Remote regions of Australia are rarely studied, but one research group from the School of Biological Sciences has been heading to the Simpson Desert for the last 25 years. This long-distance relationship has endured droughts, floods, fires and flies, but “the iron that gives the sands their brilliant, rusty red appearance must have magnetic qualities – you just keep getting pulled back!” says Professor Chris Dickman.

Chris Dickman and Associate Professor Glenda Wardle head up the Desert Ecology Research Group, who along with Bobby Tamayo, Chin-Liang Beh, David Nelson, myself, students and volunteers make the 2.5 day drive from Sydney to our field sites in south-western Queensland. “The possibility of new discoveries and a genuine curiosity for how a mostly dry environment can support abundant life keeps us keen for more.” says Glenda.

The red sand gets under your skin and we gladly leave city comforts behind and head into the outback to pursue new research questions. Over the last 25 years we have expanded our efforts across the eastern Simpson Desert. The first trip in January 1990 consisted of one 4WD with four people to survey the small mammals, reptiles and vegetation at one site, but now crews head out several times per year. Our annual ‘big trip’ requires four 4WDs and 20 people to survey 12 sites across an area of 8000 km².

More recently, the project has grown with collaborations, such as the Nutrient Network, an international effort to study how nutrients change productivity and diversity in grasslands around the world. Our studies form part of the Long-Term Ecological Research Network and we are collaborating with AusPlots Rangelands and the remote sensing facility, AusCover, all national infrastructure facilities of the Terrestrial Ecosystem Research Network.

When you think of a desert, many people think desolate, but over the past 25 years we have discovered that the Simpson Desert is the most diverse place in the world for reptiles and insectivorous mammals. “The abundant plant life supports hundreds of species of pollinators such as the native bees and wasps, many of them still undescribed. The world below ground is just as rich with burrowing frogs, termites and importantly the seeds that bring new life to the desert after big rain events” says Glenda.

In addition, said Chris “Australian deserts do not ‘behave’ in the same way that other world deserts do. They are especially different from the once-paradigmatic deserts of North America. The high unpredictability of the rainfall regime has probably been a key driver of many of the biological adaptations that characterise our desert biota.”

Continued page 4
Last month the University officially launched the Charles Perkins Centre, a major interdisciplinary centre focused on the chronic human diseases of obesity, diabetes and cardiovascular disease. The School of Biological Sciences is playing a critical role in this exciting initiative. Our Professor Stephen Simpson, whose fundamental work on nutritional ecology of animals from locusts to mice and humans has generated new insights to the causes of human obesity, is driving the program as Academic Director. Other members of the School to be based in the Centre are Professor David Raubenheimer, a nutritional ecologist, and Professor Edward Holmes, an evolutionary biologist focusing on viruses. The School looks forward to active involvement in the research and teaching activities of this new Centre.

It is with great sadness that I report on the passing of our colleague Associate Professor Jan Marc after a long and brave battle with leukaemia. Our students will miss Associate Professor Marc’s effervescent teaching. He leaves a significant legacy to the field of plant cell biology with his discoveries of how the cytoskeleton in plant cells detects environmental signals and how the meristems or growing tips of plants operate.

I hope you enjoy reading the story of Dr Jane Chrystal, the alumni featured in this newsletter, as much as I have (page 7). Jane works in the Central West Local Land Services where she still uses the scientific skills she learned in the School more than twenty years ago.

We have two major alumni events in the next semester. You are invited to the Murray Lecture on Wildlife Wars, exploring situations when people are in conflict with nature. It will be held on 24 September 2014 in the Eastern Avenue Auditorium and it promises to stimulate controversial discussion. For our second event, we look forward to reuniting with our alumni and previous staff members at our first formal Alumni dinner Make your way Back to the School of Biological Sciences on 25 October in the Holme Building. This is your opportunity to reconnect with a favourite lecturer or supervisor. In addition to current members of academic staff, we have a number of retired academics joining us including Roger Carolin, Roz Hinde, Ian Hume, Peter Myerscough, David Patterson, Kathie Raphael, John Thomson and Peter Valder. Please see the back cover of this newsletter for more details about both of these events.

I do hope that I will have the opportunity to meet you at this Alumni Dinner in October.

Best wishes,

Robyn Overall
Amputations, scarring, longer hospital stays, rising mortality rates - the spectre of returning to a pre-antibiotic era is frightening. But Associate Professor Neville Firth is doing more than hoping to avoid this scenario; he is working towards an understanding of multi-resistance which goes beyond finding yet another antibiotic.

'Golden staph' (Staphylococcus aureus) is the most-studied example of a pathogen which has acquired antibiotic-resistance. “Golden staph is carried by about 30% of the population without any problem,” explained Neville. “In the past this pathogen struck down people who were sick, injured or immuno-compromised. But that changed with the introduction of antibiotics, which allowed these people to be saved.”

Over the last 60-70 years, some strains of Golden staph have become resistant to many antibiotics. “We are turning back to the pre-antibiotic era, which most of us can’t remember, but was pretty awful.”

Antibiotic resistance not only impacts on patients with infections. “Many of the modern treatments in medicine rely on antibiotics,” Neville explained. “If we don’t have antibiotics you can’t do transplantation or cancer chemotherapy. If you can’t minimise the risk of infection, it will become too risky to do surgery.”

So how do bacteria become resistant? “In most cases they pick up resistance genes from other organisms. While some resistance is due to mutations in the bacterial chromosome, mostly it’s due to the acquisition of pre-existing resistance genes.”

These resistance genes are often carried on small circular bits of DNA, called plasmids. Neville’s research focuses on how these plasmids ‘survive’ in bacteria and transfer between them. “We look at how they replicate and how they’re maintained,” he elaborated. “A plasmid has to be able to replicate in such a way that when its bacterial host cell divides both daughter cells get a copy. This kind of transmission is called vertical transmission. Plasmids have genetic systems to ensure that plasmid-free cells hardly ever arise.

Horizontal transmission is where the plasmid is passed on to other neighboring cells – and one mechanism for this is called conjugation. “The conjugative plasmids are a particularly important threat because they carry 4-5 resistance genes. So if they transfer to a recipient strain that was sensitive, that recipient becomes resistant in less than an hour and can then act as a donor of the plasmid!”

To recap, antibiotic resistance is bad and the genes for resistance are often carried on plasmids that can be passed around the bacterial party like a plate of sandwiches. But how are plasmids inherited so efficiently? and how do they transfer so promiscuously at a molecular level? Neville investigates the genes and proteins involved in replication, partitioning (moving copies of the plasmids into the daughter cells) and conjugation.

“If we understand the mechanisms in detail – things like the shapes of the proteins that are involved in replication, what they interact with, how they fit together and where they go in the cell – we might be able to design drugs to block those mechanisms.” Lose the plasmid, lose the resistance.

“The traditional approach to dealing with pathogenic bacteria is to develop drugs to kill them.” Another antibiotic. “But we’re running out of these drugs. History tells us that the bacteria will eventually become resistant to any new drugs, and they’re doing so faster than we can develop new antibiotics.” Neville’s approach is different. Rather than trying to kill the bacteria, he wants to develop drugs to combat the evolution of antibiotic resistance.

“These drugs will not be treatments to cure people; instead they will be agents to prevent resistance developing so quickly. And because they don’t actually kill the bacteria, they are not selecting for resistance.” Neville envisions these drugs being used to ‘disinfect’ wards in order to minimise resistance plasmids in the environment.

“They won’t be a substitute for new antibiotics but they will prolong the useful life of antibiotics.”
One clue to why males die earlier and are less fertile than females across many species has been explored by Professor Madeleine Beekman. “We found evidence for mitochondrial effects on male fertility and longevity.”

Mitochondria are inherited from one parent, in the vast majority of organisms, through the female. “Males don’t matter to mitochondria because they are never transmitted via the male line. Therefore, in evolutionary terms, mitochondria couldn’t care less about their effect in males, even if that means their presence harms males.”

Published in Philosophical Transactions of the Royal Society B on 26 May 2014

Surveillance cameras have been integral to unravelling the complex relationships between the predators of the desert. In particular, during boom and bust cycles of rain.

Aaron Greenville from the Dickman lab said, “During droughts, dingoes suppressed the introduced red fox and cat.” However after rain, as populations of rodent prey boomed in number, this relationship broke down - the surveillance cameras showed an increase in all predator populations. “As prey populations declined and fell back to drought levels, the interaction between dingoes and the smaller introduced predators began again.”

Published in Oecologia on 8 June 2014

Camera installation, Simpson Desert. Photo by Alan Kwok

Aphelid infection of yellow-green alga cells. Photo by Professor Sergey Karpov.

Who am I? I am a parasitoid of algae. I can be found in fresh water or marine environments. My taxonomic classification has recently been re-organised within the superphylum Opisthosphorida. Who am I? I am Aphelidea!

Dr Osu Lilje, Dr Frank Gleason and colleagues in Russia have investigated the life-cycle, morphology, ecology and molecular phylogeny of the aphelid species. Their findings resulted in a taxonomic revision of this small group of intracellular parasitoids.

Published in Frontiers in Microbiology (Aquatic Microbiology) on 28 March 2014

Published in Philosophical Transactions of the Royal Society B on 26 May 2014

(Continued from cover) “Large rainfall events can be – paradoxically – very bad for many native species and communities because they provide windows of opportunity for invasion by weeds and pest species. You need to be there long-term to document and understand the changes that occur” says Chris.

Even after 25 years there is still more to learn. “We still have to discover how to use the desert regions in a sustainable manner, how to effectively manage the threats to their biological riches, such as from introduced predators and feral herbivores, and what will be the effects of climate change on the character and composition of deserts in the future” says Chris.

The many people who have joined us over the years have contributed to the work and the social life of our desert trips and we thank them for enriching our experience and helping us to deliver new knowledge to help sustain this important ecosystem.

Camera installation, Simpson Desert. Photo by Alan Kwok

Aphelid infection of yellow-green alga cells. Photo by Professor Sergey Karpov.
LET THEM EAT PLACENTA

Reptiles may need plentiful food to evolve placental feeding

BY JESSE HAWLEY

Egg laying or live birth, yolk or placenta — reptile mothers have evolved a wide range of solutions to the problem of providing nutrients to their developing offspring. But each method has its own drawbacks. For species that nourish their young through the mother’s placenta, rather than through the yolk, plentiful food might be a necessity.

Reptiles have evolved live birth over 100 separate times. In lieu of external eggs, offspring of live-bearing species are nourished internally with yolk sacs. However, at least six times in lizards and once in our own mammalian evolution, reptiles evolved a complex placenta capable of transporting nutrients to developing offspring.

Placentotrophy (placenta = ‘cake’ and trophé = ‘nourishment’) may have evolved to overcome the costs of yolk provisioning. Lizards that allocate yolk to their young do it en masse and prior to ovulation so that developing offspring have all of the nutrients they need. This safeguards the embryos against resource fluctuations said Dr James Van Dyke, lead author of the paper published in The American Naturalist. “However, this means that the mother has to carry the equivalent mass of all of her offspring, in yolk form, throughout embryonic development... which might reduce her ability to forage, or to escape predators,” said James.

If the young could be fed exclusively through the placenta, the female need only be burdened with baby’s maximal weight at the end of gestation. “However,” explained James, “this requires that females be able to successfully forage throughout pregnancy, so that they can replace all of those nutrients that were once present in the yolk. And this is what our experiment tested.”

James’ study used Southern Grass Skinks, a placentotrophic species, to test the effects of food limitation on maternal and offspring fitness. When food was limited, the female skinks had reduced success in offspring development. This is in contrast with skinks that use yolk to nourish their young, which are unaffected by food limitation. This suggests that in order to evolve placentotrophy, resources must be constantly available during pregnancy.

Placentotrophy is dynamic however, when resources do fluctuate, the mother can abort and cannibalise her embryos to regain precious nutrients.

The reproductive system of the Southern Grass Skink may be analogous to the transition our own ancestors went through around 200 million years ago. Studies such as this one help to answer the origins of our own placental arrangement.

CHILLING DISRUPTS POLLEN FORMATION IN WHEAT

BY JESSE HAWLEY

In Australia, wheat is sown during autumn in order to avoid growth in our intense summer. Yet this leaves the plants exposed to frosty night temperatures in late-winter and early-spring.

It has been known for some time that pollen formation in wheat is disrupted by frost leading to significant losses in yield. However the Overall lab in the School of Bioiological Sciences had shown that, in the case of rice, chilling overnight to just 16°C also disrupts pollen formation thereby decreasing yield. The Grains Research and Development Corporation asked them to determine if pollen formation is wheat might also be disrupted at non-frost low temperatures. Such temperatures (0-2°C) occur regularly overnight while wheat is flowering in the Australian wheat belt. A study, just published in Plant, Cell and Environment from the Overall lab, has investigated the effects of low non-frost forming temperatures (0-2°C) on Australian spring wheat cultivars. Lab-tested cultivars were found to be most vulnerable during pollen production, leading to a reduction in grain yields.

Low temperatures usually denature the spindle involved in sex-cell division, but this did not occur in the analysed cultivars. Instead, cold temperatures induced the cells to shrink away from their cell walls and in some cases the genetic information travelled freely into neighbouring cells, reducing overall fertility. Interestingly the cold affected only anthers, the male reproductive organs. Female components were unaffected by chilling.

Armed with this new information, farmers in regions in which temperatures of 0-2°C regularly occur during August, the common time for wheat flowering, may delay the time of sowing.
VALE JAN MARC

Associate Professor Jan Marc passed away in March after a long and brave battle with leukaemia. Jan has been a member of the School since 1992 and was a very popular teacher to countless undergraduate students.

Jan was an inspiring teacher and supervisor. His undergraduate students were uniform in their praise for him. He enthusiastically demonstrated in lectures with a variety of props and often used his body to demonstrate a point. Jan was famous for doing a jig to demonstrate how chromosomes move during cell division and for asking students “Have you thanked a plant today?”

Jan made major advances to our understanding how plants grow and respond to their environment. During his PhD he described the precise pattern of cell divisions that underlie the development of the patterns seen in sunflowers. However the focus during his career moved to increasingly finer detail. For the last two decades he investigated the factors that regulate the precise positioning of fine filaments just inside the plant cell known as microtubules. He helped show that these filaments control the orientation of the cellulose in the plant cell wall which ultimately gives the plant cell its shape as it expands. With a colleague in the US, Jan was the first to tag microtubules in plants with green fluorescent protein so that the microtubules can be seen in a living cell. This technique is now used routinely around the world.

Along with his students, Jan also identified a protein that links the microtubules to the outside the environment - phospholipase D. But Jan called it ‘the smart link’ because it is able to detect signals in the environment and pass this information onto the microtubules inside the cell. In this work, he discovered some of the molecular details of how plant growth is controlled by the environment.

Jan’s scientific contributions will live on through the students he has trained and the papers he has written, which will continue to be cited into the future. Jan’s students will also continue to remember him by his triceratops doorstop, Mickey Mouse watch and rubber chicken conversations.

SHOWING THE WAY TO HIGHER EDUCATION

Studying at university can seem an unlikely option for some high-school students. Not because they are not capable, but because no-one in their family has ever been, or they live remotely, or they are confused about what career they will have afterwards.

The University of Sydney program, Compass, encourages students from backgrounds traditionally underrepresented to participate in higher education. The School of Biological Sciences participated in two recent Compass programs and created experiences and opportunities for these high-school students. The programs were STEM ‘A Day of Inquiry’ and the Bunga Barrabugu Summer camp. At the STEM day over 80 year nine students were set the task of radio tracking animals hiding around the university. This day was about discovering professions, industries and sectors that employ science, technology, engineering and mathematics graduates.

The Bunga Barrabugu Summer program targeted indigenous students in years 11 and 12. Those that selected the science-stream of the five day camp began the week in the lab with biology. They extracted DNA, ran an electrophoresis experiment and asked loads of insightful questions. We hope all the students we’ve seen over the past few months find their way to uni! sydney.edu.au/compass/
ALUMNI PROFILE: JANE CHRYSTAL

Approaching problems with an evidence base and with scientific inquiry are fundamental to Dr Jane Chrystal’s (BSc 1982, PhD 1989) natural resource management philosophy.

Dr Chrystal is the Manager of Strategic Land Services at Central West Local Land Services. She began her career focusing on molecules but now works on the scale of landscapes – and how the community works with them.

Your PhD with Professor Tony Larkum investigated photosynthesis in algae. What aspect of photosynthesis were you exploring and what did you find?

I studied the biochemistry of algal light-harvesting systems. Pigments in plants (and algae) capture light energy, then pass it through photosystems I and II. I was looking at the pigments and proteins within the light-harvesting systems of a primitive algae. I wanted to understand how the pigments and proteins are arranged, and if they absorb light in the normal range of higher plants or something different. I found there were some unusual overlaps in the energy that the pigments absorbed and emitted. Also, what I discovered highlighted how some of the pigments may have evolved from the primitive algae to higher plants.

After my PhD, I did a post doc with Robyn Overall using electrophysiology to look at sea urchin’s embryology and development. It was a completely different field to my PhD. I hadn’t worked on animal systems previously but it was a lot of the same principles – getting the bathing solutions right and being patient!

You also completed a Master of Commerce. What drove this decision?

I decided to move out of science research and into science policy. I worked for the NSW State government in the Environmental Protection Authority, particularly in water policy. I worked on both the water quality guidelines and the environmental flow guidelines for Australia. My water policy activities covered all sorts of topics – including the use of lead shot in duck hunting. Following a hunting season there can be tons and tons of lead in a lake and I looked at what to do about reducing that damage.

One of the things that became obvious to me was that the scientific evidence was there, but it was the economics that was driving the decision making. So I decided to study economics to find out how these two worlds could meet – how we could make sure that the science could be used more effectively within decision making in environmental policy. I then moved into environmental economics and worked a lot with industries looking at how to reduce pollution using economic instruments.

What is a ‘knowledge broker’?

In lots of big environmental issues there is misinformation, there are people who have different points of view or who want to lobby for a particular position. The knowledge broker gathers the scientific evidence, which may include commissioning more research, and then makes sure all the community members involved in the issue have an understanding of what the science is and how it can be interpreted. They also bring together landholder, local community, aboriginal and local government knowledge to solve problems.

I was doing this in central west NSW where I was involved in a three-year project about invasive native scrub. I really saw the need to bring lots of different skills together to address environmental and natural resource management issues. That was where I started in what was then the Central West Catchment Management Authority [now the Local Land Services].

And I stayed here because there was lots of work to be done.

What is the Local Land Service organisation responsible for?

The Local Land Services works to coordinate natural resource management, agricultural advisory services, biosecurity services and emergency management and response. It is a multidisciplined group of people working to make it easier to do agriculture in NSW. Basically, we work together to enhance the resilience of our landholders and the broader community.

Do you think the landholders are interested in working with the scientific evidence for best practices?

Absolutely. Many landholders are very scientific in their approach. But what they need is access to unbiased evidence. They need relevant information, and principles they can apply in new situations.

What is your role at Central West Local Land Services?

I am part of a team of about 80 people. My group covers strategic and regional planning, and monitoring, evaluating and reporting on what we do. My group is also involved in communication. We want to know the best way to get information out to people. For instance, do people like social media or print publications? Do they want a phone call or a chat in the paddock? Do people want to come to meetings? It’s a case of understanding the communication needs of different people in the community and using that to get information out.

The best part of this job is a sense of making a contribution to the community, particularly the agricultural sector.
EVENTS

MURRAY LECTURE - WEDNESDAY
24 SEPTEMBER 2014

Wildlife Wars (co-presented with Sydney Ideas)

Dingoes are shot for eating our sheep; sharks and crocodiles are ‘culled’ for chewing on humans. All around us people are in conflict with nature. When humans are either on the menu, or being forced to share it, our response reveals our recent evolutionary history as both a food source and a competitor.

It is within this framework that Professor Justin O’Riain (University of Cape Town) explores the widespread conflict between humans and wildlife species that are adjusting to life in the Anthropocene (the current geological epoch that acknowledges the impact of humans on Earth). With reference to recent research on species as different as baboons and white sharks, O’Riain uses his training as a behavioural ecologist to explore the drivers of the human-wildlife conflict. In the search for possible solutions we are forced to grapple with the uncomfortable contradiction between current conservation efforts and our determined march towards global economic security.

VENUE: Eastern Avenue Auditorium, The University of Sydney.
TIME: 6:00pm-7:00pm, with a cocktail reception to follow.

ALUMNI DINNER - SATURDAY 25 OCTOBER 2014

Make your way back to the School of Biological Sciences and re-connect with your lecturers, supervisors and former lab mates. Join academics, past and present, for a delicious dinner in The Refectory. Limited seats so don’t delay!

VENUE: The Refectory, Holme Building, The University of Sydney.
TIME: 6:00pm-9:30pm
COST: $50 for alumni and $90 for guests, includes canapés on arrival, two course seated dinner, wine and beer.
REGISTRATION: sydney.edu.au/science/biology/alumni/dinner

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