ALLAN WILSON CENTRE

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Jane Goodall's New Zealand Tour

The Allan Wilson Centre is proud to be a national sponsor of Jane Goodall's tour of New Zealand this month, together with the University of Otago Centre of Science Communication, and with support from the Royal Society of New Zealand. Jane will be speaking in Dunedin (20 June), Wellington (22 June) and Auckland (23 June), sharing insights from her lifetime of research into chimpanzee behaviour, and her extensive work on general conservation and animal welfare issues. The tour is part of a fund-raising initiative to support that work.

Jane's work with chimpanzees started more than 50 years ago when she began observing wild chimpanzees in the Gombe Stream Game Reserve in present-day Tanzania. She had applied to, and been recruited for this project by, the famous Kenyan archaeologist and palaeontologist Louis Leakey, whose work in Olduvai Gorge was uncovering fossil evidence of the distant human past, and the evolutionary relationships between humans and the great apes. During Jane's fieldwork at Gombe she developed a close bond with the Kasakela chimpanzee troop, naming her subjects and effectively becoming accepted into their society.

Her observations of meat-eating and aggression in the troop were ground-breaking, challenging previously held ideas of chimpanzee behaviour, and her descriptions of tool use by chimpanzees changed the traditional view that humans alone amongst animals used tools.

Jane Goodall PhD, DBE Founder of the Jane Goodall Institute and UN Messenger for Peace. Pictured with Freud, at Gombe in Tanzania

Inside this Issue

In addition to making significant contributions to the scientific understanding of chimpanzee behaviour, Jane's work has fascinated public audiences from the early 1960s when she and her subjects were introduced to the world in the first film produced by National Geographic – 'Miss Goodall and the Wild Chimpanzees'. Several other films have followed, and Jane herself has written several books, for both adults and children, sharing with readers her knowledge and experience of chimpanzee life.

The chimpanzee observation project begun by Jane is now the world's longest running continuous wildlife project. In 1977 she established the Jane Goodall Institute which supports the Gombe Stream National Park research, and works to protect great apes and their habitats. The Institute is widely recognised for its community-centred conservation and development programmes in Africa. One of its main focuses is its global youth programme, Roots and Shoots, which aims to create a worldwide network of young people 'who have learned to care deeply for their human community, for all animals and for the environment, and who will take responsible action to care for them'.

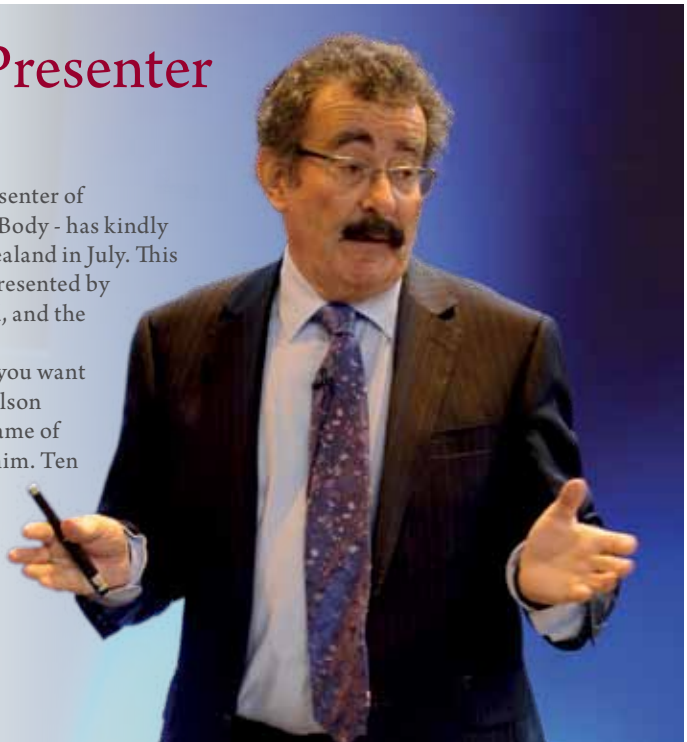
In recent years Jane has spent the majority of her time on international speaking tours, raising funds for, and public awareness of factors affecting chimpanzee habitats and conservation issues in general. Audiences attending her lectures this month will hear Jane speak of her work with the Gombe chimpanzees, from her early research to the latest news from the field, and the work of the Jane Goodall Institute. She will also discuss current problems facing the planet, and her reasons for hope in these complex times – encouraging all present to make a positive difference every day.

Don't miss one of Jane's unforgettable talks:

Dunedin	Wellington	Auckland
20 June, Regent Theatre, 7.00pm (Thanks to University of Otago Centre for Science Communication)	22 June, Michael Fowler Centre, 2.00pm (Thanks to Wellington Zoo, Wellington City Council, Victoria University of Wellington)	23 June, ASB Theatre, Aotea Centre, 7.00pm (Thanks to Auckland Zoo)

Bookings: Go to **www.allanwilsoncentre.ac.nz** and click on the city to go to the ticketing site. Tickets are $25 each, and all profits will go to the Jane Goodall Institute.

Opportunity to hear BBC Presenter Professor Lord Winston



Professor Lord Winston - fertility expert and BBC Television presenter of popular science series including Child of our Time, and The Human Body - has kindly offered to give a public talk, in Wellington, during his visit to New Zealand in July. This will be at the Embassy Theatre, 6pm, Monday 14 July, and is jointly presented by the Allan Wilson Centre, Gravida, the Royal Society of New Zealand, and the University of Otago Medical School.

Tickets ($20/$10) may be purchased from the Royal Society – if you want to register to receive early information about this and other Allan Wilson Centre public events, email **awc-lectures@massey.ac.nz** with the name of the city you live in, in the subject line. Be in quick if you want to see him. Ten years ago, Professor Lord Winston gave a public talk in Palmerston North, filling the Regent Theatre (capacity 1400), and causing such a traffic jam in the Square that he had to abandon his vehicle and walk to the Theatre. Many disappointed people had to be turned away from the packed auditorium.

Altruism in Slime Moulds, Rats and Humans

Wendy Newport-Smith, Jon Waters and Lee Dugatkin at Moeraki to observe the yellow-eyed penguins returning to land for the night

Record numbers turned out for the recent talks by visiting Professor Lee Dugatkin in Nelson and Tauranga, and the other venues were close to capacity. It seems *The Evolution of Goodness* was a topic of fascination. There was general astonishment at the degree to which altruism occurs, even among lowly slime moulds and rats.

Those who think of goodness as emanating from some higher spiritual wellspring would have been very disappointed. It seems altruism all boils down to a simple equation, called Hamilton's Rule, after the late evolutionary biologist W.D (Bill) Hamilton who managed to quantify the probability of goodness occurring:

- Relatedness (e.g. 0.5 for a sibling, parent or child) multiplied by the benefit accrued to the subject of your altruism (expressed as a fraction), has to be greater than the cost to you.
- If there is more than one subject of your good deed, then they add together. Saving two sisters from drowning – or twice as many of your genes that they might carry (0.5 plus 0.5) – is better than risking your life for one.

To demonstrate our strong emotions about fairness, Lee played a popular Youtube video of an experiment with two capuchin monkeys, and the reaction of one given cucumber, when the other subject received grapes – their much preferred food. **https://www.youtube.com/watch?v=gOtlN4pNArk**. MRI scans showed that while we humans feel good about cooperating, and sharing with others, getting revenge against those who cheat is just as sweet.

Of course, a significant reward for acts of altruism is enhanced reputation and simply feeling good, or relief from the pain we share in others' suffering (empathy). This explains why we give money to unrelated children in far off places. Lee argues that this rather uncomfortable knowledge about how we are wired can help civilisation override its baser instincts and work for a fairer society. But the case is proven: blood is thicker than water. "Family comes first", as Lee's beloved father Harry always taught him.

You can see Lee's lecture at **https://www.youtube.com/watch?v=thDufXdydp0**

The genetic relatedness between various sets of relatives

Generation	Brother	Half-brother	First cousin	Half-first cousin	Second cousin	Half-second cousin
Self	1/2	1/4	1/8	1/16	1/32	1/64
Father's	1/4	1/8	1/16	1/132	1/164	1/128
Grandfather's	1/8	1/16	1/32	1/64	1/128	1/256
Great-grandfather's	1/16	1/32	1/64	1/128	1/256	1/512
Great-great-grandfather's	1/32	1/64	1/128	1/256	1/512	1/1,024

Notes: For relatedness to your brother, half-brother, first cousin, and so forth, simply read across the "self" row. For relatedness to your father's brother (your uncle), your father's half-brother, and so forth, read across the second column. Do the same for relatedness to your grandfather's relatives (row 3), your great-grandfather's relatives (row 4), and your great-great-grandfather's relatives (row 5). Extract from Lee's book, *The Altruism Equation*

Ancient DNA Solving More Prehistoric Puzzles

Michael Knapp sampling bone

The first studies of ancient DNA were reported in the 1980s. Despite early high hopes of the international scientific community (and wild public imaginings) of being able to recover and study DNA from long-extinct organisms, it quickly became apparent that degradation and contamination problems were technically difficult to overcome.

Since the late 1990s ongoing improvements in laboratory methods for treating samples, and more recent advances in sequencing technologies, have greatly increased the potential for recovering authentic ancient DNA sequences. A striking example of this is the report, late last year, of the recovery of an almost complete mitochondrial genome sequence from a 400,000 year old hominin from Spain.

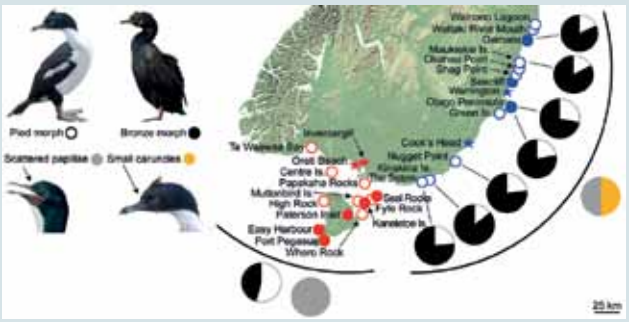
From its early days to the present, the Allan Wilson Centre (established in 2002) has been very successful in identifying key questions in New Zealand and Pacific ecological and evolutionary history that can be addressed using ancient DNA data. Former and current members of the AWC have recovered and analysed DNA from many sources, including moa, elephant birds, Adelie penguin, kiwi and Chatham Island Taiko samples, adding much to our understanding of these birds, and aspects of microevolution.

AWC Principal Investigator Lisa Matisoo-Smith and her group have used ancient DNA recovered from Pacific rats, chickens and dogs to gain valuable insights into New Zealand and Pacific prehistory. Notably, in 2012 Lisa's postdoctoral fellow Michael Knapp and colleagues published the results of their work on human samples from the Wairau Bar archaeological site – the first complete mitochondrial genome sequences recovered from prehistoric Polynesians.

These human samples were analysed at new laboratories Lisa and colleagues set up at the University of Otago, in 2010, especially for ancient DNA studies. The new facilities have been used recently by AWC scientists, along with the historic DNA laboratory at Otago's Department of Zoology, to take a close-up look at the taxonomy of a seabird (the Stewart Island Shag) and the impact of human-mediated changes on species' distributions in New Zealand.

Postdoctoral fellow Nicolas Rawlence, working with several other AWC members and researchers from the University of Otago, Canterbury Museum, Te Papa and

Auckland Island Shag, Enderby Island, New Zealand



Distributional and morphological data for Chatham Island and Stewart Island shags

DOC, examined the genetic differences and similarities between two regional groups of Stewart Island Shag, using a combination of ancient, historic and modern DNA data. The report was published in March this year in the open access journal PLOS ONE.

The Stewart Island Shag is one of many species of blue-eyed shags, and their breeding colonies are found from the Stewart Island region north to the Otago coast. The Stewart Island Shag differs from other blue-eyed shag species in having two distinct types of plumage patterns, known as the pied and dark-bronze morphotypes, and the description of the species has been complicated by shared physical characteristics with other species such as the New Zealand King Shag.

Nicolas analysed the genetic variation within a dataset of more than fifty shag samples, including Stewart Island Shags from throughout their range, and samples from a sister species, the Chatham Island Shag. The DNA was retrieved from a mixture of sources: modern tissue, historical museum specimens and sub-fossil bone material. While there is no obvious physical barrier within the range of the Stewart Island Shag, the analysis found a north-south split between the birds, with those from the Otago breeding sites more closely related to each other, and to the Chatham Island Shag, than those from the Foveaux Strait colonies.

Similarly, Dr Catherine Collins (University of Otago) used ancient DNA techniques to examine the history of sea lion populations in New Zealand. Previous work by her PhD supervisor, AWC Principal Investigator Professor Jon Waters, and colleagues, examining DNA from yellow-eyed penguins had revealed that they were not, as previously thought, descended from populations which had existed here for thousands of years, but rather relatively new arrivals from the subantarctic region. The newcomers appear to have effectively filled the space left empty by the extinction of earlier lineages of penguins following the human settlement of New Zealand, from about 800 years ago.

This finding led Jon to question whether this extinction and recolonization event was paralleled in other species. Catherine's research, published in May in the Proceedings of the Royal Society Biological Series, found that this was indeed the case for sea lions. The genetic evidence showed that the sea lions present when New Zealand was first settled belong to a different group than today's populations, a group that went extinct following human settlement. Similar to the yellow-eyed penguin, the sea lions present on the mainland today are the result of a range expansion of the subantarctic populations of New Zealand sea lions – striking examples of dynamic biological responses to human-mediated extinctions.

Teaching suggestions

Curriculum links:

- Nature of Science: Understanding about science Levels 6-8
- Living World: Ecology Levels 6-8, Evolution Levels 7-8

Find out more:

- This article by Ewen Callaway summarises the analysis of aDNA recovered from a 400,000 year old hominin from Spain: **http://www.nature.com/news/hominin-dna-baffles-experts-1.14294**
- Lisa Matisoo-Smith wrote about ancient DNA and the establishment of the University of Otago labs in an earlier issue of Pheno (p4, Issue 4, April 2010, available from the AWC website)
- A recent open-access review of ancient DNA methods co-written by former AWC postdoctoral fellow Michael Knapp ("Next Generation Sequencing of Ancient DNA: Requirements, Strategies and Perspectives" by Michael Knapp and Michael Hofreiter) is available from: **http://www.mdpi.com/2073-4425/1/2/227**
- Listen to Jon Waters and Catherine Collins describing their sea lion and penguin research on 'Our Changing World': **http://www.radionz.co.nz/national/programmes/afternoons/audio/2566207/our-changing-world-discovering-prehistoric-new-zealand**

Allan Wilson Centre Students Applying Mathematics to Biology

Joshua researches the origin of life

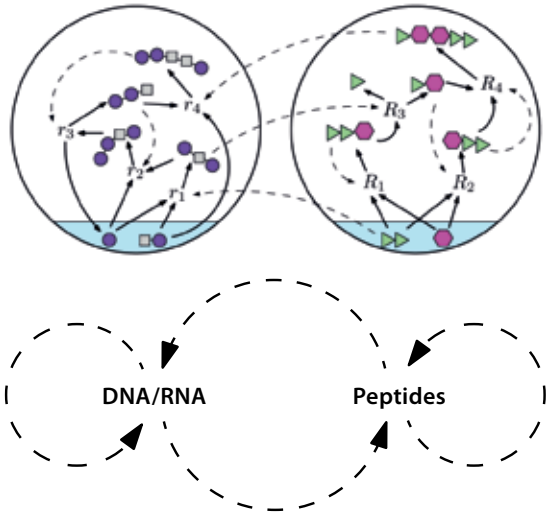
Joshua Smith is a medical student at Otago. Last year he decided to take a year off his medical studies to complete a Maths Honours degree. This included an AWC project on the mathematics of early life and two AWC summer studentships. Joshua shared the University of Canterbury Cook Prize for the top maths honours student in 2014, and his research has now been published in two international journals. He talks to *Pheno* about his experience.

What made you take a year off medical school to return to study mathematics?

In the early years of medical school there is so much existing knowledge to cram into your head and not enough time to talk about interesting research. I wanted to have the option of generating new knowledge one day, so decided to take a year out and get a taste for the research process. Using mathematics to answer questions in biology is a fairly recent idea, so there are lots of opportunities for research in this field. Funding from the Allan Wilson Centre allowed me to work with Professor Mike Steel at the University of Canterbury on a very exciting project.

Tell me a little bit about the project

Most people agree that all modern life has evolved from simpler common ancestors, but it is still not known how the very first living cells came into existence - this is the "Origin of Life" problem. In our project, we created a mathematical model that represented a system of interacting molecules that may have been present on early Earth. We then analysed the system to see if it could have generated a special self-replicating subset of molecules - a very primitive form of life which could have formed the first "cell". By analysing variations on the model, we could start to figure out which properties of the system were necessary to allow life to form spontaneously.



What did you discover?

All modern life relies on the interaction of two basic types of molecules - nucleic acids (DNA and RNA) and proteins. Since the earliest form of life was probably very simple, many scientists believe it must have involved only one of these molecule types (sometimes called the "RNA World hypothesis"). However our research suggests that a system consisting of two different types of molecules (like nucleic acids and proteins) is just as likely to produce self-replicating subsets as a system with only one type, and that when it does, those subsets tend to be larger.

Why might this be useful for our understanding of early evolution?

The results are interesting because they suggest that, when trying to figure out possible scenarios for the origin of life, we don't have to restrict ourselves to those in which RNA molecules evolved before proteins - it is possible that they evolved together, helping each other along. This idea has been proposed by some biochemists in the USA, and our theoretical research supports the results of their lab experiments.

You used a supercomputer for part of your study – why was that?

Our model involved millions of molecules, and searching through them all for a special self-replicating subset would take months or even years on a laptop! The supercomputer allowed us to perform this analysis in just a few hours, allowing us to analyse more copies of the model and get more useful results.

What was the most fun part of the project?

Using the supercomputer was a very exciting opportunity. However I think the most fun part was learning how to write an article for an academic journal. You have to be really careful to say exactly what you mean, reference everything properly, and produce a handful of illustrations that communicate your results. Although this involves a lot of thought and hard work, it is very rewarding to watch your work grow into something meaningful!

Do you think this project will be useful for your future career in medicine?

Definitely. The most useful things I have gained from the project are an understanding of how research is done, and mathematical skills. In medicine it is essential to keep up with current research, and many doctors will participate in research alongside their clinical practice, so having prior experience is really useful. In addition, medical research is becoming more and more quantitative, using not just statistics, but mathematical modelling to investigate the function of the body in health and disease. Very few medical graduates have trained in mathematics, so those that have can help bridge the gap between research and clinical practice and are highly sought after.

Disentangling ecology and evolution

Another AWC student at Canterbury is Giulio Dalla Riva, currently half-way through his PhD thesis with Mike Steel, Charles Semple and Daniel Stouffier. This is his story of applying mathematics to study the interaction of evolution and ecology.

What do you do?

Most people consider "What do you do?" an easy, friendly question where simple answers like "I'm a journalist", "I'm a doctor" or "I'm a manager" are accepted as satisfactory. For me, as an apprentice mathematician, the question had been sincerely scaring. How could I explain what I am doing without being extremely technical or, even worse, boringly vague?

I studied mathematics in Italy at the University of Trento, a nice town between the snowy peaks of the Dolomites, and in Paris' Pierre et Marie Curie University. I enjoyed pure mathematics – functional analysis, differential geometry and probability theory. I ventured into the slightly more "exotic" lands of random graph theory and mathematical sociology.

I've always been interested in the complex behavior of natural life: as a child I fell in love with the richness of animals and plants, of insects and things I couldn't even see, tramping on the mountains and forests of north east Italy. And as a child I couldn't avoid to wonder what was the game they were playing together, which the rules, and how did they learn to play so well? However, it required me some time to discover that mathematics could be used to approach such question.

Tell me a little bit about the project?

It all happened while writing my master dissertation. Still fascinated by nature machineries, I stumbled upon the work of Professors Mike Steel and Charles Semple in evolution and the work of Professor Daniel Stouffer in ecology. For me, coming to the Allan Wilson Centre at Canterbury University to work with my supervisors in phylogenetics and food web theory represented the incredible opportunity to fulfill a childhood dream.

So, what do I do? I'm trying to answer those questions that occupied my mind while I was hiking on the Alps, just now they are the Southern Alps, not the Italian Alps. How does a community of species fit together and not crumble down? How did they evolve to fit in the complex web of ecological relationships surrounding them? We think that the two processes are far from being independent: predation pressure and the ability to prey are strong evolution driver; on the other hand the role that a species will occupy in a food web is to a large extent determined by its evolutionary history. Disentangling this ecology/evolution mutual influence requires some mathematical effort, and we are exploring different approaches to model the evolution of a food web along a phylogenetic tree or, that is the same, the developing of an evolutionary tree under the influence of a food web.

Taking Gisborne by Science

Jim McLean and Dr Hope Tupara signing the Memorandum of Understanding with Ngai Tamanuhiri, at Muriwai Marae

The Allan Wilson Centre recently signed a memorandum of understanding with Ngai Tamanuhiri, the progressive iwi that has Te Kuri a Paoa / Young Nick's Head in their rohe.

Celebrity tuatara, Spike

An MOU is just a piece of paper, unless you make it mean something. Part of the AWC's commitment to the relationship, in practice, has been regular visits by scientists to give talks at Muriwai Marae and in Gisborne city. AWC Principal Investigator, Associate Professor Nicky Nelson, went up in March with Victoria University's resident tuatara, Spike, snug in her backpack. He's very used to flying and being the centre of attention. Not many people have actually seen, or had the chance to hold, this amazingly ancient-looking creature (Spike is actually still in his twenties), so there were audible intakes of breath when she conjured him from her bag.

In May, the East Coast again got two personalities for the promised one: Director of the Centre, Professor Hamish Spencer, and AWC Principal Investigator Professor Jon Waters (see previous article on Ancient DNA). Though not quite equal to Spike in the celebrity stakes, Hamish gave an entertaining account of cultural and legal practices around the world, and the actual biological risks to the progeny, of first cousin marriage, including some notable historical examples – Charles and Emma Darwin, and Queen Victoria and Prince Albert. His presentation included a Tui beer Yeah Right advertisement (It's OK, we're not cousins by blood) to illustrate local attitudes.

Jon outlined his team's recently published findings about New Zealand sea lions moving in from the south to fill the habitats vacated by the populations hunted to extinction by humans. Jon had previously found, by comparing the DNA from sub-fossil bones with DNA specimens from existing populations, that yellow-eyed penguins are also recent immigrants from the sub-antarctic. To the coastal inhabitants of Gisborne, this information about the recovery of other coastal inhabitants, was of great interest. The large audience included regular attendees Michael, Anne and son Jeremy Muir, owner/editors of the Gisborne Herald, one of only four independently owned newspapers in this country – a critically endangered species.

Next up in Gisborne on 3 July: Professor Neil Gemmell, to tell the Tairawhiti males why they can blame almost everything on their mothers – from disease and infertility to ageing. That'll draw a crowd.

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