for many years in the region. This knowledge could help the development of preventive measures against the disease.

BIRDCAGES SOURCE OF DENGUE VIRUS

Birdcages could provide an ideal environment for the development of mosquitoes that transmit dengue virus to humans.

The mosquito *Aedes albopictus* can transmit more than 20 diseases to humans, including dengue.

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Individuals who get the flu vaccine lose their immunity to the H1N1 influenza virus in about two years, according to an analysis led by The Hong Kong Polytechnic University.

H1N1, commonly known as “swine flu,” was a new flu strain that appeared in 2009 and quickly spread around the world, killing thousands of people. It is now a regular part of the annual flu season.

IMMUNITY FROM H1N1 FLU VACCINE WEARS OFF RAPIDLY

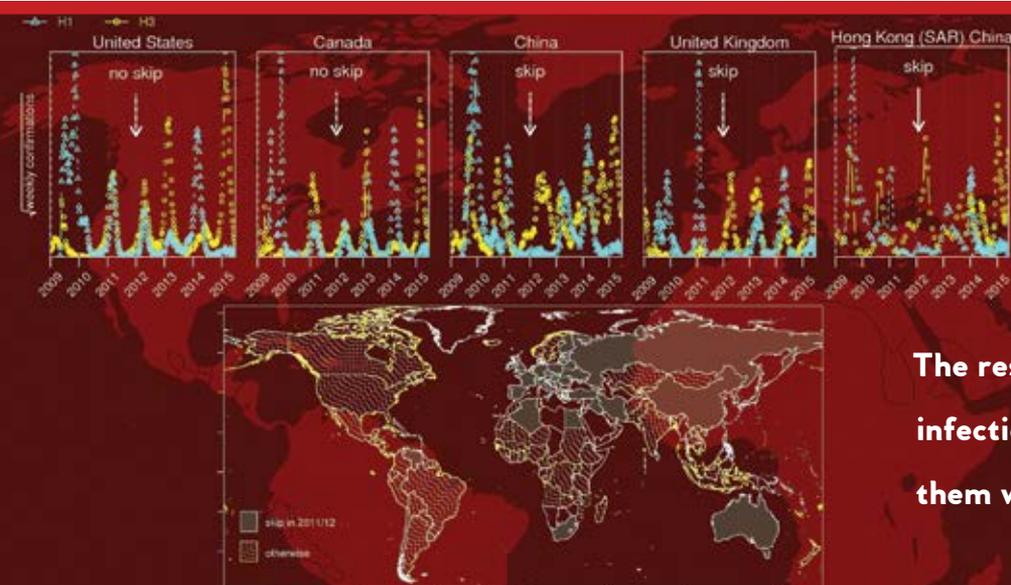
Researchers in China, Australia and the United States used a mathematical model to map the spread of different flu strains between 2006 and 2015 and found H1N1 spread in a “skip and resurgence” pattern in Europe and

The skip and resurgence pattern was observed throughout Europe and Eastern Asia, including the United Kingdom and China. However, North America was noticeably different; there was no skip year there.

The researchers suspect different vaccination policies may play a role.

In Europe, less than 30% of the population gets vaccinated against the flu, compared to almost 40% in the United States and 30% in Canada. Despite its higher vaccination rates, North America had a much higher incidence rate and associated mortality of H1N1 in 2009 than Europe. The researchers believe that vaccination against another major seasonal influenza strain, H3N2, might have slowed the spread of H3N2, reducing competition with H1N1, thus allowing it to gain a larger foothold in the population.

The researchers stress that their results do not justify people avoiding vaccinations. “Vaccination is still the



The researchers mapped the waves of H1N1 infection across the world and compared them with the waves of H3N2 infection.

Eastern Asia. H1N1 was expected to hit again in 2011/12, but no outbreak materialized in these regions. It skipped that year, but came back the next season.

Fundamental epidemiological theory explains this pattern. After the first waves of infection, the population built up immunity and the virus could not explode. But immunity wore off after a couple of years, so enough people were once again susceptible in 2013.

most efficient way to protect humans against the flu,” says applied mathematician Daihai He of The Hong Kong Polytechnic University, who led the study. “More in-depth study on the impact of vaccination policy, more accurate prediction of future dominant strains and the design of better vaccinations is urgently needed.”

The results of this study were published in *Scientific Reports* in 2015.

More in-depth study on the impact of vaccination policy, more accurate prediction of future dominant strains and the design of better vaccinations is urgently needed.

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Researchers report that a common bacterium infecting the human stomach has significant links with worsened symptoms of Parkinson's disease.

Parkinson's disease is the world's second most common neurodegenerative disorder, causing tremors and decreasing motor coordination. Causes are elusive and doctors currently can only treat its symptoms.

Researchers at the University of Malaya analysed a small group of Parkinson's disease patients with and without a common infection of the stomach lining caused by the bacterium *Helicobacter pylori*. Their results showed that those with the infection – about a third of the total – tested worse in motor problems related to Parkinson's disease.

Subjects whose infection could be treated and eradicated showed fewer Parkinson's disease symptoms

LINK FOUND BETWEEN STOMACH INFECTION AND PARKINSON'S SYMPTOMS

in motor performance tests, while those who stayed infected had further declines in their test results.

More than half of the world's population carries *H. pylori*, with the highest infection rates in Asian countries. It affects mucous membranes in the gut and causes chronic infections, often contracted during childhood. The bacterium can cause a range of digestive tract disorders and can linger indefinitely unless treated, although some subjects show few symptoms.

The researchers propose two main theories to explain their results. The first is that the infection may reduce the uptake of levodopa, a drug that reduces symptoms of Parkinson's disease. More speculatively, chronic *H. pylori* infections might aggravate or even trigger Parkinson's disease. However, they also speculate that it's possible that Parkinson's disease may make subjects more prone to contracting the infection.

The researchers say their limited study of 103 subjects aimed mainly to confirm the link between *Helicobacter pylori* infection and Parkinson's disease suggested by previous, less rigorous research. In addition to its size, the study was limited by the fact that it took place in a single Malaysian clinic and that it was cross-sectional; so it was essentially a data snapshot taken at a certain place and time.

But they say the link they found between the infection and worsened symptoms of Parkinson's disease is strong enough to justify further, larger, well-designed clinical trials to confirm it and investigate its causes in more depth.

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More than half of the world's population carries *Helicobacter pylori*, which affects mucous membranes in the gut and can cause a range of digestive tract disorders.

SUPERFILTER NANOMASK PROTECTS FROM INVISIBLE KILLERS

Conventional masks cannot effectively filter nanosized particles such as the influenza A, MERS and SARS viruses, which can cause serious infections, illness and even death.

Scientists have invented an easily breathable nanomask that can filter incredibly tiny particles, such as viruses and air pollutants.

The novel mask, developed by Professor Wallace Leung of The Hong Kong Polytechnic University, is made out of multiple layers of different types of nanofibres, which filter nanosized particles.

Layering the nanofibres provides a large surface area, enhancing the natural movement of particles and their interception by the fibres. It also allows users to breathe comfortably since air flows freely through the multiple layers of nanofibres without much resistance.

Conventional masks made from microfibres cannot effectively filter nanosized particles such as the influenza A virus, or the more seriously damaging MERS and SARS viruses, which can cause serious infections, illness and even death. Many Asian countries also deal with serious airborne particles from pollution and forest fires, which are too small to be filtered by conventional microfibre masks.

Different types of nanofibres can be used in some layers of the mask to provide additional functions. For example, incorporating a layer of titanium dioxide and other semiconductor composite nanofibres in the mask converts pollutant gases, such as nitrous oxide, to harmless substances when the fibres are exposed to visible light, even under room light conditions. Also, incorporating chitosan nanofibres in the mask can provide antibacterial functions when the fibres become wet from sweat, for example.

Did you know?

The influenza A, SARS, and MERS viruses range in size from about 80 to 140 nanometres in diameter. Ultrafine particulate matter suspended in the air originates from combustion and ranges from 10 to 100 nm in size. When these particles gather, they form larger particles several hundreds of nanometres in size and reflect visible light. This is what we know as “smog”. In comparison, the diameter of a human hair is about 100 microns or 100,000 nanometres.

This mask is made from multiple layers of nanofibres, which filter nanosized particles including viruses and particles from pollution and fires.

Dr Leung has also adapted the nanofibre filter for use in airplane and vehicle cabin ventilation systems. Both the nanomask and cabin ventilation filter have been internationally recognized, receiving a Gold Medal in 2014 from the 42nd International Exhibition of Inventions in Geneva and a Special Merit Award from the Romanian National Ministry of Education. Both technologies have been licensed to Avalon Nanofibre Ltd., which has immediate plans to develop and commercialize products based on these technologies to meet market needs.

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Scientists in India have found that garlic extract may be an effective weapon against multidrug-resistant strains of pathogenic bacteria associated with urinary tract infections.

In a study published in the *Pertanika Journal of Tropical Agricultural Science*, researchers at the Birla Institute of Technology and Science Pilani found that even crude garlic extracts were effective against multidrug-resistant strains of bacteria where antibiotic therapy had limited or no effect. "This provides hope for developing alternative drugs, which may be of help in fighting the menace of growing antibacterial resistance," the researchers say.

Urinary tract infection (UTI) is the second most common infectious disease encountered by family physicians. About 150 million people worldwide are diagnosed each year with UTI, at a total treatment cost in the billions of dollars. Although UTI is usually treated with antibiotics, emerging antimicrobial resistance is leading researchers to explore traditional medicines and herbal products for alternative solutions.

Garlic (*Allium sativum*) has been used for the treatment of various ailments since ancient times. A wide range

of microorganisms, including various bacteria, fungi, protozoa and viruses, are sensitive to garlic preparations. Allicin and other sulphur compounds are thought to be the major antimicrobial substances in garlic.

In the study, the researchers found that 56% of 166 bacteria strains isolated from the urine of people with UTI showed a high degree of resistance to antibiotics. However, about 82% of these antibiotic-resistant bacteria were found to be susceptible to a crude aqueous extract of *A. sativum*. According to the researchers, this is the first study to report the antibacterial activity of aqueous garlic extract against multidrug-resistant bacterial isolates from infected urine samples leading to UTI.

The researchers conclude that there is evidence that garlic has potential in the treatment of UTI and perhaps other microbial infections. The team is currently using animal models to investigate the bioavailability, side effects and pharmacokinetic properties of garlic in more detail.

COMBATING ANTIMICROBIAL-RESISTANT URINARY TRACT INFECTIONS



Garlic (*Allium sativum*) has been traditionally used for the treatment of diseases since ancient times.

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Brain maps of people with autism spectrum disorders (ASD) show different levels of connectivity between parts of the brain compared with typical individuals.

Autism spectrum disorder is a group of neurological dysfunctions ranging from hyperactivity to Asperger's syndrome, resulting in challenges in thinking, talking, recognizing and expressing emotion, and social interactions. Researchers at Universiti

Malaysia Sarawak compared

the brainwave patterns of ten individuals with ASD to those of ten typical individuals to try to pinpoint what anomalies might be associated with particular disorders.

The team used a quantitative electroencephalogram (QEEG), which measures electrical activity through 19 electrodes resting on the head during specific tasks. It allows them to see brainwaves that move at different frequencies, creating a brain map showing more or less activity in different regions of the brain.

Overall, individuals with ASD have fewer beta waves throughout the brain than normal, indicating under-connectivity throughout the brain. Decreased beta waves

are usually associated with attention problems, learning disabilities and brain injuries.

The brain maps further revealed ASD individuals had both excessive slow and fast waves in the frontal lobe. This might suggest faulty connections between the front and back regions of the brain.

ASD individuals also had reduced alpha waves in brain regions associated with senses and gross motor movement, which might explain why they could not mimic instructed tasks.

The observations are consistent with other studies using different brain imaging tools, like functional magnetic resonance imaging. The researchers note that by observing specific anomalies with QEEG, clinicians can develop individualized neurofeedback training plans for ASD patients. Neurofeedback training involves measuring an individual's brainwaves and producing auditory and/or visual signals as feedback to the brain to teach it to regulate its own functions. The researchers found that neurofeedback training based on a QEEG-guided protocol was more effective than neurofeedback based on symptoms.

BRAIN MAPS HIGHLIGHT AUTISM DISORDERS

Researchers compared the brainwave patterns of ten individuals with autism spectrum disorders to those of ten typical individuals to try to pinpoint what anomalies might be associated with particular disorders.

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Researchers in Malaysia have tested a combination of screening tools to assess their validity for the early diagnosis of schizophrenia.

Schizophrenia is a long-term mental disorder with a genetic component that involves abnormal interpretation of reality, which can manifest as hallucinations, delusions, and disordered thinking and behaviour. Studies reveal that subtle indications of the disease can be identified long before full-blown psychosis develops. Early diagnosis could help doctors prescribe treatments to prevent the disease's progression.

Screening tools that are commonly used for this purpose involve self-assessments, since the initial symptoms are experienced rather than obvious from people's behaviours. These include subjectively experienced disturbances of perception, cognition, language, motor function, will, initiative, energy level and stress tolerance.

However, used on their own, currently available self-assessments aren't perfect, often producing exaggerated false positive results.

A team of researchers from Universiti Teknologi Mara and Universiti Sains Malaysia developed a two-stage process to screen two groups of people: at-risk relatives of people with schizophrenia and a corresponding sample from the general population. The first stage of the process involved using two common early schizophrenia screening questionnaires on all participants, which produced 190 positive results (29%) from the total number of participants (660) in both groups. Interestingly, a larger number of positive results appeared in the general population (36%) compared to the at-risk participants (21.5%).

However, when the 190 participants who tested positive were given a third questionnaire, only 29 tested positive, nine of whom were categorised as having what is known as ultra-high risk psychosis. Previous research has shown that 30-50% of individuals diagnosed with ultra-high-risk psychosis progress to full-blown psychosis. The remaining positively testing participants were diagnosed through the screening process as having sub-threshold psychosis, the symptoms of which normally disappear over time.

Researchers believe there are two explanations for the very high false positive results from the first stage of the screening process. At-risk individuals might be underestimating their symptoms because of their relative separation from reality, while people from the general population might overestimate their experiences or misinterpret them.

The researchers conclude that clinical assessments or re-interviews should be mandatory following positive self-report questionnaires to eliminate false positive individuals. They also recommend using combinations of self-assessment tools to detect different stages of early psychosis.

COMBINED SCREENING COULD DETECT EARLY SCHIZOPHRENIA

Schizophrenia involves abnormal interpretation of reality, which can manifest as hallucinations, delusions, and disordered thinking and behaviour.

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Credit: Eugene Sergeev*



MICROFILTER ALLOWS NON-INVASIVE DIAGNOSIS OF FETAL ABNORMALITIES

A new method could allow physicians to diagnose fetal genetic abnormalities during pregnancy without the risks involved in current techniques.

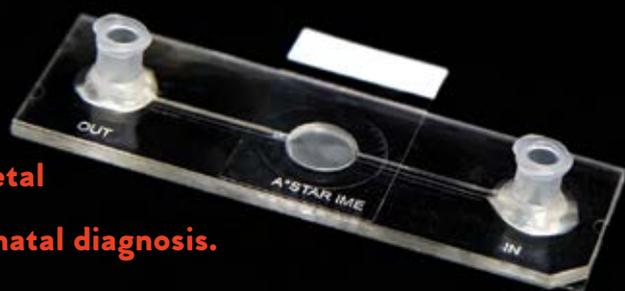
A team of scientists at the Agency for Science, Technology and Research (A*STAR) Institute of Microelectronics (IME) has fabricated a microchip that can filter fetal red blood cells from the mother's circulation. Retrieving these isolated fetal cells could allow the early diagnosis of fetal genetic abnormalities.

The technique, which would require drawing only a few millilitres of blood from an expecting mother, could be used from the eighth week of pregnancy; earlier than current prenatal diagnostic procedures.

Current procedures used to diagnose fetal abnormalities include amniocentesis and chorionic villus sampling (samples are taken from the fluid surrounding the baby or from the fetal side of the placenta respectively). These techniques are invasive and hold small but real risks including miscarriages, injury to the mother or fetus, infection, or induction of preterm labour.

Fetal red blood cells contain a nucleus, making them relatively larger than adult red blood cells. IME's microchip consists of a circular microfilter membrane that contains thousands of microslits. It allows the mother's

IME developed a microfilter contained in a microfluidic chip (25mm X 75mm) to isolate rare fetal cells from maternal blood for prenatal diagnosis.



Credit: Agency for Science, Technology and Research

smaller red blood cells and platelets to pass through while trapping the fetal red blood cells.

Fetal red blood cells normally circulate through the mother's bloodstream but in extremely small numbers – in the range of one cell per millilitre of maternal blood – making them very difficult to isolate. Cells captured in the IME microfilter are treated with dyes that differentiate them, allowing researchers to retrieve and then analyse the fetal red blood cells for genetic defects.

This technique could also be applied to monitor the numbers of circulating tumour cells in cancer patients. If treatments are working, there will be less circulating tumour cells within patients' blood.

The team aims to conduct experiments for preclinical validation of its method until June 2016. After preclinical validations, the researchers hope to determine the number of genetic disorders that can be detected through this technology. So far, two patents have been filed from the project and the IME has been given funding to accelerate the process of bringing the technology to market.

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Brightly fluorescent nanocrystals, called quantum dots, can be used to test the delivery of drugs packaged into nanocapsules.

Drug treatments are made more efficient by delivering them to specific sites in the body where they are needed. For example, specific targeting of anticancer drugs to tumour sites could reduce required doses, provide more sustained effects and minimise side effects. Such targeting is possible by encapsulating drugs in polymeric nanoparticles, or nanocapsules, that transport them through the body to their targets. However, the properties of various nanocapsules and of drugs can vary, and testing the effectiveness of different systems can be difficult.

Some drugs are inherently fluorescent and can therefore be easily visualised, making their transport and targeting easy to track. However, many drugs cannot be visualised in this way, making it impossible to know whether they are delivered to targets appropriately or efficiently. Researchers at the Agency for Science, Technology and Research (A*STAR) Institute of Materials Research and Engineering aimed to develop an effective strategy for assessing new delivery systems.

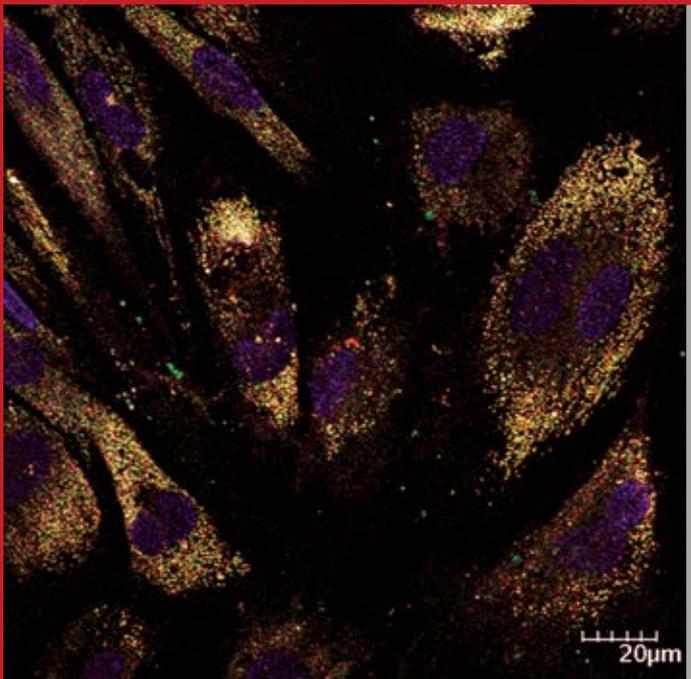
The team first demonstrated that the uptake of a drug by target cells depends on the properties of the nanocapsules rather than the properties of the drug. They packaged the anticancer drug doxorubicin – which is inherently fluorescent and exists in water-soluble and water-insoluble forms – into nanocapsules, and found that cultured cancer cells took up both forms of the drug with the same efficiency.

Drug treatments are made more efficient by delivering them to specific sites in the body where they are needed.

The researchers then showed that when quantum dots – semiconductor nanocrystals that glow when hit by light – were put in nanocapsules in place of doxorubicin, they were delivered to several different types of cancer cells the same way as the drug. The scientists concluded that quantum dots could be used in place of both water-soluble and water-insoluble drugs to test the feasibility and effectiveness of different polymeric nanoparticles as drug carriers.

Having validated their technique, the researchers now hope to qualitatively and quantitatively evaluate possible polymeric nanoparticle systems, thereby enabling improvements in drug delivery.

DRUG DELIVERY THAT HITS THE DOT



Cultured fibroblasts

took up both the
(green) quantum
dots and the
(red) doxorubicin.

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NEWLY SYNTHESISED MOLECULES TURN BACK BIOLOGICAL CLOCK

Most living organisms, including humans, have a biological clock that resets every 24 hours, regulating functions such as sleep/wake cycles and metabolism.

Scientists in Japan have designed new molecules that modify the circadian rhythm, opening the way to the possibility of managing jet lag and improving treatments for sleep disorders.

The negative impacts of jet lag and shift work could be significantly reduced if it were possible to reset our 24-hour natural circadian or sleep/wake cycle. Researchers at Nagoya University's Institute of Transformative Bio-Molecules (ITbM) have taken the first step in that direction by synthesising molecules that can shorten the circadian period. These molecules act directly on one of our "clock proteins", called CRY.

BMAL1, when combined, promote the production of the proteins PER and CRY. These proteins, in turn, block CLOCK and BMAL1, thus closing the cycle. This cycle of activation, production and stop/block goes around once a day and is also influenced by a protein called FBXL3, which flags CRY for degradation by cellular enzymes.

A molecule discovered in 2012, called KL001, lengthens the circadian cycle by competing with FBXL3 for the same spot on the CRY protein, preventing its degradation. By carefully analysing its structure, the ITbM researchers prepared compounds that were similar to KL001, thus synthesising the first circadian



Most living organisms, including humans, have a biological clock that resets every 24 hours, regulating functions such as sleep/wake cycles and metabolism. When this cycle is disrupted, like in jet lag, sleep disorders ensue. Long-term sleep loss may affect the cardiovascular, endocrine, immune and nervous systems with severe consequences including hypertension, obesity and mental health disorders, among others.

Our biological clock is basically run by four "master regulator" proteins that work in tandem. CLOCK and

shortening molecules that target the CRY protein.

This tailor-made approach to designing molecules holds great potential for the future. Takashi Yoshimura, one of the authors of the article, says, "We hope we can make further use of synthetic chemistry to make bioactive molecules that can control the circadian rhythm of animals and gain further insight into the circadian clock mechanism, which will surely contribute to medical applications, food production and advances in clock research."

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GOLD DUST TO CONTROL STEM CELLS

Gold nanoparticles can encourage stem cells in the bone marrow (image background) to differentiate into bone cells.

Researchers in Japan have shown that modified gold nanoparticles can be used to control the differentiation of stem cells into bone.

Stem cells can differentiate into any type of cell in the body and create new tissues to repair injuries. The ability to control the differentiation of human stem cells could improve tissue repair or enable the growth of tissues and organs that could be used for repair.

Research conducted at Japan's National Institute for Materials Science built on previous findings that gold nanoparticles can encourage stem cells in the bone marrow to differentiate into bone cells, and that specific biomolecules can inhibit or promote stem cell differentiation. The researchers attached three different biomolecules – one positively charged, one negatively charged and the other with no charge – to the surfaces of gold nanoparticles. They then used human stem cells derived from bone marrow that would normally become bone cells to test the effects of the nanoparticles on stem cell proliferation and differentiation.

The nanoparticles with the negative biomolecules on their surface promoted stem cell proliferation but suppressed "matrix mineralization": the process that leads to the deposition of minerals into the bone's scaffolding, which makes bones strong. The positively charged and neutral nanoparticles mildly inhibited stem cell prolifer-

ation but had no effect on their differentiation into bone cells. Further investigations revealed that the nanoparticles caused some genes related to the proliferation and differentiation of stem cells to express differently.

The findings demonstrate that gold nanoparticles that are modified in different ways have varying effects on stem

cell proliferation and differentiation. A similar approach could be used to produce an assortment of nanoparticles with a variety of surface modifications designed to control the functions of stem cells in different tissues. Such specific control could enhance stem cell manipulation for regenerative medicine.

The researchers next plan to develop scaffolds that can be used, together with the nanoparticles, to support tissue regeneration.

The ability to control the differentiation of human stem cells could enable the growth of tissues and organs.

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Credit: royaltystockphoto*

Scientists in Korea have developed a protein-scaffolding tool that paves the way for the assembly of diverse proteins with defined structures and functions.

Large protein assemblies have a wealth of potential uses, such as in drug and vaccine development or in the production of chemicals, fuels or agricultural additives. But the sheer complexity of protein structures makes it extremely challenging to understand and assemble them at a basic level.

That may be about to change, say scientists at the Korea Advanced Institute of Science and Technology (KAIST). Their findings form a big step in discovering better ways to build diverse protein assemblies with new structures and functions.

The KAIST team has developed a set of green fluorescent protein (GFP) assemblies with relatively simple, well-defined structures that can be powerful scaffolds for assembling other proteins.

GFP is a fluorescent protein composed of 238 amino acid residues. It is commonly found in some fluorescing marine animals such as jellyfish. Because of its fluorescing properties, making it easy to see, it has been widely used in research.

The team formed the scaffold by taking advantage of the fact that two different GFP units with specific chains of GFP amino acids can be spontaneously linked in a bacterial cell. A GFP monomer was designed to have these two linking units. This monomer then self-assembles with other GFP monomers to form polymers. The researchers discovered that each polymer was organized in a polygonal shape

GREEN FLUORESCENT PROTEIN A POTENTIAL SCAFFOLD FOR PROTEIN ASSEMBLY

resembling a windmill with 2 to 10 blades, each blade representing a GFP monomer. A four-bladed polymer, for example, is composed of four monomers linked together to form a tetramer. The team was able to separate the polymers based on their sizes. Proteins were then genetically linked to the free ends of each GFP monomer "blade".

The team also showed that they could block one link in the polymer "windmill" to create linear chains of GFP units, up to 15 units in length. The researchers were able to link proteins to this new GFP open structure, demonstrating the ability to assemble proteins with varied spatial organisations.

Finally, the team successfully linked antibodies to their polygonal and linear chain scaffolds; something that could, in the future, facilitate antibody delivery to cells.

This is the first time that researchers have managed to form discrete polygonal scaffold structures of functional proteins, allowing the precise spatial assembly of other proteins onto them.

The use of these discrete protein nanoscaffolds will be highly beneficial for future understanding and control of biological processes such as viral entry, cell-to-cell communications and immune responses, the researchers say.

GREEN FLUORESCENT PROTEIN A POTENTIAL SCAFFOLD FOR PROTEIN ASSEMBLY

The green fluorescent protein is composed of 238 amino acid residues commonly found in fluorescing marine animals such as jellyfish.

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Malaysian scientists have provided evidence that a widely used chemical is more toxic to certain blood cell precursors in the bone marrow than to others.

Benzene is among the most widely used chemicals in the world. It is mainly used to make materials such as plastics, rubbers, dyes, detergents and pesticides. It can also be found in automobile and industrial fumes. Its toxic effects on blood cells are well documented and it's known

COMMON CHEMICAL HIGHLY TOXIC TO BLOOD CELL PRECURSORS

Benzene is one of the most widely used chemicals in the world.

to cause different kinds of leukaemia, multiple myeloma and non-Hodgkin lymphoma. However, the exact mechanisms involved in its toxicity are not yet understood.

Researchers from Universiti Kebangsaan Malaysia built on previous research that shows that benzene is metabolized in the liver, then its metabolites are further metabolized in the bone marrow to produce 1,4-benzoquinone (1,4-BQ), which is known for its toxic effects on blood cells. The team studied the effects of 1,4-BQ on "haematopoietic stem cells" (HSCs are stem cells found in the bone marrow that can give rise to any kind of blood cell) and "haematopoietic progenitor cells" (each HPC in the bone marrow can differentiate into only one specific type of blood cell) in mice.

This study provides an experimental system to further understand how benzene metabolites impair the regulation of stem cells.

The researchers exposed mouse bone marrow cells to different concentrations of 1,4-BQ and found it induced cytotoxicity that leads to suicidal cell death, or apoptosis.

They also found that 1,4-BQ was more toxic to HSCs, myeloid progenitors (which give rise to red blood cells and platelets, among others) and B cell lymphoid progenitors than it was to T cell lymphoid progenitors. They also found that 1,4-BQ was more toxic to progenitors that give rise to a single group of blood cells than it was to progenitors that give rise to multiple groups.

No studies to-date have compared the toxic effects of 1,4-BQ exposure on different haematopoietic progenitors, the researchers say.

Although benzene itself is not likely to be toxic to blood cells, scientists believe its metabolites are. This study provides an experimental system to further understand how benzene metabolites impair the regulation of haematopoietic stem cells, the researchers say.

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DAEJEON

Located in the
centre of Korea
with a history
dating back to the
Stone Age, Daejeon
Metropolitan City has,
in recent decades,
established itself as
Asia's hub for science
and technology.

This city of 1.5 million residents lies only one hour away from the capital Seoul by high-speed train and is a convenient 30-minute drive from Cheongju International Airport.

Science, Administrative and Media City

Daejeon is a metropolis with over 250 research institutes, universities and high-tech companies located in specialised zones within the city. It is also the country's second administrative capital after Seoul, housing many central government agencies including the headquarters of the army, the navy and the air force, and is the provincial centre for the media industry.

Culture and Nature

Surrounded by several mountains with Gyeryongsan National Park to the west and streams flowing through the city, Daejeon offers both electric excitement and the tranquility of nature. It is home to the National Science Museum, the Daejeon Zoo, the Daejeon Culture and Art Center, the Gyeongju-Sanseong Fortress, a prehistoric museum and two Confucian academies.

Global Convention City

Daejeon has hosted thousands of international events. In 2015, it hosted, among others, the World Computer Congress and the World Science and Technology Forum, which was followed by an OECD Ministerial Meeting. Upcoming conferences in 2016 include the International Conference on Intelligent Robots and Systems, the International Conference on Space Operations, the Congress of the International Council of the Aeronautical Sciences and more. The Daejeon Convention Center (DCC) is one of Daejeon's premier conference venues. It features 20 meeting rooms, a grand ballroom, two exhibition halls and a guesthouse.

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