



University of Auckland

Scientific

A student-run publication

June 2021

Volume 1 No.2

13 Comorbidity in Mental Health and Medicine

8 Cichlids: An Evolutionary Enigma

17 University Rankings: For Who, for What, and Why?

25 Will Kauri Survive?

Resilience of Ancient Kauri Populations to the Modern World.

EDITORS' NOTE

Welcome to the second issue of the *University of Auckland Scientific*.

We want to thank you for all the support and the feedback we received after publishing our first issue in early May. Although the number we could print out in our first run was limited, we were thrilled by the amount of people we were able to reach. Since then, our small team of five people has grown to a team of nine, and we are excited for you to see what we can do next and how we can improve.

As we approach exam season, we hope that you can all find some respite amongst the slew of assignments and study. If you're reading our magazine as a way of procrastinating, you can rest assured that you're in good company; that was precisely what our editorial team was doing while writing it. Nonetheless, there is light at the end of the tunnel. The semester is nearly done, and a three-week break (or three-week catch-up-on-research-time) beckons.

Our goal in this issue was to place a strong emphasis on real research going on at the University of Auckland and around the world. If you're interested in pursuing research, perhaps you will find a topic that grabs your attention and inspires your summer research application (which opens in just over a month).

Regardless, we hope you enjoy reading about fish, farmland, and all else besides. Best of luck with exams, and remember to take care of yourself.

Yours faithfully,

The University of Auckland Scientific team

Table of Contents

1

Opinion: Skincare's Pseudoscience

Stella Huggins

The pseudoscientific roots of skincare and an overview of the debate surrounding new technologies.

4

Explained: The New Era of Macs

Struan Caughey

What makes the new Mac computers so different? M1 vs Intel, ARM vs x86, RISC vs CISC? We discuss what these all mean, how they will affect you and how they will change the future of computing.

8

Cichlids – An Evolutionary Enigma

Jasmine Gunton

Cichlids are an evolutionary mystery. How did they evolve and why are they such a conundrum for biologists?

10

Restoring Landscapes Post-Farming:

Is Replanting Really the Answer?

Nina de Jong

An exploration into the ways that the popular restoration technique of replanting might not be the holy grail of conservation in post-agricultural landscapes after all.

13

Comorbidity in Mental Health and Medicine

Gene Tang

One of the major issues in medicine and psychology right now is comorbidity. Why is this a problem and why should we pay closer attention to it?

16

Ultralight Dark Matter

You-Rong F. Wang

Ultralight dark matter is a category of theories that we can use to attempt to explain galactic-scale phenomena. It lives at the intersection of cosmology and quantum physics, and here You-Rong outlines his PhD research in this topic.

17

University Rankings: For Who, for What, and Why?

Alex Chapple

University rankings play a huge role in our tertiary education system but who is it for, and why does it exist?

21

Opinion: Dissonance in Attitudes between Blood

Clotting in Vaccines and Oral Contraceptives

Stella Huggins

A comparison of society's attitudes towards side effects caused by new COVID-19 vaccines, and similar, well documented side effects caused by oral contraceptives.

25

Will Kauri Survive?

Resilience of Ancient Kauri Populations to the Modern World.

Toby Elliot

Toby outlines his PhD research, which explores the population dynamics of kauri and their response to modern threats such as kauri dieback and climate change.

Opinion: Skincare's Pseudoscience

By Stella Huggins

How's your skin feeling right now? Radiant? Hydrated? Are you giving off an effervescent glow that touches every stranger you walk past? If you are, you've probably got a great diet going, with an exercise routine to match.

However, an industry preys on your worries about crows feet, that dark scarring on your chin, and the stretch marks that your body naturally creates when your tissue increases. Skincare; the bane of every collagen cell's existence. Littered with emotive, fantastical language that touches the heart, scientific terminology that appeases the mind, and a looming lump of pseudoscience that leaves your pores wanting more, the billion-dollar industry keeps itself in operation day in, day out.

Long have I wondered if the various goops, creams, foaming washes, plant-based protein creams, acids, and face masks actually do anything to improve the condition of my largest organ. Just anecdotally, some products of course feel better than others – that \$10 cleanser probably has some harmful chemicals that don't do you any favours. But the more expensive and elaborate skincare gets, the harder it becomes to pick holes in the iron-clad marketing ploys cooked up by the industry.

First, let me differentiate between dermatology and skincare. Dermatology is absolutely not a pseudoscientific practice. It's a study of the skin, involving extensive undergraduate study in a Bachelor of Medical Science. Dermatology's focus is to treat diseases of the skin. Skincare, on the other hand, is purely cosmetic. This cosmetic obsession is what I am referring to when I talk about the skincare industry.

Cosmetics are complicated. Deeply intertwined with numerous complications of the world; capitalism, misogyny, to name a few, as well as more personal matters of self-identity, dysmorphic views of your own appearance, and personal wealth, it's a dense topic to unpack. The issue is complicated further by rapidly evolving narratives in social media, not yet touched by the literature of self-image. The notion of 'self-care', and new hyper-versions of self-image that are symbiotic with modern feminism, can make the use of cosmetic products sometimes too complex to even bear thinking about. Companies know this. Marketing strategies work significantly faster than journal literature does when it comes to penetrating the public perception of a topic, making skincare one of the most insidious pseudoscience industries. Differentiating between a discussion of intrinsic and extrinsic degradation of the skin is important to note here. Intrinsic degradation describes



The skincare industry develops both endless products and endless skin "problems" that need to be "treated". Photo by Brett Ritchie on Unsplash.

cellular processes that regenerate tissue as a result of normal ageing. It occurs in the absence of harmful substances due to free radical production, normal hormonal shifts and other biological processes. It is safe to say that a definitive answer to slow the effects of this process has not yet been found. Extrinsic degradation describes environmental factors or lifestyle choices that cause deterioration of the skin condition.

Skincare in of itself is not completely invalid. It can alleviate some negative effects; moisturising protects the skin's function of protecting the body from dehydration or desiccation [1], cleansing daily immensely reduces the risk of infections and open wounds becoming unsightly [2], and SPF application (arguably the most important long-term product use) protects against harmful ultraviolet rays [3]. However, breaking past these very basic routines lies a plethora of products that use carefully concocted language.

Intended to convince the consumer of its efficacy, the marketing aims to succeed at moving products whilst avoiding concrete claims that could expose them to legal action. Capitalist models of beauty are designed to keep the consumer buying, and believing the narrative of

external beauty – the idea that one’s appearance should fit a certain mold, and that certain products will help you get there. It seems apparent that the issue of misleading information within the skincare industry lies mostly within the emphasis placed on products, and a gross extrapolation of the extent to which products can aid appearance to the consumer’s desire.

Most societies grasp the benefits of exercise, diet, and significance of environment in overall health – skin is no exception. 80% of extrinsic skin health can be attributed to the quality of several factors, including: UV exposure, pollution, diet, hygiene, drug use and sleep [4]. That is to say, a large majority of skin appearance is dictated by your lifestyle, and where you live.

Topical treatment of amino acids is an example of a popular practice in skincare. Select amino acids are able to be absorbed through the skin. However, evidence for this was procured through in vitro experiments, and generally performed on animal skin [5]. Animal testing has been a long-standing feature of the skincare industry. A common experimental design utilises the Franz diffusion chamber [6], and measures the amount of amino acids that pass over the tissue, rather than the quantities of amino acids that are retained [7]. Chemical absorption can occur through a number of pathways in the skin. Intercellular routes, intracellular routes, through sweat glands and through hair follicles are all places where absorption can occur [8].

This is all good and well, but it means that the evidence that amino acids are retained by topical treatments is shaky. This is not helped by the motives of researchers. Most skincare research is performed or funded by companies themselves [9]. This should ring alarm bells in a reader’s head. A clear conflict of interest is present here. It’s highly unlikely that companies would engage in malpractice, altering results to fit their marketing ploys. However conscious or unconscious bias may have an effect on how results are presented to corporate bodies, and subsequently to consumers [10]. This is a common dilemma of commercial science; when profit and margins drive results, personal influence can become increasingly confounding.

The darker end of the skincare industry is that the developing science sometimes confidently oversteps, promising safety and efficacy – when the long-term results harbour quite the opposite effects. The commercial model aids this mindset, with profit motivating the message that the treatment in question is safe. Intentionally or unintentionally, this sometimes leads to adverse outcomes for consumers [11]. Nanoparticles are a producer’s dream – they do in fact increase efficacy [12]. But their newness comes with downsides.

We do not yet understand the limits to which these transportation agents can travel [13]. The effects of interactions of carbon nanoparticles with DNA are not yet fully understood, though the mechanisms through

which they interact are. Small enough nanoparticles can enter cells through the nuclear pore, and potentially bind to DNA – this could inhibit replication [14]. Nanoparticles may also produce free radicals, an example being metals that interact with hydrogen peroxide (present in every cell [15]), in turn causing the conversion to the hydroxyl radical. Titanium dioxide nanoparticles, used commonly in cosmetics, have been proven to produce excessive free radicals in the presence of both light and ultraviolet light [16].

The heterogeneity of ageing effects also confounds a multitude of claims products make about efficacy [17]. Ageing is highly variable among individuals – what works for some in slowing the ageing process can depend largely on the epigenetics of that individual [18]. Of course there are general rules that apply to most – SPF protection being beneficial is a prime example – but at the nitty gritty level, we’re all painstakingly individual. Skincare is important for maintaining general health, but there’s only so far that products can take you. After the basic routine of cleansing, moisturising and applying sunscreen, the rest of it lies on shaky science, carefully presented to imply fantastical results. Choose your goops wisely.

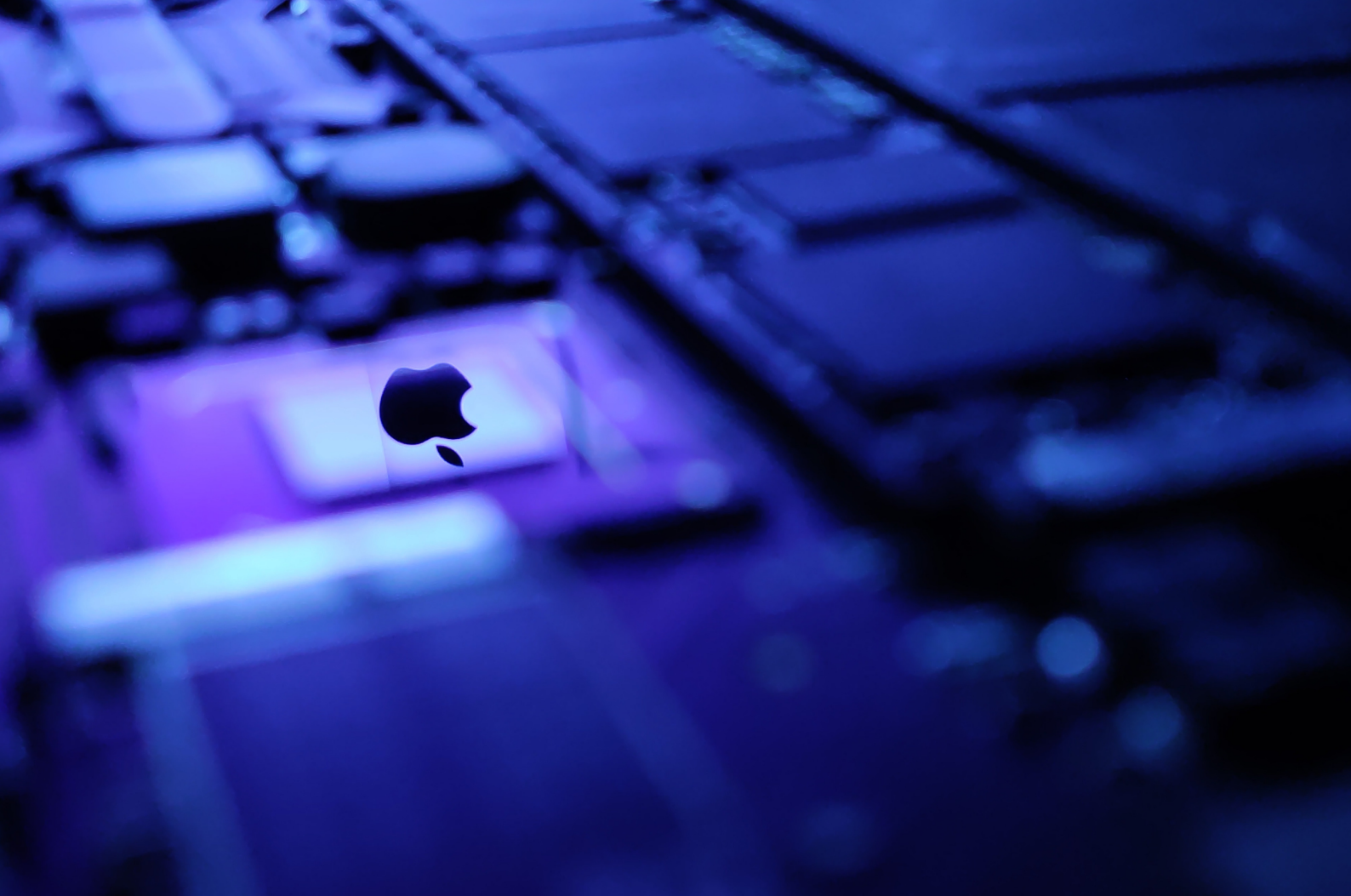


The science of the skincare industry is at risk of being confounded by profit-driven conflicts of interest. Photo by Doğançan Özturan on unsplash (2021).

References

- [1] Epidermis Hydration. (2006). Handbook of Non-Invasive Methods and the Skin, Second Edition, 327–327. <https://doi.org/10.3109/9781420003307-45> Edited by Jorgen Serup, Gregor B.E. Jemec & Gary L. Grove
- [2] Larson, E. (2001). Hygiene of the Skin: When Is Clean Too Clean? Emerging Infectious Diseases, 7(2), 225–230. <https://doi.org/10.3201/eid0702.010215>

- [3] Flament, F., Bazin, R., Rubert, Simonpietri, Piot, B., & Laquieze. (2013). Effect of the sun on visible clinical signs of aging in Caucasian skin. *Clinical, Cosmetic and Investigational Dermatology*, 221. <https://doi.org/10.2147/ccid.s44686>
- [4] Bielach-Bazyluk, A., Zbroch, E., Mysliwiec, H., Rydzewska-Rosolowska, A., Kakareko, K., Flisiak, I., & Hryszko, T. (2021). Sirtuin 1 and Skin: Implications in Intrinsic and Extrinsic Aging—A Systematic Review. *Cells*, 10(4), 813. <https://doi.org/10.3390/cells10040813>
- [5] Cosmetics testing FAQ. The Humane Society of the United States. (n.d.). <https://www.humanesociety.org/resources/cosmetic-testing-faq#:~:text=Although%20they%20are%20not%20required,rabbits%2C%20with%20any%20pain%20relief.>
- [6] Baert, B., Boonen, J., Burvenich, C., Roche, N., Stillaert, F., Blondeel, P., Van Boxclaer, J., & De Spiegeleer, B. (2010). A New Discriminative Criterion for the Development of Franz Diffusion Tests for Transdermal Pharmaceuticals. *Journal of Pharmacy & Pharmaceutical Sciences*, 13(2), 218. <https://doi.org/10.18433/j3ws33>
- [7] Myer, K., & Maibach, H. I. (2013). A Dermatological View—Percutaneous Penetration of Amino Acids. *Cosmetics and Toiletries*.
- [8] Rodrigues, F., & Oliveira, M. B. (2016). Cell-based in vitro models for dermal permeability studies. *Concepts and Models for Drug Permeability Studies*, 155-167. doi:10.1016/b978-0-08-100094-6.00010-9
- [9] Caulfield, T. (2017, February 08). The pseudoscience of beauty products. Retrieved May 22, 2021, from <https://www.theatlantic.com/health/archive/2015/05/the-pseudoscience-of-beauty-products/392201/>
- [10] Boy, J., Pandey, A. V., Emerson, J., Satterthwaite, M., Nov, O., & Bertini, E. (2017). Showing people behind data. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. doi:10.1145/3025453.3025512
- [11] Khan, A. D., & Alam, M. N. (2019). Cosmetics and their associated adverse effects: A review. *Journal of Applied Pharmaceutical Sciences and Research*, 1-6. doi:10.31069/japsr.v2i1.1
- [12] Larese Filon, F., Mauro, M., Adami, G., Bovenzi, M., & Crosera, M. (2015). Nanoparticles skin absorption: New aspects for a safety profile evaluation. *Regulatory Toxicology and Pharmacology*, 72(2), 310-322. doi:10.1016/j.yrtph.2015.05.005
- [13] Saunders, F. (n.d.). DNA Damage and Nanoparticles. Retrieved May 22, 2021, from <https://muckrack.com/fenellasauanders>
- [14] Li, K., Zhao, X., K. Hammer, B., Du, S., & Chen, Y. (2013). Nanoparticles inhibit dna replication by binding to dna: Modeling and experimental validation. *ACS Nano*, 7(11), 9664-9674. doi:10.1021/nn402472k
- [15] Halliwell, B., Clement, M. V., & Long, L. H. (2000). Hydrogen peroxide in the human body. *FEBS Letters*, 486(1), 10-13. doi:10.1016/s0014-5793(00)02197-9
- [16] Bhattacharya, K., Davoren, M., Boertz, J., Schins, R. P., Hoffmann, E., & Dopp, E. (2009). Titanium dioxide nanoparticles induce oxidative stress and dna-adduct formation but not dna-breakage in human lung cells. *Particle and Fibre Toxicology*, 6(1), 17. doi:10.1186/1743-8977-6-17
- [17] Cevenini, E., Invidia, L., Lescai, F., Salvioli, S., Tieri, P., Castellani, G., & Franceschi, C. (2008). Human models of aging and longevity. *Expert Opinion on Biological Therapy*, 8(9), 1393-1405. doi:10.1517/14712598.8.9.1393
- [18] Ganceviciene, R., Liakou, A. I., Theodoridis, A., Makrantonaki, E., & Zouboulis, C. C. (2012). Skin anti-aging strategies. *Dermato-Endocrinology*, 4(3), 308-319. doi:10.4161/derm.22804



Apple is moving from Intel x86 processors to M1 ARM processors. Photo by David Monje on Unsplash (2020).

Explained: The New Era of Macs

By Struan Caughey

The end of 2020 led to the introduction of Apple's next generation hardware, all powered by their in-house M1 processors [1]. They announced the chip on November 10th, and one week later it could be purchased with their Macbook Pro, Air and their Mac Mini computers [2]. This change was not just to an in-house processor, but to a new architecture altogether – ARM or Advanced RISC Machines. The last time Apple went through a similar architecture change was in 2006 [3] when they shifted from PowerPC chips which they helped develop into Intel's x86 design. They made this change as at the time Intel and therefore x86 appeared to have the strongest roadmap ahead which, considering the partnership lasted 15 years, appears to have been a good decision. When we look to other areas of the industry, we can see a similar shift towards ARM. The current holder of the world's most powerful supercomputer goes to Fugaku, which is based in Japan. It is the first computer to hold this title which also runs on the ARM architecture [4]. On the other end of the processing power scale we have phones. Almost all mobile computer chips are ARM-based, while currently, nearly all Windows PCs are x86 [5]. To introduce the concept of these architectures, we have to work from first principles.

Computers and Processors

A computer is an electronic device designed to store and manipulate data, usually through a system of 1's and 0's: binary. They range from what most people think of when they hear about a computer – a laptop or desktop – but also phones, smart light bulbs, cars, and even vending machines either are or contain a computer. The powerhouse of these computers which processes data is called the processor. The processor is a chip made up of billions of the simplest logical units: transistors [6]. Processors come in a range of forms, each of which is optimised for its specific tasks. In places like the aforementioned Fugaku supercomputer, this is maximising computational power while maintaining some level of efficiency to manage costs. For high-end home PCs and high-performance servers, the weighting is towards power at all costs. Vending machines, light bulbs, and other small items are purely about whatever is cheapest. Lastly, for phones, and to a similar extent laptops, the decision is all to do with power efficiency and what will draw the least charge from the battery. These can be optimised in many ways, such as processor size. The smaller the transistors, the denser the processor, which can make it more powerful and

more efficient. In contrast, processors with larger transistors are much cheaper to produce. While there are many ways that processors differ to each other, in this article we will be looking at architecture.

Architecture

Architecture is the design of the processor. It represents how data is processed within the chip, and because of this, it also changes how data is sent and received. There are many types of architecture, each with its own benefits and drawbacks; however, they generally come in one of two designs, RISC and CISC. RISC stands for Risk Instruction Set Computer and CISC, Complex Instruction Set Computer. We will break this down word by word.

First, you have "reduced" versus "complex" – the one letter that differs between both acronyms. This is in reference to the type of instructions the architecture can handle. RISC will only process simplified or reduced instructions, whereas CISC can handle more specialised and complex tasks. Next, we have instruction. This can be anything from ADD to STORE or PROD. Essentially, they are directions for what the computer is to do at that moment. Each instruction will trigger a specific sequence to be carried out, such as storing a piece of data or adding two numbers. Next, we have "set", which states that there isn't just a single instruction but that these reduced or complex instructions come in a set. Below I have illustrated the different approach these two systems use to combat the multiplication of two numbers [7].

CISC:

```
MULT loc1, loc2
```

This takes the number stored in location 1, multiplies it with location 2 and saves the result in location 1. This all happens in one line.

RISC:

```
LOAD register1, loc1  
LOAD register2, loc2  
PROD register1, register2  
STORE loc1, register1
```

This does the same thing as before; however, it has been reduced to the most fundamental instructions. The data can only be processed from the registers and not from their locations, meaning you have to do extra steps to store your values in the processors' registers. Registers are small storage areas which are on the processor itself making them super quick to access but have very limited capacity. From this, it may seem that CISC is significantly better only having one step. It appears to be simpler to implement as well as not having to use the register space. This isn't correct, however, as the MULT instruction incorporates all the LOAD and STORE functions within it. This brings out the main difference. CISC can have one instruction take multiple clock cycles, whereas RISC will only ever take one. However, there are genuine

benefits to CISC's method. The lower number of instructions require less memory to store, which makes CISC less RAM intensive. Also, the computer's compiler, the system which converts high-level human-written code into the computer language above, has to put in more work to entirely reduce the instructions with RISC, again using more resources.

CISC must be better then... right?

It's complicated. While the above comments are true, they also pose some issues. The complex instructions require more complex hardware and more specialised circuitry within the chip to operate. This may make the processor better at these specific tasks; however, that makes much of the processor unable to be used for more general tasks, as sections are reserved for these additional instructions. Due to RISCs much fewer base instructions, the circuitry can be designed to have far more general-purpose circuitry, which can be better optimised, resulting in smaller and more efficient processors. The simpler circuits can also be made in higher density meaning the same sized processor can be more powerful. RISC essentially relies on software to do much of what CISC does in hardware.

x86 vs ARM

This brings us back to x86 vs ARM, where we can see how this all ties in. x86 was developed way back in 1978 by Intel [8]. This was based on CISC, and while it has undergone iterations, it is essentially the same as it was over 40 years ago. Intel owns x86, and currently, only AMD and Intel hold licences to produce 64 bit desktop processors with the x86 architecture [9]. 64 bit refers to the amount of data a processor can handle in one cycle, almost all modern home computers are 64bit however older ones may still be on 32 bit. ARM processors, on the other hand, utilised the RISC design and their current generation was released in October 2011 [10]. ARM is owned by itself, and it does not construct its own chips, instead licencing them out to many different chip manufacturers. Due to ARM's more straightforward design and greater efficiency, they are increasingly becoming more dominant within the smartphone market due to phones' reliance on batteries. A similar trend is happening with smaller, cheaper devices such as wifi modems and similar low powered devices. The openness of their licencing method also helps, since many more companies are able to produce these chips, thus generating more competition which should lead to better value chips with better features being developed.

Apple's Approach

Apple has decided to pivot away from intel and x86 altogether, now producing their M1 chips in-house, which all operate off the ARM implementation. Because of this shift, Apple has had to completely redesign many of its programs and its operating system as a whole. Not only

this, but all programs made for macOS now will have to be adapted to this new architecture which relies on third-party developers to restructure their programs entirely. There is a system called Rosetta 2 which can emulate x86 applications on M1 chips, and while this works surprisingly well, it cannot work as well as a natively designed program. It is a temporary solution [11]. For these reasons, Apple's move to M1 is a massive change, much more than a standard CPU upgrade. This also explains why Apple is going for a full hard swap instead of a gradual shift or running on both systems simultaneously. For as long as developers support the older x86 platform, they will have to be developing two apps simultaneously. Because of this, Apple, as well as third-party app developers, will inevitably move away from legacy support making the x86 apple programs eventually redundant and we do not know how long this will be [12].

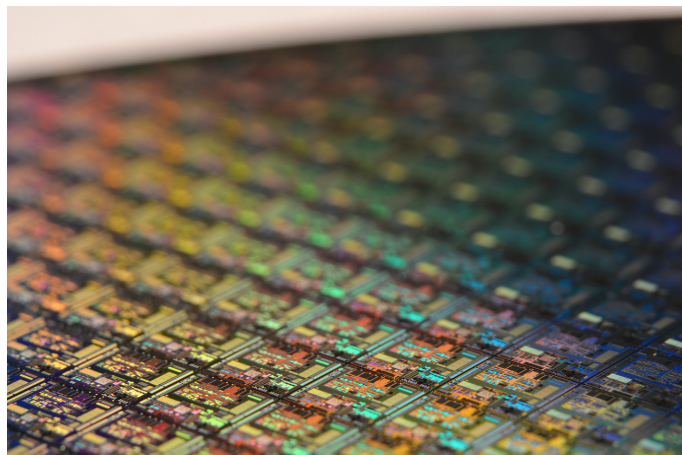
Microsoft's Approach

Apple's move to ARM has led to cheaper laptops that have improved battery life and greater performance [13], which begs the question: why haven't Windows gone down the same route? The answer is that Apple has complete control over their entire system from hardware to software, and the third-party developers have to follow their lead. On the other hand, Microsoft only is in charge of the operating system, while other companies are in charge of the hardware side of things. This means that there is far more pressure on Microsoft to maintain their current version of Windows. Interestingly a version of windows was made for ARM back in 2012 called Windows RT [14], but the lack of software leads to a chicken and the egg problem. Poor software support meant not many manufacturers produced computers for Windows RT, again leading to software developers having little market and therefore little incentive to program for this version. This has resulted in a version that is clunky and has significant compatibility issues. Emulation is working to resolve these issues [15], but this has proved a complex cycle to break without the control Apple holds.

Another point that makes it difficult for Windows to shift across is backwards compatibility. Many features are still supported back from MS DOS in the 1980s. For instance, the fact that a folder cannot be named 'CON' as it was reserved back then, to ensure compatibility, is still there now [16]. While Apple has often opted for a fresh start in each OS iteration, Microsoft has maintained these features, so shifting entirely across to ARM would require them to change this policy or rewrite much of these into the updated edition.

Future

With the constant improvements and attention, ARM is getting along with the fact that unification between different platforms such as tablets, phones, and computers could reduce programming redundancy if they shared systems. Coupled with better emulation to improve compatibility, we may see in the future Windows



A close up of a silicon wafer. Photo by Laura Ockel on Unsplash (2018).

and their hardware partners follow Apple's lead into ARM. Google looks to be pursuing a new OS called Fuchsia which will potentially unify their Android OS and Chrome OS together [17]. Chrome OS runs on both x86 and ARM natively [18]; however, if they shift all of their chips onto one architecture with one OS, this may not be required. Lastly, these are not the only two architectures. x86 is the industry standard and has been for a long time, whereas ARM is the new kid on the scene; however, you also have other options such as RISC-V, which is entirely open-source and does not have licencing [19]. NVIDIA was looking at making their future GPU's* on this system [20], but this may be in question now as they are trying to acquire ARM. This is also RISC based like ARM but currently doesn't have the same industry backing.

*A GPU or graphical processing unit is much like a CPU except it excels at running many less intensive processes at the same time, making it ideal for graphics and games.

Conclusion

Over this article, we have outlined why ARM versus x86 has become a recent discussion with the new Mac M1 chip being introduced. This further expanded by outlining the difference between these two architectures, ARM being RISC and x86 CISC. Next, we broke down the difference between the two design methods, how they work, and the benefits of both of them. This was expanded to talk about the history, differences and licencing methods of x86 and ARM. Furthering this discussion, we looked at Apple's vs Microsoft's business models and how that has affected their relationships with their architecture. We then had a brief look into the future of computer architecture and a potential third option. This should give the reader a bit more insight into what the change in new Macs mean and why it was such a large decision for them to pursue.

To draw a conclusion from this we can see that Apple assessed the large short-term cost of changing architecture against the longer term benefits of this swap. ARM's inherent greater efficiency, more lenient licensing and cheaper construction were too good to resist which lead Apple to end their 15 year partnership with intel. The question is, now, not if, but when Microsoft will follow suit.

References

- [1] Apple. "Apple Event November 10, 2020", <https://www.apple.com/apple-events/november-2020/>.
- [2] Hanson, Matt. "Apple MacBook Air (M1, 2020) review", April 2020, <https://www.techradar.com/nz/reviews/apple-macbook-air-m12020>.
- [3] Apple. "Apple to Use Intel Microprocessors Beginning in 2006", 06/06/2005, <https://www.apple.com/newsroom/2005/06/06Apple-to-Use-Intel-Microprocessors-Beginning-in-2006/>.
- [4] TOP 500. "TOP500 EXPANDS EXAFLOPS CAPACITY AMIDST LOW TURNOVER" November 2020, <https://www.top500.org/lists/top500/2020/11/press-release/>.
- [5] Bajarin, Tim. ARM Aims to Take a Bite Out of Intel's PC Market Share, 27/07/2018 <https://au.pcmag.com/processors/58283/arm-aims-to-take-a-bite-out-of-intels-pc-market-share>.
- [6] Apple. "Apple unleashes M1", 10/11/2021, <https://www.apple.com/nz/newsroom/2020/11/apple-unleashes-m1/>.
- [7] Stanford University. "RISC Architecture: RISC vs CISC", accessed 26/05/2021, <https://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/riscisc/>.
- [8] Intel. "Intel's First 16-bit Microprocessor", accessed 26/05/2021, <https://www.intel.com/content/www/us/en/history/virtual-vault/articles/the-intel-8086.html>.
- [9] Tang, Greg. "Intel and the x86 Architecture: A Legal Perspective", 04/01/2011, <https://jolt.law.harvard.edu/digest/intel-and-the-x86-architecture-a-legal-perspective>.
- [10] ARM. "ARM Discloses Technical Details Of The Next Version Of The ARM Architecture", 27/10/2011, <https://web.archive.org/web/20190101024118/https://www.arm.com/about/newsroom/arm-discloses-technical-details-of-the-next-version-of-the-arm-architecture.php>.
- [11] Apple. "If you need to install Rosetta on your Mac", 15/01/2021, <https://support.apple.com/en-nz/HT211861>.
- [12] Mah Ung, Gordon. "Why Apple's move from Intel to ARM means we should stop buying Macs", 10/11/2020, <https://www.pcworld.com/article/3563892/why-apples-move-from-intel-to-arm-means-we-should-stop-buying-macs.html>.
- [13] Apple. "Apple M1 Chip - Apple (AM)", Accessed 26/05/2021, <https://www.apple.com/am/mac/m1/>.
- [14] Bisson, Simon. "CES: Windows to run on ARM chips, says Microsoft", 06/01/2011, <https://www.zdnet.com/article/ces-windows-to-run-on-arm-chips-says-microsoft/>.
- [15] Pulapaka, Hari. "Introducing x64 emulation in preview for Windows 10 on ARM PCs to the Windows Insider Program" 10/12/2020, <https://blogs.windows.com/windows-insider/2020/12/10/introducing-x64-emulation-in-preview-for-windows-10-on-arm-pcs-to-the-windows-insider-program/>.
- [16] Tiwari, Aditya. "Windows Doesn't Allow You To Create Folder Named 'CON', PRN, NUL, etc. Here Is How You Can Still Create It", 20/02/2017, <https://fossbytes.com/windows-reserved-folder-con-create/>.
- [17] Friday, Richard. "Google's Fuchsia could replace Android and unite all devices", 07/04/2018, <https://www.wired.co.uk/article/google-fuchsia-chrome-os-android-demo>.
- [18] Hildenbrand, Jerry. "Should I buy an x86 or ARM-powered Chromebook?", 20/06/2019, <https://www.androidcentral.com/should-i-buy-x86-or-arm-powered-chromebook>.
- [19] RISC-V. "RISC-V: About", Accessed 26/05/2021, <https://riscv.org/about/>.
- [20] Hashim, Shakeel. "The Nvidia-Arm deal hasn't boosted RISC-V. But it soon could." 25/09/2021, <https://www.protocol.com/risc-v-chips-arm-nvidia>.



*Cichlids are an enigma for having evolved so many species sympatrically.
Photograph by Munheer Ahmed on Unsplash (December 2019).*

Cichlids – An Evolutionary Enigma

By Jasmine Gunton

The concept and processes of evolution have always been highly controversial and contested amongst academics. Since the publication of Charles Darwin's famous scientific literature, '*On the Origin of Species*', great advancements have been made in understanding how evolution works. However, biology is still a messy subject, with many species displaying exceptions to commonly accepted evolutionary theories.

A salient example that demonstrates exceptions to the rule is the case of freshwater cichlid fish, native to tropical America, Africa, and southern Asia. Cichlids evolved via a process known as sympatric speciation. During this process, hundreds of species of cichlid evolved from a single ancestor while still all occupying the same geographical region. From DNA analysis we can determine that over 1,650 species of cichlids [1] evolved from one ancestor in just 100,000 years (approx.) [2]. To understand why this phenomenon is exceptional, one must have a basic understanding of the principal mechanisms and causes of evolution.

Formation of Species

Most biologists agree that a species can be defined as populations of individuals that are able to interbreed in the wild to produce viable offspring. Most commonly, new species are created when populations get physically separated. This can result from either a geographic event (e.g. formation of a mountain range, moving of tectonic plates, etc.) or when a subset of the population migrates to a different area. The two groups of organisms are often not representative of each other and are also subjected to different selection pressures provided by the two different habitats. More importantly, the two populations are now reproductively isolated and are therefore not influenced by gene flow (migration of organisms from one population to another) [3]. Over a long period of time, two new species are formed. This type of speciation is known as allopatric speciation, 'allo' meaning 'different', and 'patric' meaning homeland. In the case of cichlids, there was no such geographic barrier preventing different populations of fish from interbreeding. This phenomenon has been called sympatric speciation ('sym'

meaning 'same'). Due to the large number of distinct cichlid species, we specifically call this type of evolution 'adaptive radiation'.

Gradualism

Another once commonly accepted theory of cichlid evolution was the concept of gradualism. This theory has since been contested using examples from a number of evolutionary events. Gradualism suggests that a species evolves over a very long period of time, as beneficial phenotypes rarely arise within a given population. However, a noticeable lack of transitional forms exist between the original cichlid ancestor and its descendants, indicating a rapid rate of speciation. This theory of evolution has since been called the punctuated equilibrium model. Contrary to the idea of gradualism, the punctuated equilibrium model suggests that species experience long periods of stasis, followed by short bursts of evolutionary change.

An Alternative Hypothesis

When considering this question, one may ask whether the 1,650 species of cichlid fish can actually all just be classified under the same genus. This judgement can be disproven using a number of taxonomical techniques. First, cichlids show an incredibly large range of morphological differences, including different colour, pattern, size, and mating behaviour. They have also been shown to exhibit sexual behaviour which prohibits them from forming hybrid offspring. Finally, molecular analysis of individual species shows that under the speciation continuum, the Cichlidae family can be classed as encompassing a number of truly distinct species [4].

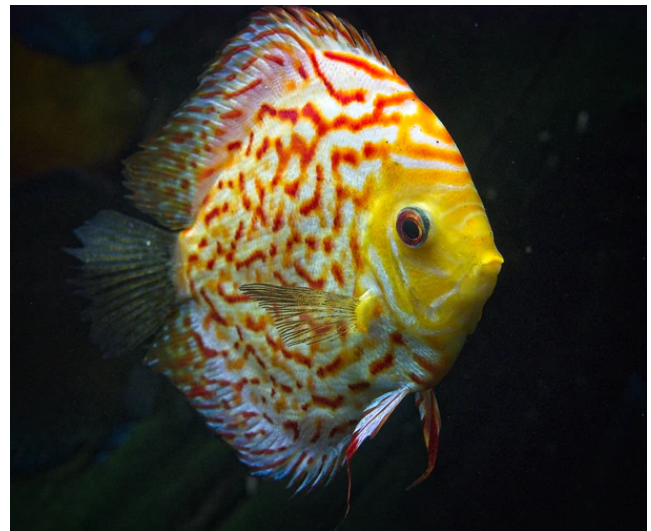
The Current Verdict

With this information, biologists have long pondered why this species suddenly diverged for seemingly no reason. Currently, no other vertebrate species have been found to display this type of adaptive radiation [4]. For this reason, East African cichlids were one of the first species of fish to undergo extensive genome sequencing. New research has uncovered the importance of considering ecology in the process of speciation. By analysing the DNA of several cichlid species it is also thought that speciation can still occur with some levels of gene flow between different populations. Current hypotheses propose that the hundreds of cichlid species may have formed by competition and sexual selection. Essentially, it is thought that to avoid competition, different cichlids would occupy slightly different areas within the same habitat, subsequently forming new ecological niches. Sexual selection of male colour patterns further prevented these populations from interbreeding. This current theory might explain how the 1,650 cichlid species evolved from just one ancestor.

Future Research

Research into cases of adaptive radiation is relatively

limited in the biological science field, and the underlying mechanisms of adaptive radiation are yet to be fully understood. Therefore, academics are reluctant to label a species' evolutionary history under this category. Due to a lack of research, further analysis is required to fully understand the strange evolution of the Cichlidae family. Sympatric speciation in fish shows that scientific theories are not rigid in nature, but rather ever-changing and 'evolving' (bad pun, I know), with new theories being constantly proposed and integrated into our understanding of the world. Although greatly appreciated as one of the most revolutionary pieces of scientific literature, concepts in '*On The Origin of Species*' have since been contested by members of the scientific community. The same will inevitably occur with our current conclusions about evolutionary biology. Cichlids, on the other hand, will simply keep on living their lives in rivers and lakes, completely unaware of the mystery that surrounds their history.



Photograph by Michael Rodock on Unsplash (January 2019).

References

- [1] Fishbase. Accessed May 20, 2021. URL: <https://www.fishbase.se/Nomenclature/NominalSpeciesList.php?family=Cichlidae>
- [2] Brawand, David, Catherine Wagner, Yang I. Li, Milan Malinsky, Irene Keller, Shaohua Fan, Oleg Simakov et al. "The genomic substrate for adaptive radiation in African cichlid fish". *Nature* 513 (2014): 375-381. URL: <https://www.nature.com/articles/nature13726>
- [3] Ellstrand, Norman & Loren Rieseberg. "When gene flow really matters: gene flow in applied evolutionary biology". *Evol Appl* 9 (2016): 833-836. URL: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4947145/>
- [4] Salzburger, Walter. "Understanding explosive diversification through cichlid fish genomics". *Nat Rev Genet* 19 (2018): 705-717. URL: <https://doi.org/10.1038/s41576-018-0043-9>



Sheep grazing on farmland at Tawharanui, New Zealand. Farming drastically transforms the hydrology and ecology of a landscape. Photo by Koon Chakhatrakan on Unsplash (2020).

Restoring Landscapes Post-Farming: Is Replanting Really the Answer?

By Nina de Jong

Volunteer restoration groups in Aotearoa are a huge part of national conservation and restoration progress. Generally, we have a “top-down” approach to environmental management, where the Department of Conservation largely manages public land. However, resource constraints often lead to communities taking on restoration projects, overseen and approved by DOC. In many reserves, community groups do the bulk of the management and provide on-the-ground labour. These groups engage in a huge range of activities including pest trapping, native bird and invertebrate monitoring, building recreational and conservation infrastructure such as tracks, toilets, nurseries, and tree planting.

Tree planting is usually central to restoration, and arguably for a good reason. Replanting can accelerate ecosystem regeneration processes [1]. It is seen as important for carbon fixation [2], and aligns more with human time scales – natural regeneration is far slower [3]. There are also strong social dimensions to tree planting. It’s a great activity for getting stuck in and making change that you can see. It’s extremely satisfying to overlook a field that a group of you have replanted, and

growing native plants in the nursery is delightful and industrious. Restoration groups are important places for forming friendships and communities, and the practices centred around replanting keep meetings regular and give groups direction and purpose. I can say this from personal experience! However, replanting is not the only approach restoration groups can and should take, both for the landscape they are involved with and the group themselves. How we are replanting, and perhaps in some cases, whether we should replant at all, might be important to rethink.

Over recent generations, land in Aotearoa that was previously used for farming has been transferred to regional parks and state reserves, and now this land is managed with environmental conservation in mind. In many instances, new land that is adopted into conservation management has been drastically altered from its pre-human condition by farming. Like any land-use activity, farming involves making profound changes to the environment. Pākehā settlers and the colonial state that bought or confiscated millions of acres from Māori, had clear priorities: to make the land suitable for farming, and become educated in profitable farming

techniques [4]. To do this, firstly they had to burn off the forest to create better conditions for agriculture. If the land was poorly draining, farmers would drain the land so that it wasn't as muddy, reducing the extent of wetlands and increasing the probability of river flooding. To reduce river flooding, they then needed to place stopbanks and train river channels so that land would flood less frequently, and the river would carry water more efficiently out of the farm. Drained land and naturally drier land is more drought prone, and so irrigation from rivers back onto the fields might be necessary. As farming is practiced, soil fertility is reduced. Without continued input of nutrients from ecosystem processes like decomposition, nitrogen-fixing, or regular flooding, fertilisers must be added to the land to improve production. This creates nutrient-rich run-off that flows into waterways, promoting algal blooms, anoxic conditions and local extinction of aquatic species... and of course you can follow these threads on and on.

These processes are not straightforward and don't always occur in the same way or in the same order. However, the important pattern is that colonial farming practices develop a completely different set of hydrological and ecological processes for the land they are practiced in. The changes made under agricultural production do not disappear when the farming stops and planting starts. History accumulates in the memory of a landscape, which means reversion back to "pristine", pre-human ecosystems will never happen. This has consequences for remediation of land. Restoration approaches have to understand the land's history, and take this history into the new, remembered, ecosystem of the future. For example, replanting at the edges of streams is often considered an effective way to absorb and filter nutrient run-off from farms before it reaches the water. However, on farms where drains have been laid or where groundwater flow is deeper than where roots have grown to, run-off can flow straight past riparian planting and into waterways [5]. If this history is not addressed, the same issue remains and the replanting is ineffective.

Clearing vegetation is only one part of the drastic transformations that landscapes undergo when land conversion occurs. The complex networks of connections between soils, waterways, animals, plants, fungi, nutrients, and everything in between means that restoration projects have to tackle lots of things at once. Successful replanting relies on the state of other aspects of the environment, such as water availability, pest species, and exposure. For example, some plants that do best in wet places, such as kahikatea, may struggle to grow in a landscape that has been drained, where they can't compete with other species [6]. A lack of pest control can prevent the success of planting, as rabbits, possums and deer can easily continue to browse new plants to death, and invasive plants can smother native trees [7,8,9]. It might be better to focus just as much, or more, on these other issues than to give all our energy to replanting.

Across the world, reforestation projects often use only one or only a few species when replanting, leading to low biodiversity plantations that do not resemble a naturally regenerating land [10]. In Aotearoa, replanting schemes use mānuka and kānuka far in excess of any other plants. This is because they're thought of as classic "pioneer" species that grow quickly in exposed paddock environments, creating shelter and shade for trees more typical of mature forest to grow beneath. The economic value of mānuka honey has also led beekeepers to plant monospecific crops for honey-making. However, this approach may not be best for restoration if creating a "natural" forest is the goal. Mānuka and kānuka have very dense canopies, especially when they are young. Although some protection from the elements is important for many forest trees, the darkness beneath dense mānuka or kānuka canopies prevents most plants from surviving, especially where the trees are still low and bunched up. As a result, instead of the multi-storeyed, species-rich, complex forest structures that you see in naturally regenerated kānuka or mānuka dominated pioneer forest, beneath these monospecific canopies, there is usually bare, dry ground. Other plants often used in pioneer planting such as harakeke, do not actually have a canopy at all as it is a large flax bush. Tī kōuka has only a small canopy that is unlikely to provide extensive shade and shelter. The conditions required for the biodiverse, multi-layered forests everyone wants to see might not be achieved by planting large, dense swathes of just a few species.

The scientific understandings of actual natural regeneration and succession in native ecosystems are far from complete. Plants used in "pioneer" planting are used to recreate what research has suggested occurs in natural landscape regeneration, but this isn't the only way a forest can develop. Not all mature forest trees require a sheltered nurse canopy to grow beneath. Iconic forest species such as kahikatea, totara, and other conifers need high light environments to regenerate [11]. If all the abandoned fields across the country were planted with "pioneer" plants, we could lose opportunities for these conifers to establish. The plants that arrive first in a regenerating plot often determine what comes next. For example, the native species established beneath gorse growing in a paddock are different from the species found growing beneath mānuka [12], and the species that regenerate under kānuka and silver fern are not the same species that regenerate beneath mamaku [13]. Letting land regenerate naturally can reveal the interesting patterns of how plants appear in the landscape. It is fascinating to see how many different directions ecosystems might take, and how this could lead to different plant communities [14]. If we create "garden" forests, where we try to recreate natural regeneration with our best guess at the plants that should be there, we might never know what sort of community would have developed otherwise.

Replanting landscapes can be very important, for example where erosion is a major problem or where



Replanting is an important and popular aspect of landscape restoration. Photo by Lachlan Cormie on Unsplash (2019).

there is social pressure for action and results. However, not every landscape must be replanted, because every landscape is different. Other aspects of restoration, such as raising the water table, or reducing pest plants and animal populations, might be more important to restoring the wellbeing of a landscape. Sometimes it can feel like replanting is a way of covering over our mistakes – we can cover a paddock with trees and pretend it was never a paddock at all. However, the landscape doesn't forget, and it isn't transformed back to a pre-human ecology by planting. It might be slower, less satisfying, more unpredictable and even more work (if other aspects of restoration are more difficult), to just let plants naturally return to the land. However taking things slowly, learning as we go and working with landscapes rather than just re-managing them over again, might be an interesting alternative for restoration.

References

- [1] Omeja, Patrick A., Colin A. Chapman, Joseph Obua, Jeremiah S. Lwanga, Aerin L. Jacob, Frederick Wanyama, and Richard Mugenyi. "Intensive tree planting facilitates tropical forest biodiversity and biomass accumulation in Kibale National Park, Uganda." *Forest Ecology and Management* 261, no. 3 (2011): 703-709.
- [2] Bastin, Jean-Francois, Yelena Finegold, Claude Garcia, Danilo Mollicone, Marcelo Rezende, Devin Routh, Constantin M. Zohner, and Thomas W. Crowther. "The global tree restoration potential." *Science* 365, no. 6448 (2019): 76-79.
- [3] Holl, Karen D., and T. Mitchell Aide. "When and where to actively restore ecosystems?." *Forest Ecology and Management* 261, no. 10 (2011): 1558-1563.
- [4] Nightingale, Tony. "Government and agriculture." *Te Ara - the Encyclopedia of New Zealand*, <http://www.TeAra.govt.nz/en/government-and-agriculture/print> (accessed 21 May 2021)
- [5] McKergow, Lucy A., Fleur E. Matheson, and John M. Quinn. "Riparian management: A restoration tool for New Zealand streams." *Ecological Management & Restoration* 17, no. 3 (2016): 218-227.
- [6] Ogden, John., Stewart, Glenn. H. "Community Dynamics of the New Zealand Conifers." In *Ecology of the Southern Conifers*, 81-119. Melbourne University Press, 1995.
- [7] Husheer, Sean W. "Introduced red deer reduce tree regeneration in Pureora Forest, central North Island, New Zealand." *New Zealand Journal of Ecology* (2007): 79-87.
- [8] Gillman, L. N., and J. Ogden. "Seedling mortality and damage due to non-trophic animal interactions in a northern New Zealand forest." *Austral Ecology* 28, no. 1 (2003): 48-52.
- [9] Standish, Rachel J., Alastair W. Robertson, and Peter A. Williams. "The impact of an invasive weed *Tradescantia fluminensis* on native forest regeneration." *Journal of Applied Ecology* 38, no. 6 (2001): 1253-1263.
- [10] Seddon, Nathalie, Beth Turner, Pam Berry, Alexandre Chausson, and Cécile AJ Girardin. "Grounding nature-based climate solutions in sound biodiversity science." *Nature Climate Change* 9, no. 2 (2019): 84-87.
- [11] Lusk, Christopher H., Murray A. Jorgensen, and Peter J. Bellingham. "A conifer–angiosperm divergence in the growth vs. shade tolerance trade-off underlies the dynamics of a New Zealand warm-temperate rain forest." *Journal of Ecology* 103, no. 2 (2015): 479-488.
- [12] Sullivan, Jon J., Peter A. Williams, and Susan M. Timmins. "Secondary forest succession differs through naturalised gorse and native kānuka near Wellington and Nelson." *New Zealand Journal of Ecology* (2007): 22-38.
- [13] Brock, James MR, George LW Perry, William G. Lee, Luitgard Schwendenmann, and Bruce R. Burns. "Pioneer tree ferns influence community assembly in northern New Zealand forests." *New Zealand Journal of Ecology* 42, no. 1 (2018): 18-30.
- [14] Wilson, H. D. "Nature not nurture; minimum interference management and forest restoration on Hinewai reserve, Banks Peninsula." *Canterbury Botanical Society Journal* 37 (2003): 25-41.



Comorbidity in Mental Health and Medicine

By Gene Tang

Comorbidity is a major challenge that has emerged in the fields of psychology, psychiatry, and medicine within the last few decades. While many people may not have heard this term before, the concept behind it may be quite familiar. Comorbidity is associated with adverse outcomes at various scopes, from personal to clinical health care level. To this end, comorbidity is an issue that needs to be addressed.

Comorbidity as a term was first introduced by A. R. Feinstein, a well-known American doctor and epidemiologist. The term referred to the co-occurrence of multiple mental or physical health conditions within individuals. The term 'comorbidity' became somewhat fashionable not only in the field of psychiatry but also in general medicine [1], as its uses became increasingly frequent across different fields.

The prevalence of comorbid disorders is not limited to the co-occurrence of multiple mental disorders or multiple physical disorders, but simultaneous mental and physical disorders are also possible. Comorbid diseases and disorders have undoubtedly increased over the past few decades and it is likely that this trend will continue in the following years. This issue applies across many demographics; people of all ages can still suffer from numerous conditions, whether they are young or

elderly. Norman Sartorius, a former president of the World Psychiatric Association, saw comorbidity as more of a rule than an exception [2] as it is now more prevalent than ever before. Thus, it is not at all uncommon for individuals to be diagnosed with comorbid illnesses.

So what causes comorbidity? Several factors may be contributing to its increasing prevalence. It is undoubtedly tricky, potentially even impossible, to pinpoint a singular root of the problem. However, one of the possible causes might be linked to people's lifestyles in our contemporary world. An epidemic of unhealthy lifestyles, including changes in consumption and increased exposure to detrimental environments, may offer us an explanation for this phenomenon. These lifestyle changes can lead to an increased intake of pollutants and mutagens, which in turn, can play a part in one's immunological susceptibility against comorbid diseases and disorders. Another reason may be the success and advances in the field of medicine. Being able to prolong and sustain life without completely curing one disease could make it easier for patients to contract multiple illnesses simultaneously [2].

Even though external factors mentioned previously could partly inform the observed prevalence of comorbidity, the use of psychiatric classifications may

explain another part of this story, particularly when it comes to mental health comorbidity. DSM (Diagnostic and Statistical Manual of Mental Disorders) plays a central role in the theoretical debate on comorbidity [3]. The proliferation of having such diagnostic categories was amongst other arguments made to inform the emergence of psychiatric comorbidity [1]. The argument asserts that the increase in the number of diagnostic categories may result in a higher likelihood of individuals being diagnosed with an illness and, consequently, increased comorbidity rates.

Another argument points to the problem of diagnostic inflation. Due to frequent revisions of diagnostic criteria [5], new diagnoses and lowered, easy-to-meet thresholds were introduced, thus significantly increasing the comorbidity rates [4]. The diagnostic criteria for anorexia nervosa can well exemplify this issue. In DSM-V, the number of necessary symptoms required for any patient to be diagnosed with anorexia nervosa was reduced from four to three [6]. This can be problematic because patients will not only have an increased likelihood of being diagnosed with anorexia nervosa but also potentially higher comorbidity rates. With this in mind, we could probably agree that it is not unlikely for an individual to be diagnosed with additional disorders once diagnosed with one.

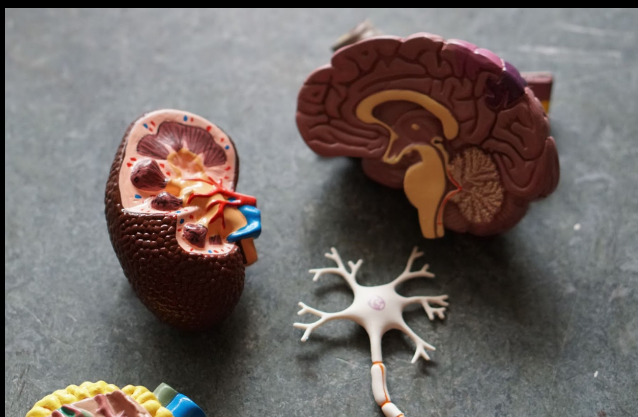
Studies from different countries have found a similar statistical trend regarding this issue. In the US, it was found that 54% of those who met the criteria for at least one mental health disorder at some stage in their lives, also met the criteria for two or more other disorders. Meanwhile in Australia, 40% of those who met criteria for at least one disorder in the period of 12 months also met the criteria for two or more disorders [7]. For New Zealand, the number falls to around 37%, meaning that over a third of people with any disorders will also have more than one disorder [7].

Now let us look at a smaller scale, focusing on the patterns of comorbidity on specific mental disorders. In NZ, of the people diagnosed with anxiety disorders, approximately 27% also suffered from a comorbid mood disorder, and 9% had a comorbid substance use disorder. We can see that comorbidity occurs quite often in anxiety disorders. In fact, social anxiety disorder (SAD, which is a major type of anxiety disorder), was reported to have a considerably high comorbidity prevalence rate across different populations. This rate could sit as high as 90% [8]. The high rate of comorbidity we see in SAD may partly be due to how this disorder was found to be a predictor for the development of other disorders [9,10]. SAD subsequent disorders like mood disorders (e.g., depression, bipolar disorder, and dysthymia), therefore commonly co-occur with anxiety disorders [8]. This overlap was also the most common comorbidity in the NZ population, as reported in Te Rau Hinengaro.

Even though numerous studies on mental health comorbidity pay attention to anxiety disorders, we cannot disregard the fact that comorbidity can occur with any disorders of any form. That is, comorbidity does not necessarily have to come in the form of mental-mental comorbidity, but it can also be a mental-physical or physical-physical one.

Now that we know the potential causes of comorbidity and its prevalence in the population, we might ask ourselves, why is this a problem? Why is this important? Comorbidity is associated with a variety of adverse outcomes. First of all, overlapping symptoms or co-existing disorders may make prognoses extremely difficult. The presence of multiple disorders may create serious complications that limit clinicians from producing accurate diagnoses, and increase the rate of misdiagnoses. Secondly, comorbidity is associated with worse health outcomes. People who have comorbid diseases are more likely to have increased severity of the disease. More than 59% of the patients in NZ who suffered three or more disorders were classified as serious or severe cases [7]. This will undoubtedly impact the mortality as well as the general quality of life of the patients. Another significant issue that emerged from comorbidity and has been highlighted in several papers is the treatment difficulty [2,5,8]. The nature of co-existing diseases might result in inadequate and inappropriate treatment responses. When multiple diseases are comorbid, overlapping medication could be one of the problems. Some medications may restrict the effects of other medication required for the additional disorders suffered by the patient. That is, the potential interactions between medications can induce unwanted side effects. For example, a drug prescribed for chronic obstructive pulmonary disease will have an antagonistic effect on the diabetes treatment [11]. This shows that the medication or treatments prescribed in comorbid disease have the potential to be inefficacious.

Another major concern raised when it comes to diagnosing comorbidity is that sometimes clinicians fail to recognize or overlook the comorbidity that exists [2,8]. A psychiatrist we previously mentioned, Norman Sartorius, had made some noteworthy arguments regarding this. He argued that clinicians are usually focusing on the disorders or diseases they are already familiar with. This seems to be commonly the case for mental-physical comorbidity. Non-psychiatric specialists tend to avoid making the diagnosis of mental health disorders due to the unfamiliarity and uncertainty about the treatments and diagnosis. Clinicians often would proceed with a single-disease treatment, expecting psychological symptoms to fade after treating the physical disease [2]. This is also the case for psychiatrists. Because they are unfamiliar with physical diseases, they might avoid conducting the examinations necessary to detect the presence of another concomitant disease.



Photograph by Robina Weermeijer on Unsplash (June 2019).

At the end of the day, we all know that comorbidity is something that will continue to persist and we cannot expect the rate to drop anytime soon. However, what can be done or changed is the way professionals deal with this issue. Health care should not just focus on treating one specific disease, but rather should treat the patient holistically [12]. Hence, clinicians need to be trained and become competent in treating comorbid conditions. They need to understand their responsibility in dealing with various diseases and the diagnoses, even if some conditions are not their area of expertise. Non-psychiatric specialists should be able to confidently identify psychiatric disorders and likewise, psychiatrists should also be able to deal with physical illnesses competently. Having said that, we still need to understand that this may not be entirely possible—not without the reorientation of medical education. Therefore, clinicians may want to consider involving other specialists in the patients' diagnostic and treatment strategies. This will offer patients more accurate diagnoses as well as an assurance that comorbid diseases are not left undetected. To this end, we could say that the coordination and cooperation of professionals are essential in dealing with comorbidity.

Comorbidity is a big challenge that people are often unaware of. Even if we may not have heard about it before, it does not mean that it is not present in the world around us. We cannot forget that there are people out there whose lives have been devastatingly affected by this problem. The seriousness of this issue should not be underestimated, regardless of whether we are health professionals or not.

References

- [1] Maj, Mario. “‘Psychiatric comorbidity’: an artefact of current diagnostic systems?,” *British Journal of Psychiatry* 186. no. 3 (Jan 2005): 182-184.
- [2] Sartorius, Norman. “Comorbidity of mental and physical diseases: a main challenge for medicine of the 21st century,” *Shanghai Archives of Psychiatry* 25. no. 2 (Apr 2013): 68-69.
- [3] Van Loo, Hanna M., and Jan-Willem Romeijn. “Psychiatric comorbidity: fact or artifact?,” *Theoretical Medicine and Bioethics* 36. no. 1 (Feb 2015): 41-60.
- [4] Vella, G, M. Aragona, and D. Alliani. “The complexity of psychiatric comorbidity: a conceptual and methodological discussion,” *Psychopathology* 33. no. 1 (Feb 2000): 25-30.
- [5] Batstra, Laura, and Frances Allen. “Diagnostic Inflation : Causes and a Suggested Cure,” *Journal of Nervous and Mental Disease* 200. no. 6 (June 2012): 474-479.
- [6] American Psychiatric Association. *Diagnostic and statistical manual of mental disorders: DSM-5*. Arlington: American Psychiatric Association, 2013.
- [7] Scott, Kate M. Te Rau Hinengaro: The New Zealand Mental Health Survey. Chapter 5: Comorbidity. Wellington: Ministry of Health, 2006.
- [8] Koyuncu, Ahmet, Ezgi İnce, Erhan Ertekin, and Raşit Tükel. “Comorbidity in social anxiety disorder: diagnostic and therapeutic challenges,” *Drugs in Context* 8, (2019): 21573.
- [9] Ohayon, Maurice M., and Alan F. Schatzberg. “Social phobia and depression: Prevalence and comorbidity,” *Journal of psychosomatic research* 68. no. 3 (2010): 235-243.
- [10] Kessler, R. C., P. Stang, H.-U. Wittchen, M. Stein and E. Walters. “Lifetime co-morbidities between social phobia and mood disorders in the US National Comorbidity Survey,” *Psychological Medicine* 29. no. 3 (May 1999): 555-567.
- [11] Valderas, Jose M., Barbara Starfield, Bonnie Sibbald, Chris Salisbury, and Martin Roland. “Defining Comorbidity: Implications for Understanding Health and Health Services,” *Annals of Family Medicine* 7. no. 4 (July 2009): 357-363.
- [12] Gijzen, Ronald, Nancy Hoeymans, Francois G. Schellevis, Dirk Ruwaard, William A. Satariano, and Geertrudis A. M. van den Bos. “Causes and consequences of comorbidity: A review,” *Journal of clinical epidemiology* 54. no. 7 (July 2001): 661-674.

Ultralight Dark Matter

By You-Rong F. Wang

Ultralight Dark Matter (ULDM), also called “Fuzzy” Dark Matter, is a class of hypothetical dark matter candidates in cosmology. It postulates that very-low-mass particles (so-called ultralight axions) from beyond the Standard Model are responsible for some observed large-scale structures of the universe but remain elusive at lab-accessible scales of physics.

Due to the axions’ low mass, ULDM behaves almost entirely according to the laws of quantum mechanics. With a typical de Broglie wavelength at the order of kiloparsecs, i.e. tens of quadrillions of kilometres, ULDM can give rise to a range of galactic-scale phenomena analogous to what you might only associate with a microscopic particle (of course, the effects are mediated here by gravity instead), such as superposition, interference and tunnelling. Therefore, ULDM is poised to leave behind unique signatures in a range of astrophysical systems, from stellar rotational curves in core regions of galaxies to the origin of certain gravitational wave events.

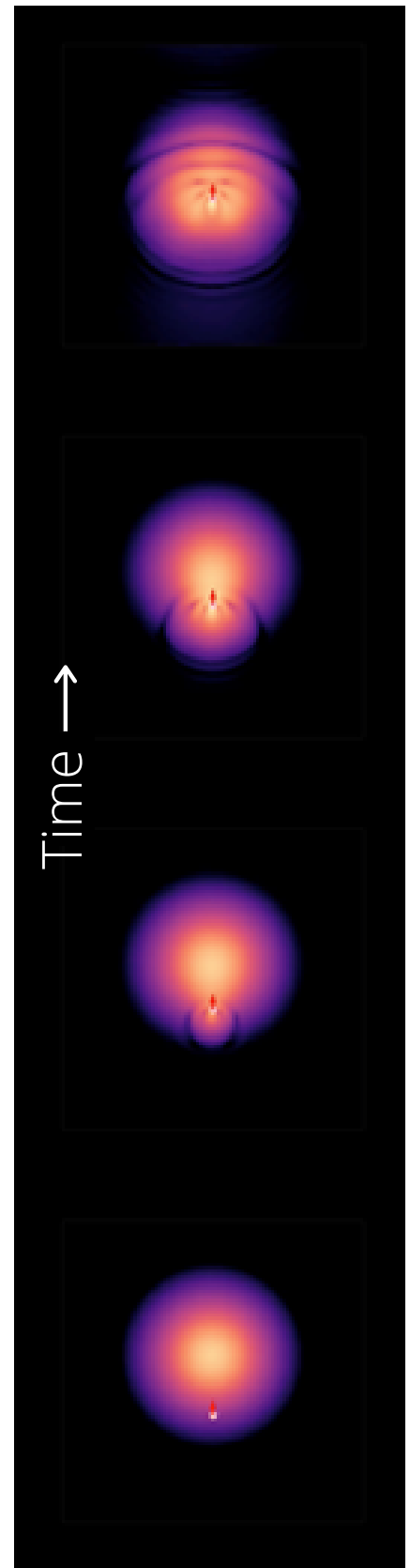
The dynamics of ultralight axions may be described collectively as a single wavefunction evolving according to modified Schrödinger Equations. In the simplest of ULDM models, one takes into consideration the gravitational potential generated by the wavefunction itself. This modification, known as the Schrödinger-Poisson equation, introduces nonlinearity to our system of partial differential equations. In addition, there also exist more exotic models that hypothesise complex self-interaction terms beyond just gravity, requiring even more sophisticated numerical techniques to simulate and understand.

As my first project during my PhD at Auckland Cosmology under Prof. Richard Easther, I am working on such numerical simulations, developing a scheme through which we can study the influence that Ultralight Dark Matter (ULDM) has on N-body particle systems. This effort offers us an opportunity to test the validity of ULDM theories and is relevant for our understanding of, for example, the interaction between supermassive black holes during galaxy mergers.

The figure shows a massive point particle’s motion into a ULDM halo. The colour represents ULDM density in a plane, and the quantum “fuzziness” is evident as the mass reaches the core. This simulation is achieved using Auckland Cosmology’s PyUltraLight2 simulation program, and a paper with detailed discussions of such interaction models is currently in preparation.

Further Reading

- [1] John Preskill, Mark B. Wise, and Frank Wilczek. Cosmology of the Invisible Axion. *Phys. Lett. B* 120:127–132, 1983.
- [2] Lam Hui, Jeremiah P. Ostriker, Scott Tremaine, and Edward Witten. Ultralight scalars as cosmological dark matter. *Phys. Rev. D*, 95(4), 2017.
- [3] Faber Edwards, Emily Kendall, Shaun Hotchkiss, and Richard Easther. PyUltraLight: A pseudo-spectral solver for ultralight dark matter dynamics. *J. Cosmol. Astropart. Phys.*, 2018(10), 2018.
- [4] Elisa G. M. Ferreira. Ultra-Light Dark Matter. 2020. <https://arxiv.org/abs/2005.03254>





Choosing your university is a huge decision, which can be made more confusing by international rankings. Photo by Vasily Koloda on Unsplash (2018).

University Rankings: For Who, for What, and Why?

By Alex Chapple

In year 13, many students are faced with an important decision of their life: which university should they go to? You may have seen videos online called “college decision videos”, where high school students in other countries record their live reaction of finding out if they got into the university of their dreams. Some jump up for joy and hug their families, and some crumble into tears as reality hits them. Perhaps not so much in New Zealand but in much of the world (for example Japan), society is built around an academic meritocracy where which university you study at determines much of your life after graduation.

There are huge industries built around university admissions and entrance exams around the world, like tuition services for specific universities and private college counsellors. Often parents will do whatever they can to get their kids into prestigious universities because for them it’s a status symbol. This was even adapted into a Netflix Original called “Operation Varsity Blues: College Admission Scandals”, where parents would bribe athletic coaches through a middleman to get a recommendation to the admissions office for their kids.

Universities are a place for research and higher education, but they can be just as much about prestige and status. Often this status is driven by University rankings. There are many different rankings around the world, but the three global rankings that are most prominent are: The Quacquarelli Symonds (QS) World University Rankings, the Times Higher Education World University Ranking, and the Academic Ranking of World Universities (also known as the Shanghai Ranking).

In New Zealand, all eight universities are ranked in the top 500 globally [1]. At the time of writing, the University of Auckland is ranked at 81st on the QS World Ranking, 147th on the Times Higher Education World University Ranking®, and somewhere between 201st-300th on the Academic Ranking of World Universities. From this, we can already see that there is great variation between the rankings. There are over 20,000 universities globally [2], so a university ranked in the top 500 is already in the top 3% of universities worldwide (You probably have seen the buses around Auckland with this sort of statistic about AUT). Despite many universities being in the top 3%, we often look at only the universities ranked in the top 50 or

100 as the “worthy” universities. This is concerning because many other universities not ranked in the top 100 worldwide have excellent courses, world-leading research being done, and a great learning environment. These rankings shine the light only on the “top” universities, driving resources and attention to them and them only, leaving other universities in the dust. This isn’t beneficial for society as a whole at all, because the few get it all. Additionally, we’ve already seen that there can be large variations between the rankings. What does it really mean to be a “top” university? Which rankings, if any, can we trust?

Each of the three main rankings has its ranking methodology public, so let’s look at how they rank universities and how they differ from one another.

Firstly the QS World University Rankings [3]. The ranking is broken down into 6 categories with each weighted as follows:

- Academic Reputation - 40%
- Citations per Faculty - 20%
- Student to Faculty ratio - 20%
- Employer Reputation - 10%
- International Faculty ratio - 5%
- International Student ratio - 5%

Academic reputation is calculated from a survey sent out to over 100,000 academics around the world. It’s now the largest survey conducted of its kind. Citations per faculty are calculated based on the number of citations the publications from the university has gained in the past 5 years, divided by the number of academics at the institution. It’s a measure of the research output of the institution, suggesting that the number of citations that the research gets is the indicator of how important and valuable the research is. The student to faculty ratio is the ratio between the number of students and the number of staff at the university. The QS World Ranking suggests that this is a measure of the quality of teaching done at the university. The international faculty/student ratio is a measure of how good the university is at attracting talent from overseas. Much of the QS World University Ranking is based on institution reputation, student to staff ratio, and citations per faculty. It can be a good indicator of how the university is perceived by others, but it is not very indicative of the experience students can expect at the university.

Next, the Times Higher Education World University Rankings [4]. Their methodology is broken into 5 main categories, which are further broken down into smaller categories. The main 5 categories are as follows:

- Teaching - 30%
 - Reputation survey - 15%
 - Staff to student ratio - 4.5%
 - Doctorate to Bachelor’s ratio - 6%
 - Institutional income - 2.25%
- Research - 30%
 - Reputation survey - 18%
 - Research income - 6%
 - Research productivity - 6%

- Citations - 30%
- International Outlook - 7.5%
- Industry Income - 2.5%

The teaching is further broken down into another 5 categories, with 15% a reputation survey, 4.5% staff to student ratio, 2.25% Doctorate to bachelor’s ratio, 6% doctorates awarded to academic staff ratio, and 2.25% institutional income.

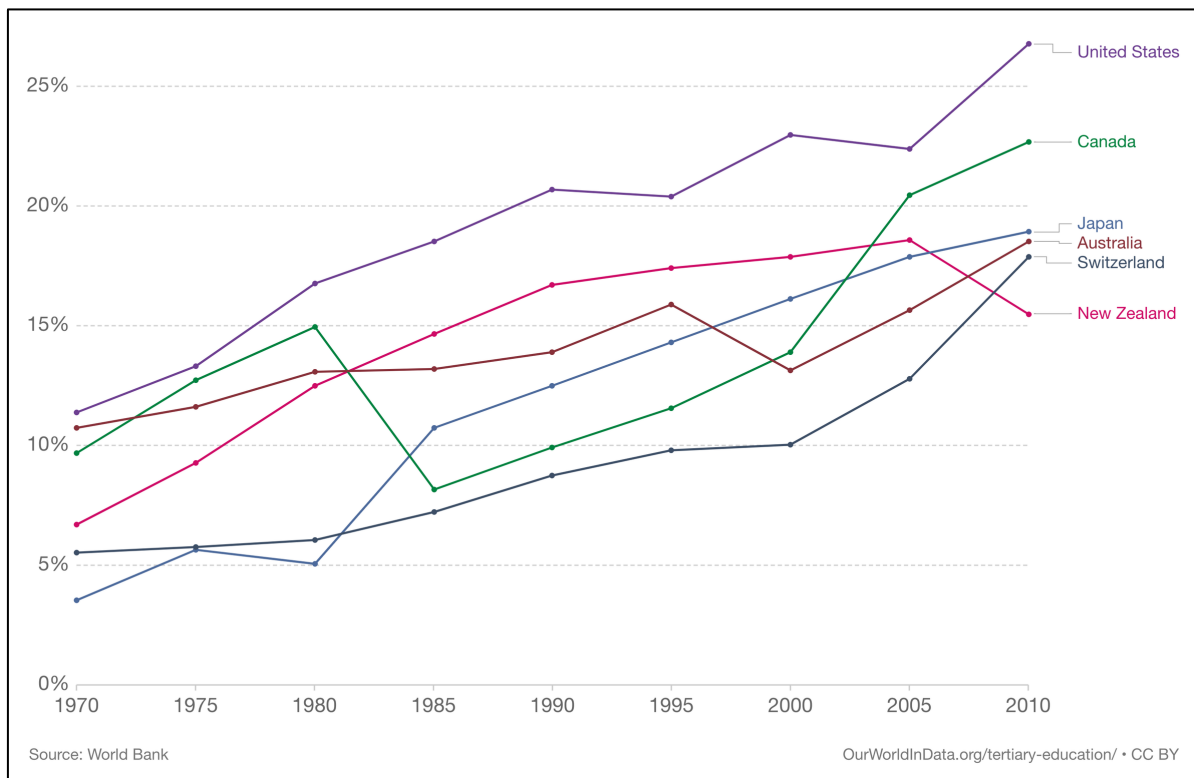
The research category is also further broken down into 3 categories. 18% is attributed to a reputation survey, 6% to research income (which they say describes the importance of the research being done), and 6% to research productivity. Interestingly, Times Higher Education admits that research income is a controversial metric because it can heavily depend on national policy and economic circumstances [5]. Nevertheless, they argue that it’s an important metric because research income is vital to conduct world-class research. Research productivity is measured by the number of papers published per academic. The Times Higher Education says that this is a measure of how good the university is at getting its publications published in a high-quality peer-reviewed journal.

The industry income is funding received from commercial sources, for example, businesses commissioning research. This category describes the commercial impact the university’s research has, which is a unique category not found in the other two rankings. The international outlook category is a measure of how good the university is at attracting students and academics from around the world. This is calculated by looking at the international staff and student ratio, as well as the number of research publications with international co-authors.

The Times Higher Education has a stronger focus on teaching and education than the other two rankings, but this can be quite subjective and hard to understand from a student’s perspective. Despite the strong teaching focus, the ranking is still more than 60% determined by the research output of the institution.

Finally, we have the Academic Rankings of Universities (Shanghai Ranking) [6]. This ranking originally was created as a way for Chinese universities to see how they stack up against the global competition. As the name suggests, it’s a ranking based almost solely on the academic performance and prestige of the institute. The methodology is as follows:

- Number of alumni winning Nobel Prizes and Fields Medals - 10%
- Number of staff winning Nobel prizes and Fields Medals - 20%
- Number of highly cited researchers in 21 broad subject categories - 20%
- Number of articles published in Nature and Science - 20%
- Number of articles indexed in Science Citation Index - 20%



The graph shows the percentage of the 15+ year old population with a tertiary degree over time.

Source: <https://ourworldindata.org/tertiary-education>.

- Per capita academic performance of an institution - 10%

The Academic Rankings of World Universities is heavily influenced by whether or not academic staff/alumni at the institution have won these prestigious awards and medals. When you look at the actual rankings, you see that it's dominated by institutions that have been around for centuries. By using Nature, Science, the Nobel Prize and Fields Medal as indicators of high academic performance, the Shanghai Ranking itself amplifies the prestige and status of these prizes and journals.

Note: the Fields Medal is sort of like the Nobel Prize equivalent for mathematics.

You may disagree with the methodology of these rankings, or the general philosophy behind ranking institutions in this way. However, there is one undeniable fact, university rankings matter. They matter to the students who go to or want to go to these universities, they matter to the universities themselves, as they heavily determine the future of an institution, and they matter to governments too as they often use these metrics to decide on the allocation of funding. Although the three rankings are transparent about how the total score is calculated, how they decide the weighting of each category is quite arbitrary. Who is to say that citations per faculty should be 20% of the overall score instead of 15%?

In a survey conducted by professor Ellen Hazelkorn at Technological University Dublin, it was found that more than half of the universities had taken strategic actions because of the rankings [7]. Sometimes the strategic decisions that universities make can have a negative influence on the teaching or learning experience for students at the university, but it is justified for the university because being highly ranked can lead to more students, more funding, and more prestige. For many smaller and lesser-known universities, the rankings can mean life or death as it's crucial in attracting students, and getting funding from the government. It should also be noted that most of the data used for these rankings are self-reported by the universities. As you can imagine, this has caused some issues in the past, and there have been numerous reports/scandals of universities bending the statistics or outright cheating to climb up the rankings. In 2020, Temple University was fined \$700,000 by the US Department of Education for sending fraudulent data about its online MBA program which helped the course to be ranked at the top in the country for several years. This year, the course is ranked 88th, tied with six other universities [8]. Back in 2015, Trinity College Dublin was accused of trying to influence academics that are part of the annual reputation surveys. Trinity College Dublin issued a statement of regret but said their intentions were in good faith [9].

There are other concerns around the legitimacy of the rankings as well. Recently a paper was published by

researchers at the Centre for Studies in Higher Education at the University of California, Berkeley, raising concerns about conflict of interest between QS World University Rankings and some universities. QS has a consulting business that helps universities in various aspects of their business [10]. Igor Chirikov, a senior researcher at the Centre for Studies in Higher Education argues that this consulting business is inappropriately influencing the rankings of universities [11]. The study looked at 28 universities, of which 22 of them had spent collectively nearly three million US dollars in QS consulting services. These universities that had used this consulting service frequently, rose approximately 140 positions than they would have otherwise if they hadn't used the service. Though other ranking institutions hold events for universities, their revenue is not nearly as reliant on universities as QS is. For example, Times Higher Education makes money from advertising and through its subscription-based content. Igor says that this type of conflict of interest is similar to those that are seen in other sectors of the economy where consultation leads to a biased evaluation of the rankings.

So should you trust university rankings, and are they useful? The fact of the matter is that rankings aside, there are plenty of great universities for us all to get a great education at. The differences between universities can be quite arbitrary and whatever methodology these rankings employ, they will never be able to encapsulate the entire experience and the entire calibre of a university down to a number. It's important for us to be aware of how universities are "ranked" and what this actually says, or doesn't say, about the quality of a university. A university is a place with vast responsibilities, from educating the next generation, to doing cutting edge research that changes the world and the way we think, to helping other sectors of the economy to grow. Universities play a huge role in our society, and for better or for worse, universities will continue to make strategic decisions around the rankings. One thing is for certain, these rankings aren't going anywhere anytime soon. So maybe it's time to not take these rankings too seriously ourselves.

References:

- [1] Universities NZ, 2021, Introducing NZ's eight universities, <https://www.universitiesnz.ac.nz/universities>
- [2] TruOwl, 2018, How many universities exist in the world?, <https://truowl.com/university/how-many-universities-exist-in-the-world/>
- [3] QS Quacquarelli Symonds Limited, April 20 2021, Ranking Methodology, <https://www.topuniversities.com/qs-world-university-rankings/methodology>
- [4] Duncan Ross, Times Higher Education, September 2020, Times Higher Education Ranking Methodology, https://www.timeshighereducation.com/sites/default/files/breaking_news_files/the_2021_world_university_rankings_methodology_24082020final.pdf
- [5] Times Higher Education, September 2019, Times Higher Education Ranking Methodology, <https://www.timeshighereducation.com/world-university-rankings/world-university-rankings-2020-methodology>
- [6] Shanghai Ranking, 2020, Shanghai Ranking Methodology, <http://www.shanghairanking.com/ARWU-Methodology-2020.html>
- [7] Hazelkorn, Ellen. (2019). University Rankings: there is room for error and "malpractice". <http://doi.org/10.5281/zenodo.2592196>
- [8] Scott Jaschik, December 7 2020, Education department fines Temple \$700000, <https://www.insidehighered.com/admissions/article/2020/12/07/education-department-fines-temple-700000-rankings-scandal>
- [9] Carl O'Brien, March 22 2016, Trinity College Dublin accused of trying to sway world university rankings <https://www.irishtimes.com/news/education/trinity-college-dublin-accused-of-trying-to-sway-world-university-rankings-1.2582286>
- [10] Scott Jaschik, April 27 2021, Buying Progress in Rankings?, <https://www.insidehighered.com/admissions/article/2021/04/27/study-charges-qs-conflicts-interest-international-rankings>
- [11] Chirikov, I. (2021). Does Conflict of Interest Distort Global University Rankings? . UC Berkeley: Center for Studies in Higher Education. Retrieved from <https://escholarship.org/uc/item/8hk672nh>



The combined oral contraceptive pill is known to cause blood clots in some people who use it. Photo from Reproductive Health Supplies Coalition on Unsplash (2019).

Opinion: Dissonance in Attitudes between Blood Clotting in Vaccines and Oral Contraceptives

By Stella Huggins

As vaccines of all stripes begin to be distributed throughout the population, inevitable panic over side effects descends with them. New technology is always daunting if you do not understand it. The psychology lying behind the fear of new phenomena is complex [1], and often begins with denial and outright refusal to partake [2]. Every individual has the right to refuse anything they wish – bodily autonomy is absolutely a human right. The recent pandemic has created a fascinating development in modern science; three distinct variations of vaccines [3]. Inevitably, some have unpredictable side effects, the most concerning being blood clots associated with the Johnson & Johnson vaccine.

The mechanisms through which the vaccine developed by Johnson & Johnson acts are not new concepts. It functions through the utilisation of adenoviruses, a common subgroup of medium-sized, double-stranded viruses that infect humans. They were discovered in 1953 [4]. However, it hasn't been in such wide use throughout the population. The public has clutched onto the pitfalls

of the vaccine with merciless scrutiny; this is a good thing in some respects. We should be wary of the scientific narrative. Scientists themselves are critical of it and are constantly reshuffling ideologies and things considered to be the ultimate truth. However, an interesting observation is that the scrutiny placed on COVID-19 vaccines does not appear to be attributed to other medications distributed nearly just as frequently in the population. To me, a striking difference in the priorities of public debate lies in who is being affected by the issues.

Johnson & Johnson has produced adverse side effects in a small majority of individuals. Blood clots, namely, have caused immense pressure on governments from certain sectors of society to discontinue their use [5]. Walking the line of caution is no easy feat, and the relative newness of the technology adds another layer of complexity to the matter. However, blood clots as a side effect of oral contraceptives are a well-documented occurrence; so where is the outcry for females taking this medication?

The advent of birth control was in the 1960s [6]. It provided an incredible amount of liberation to women, uprooting the narrative that a female must have a child if she were to enjoy the same sexual liberation as men. There is an obvious imbalance in the burdens placed upon each gender when it comes to pregnancy, and technologies to alleviate this imbalance gifted us with strides towards bodily autonomy for females.

Johnson & Johnson has a 66% efficacy rate against symptomatic infection, and an 85% efficacy rate against severe COVID-19 that produces hospitalisation. Oral contraceptives have a 99% efficacy rate with perfect use (taking the pill at the exact same time every day) and 91% success when human error is factored into the equation. Blood clots have occurred in 6 of the 7 million patients receiving the Johnson & Johnson vaccine (in the USA, one of the places Johnson & Johnson is being distributed) [7], whilst oral contraceptives (using Ava30 ED as an example, there are numerous oral contraceptives) have a risk of causing blood clots in about 5-7 out of every 10,000 females taking the medication, annually. In some cases, the blood clot risk is unknown in oral contraceptive types (estradiol + norgestrel hormone pill Zoely, and estradiol + dienogest hormone pill Qlaira [8]). This, to some extent, could reflect the priorities of the system: why is there an unknown, for such a significant side effect risk?

The medications are clearly inherently different in a myriad of ways – a vaccine requires no effort from the patient in terms of administration. Oral contraceptives are clearly more established, and have more data in terms of the long-term risks associated with these blood clots. Females are educated, generally, on the potential side effects of their birth control. There may be less quantifiable motives underlying a female's decision to accept the risks, and the raft of side effects, social and economic gain, bodily autonomy, are all factors that play into the decision. It's a highly personal choice in both cases. But the general social attitudes towards them seem so wildly different when the side effects are so similar.

Of course, 100% success is an enormous task – body chemistry is ridiculously complex, and side effects are to be expected in some capacity. The curious part is the attitudes towards such side effects. Birth control is distributed at a similar frequency in the population. In New Zealand, 89% of women aged between 35-69 use the pill [9]. Our vaccination rollout programme is still in progress (though it's important to note New Zealand is using Pfizer, a vaccine not associated with blood clots), the intent being to vaccinate as many people as possible, and cultivate herd immunity [10]. These numbers obviously do not pertain to the issue of blood clot parallels, but instead illustrate the frequency at which vaccines and oral contraceptives are distributed in populations. It begs the question; would the standard of

birth control's efficacy in relation to its side effects (which are by no means limited to blood clots), be tolerated today? Would the outcry be so outrageous, passionate and personal? Do groups who are unaffected by the immediate effects of such medications, have any regard for the health of women?

The climates under which both medications were produced were both ones of urgency, relating to a health issue. It's clear that the COVID-19 pandemic needed a far more rapid solution, but women were still dying of at-home abortions – an epidemic of sorts, though a far more socially oriented one. I am well aware that the drugs are not directly comparable, though I do urge you to consider society's overall attitudes to women's health, and compare these with the public's attitudes to the new vaccines becoming available.

It appears to reflect an insidious structural problem in the healthcare system, rooted in a historically male-dominated perspective to female health. It's something to ponder, when women across the globe are accepting such a risk, and passionate outcry is happening for a new medication. Part of this can be attributed to the fact that people born into an age where oral contraceptives are the norm may have less trouble accepting their risks – after all, their predecessors have coped with this subpar quality of life, how bad can it be? I can imagine that there was a degree of hesitancy when the drug was first rolled out worldwide.

Again, I am by no means advocating we blindly accept subpar accuracy of vaccines, and erring on the side of caution is perfectly acceptable. We should absolutely not stride forward with a solution that isn't quite right. However, the perception of the facts of the situation needs to change. Oral contraceptives are well established and socially accepted in most parts of the world – of course, as I have detailed, so the standards are slightly different – but maybe it's time we reconsider these entrenched attitudes.

Health psychology is difficult. Our attitudes to medication are understandably deeply personal, intertwined with our identity, our perceptions of our personal safety, the safety of our loved ones, and cultural attitudes. It's not easy to ask people to unpick these things, especially in a tumultuous period in history – in times of change, people burrow further into their previously entrenched beliefs, taking the global financial crisis of 2008 as an example [11]. It's likely that a pandemic is no exception to these psychological rules.

Oral contraceptives are by no means the only drugs that cause blood clots as a side effect. In an analysis by Ramot, Nyska and Spectre, a detailed consolidation of all known medicines to cause blood clots revealed a fascinating trend. A huge number of blood clotting drugs exist, however a huge majority of their uses relate to life-



Image from Hakan Nural on Unsplash (2020).

threatening or seriously quality of life impairing conditions. Chemotherapy, antipsychotics, antidepressants, acute skin conditions, pain relievers, muscular degeneration, and anemia are among the conditions treated by classes of medication that cause blood clotting side effects [12].

Whilst not to degrade the physical benefits that contraception can bring (hormone and mood regulation, alleviation of adverse menstrual experiences, treatment of mild endometriosis and PCOS cases, etc.), as well as the social-societal benefits of females having increased choice in their bodily autonomy, it seems as if the costs sometimes outweigh the benefits [13,14,15]. Or, at least, the technology simply isn't being improved, due to a disregard (whether intentional or unintentional), for improvement and progress, and a satisfaction with subpar female healthcare. The priorities of our society are overwhelmingly directed towards other areas of progress, and the treatment of female specific ailments is decidedly average.

It's coming to light now, too little too late, that medical research done on men and extrapolated to women is simply not directly transferable [16]. Women are not miniature versions of men, and their biochemistries are not parallel – at the most basic level, estrogen and testosterone production in each sex are inherently different. Female healthcare has long been neglected. The profession of medicine is finally becoming more gender-balanced [17], but this does not necessarily change the structures it was built on. This is not to say that we tear down frameworks of healthcare in a critical period, but rather, that we are acutely aware of their existence and origins. We must be cognisant of the fact that marginalised groups can easily fall under the radar in times of chaos [18,19]. The attitudes towards side effects are just one symptom of a larger ailment afflicting health perspectives.

References

- [1] Riezler, K. (1944). The Social Psychology of Fear. *American Journal of Sociology*, 49(6), 489–498. <https://doi.org/10.1086/219471>
- [2] David Ropeik (2013) How society should respond to the risk of vaccine rejection, *Human Vaccines & Immunotherapeutics*, 9:8, 1815-1818, DOI: 10.4161/hv.25250
- [3] World Health Organization. (n.d.). Coronavirus disease (COVID-19): Vaccines. World Health Organization. [https://www.who.int/news-room/q-a-detail/coronavirus-disease-\(covid-19\)-vaccines?adgroupsurvey=%7Badgroupsurvey%7D&gclid=CjwKC AjwtJ2FBhAuEiwAIKu19lqtp526TPSd6wN80siLLpctk5_oFG9wFwOhtK9XvhmOyIomEoDzBoCVF0QAvD_BwE](https://www.who.int/news-room/q-a-detail/coronavirus-disease-(covid-19)-vaccines?adgroupsurvey=%7Badgroupsurvey%7D&gclid=CjwKC AjwtJ2FBhAuEiwAIKu19lqtp526TPSd6wN80siLLpctk5_oFG9wFwOhtK9XvhmOyIomEoDzBoCVF0QAvD_BwE).
- [4] Desheva, Y. (2019). Introductory Chapter: Human Adenoviruses. In Y. Desheva (Ed.), *Adenoviruses*. essay, IntechOpen. DOI: 10.5772/intechopen.74757
- [5] Ledford, H. (2021, April 16). *COVID vaccines and blood clots: five key questions*. *Nature News*. <https://www.nature.com/articles/d41586-021-00998-w>.
- [6] Public Broadcasting Service. (2010, May 11). A brief history of the birth control pill. PBS. <https://www.pbs.org/wnet/need-to-know/health/a-brief-history-of-the-birth-control-pill/480/>.
- [7] Centers for Disease Control and Prevention. (2021, April 23). Agencies Underscore Confidence in Vaccine's Safety and Effectiveness Following Data Assessment; Available Data Suggest Potential Blood Clots Are Very Rare Events. Centers for Disease Control and Prevention. <https://www.cdc.gov/media/releases/2021/fda-cdc-lift-vaccine-use.html>.
- [8] MEDSAFE. Oral Contraceptives and Blood Clots. (n.d.). <https://www.medsafe.govt.nz/consumers/leaflets/ora-contraceptives.asp>.
- [9] Chesang, J., Richardson, A., Potter, J., & Coope, P. (2016). Prevalence of contraceptive use in New Zealand women. *The New Zealand medical journal*, 129(1444), 58–67.
- [10] World Health Organization. (n.d.). Vaccines and immunization: What is vaccination? World Health Organization. https://www.who.int/news-room/q-a-detail/vaccines-and-immunization-what-is-vaccination?adgroupsurvey=%7Badgroupsurvey%7D&gclid=CjwKC AjwtJ2FBhAuEiwAIKu19p7EEwGbhHCdtTp0jib3vNjxP_74_9a_wuGlEvrYg8IhlaZITSDkSsXhoCMPYQAvD_BwE.

- [11] Sufi, A. (2018, September 23). Why You Should Blame the Financial Crisis for Political Polarization and the Rise of Trump. *Economics*. <https://economics.com/blame-financial-crisis-politics-rise-of-trump/>.
- [12] Ramot, Y., Nyska, A., & Spectre, G. (2013). Drug-Induced Thrombosis: An Update. *Drug Safety*, 36(8), 585–603. <https://doi.org/10.1007/s40264-013-0054-6>
- [13] Martinelli, I., Battaglioli, T., & Mannucci, P. M. (2003). Pharmacogenetic aspects of the use of oral contraceptives and the risk of thrombosis. *Pharmacogenetics*, 13(10), 589–594. <https://doi.org/10.1097/00008571-200310000-00002>
- [14] Coata, G., Ventura, F., Lombardini, R., Ciuffetti, G., Cosmi, E. V., & Di Renzo, G. C. (1995). Effect of low-dose oral triphasic contraceptives on blood viscosity, coagulation and lipid metabolism. *Contraception*, 52(3), 151–157. [https://doi.org/10.1016/0010-7824\(95\)00148-4](https://doi.org/10.1016/0010-7824(95)00148-4)
- [15] Rosing, J., Middeldorp, S., Curvers, J., Thomassen, M. C., Nicolaes, G. A. F., Meijers, J. C. M., Bouma, B. N., Büller, H. R., Prins, M. H., & Tans, G. (1999). Low-dose oral contraceptives and acquired resistance to activated protein C: a randomised cross-over study. *The Lancet*, 354(9195), 2036–2040. [https://doi.org/10.1016/s0140-6736\(99\)06092-4](https://doi.org/10.1016/s0140-6736(99)06092-4)
- [16] Zucker, I., & Prendergast, B. J. (2020). Sex differences in pharmacokinetics predict adverse drug reactions in women. *Biology of Sex Differences*, 11(1). <https://doi.org/10.1186/s13293-020-00308-5>
- [17] *Gender equality in medicine: change is coming*. *The Lancet*. (2019, December). [https://www.thelancet.com/journals/langas/article/PIIS2468-1253\(19\)30351-6/fulltext](https://www.thelancet.com/journals/langas/article/PIIS2468-1253(19)30351-6/fulltext).
- [18] Cairns, D., Growiec, K., & de Almeida Alves, N. (2014). Another ‘Missing Middle’? The marginalised majority of tertiary-educated youth in Portugal during the economic crisis. *Journal of Youth Studies*, 17(8), 1046–1060. <https://doi.org/10.1080/13676261.2013.878789>
- [19] Kantamneni, N. (2020). The impact of the COVID-19 pandemic on marginalized populations in the United States: A research agenda. *Journal of Vocational Behavior*, 119, 103439. <https://doi.org/10.1016/j.jvb.2020.103439>

Will Kauri Survive?

Resilience of Ancient Kauri Populations to the Modern World.

By Toby Elliot

Kauri (*Agathis australis*) is one of New Zealand's most prominent, notable and exceptional tree species. It is a taonga species for Māori, as kauri are considered irreplaceable ancestors, and their health is often used as a sign of the wellbeing of the ngahere (forest), as well as the plants and animals within it [1,2]. Kauri is also economically important, as its valuable timber was logged and used for various projects [3]. However, recently kauri has gained economic value through tourism. Visitors to the Northland region often visit prominent kauri, such as Tāne Mahuta, and learn more about their rich history and the fascinating ecology of these important trees [4].

Kauri is an integral part of the many ecosystems that it inhabits – its leaf litter creates acidic and nutrient-poor soils that can promote the growth and survival of some species, while also inhibiting others [5,6,7]. Therefore, kauri can create distinctive vegetation communities composed of kauri and a suite of associated species – such as *Corokia buddleioides* – with competitive advantages in kauri forests [8,9]. However, the value of kauri for materials and human-mediated habitat clearance resulted in a rapid decrease in its range since the arrival of humans to New Zealand. Less than 1% of the original kauri forest area remains [1], and many of the largest and oldest kauri trees have been lost. Although large areas of secondary (planted) kauri forest now exist, kauri now has a new microscopic enemy: kauri dieback (*Phytophthora agathidicida*). Furthermore, climate change is predicted to cause a variety of modifications to Northern New Zealand. It is expected to impact aspects such as temperature and rainfall patterns and the frequencies of disturbances, such as fires [9,10], therefore casting further uncertainty over the long-term survival of kauri.

Kauri dieback is a fungal pathogen that affects kauri roots and kills trees of all ages by essentially ringbarking them [2]. *P. agathidicida* has been found in many *A. australis* forests throughout its present range [14], making it a potential imminent threat to the survival of these important trees. Infected trees typically have bleeds at their bases that do not appear to be caused by physical damage. They also typically have thinning canopies that degrade over time [2]. Kauri dieback is primarily spread through soil and water, and the movement of humans between forest patches can facilitate the spread of kauri dieback over long distances. Pig activity serves as a secondary disease pathway [12].



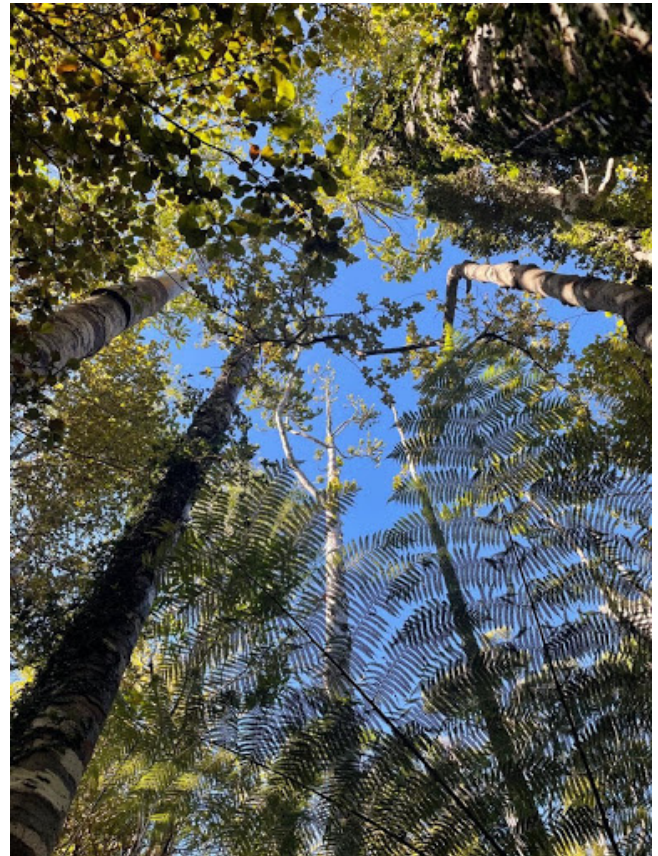
A large healthy kauri tree. Photo by Toby Elliot.

Various methods are in place to contain kauri dieback, slow its spread, and give researchers time to develop effective ways to treat infected trees. These methods include track closures, spray stations for people to wash their shoes before and after entering kauri forests, and strategies to control pig numbers [2,12]. The primary treatment method for infected trees is through the injection of phosphite into infected kauri trunks, which can temporarily control kauri dieback and reduce mortality rates in infected trees [13]. A permanent control method, however, is currently absent. Additionally, little research is present on the effect of kauri dieback on kauri population dynamics (e.g. growth rates, death rates, recruitment rates), which can be used to predict the long-term survival of kauri in a particular forest, and as a species as a whole.

For my PhD, I will be attempting to explore kauri population dynamics, how they might be impacted by kauri dieback and climate change, and assess the survival of kauri as a species. To do this, I will investigate the population dynamics of kauri under 'normal' conditions by creating various population models, which can predict long-term changes in forest compositions using this demographic data. I will then analyse how these factors might change with kauri dieback and under conditions and disturbance regimes predicted to occur

under future climate change scenarios. One of the methods I am using to achieve this is using permanent plots, which are plots within kauri forests where trees were measured and had tags with unique codes. The idea is that one can go back and re-measure these plots after a few years, as they can give invaluable information regarding how much the trees grew between measuring times, and which new trees came into the plot or have died between measurements. Some of the plots that I will be using are in the Waitakere Ranges, which are heavily affected by kauri dieback. I will also look at how these dynamics change in different regions, which can help see what forests are most likely to suffer more into the future, especially if they are infected with kauri dieback.

I hope that my research can shed some light on the severity of kauri dieback, and identify stands that are most at risk of being lost to this terrible disease. This identification, hopefully, will allow for more targeted containment and control measures to protect these incredible trees and the unique forests that they help create.



Canopy of an infected tree. Photo by Toby Elliot.



Basal bleeding, which commonly appears when trees are infected. Photo by Toby Elliot.



Mairihau (Leionema nudum) is common within kauri forests. Photo by Toby Elliot.

References

- [1] Steward, G. A., & Beveridge, A. E. (2010). A review of New Zealand kauri (*Agathis australis* (D. Don) Lindl.): its ecology, history, growth and potential for management for timber. *New Zealand Journal of Forestry Science* (New Zealand Forest Research Institute Ltd (trading as Scion)), 40.
- [2] Bradshaw, R. E., Bellgard, S. E., Black, A., Burns, B. R., Gerth, M. L., McDougal, R. L., Scott, P. M., Waipara, N. W., Weir, B. S., Williams, N. M., Winkworth, R. C., Ashcroft, T., Bradley, E. L., Dijkwei, P. P., Guo, Y., Lacey, R. F., Mesarich, C. H., Panda, P. & Horner, I. J. (2020). *Phytophthora agathidicida*: research progress, cultural perspectives and knowledge gaps in the control and management of kauri dieback in New Zealand. *Plant Pathology*, 69(1), 3-16.
- [3] Steward, G. A., Kimberley, M. O., Mason, E. G., & Dungey, H. S. (2014). Growth and productivity of New Zealand kauri (*Agathis australis* (D. Don) Lindl.) in planted forests. *New Zealand Journal of Forestry Science*, 44(1), 27.
- [4] Boswijk, G. (2010). Remembering kauri on the 'Kauri Coast'. *New Zealand Geographer*, 66(2), 124-137.
- [5] Jongkind, A. G., Velthorst, E., & Buurman, P. (2007). Soil chemical properties under kauri (*Agathis australis*) in the Waitakere Ranges, New Zealand. *Geoderma*, 141(3-4), 320-331.
- [6] Wyse, S. V., Macinnis-Ng, C. M., Burns, B. R., Clearwater, M. J., & Schwendenmann, L. (2013). Species assemblage patterns around a dominant emergent tree are associated with drought resistance. *Tree Physiology*, 33(12), 1269-1283.
- [7] Wyse, S. V., Burns, B. R., & Wright, S. D. (2014). Distinctive vegetation communities are associated with the long-lived conifer *Agathis australis* (New Zealand kauri, Araucariaceae) in New Zealand rainforests. *Austral Ecology*, 39(4), 388-400.
- [8] Wyse, S. V. (2012). Growth responses of five forest plant species to the soils formed beneath New Zealand kauri (*Agathis australis*). *New Zealand Journal of Botany*, 50(4), 411-421.
- [9] Wyse, S. V., & Burns, B. R. (2013). Effects of *Agathis australis* (New Zealand kauri) leaf litter on germination and seedling growth differs among plant species. *New Zealand Journal of Ecology*, 178-183.
- [10] Sansom, J., & Renwick, J. A. (2007). Climate change scenarios for New Zealand rainfall. *Journal of Applied Meteorology and Climatology*, 46(5), 573-590.
- [11] Watt, M. S., Kirschbaum, M. U., Moore, J. R., Pearce, H. G., Bulman, L. S., Brockerhoff, E. G., & Melia, N. (2019). Assessment of multiple climate change effects on plantation forests in New Zealand. *Forestry: An International Journal of Forest Research*, 92(1), 1-15.
- [12] Bassett, I. E., Horner, I. J., Hough, E. G., Wolber, F. M., Egeter, B., Stanley, M. C., & Krull, C. R. (2017). Ingestion of infected roots by feral pigs provides a minor vector pathway for kauri dieback disease *Phytophthora agathidicida*. *Forestry: An International Journal of Forest Research*, 90(5), 640-648.
- [13] Horner, I. J., & Hough, E. G. (2013). Phosphorous acid for controlling *Phytophthora* taxon *Agathis* in kauri glasshouse trials. *New Zealand Plant Protection*, 66, 242-248.
- [14] Waipara, N. W., S. Hill, L. M. W. Hill, E. G. Hough, and I. J. Horner. "Surveillance methods to determine tree health distribution of kauri dieback disease and associated pathogens." *New Zealand Plant Protection* 66 (2013): 235-241.

Meet the Team



Alex Chapple

I'm a 4th year Honours student studying physics. I'm interested in quantum optics, computing, and quantum information science.



Caleb Todd

I'm a physics Honours student researching nonlinear photonics — the study of intense laser light.



Struan Caughey

I'm a final year Bachelor of Science student majoring in physics and computer science. My passion lies in the communication of science to the wider community.



Jasmine Gunton

I am an ecology major in my first year of a Bachelor of Advanced Science. I am especially interested in researching areas in marine ecology and evolutionary biology.



Gene Tang

I am a second year Bachelor of Advanced Science (Hons) student specializing in Psychology. I am inspired to pursue my postgraduate study in neuropsychology.



Stella Huggins

I am a third year Bachelor of Science and bachelor of arts student in biological sciences, psychology and politics. I'm passionate about making science communication accessible.



Nina de Jong

I am an Honours student studying ecology. I'm interested in kahikatea tree dynamics and restoration ecology.



Louisa Ren

I'm in my final year of my Bachelor of Science degree majoring in chemistry. I am interested in applications of science to real life and how they can be used to solve problems.

Comic



If you think you're funny and have comic ideas, get in touch with us!

Fun Fact

A flea can accelerate faster than a Space Shuttle

Closing Comments

Thank you for taking the time to read our magazine. We put a lot of effort into producing the best quality output that we can, and it means a lot to us when people enjoy our work. If you have any thoughts about any of our articles, please do get in touch with us. We want University of Auckland Scientific to be part of a conversation that extends beyond its borders.

If you're itching to write about a topic that fascinates you, or want to put your research on display, we would love for you to write for us. You can join our team in an official capacity and be part of all future publications, or be a guest writer and just write a piece or two whenever you want. Either way, email or message us (contact details below) with your idea and we can discuss how it can be realised.

Check out our instagram or website and join our mailing list to never miss an issue of University of Auckland Scientific. We'll see you next time!

Contact Us

website - uoascientific.wixsite.com/uoascientific

email - scientific.review.uoa@gmail.com

instagram - [uoascientific](https://www.instagram.com/uoascientific)

facebook - [UoA Scientific Review Club 2021](https://www.facebook.com/UoA_Scientific_Review_Club_2021)

twitter - [@UoA_Sci_Review](https://twitter.com/UoA_Sci_Review)