Life’s a gas

Art+Air Exhibition

AIR
Life’s a gas

Art + Science
Exhibition Catalogue
2022

Curated by
Pam McKinlay

Art+Air,
a project in collaboration with
the University of Otago, NIWA,
and the Dunedin School of Art.

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Life’s a gas

An Introduction

Nau mai, haere mai. We invite you to attend and take part in the Art+Air Exhibition – Life’s a Gas.

Air is life. We can last three weeks without food, 3-4 days without water but mere minutes without “air”. Air flows in an endless cycle, nurturing, sustaining and transforming all whom it touches. Air/breath/wind is the nebulous thing that connects all living beings. In te Ao Māori hau is the breath or wind of life. Tihei Mauri Ora – behold the breath of life.

What happens when we are breathing? What’s in our air? Air appears transparent to the naked eye, but we have ways of reading the changing nature of “air”. Analysis of dry air reveals the chemical composition of gases and fluxes in stratification inside the thin blue line of our atmosphere. The air in Earth’s atmosphere is made up of approximately 78 percent nitrogen and 21 percent oxygen as well as other gases.

We are living in our third planetary atmosphere. How has our “air” changed over the history of our planet and why is the Great Oxygenation Event called the oxygenation catastrophe. We think of terrestrial trees and plants as being the “lungs of the earth”, providing a kind of essential bioservice for “us” as photosynthesising oxygen producers and air scrubbers. However, every second breath we take was made in the ocean.

Tiakina te āngi | protect our air

Natural navigators have been adept at reading their local environment for thousands of years enabling them to read changes in air factors to enable weather forecasting on land and water. Over the centuries, biomonitors have been used to forewarn of changes in air quality, like the “canary in the mine”, while others such as mosses and frogs are the unwitting bioindicators of environmental air quality. How might our intimate relationship with each breath draw our attention to global atmospheric changes driving climate change?

In this, the ninth theme in the Art+Science collaboration series we will be exploring many interconnected notions of “air”, scaling between human breath and the cycles of planetary breathing in the past, present and future.

Pam McKinlay – Project Convenor

With assistance from Jenny Rock

Geoff Wyvill

Scientist

Revolving through the Megacosm

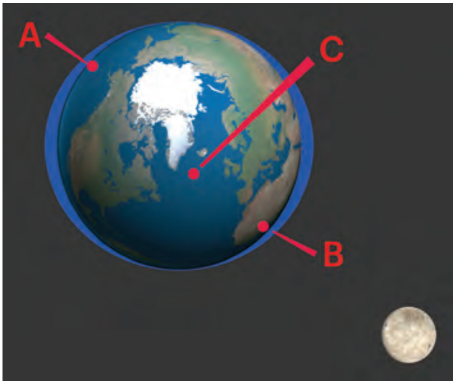
What can physics tell us about the weather? We live on an oblate liquid spheroid which has a thin solid crust, partly covered by water and the whole wrapped in a layer of air. What are the driving forces?

Our world has a moon whose mass is about one eightieth of the earth's. We say that the moon orbits the earth, but it would be more accurate to say that the earth and moon swing around a common centre. On the surface of the earth, gravity appears to be least when the moon is overhead or on the opposite side and most when the moon is near the horizon.

This causes the familiar two tides per day gradually getting earlier through the lunar month. The tide is really the difference between the sea-tide and the smaller tide in the earth's crust which also moves up and down. There is an even larger tide in the air above.

Our weather is driven by a number of forces acting in cycles. The daily heating and nightly cooling together with these tidal forces are the main ones. The slower, annual shifting of warmth from south to north and back causes the monsoons.

It is the response of the atmosphere to these cycles that produces the chaotic complexity of our weather. Movement in the sea is altered by resonance of waves generated by the shape of the seabed. Winds are disturbed similarly by mountains and valleys.

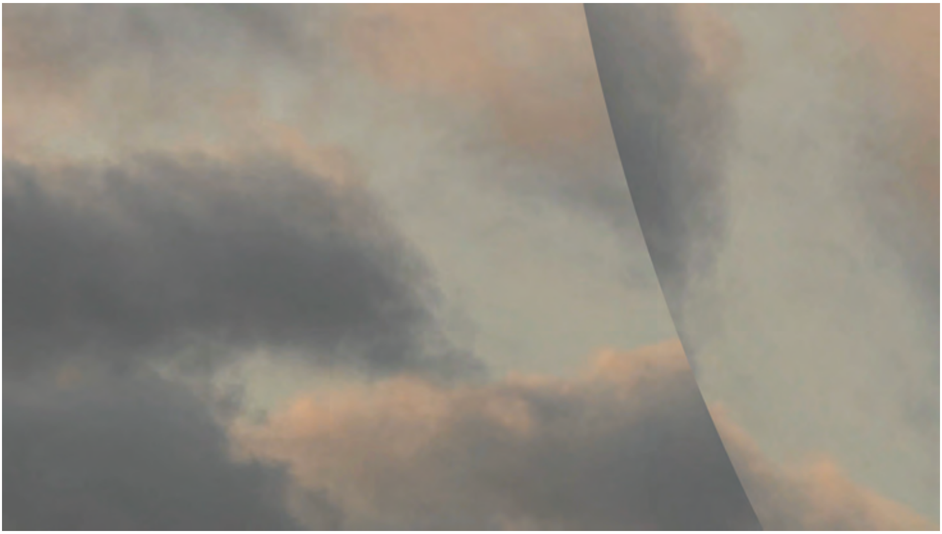


Earth, moon and ocean tides, showing centre of rotation, C, and points of minimum apparent gravity, A which is further from C and B where the moon's gravity works upward. The highest tide level, thickest blue area, occurs later than the lowest gravity as the earth rotates. Distances are not to scale.

Louise Beer

Artist

Revolving through the Megacosm



Film still, Revolving through the Megacosm, 2022.

My practice is fundamentally concerned with the night sky and how our connection to it is fading through light pollution. This project has challenged me to think more about our atmosphere itself, rather than its transparency.

Air tides are something that I hadn't explored before and learning about them from Geoff inspired me to think about the atmosphere being pushed and pulled as it travels around the solar system with our planet and as the solar system spirals around the Milky Way. All the forces at play on our planet have created a semblance of balance over billions of years and this thin blue line is all that exists between us and the brutality of the vacuum of space. This cosmic wisp of gases makes our world a garden of life, instead of an inhospitable, dangerous place impacted by solar radiation, cosmic radiation, massive temperature fluctuations and meteorites.

Our ever-evolving blue marble has travelled around the Milky Way 18 times since its formation 4.5 billion years ago, whilst these earthly weather systems, influenced by our star, our satellite and our neighbouring planets have carved and shaped our world and everything that lives within it.

Faye Nelson

Scientist

Marine sediment samples from Ata Whenua Fiordland

Deaccessioning is a term shared by the art and science worlds. Storage space is finite. In this case, marine sediment samples from a research cruise in Ata Whenua Fiordland were reduced in size and the excess material was made available for art+science. The original research goal for the samples was reconstructing westerly wind patterns – important to global climate – from precipitation and fiord circulation proxies.

Paleomagnetists study Earth's magnetic field as recorded by magnetic minerals to answer questions about the timing and nature of Earth processes, and about Earth's field itself. Ferrimagnetic iron oxides – like magnetite or Fe_3O_4 – have unique properties that lock in Earth's magnetic field strength and direction at the time of cooling below the mineral's Curie temperature. As free ferrimagnets settle – for example, on the seafloor, they rotate to lock-in the magnetic field of *that* time like tiny compasses.

Ferrimagnets' magnetic mineralogy, grain-size, and concentration is a way to answer environmental questions, but involves unmixing biogeochemical processes. Magnetite, eroded from rocks by wind, rain, snow and ice, is washed into the fiord. Magnetotactic bacteria in the water precipitate uniformly sized magnetite that allow them to navigate up and down, seeking their preferred level of oxygenation. Unmixed water in fiords can also act as oxidising or reducing environments, transforming one mineral to another through gain or loss of electrons.

The new life breathed into these samples by artists pays homage to oxygen in its many forms – the rush of air that is wind, free oxygen in water and oxygen ions in minerals.

Locke Unhold

Artist

Mud Cores

Sand and iron-rich ochre have been used for thousands of years in pottery – both in the clay itself and as glaze materials. Using marine core samples, I fired the samples in glazing and clay body applications.

First, the samples were fired in small dishes to 1200° Celsius to test their melt quality. Based on the nature of the samples, I knew they would be high in Silica and some of them would have a decent Iron content as well. Some would also have Calcium, and potentially Calcium Phosphate if there was enough shell and bone material.

From this batch of tests, I chose six to use as glaze materials. Three of the samples I chose to fire in an otherwise clear glaze to 1285° Celsius in a reduction atmosphere. The other three I fired in the same clear glaze to 1200° Celsius in an oxidation atmosphere. The temperatures for each sample were chosen based on the quality of the melt of the material at 1200°C. The glaze – Ferro Frit 6935 – was chosen for its stability at both temperatures and its clarity.

Using sand samples taken at the beaches, I wedged the sand into white clay. After bisc firing these tests to 980° C, the 6935 glaze was applied and they were fired to 1200°C to see the results and whether the sand would contribute to the visuals of the glaze and clay.

Locke Unhold, work in progress glaze test on cup.

Faye Nelson

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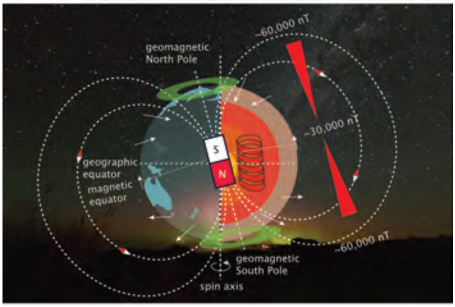
Scientist

Earth's magnetic field

Auroras are sub-polar neon crowns signaling 'life exists here,' for greenish-yellow auroras (wavelength 557.7 nm) predominate on Earth due to free oxygen – produced via photosynthesis – in the atmosphere at 100–150 km altitude.

Auroras require three components: solar plasma, a planetary magnetic field, and atmospheric gases. Solar plasma hits the magnetosphere enveloping and protecting Earth's atmosphere; charged particles then spiral down magnetic field lines and penetrate Earth's atmosphere, exciting atmospheric gases. As the excited gases relax, they emit visible light.



Background photo credit:
Ian Griffin/Tūhura Otago Museum.

As a paleomagnetist, I study Earth's changing magnetic field as recorded by rocks and sediments. Ferrimagnetic minerals such as magnetite (Fe_3O_4 – an iron oxide – act as tiny compasses locking-in the magnetic field strength and direction (currently -70 degrees in Dunedin) to the geologic record. Paleomagnetism tells us that Earth's magnetic field has weakened, and the magnetic poles have settled in the opposite polar region, at various times throughout geologic history. While these events expose Earth's atmosphere to increased solar erosion and radiation, they are thought to be compatible with life.

We normally see the top of distant auroras over the horizon, but during solar storms auroras occur at much lower latitudes. (My first aurora experience dates to August 1989 when strong solar flares pushed aurora borealis to the skies directly above the 49th parallel.) Through auroral beams, we see what is normally invisible – oxygen and Earth's magnetic field.

Christine Keller

Artist

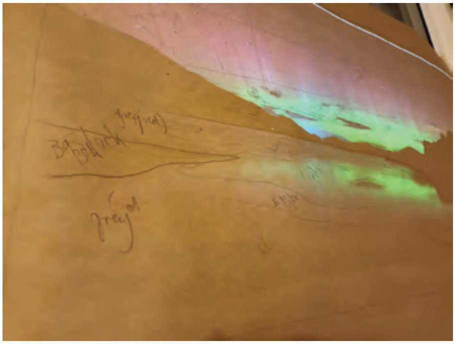
Excited Oxygen

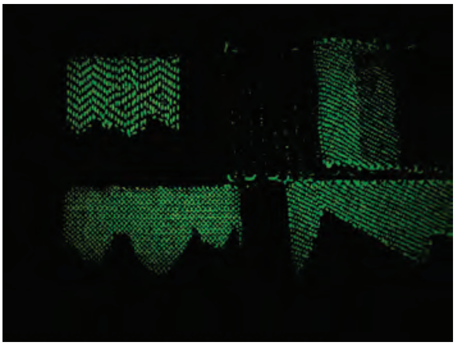
Growing up in a city of two million people in Germany, seeing the milky way was an aspiration, with most stars hidden by city light and sometimes smog. Monthly visits to the Hamburg Planetarium with my grandmother Maria awoke my interest for a night sky that was in reality mostly invisible to me. At the Planetarium, famous astronomer, Dr Übelacker shared his passion for space in everchanging lectures (following an obligatory virtual sunset over the Hamburg silhouette, accompanied by classical music). I saw my first amazing night sky at age 27 in Canada, in a night sky free of air pollution. Viewing an aurora with my own eyes was a dream which had to wait until I was 54.

The Art and Science series has given me as an artist a license to play with my weaving knowledge in response to the scientist's work. As a weaver I have a stash of collected and treasured yarns. 20 years ago, I was given some glow-in-the-dark yarn from a German research institute and while ideas have been dancing in the back of my head, the time was never right for using it until now.

From Faye I learned that the green aurora is a phenomenon created by a mix of magnetism and oxygen. The oxygen is a product of photosynthesis and therefore a proof of potential life on our planet.

Ian Griffin provided images of local aurora. The magnetic lines in Dunedin are mostly at an angle of -70 degrees. Twill weave structures can be woven at any angle so now I had all ingredients I needed to weave my aurora.





Concept image Christine Keller,
background photo credit:
Ian Griffin/Tūhura Otago Museum.

David Orlovich

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Scientist

Cryptic Purple Fungi

Fungi are the great mediators on Earth. Some fungi decompose other organisms, making nutrients available for new life. Some fungi help other organisms to grow and flourish. Some are farmed by animals (e.g., ants and humans!) to provide food. Fungi can convert waste products into carbon dioxide, and yet others help to remove carbon from the atmosphere and lock it up in soils. Fungi are an intrinsic part of the cycle of life and death, and life would not be the same without them.

Many different species of fungi live in a symbiotic relationship with Southern New Zealand beech trees (*Nothofagus*). The Department of Conservation estimates New Zealand has about two million hectares of forest predominantly in beech trees, and another two million that contain different proportions of beech, which means that fungi are playing a key role in maintaining and growing our native forests. The fungi wrap themselves around the tree roots and absorb sugars that the tree has produced by photosynthesis, while the beech trees absorb minerals from the fungus, which the fungi absorb from the surrounding soil. As the tree grows and require more nutrients it pushes out more roots and so too the scaffolding for the fungi. The tree can't go anywhere without the fungus.

Students in the Botany Department have been discovering and describing new species of fungi, mapping where fungi species grow and using DNA sequences from samples to discover lineages and create family trees. They also analyse DNA from the soil to identify a species presence in the absence of a mushroom so they can go back on a later field trip to look for it. This has been very helpful for re-discovering rare or poorly known species.

Fungi come in all shapes and sizes such as the familiar mushrooms, toadstools and truffles, also pouch fungi. Pouch fungi still have a stalk, while the truffle-like ones have gone further down the truffle path and lost their stalk. Many in New Zealand are very brightly coloured. The late Ross Beever suggested that they had evolved to resemble colourful fruits, to encourage birds such as moa to eat them and spread the spores in their droppings. Another theory is that the trait evolved in response to changing climates.

In New Zealand, one of the most recognizable and common pouch fungi are the purple pouch fungi, which are species of *Cortinarius*. When the fungi reproduce, they produce brightly coloured stalked truffles. There are at least six species of purple pouch fungi, and interestingly they are not closely related to one another, but have evolved independently at different times, even though they have a similar appearance. Purple pouch fungi are not that easy to tell apart in the field. It really reinforces the amazing convergent evolution that has happened with these purple pouch species—none of them are each other's closest relative.

"Purple haze: Cryptic purple sequestrate Cortinarius in New Zealand," *Mycologia*, vol 112, 2020, 3, https://doi.org/10.1080/00275514.2020.1730120

Andy R. Nilsen, Xin Yue Wang, Karl Soop, Jerry A. Cooper, Geoff S. Ridley, Michael Wallace, Tina C. Summerfield, Chris M. Brown, & David A. Orlovich.

Fig. 1: The most common purple pouch fungus, *Cortinarius violaceovolvatus* var. *viola*. Yep, it's a mouthful! Pouch fungi still have a stalk. Fig. 2: Andy Nilsen (in red) and David Lyttle on the beautiful Lake Christabel Track in Victoria Forest Park, where we collected another purple pouch fungus *Cortinarius diaphorus* (Fig. 3).

Danielle Munro

Scientist

Hidden Worlds

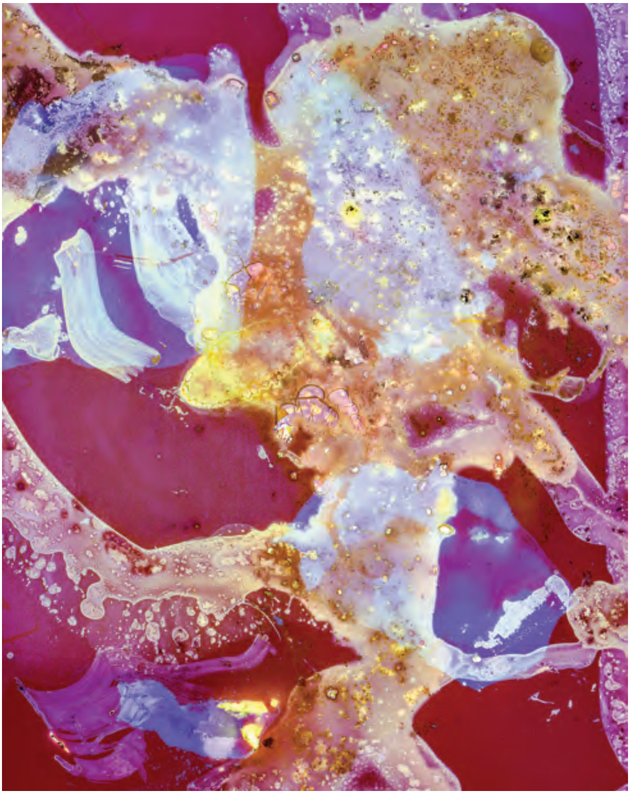
Ever since I was little, I have loved the worlds hidden in the undergrowth and when David shared his presentation at the first Art+Air meeting I knew I wanted to work with him. When we spoke after that meeting, I found that he shared that love and that we both wanted to create a work of beauty that celebrated those wondrous, miniature worlds. The vision for our collaboration was almost instantly clear: a stained-glass window to share with everyone the beauty beneath our feet that is so often overlooked.

This work is not meant to be cutting edge or avant-garde; its purpose is to catch the eye and capture the heart; to celebrate nature and the natural world; to immortalize the minuscule in a medium traditionally used to canonise saints.

Concept sketch for stained glass window.

Thomas Lord

A Primordial Touch



David's research and passion about mycorrhizal fungi challenged me to think about these intricate hidden systems which we walk over every day and how to interpret this knowledge through my photographic practice.

The indexical qualities of camera less photography led me in this direction by attempting to grow mycelium onto some 4x5 colour sheet film. At first with David's advice, I was able to identify an ectomycorrhizal mushroom from the genus *Russula*. It was found on a friend's property in Broad Bay surrounded by kānuka, kōtukutuku and a variety of broadleaf trees. The *Russula's* likely host from this selection is the kānuka as the other trees do not host this type of fungi.

From this sample I was able to isolate and obtain clean growth in a petri dish. In complete darkness, and when I was confident enough, I transferred the agar and growing mycelium onto several sheets of film which were then left to interact with each other in a dark bag for a month. It was a happy surprise when I received the negatives back from the lab. As a 2D object they not only show evidence of duration, the embrace of facilitative chance but also question authorship through the collaboration with David and the materials used.

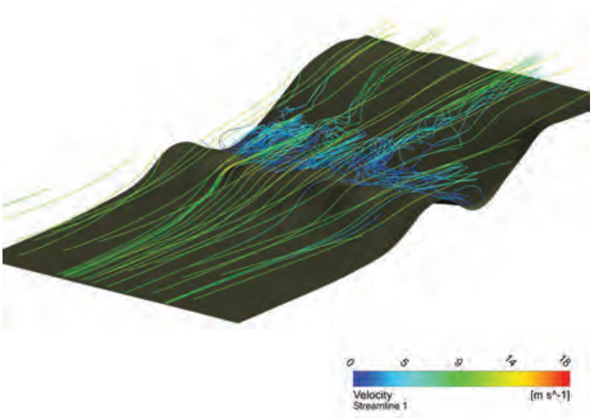
I can see comparisons in this work to the early photogenic drawings by photography pioneer Henry Fox Talbot. Fox Talbot describes these images as natures magic self-manifestations and the results are of the images making themselves. A quote that echoes the process and the images made for this exhibition.

Sarah Wakes

Scientist

Making the invisible visible

Wind surrounds us and we interact with it every day. However it is mostly invisible and we only ever see the effect it has on our world through clouds moving in the sky, grasses swaying or shifting piles of sand on the beach. Understanding how air moves over coastal dune systems, such as the one on St Kilda beach, Dunedin, is important for work on climate adaptation and future planning for coastal managers and engineers. Sand is moved by the wind across the beach, through the artificial notches and over the dune systems at St Kilda beach.



Streamlines coloured by wind speed show the flow of air over and through artificial notches cut into the St Kilda foredune.

One tool to make this invisible force visible is numerical modelling. Using a Computational Fluid Dynamics code we can solve the governing equations of fluid flow to obtain three-dimensional data on wind velocity and other variables across a dune landscape. We can compare the landscape with and without the notches to determine how the notches affect the wind flow in the swale between the foredune and John Wilson Drive. It also allows us to change wind speed and direction to emulate the effect changing weather conditions may have on wind flow and sand transport. Post-processing of the data from the simulations the wind flow becomes visible through streamlines coloured using wind speed.

Katharine Allard

as no clean slate

Of landscape itself as artefact and artifice; as the ground for the inscribing hand of culture and technology; as no clean slate.

Joanna Paul[1]

Making the invisible visible is a continually intriguing idea: whether it is revealing the shape of an unseen force outlined by the complex path of tiny particles; or visualising the potential impact of our actions on the future. Sarah Wakes' CFD modelling helps us see both.

Views from the top of 'Notch,' St Kilda beach, Ōtepoti Dunedin. Site visit, 2022.

Our collaboration brings these exquisite wind models out of research papers and embodies them in observational drawing. The two drawings enable direct comparison of wind patterns along the squeezed coastline between St Kilda beach and John Wilson Ocean Drive in Ōtepoti Dunedin. The first shows the wind caught in the steep dune system planted with deep-rooted marram grass. The second shows the change in wind dynamics after a notch is created in the dune to let the prevailing wind carry sand through the gap and soften the dune shape.

Metal point drawing needs the roughness of a bespoke drawing ground in order to abrade the metal wire and for particles to stick to the substrate. Here then, is an echo of Wakes' research into modelling wind flow over the varied roughness of marram grass dunes. Marram grass, as an invasive non-native plant with relatively high silica content, has been a perfect candidate for furthering my investigation into sources of biogenic silica to use in metal point ground. Marram ash from the cleared notch site is used as material in the work.

1. Joanna Paul "Landscape as Text: The Literacy of Wayne Barrar," *Now See Hear! Art, language and translation*, Ian Wedde and Gregory Burke, eds. (Wellington: Victoria University, 1990) 80.

Gabrielle Keeler-May

Scientist

Undaria pinnatifida

Diver removing *Undaria pinnatifida* from a dense monospecific stand on a rocky reef in Te Puaitaha/Breaksea Sound Fiordland. Photograph: Louise Bennett-Jones.

Seaweeds are ecosystem engineers that provide structure and oxygen to the underwater world. For humans to experience the environment in which seaweeds thrive, we need only to walk along the seashore to witness their fronds swaying back and forth in the shallow waves, capturing light from the sun. Yet seaweeds also inhabit subtidal depths, where fewer of us are able to marvel at their beauty. We can temporarily glimpse at kelp forests and seaweed beds beneath the water by holding our breath and diving down, or we can defy our basic physiology and carry air with us on our backs to breath underwater and marvel at life in te moana.

Scuba diving has allowed me to spend countless hours underwater around the world measuring seaweeds, invertebrates, and fishes as well as salinity, light, and temperature, to better understand the ecology of coastal rocky reefs. In Aotearoa New Zealand, I am researching the invasive kelp wakame, *Undaria pinnatifida,* through large-scale removals to understand its impact and to support invasive species control programmes with scientific data. As an annual species, *Undaria* grows quickly and accumulates biomass in greater amounts than native species in a short amount of time. Yet, *Undaria* can slowly monopolise reef space and resources by outcompeting native seaweeds, which can eventually alter the ecosystem. My research shows it may be possible to reduce this impact by divers manually removing the invader from the reef, thus slowing the spread of *Undaria* in our harbours and along our coastlines.

Teina Ellia

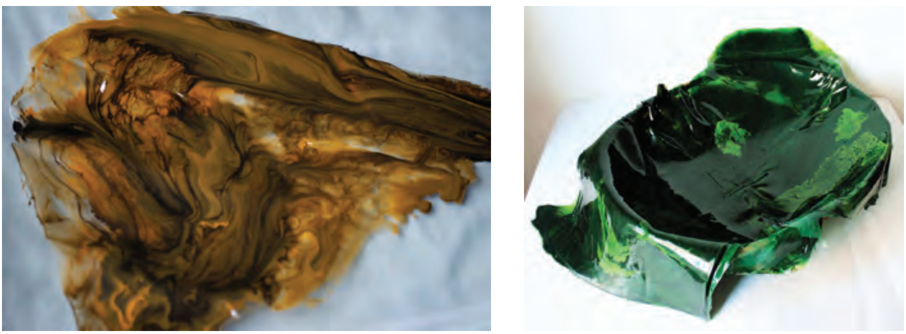
Artist

Rimurimu

Koia nei te whanau a Hine-moana i tukua e raua hei whakaruru i a ratau tamariki, ka reawea e ratau ki te taha o Rakahore raua ko Tuamatua ma raua e tiaki, ewhangai hoki. Koia e kite na koutou kaore taua whanau, a te Rimurapa ratau ona taina, e taka i o ratau matua whangai.

In Te Ao Māori, Hinemoana, granddaughter of Tane, was the creator of all forms of seaweed critical in the whakapapa of all shellfish and kai moana.[1] Hinemoana (with Kiwa, guardian of the sea) produced all forms of seaweed, and these were attached to Rakahore and Tuamatua, who are the rock and stones. Thus, the seaweed family ever clings to their foster parents, Rakahore and Tuamata to protect and cover the body of the Papatūānuku, under the sea.

Marine macro-algae, seaweeds, are photosynthetic aquatic organisms vital to the functioning of our marine ecosystems not only for gas exchange but providing habitat and crucial nursery environments. There are three main types of macroalgae differentiated by pigment: green, brown and red. They are not closely related but have different evolutionary paths, but similar features because of the environment they share.[2] They vary enormously in size, shape and growth. The smallest can only be properly seen with a microscope whereas kelps can become massive forests reaching more than 30m. There are an estimated 48 foreign species of introduced seaweeds now in New Zealand waters. Of these *Undaria Pinnatifida* a species highly valued in Asia where it is cultivated as a commercial variety. However, it is a species not welcome in our waters. Because of its size and ability to live in a wide range habitats and reproductive output *Undaria* is outcompeting our native species of seaweed such as *karengo* (southern laver) and having an effect on other traditionally important species such as *rimurapa* (bull kelp).



Teina Ellia, work in progress.

1. Elsdon Best, Maori Religion and Mythology Part 2: Origin Of Shellfish, Etc http://nzetc.victoria.ac.nz/tm/scholarly/tei-Bes02Reli-t1-body-d4-d3-d8.html
2. Wendy Nelson, *New Zealand Seaweeds an Illustrated Guide*, (Te Papa Press, 2020) 118

Tina Summerfield

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Scientist

Cyanobacteria

Life on Earth is sustained by oxygenic photosynthesis, where light energy is captured and converted into chemical energy. This process, that plants perform across the planet, evolved billions of years ago in the ancestors of present-day Cyanobacteria. These ancient and resilient organisms are found in almost all environments on Earth. Their photosynthesis makes them ecologically important but for the most part they are inconspicuous in the soil, rivers and oceans. However, Cyanobacteria are seen when they form toxic blooms and these have potential to cause widespread damage.

In the laboratories around the world, including here at Otago, scientists are using Cyanobacteria to understand more about photosynthesis. We can investigate the mechanisms underpinning the capture of light energy and its conversion to chemical energy. The Photosystems are the pigment protein complexes that harvest light energy. We are able to examine the role different proteins in the Photosystems to understand these mechanisms of photosynthesis. In addition, we are learning how these resilient organisms can maintain photosynthesis by sensing and responding to changes in their environment.

Craig Cook

Artist

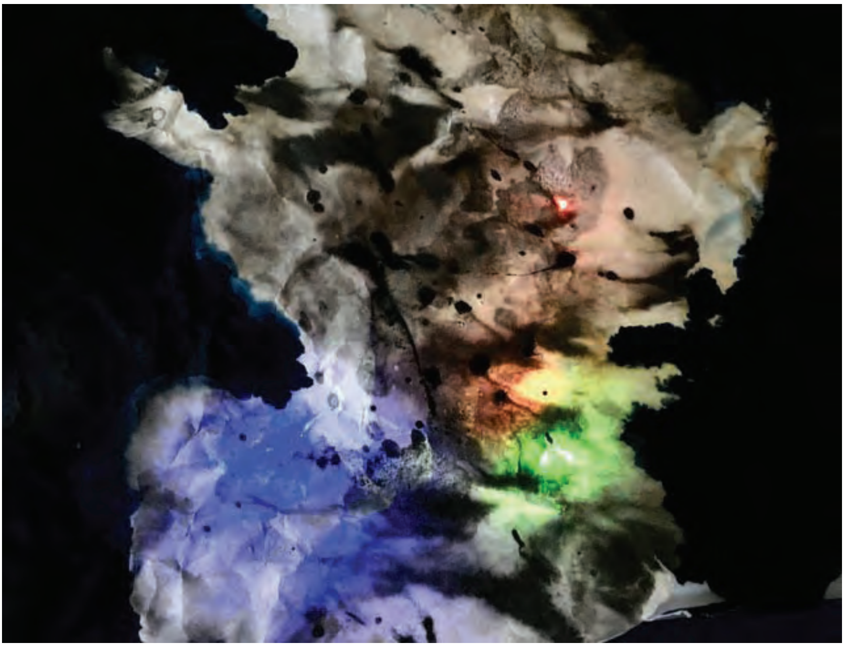
self-organising flows of energy and matter

By drawing on knowledge of the environment and the expertise of Dr Tina Summerfield, I was enticed into the realm of cyanobacteria. Ecological thought incorporated into science and art creates an ethically sound approach to human and non-human organisms.

Cyanobacteria evolved over 2.7 billion years ago and were the first lifeforms to absorb sunlight and water to create energy and oxygen through the process of photosynthesis. After surviving all five of the last mass extinction events on the planet we can be assured that cyanobacteria are here to stay.

Anthropocentric logic considers that all nonhuman entities that have use for humans are a resource to be exploited and controlled. This entitled sense of the plant and animal life that surrounds us has caused a disconnect that has produced alarming results for the planet and its species.

The artwork I have created has been in a constant state of metamorphosis. The interconnectedness with the location can be considered a living entity, all is vibrating to a particular rhythm. The rhythm explores the habitat of cyanobacteria and gives a visual voice to an idea or thought that can be observed over time.



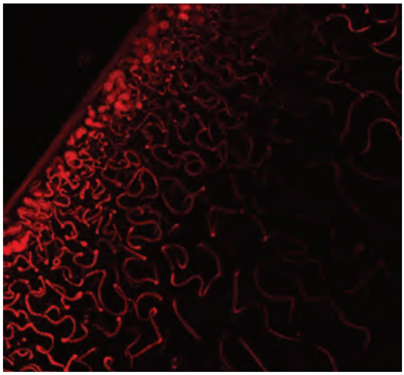
Craig Cook: "self-organising flows of energy and matter" (2022),
Lana cotton rag, Xuan rice paper, cyanotype, watercolour, micro LED, 800 x 650mm.

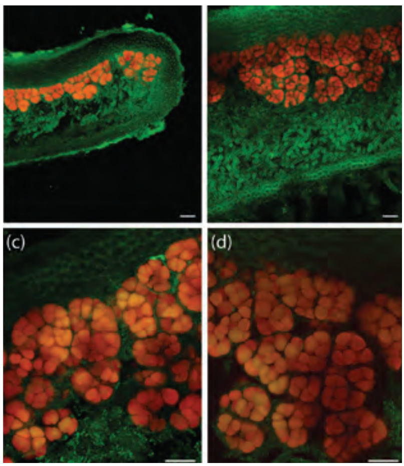
Tina Summerfield

Scientist

Nostoc

Cyanobacteria are photosynthetic bacteria. They are present, but mostly unseen, in almost all environments on Earth. They play an important role globally in fixing carbon dioxide, capturing light energy converting it to chemical energy and releasing oxygen. Some cyanobacteria, including *Nostoc*, are also able to fix atmospheric nitrogen to produce essential nitrogen compounds. In a chain of *Nostoc* cells, most will be photosynthesising but in a tightly controlled process some will be specialised for nitrogen-fixation. Exchange between the two types of cells includes the supply of chemical energy to the nitrogen-fixing cells and supply of nitrogen compounds to the photosynthesising cells. *Nostoc* can be seen free-living in visible colonies e.g., in wetlands and rivers. They can also be seen in symbiotic associations with fungi in lichen. In a lichen, the partners form a specialised structure where the *Nostoc* is surrounded by the fungus. In this association, the *Nostoc* is supplying both chemical energy and nitrogen compounds to the fungal host. The fungus is thought to control the *Nostoc* including formation of specialised nitrogen-fixing cells and co-ordinating the growth of both partners. The mechanisms of communication between the partners that gives rise to these structures are still not known. We have been using molecular techniques to investigate these associations.





Free-living *Nostoc* – in a gelatinous ball (top), confocal images (detail). In lichen the *Nostoc* (orange) are supplying nitrogen and carbon to the fungal host which is the photosynthetic partner (fluorescing green in the bottom images).

Pam McKinlay

Artist

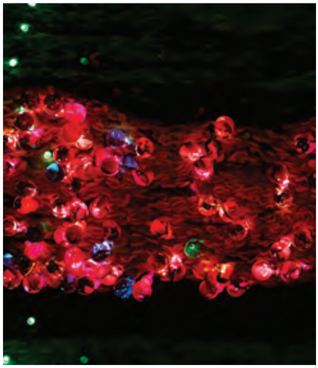
Cyano - Fluere

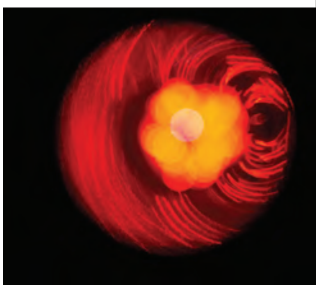
> "Photoautotrophic, oxygen-producing cyanobacteria created the conditions in the planet's early atmosphere that directed the evolution of aerobic metabolism and eukaryotic photosynthesis."[1]

These two small works are an exploration of cyanobacteria oxygenic photosynthesis systems based on Tina Summerfield's research (Botany). The two starting points were her confocal microscopy images of a *Nostoc* cyanobacterium. The samples used were one in the wild and another where it is found in symbiosis in a lichen.

Both art works incorporated light and colour using LEDs to show the fluorescence of the light capturing cells and the differentiated specialists cells for fixing nitrogen (non-fluorescing). In *cyano-fluere*[2], a small sculpture of a free-living *Nostoc* was made from fired clay, red wool yarn and LEDs to create a video work which captured the beauty of the fluorescence and microscopic focal challenges of confocal imaging.

Cicumfluo is a tapestry of woven light. It evokes the sense of the energy exchange at play in these extraordinary cyano-lichen organisms. The autofluorescence was expressed by using RGB LEDs programmed to the green of the fluorescence for the photosynthesising cells of the lichen with the strings of cyanobacteria crammed into the middle in an undulating mass folding back on itself in the confined space. SEM photography reveals that each cell is like a small "pop-bead" that makes up a string of cells. The phasing of the lights from bright to low and changing of colour in the woven cyano-lichen references cellular communication between the symbiotic partners and how this alters photosynthetic metabolism and exchange in the lichen partnership.





From top: Lichen, *Cicumfluo*, Nostoc, *cyano-fluere (video still).*

1. Stewart and Falconer in P J Walsh et al eds. *Oceans and Human Health: Risks and Remedies from the Seas.* Academic Press,271–96.

2. Fluorescence (from the Latin "Fluere") which means flowing.

David Rock

Scientist (artist's deceased father)

Journal Records

This project explores 30+ years of my father's daily record keeping on our farm. First thing every morning he recorded shaded air temperature (as well as detailed agricultural and phenological observations from the land (from first frost to migrating birds etc). He was an all-round naturalist, an observant outdoorsman of Cree heritage, and a farmer, including of trees (maintaining a sustainable woodlot and sugar maple stands). I will also call him a scientist. The data in his journals is detailed and accurate (same observer, equipment and site). The air temperatures he recorded are essentially a daily minimum (observed before sun-up on an outside thermometer on the dark side of the house). We increasingly recognise the value of local knowledge and record keeping from 'outside' professional science: "for it is the ordinary, the everyday, that gives us the truest picture of life."[1] Local phenological and meteorological data reveals wider trends, connecting us from local to global and back again.

From my father's journals.

As I work my way through his pile of carefully pencilled, spiral-bound notebooks, multiple questions guide my inquiry. Do these records of air temperature capture the climate change I feel so tangibly now when I return to the farm? How do these records reveal the scientific method in his observation, record keeping and seasonal analysis (e.g. comparing between years), and as such blur the divide between scientist and farmer, scientific practice and the generation of traditional ecological knowledge?

1. Susan L. Tomlinson, *How to Keep a Naturalist's Notebook*, Stackpole Books 2010; p 124.

Jenny Rock

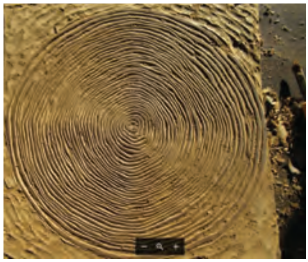
Artist

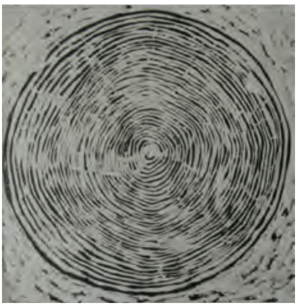
Air Temperatures of Sigwankas and Piaôdagos

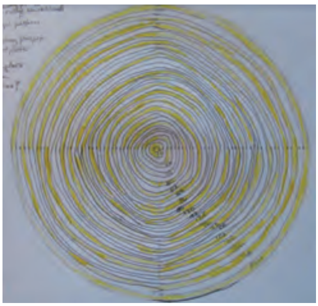
Combining backgrounds in science (especially thermal biology) and printmaking, I explore with words, numbers and art each month across the 30+ years of my father's journaling. Representing his air temperature data visually means devising ways to make artwork 'accurate' and evocative. Secreting a grid that maps daily minima across the decades and uses a set colour gradation, the detection of trends is in the eyes of the beholder.

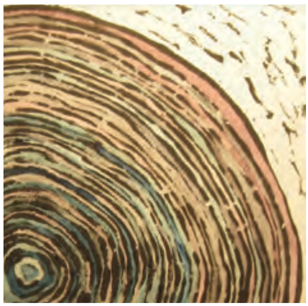
Here I share the months February and March, the end and the beginning of my 12-month exploration. My father's journals began in spring, March 1974. The lunar calendar of North Americas' indigenous people also begins in spring, tying the rebirth of plant and animal cycles to human observance of a new year. (Traditionally months are counted by moons with the first day of each new moon the first day of the month.) Although our heritage is Cree, the farm rests on Wabanaki land and so is tied to their names and knowledge about each month's moon.

March holds Mozokas the 'Moose Hunter Moon', with spring moons of March, April and May also known as Sigwankas ('Spring Maker' or 'Birds Return Maker Moons')[1] Piaôdagos is February's 'Makes Branches Fall Into Pieces Moon' – when ice storms and heavy snows often fell tree branches. Congruent with the rustic nature of the farm and data collection, I use a dry point and collagraph printmaking approach that also echoes indigenous mark-making (e.g. Cree birch bark bite or scrimshaw).

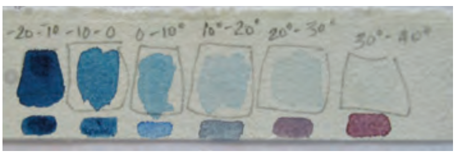








Jenny Rock, exploratory print works.



1. Christine Sioui Wawanoloath, *The Thirteen Wabanaki moons* http://westernabenaki.com/dictionary/moons.php

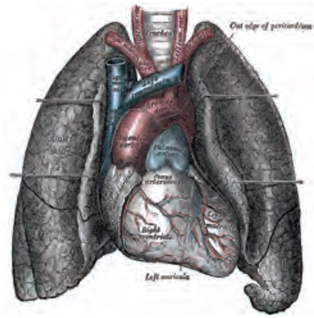
Sophie White

Scientist, Lab technician, preparator, dissector

There's Blood in the Air

The air we breathe has a close relationship with the blood we beat. The way we feel and think about the passage of breath is deeply intuitive, and our lungs are often the organ we are most acutely and physically aware of. When we see diagrams of the respiratory system, which often view the lungs as a stand alone structure, we envisage and breathe in the air coming in through our nose and mouth, down through our trachea, diverging through our bronchi to our lungs. When opening our rib cages into the thoracic cavity, the connection with the heart and the relationship of blood and air is deeply connected, not isolated, in the vital exchange of pulmonary circulation. The oxygen in the air we inhale moves from the lungs to the blood, as carbon dioxide gas moves from our blood to be exhaled, in exchange and vital movement.

Inside medical imaging techniques and in physical dissection and surgery, we see a rare window into our internal worlds, and slices of often exquisite structural beauty. This connects us into ourselves and into each other, in an often unexpected and awe-inspiring way. My work and collaborations as a technician and researcher focus on facilitating our exploration inside ourselves and others, in appreciation of nature and the intelligence of its structures. In breaking down barriers between people and the constructs of science, it opens up access into these worlds, and involves and maintains art as a critical part of the scientific process.



Heart and Lungs,
Henry Vandyke Carter,
Gray's Anatomy, 1918.

Spectra of colour, thoracic cavity of a tawaki Fiordland crested penguin, during an avian necropsy workshop. Sophie White, 2018.

Sophie White

Artist

There's Blood in the Air

Modelling, casting, mount work, painting, jewellery, traditional plant, bone and stone materials

Anatomical illustration remains a vital and essential practice in the medical sciences, and scientific illustration as a whole maintains its integral nature in exploring and highlighting structures in ways that pure photography alone cannot. This exploration into the wonders of the human body drives our constant development towards deeper ways of seeing, branching into complex modelling in the digital realm, but also maintaining traditional key hand skills and practices, and opens realms of appreciation, internal and external reckoning, which in turn helps us care for and appreciate our bodies, nature, and environments as a whole.

The sheer beauty of traditional scientific illustration and resurgence in public popularity has seen a rise in visibility of artists involved in the sciences, and these works serve to showcase the integral and essential role of technicians as the nexus between art and science, which is often obscured.

This foray into a new material showcases curious optical elements and characteristics of glass: reflectivity, parallax, appreciation of delicate physical structure, fine layers, heightened keen and careful observation, and the deeply tactile and fascinating nature of etched surfaces. The tools and techniques, like engraving, sandblasting, acid etching, and polishing are all parts of my every day working life, and naturally stem from my personal interests and making processes in my art life. They are one in the same, like blood and air. All of my art techniques mirror my scientific techniques and hand work, with high focus fine detail repetitive processes.

Glass is notoriously challenging with its natural limits defined by its internal structures and chemical compositions. It has a deeply scientific context as an integral material in the industrial revolution in optics, in opening our spaces and views in architecture, and as a treasured material of deep physical beauty. The traditional mouthblown glass specialists of the Verrerie de St Just excel in producing both the optically challenging flashed reds and deep cobalt blues, which lend themselves perfectly to the vascular system, with arterial red and veinous blue. The acid techniques are again adapted from other industrial sciences, as are the engraving and abrasion tools, and embody the relationships between fine eye and hand skill, much like the state of mind in dissection.

Karen Reader

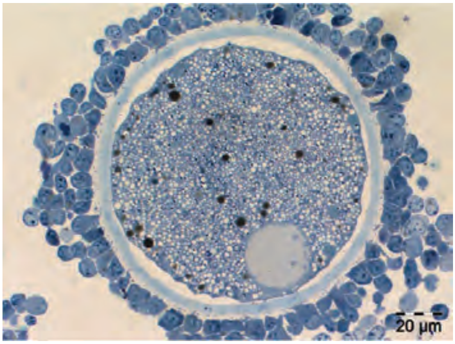
Scientist

Oocyte mitochondria

One in six couples have infertility and less than a quarter of fertility clinic treatment cycles result in a live birth. Poor oocyte (egg) quality is the leading cause of reduced fertility in humans and animals, but we do not yet understand how to improve oocyte quality nor how to identify good quality oocytes.

Oocytes carry the female chromosomes (DNA) and all the cell organelles (specialised structures) and nutrients that are needed to support fertilisation and the first week of embryo growth. They are round cells that are only 0.1mm in diameter. One type of cell organelle that is important for oocyte quality are the mitochondria. These fascinating organelles contain enzymes that convert oxygen and sugar or fat to make energy for cells to function.

Mitochondria are less than 1/1000th of a millimetre in size. They even have their own DNA and are thought to have evolved from bacteria. A single oocyte needs to contain more than 100,000 mitochondria for fertilisation to be successful and the embryo to survive. My research is focused on understanding how the structure and function of the mitochondria changes as the oocytes mature prior to fertilisation. I use an electron microscope to observe these tiny structures in sheep oocytes to identify how they change in response to different supplements. The goal is to identify factors we can add to culture media to improve the quality of oocytes and thus increase the success of in vitro fertilisation for people with infertility.



Light microscope image of a section through a sheep oocyte surrounded by cumulus cells.

Transmission electron microscope image of a thin section through three oocyte mitochondria ~ 0.5um in size.

Vivien Dwyer
Andrea Muggeridge

Artists

Dreaming of Oocytes

We have magnified the beginnings of life with thread, wire and beading, a visual imagining of what is not normally seen by the human eye, of the promise of life to come.

Life

the endless mystery

unsolvable

Live.

Janet Hoek
Lani Teddy

Scientists - ASPIRE2025

Daring to dream

Public health researchers aim high! Creating a smokefree nation by 2025 means confronting the commercially-driven pandemic that kills nearly 5000 New Zealanders every year. The goal calls on us to rethink our environment, where tobacco is easily available and highly addictive, and challenges us to build a society where our tamariki will lead full, healthy lives that are not burdened by smoking.

Realising the smokefree goal also means thinking more creatively about how to support people who smoke to quit. Around 80% of people who smoke regret ever having started and would like to be smokefree. Yet visions of a smokefree nation in just three years can seem threatening and even coercive.

At the same time as protecting our rangatahi and tamariki from the many harms tobacco causes, we must recognise some people will see smoking as a friend that brings comfort and security, provides structure, and offers reliability. Encouraging people to quit smoking not only asks them to stop using nicotine but means they must rethink their daily routines. They must recreate social interactions, identify new rewards, and find different buffers to help them weather times of stress. For some people, these changes will be straightforward; however, for others, they may feel insurmountable.

Heramaahina recognised these tensions. Her vision of aroha draws on hā, the breath of life, and the belief that people can act generously and with compassion towards each other. It brings together the vision of a healthy life for all people and the need to work in harmony to realise that dream.

Heramaahina Eketone

Artist

Kōwhiti - Aroha

Being an ex-smoker I decided that I wanted to do an 'in your face' piece weaving a wahakura (bassinet) out of my old cigarette packets.

After meeting with both Janet and Lani and listening to their gentle point of view, it was clear to me that this wasn't the way to go for this particular project. To shame someone for something that they already know is bad for them is not coming from a peaceful place of aroha and would not support anyone who is struggling in their journey to heal in that space. This brought me to my most recent use of aro, the acknowledgment of mahi tukutuku using ceramic tiles.

The aho or thread creates the koowhiti. In this context, it is the intention behind the work.

What do I ultimately want to achieve and how am I going to do it?

The use of koowhiti and their placement creates the overall tohu/ design. Our intention goes into our work, the words that we use and share with ourselves and others. Are we gentle? Are we forgiving?

The spiral tohu in this mahi is representative of the breath of the smoker. That their breath is just as precious as a non smoker. And how we should aro our precious hā with gentle encouragement. Hā ki roto, hā ki waho.

Therefore - This mahi is to encourage and tautoko someone in their journey to wellness.

No reira

Hau Ora, Mauri ora

ps. I still want to do something with the old packets and cigarette butts at some point - I just need to figure out what my intention is, who it's aimed at and what I want to achieve from it.

Michael Baker
Lucy Telfar-Barnard

Scientists

Making the Most of Masks

There are many inconvenient truths in protecting our health so that we can live long, healthy, and contributing lives. Clicking on a safety belt in the car, slapping on sunscreen on a summers day, and now putting on a mask when we are indoors with other people. Much like vaccination, masks protect both the user and those around them. Unlike vaccines, a single mask stops the full range of respiratory infections – including all Covid-19 variants, influenza, and RSV. Masking needs to become a new social norm in Aotearoa New Zealand, just as it is many Asian countries.

Over the last two and a half years our understanding of how masks work, and how to make them work better, has improved rapidly. That new evidence means that health authorities now firmly recommend universal mask use as safe, effective, and necessary; and the types of masks recommended have changed, from the early cloth masks many of us made at home, to more technical fabrics and fit solutions.

Much more needs to be done to normalise mask wearing. One way to change attitudes and behaviours is to reframe the role of masks. For example, clean indoor air may now be as fundamental for good health as clean drinking water and safe food.

Art and artists reframe the familiar and change how we look at it. We are therefore delighted to contribute to this collaborative work with Stella Lange, drawing attention to mask wearing as part of the suite of actions which helped New Zealand get through the most lethal period of the Covid-19 pandemic with one of the lowest mortality rates in the world.

Stella Lange

Artist

1,042,678

Of the 5 million+ New Zealanders, 1,042,678 New Zealander's have recovered from Covid-19 (as of the 24th May 2022). This remarkable number of survivors is a marvel, a testament to epidemiology and science. This number changes daily, sadly always increasing, 1042678 reflects a specific date chosen over two years into the 'Pandemic' and Covid arriving in New Zealand. The toll in other nations was higher and more devastating – New Zealand by its location, and distance was able to set in place measures to reduce the spread and severity of infection. Hand washing, was one we all knew and were familiar with, social distancing seemed strange at first as we developed the elbow tap and the 2-m rule, and mask wearing. Mask wearing was new for New Zealanders outside of health care. Masks were something that medics wore, masks were something strange, and odd and yet they were the mechanism by which we could keep ourselves and our communities safe. This work uses the form of the medical mask, to present key data about New Zealand's Covid Response. Prof Michael Baker and Dr Lucy Telfar Barnard's work provided valuable understandings of how these simple measures including wearing masks – saved lives.

Susan Wardell
Sofia Kalogeropoulou

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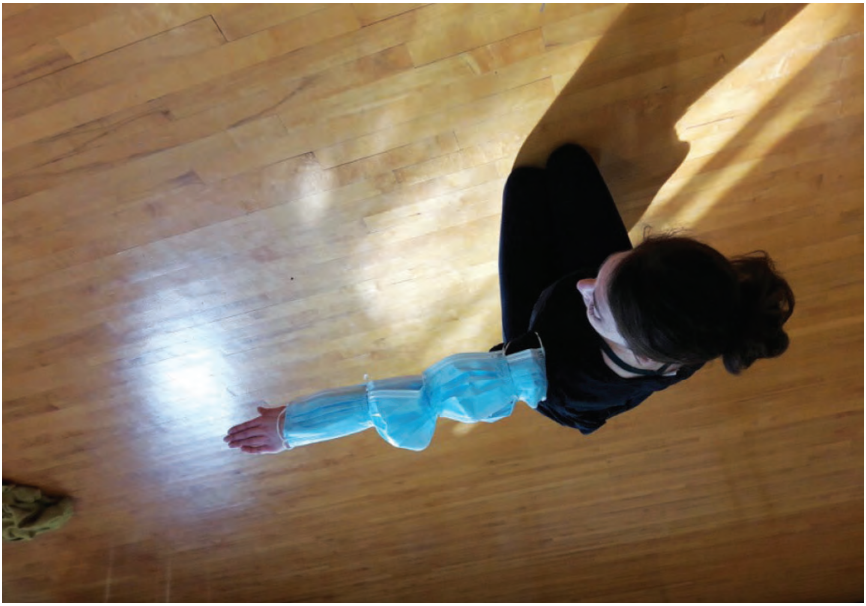
The Air we Breathe the Air we fear



The Air we Breathe, the Air we Fear is an artistic response to the Covid-19 pandemic. It weaves together choreography and poetry to comment on the embodied and sensorial experiences encountered as we transitioned from a carefree life into the spatio-temporal restrictions of the Covid-19 era that was epitomised by lock downs, masks and PPE screens. The first part of the dance celebrates breath that gives life to all things with a choreographic score that was developed using the chemical composition of air.

The first letter of elements such as Nitrogen, Oxygen, Water Vapor, Argon and Carbon Dioxide is abstracted to create a motif that underscores the vitality of breath in filling up every inch of our body, our cells, our bones, our muscles, our lungs as we run, dance and physically curve the air that surround us. This blue print is marked by a stark contrast in mood and quality as *the air we breathe* becomes *the air we fear* in the second part of the dance. The touch that used to connects us becomes a limitation in human interactions while the pathways shift to linear and confined reflecting the yellow lines in shops and supermarkets. The poetic language of Susan Wardell acts as a soundscape and a pulse to the overall piece only to be interrupted by the cacophony of Covid-19 announcements which nevertheless, adds to the audio-visual modality of the work.

Public programme

In addition to the exhibition we are pleased to invite you to take part in the hands-on art making activities in the gallery during the exhibition, plus workshop sessions for which participants will need to book. Thanks to the following people for contributions to the public programme:

Jenny Rock (Air time - community engagement)

Pam McKinlay with Alicia Halls (Insp-AIR-ation Curious Minds schools project)

Dance performance choreography by Sofia Kalogeropoulou

Vivien Dwyer, Andrea Muggeridge, Faye Nelson, Enviroschools, Orokonui Ecosanctuary and New Zealand Marine Studies Centre (additional workshops/events)

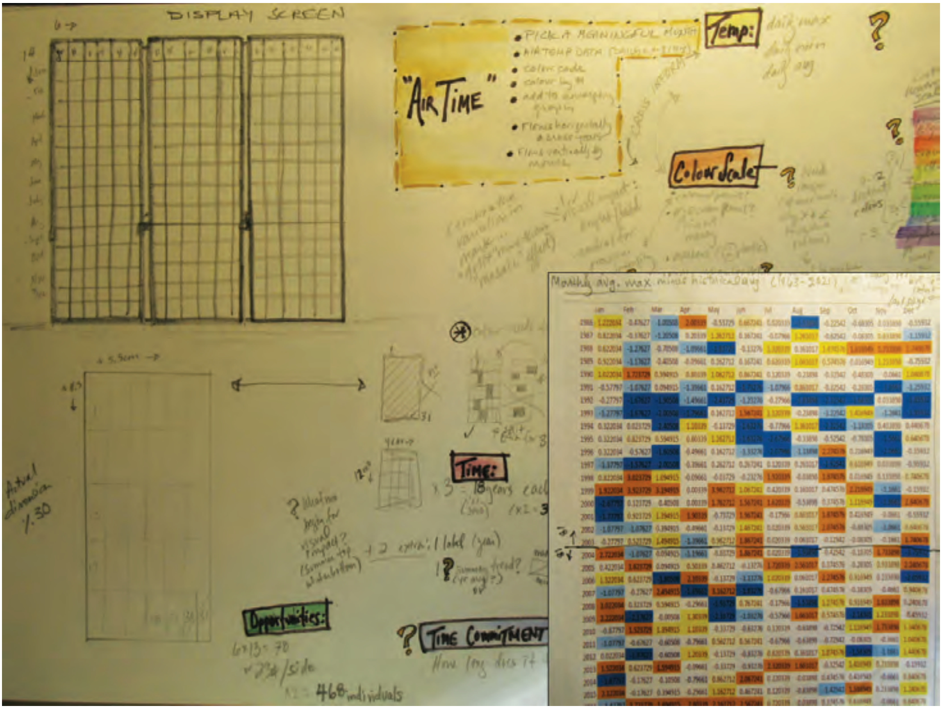
and Down the Rabbit Hole (DTRH 2022)

DTRH 2022 works came about from a series of conversations: Pam McKinlay with Grace Duke (Geology), Linn Hoffman (Botany) and Jamie Perrelet (Holistic Science UK, BC) (with assistance from Brendon Monson, William Early, Lynn Taylor for 3D modelling and printing);

Jessie-Lee Robertson (with assistance by Pam McKinlay and Ken Wyber laser cutter);

Joanna Wernham graphic and furniture design.

Air time
community engagement



Dr Jenny Rock worked with Lewis Ferris from Metservice to access and analyse Dunedin air temperature records for the last 36 years, looking at the daily temperature statistics and their deviation from preceding decades.

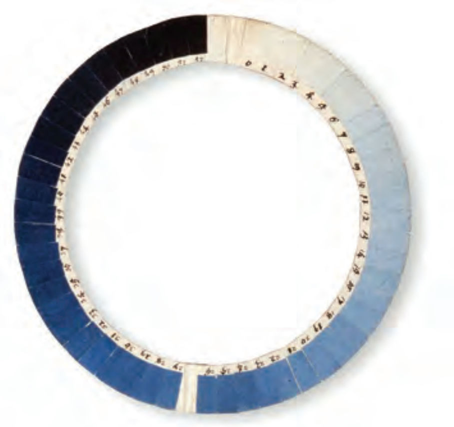
From this Jenny created a massive mosaic art graph that people could contribute to and watch grow across years. Each participant picks a month with meaning to them in the time period 1985 - 2003 and receives a wee list of daily temperatures for Dunedin during that month. People then apply a devised colour code to create a mosaic on a card to represent the air temperature variation that month. On the reverse side they then colour code the monthly average and add some personal symbolism/'graffiti' before fixing their work into the overall free-standing grid which flows from left to right across years and top to floor by months.

As people contribute their colour-coded months we should see seasonal variation in air temperature flow down, and yearly change emerge across the horizontal flow across three fold-out screens. The giant matrix will be digitised following the exhibition and animated as a time lapse.

Conceptually the mosaic will give "airtime" to local conversation about climate change, through 'real time' hands-on reflection through participants visually representing and interpreting temperature variation.

Cyanometer
a sky wheel to measure sky humidity

The cyanometer was developed by Swiss meteorologist and geologist Horace-Bénédict de Saussure in 1789. His original had 53 values of Prussian blue. The cyanometer is a simple manual tool for measuring a moisture in the air. Simply hold up to the sky and look up to select the closest value for sky blueness. The paler the sky, the more water vapor is present in the atmosphere. The blueness is due to Rayleigh scattering by nitrogen and oxygen molecules. Dry air is 78% nitrogen and 21% oxygen. Atmospheric water content ranges from 0% to 5%.



You can make your own cyanometer.

Here we share Bethan Burton's method:

On a piece of heavy watercolour paper, draw three concentric circles

Divide the circles in to segments (16). Cut around the outer circle and close to the inner circle until you have a ring

Choose a blue shade that best approximates your typical regional sky such as cobalt or Prussian blue. Start with pure pigment and add a touch of water each time for a new segment to light the colour.

Leave the final segment white.

Add the numbers under the gradient

Now you are ready to use your cyanometer to measure the blueness of the sky.

Air quality
Insp-AIR-ation

Join us for a carbon footprint workshop where we ask just "How bad are bananas?"

The Art+Air theme this year was inspired in part by a media release in 2020, by NIWA air quality scientist Ian Longley. It was a good-news story following New Zealand's first Covid-lockdown on the effect that less cars on the road had on New Zealand's Carbon emissions. This got us thinking about something we see everyday (cars) and the invisible effects (CO_2e) they have on our air quality. Since the industrial revolution, humans have caused a big change in the composition of the atmosphere and significantly increased the amount of gases in the atmosphere that trap heat – a bit like the earth wearing an extra duvet.

We got in touch with Ian and colleague Gustavo Olivares who work as atmospheric chemists for NIWA. "Air pollution is one of those things, like weather and climate, that because it affects everyone we all have an opinion about it. This makes it an ideal area for "citizen" and "traditional" scientists to collaborate and work towards improving our lives. Air pollution is not an air pollution problem, it is an energy supply problem, a transport management problem, an urban design problem ... ultimately, it is a human problem that needs answers from all aspects of human activities." (Gustavo Olivares).

A Curious Minds project was created from those conversations: Tiakina te āngi | protect our air – Schools Project, Pam McKinlay with assistance from Alicia Hall

The Insp-AIR-ation schools project was an opportunity for classrooms to take part in a citizen science and citizen art activity. A lesson plan was prepared and workshopped using NIWA education resources. The project included a citizen science car count (which converted tail pipe emissions into carbon dioxide equivalent then into the number of trees to offset the emissions produced by passing cars, see our trial school's data for an example). The aggregated car count data from the classes was then visualised in a series of fantasy trees in the exhibition.

Schools also had the opportunity to take part in a citizen art activity (a series of fabric collages 1m^2 made using upcycled textiles and other found materials, these were then collated into a larger mural). The collages depicted student aspirations and values about air.

The Insp-AIR-ation schools project was led by Pam McKinlay with funding and support in kind from Curious Minds - Participatory Science Platform, Stitch Kitchen, Orokonui Ecosanctuary, NIWA, Dunedin School of Art and Otago EV Society. Alicia Hall assisted with the final assemblage of collages.

RESULTS FROM TRIAL SCHOOL

How many trees must we plant each year to bind CO_2 each year to compensate for those cars?

Car count example:

Child A 50
Child B 50
Child C 50
Child D 49

- Average = 50 cars went through locale in 10 minutes
- How many in an hour? 300 cars in an hour

How many in a day?

Note: are there busy and quiet times

– for example the roads are quieter at night and early morning.

8 hours at 300 cars (busiest time – during day) = 2400 cars

Estimate 8 hours at 10 cars (quiet time – overnight) = 80 cars

Estimate 8 hours at 125 cars (intermediate times) = 1000 cars

- Total in a day: 3480 cars

How many in a year?

3480 x 365 = 1,270,200 cars passing through this1km stretch in a year

So, 1,270,200 x 2 = 2,540,400 km is the distance the cars passing through your local school community locale will travel in a year.

We assume 10 litres of petrol per 100km for a vehicle to travel.

So: 254,040 litres of petrol are expended in our community each year.

Each litre of fuel generates 2kg of CO_2

635,100kg of CO_2 is emitted per year

1 tree can compensate for 1 litre of fuel

We would need 254,040 trees in our area to compensate for the gases produced.

60 kg of CO_2 emitted every hour.

There are 525,600 minutes in a year therefore if we had no existing trees already in our community, we would need to plant a tree roughly every 2 minutes to absorb all the CO_2.

How can we help?

- Plant trees at school and a garden
- Make people aware of the problem
- Talk to other schools about what they are doing
- Organise vehicle trips so you do lots of jobs in one trip
- Bike or scooter to the shop
- Use the carbon footprint calculator for our house – what are other ways to reduce CO_2
- Find out where the most GHG are coming from

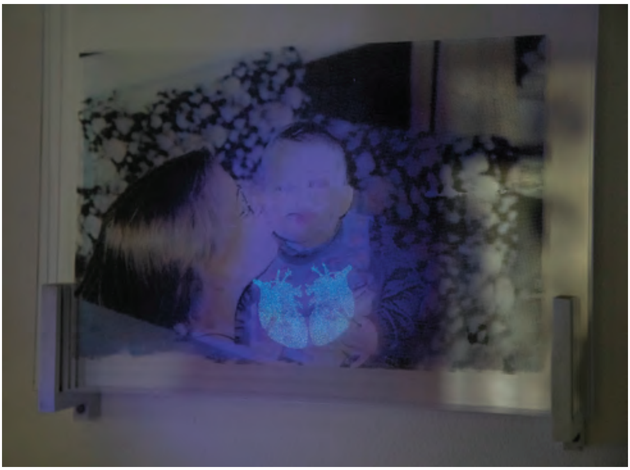
The last moa's breath

Join us for breathing workshops.

What happens when we breathe? How do other lifeforms 'breathe'? Like the sea, our breath begins somewhere else each day. Each breath is different; "the ghosts of breaths past continue to flit around you every second of every hour, confronting you with every single breath."[1] We share breath with anything and everything that ever lived … and we breathe on average 20,000 times a day. There is a thought experiment (Eurocentrically) named "Caesar's last breath" which simply asks the question, how many molecules of Caesar's last breath did we just inhale in our last breath? For the purposes of this exhibition (and a younger audience), we made the subject of our question "the last moa's breath." The experiment assumes that there is half a litre of air in each breath (it was small moa) and that the last breath is one full litre (enough to fill a balloon five inches in diameter). The last breath when exhaled is blown away and around the globe. The whole breath is dispersed but does not disappear – its molecules remain. According to calculations, each litre of air has 25 sextillion (21 noughts) molecules which is 0 … (19 noughts).1 percent of all our air. At the end of some mind-blowing calculations (spoiler alert!), one molecule of the last moa's breath will appear in our next breath and, over a day, thousands will be inhaled.

Jonathan Bretz

In making this work I wanted to use a part of the body that is hidden and somewhat ignored. I wanted to make work that was similar to an x-ray and in doing so I created an ink that is invisible until exposed to a U.V light, or left in darkness.



"I Can't Find My Way" 2021, 23 x 30 x 6cm,
Ink, House paint, Spray paint.

1. Sam Kean, *Caesar's Last Breath: The Epic Story of the Air around Us* (New York: Doubleday, 2017)

COVID-19
Public Health Response 2020

From March 26 to May 13, 2020, the New Zealand public received lockdown orders as part of our covid-19 pandemic response. We were to "stay at home" unless exercising, seeking essential supplies or medical care, or providing essential services.

Immediately noticeable was the sudden flurry of government posters in print, online and broadcast media advising us of the alert settings and what was required of us in our collective responsibilities as the "team of five million" united to keep the country safe from run-away infections and community transmission of the virus.

The 1PM daily briefing with Jacinda and Ashley became a way of life along with QR codes, scanning-in with the NZ Covid Tracer App and contact tracing.

Jaqui Herkt's pick-up woven panel was inspired by the "Scan in" Poster issued by the Ministry of Health during the 2020 Covid-19 pandemic lockdown.

"Be kind" was another poster, which encouraged us all to take collective care of each other and in particular of the more vulnerable members of our communities and those who might be struggling.

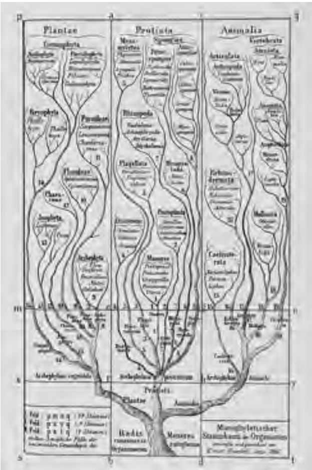
Today we are learning to live with Covid but the spirit of the "Be Kind" message of mutual aid, support and hope is still alive, that we can make the world a better and happier place through our acts of kindness.

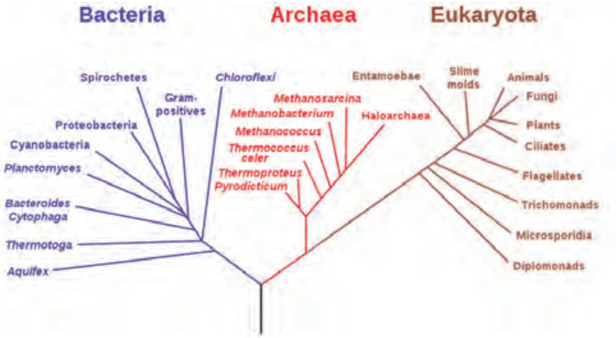
The Great Oxygenation Event

At the first meeting of the *Art+Air project* Mike Palin (Geology Department) gave a talk on the Great Oxidation Event (GOE).

From geological evidence we know that this is Earth's third and current atmosphere. The first living organisms were anaerobic and lived underwater near volcanoes, using sulphur to drive their metabolism. The Great Oxidation Event (GOE) was caused by cyanobacteria, living in shallow oceans which evolved three billion years ago to use photosynthesis to capture the sun's energy. Our atmosphere went from one low in oxygen to an atmosphere rich with oxygen. Oxygen produced as a side product caused oxidation (rusting) of iron in earth's crust. For a long time the oxygen was soaked up by iron in the shallow ocean, which later would create banded iron in rock formations. The Great Oxidation Event changed what life on Earth was like dramatically.

To illustrate the shifting iron sensitive atmospheres, Locke Unhold fired six different glazes in different kiln atmospheres. Each glaze was applied to two ceramic tubes, one tube fired in an oxygen poor (reducing) atmosphere and one tube fired in an oxygen rich atmosphere. The materials in the glazes reacted to each atmosphere differently, sometimes in subtle ways and sometimes in much more dramatic ones.





Photosynthesising cyanobacteria not only changed the geochemistry of the planet, they transformed the tree of life, enabling development opportunities for multicellular life on Earth as we know it now, including plants and animals. These were the first breaths to be taken on Earth. (image Ernst Haeckel (1834–1919). See also a modern phyolgenic tree, showing the three life domains: bacteria, archaea, and eukaryota. (images Wikimedia commons)

Jessie-Lee Robertson and Pam McKinlay artist assistant, (Down the Rabbit Hole Art Collective), made an interactive piece in response to Mike's presentation on The Great Oxygenation Event. The surface of the artwork was treated with an iron rich finish, which rusted in real time when visitors to the gallery sprayed it with sea water to accentuate surface rusting during the exhibition.

This acknowledged the relationship of GOE/iron saturation to the notion of first breath drawn by animals. Tihei Mauri Ora – Behold the breath of life. Behold the first breath. We are all connected to the environment and weave our hauora back to that very first breath taken by Hineahuone.

Diatoms

Grace Duke

For this work, Pam McKinlay met up again with diatomist Grace Duke who had just completed her doctoral thesis. Fossil diatoms have been found dating from at least the early Jurassic Period, 185 million years ago; although, there is evidence they may have lived on the Earth for much longer. The study of diatoms, both recent and fossil, in relation to their geographic distribution has become an important tool in understanding our natural environment and climatic conditions, both past and present.

Diatoms provide a lot of scientific information! During her thesis, Grace used diatoms to constrain biostratigraphic datums, environmental conditions, and primary productivity at Site U1361. The diatoms were from ocean sediments acquired off the Wilkes Land continental rise at Site U1361 during the 2010 IODP Expedition 318. The presence, abundance, and extinction of diatoms can be used to reconstruct past sea surface conditions and establish an approximate age to sediments. Grace also used the weight percent of biogenic silica in these samples to understand changes in Pliocene-Pleistocene (2-3 million years ago) primary productivity and solar insolation at Site U1361.

Diatom-based reconstruction of ocean environment warming or cooling (open water or sea ice) gives us a picture of Antarctic flow. The core samples record the response to changes in circumpolar current and the dramatic shifts in currents of the Southern Ocean. From this we can also infer the corresponding atmospheric gradients. Analysing shifts in diatom taxa can be used to predict not only the conditions but positions of the Polar Front and other circulation features in the past and as a tool for climate modellers of future conditions.

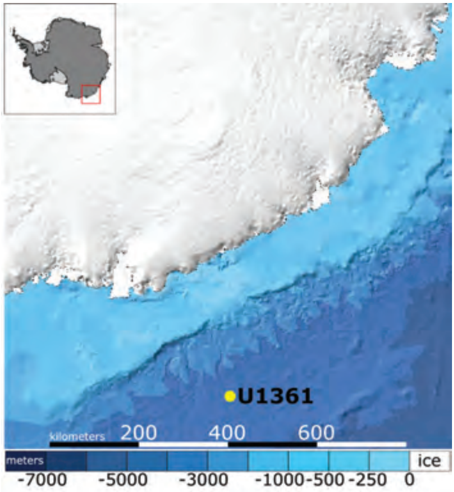
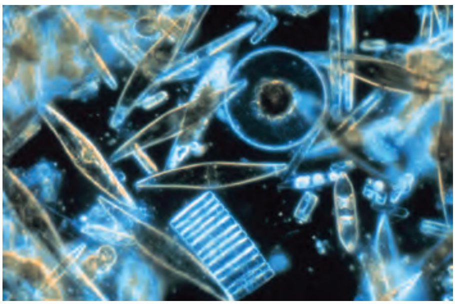


Image credit: Base map showing the location of Site U1361, International Bathymetric Chart of the Southern Ocean (IBCSO)



Antarctic diatoms through the microscope. (photo by National Oceanic and Atmospheric Administration)

There's a crack in my ocean – Pam McKinlay

Great care was taken with rolling and slab building a gigantic bowl to represent a body of water – an ocean, followed by two months of drying to ensure it was at peak dryness before biscing. However the atmospheric gradient at firing was extreme and my ocean suffered a dramatic fracture. Conditions and positions were key to this kiln result. Instead of the top of the large gas kiln where the pot would experience ambient kiln temperatures, it was inadvertently placed in at the bottom and experienced extreme heat conditions from firey fossil fuelled heat jets. It cracked in a dramatic and unusual fashion due to severe thermal shock.

Why am I telling you this long story? Everyone in the ceramics studio was terribly upset for me that my bowl had cracked and consoled me that I still had time to make a new one. However I decided to use what the kiln had given me. I didn't throw the fractured pot away, but I applied a Japanese repair technique Kintsugi (金継ぎ, "golden joinery"). The name of the technique is derived from the words "Kin" (golden) and "tsugi" (joinery), which translate to mean "golden repair." The scars and cracks of the broken ceramic became the focus and turned the object into something unique and exquisite. In terms of the climate change story it had taken on a new meaning. We can't throw away our ocean which we have damaged, we must fix it. It will never be as pristine as it once was, after any interventions, but we must do it, we must remember where we have been and value the results even as the scars of those interventions linger. If anything the repair reminds me now of the distress that our oceans are in and the lengths we must go to, to repair the damage.

(Top) fired pot,
(Bottom) final Kintsugi piece;
repaired with kneadable expoxy resin, mortar, sand and golden sand collected south of Ōtepoti.
The bowl was filled with saline water, 3D models and Perspex-glass navicular shaped slips of the poem, *3D modelled diatoms*, modelling and printing by Brendon Monson (image work in progress)

Purple skies

Sunrises and sunsets reveal the dramatic and picturesque effects of volcanic aerosols in the stratosphere (at around 20-25km) above New Zealand).

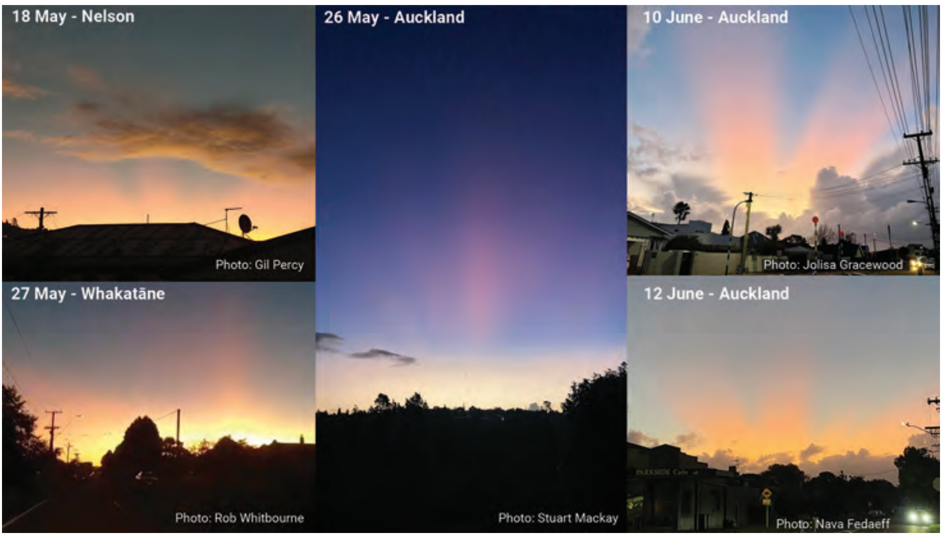
The aerosols causing this unusual phenomenon originate from the plume of gas and ash that was ejected when the Hunga Tonga-Hunga Ha'apai (HT-HH) volcano erupted in January. They have been dispersing around the globe, with concentrations spiking in the New Zealand region since mid-May.

The effects of glowing purple and violet are most pronounced just before or just after the sun crosses the horizon.

"Since the colours achieve their greatest intensity after the sun has set or before it rises," Nava Fedaeff NIWA weather forecaster says. "volcanic twilights are known as "afterglows." The colour and intensity of the afterglow is affected by the amount of haze and cloudiness along the path of light reaching the stratosphere."

Photograph of purple sunset by Lana Young.

Photograph of Dunedin over St Clair by Stephen Jaquiery, image used with permission© Otago Daily Times.



Composite image by Nava Fedaeff, NIWA.

Photosynthesis

Join us for a session of “Meet a tree” with enviroschools facilitator Jennie Upton.

Join us for Seaweed Sunday to do a seaweed identification workshop, with the NZ Marine Science Centre

Find out how to make a pōho (bull-kelp bag)

Anne-Marie Davis, Landing, 2022.

Chlorophylia — a human’s love for or attraction to trees and plants — characterises Anne-Marie Davis’ suite of photographic works at the Dunedin Botanic Garden Visitors’ Centre. Describing her works as “light drawings,” Davis pays particular attention to the analogy of creating with light: plants via photosynthesis and humans through photographic technology. As the title, “Photosynthesis: Drawing with Light” suggests, Davis’ chlorophylia revels in the ability of plants to absorb sunlight (and rain and nutrients from the earth) in order to grow.

Davis’ time spent with plants and trees is evident in the four seasons captured, which provide the conceptual and formal foundation for four photographic works composed of four images arranged by a horizontal grid. Titled *Pink Hue, Green Hue, Yellow Hue*, and *Silver Hue*, these four works document spring, summer, autumn, and winter respectively. In addition to capturing the beauty of each season, Davis’ titles for the four works that comprise each of the *Hue* series demonstrate her botanical knowledge of plant processes. *Transpiration, Solar radiation, Osmosis*, and *Stomata* correspond to *Yellow Hue*, or autumn. Among the scientific terminology, Davis also uses onomatopoeic words such as *Pit-pat* (*Silver Hue*) and attributes such as *Sustenance* (*Pink Hue*).

From review by ROBYN MAREE PICKENS first published in the Otago Daily Times, Thursday, 10 February 2022.

CO_2 *Sensor*

Pam McKinlay and Henry Greenslade

In rooms, CO_2 concentrations naturally fluctuate over the day depending on occupancy numbers, activities and time of year. In its Designing Quality Learning Spaces Report, the Ministry of Education outlines requirements for indoor air quality and thermal comfort:

> Indoor air quality and thermal comfort have a direct impact on the usability of the space and on learning outcomes. … Indoor air quality is dependent on the concentrations of CO_2 and other respiration derived pollutants, volatile organic compounds (VOC), particulate matter and other pollutants such as formaldehyde … Occupied learning spaces are expected to have adequate ventilation and to provide a minimum indoor air quality range of 1000-1500 ppm CO_2 (or less) over the course of the school day [and] indoor air temperatures within occupied learning spaces are expected to be within a range of 18˚C to 25˚C for the majority of the year.

CO_2 is recognised as a useful proxy for outdoor and indoor airborne pollutants. Indoors, it also serves as a proxy for airborne respiratory pathogens which would otherwise be invisible. This has become more topical in a Covid-19 world. Our aim to create a visual indicator that would alert room occupants to their internal air quality and encourage them to take responsibility for increasing ventilation and air movement, was successful.

Too hot to handle at 2^0 warming

Join us for a workshop to make crochet models of Emiliania huxleyi, with Vivien Dwyer and Andrea Muggeridge.

Join us for a workshop to make origami coccolithophores with Finn McKinlay.

> "Calcifying marine phytoplankton— coccolithophores— are some of the most successful yet enigmatic organisms in the ocean and are at risk from global change."[1]

In 2018, a species of plankton, *Syracosphaera azureaplaneta*, was named after the television series Blue Planet and its world-renowned narrator Sir David Attenborough, who stated, "If you said that plankton, the phytoplankton, the green oxygen-producing plankton in the oceans is more important to our atmosphere than the whole of the rainforest, which I think is true, people would be astonished."

For "Too Hot to Handle," Pam McKinlay talked to scientist Linn Hoffmann (Botany) about the importance of photosynthesising phytoplankton and effects of elevated carbon dioxide levels on coccosphere form and function which was explored in a science communication piece.

What are function of the coccoliths?

Monteiro et al.[3] discuss the different theories about why coccolithophores calcify from an armour like structure that inhibits grazers and protects from viral penetration, to curvatures that accentuate energy flow. Number K and L on plate 1 show the species *Florisphaera profunda*. This is a species where the shape of the coccolithore might work like little mirrors to direct or funnel the photons to the cell for photosynthesis. Alternatively the shape of the liths might act as a shade like a sun umbrella to scatter light away at times of solar intensity to protect the cell from sun damage.

Coccolithophores need the right trace metals in the right concentrations to make these beautiful scales and if they have too little or too much of certain metals, something goes wrong. Deformation of liths is similar to what ocean acidification does.

Trace metal concentrations in the ocean affect

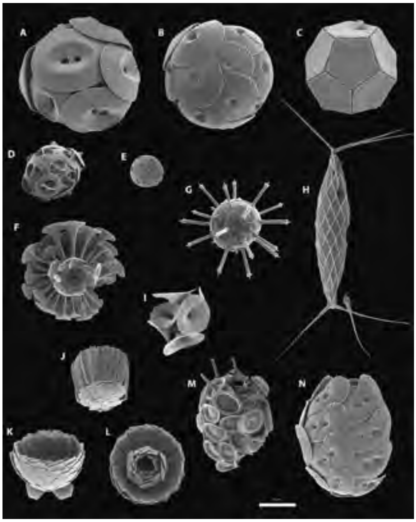


Plate 1. Diversity of coccolithophores. *Emiliania huxleyi*, the reference species for coccolithophore studies, is contrasted with a range of other species spanning the biodiversity of modern coccolithophores. All images are scanning electron micrographs of cells collected by seawater filtration from the open ocean.[2]

Image credit Giulia Faucher, "Impact of trace metal concentrations on coccolithophore growth and morphology: laboratory simulations of Cretaceous stress," Biogeosciences, 14, 3603–3613, 2017. Creative Commons Attribution 3.0 License.

Pam McKinlay,
Too Hot to Handle, photo (left);
Emiliania huxleyi work in progress,
3D model by James Perrelet,[5]
printing by William Early.

coccolithophore growth and morphology. A study by Faucher (2017)[4] found that adding trace metals in concentrations similar to those present during Cretaceous times cause the cells to produce smaller coccoliths (dwarfism) which is something that has been found in sediment cores samples from that time as well. In an ongoing project Antarctic seawater that has very low trace metals concentrations, also causes many coccoliths to be malformed.

Coccolithophore species are adapted to different ecological niches. *Emiliania huxleyi* is one of the smallest coccolithophore species and is omnipresent in all oceans except polar oceans. Because it can be successfully grown in the lab, *Emiliania huxleyi* has become the "lab rat" of coccolithophore laboratory studies. Scientists have found that when *Emiliania* grows with the addition of volcanic ash, fewer cells produce malformed coccoliths with the assumption that they need certain metals that were limited in the seawater and that they are made available from the volcanic ash.

Recently Linn Hoffmann was part of a research group that visited Tongan waters after the eruption of Hunga Tonga–Hunga Ha'apai, a submarine volcano in the Tongan archipelago in the southern Pacific Ocean. The eruption in Tonga raises many questions about how it will affect phytoplankton growth. However, the eruption in Tonga might have caused different effects, as every ash has a unique trace metal composition.

Looped video: time lapse imaging of coccolithophore *Coccolithus pelagicus* producing the calcium.[6]

1. Monteiro et al, "Why marine phytoplankton calcify," *Marine Biology*, 2016, DOI: 10.1126/sciadv.1501822
2. Monteiro et al.
3. Monteiro et al.
4. Giulia Faucher,"Impact of trace metal concentrations on coccolithophore growth and morphology: laboratory simulations of Cretaceous stress," *Biogeosciences*, 14, 3603–3613, 2017. Creative Commons Attribution 3.0 License.
5. DTRH 2022 works came about from a series of conversations: Pam McKinlay with Grace Duke (Geology) and Linn Hoffman (Botany) and Jamie Perrelet (Holistic Science UK, BC) 3D printing file "3D Printing the Long Term Carbon Cycle", https://www.fractalteapot.com/portfolio/3d-printing-carbon-cycle/ with assistance from William Early, Lynn Taylor (Sandpit Collective) for 3D modelling and printing.
6. Alison Taylor et al 2007 European Journal pf Phycology, https://doi.org/10.1080/09670260601159346

Triboluminescence

Lifesaver luminescence (excited nitrogen)

What do auroras and Wint-o-green Lifesavers have in common? They both emit cold light (luminesce) and the colours of their luminescence come from excited gases in the atmosphere.

Auroras are radioluminescent, with the green colour (557 nm on the visible light spectrum) produced by excited oxygen (see Excited Oxygen in this exhibition).

Snap a Wint-o-green Lifesaver with your teeth in a dark room and you will (hopefully) see something called triboluminescence, created by fracturing sugar crystals in the candy. The fracturing crystals produce a miniature lightning bolt because oppositely charged electrons on either side excite (energise) nitrogen molecules in the air (just like real lightning). The blue green colour (400-500 nm on the visible light spectrum) is enhanced by the methyl salicylate (wintergreen oil) flavouring, which absorbs most of the invisible ultraviolet energy.

Nitrogen is the most plentiful element in Earth's atmosphere and part of all living things---a life saver indeed.

Read more here: Sweeting, L. (1990, October). *Light your candy*. Chem Matters, 10-12.

1. https://www.instagram.com/reel/CSHbCrch9ss/?utm_source=ig_web_copy_link

Simone Montgomery

Guest Artist

Worker: One Nine Eight Four Manifesto

Worker 1984 is green, is embracing climate change, producing food, cleaning the air and evolving to be a self-sufficient human momentum machine.

There is a fundamental transformation in the future of work. Automation is replacing human tasks, but what will the future look like?

The Fourth Industrial Revolution is expected to transform more than 1 billion jobs – almost one-third of all jobs worldwide – in the next decade.

That coupled with global warming, food security and pandemic readiness, paints an interesting picture for employees. The complicated supply chains of globalised industry mean that a disruption in one place can cause consequences elsewhere. As well as affecting the availability of clean water and food, extreme weather is increasing the vulnerability of areas already at risk.

Future work will be characterised by a strong social conscience, a sense of environmental responsibility, a focus on diversity, and human rights. This is a world where workers seek out greater meaning and relevance in what they do.

Reflecting the values of the employer, both at work and at home through via the Social Credit system will be crucial.

Travel will be controlled and there will be incentives for efficient use of resources and creating greener societies.

Simone Montgomery's garment *Worker 1984* won the Hokonui Heritage Precinct Avant Garde Award 2022. Images photo credit Still Vision Photography.

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Many of the artworks in the exhibition are available for sale. Please contact the artists directly regarding their work.

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