ANNA KLUIBENSCHEDL AND NADJEJDA ESPINEL VELASCO

# What do you foresee?

Public awareness of many climate change-related issues is rising globally, as well as in New Zealand.[1] However, ocean acidification (OA) seems to be one of the least perceived and understood threats to the marine environment.[2]

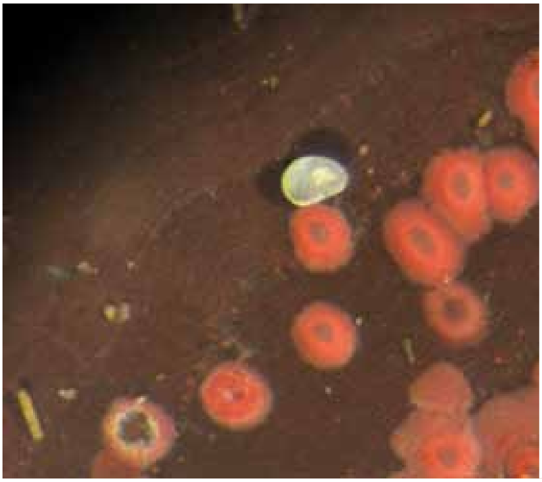
Increasing levels of atmospheric carbon dioxide are taken up by the global oceans, causing changes in the water chemistry, a process known as ocean acidification. An estimated 2.6 billion tons of carbon dioxide are absorbed by the ocean every year.[3] While the water is not quite literally turning into acid, the water pH shifts to a less alkaline state (or 'more acidic').

It has been estimated that the global average surface seawater pH has dropped by 0.1 units since the beginning of the Industrial Revolution; taking into consideration the fact that pH is measured on a logarithmic scale, this shift translates into a 30 percent increase in acidity. New Zealand marine ecosystems are already experiencing OA-related stress and it is expected that they will continue to do so in the near future.[4]

The chemical changes in the water come at a cost for many marine organisms and may have severe impacts on key physiological processes such as growth, shell formation, reproductive capabilities, competitive fitness and photosynthesis. Furthermore, lowered pH may lead to shell dissolution in shell-building organisms.[5]

One organism that has been identified as most vulnerable to OA is a group of calcifying algae called coralline algae.[6] Coralline algae belong to an evolutionary old group of algae, the red algae or Rhodophyta (ῥόδον /*rhodon*, 'rose,' and φυτόν /*phyton*, 'plant'). As the name suggests, they come in all shades of red, from dark red or purple to bright pink (Figure 1). The colour arises from the photosynthetic pigment Phycoerythrin.[7] Unlike other algae within the Rhodophytes, they form a solid carbonate structure. Some coralline algae grow as tufts and have thin jointed branches that sway with the currents (geniculate coralline algae), while others grow as thick pink crusts (crustose coralline algae[8]).

Coralline algae thrive globally in almost all coastal habitats where there is sufficient light and hard substrate to attach. Their distribution ranges from the cold polar waters to the tropics, and they can



Figures 1-2. A pāua larvae settling on a coralline algae. Image: Anna Kluibenschedl.
Subtidal coralline algae assemblage. Image: Peri Subitzky.

be found from the harsh intertidal down to the deep subtidal zones. The deepest ever discovered macroscopic plant life was a coralline alga found at a staggering 210m deep[9].

While mostly overlooked or even considered a nuisance among aquarium keepers – as they grow rather fast on the walls of the tanks – they nevertheless fulfil a multitude of ecological functions. New Zealand has a particularly rich diversity of coralline algae and they can extensively cover hard substratum (Figure 2). Coralline algae are ecosystem engineers and consolidate the reef structure, provide habitat and protection and constitute a food source; they have an intricate relationship with invertebrate larval settlement[10].

The New Zealand abalone is among those invertebrate larvae that depend directly on the presence of crustose coralline algae. Commonly known as pāua, it is a key coastal species, given its huge economical, ecological and cultural importance.

Pāua reproduce through an indirect cycle, which is characterised by the presence of free-swimming larvae that metamorphose into juveniles after settling on their preferred substrate. Pāua larvae use a signal given by the crustose coralline algae as a cue to settle and metamorphose into juveniles. Once metamorphosed, the juveniles will use the crustose coralline algae as a source of food. Besides pāua, many other organisms rely on crustose coralline algae as a preferred settlement substrate for their larvae and as a source of food for juveniles.

OA-induced changes in settlement substrates such as species composition or distribution could cause changes in settlement rates of pāua – as well as other invertebrate – larvae. Altered settlement rates could alter the abundances, distributions and ecology of future marine communities. Aquaculture services that rely on a continuous supply of (pāua) adults might be negatively influenced as well.

Figure 3. Kaikoura coastline one year after the 2016 earthquake. The newly exposed coastline is extensively covered in bleached coralline algae. Image: Anna Kluibenschedl.

**Anna Kluibenschedl** and **Nadjejda Espinel Velasco** are PhD candidates in Marine Science, University of Otago. Nadjejda studies the effects of ocean acidification on settlement of NZ invertebrates. Anna works on crustose coralline algae - calcifying algae that facilitate settlement of larvae and connect their planktonic and benthic life cycles.

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MEG VAN HALE AND LUCY WINTON

# What do you foresee?

Fundamentally, art is about communication. It is an innovative and varied platform to connect with an audience and share information. The goal of this project is to showcase the largely unknown issue of ocean acidification and how it could affect future New Zealand ocean life. Scientists Anna Kluibenschedl and Nadjejda Velasco's research shows how one environmental change can affect an extended ecological chain. Our work makes this change visible, focusing on the connection between coralline algae and the survival of pāua.

The collaboration and crossover of our scientific and artistic approaches has been the foundation of the work. Meg has already extensively explored human perceptions of climate change through her jewellery practice. She is interested in anthropocentrism and how this ethos has created a divide between Man and Nature, an issue that sits at the heart of climate change. Her work aims to disparage this attitude and to call for a new system of values, often using the aspect of 'preciousness' within jewellery to highlight overlooked beauty within the natural world.

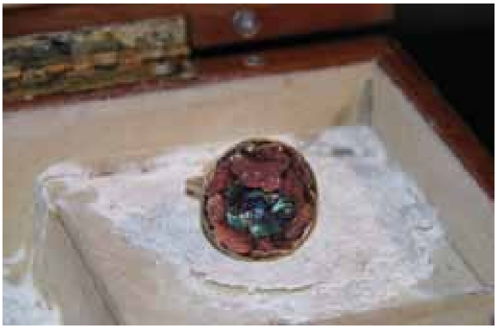
Lucy's work questions the imbalanced relationship between humanity and the natural world. She uses sculpture as a place of interaction, where our relationship to animals and the environment can be reimagined as intertwined rather than separate. Anna and Nadjejda's separate studies have overlapped to form the basis of their research, and it was important to us that this collaborative approach was manifested through our combined fields of art making. The resulting work, *What Do You Foresee?*, is an interactive unification of sculptural installation and wearable jewellery pieces. Each part considers a changing ocean, and the human values that change with it.

The work consists of three jewellery or treasure boxes, each representing a different potential stage of ocean acidification. The whimsical idea of deep-sea treasure pulled from the depths draws the viewer in to explore each box, with the element of discovery adding excitement and curiosity. The first box, covered in a healthy growth of bright crustose coralline algae, is filled with an abundance of pāua jewellery. The most sensitive time for pāua is at the larval stage, in which they settle and grow on coralline algae. The invertebrate can take up to ten years to mature, growing the distinct blue-green shimmering shell seen in every souvenir shop. Pāua shell has the status of a prized national icon, and in Māori culture is considered taonga, while simultaneously being consumed as mass-produced kitsch jewellery and ashtrays. It is this lack of value placed on common species that makes them vulnerable.






In the second box, the pink crusty growth has been replaced with brown algae, which might be more competitive in the future. Pāua larvae settles on crustose coralline algae, so an ocean without these building blocks is tougher to survive in. A once common species could become endangered. The box contains one precious object as a warning to protect what we currently take for granted: a pair of glasses with rotating disc-like 'lenses.' One side is pāua and, when turned, the other side shows a cluster of pink coralline algae, representing the two species' reliance on each other. The wearer struggles to see something when it is so close to their face, reminiscent of the adage, "I can't see the forest for the trees." The glasses reflect our struggle to understand complex ecological relationships in what feels like a race against an exponentially growing problem.



Inspiration to make a pair of glasses came from the desire to immerse the wearer. Immersion need not involve the wearer's full body. By covering their eyes, they are given a sense of total immersion. This idea stems from a quote by founder of Parley for the Oceans, Cyrill Gutsch – "We want to people to get their heads underwater" – urging us to *think* more about the ocean, experience the ocean, and consider invisible issues like OA. Further inspiration for the glasses comes from traditional Māori carving. Pāua shell is used on eyes to represent the eyes of our ancestors looking down from the night sky. In terms of climate change and ocean acidification, we are the eyes looking forward for future generations.

The final box presents a bleak picture of an apocalyptic ocean. The few things that have grown on it are bleached and dead. With even coralline algae now a rare and treasured species, it has been carefully preserved in a solitary ring along with a cluster of pāua shell, placed inside the desolate box. In this box, seemingly too late, we see pāua and algae side by side. The use of pāua again references eyes, and the algae is clustered womb-like around it. When worn on the hand, held up to be gazed at, the ring gazes back.

**Meg Van Hale** and **Lucy Winton** are graduates of the Dunedin School of Art.

Photographs: Pam McKinlay.