

Prepare for the invasion

New diseases are emerging faster than ever, and it's mostly our fault. **Maximilian Larena, Yoichi Furuya** and **Carolina Silva** write

The year was 1918. One of the most deadly wars in history was nearing its conclusion. The world was on the verge of resting from the catastrophic effects of World War I, and yet a new formidable tragedy had insidiously emerged which humankind had never before encountered.

A novel pathogen had spawned. It started spreading in pockets along various continents, resulting in a pandemic disaster of global proportions in a short space of time. In a span of just two years, the H1N1 strain of the influenza virus infected one-fifth of the world's population and killed an estimated 25 to 50 million individuals – more than the number of people who died in the Great War.

This flu virus redefined our view of the capricious nature of disease-causing micro-organisms. The virus, on the whole, affected young and healthy adults, literally drowning them in their own mucus. It restructured family trees, almost wiped out some villages, and paralysed major cities. An organism that had previously caused a simple cold or the common flu suddenly emerged to cause something much more lethal.

The Spanish flu pandemic of 1918 exposed the vulnerability of the human race, its lasting impact causing us to reflect on the risks and dangers of a single-disease outbreak.

Rise of Pathogen Emergence

For the past four decades, we have been faced with a daunting challenge. Approximately 40 new infectious diseases were added to the compendium of human threats during this time.

Pathogens are emerging more rapidly than ever before, at an unparalleled rate of one or more per year. Adding to the burden, these infectious organisms can spread at a much faster pace than was previously recorded, defying most geographical boundaries.

Only late last year, three people from Zambia and South Africa presented with fever, headache, malaise, diarrhoea, rashes and myalgia, followed by rapid systemic deterioration and death.

Preliminary investigations by the National Institute for Communicable Diseases in Johannesburg and the Centers for Disease Control in Atlanta, Georgia, showed that the culprit was a previously unidentified virus belonging to the family Arenaviridae.

On another front, the Ebola Reston virus was detected among a number of sick and deceased pigs in the Philippines. This was the first confirmed case of the virus adapting

from monkeys to pigs. The danger lies in the fact that humans interact more closely with pigs, thus increasing the risk of transmission and adaptation. And, in fact, early this year the Philippine government announced that six people working in pig farms tested positive for the virus. Although their cases didn't result in clinical illness, it is too premature to conclude that the virus poses a low risk. The virus may find an opportunity to thrive and adapt, with severe consequences in immuno-compromised people, pregnant women, children, and those with debilitating medical conditions.

On a larger scale, the emerging H5N1 strain of avian influenza virus poses a serious threat of widespread dissemination comparable with previously known pandemics. Since its first appearance in 1996 in Guandong, China, the virus has been consistently infecting people in a wide-ranging area, from Vietnam, Laos, Cambodia, Myanmar and Indonesia, to Bangladesh, Pakistan, Azerbaijan, Iraq and Turkey, even reaching as far as Africa – Egypt, Djibouti and Nigeria. Each time it appears, it is able to modify itself into a more virulent form. It is able to thrive longer in the environment, expanding its reservoir of hosts into various bird species, from migratory to domestic birds that people are in close contact with. Recent strains of the virus have usually been associated with an aggressive progression of the disease and, often, death.

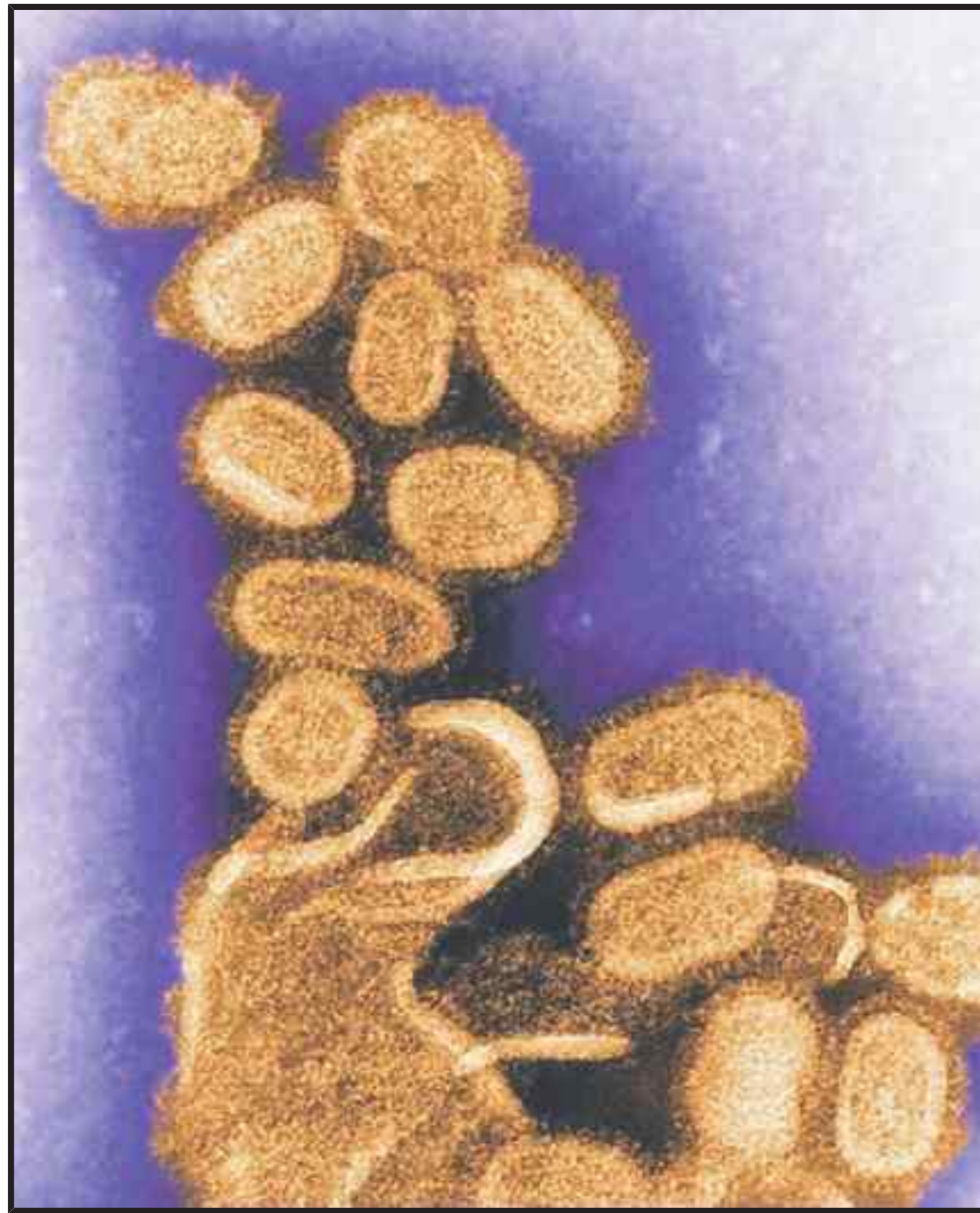
The diseases mentioned above are just the beginning of unprecedented pathogen emergence and dominance. After the successful worldwide eradication of smallpox in 1979, we prematurely celebrated. We looked forward to containing numerous pathogens that had been a menace to humans for centuries. We thought that we had gained control of disease.

Amid many scientific discoveries and technological advancements, smallpox was the last and only pathogen we were able to eradicate.

The vast amount of information we now have has only made us realise how complex and unpredictable the nature of pathogens is.

Factors affecting Pathogen Emergence

In delving deeper into the issue, the reason for the spike in pathogen emergence and the ability of pathogens to disperse widely are largely attributable to our own activities. It is principally our behaviour, as individuals and as societies, that has provided pathogens with a focus for subtle



This negative stained transmission electron micrograph (TEM) shows recreated 1918 influenza virions that were collected from supernatants of 1918-infected Madin-Darby Canine Kidney (MDCK) cells cultures 18 hours after infection. Photos: Centers for Disease Control and Prevention.

transformations and rapid expansion. Increased urbanisation coupled with an uncontrolled boom in population has expanded their host territory. The surge in international travel in recent years has provided them with easy access to previously unexposed communities. In 2006 alone, there were an estimated 2.1 billion airline passengers. A sudden outbreak in one area of the world can be just an hour's flight away from spreading into other distant parts of the globe.

The rise in the number of immuno-compromised hosts has provided an infinite array of opportunities for pathogen transformation. The long list includes an expanding ageing and malnourished population, cancer

patients undergoing chemotherapy, individuals receiving immuno-suppressive drugs and, of course, the scourge of the latter part of the 20th century: the HIV pandemic. Careless and promiscuous human sexual activities expanded geographically the spread of fatal HIV.

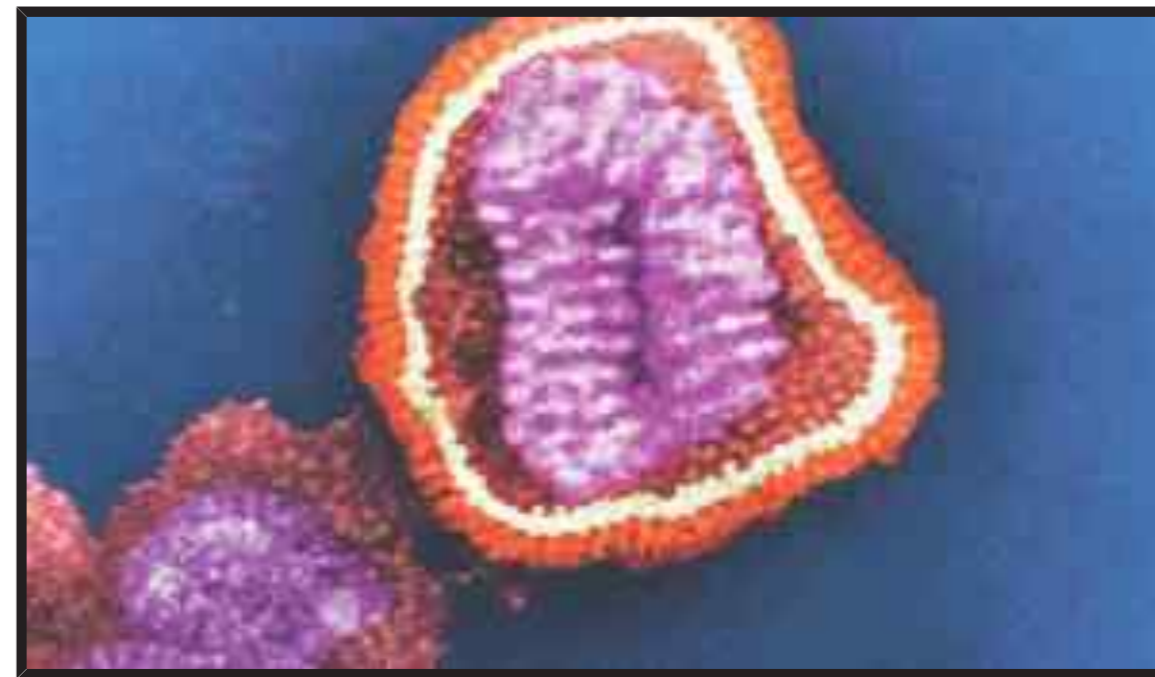
HIV brought in a new catalogue of opportunistic pathogens, whether fungal, bacterial, protozoal or viral. Its association with the indolent but life-threatening *Tuberculosis bacilli* shifted the course of case management. Each accelerates the other's progress, producing a lethal combination for health professionals to combat.

The 2009 global tuberculosis report by the World Health

Organisation revealed that one out of four TB deaths is HIV-related. Tuberculosis is the leading cause of death among patients with AIDS, killing nearly a quarter of a million people each year. Our abuse, misuse, and overuse of the currently available therapeutic drugs have delivered a nesting ground for pathogens to emerge into more resistant forms. The emergence of community-acquired MRSA (methicillin-resistant *Staphylococcus aureus*) was largely attributed to the injudicious use of antibiotics. What was known to be the cause of boils, carbuncles, cellulitis and abscesses gradually surfaced to be a superbug unresponsive to the usual antibiotics. Poor treatment

compliance has led to the coming out of multi-drug resistant *Mycobacterium tuberculosis*. Unwarranted prescription of antiviral drugs in simple cases of respiratory tract infection brought in a resistant form of the influenza virus. This complicates the issue once it emerges as a virulent form with pandemic capability.

The predominant anthropogenic cause of climate change has also had repercussions. The irrepressible soar in global average temperature has created a broader natural environment for the arthropod vectors of infectious micro-organisms. One of these mosquito-borne flaviviruses has resulted in the resurgence of dengue fever in tropical and subtropical areas. It



This negative-stained transmission electron micrograph (TEM) depicts the ultrastructural details of an influenza virus particle, or virion. A member of the taxonomic family Orthomyxoviridae, the influenza virus is a single-stranded RNA organism.



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1. Which is faster: a cheetah or a peregrine falcon?
2. True or false: in computer speak, one nibble is equivalent to half a byte.
3. Theobromine, a chemical in chocolate, is potentially lethal to which domestic pet?
4. Despite their appearance in comic books, sea monkeys aren't primates. What are they?
5. When talking weather, what is a blocking high?

Answers: 1. A peregrine falcon. 2. True. 3. Dogs. The first signs that a dog is suffering from chocolate poisoning are vomiting and diarrhoea, increased urination and nausea. Untreated this can result in cardiac arrhythmias, seizures and death. 4. Brine shrimp. 5. A blocking high is a persistent high pressure system that occurs on a large scale, remaining stationary for a period of time, compressing and warming the air below.

was not until 1999 that a strain of the West Nile virus was able to establish in the US mainland, spreading throughout continental North America within five years. Another encephalitic flavivirus, Japanese encephalitis virus, established itself in mainland Australia in 1998. These recent epidemiologic trends will endure in the coming decades since human-induced climate change coupled with changing socio-economic factors such as increasing commerce, urbanisation, and population growth are projected to continue.

What is more, the ready availability of scientific information poses an ever-present threat. Fundamental extremists may dream of waging fear through bioterrorism. This was exemplified by the mysterious, unresolved case of the anthrax scare just after the September 11 attack in the United States. Publicly available data on synthetic genomics could provide skillful radicals the specifics to construct deadly strains of polio, influenza or Ebola. A virulent pathogen could easily emerge once information ended up in the wrong hands.

Multiple factors set in to augment the emergence and transmission of various diseases. Infrastructure collapse, mass crowding, malnutrition, unsafe water, poor sanitation and disruption to services come together to drive a locality into a public health nightmare. Unfortunately, these conditions often arise in areas of political instability and health inequity. The grave situation in Zimbabwe reflects this undesirable scenario. The cholera epidemic has seriously affected a starving population. It is one of the countries worst hit by the plague of HIV, with a quarter of its population carrying the pathogen.

Future prospects

The threat of emerging pathogens is largely of our own creation. Faced with dire consequences, nations are duty-bound to address the issue in a more comprehensive, constructive and insightful manner. As we have learned from the stories of the past, it is only through a concerted effort that we can combat this type of threat efficiently.

The SARS success story of containment is an example of indispensable collective action. The world requires an international system that can quickly recognise and contain any pending infectious threat. The revised International Health Regulations (2005), instituted by the World Health Organisation, present a global framework to deal with these issues through a collective approach to the prevention, detection and timely response to any public health

emergency of international concern. The regulations list the strategies to reduce panic in the population, prevent economic disruptions of trade and travel, and minimise interruptions to the daily lives of people.

In addition to having in place a coordinated response system, it is vital that substantial funding be allocated to basic and clinical research. Understanding the nature of the threat can lay the foundation for strategic control measures, treatment formulations and vaccine development. Previous funded research has brought in vaccines that have, in certain countries, eliminated diseases such as polio, measles, mumps, rubella, diphtheria and hepatitis. A well-funded, integrated and multidisciplinary research network can provide policy makers with the objective information and efficient measures to address the problem at hand.

An information drive is also vital to increase public awareness. This can include issues such as personal hygiene and comprehensive vaccine coverage.

Lastly, aid given to developing countries to control and eliminate certain emerging diseases is also crucial. This may be in the form of financial support, equipment provision, expert advice and supervision, education and community empowerment. Infectious diseases are still the leading cause of morbidity and mortality in these nations. Considering the modern global village people live in, a disease outbreak in these countries can impart risk to others as well.

In summary, humans have, directly or indirectly, provided opportunities for pathogens to emerge. We may think it puzzling that an organism so minute can outwit us. But these micro-organisms had been living in the environment for a long time before we came along. They were naturally designed to last. They continually adapt, modify and mutate. And the forces of nature have given them numerous advantages that are beyond our control.

We live in a world currently pressed by a range of challenging issues. As we contemplate the tribulations of economic recession, the danger of terrorism and the misfortune of wars, in the end we might just be at the mercy of organisms that are invisible to the naked eye.

The Asia-Pacific region is likely to be the epicentre of new emerging infections and Australia is on its doorstep. All we can do is plan and prepare – for there is a threat. It is imminent. It is going to happen. It is inevitable.

NYSSA SKILTON

BYTE SIZE



Snails are helping pharmacologists better understand the effects of anti-depressants. The key lies in a snail's heart. Dr Michelle Gibson, of La Trobe University in Melbourne, has identified two receptors for serotonin – a brain chemical that can regulate moods – in the snail heart. Snails' hearts have a single auricle, which receives blood from the lung, and a single ventricle that pumps blood to the rest of the body, much like it does in humans. Gibson said snail heart tissue worked as a good model for testing anti-depressants such as Prozac and it was much easier to obtain than human tissue. Her findings were presented to the Australian Health and Medical Research Congress in Brisbane.

About 40 per cent of surveyed Americans fail to check their home for recalled food products, a Rutgers' Food Policy Institute study reveals. The study, based on more than 1000 respondents, also found about 12 per cent reported eating a food they thought had been recalled. Professor of human ecology at Rutgers, the State University of New Jersey, William Hallman, said despite widespread awareness of recent food-borne illness outbreaks, about half of Americans said that food recalls had no impact on their lives. The United States Department of Agriculture and the Grocery Manufacturers Association funded the study.

A Californian researcher has named a newly discovered species of lichen after American President Barack Obama. The organism, which consists of fungus and algae living in symbiosis, was found on Santa Rosa Island in California. The lichen curator at the University of California Riverside Herbarium, Kerry Knudsen, said he named the species *Caloplaca obamae* to show his appreciation for the President's support of science and science education. The lichen, the first species to be named in honour of Obama, grows on soil and almost became extinct during the days of cattle ranching that spanned nearly 100 years on Santa Rosa Island.

A \$200,000 robotic submarine glider has completed a two-month 1500km voyage in the Tasman Sea. The "ocean glider" will play a part in measuring changes in two of Australia's most influential ocean currents: the East Australian Current and the Leeuwin Current. The glider's sensors measure variables such as temperature and salinity as it swims with a porpoising motion to depths of nearly 1km. Senior CSIRO Wealth from Oceans Flagship researcher Ken Ridgway said its trial swim generated new confidence among scientists to broaden the array of instruments available to them to better understand the ocean currents.

NASA scientists have glimpsed their first view of the three-dimensional shape and speed trajectory of powerful explosions from the sun known as coronal mass ejections. The information, collected using twin NASA spacecraft, will help scientists predict if and how these "solar tsunamis" may affect Earth. The brightly coloured phenomena commonly called Northern or Southern Lights are examples of coronal mass ejections disturbing Earth's upper atmosphere. But ejections can produce a form of solar cosmic rays that can be hazardous to spacecraft, astronauts and technology on Earth. The researchers say their new vantage point from the spacecraft has revolutionised the study of the physics behind the explosions.