The Allan Wilson Centre Newsletter

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Are Evolutionary Naïve New Zealand Lizards Still Under Threat?

Did you know that New Zealand is home to about 70 different species of reptiles? The tuatara, skinks and geckos that make up our reptile fauna are found only in New Zealand.

On the main islands of New Zealand, reptiles are now quite rare, and most people only see the occasional brown skink (often courtesy of the cat). But before people arrived, the land and trees would have been alive with reptiles. Unfortunately, many of our unique reptiles have been devastated by the introduction of mammals to New Zealand. Until humans arrived, bats were the only terrestrial mammals present, and they eat insects rather than reptiles. So when rats, cats, mice, stoats, ferrets, weasels and other mammals arrived, it is unlikely that New Zealand lizards knew how to avoid predation from these foreign animals.

Now a third of New Zealand lizards can be found only on offshore islands (such as North Brother Island) where mammals are absent, and many more are restricted to a few small areas on the mainland.

Mammal-free offshore islands now act as refuges for many endangered reptile species, and have become targets for conservation. Stepping onto an offshore island around New Zealand is like stepping into an ancient world – a chaotic world full of noisy birds, and a lively world where skinks dart between tussocks and green geckos can be spied as jewels amidst green bushes. Such islands provide a glimpse of a pre-human New Zealand and an idea of the ecological systems that operated in the past.

On mammal-free offshore islands, the dominant predators of New Zealand

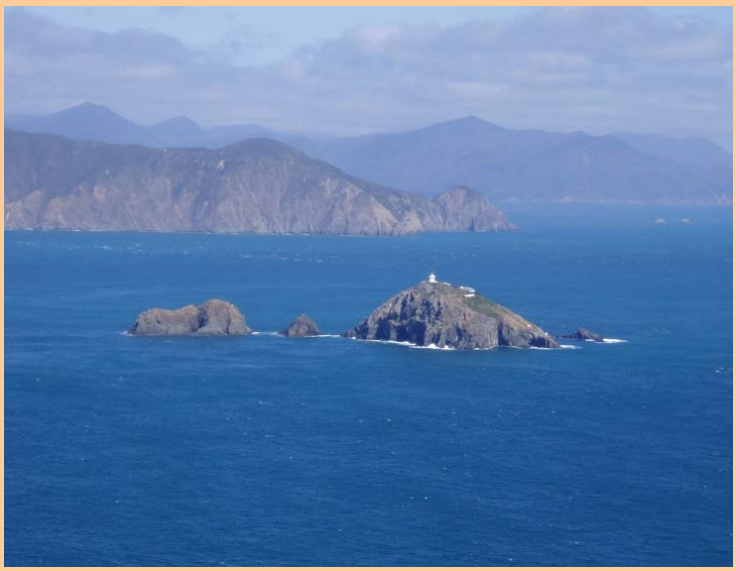

Photo credit: Joanne Hoare

Figure 1: Mammal-free offshore islands, such as North Brother Island located in Cook Strait, act as refuges for many endangered reptile species.

lizards are birds and tuatara. These animals hunt primarily using vision, which may explain the evolution of cryptic colouration (camouflage) and secretive behaviour in our lizards. In contrast, introduced mammals often use scent to detect prey.

New Zealand's history of isolation from predatory mammals and subsequent recent introductions, give a unique opportunity to investigate behavioural aspects of the simultaneous evolution of predators and prey.

Between November 2003 and June 2005, Joanne visited four sites: mammal-free Stephens (Takapourewa) and North Brother Islands in Cook Strait, and mammal-present Pukerua Bay and Turakirae Head near Wellington, with the aim of investigating how New Zealand's mysterious lizards perceive their world.

Specifically, Joanne was aiming to address the question of whether New Zealand lizards use their sense of smell to detect and avoid potential predators. To answer this question, she tested the behavioural responses of lizards to the scent (urine) of native (tuatara) and introduced (rat) predators in the laboratory, and statistically analysed the behavioural patterns to assess differences.

Behaviour of lizards did not differ according to the various scent treatments. Thus it seems that mammal-naïve lizards do not use scent to detect predators, which may partially explain their extreme vulnerability to mammalian predators.

However, Joanne found significant behavioural differences between lizard populations according to their predation regime (natural or modified), which may indicate micro-evolution where introduced mammals are the primary selective agents. Skinks and geckos that can be seen on the mainland now represent the relatively few survivors of the mammalian invasion of New Zealand.

Joanne's next step is to investigate the use of microhabitat by nocturnal geckos in the presence and absence of introduced rats in order to further investigate behavioural and ecological differences between "mammal-aware" and "mammal-naïve" lizards.

Research into behavioural and ecological changes evoked by introduced mammals should help to predict the future of the lizards that still manage to live on our main islands and contribute to progress in ecological restoration.

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Figure 2: Reptiles of New Zealand include the Common gecko (above left), the Common skink (above centre) and the Tuatara (above right) which is a native predator of lizards. Photo credits: Joanne Hoare

Ultimate Origins - How Did Life Begin?

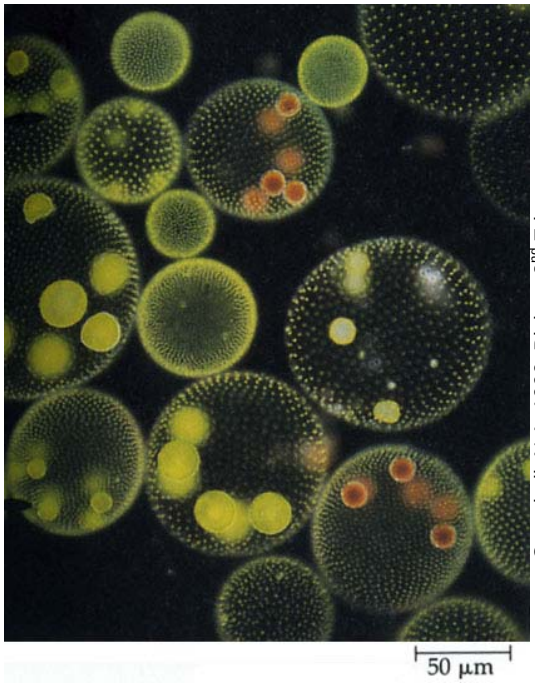
The wonderful diversity of life on Earth today is the result of billions of years of gradual evolution. A great deal has been discovered about the processes and changes that have occurred in the vast stretches of time since the beginning of life, and how the processes of evolution might occur. But one long-standing mystery still remains - how did life begin in the first place?

Professor Mike Steel, Director of the University of Canterbury's Biomathematics Research Centre, together with colleagues in the Allan Wilson Centre, has been using maths to help investigate the mysteries of the beginnings of life.

Many theories on how life began have been proposed, ranging from the heat of deep-sea vents to life arriving from other planets. One theory, however, suggested by biochemist Stuart Kauffman, proposes that if any mixture of the right sort of chemicals is complex enough, then under the right conditions the emergence of life is actually almost a certainty.

The key is the emergence of an 'autocatalytic set' - a group of molecules which can replicate themselves. This ability to reproduce unaided is, in fact, the key difference between life and non-life; living things can reproduce themselves, whereas non-living things can not. Once a self-replicating set of molecules emerges, then over many generations it can change and become more complex, eventually leading to intricate forms of life such as ourselves.

Professor Steel has been using maths to investigate Kauffman's idea, with the aim of answering questions such as: What is the probability that a complex 'soup' of chemicals could start to develop into a simple life-form by chance? Under what conditions could this occur? And what order are the steps in the emergence of self-replicating sets of molecules?



source: Campbell, N.A. 1990 Biology 2nd Ed.

By using computer simulations and mathematical arguments based around probability theory, Professor Steel has developed a method for detecting self-replicating sets in any chemical reaction system. This method has been used to look at the conditions under which the simplest life forms would emerge. For example, certain molecules catalyse reactions which are needed for a system to be self-replicating, and so a range of molecule types are necessary in a mixture for there to be a high probability that simple life-forms will develop. The research revealed a surprising result - that the amount of catalysation needed for self-replication is actually far less than Kauffman had assumed.

Future work will involve the use of DNA from primitive bacteria to try to unravel some of the processes that occurred soon after the beginning of life – another step in unravelling the mystery of our ultimate origins.

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Information about Proffessor Mike Steel's research can be accessible from: http://awcmee.massey.ac.nz/contacts_staff.htm

Stuart Kauffman's latest book: "At Home in the Universe: The Search for the Laws of Self-Organization and Complexity" (1995) can be purchased online at: http://www.oup.com/us/catalog/general/subject/LifeSciences/?view=usa&ci=0195095995#

The International Biology Olympiad

The Allan Wilson Centre recognises the importance of developing an interest in biology right from the school years and for this reason was actively involved in the 2005 International Biology Olympiad. The Centre assisted by sponsoring the travel of qualifying students to attend a Workshop over the winter school break in Auckland, and in the training of the students over that period. The Centre also made sure that the members of the New Zealand team were instantly recognisable by printing T-shirts and polo shirts for those chosen to travel to China to represent New Zealand.

In 2005 New Zealand entered its first-ever team in the International Biology Olympiad (IBO) competitions, held this year in Beijing, China. The IBO is a competition for secondary school students, which tests students' skill in tackling biological problems and dealing with biological experiments.

This involves a week-long programme of intense scientific competition. Competitors sit six hours of practical laboratory exams on one day, followed by another six hours of theory exams on a second day. As you can imagine, this is an extremely stressful event, and so team selectors must look not only for students with the necessary academic qualifications and skills, but also for those with the personal qualities that allow them to perform under pressure. Not only are the students working in a pressure-cooker environment: two adults from each country travel with their teams – one a theory and one a practical examiner.

Before the students sit the exams, the examiners themselves are sequestered for many hours at a time, determining the fairness and validity of each and every question. This sometimes takes until 4am on the day of the exam, after which the team of examiners then meet to review the students' answers and performance. The accompanying adults are definitely not along for the ride!

Obviously we needed to ensure that the best possible team was chosen to represent New Zealand in the IBO. This is done through the NZ International Biology Olympiad (NZIBO), which in 2004-05 consisted of 3 phases:

1. Over 70 top students, from all over New Zealand, entered a national exam, held last October. The top 30 students had their achievement recognised with bronze medallist certificates.

Figure 1: The top 13 students (silver medallists) went forward to the practical training camp.
Photo credit: Courtesy of Jules Robson

2. We then ran ten theory tutorials from December 2004 – March 2005. These tutorials were designed to begin to bring the students up to speed with the level of knowledge that would be expected of them in the Olympiad itself. The tutorials were followed in March 2005 by an IBO theory exam. The top 13 students (silver medallists) were determined on the basis of this exam, and went forward to the practical training camp held in Auckland and Hamilton in April 2005. (Figure 1).

Our sincere thanks to the Allan Wilson Centre and Waikato University, as well as Massey University, UNITEC and Kings College, for hosting and funding the event.

3. At the practical camp the students learned a wide range of laboratory techniques and practical skills, in preparation for the practical exams. They were assessed on their ability as well as how they performed under pressure. The final New Zealand International Biology Olympiad team (Gold medallists), selected at the end of this camp, were Eric Liu, Cameron Cole, Chinthaka Samaranayake and Kate Duggan (Figure 2). They travelled to Beijing with 2 teachers (Max Thompson and Angela Sharples), who represented New Zealand on the IBO examination jury panel.

Angela's diary of the trip makes it clear that both students and examiners were under huge pressure to perform – but they also found time for water fights, shopping trips, and a tour of the Great Wall. Not only was the trip a wonderful experience for all concerned but – on our first attempt in this highly competitive international event – the team brought home two bronze medals! Congratulations to Cameron and Eric on this achievement, and to Chintaka and Kate, who missed out on the medal placings by just a single mark.

China was the top-ranked country overall, with NZ in the middle of the International ranking. This is a great result for a first attempt, especially when you consider that we only had a few months to prepare our students! We've learned a great deal from the experiences of the team, and from Angela and Max in their capacity as examiners, and this will all go towards improving and enhancing our preparations for the 2006 event.

The 2006 International Biology Olympiad will be held next July in Argentina, and the 2006 NZIBO entrance exam will be on Wednesday 12th October 2005.

This year we'd like to see even more students enter, from right around the country. Entry forms will be sent to schools at the beginning of Term 3. For more information about these exams, or about the NZIBO, please contact the NZIBO secretary: heatherm@inspire.net.nz

Jules Robson
Biology Educators Association NZ (BEANZ)

Figure 2: The New Zealand International Biology Olympiad team:
(left to right): Kate Duggan, Eric Liu, Cameron Cole, and Chinthaka Samaranayake
Photo credit: Courtesy of Jules Robson

The Dating Game – How Do Tuatara Choose Their Mates?

As most of us are aware, the dating scene can be tough – and it is no different for tuatara. Before mating can begin, males must compete with each other for access to females, defend territories and undergo intricate courtship rituals. Females too, may have a tough choice to make in finding the perfect partner.

PhD student Jen Moore from the School of Biological Sciences at Victoria University, together with colleagues at the Allan Wilson Centre, is studying the mating system, mate choice and territoriality of tuatara.

Sexual selection theory has generated a long-standing interest in the mechanisms underlying the mating processes. The aim of Ms Moore's research is to better understand how the tuatara mating system works and what effects it has on the fitness - the ability to transfer genes to the next generation - of the species.

As part of her research, Ms Moore has been able to capture on video, detailed mating behaviour and sperm transfer of tuatara on Stephens Island. Courtship on this island begins around January, which correlates with elevated testosterone levels in males at that time. Mating follows and continues until March or April. "I was very happy and surprised to witness 25 matings," she said. "I also tried to video tape all mating behaviour and territorial or courtship interactions, to attempt to better understand specific behaviours involved in mating." So far, the research has confirmed that the tuatara mating system is 'polygamous', where multiple males mate with multiple females, and vice versa. It has also been revealed that the same pairs will mate more than once in a season. This has, of course, raised many new questions. "It will be interesting to see what happens during mating next year," said Ms Moore.

photo credit: Nicola Nelson

The results to date include a detailed video of sperm transfer, which has never before been seen. The researchers also think that certain behaviours, particularly by males after copulation, may have a very different function than was previously thought.

In November, Ms Moore plans to radio-track females, who are known to have mated, to their nests and following a 12 month incubation period, will take DNA samples from the hatchlings to determine who the father is. This will then be related back to what was observed in March, during mating.

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The Heat is On - How Will Tuatara Survive Global Warming?

One of New Zealand's most unique and treasured icons, the tuatara, has survived an almost unfathomable span of time. Their continued existence, however, depends upon their ability to maintain a healthy breeding population in the face of environmental changes such as global warming. How will tuatara adjust when the heat is on?

Dr Nicola Nelson from the School of Biological Sciences at Victoria University, together with colleagues in the Allan Wilson Centre, has been conducting research to investigate how tuatara will cope with global warming. Dr Nelson works with the Department of Conservation and Ngati Koata Iwi, and is funded by the San Diego Zoo.

"Tuatara are reptiles with temperature-dependent sex determination", said Dr Nelson. This means that males are produced from warmer nests, and females from cooler ones. This poses a potential problem for the species, "because if it's supposed to get warmer, will we get too many males?"

The fact is, however, that tuatara have already survived through many changes in global temperatures. "Tuatara have been around since the time of the dinosaurs, which has been a huge period of climate upheaval, and they've managed. So they must be doing something right" Dr Nelson explained.

Just how they do manage is the subject of Dr Nelson's research.

The key is believed to be in the behaviour of female tuatara, who may adjust their nests based on environmental cues. Working with a natural population on Stephens Island in Cook Strait, Dr Nelson is observing female nesting tuatara and monitoring temperature changes over the months that the eggs are in the ground. Observations are made of natural diversity in temperatures and nesting characteristics, female nest choice, and the resulting sex ratios of the juveniles that are produced. Studies are also being made of whether individual females behave differently in different years, depending on environmental cues.

"As we monitor more, we can see that they can get an even sex ratio" said Dr Nelson. "It's a really robust system so long as they are able to nest in variable conditions." As this is a five-year project, the next step is to translate the research to other islands, and to investigate the implications for conservation management.

Dr Nelson thoroughly enjoys working with tuatara in their natural environment. "On Stephens Island there are tuatara everywhere. You have to watch where you stand. It gives you a hint at what it would have been like around the mainland before humans arrived. They're just there, doing their thing."

photo credits: Nicola Nelson

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Molecular Biology and Evolution Conference 2005

The MBE Conference was recently held at the Aotea Centre, Auckland (19-23 June 2005).

Five hundred biologists from 28 countries made this the biggest conference in this field ever held in New Zealand. Molecular Biology and Evolution 2005 was hosted by the Allan Wilson Centre and attracted strong participation from academics across the world. Pictured at the Aotea Centre are a group of biology professors of international reputation (see below).

This international meeting was hosted by Massey University scientists from the Allan Wilson Centre for Molecular Ecology and Evolution. At the initiative of Professor David Lambert and the Allan Wilson Centre, this event was held for the first time in New Zealand, significantly boosting the international profile of researchers in this country.

Keynote speakers were experts in the various disciplines of molecular biology and evolution. They presented the latest innovations, technologies, ideas and research findings in their fields. They came from Cambridge and Oxford Universities, the University of Hawaii, from Harvard University, from the National Institute of Genetics in Japan and from institutions in Germany, Australia and Canada.

Massey University researchers and other New Zealand scientists also presented at this select gathering. The high profile work of Professor Lambert's team with ancient DNA was featured along with projects on Tuatara and Kiwi.

Australian geneticist, Professor Jennifer Marshall-Graves brought science direct to the proverbial man in the street with her provocative public lecture - Sex, Chromosomes and the Future of Men. Professor Marshall-Graves heads the multi million dollar Kangaroo genome project and from her work on Australian mammals, provides a unique view on the way that the human genome evolved and how it works. She suggests men may eventually become extinct, and says the human Y chromosome is running out of time. "The Y chromosome looks like a degraded relic of the X because most of its genes, even those with important male-specific functions – have partners on the X from which they evolved."

Dr James Watson, founder of Genesis Research & Development and (chief scientist for that corporation) delivered a public lecture on the evolution of sustainability. He explored the evolution of biotechnology, energy resources and the environmental sustainability issues, "the next generation faces unless science provides smart solutions to economic growth and well being. It's biotechnology that has the potential to provide energy security and sustainability in the near future."

From Cambridge University, Professor Bill Amos brings expertise in genetic archaeology with a new approach to finding out who was where and when, in the context of world history. "The goal of reconstructing accurate population histories remains frustratingly distant," he says. He says new methods in his discipline are proving surprisingly effective at recovering the history of the British Isles.

Biology Professors at the MBE conference (from left to right): Axel Meyer (Konstanz University), David Penny and David Lambert (Massey University/ Allan Wilson Centre), Rebecca Cann (University of Hawaii), David Mindell (University of Michigan). Photo credit: Courtesy of Massey News.

This article was courtesy of Massey News.

Molecular Ecology and Evolution Tri-National Young Investigators' Workshop

The Young Investigators Workshop Conference was recently held at the Te Manawa Centre, Palmerston North (24-26 June 2005).

A tri-nation Young Investigators' Workshop, hot-housing the talents of 21 international researchers, was recently hosted by the Allan Wilson Centre for Molecular Ecology and Evolution. The three-day intensive workshop was a satellite event to the international Society for Molecular Biology and Evolution conference held earlier in Auckland and also hosted by the Allan Wilson Centre (see previous story).

This Young Investigators event brought together seven young scientists each from New Zealand, Japan and the United States (all PhD or post-doctoral researchers) to gather at the Te Manawa Science Centre in Palmerston North to share research and to forge lifelong associations.

This is the first time this workshop has been held in New Zealand. Two previous workshops have been held in Japan and Germany, the last being held in 1997. Four of the seven high-flying young New Zealanders are from Massey, and all seven are members of the Allan Wilson Centre, a success that Professor Mike Hendy says reflects the Centre's expertise. The AWC is a joint Centre of Research Excellence among five national universities. It brings together world-class ecologists, evolutionary biologists and mathematicians who work to unlock the secrets of plants, animals and microbes.

Professor Hendy says the young investigators will be among the world's next generation of top researchers in their fields, and the workshop facilitated invaluable relationships among these early-career scientists. He says participants at the previous two workshops have enjoyed the opportunity to extend their scientific networks, a critical step for young scientists looking to formulate independent research programmes.

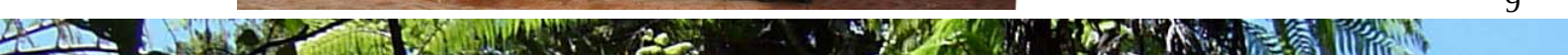
The workshop highlighted research reflecting some of the most exciting areas of research in molecular evolution, where recent advances in DNA sequence analysis have led to significant and novel insights. Presentations and discussion covered a wide range of topics in molecular evolution: genome and gene evolution in insects, primates, plants, fish, tuatara, ancestral eukaryotes and bacteria.

photo credit: Mark Stevens

Mathematical research included analysis of how populations, species and genes change over time. Other presentations highlighted the relationship between adaptation and diversity and how human population movements can be traced using genetic analysis. Details of the participants' research will be published in the esteemed journal, "Molecular Biology and Evolution" later this year.

Meetings such as the Young Investigators' Workshop offer many professional benefits. This workshop offered the opportunity for young New Zealand scientists to forge associations with two of the most prolific countries in the field of molecular evolution. Benefits include strengthening ties with researchers in the participants own countries but also establishing new contacts for career advancement. Such associations have can only have enormous benefits for this field, and science in general in New Zealand.

The original article was courtesy of Massey News. This story has been modified by Lesley Collins for this publication.



Passionate About Reptiles

Richard Romijn, a primary school teacher from Mount Cook School in Wellington, joined the Allan Wilson Centre (AWC) and Victoria University of Wellington in 2004 as a NZ Science Mathematics and Technology Teacher Fellow. Throughout the year he learned about the research of reptiles – everything from animal husbandry to observing and catching animals in the wild. Richard is passionate about New Zealand's reptiles and this was a wonderful opportunity for him to learn more about these amazing creatures.

Richard assisted in a number of research projects. His year started with the annual check up of the 48 juvenile tuatara (*Sphenodon guntheri*) at the Wellington Zoo. Richard caught tuatara and observed the measuring and weighing of them. These animals are part of the Head Start programme, and when they are five years old they will be transferred to an island in the Marlborough Sounds to start a new population.

Richard then spent three days on Matiu/Somes Island as part of the first five year survey of the tuatara (*Sphenodon guntheri*) there. This population of tuatara is very special, as it was the first that could be viewed by the general public without a permit and it is only 20 minutes from down town Wellington. The purpose of the survey was to locate as many of the released animals as possible and to look for signs of breeding.

Tuatara that were caught looked healthy and some had grown much larger than expected. There were also signs that indicated breeding may have taken place. This trip was a great thrill for Richard as he actually got to catch a tuatara in the bush at night. There was also the added bonus of seeing little blue penguins, giant weta and a variety of lizards in their natural surroundings. Richard has been involved in the pitfall trapping of skinks and geckos, and is learning about their animal husbandry.

photo credit: Joanne Hoare

These animals will be used in research investigating why New Zealand lizards are so vulnerable to predation by introduced mammals, and how they manage to stay active during our cool night temperatures. The highlights of Richard's year were his trips to North Brother Island and Stephens Island.

As part of his fellowship, Richard wanted to raise the conservation consciousness of New Zealanders by educating people about our reptiles. Projects involved assisting with the creation of the new Victoria University of Wellington Tuatara website and producing materials for it, updating the Victoria University of Wellington Tuatara Outreach programme and trialing it in schools, researching the uniqueness of New Zealand reptiles and publishing his findings for a general audience. These projects gave him the chance to work with a variety of people including staff from the San Diego Zoo, who are world leaders in conservation education. While educating people about our amazing reptiles is important, Richard feels that it is only the first step. He wants to give people strategies so they can be actively involved in the conservation of New Zealand reptiles. While individuals can't do a lot for the conservation of tuatara, as they are all in reserves, they can help several species of lizard that are still found within our own backyards. Richard is collating and promoting strategies that will allow people to attract native lizards and other animals into their own local environments. Richard believes that this is vitally important, as it creates a belief in people that they can make a difference.

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Teacher Fellowship
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Novel Excuses

School teacher and writer Bernard Beckett is currently being hosted by The Allan Wilson Centre, on a Royal Society of New Zealand Science, Mathematics and Technology Teaching Fellowship. He reflects on the experience to date, and explains his plan from here on out.

This year I seem to be spending a lot of my time surrounded by doctors, reading magazines and waiting for test results. Either I'm really sick, or I've stumbled upon a research centre. In fact, I'm treating the AWC as something of an intellectual A & E, so perhaps the analogy isn't too far from the mark.

I arrived here at the end of January with a clear set of simple goals, in much the same way as one arrives at a swimming pool with a dry set of togs. Having jumped right in the deep end, I can happily report my goals are now misshapen and waterlogged. But, you know, whose aren't?

When describing any research activity, it is always useful to distinguish between three states: what the funding provider thinks you are doing, what you think you're doing, and what you appear to be doing to any outside observer of moderate intelligence. My funding provider, the Ministry of Education, think I am studying human migration in the Pacific, whilst gaining an insight into the lab and math techniques used in uncovering the DNA clues to this story. They also think I am writing a novel; based in part about this migratory story, and in part about the experience of a research scientist.

Having access to slightly more reliable data, I think I am doing some other things as well. The trouble with novels is that you can't plan them. They are a self-assembling biological process, and the writer's job is simply to feed them, and provide a benign developmental environment. As if to drive the point home, the novel I began working on in February underwent a lethal mutation somewhere in the middle of June, and by July I had to face the fact that the heart of my 50, 000 word work-in-progress was no longer beating. On the upside, it had produced healthy offspring, and I am now planning three new writing projects. The first, already well advanced, is a sci-fi novel for teenagers, working off an evolutionary theme. The second is a series of essays, based upon my research and musings during the year, and the third's an historical novel set in the mid 1800's, using the twin arrivals of Darwin's Dangerous Idea, as it has been called, in Victorian England, and Catholicism in Tokelau. Which of these which will grow strong and true enough to make it onto the book shelves remains to be seen.

And as for what it looks like from the outside, who knows? A feckless writer amongst scientists probably, asking too many questions, and tapping too loudly upon his keyboard.

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