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Editors’ Note

Kia ora koutou katoa, and welcome to UoA Scientific’s Volume 3, Edition 3, the Scientific’s first-ever special language edition!

We hope that everyone has had an enjoyable and fruitful mid-semester break. The third edition of this year features a variety of subject topics that are bound to keep you hooked.

As part of the language edition, each article features a brief summary of the article in another language—including Spanish, Sinhala, Urdu, German, and French. The Scientific is also incredibly proud to present a transboundary collaboration between writers from Chile and New Zealand, with the intent to investigate the similarities between these two countries’ biological and cultural ecology. It is fantastic to see how two countries that are now so distant are so closely related.

Zoé provides us with an introduction to Anauralia and is currently looking for research study participants, while Binu discusses the potential benefits of the tropical fruit papaya. Did you know studies have found that the components of the papaya are beneficial against cardiovascular illnesses, some cancers, and some bacteria?

This special edition also features diverse articles from the executive team. Rahma explores the hallmarks of cancer, including an overview of how cancer may spread and the possible symptoms cancer patients may face, while Kevan provides an exciting rundown of several types of mathematical proof. Finally, Jasmine and Cindy describe and explore Latin and its ties to biological classification and the naming of chemical elements.

The diversity in language, culture, subject, and thought demonstrated in this edition was truly awe-inspiring. Thank you so much to all of our writers, the AEB Chile Club, and everyone else who participated. Additionally, thank you to the Science Faculty, particularly Vanessa, Grace, Linda, and Irene, for their invaluable assistance and support. Finally, we hope that all of our readers enjoy this special edition of UoA Scientific.

Ngā mihi nui,
Lucas Tan, Writing Coordinator for UoA Scientific 2023

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Living with a Silent Mind

Zoé Mi Schelp

Have you ever wondered what happens in other people's minds? How do they cope with songs stuck in their heads? Do they talk to themselves too? Do they have discussions inside their mind before debating things with others?

Some people can imagine their favourite band playing right in front of them, while others can't seem to imagine an ambulance siren or car horn. Try and imagine a small dog barking. A bright, shrill and very frequent bark. Now morph it into the bark of a big dog. Deep and loud. Can you hear it? If your response to this was: 'What am I supposed to be hearing? I know what they sound like, but I don't hear anything'—then you might have Anauralia. A lack of auditory imagery. Anauralia is a phenomenon that affects around 1% of our population (unpublished from data collected by the New Zealand Attitudes and Values Survey (NZAVS) in 2022), and data thus far suggests that there are no implications on people's wider well-being and behaviour. Anauralia can be viewed as the auditory equivalent to aphantasia—the lack of an inner eye or visual imagery.

Aphantasics usually report an inability to recall images in their inner eye. Their visual imagery is reported on a spectrum between very faint and non-existent. This leads to the question of whether aphantasia is related to a more general absence of imagery or whether there is a difference between auditory/visual/olfactory/kinetic imagery. The co-existence of anauralia and aphantasia seems to be quite high. This means that people who have aphantasia might likely also be affected by anauralia and thus, there is a high likelihood for overlap in terms of the function of imagery, disregarding the related sense. So far, anauralia has been described as the complete lack of auditory imagery [1], yet there has not been a clearer understanding of whether people with anauralia also lack inner speech. There may be a need for differentiating between people who lack imagery, people who lack inner speech, and people who lack both.

Inner speech has previously been linked to cognitive processes, including executive function, working memory and even some psychopathology [2]. Inner speech also relies on something called 'subvocalisation', which is measurable by putting small electrodes on the muscles around the mouth and neck [3]. The same muscles are activated at higher rates when we speak. On the other hand, auditory imagery has been found to relate to memory, creativity and helping process auditory information. Imagery has been found to be neurologically quite similar to the way we perceive sounds in real life [4]. This means that our inner ear and our inner voice create a somewhat internal and personal parallel to our outwardly expressive senses of speech and hearing.

Even though having an inner parallel to our senses in which we can manipulate information, recall and create seems to make perfect sense, not everyone experiences this internal world the same. People who experience Anauralia can still do all these things, but they somehow don't seem to have the need to utilise their internal world to do so. As of now, it is unclear to what extent the inner ear and inner voice are linked and whether all anauralics experience the lack of both or if there is divergence in regards to either inner speech or inner ear.

This is what the Anauralia Lab at the University of Auckland is currently trying to figure out. Current studies involve figuring out whether anauralia has any effects on the way people memorise and remember information using their working memory, finding a physiological measurement for anauralia using pupillometry and creating a questionnaire (Auckland Auditory Imagery Scale (AAIS)) to identify Anauralia more clearly. Future studies also involve using electroencephalography (EEG) and other imaging methods to identify similarities and differences between anauralics and controls. If you think you may be anauralic, and/or want to know more about it, visit anauralia.com, and contact us! We would love to have you participate in our studies and chat with you!

German Summary

Anauralia/Anauralie ist ein Phänomen, bei dem Betroffene keine innere Verbildlichung von Tönen empfinden. Fehlende auditive Verbildlichung betrifft ungefähr 1% der Gesellschaft und scheint bis jetzt keine Auswirkungen oder Konsequenzen auf weitere kognitive Fähigkeiten zu haben. Obwohl innere Verbildlichung uns dabei hilft Informationen zu verarbeiten und abzurufen und kreativ zu sein, scheinen Menschen ohne Verbildlichung all diese Prozesse ohne Probleme ausführen zu können. Wozu genau ist unsere innere Welt und Fähigkeit, Bilder und Töne in unserem Kopf abrufen zu können, dann überhaupt da? Können wir unsere innere Stimme und unser inneres Ohr unterscheiden? Und was hat all das - und Anauralie- mit anderen kognitiven Prozessen, wie zum Beispiel Gedächtnis oder Selbstbeherrschung, zu tun?

Zoé Mi Schelp - PhD, Cognitive Neuroscience

Zoé is a PhD candidate in cognitive neuroscience at the University of Auckland investigating anauralia. Her research focuses on the effects of anauralia on memory and inner speech. Outside of studies and teaching, she loves playing violin and guitar, reading, cooking/baking and winter sports.

Explained

Cancer: Unravelling Complexity, Hallmarks, and Symptom Insights

Rahma Iftikhar

Pathology

Cancer is a complex and diverse foe that affects millions of individuals worldwide, and years of research have revealed several underlying principles known as the hallmarks of cancer, initially described by Hanahan and Weinberg. These hallmarks provide a comprehensive framework that helps us understand the development and progression of this disease.

The Hallmarks of Cancer encompass several key capabilities that cancer cells acquire during their evolution [1]. According to Fig. 1, these include:

Sustained Proliferative Signalling:

The growth signals of regulated cell cycles that encourage controlled proliferation and tissue homeostasis are interrupted, leading to uncontrolled cell **proliferation**. These can be done by **cytosolic signalling molecules**, growth ligands or their receptors [2]. A growth ligand is 'growth promoting' to encourage tumour progression or 'growth inhibiting' to allow tumours to escape from braking signals [3].

Evading Growth Suppressors:

Cancer cells are resistant to growth-preventing signals produced by tumour suppressor genes from surrounding cells. In cancer, these genes are altered to no longer prevent cell division when cells have severe abnormalities. Cancer cells also do not contact inhibition and therefore grow and divide regardless of their surroundings [4].

Resisting Cell Death:

Apoptosis is the cell's ability to self-destruct after it has been damaged, allowing the organism to grow and develop as normal. In cancer cells, mechanisms that detect abnormalities are altered, resulting in a lack of signalling that then prevents apoptosis activation. There are also changes that may occur in the downstream signalling of proteins involved in apoptosis, preventing the process from occurring as usual.

Enabling Replicative Immortality:

Normally, cells in the body have a limited number of divisions before the cell becomes unable to divide or die. This is due to the shortening of telomeres in the DNA. Cancer cells manipulate enzymes like telomerase to increase **telomere** length and cause unlimited replication [5].

Glossary

Proliferation: Increase in the number of cells by cell division.

Cytosolic Signalling molecules: Molecules involved in transmitting signals within the cell.

Telomeres: The ends of chromosomes consisting of repetitive sequences of non-coding DNA that protect the chromosome from damage.

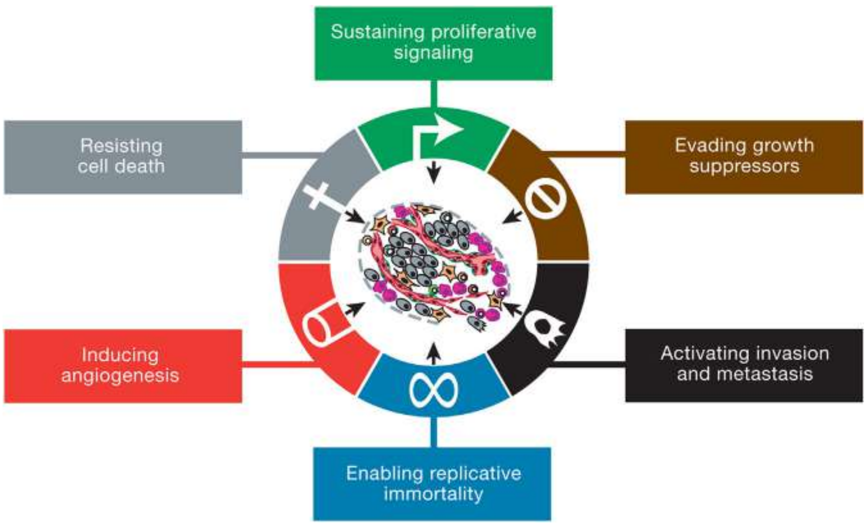

Figure 1: Hallmarks of cancer. D. Hanahan and Robert A. Weinberg, "Hallmarks of cancer: the next Generation," Cell, vol. 144, no. 5, pp. 646–674, Mar. 2011, doi: https://doi.org/10.1016/j.cell.2011.02.013.

Inducing angiogenesis:

Angiogenesis is the process that allows the formation of new blood vessels. Cancer cells start this process to ensure a good supply of blood that carries the oxygen and nutrients needed to develop melanoma. Cancer cells do this by reducing the production of factors that inhibit blood vessel production and increase factors that promote angiogenesis in their microenvironment [6].

Activating invasion and **metastasis**:

Cancer cells can break away to invade their surroundings and metastasise to other body parts. This ability of the tumour helps us decide if the tumour is benign or malignant. Cancer cells allow metastasis by first invading their surrounding tissue and then invading blood vessels. They then end up in a new environment which may or may not allow the tumour to survive its harsh conditions [7].

Cancer research has revealed that there are more hallmarks beyond the original six described by Hanahan and Weinberg. Ongoing scientific investigations have identified new hallmarks, highlighting the complex nature of cancer. As shown in Fig. 2, these emerging hallmarks include deregulated cellular metabolism, tumour-promoting inflammation, genomic instability, and evasion of immune destruction. Active research in this field continues to expand our understanding and uncover novel insights. By exploring these additional hallmarks, scientists aim to develop innovative approaches for prevention, diagnosis, and treatment, offering hope for improved outcomes in the battle against cancer.

Glossary

Metastasis: The spread of cancer from one organ to another non-adjacent organ.

Micrometastases: small colonies of cancer cells in other tissues.

Macrometastases: large colonies of cancer cells in other tissues.

What may cause cancer?

- Genetic mutations
- Age
- Lifestyle
- Hormonal factors

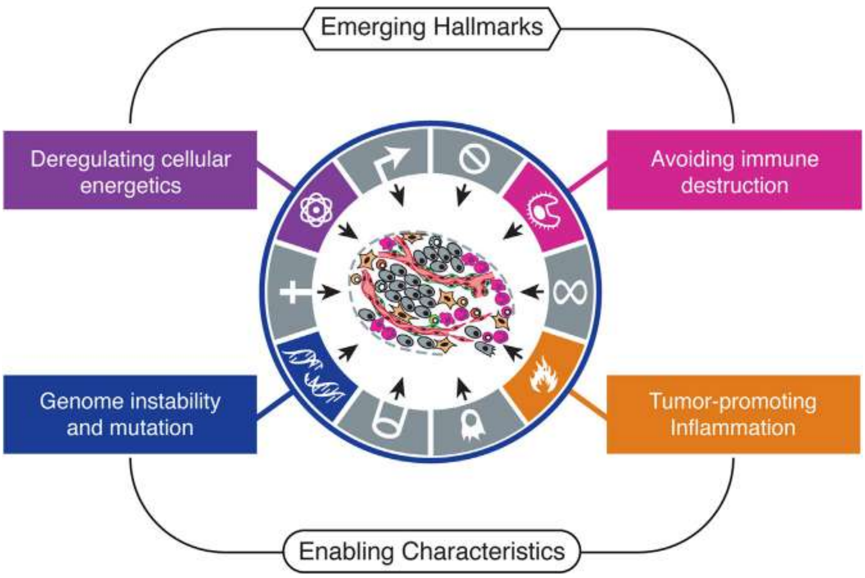

Figure 2: Emerging hallmarks of cancer. D. Hanahan and Robert A. Weinberg, "Hallmarks of cancer: the next Generation," Cell, vol. 144, no. 5, pp. 646–674, Mar. 2011, doi: https://doi.org/10.1016/j.cell.2011.02.013.

The process of cancer metastasis:

Tumour cells can metastasise alone or as cell clusters. This invasion-metastasis cascade has two phases, where phase 1 consists of the physical distribution of cells from the primary tumour to distant tissues, and phase 2 consists of colonisation, where the disseminated cancer cells adapt to the new tissue microenvironment.

As shown in Fig. 3, the carcinoma breaches the basement membrane and intravasates into the blood microvessels, therefore entering circulation. Then cancer cells get trapped in microvessels in other organs and extravasate into tissues to form dormant **micrometastases**. These may colonise the tissue and form **macrometastases**.

Type of Cancer	Symptoms
Breast Cancer	This is now the fourth most common type of cancer amongst women worldwide. It can develop in the breast tissue of both men and women and has risk factors, including age, family history, hormones, and lifestyle choices. Symptoms may include malignant mass in the breast area and skin changes (i.e. thickening, swelling and redness) [8].
Lung Cancer	This cancer mainly affects the lungs and has strong associations with smoking (both active and passive). Symptoms may include chest pain, dyspnoea, fatigue, a persistent cough and even anorexia [9].
Prostate Cancer	This cancer affects the prostate gland, which is part of the male reproductive system and is the most common cancer among men. Early-stage symptoms are not noticeable, so regular prostate-specific antigen testing and digital rectal exams aid in early detection. Symptoms that may arise later include frequent urination, blood in urine, erectile dysfunction, and pain in the lower back or pelvic area.
Skin Cancer	This cancer occurs mainly due to exposure to ultraviolet radiation from the sun. Symptoms may include changes in the appearance of moles (including growth, irregular shaping borders and colour variation of moles) and changes in skin (for example, redness or itching) [10].
Leukaemia	This is a cancer of the blood and bone marrow due to the abnormal production of white blood cells. Though symptoms differ depending on the type of leukaemia, patients commonly have excessive fatigue, bruising, weight loss, and frequent infections [11].

Note: We must note that these symptoms can also be caused by other conditions. If you are experiencing any persistent symptoms, a consultation with a healthcare professional is recommended to further test and evaluate them. Early detection and treatment can significantly improve outcomes for individuals with cancer.

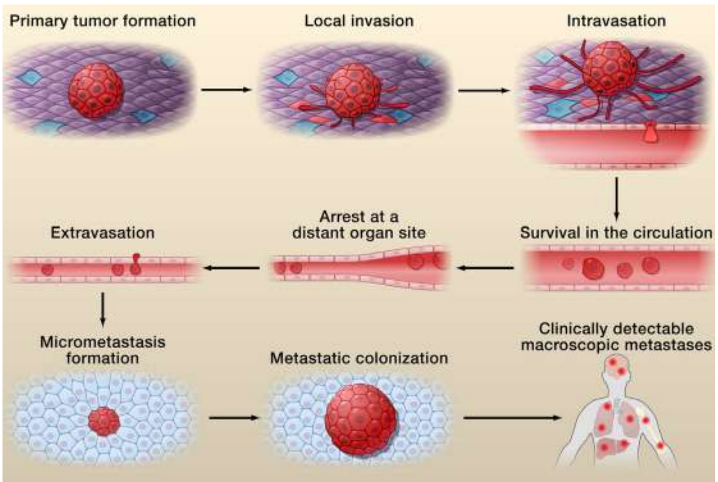

Figure 3: Invasion-metastasis cascade. S. Valastyan and Robert A. Weinberg, "Tumor Metastasis: Molecular Insights and Evolving Paradigms," Cell, vol. 147, no. 2, pp. 275–292, Oct. 2011, doi: https://doi.org/10.1016/j.cell.2011.09.024.

Glossary

Dyspnoea: Difficulty in breathing.

Urdu Summary

کینسر ایک پیچیدہ بیماری ہے جو دنیا بھر میں لاکھوں افراد کو متاثر کرتی ہے۔ ہناہین اور وائنبرگ کی تحقیق کینسر کی ترقی اور ترسیل کی سمجھ میں مدد فراہم کرتے ہیں۔ کینسر کے نشانات میں شامل ہیں تکوینی سگنلنگ، تکوین سے بچاؤ، سیل موت کی مخالفت، تکونی ناتواقفی، رگ بھراؤ، اور حملہ اور میٹاستیس۔ کینسر کے اسباب میں جینی تبدیلیاں، عمر، زندگی کا اندازہ، اور ہارمونی فیکٹر ہیں۔ ہوسکتا ہے کینسر کا علاج بہتر ہو، لیکن درست تشخیص اہم ہے۔

In conclusion, ongoing research and a comprehensive understanding of cancer hallmarks provide a promising direction towards combating this formidable disease and improving the lives of those affected. Early detection, timely treatment, and continued research are vital in the fight against cancer and to provide better prospects for cancer patients in the future.

Rahma Iftikhar - BSc, Biological Sciences, Computer Science

Rahma is a third-year Bachelor of Science student doing a double major in Biological Sciences and Computer Science. Amongst many things, she is interested in the genetics behind diseases and the ways to cure them using technology. She is also the Outreach Coordinator for UoA Scientific this year.

Academic

An Exploration into Chemistry and Biology Etymology

Cindy Yi & Jasmine Gunton

Etymology

Have you ever wondered why the chemical symbol for sodium is Na? Or why humans are known as *Homo sapiens*? This two-parter article answers these questions and more by analysing the etymology of modern scientific classification systems.

Unusual Chemical Naming and Chemical Element Etymology

Hg is my favourite element beginning with 'm.'

While the beginning stages of the modern periodic table were invented as recently as 1869 by Dmitri Mendeleev [1], many chemical elements have been independently discovered, and named, for millennia. The structure and order of the periodic table, however, has not always been reflected in the naming.

The naming of chemical elements is not just a scientific matter, but a historical one. Although the principles of scientific reasoning, observation, and logic are universal, the nature of language and the very human characteristic of bias has led us to relate to things – and elements – we observe with varying degrees of 'correctness.' And so, while the origins of many element names may no longer be considered chemically accurate, some have become engrained and remain in chemical nomenclature. The languages from which we derive our 'official' periodic names are numerous, and their reasons for naming are abundant; however, this essay will focus on a few unusual names of interests and their various roots and stories.

Mercury – Hg

Mercury may be the best known unusually abbreviated element. Neither 'H' nor 'g' are in the word 'mercury', but the chemical symbol in fact pays homage to the origins of the element's written history. Mercury is one of the oldest known elements, having been known in Egypt and probably parts of Asia from as early as 1500 BCE [2]. It is a shimmery, silver-coloured metal, well-known for being the only liquid metal at room temperature. The symbol 'Hg' was from the initial Latin characterisation of the mercury obtained from cinnabar as *hydragyrum* [3], which itself has Greek origins from the words *hydor* and *argyros*, meaning 'water-silver.'

Mercury later also became known as argentum vivum when in its liquid elemental state, literally 'living silver' [3]. Anglicized to 'quicksilver,' known in Middle English as *quikselver* and Old English as the barely recognisable *cwicseolfor*, mercury is still known in many other languages as cognates such as the Dutch *kwikzilver*, German *Quecksilber* and the Swedish *kvicksilver*. So, while quicksilver is still a relatively common name in other Germanic languages, why has modern English deviated to using 'mercury'?

The answer lies in alchemy. Ancient humankind linked the seven known metals to the seven celestial bodies, and the perceived relationship between the metals and the planets was reflected in the practices of alchemy and astrology in the Middle Ages [4]. Some connections are more obvious than others – gold was associated with the yellow sun, and silver with the silver moon. The rust-red of Mars mirrored the red rust of iron; lead, being a heavy metal, was associated with the sluggish orbit of Saturn, perceived to be a 'heavier' planet due to its longer orbit time.

Notes

* While mercury is the only element to retain its alchemical planetary name, other elements do bear names derived from planets and other celestial bodies; for example, neptunium (Np), uranium (U), plutonium (Pu), tellurium (Te), and cerium (Ce). For more, see reference [4].

Quicksilver's fluidity and mobility earned its title of Mercury, the quick-footed Roman god of messengers and thieves. While the alchemical assignments for other metals have all but faded away along with alchemy itself, mercury bears its planetary name* to this day. Antoine Lavoisier et al.'s book Méthode de nomenclature chimique, published in 1787, proposed the new nomenclature of chemical substances, providing a foundation for the progress of modern chemistry [5]. In the Méthode, the authors corrected many alchemical names, with the exception of mercure – and so, the name mercury has stuck.

Potassium – K

While some elements were assigned names based on their characteristics, much like mercury above, others have names derived from their derivation and use. Potassium is one such element – the name potassium comes from the word 'potash,' referring to early methods of potassium salt extraction; the ash of burnt wood and tree leaves would be placed in a pot, water added, and heat applied to evaporate the solution [6]. The suffix *-ium* is common for most metals (calcium, magnesium, palladium, cadmium, etc.) and thus the name *potassium* was born.

But why the chemical symbol K? Surely P (phosphorus won that one), Po (sorry, taken by polonium!) or even Ps (that one's free) would make more sense?

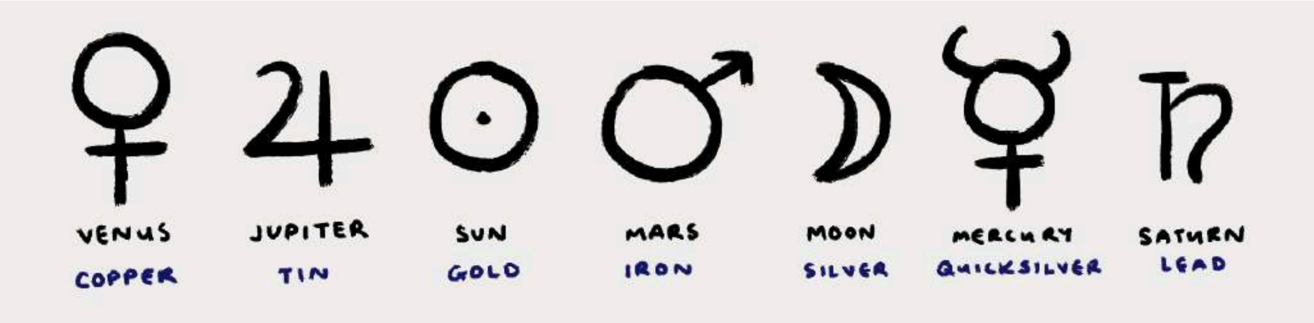

Figure 1. The planetary alchemical symbols. Illustration by Cindy Yi.

While you'd be forgiven for thinking Latin was the culprit, as it has been in numerous cases (Au - *aurum* for gold, Ag – *argentum* for silver, Na – *natrium* for sodium, the list goes on...), the symbol K is actually derived from *kali*, from the root word *alkali*, derived from the Arabic *al-qayah* - 'plant ashes.' Although one may think an Arabic chemist was responsible for nomenclature, it was in fact German chemist Martin Klaproth who discovered potash in the minerals lepidolite and leucite – not just plants, as previously believed. Klaproth thus concluded that it 'can no longer be viewed as a product of growth in plants,' establishing potassium as a new element and proposing the name...*kali* [7]?

French chemists of the time called bestowed the name potasse onto potassium salts, rather than the element potassium itself. Deciding the name 'potash' would not find acceptance amongst German scientists as 'the etymological derivation of it is faulty' [7], Klaproth proposed calling the element *kali*. British chemist Humphry Davy, produced potassium via electrolysis in 1807, and in 1809 Ludwig Wilhelm Gilbert proposed that Davy's potassium be called *Kalium* in German nomenclature, reinforcing support for a Germanic name [8].

Interestingly, Swedish chemist Berzelius' 1813 publication in Thomas Thomson's *Annals of Philosophy* initially follows Davy's atomic symbol nomenclature, abbreviating potassium as Po (now taken by polonium) - but merely a year later (1814) advocated for the elemental name *kalium*, alongside the chemical symbol K [9]. French chemists Gay-Lussac and Thénard (who also investigated the alkali metal) named potassium *métal de potasse* [10].

English and French-speaking countries henceforth adopted Davy, Gay-Lussac and Thénard's *potassium*, while Germanic countries remained in favour of the *kalium* proposed by Klaproth and Gilbert [10]. Regardless, the International Union of Pure and Applied Chemistry (IUPAC) has designated the elemental name potassium and the official chemical symbol of K – a middle ground of some kind [12].

Tungsten – W

The name *tungsten* is somewhat unimaginative. Named for its heftiness (with an atomic number of 74 on the periodic table), tungsten is derived from Swedish: *tung* meaning heavy, and *sten* meaning stone [4]. Tungsten was first found in the minerals wolframite and scheelite ($CaWO_4$), and first isolated as a pure metal from the former [12].

The high density of scheelite led Torbern Bergman to believe that it contained the alkaline earth baryta, but he found instead an acidic oxide now known to be tungsten oxide [12]. Wolframite has been known in written history since at least 1556 (as *lupi spuma*) [13], but it was some time before the element could be isolated from its mineral matrix.

The Latin name *lupi spuma* translates to German as wolf rahm, meaning '*wolf's foam*;' the frequent co-occurrence of the mineral with casserite (also known as tin-stone), leading to apparent tin 'eating' during extraction, much like the way a wolf devours a sheep – and thus, the name *wolframite* came into existence [13].

It was not until 1783 that the pure metal was isolated, when Spanish chemist Juan José de Elhuyar y de Zubice and his younger brother Fausto de Elhuyar y de Zubice, reduced tungstic acid with high heat and powdered charcoal. Despite speaking Spanish (a Romance language), they claimed the Germanic name *volfram*:**

"We will call this new metal volfram, taking the name from the matter of which it has been extracted.... This name is more suitable than tungust or tungsten which could be used as a tribute to tungstene or heavy stone from which its lime was extracted, because volfram is a mineral which was known long before the heavy stone, at least among the mineralogists, and also because the name volfram is accepted in almost all European languages, including Swedish."

The name *wolfram* was originally put forth by IUPAC, but Swedish-originating *tungsten* became popular amongst English-speakers.

Notes

** The letter w did not exist in the Spanish alphabet until 1914, hence volfram instead of *wolfram*.

Other Germanic languages have adopted cognates of *wolfram* – *wolfraam* in Dutch, *volframas* in Lithuanian, *volframi* in Finnish. Ironically, the element is now most commonly called *volfram* in Swedish, and *tungsteno* in Spanish!

I will admit, I'm usually a defender of names that I have been accustomed to using (Exhibit A of the aforementioned human bias), but I will say that - in this case - I'm not on tungsten's side. Perhaps it's because 'heavy stone' isn't as creative a name as 'wolf's cream' (and, well, there are plenty of heavier elements than tungsten), or perhaps it's because the de Elhuyar brothers ought to have the honour of naming the element they discovered. IUPAC and the scientific community have still been debating about Wolfram vs. Tungsten as recently as 2005 [14] - but regardless, we've had to settle for the name of tungsten, and the ghost of *wolfram* in the chemical symbol W for now.

Conclusion

This article has barely scratched the surface of the history of elemental naming, but to fully explore every element and the drama and history behind etymologies of all name variations would be a bit too much for this magazine, let alone this article. In saying that, understanding just some of the meanings behind chemical names (not just the unusual ones!), adds a richness to scientific convention that we perhaps take for granted.

Latin and its ties with Biological Classification

Many sources consider Latin a 'dead language' as there are no native speakers alive today [15-16]. By native speaker, I mean an individual born in Italy whose first language is Latin. However, Latin is still consistently used in Western medicine and science. Specifically, in this portion of the article, I refer solely to the official use of Latinised names in categorical biology. Why do we still use this Latin system if only a small percentage of the global population is actually fluent in Latin? Of course, having a global classification system for every organism is extremely useful. Nevertheless, it seems unproductive to utilise a dead language for this role.

Let us begin our analysis with the Latinised species name most familiar to us: *Homo sapiens*. (Of course, I had to italicise that name because, for some reason, it simply HAS to be like that. Anyways.) According to the Elementary Latin Dictionary of Tufts University, Homo translates to being, man, or person. It is amusing that the 'being' translation infers that other organisms are not 'beings'. Sapiens translates to 'wise' or 'being able to discern' [17]. Similarly, this infers that other animals of the genus homo are not able to discern. If you speak to a modern biologist, they will tell you that, yes, most, if not all, apes do have intelligence and are able to recognise objects [18]. Moreover, all living organisms are technically 'beings' as they exist. Why is it that in a discipline where we know these facts to be true, we still use the term *Homo sapiens* to formally describe the human species?

We have one particular scientist to blame for the popularisation of using Latin to classify species. I am, in fact, referring to Swedish botanist Carl Linnaeus. Linnaeus had already been taught Latin at a young age. Therefore, he found it appropriate to start describing species in Latin before developing the binomial nomenclature system [19]. Additionally, Latin was known as the *Lingua Franca* of the European scientific community up until the 18th Century. In other words, Latin was the preferred language when it came to naming scientific classifications [20].

Wrens (*Troglodytes Troglodytes Troglodytes*) image by Amee Fairbank-Brown from Unsplash

By writing his book *Species Plantarum*, Linnaeus cemented Latin as the official language by which to scientifically classify species [21].

Whilst we are currently restrained by this Latinised system, humans have still found ways to create strange and humorous species names. For example, the Eurasian wren bird species is part of the family Troglodytidae. This is simple enough, right? This is until you examine the species name for this bird: *Troglodytes troglodytes*. On top of this, there are 28 Eurasian wren subspecies, with one being formally known as *Troglodytes troglodytes troglodytes* [22]. The word troglodyte originates from the Latin word troglodyta, which roughly translates to “cave-dwelling people” [23]. Eurasian wrens are associated with troglodytes not because they are cave-dwellers but because they like to live and nest in rock crevices [24]. The subspecies name *Troglodytes troglodytes troglodytes* is known as a triple tautonym. Other officially used triple tautonyms include Bison bison bison (Plains bison), *Gorilla gorilla gorilla* (Western lowland gorilla), and *Giraffa giraffa giraffa* (South African giraffe).

Even though the lingua franca of the scientific world today is English, it looks like we will not soon be discontinuing the tradition of using Latin names for formal biological species classification [25]. One could take the perspective that this is a unique way that humans value the history of their ancestors. With Te Reo being more frequently used in naming and referring to native NZ species, adding indigenous naming to a traditionally Western system could be a great combination of cultures and values.

Cindy Yi - BSc(Hons), Chemistry

Cindy is an Honours student studying chemistry. She is interested in sustainability, green chemistry, and getting 9.5 hours of sleep. Having taken Latin in high school, she knows a little bit but is nowhere near fluent, and is grateful that she has something to kinda contribute her meagre Latin towards.

Jasmine Gunton - BAdvSci(Hons), Ecology

Jasmine is a third-year Bachelor of Advanced Science (Honours) student specialising in Ecology. She is interested in researching areas in insect ecology and ecological restoration. This year she is also a part of the Science Scholars programme.

An Overview of Mathematical Proofs

Kevan Lew

For mathematicians, determining whether a statement is true requires a proof: an argument using logical steps and previously proven statements. These statements are either true or false and can be broadly divided into universal and particular kinds. An example of a universal statement is "the sum of any two odd numbers is always even," since it makes a claim about all odd numbers. An example of a particular statement is "there is some whole number greater than zero which is equal to the sum of its divisors," since the statement does not concern all whole numbers.

The type of proof used often depends on the nature of the statement. The simplest of these is the **direct proof**. In short, this proves the statement as is, without more complex steps or changing it into different (but logically equivalent) statements. Consider the universal statement from before, "the sum of any two odd numbers is always even".

To prove this, we can represent the odd numbers as $2a + 1$ and $2b + 1$, where a and b are any integers (whole numbers). For example, the odd number 5 would be represented as $2 \times 2 + 1 = 5$, where in this case a = 5. Then the sum of any two odd numbers can be represented as $(2a + 1) + (2b + 1)$.

Simplifying, we have $2a + 2b + 2 = 2(a + b + 1)$. Since, by definition, any number multiplied by 2 is even, we have shown that the sum of any two odd numbers is always even [1].

Similarly, to prove our previous particular statement, we need to show that "there is some whole number greater than zero which is equal to the sum of its divisors". This type of proof, where we show that some object indeed exists with a given property, is a **proof by construction**.

Consider 6. Its divisors are 1, 2, and 3. The sum $1 + 2 + 3 = 6$ and so we have proven the statement [2].

Since the statement was particular, we can prove it by providing one example.

Comparatively, a **nonconstructive proof** shows that something can exist with a given property, but without providing a concrete example. A famous example of a nonconstructive proof comes from Dov Jarden.

"*A Simple Proof That a Power of an Irrational Number to an Irrational Exponent May Be Rational*."

"$\sqrt{2}^{\sqrt{2}}$ is either rational or irrational. If it is rational, our statement is proved. If it is irrational, $(\sqrt{2}^{\sqrt{2}})^{\sqrt{2}} = 2$ proves our statement [3]."

Here, Jarden proves the statement without actually showing whether $\sqrt{2}^{\sqrt{2}}$ is rational or irrational, although it turns out to be the latter.

Proof by induction also deals with the statement as given, but with additional steps. They are commonly used to show a statement applies to all natural numbers (positive whole numbers, sometimes including 0). They consist of three steps: the base case, the inductive hypothesis, and the inductive step. To illustrate these steps, let's consider the statement "$n < 2^n$ for all $n \geq 1$".

In the base case, we show the statement is true for the smallest number it applies to, in this case n = 1:

When n = 1, we have $1 < 2^1$, which is true.

In the inductive hypothesis, we assume the statement is true for a given n = k, that is to say $k < 2^k$.

In the inductive step, we want to show that our assumption implies that the statement is also true for n = k + 1, that is $k + 1 < 2^{k+1}$. Using our assumption:

$$\begin{aligned} k + 1 &< k + k \\ &< 2^k + 2^k \\ &< 2(2^k) \\ &< 2^{k+1} \end{aligned}$$

So, by induction, we have proved that $n < 2^n$ for all $n \geq 1$ [4]. A helpful image is that of dominoes. We first showed our base case is true when n = 1. By the inductive hypothesis and inductive step, we know the statement is also true for n = 1 + 1 = 2. But similarly, if the statement is true for 2, it must also be true for 2 + 1 = 3, and so on for all $n \geq 1$. Then, as the first domino falls, so too will all those remaining.

Proof by contraposition uses the contrapositive of a statement, which is logically equivalent to the statement itself. The contrapositive of a statement in the form "*If P, then Q*" is "*If not Q, then not P*". So rather than prove the statement directly, we can prove its contrapositive.

Suppose x is an integer. If $7x + 9$ is even, then x is odd. The contrapositive of this statement is "If x is even, then $7x + 9$ is odd".

If x is even, we can write $x = 2a$, where a is some integer. Then $7x + 9 = 7(2a) + 9 = 14a + 9 = 14a + 8 + 1 = 2(7a + 4) + 1$.

As before, this is odd since it is a number of the form $2n + 1$ (here $n = 7a + 4$) [5].

In this case, proving the statement directly is similarly simple, although this may not always be true. With practice, it can become easier to see which statements might benefit from using a proof by contraposition.

Proof by contradiction uses the property that statements are either true or false. To prove a statement is true, we can assume it is false and then show that this assumption leads to a logical contradiction. A well-known example of this is Euclid's proof that $\sqrt{2}$ is irrational.

We first assume the opposite of the statement is true, namely that 2 is rational. This means it can be represented as the fully reduced quotient of two integers: $\sqrt{2} = p / q$, where p and q have no common factors.

Squaring both sides gives $2 = p^2 / q^2$ and so $2q^2 = p^2$.

This means p^2 is even, and thus p is even.

Writing $p = 2a$ and substituting this into $2q^2 = p^2$ gives $2q^2 = (2a^2) = 4a^2$.

Simplifying, we have $q^2 = 2a^2$. Thus, q^2 is even and so is q. But both p and q being even means they share a common factor of 2, which contradicts our assumption that $\sqrt{2}$ was fully reduced. Hence $\sqrt{2}$ must be irrational [6].

Proof by exhaustion involves breaking up the statement into a finite number of cases and then showing each case to be true. Perhaps the most famous of these proofs is the first proof of the four-colour theorem, which is also an example of a **computer-assisted proof**. The four-colour theorem states that no more than four colours are needed to colour the regions of any map such that no two adjacent regions have the same colour.
This theorem was conceived in 1852, but the first proof would not be found until 1976. Mathematicians Kenneth Appel and Wolfgang Haken proved the theorem by reducing it to 1,936 cases, which required over 1,000 hours of computing time to check. Since then, the number of cases has decreased, but computers are still used to verify in a short time what would take humans much longer. However, computer-assisted proofs are not without controversy, as some believe in the elegance of purely human proofs, while others are concerned with errors in the code itself [8].

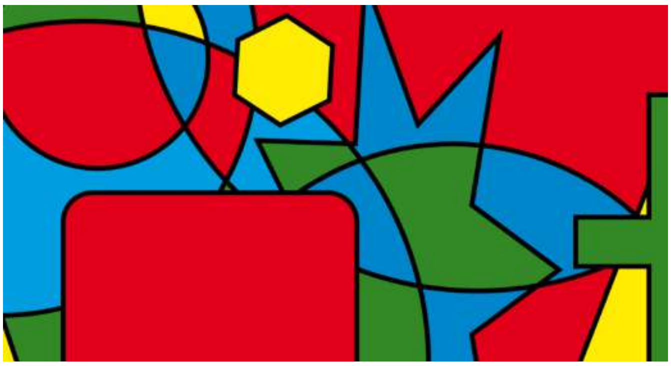

Figure 1. No two adjacent regions have the same colour [7].

Conclusion

Mathematical proofs have existed since the days of Euclid and remain relevant today. However, as the advent of modern computing has shown, the methods of proving a statement can still evolve; even now, using AI in mathematical proofs is being explored. As these methods continue to be taught and used—and technology advances—this varied set of tools already available to mathematicians may well expand.

French Summary

Comment savons-nous ce qui est vrai ? Pour les mathématiciens, il s'agit d'appliquer un système de démonstrations mathématiques, un système bien éprouvé mais également en évolution. La logique forme la base de ces démonstrations. À commencer par une proposition, qui est vraie ou fausse, des étapes logiques sont appliquées jusqu'à ce qu'une conclusion soit atteinte. Ces concepts logiques, y compris l'implication et l'équivalence, sont encore utilisés aujourd'hui par les mathématiciens comme au temps d'Euclide. Et pourtant, les inventions modernes — en particulier l'informatique moderne, ont élargi l'éventail des outils disponibles. Cet article présentera les types de démonstrations mathématiques les plus courants tout en vous montrant des exemples. Après l'avoir lu, les démonstrations seront, espérons-le, un peu démystifiées.

Kevan Lew - BA/BSc, French, Mathematics

Kevan is a second-year student majoring in French and Mathematics. This edition of the Scientific offered an exciting opportunity to integrate his studies and interests.

Explained Ecology & Anthropology

Shared Lineages: A Brief Review of the Ecology and Anthropology of Chile and New Zealand.

Emily Smith, Jarod McTaggart, Josefa Hernández & Valentina Lagos

This article is a trans-disciplinary collaboration between writers from Chile and New Zealand, with the intent to investigate and present the relationship and similarities between these two countries. The biological similarities of the two countries are intimately linked through a shared Gondwanan past and similar evolutionary pressures on each country's species. The anthropological review reveals that the indigenous people of both nations have similar views and relationships with the natural environment. Through these similarities, we may understand that while separated by more than 9000 km, New Zealand and Chile are more alike than one may think.

Introduction

Chile and Aotearoa New Zealand are two Southern Hemisphere nations that both originated from the Gondwanan supercontinent. This shared geographical heritage, as well as similar habitats and biomes, have led to phylogenetic similarity between species. In addition, the indigenous groups of Chile and Aotearoa New Zealand have similar worldviews and ways of existing within their environments that emphasise spiritual connection and reciprocity. This article is a collaboration between writers from Chile and Aotearoa New Zealand to explore our two countries' ecology. A trans-disciplinary approach was taken in order to understand not only the biology of these countries but also the ecological perspective of the indigenous peoples. We initially investigate biological links between Aotearoa New Zealand and Chile, including shared lineages, evolution, ecology and iconic species. An anthropological lens is then applied, comparing the cultural ecology of these nations. Sections pertaining to Chile are written in English for New Zealand readers, and sections pertaining to Aotearoa New Zealand are written in Spanish for readers in Chile. This collaboration aims to educate readers from each country about the other, presenting the uniqueness of our countries to a new audience.

Biological

Shared Lineages

Chile and Aotearoa New Zealand are a world away from each other; however, this was not always the case. 180 million years ago, South America, Australia and New Zealand were connected in the Gondwanan continent. During this time, species were shared, and both plants and animals could move between these now separated land masses. Due to this, biogeographical scientists have found that taxa found in Australia and New Zealand share close relationships with South American Taxa [1].

Vegetation

The vegetation of many parts of Chile and Aotearoa New Zealand are similar, notably the Southern Beech forests. Nothofagus is an iconic genus, comprising much of the forest in the South Island of Aotearoa, as well as along the Southern Andes in Chile. Another taxa linking these two countries is Fuscopannaria, a lichen species, *Laurelia novae-zelandiae* in New Zealand and its Chilean counterpart, *Laureliopsis philippiana* [1].

Animals

However, it is not just vegetation linking these countries. There are a number of animal species that appear in both regions, further connecting these two countries. The Tuatara (*Sphenodon spp*) is one of Aotearoa New Zealand's most iconic animals, namely due to them being the last extant species' of Sphenodon. While there are no more living species from the order, the most recent fossil relatives of the Tuatara were found in Patagonia [2], which is the region of South America that Chile is part of.

These are just a few of the examples of lineages that are shared between these two distant countries, illustrating this shared past of lands once connected. Many of these distributions are patterned, showing a direct link between New Zealand with specific regions of South America, where once they were joined [3].

Endemism

Chile has a high degree of endemic biodiversity, this being due to its geographical location and features of the landscape. Like Chile, New Zealand has high degrees of endemism; this, however, is due to the fact it is an island and thus, populations are isolated and are able to speciate allopatrically. Chile, while not an island, is isolated from surrounding populations due to geographic barriers, with oceans surrounding the western and southern coastlines, the Andes on the eastern border and the Atacama desert on its north [4]. These geographic features, as well as a number of other historical geographic features such as glaciers, have resulted in Chile having the highest number of endemic genera in South America [5]. Chile is one of the most conservationally focused countries in South America, with protected areas representing 19% of Chile's land surface, compared to the mean of 6.4% for South American countries [6]. This illustrates Chile's commitment to protecting these valuable and unique endemic species.

Chile is home to exotic, beautiful and unique species, high levels of biodiversity and endemic species. While at first glance, the ecology of Chile may seem alien to New Zealand, they are, in fact, related. Though distant, this relationship is multifaceted, from shared Gondwanan lineages that were broken apart 180 million years ago. To the evolutionary processes that play on these populations stemming from our respective isolating features. Aotearoa New Zealand and Chile are no doubt distinct from each other; however, considering all factors, these two countries have a number of similarities and relationships that prove they are far more closely related than one may expect.

Biological

Hace aproximadamente 240 millones de años atrás, existió un supercontinente llamado Pangea, el cuál dió paso a Laurasia (hemisferio Norte) y Gondwana (hemisferio Sur) en el periodo Cretácico. Éste último continuó separándose dando lugar a las grandes masas continentales hoy en día conocidas como Sudamérica, África, Australia, India, Madagascar, Zealandia y la Antártica. Éste supercontinente es biogeográficamente importante debido a que explica similitudes en términos de distribución geográfica de muchos grupos taxonómicos encontrados en estas grandes masas continentales. Al quedar estos grupos en condiciones de aislamiento reproductivo, se generó sobre ellos un proceso de especiación [7]. A pesar de ésto, y gracias a el seguimiento de la historia evolutiva y biogeográfica de estos linajes, aún es posible trazar ancestros comunes entre los organismos que en algún momento habitaron Gondwana.

Una muestra interesante de esto podría corresponder a la presencia del género Nothofagus en países como Chile y Nueva Zelanda. Actualmente existen 36 especies descritas de éste género en el mundo, de las cuales, cuatro se pueden encontrar en Nueva Zelanda; *N. solandri, N. fusca, N. truncata y N. menziesii*. Siendo ésta última del subgénero *Lophozonia*. De la misma forma, los subgéneros de *Nothofagus* distribuidos en ambos países, también comparten un género de hongo parasitario llamado *Cyttaria*, de las cuales, tres especies parasitan a *N. menziesii.* La filogenia de este hongo podría sugerir una mayor cercanía entre los subgéneros *Nothofagus y Lophozonia* presentes en Chile y Nueva Zelanda respectivamente. Cabe mencionar que *N. menziesii y N. fusca* corresponden a especies endémicas de Nueva Zelanda [8].

Nueva Zelanda posee una gran diversidad en términos de especies endémicas. Una de las más emblemáticas del país corresponde al Kiwi (*Apteryx spp.*). Éste pequeño género de aves se constituye de cinco especies endémicas correspondientes a las tres islas principales de Nueva Zelanda y se ha vuelto uno de los emblemas extraoficiales característicos de éste país. Sin embargo, todas las especies de Kiwi se encuentran amenazadas, siendo el Kiwi marrón de la isla Norte (*Apteryx mantelli*) el que posee la mayor tasa de disminución en su población. Debido a que estas aves evolucionaron en ausencia de mamíferos depredadores estos corresponden a su mayor amenaza, siendo los perros, gatos, cerdos, hurones, zarigüeyas, armiños y comadrejas los principales causales de su declive. Estas especies habrían sido introducidas a Nueva Zelanda por polinesios y europeos [9], por lo que la actividad humana sería clave en la conservación de muchas especies endémicas de este país. Un ejemplo de esto sería el delfín de Hector (*Cephalorhynchus hectori*) el cual ha experimentado un alza en sus tasas de mortalidad de la última década debido a la presencia de pesqueras, turismo, contaminantes y tráfico de embarcaciones. El control de estos factores sería crucial debido a que es común encontrar hotspots de este delfín en aguas cercanas a la costa [10], siendo la Península de Banks uno de los lugares más críticos [11]. Otras especies endémicas como el murciélago de cola larga de Nueva Zelanda (*Chalinolobus tuberculatus*) y el tuatara (*Sphenodon spp*) también se encuentran en estado de conservación vulnerable desde la llegada del hombre [12-13]. A pesar de esto, Nueva Zelanda forma parte del Convenio sobre la Biodiversidad Biológica desde 1992, el cual expone que las partes contratantes están al tanto de las causas de la baja en biodiversidad y promueven su prevención mediante el uso de la ciencia y la divulgación [14]. Además, sería importante destacar que, muchas de estas especies son de gran importancia para la cultura Maorí y lo relevante que resulta esta para la conservación de la biodiversidad de su país.

Cultural

Chile's cultural history is similar to that of New Zealand. Indigenous territory was conquered by Europeans, triggering a period of conflict, which eventually led to a democratic government. Spanish *conquistadores* invaded the Incan Empire during the 16th century, facing different levels of resistance from various indigenous groups. The Mapuche people of the central Chilean region of Araucania held off colonial forces successfully, and as a result, this group comprises approximately 90% of the indigenous population of Chile (other groups include the Aymara, Quechua, and Atacameño, among many others). The word Mapuche means 'people of the land' from *mapu* = land, earth, and *che* = people [15], like the Māori *tangata whenua*. Like many indigenous groups worldwide, the Mapuche place meaning on the deep and complex relationship between people and the land, rather than its economic utility [15]. The Mapuche spiritual worldview contributes substantially to their understanding and management of their ecological environment [16].

One of the most important aspects of the bond between Mapuche people and the environment is their reliance on medicinal plants (*lawen*) as a primary method of healthcare. Professional medical care is used to a much lesser extent, for a variety of reasons. Often, medical facilities are difficult to access, care is expensive, and cultural barriers may exist between indigenous patients and their doctors. However, one of the most common reasons given for this preference is the belief that herbal remedies are simply more effective [17]. Herbal practitioners are known as *machi* and are almost exclusively women [17]. A complex set of rules and traditions exists that maximise the effectiveness of the remedy. For example, when *lawen* are collected, a *machi* prays to the soul of the plant for permission to use the plant for healing purposes. If this is not practised, it is believed that the remedy will be ineffective or make the gatherer ill herself [17]. The therapeutic use of plants in this way is a practice learned by young women through an apprenticeship of 2-4 years and results in active and mutual trust and respect between the *machi* and her community and the *lawen* and associated spirits [17]. The effectiveness of these herbal remedies is a combination of both the chemically active agents present in the plants and the sociocultural understandings of the ritual and ceremony involved in the process [17]. Because both the plants and the people practising the ceremonies are located in a specific geographical area, a close link is created between the social and biological ecosystems of Araucania.

The Mapuche, as well as other indigenous groups within Chile, persist in increasing their recognition as an integral part of Chilean society [18]. Despite the losses of land and associated traditions as part of the process of colonization, some Mapuche continue their ancestral practices, even if adapted for modern circumstances. There is a growing understanding that the relationship between people and place is essential to consider alongside economics and politics [19], in order to conserve and value social as well as biological diversity.

Cultural

Los maoríes son los primeros pobladores de Nueva Zelanda, quienes llegaron al continente hace aproximadamente 1000 años desde Hawaiki, una isla ubicada en la Polinesia oriental a bordo de 7 canoas, tradicionalmente conocidas como wakas, según cuenta la mitología maorí, ellos describen a Nueva Zelanda, en su lengua, Aotearoa como "*la tierra de la larga nube blanca*". Estos polinesios eran grandes recolectores y cazadores, pues basaban su alimentación tanto en frutas y verduras como en peces y aves nativas del sector, y se organizaban en familias o *whanau* , las cuales a su vez se dividían en tribus o *iwis*.

Debido al aislamiento geográfico de este pueblo originario lograron desarrollar una cultura inigualable, la cual está profundamente en sincronía y conexión con la naturaleza. El uso de diversas plantas para la realización de rituales y ceremonias es un indicio clave de esto, y se puede evidenciar debido a que uno de los rasgos característicos de esta cultura son los tatuajes que se encuentran distribuidos a lo largo del rostro y cuerpo, dando cuenta de cada hazaña realizada. Mayormente conocidos como *tā moko*, estos tatuajes se realizaban a partir de los pigmentos de diversos hongos y trozos de madera quemados.

No solo el uso de elementos de la naturaleza era importante para ellos, sino también el culto a esta misma, los maoríes contaban con una gran diversidad de deidades las cuales representaban a distintos elementos del mundo natural, y para ellos era extremadamente relevante honrarlos.

Rongoā Māori, es el nombre que recibe la medicina maorí, la cual está profundamente centrada en el uso de plantas y la creación de brebajes con estas mismas para la curación de enfermedades, de manera holística se utilizan alimentos para la creación de estos medicamentos naturales.

Luego de la llegada de los *pakeha*, es decir, europeos a Nueva Zelanda, se desataron diversas situaciones que afectaron negativamente la población de maoríes en la isla. En primer lugar, al llegar los británicos trajeron con ellos múltiples enfermedades que fueron contagiadas a los indígenas, junto con esto se desataron varias guerras entre tribus.

Conocidas como las guerras de los Mosquetes, se lideraron un conjunto de batallas tras la adquisición de armas, las cuales eran compradas directamente a los británicos colonizadores, que lograron llevar a la erradicación de algunas de las tribus de la isla, siendo determinantes en la disminución de los maoríes.

Actualmente, esta cultura se encuentra principalmente distribuida en la zona norte de Nueva Zelanda, siendo la lengua maorí uno de los idiomas oficiales de este país.

Conclusion

Despite being a world away from each other, Chile and Aotearoa New Zealand share more similarities than one might expect. Our shared Gondwanan origin links the ancestral lineages of many species in each country, and similar evolutionary pressures have driven the development of endemism in both regions. Furthermore, the indigenous groups of both nations, while unique, share similar worldviews. Both Mapuche (as well as less populous Chilean groups) and Māori embody a spirituality linking human society with the physical and natural environment. Less emphasis is placed on the economic utility of land in these frameworks. Therefore, while distant, Chile and New Zealand may be considered sister nations.

UoA Scientific Writers

Emily Smith - BA/BSc, Anthropology, Ecology

Emily is a third-year student studying Anthropology and Ecology within a conjoint Bachelor of Arts/Bachelor of Science at Waipapa Taumata Rau. She is passionate about sharing everyday environmental initiatives with those around her and loves learning about the flora and fauna of New Zealand.

Jarod McTaggart - PGDipSci, Biosecurity, Conservation

Jarod is studying for a Postgraduate Diploma in Science (Biosecurity and Conservation) as well as holding a BA (Communications / Media, film and television) BSc (Biological Sciences- ecology pathway) conjoint degree from the University of Auckland. He has a passion for filmmaking as well as the environment, specifically within New Zealand. With the goal to make a substantial contribution to conservation in New Zealand, through research, science communications, policy and community based work.

AEB Chile Writers

Josefa Hernández - Biology

Josefa is a third-year biology student at the Pontificia Universidad Católica de Chile. She hopes to specialize in the area of behavioral and evolutionary ecology. She currently enjoys studying the behavior of top predators and some primates.

Valentina Lagos - BSBio, Neurobiology

Valentina is a second-year student at Universidad de Chile in Santiago currently studying Bachelor of Sciences in Biology. She is passionate about the neurological study of animal behavior and acquiring knowledge about the endemic flora of Chile.

Fruit of the Angels

Binu Kularathne

Nutrition

Papaya/pawpaw is also known as the "fruit of angels'' by Christopher Columbus due to their unique and pleasant flavour. Mainly grown in tropical areas, papaya fruit and the plant as a whole have been subjected to study in the last few decades due to their potential medicinal and commercial use, considering their antioxidant properties, anticancer properties, and enzyme activity.

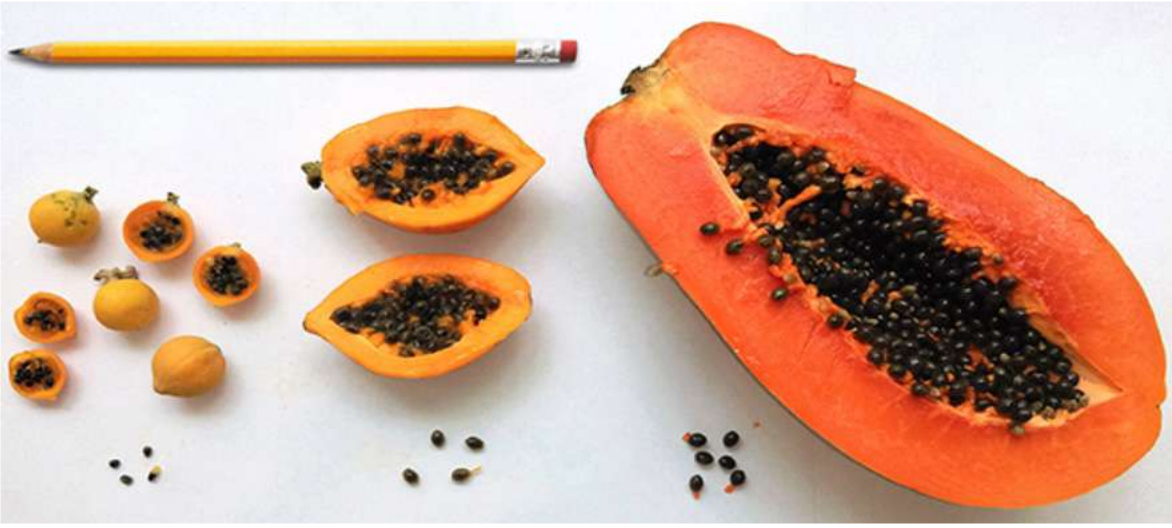

Image 1. The smallest ones are the wild papaya, followed by the hybrid between wild and domesticated papaya followed by the domesticated papaya fruit with its seeds (Maradol variety) [9].

What Exactly is the "Fruit of the Angels"?

Carica papaya L., widely known as papaya, is an orange/yellow/red sweet fruit, and one fruit has hundreds of seeds. Papaya pulp can be eaten raw after removing the peel. It is also found in jams, juice, and other food products in the market. The pulp of the fruit is rich in vitamins A, C, E, and B, minerals (magnesium and potassium), and food fibres. The seeds are rich in phenolic compounds and fatty acids, but they aren't usually eaten directly like the pulp. The leaves are rich in food fibres and polyphenolic compounds [1].

Fighting Dengue Fever

Carica papaya L. leaf extract has been used for centuries to treat dengue fever, mainly by Ayurvedic doctors. Much research has recently been conducted to prove the efficacy and science behind how *Carica papaya* L. leaf extract fights dengue fever.

Dengue is caused by the Flavivirus. The papaya leaf extract is known to increase the platelet count. This is due to a compound in papaya leaf extract, which is thought to stabilise the plasma membrane of the platelets and thus prevent it from being degraded due to stress induction by the dengue virus. However, the dose-and-effect relationship is not linear. This hemolysis inhibition was greatest when blood was treated with the extract from partially mature leaves [2].

Papaya and the Heart

The nutrients contained in papaya are known to be beneficial against cardiovascular illnesses. This is likely due to its anti-platelet cohesion, anti-hypertensive, hypoglycemic, and hypolipidemic actions. This reduces the chance of atherosclerotic plaque, thrombi, and emboli formation and hence minimises the chances of ischemia and/or myocardial infarction [1, 3-4]. Also, papaya aids in preventing damage caused by free radicals [1].

Papaya and its Antimicrobial Activity

The organic extracts of the roots of the papaya tree were found to be effective against all the tested gram-positive bacteria, such as *Pseudomonas aeruginosa* (Highest activity), as well as against some gram-negative bacteria, such as *Proteus mirabilis*. However, the aqueous leaf extracts showed stronger inhibition. The leaf extract consisted of alkaloids, tannins, saponins, glycosides, and phenols, according to phytochemical analysis [5].

The minimum inhibitory concentration of papaya plant extract for S. aureus was very low compared to other bacteria, meaning the extract is potentially effective in treating boils, breast abscesses, and surgical wound infections that involve *S. aureus*.

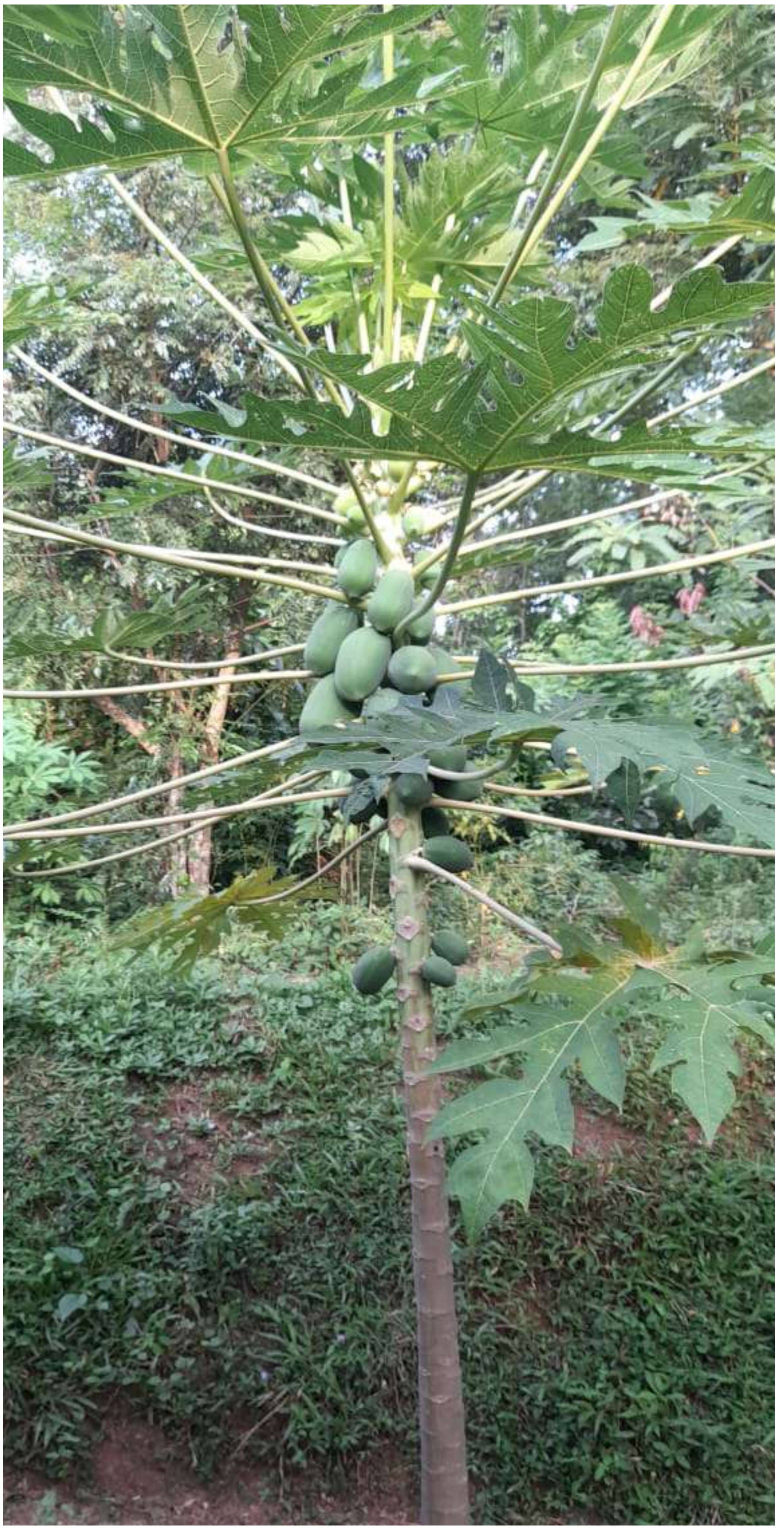

Image 2. Home-grown papaya tree in Sri Lanka with raw papaya. Photo by Nadeeka Kularathne.

Papaya and its Anticancer Properties

Research have found that papaya has compounds with many anticancer properties against a variety of cancers [6]. Considering how papaya is a plant found in nature, its extracts can be a very effective way to treat many cancers or at least decrease the tumour size until properly targeted treatments can be used for patients.

α-tocopherol, lycopene, and benzyl isothiocyanate are compounds found in papaya that were found to have potential anti-cancer properties due to the exhibition of anti-proliferative activity [6]. Anticancer activity includes TH1 formation, which results in cytokine secretion of IL-12, IFN, and TNF-α, which cause cytotoxicity against the tumour cells of cervical carcinoma, breast adenocarcinoma (MCF-7), hepatocellular carcinoma (HepG2), lung adenocarcinoma (PC14), pancreatic epithelioid carcinoma (Panc-1), and mesothelioma (H2452). Also, genes for PBMC are upregulated, causing the antitumor effects [6].

There are many compounds in papaya with anticancer properties.

These include the chlorogenic acid compound of papaya. Chlorogenic acid is also a dietary polyphenol. It exhibits anti-cancer properties such as cytotoxicity against tumour cells, induction of apoptosis by caspase-3 activation, reduction of BCL-2 activity, preventing progression of G0/G1 cell cycle phase in colon cancer (Caco-2 Cells), some breast cancers, lung cancer (A549 cells), promyelocytic leukaemia (HL-60 cells) and other leukaemias [6].

Caffeic acid, which mainly increases apoptosis rates, reduces new blood formation in cancer cells, and decreases tumour cell viability, ultimately decreasing cell proliferation. This compound is best against colon cancer (HT-29 and HCT-150), breast cancer (MCF-7 and T47D), skin cancer (A431), some cervical cancers, fibrosarcoma (HT-1080), hepatocarcinoma (HepG2 Huh70) and cervical cancer (HeLa ME-180) [6].

Also, β-carotene in papaya is known to have anti-tumour activity by inducing cell apoptosis and arresting the cell cycle in some prostate cancers [6].

Image 3. Home-grown papaya in Sri Lanka covered with a plastic bag to protect it from wild insects and birds. Photo by Nadeeka Kularathne.

Quinic acid, isorhamnetin and protocatechuic acid, ferulic acid, butyric acid, and linalool are best against certain colon cancers. Kaempferol was the best compound against breast cancer (MDA-MB453/MCF-7). Stearic acid and Linoleic acid against leukaemia (HL-60). Apigenin against colorectal cancer (SW480) and breast cancer (BT-474). Violaxanthin against breast cancer (MCF-7). Zeaxanthin against human uveal melanoma (SP6.5 and C918). Myricetin against bladder cancer (T24). Quercetin against liver cancer (HepG2). Rutin against colon cancer (HCT116), Keratinocyte cell line (HeCaT), lung cancer (A459), colon cancer (HT29, CaCo-2). Catechin against breast cancer (MCF-7), naringenin against breast cancer (SKBR3, MDA-MB-231), liver cancer (Human hepatocellular carcinoma HepG2 Cells), prostate cancer (PC3, LNCaP), melanoma (B16F10), and Gliomas-brain cancer (U118-MG). Vaccenic acid against nasopharyngeal carcinoma (5-8F and CNE-2). Xylitol against certain lung cancers. α-Tocopherol against oral squamous carcinoma (ORL-48). Lycopene against colon cancer (HT-29) and breast cancer (MCF-7 and BrdU). 5,7-Dimethoxycoumarin against some human adenocarcinoma types [6]. In rats, up to 2000 mg/kg of body weight was considered to be a safe daily dose. However, the exact safe dose is yet to be studied for humans [6].

The Use of the Papain Enzyme from Papaya

The enzyme, papain, is a cysteine protease, and proteases are the major enzymes that are commercially used [7]. Papain is used as a meat tenderizer in the food industry, to support the immune system in the healthcare industry, as a food preservative, and for tooth-removing purposes in the medical/pharmaceutical industry. Chemically modified versions are used as detergents and also used as a compound in exfoliators in the skin care industry [8].

However, papain is immobilised by a variety of methods to improve its activity and to help it thrive under many different conditions. The methods of immobilisation include the immobilisation of papain using organic supports such as agarose beads, cellulose beads, cotton fabric, chitosan, and alginate. The immobilisation of papain enzymes on synthetic organic support beads, such as nylon combined with polyacrylamide, are also widely used. Also, papain is immobilised using smart polymers, polymeric membranes, inorganic supports, mesoporous silicate, inorganic oxide support, magnetic particles, micro-magnetic porous particles, magnetic nanoparticles, and hybrid materials [7].

Conclusion

In conclusion, papaya is a valuable fruit with many medicinal properties. These properties include anti-dengue properties, cancer-fighting properties, antimicrobial properties, and heart-friendly properties. The papain enzyme from papaya is also recognised as an important enzyme that is used by many industries around the world.

Sinhala Summary

පැපොල්, විද්‍යාත්මකව කරිකා පාපායා එල්., ලෙස හැදින්වේ. එය ක්‍රිස්ටෝෆර් කොලම්බස් විසින් හඳුන්වනු ලැබුවේ දේවදූතයන්ගේ ඵල ලෙසිනි. පැපොල් පලතුරු විටමින් A, C, E, B, ඛනිජ (මැග්නීසියම් සහ පොටෑසියම්) සහ ආහාර තන්තු වලින් පොහොසත් ය. බීජ, ෆීනෝලික් සංයෝග සහ මේද අම්ල වලින් පොහොසත් නමුත් මේවා සාමාන්‍යයෙන් කෙලින්ම අනුභව නොකෙරේ. කොළ, ආහාර තන්තු සහ පොලිෆෙනොලික් සංයෝග වලින් පොහොසත් ය. පැපොල් වල පැපේන් එන්සයිමය වාණිජමය වශයෙන් භාවිතා වේ. උදා: ආහාර කල් තබා ගන්නා ද්‍රව්‍ය සහ සම ආරක්ෂක නිෂ්පාදන ලෙස භාවිතා වේ. පැපොල් වල අඩංගු පෝෂ්‍ය පදාර්ථ ඇතැම් හෘද රෝග වලට, පිළිකා වලට සහ ක්ෂුද්‍ර ජීවී ක්‍රියාකාරකම් වලට එරෙහිව කටයුතු කරයි. එසේම, පැපොල් කොළ සාරය ඩෙංගු වෛරසයට ප්‍රතිකාරයක් ලෙස භාවිතා කරයි.

Binu Kularathne - BSc, Biomedical Science

Binu is a second-year Biomedical Science student and she is fascinated by the way the human body interacts with nutrients and diseases. In her free time, she enjoys playing chess and painting canvases.

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Fun Fact

Some albatrosses (*Diomedea opomophera*) nest in New Zealand but migrate to Chile.
They can be seen in the whole Chilean coast.
In the end both NZ and Chile are their home.

Closing Comments

We have come to the end of the third edition of 2023! Thank you so much for reading.

Thank you to all our writers for your passion and drive. This edition demonstrated how diverse the field of science is—its people and sub-disciplines.

Thank you once again to our readers for constantly supporting the magazine and the executive team for all your mahi to make this magazine a great success!

Have a great second half of the semester as we approach the end of the year, and keep a lookout for our fourth edition.

Until then, Ka kite anō!

Contact Us

Website - uoascientific.com
Email - scientific.review.uoa@gmail.com
Instagram - uoascientific
Facebook - uoascientific
Twitter - @uoascientific
LinkedIn - The University of Auckland Scientific

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I'm a magazine, but I have feelings too. Don't throw me away!