Surfing bacteria reveal new insights into the ocean's health

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Credit: Macquarie University

Australian scientists have recorded more than 175,000 tiny microbes dwelling in our ocean waters for the first time, providing an unprecedented baseline against which to measure the effects of climate

change and human activities.

Microbe fact file

- Microbes were the first life on earth and formed almost 3 billion years ago
- They account for up to 98 per cent of the ocean's biomass
- They produce 50 per cent of the world's oxygen
- Microbes create clouds by generating gases that interact with the atmosphere
- They sequester carbon by sinking to the ocean floor, trapping carbon in the sediment

Invisible to the naked eye, microbes constitute almost 98 per cent of the ocean's biomass and are responsible for keeping the marine ecosystem healthy.

A paper recently published in *Scientific Data*, led by University of Newcastle's Dr. Mark Brown and Macquarie University's Dr. Martin Ostrowski, reveals the vast diversity of microbes and provides new knowledge about their environmental behaviour.

The unparalleled dataset is the result of an ongoing collaborative initiative involving 18 Australian universities, Commonwealth agencies and research institutes, which recorded more than 175,000 unique species of microbes at seven sites around Australia's coastline and into the Southern Ocean.

What are microbes?

Measuring less than five microns, which is smaller than dustmite excreta, millions of these tiny organisms are found in every litre of seawater and include cellular life forms such as phytoplankton (algae) and bacteria.

Dr. Brown said microbes in the ocean are possibly the most important organisms for maintaining our world as a healthy, inhabitable planet. "Similar to the links between human health and the human microbiome, ocean health is largely controlled by its microbial inhabitants. Forming the foundation of the entire ecosystem, microbes provide food for all other marine life and produce half the oxygen we breathe.

"In this regard, they function in a similar way to organs in a human body. Some microbes act as the lungs of the ocean responsible for gathering and distributing oxygen to the planet, while others act as the gut or liver to detoxify impurities within the water and control the flow of nutrients."

Diving beneath the surface

Scientists developed the project in 2012 to address a lack of data surrounding marine microbial communities and their changes over time.

"We were extremely concerned that no baseline existed to compare microbial activity against. Prior to this project, there was no information detailing what the microbes were like around Australia, which made it difficult to know how they might have changed over seasons or years," Dr. Brown said.

Employing filtration methods similar to those used to purify drinking water, scientists collected microbe samples each month at multiple depths, ranging from surface water down to 100 metres.

"Different microbes live in different parts of the ocean and they have evolved to occupy every conceivable niche. Different species can be found living on deep-sea hydrothermal vents, in sediments, at varying depths and in warm or cold water," Dr. Brown said.

The material extracted from the filters was then genetically sequenced using technology only available in the last few years, which provided a snapshot of the DNA blueprint of the microbial inhabitants within each sample. Forming an enormous genetic database, this first data release tracks over 200 million records of more than 175,000 unique species of microbes.

Nature's indicators

Acting as the ocean's sentinels of change, microbes respond rapidly to their environment and a slight change in conditions can dramatically reshape the community structure.

"The organisms we identified are widespread and their presence and abundance is closely linked to their environment. We found that the microbial assemblages display seasonal cycles, changing with the progression of summer, autumn, winter and spring, returning to the original assemblage again in summer," Dr. Brown explained.

"We have now set baselines for seasonal cycles against which we can identify the impact of climate change," he added.

Co-author, Dr. Martin Ostrowski from Macquarie University, said the project team is now building models to predict where organisms will live in the future and what functions they will carry out.

"We can now use the baseline data we have collected to make models that tell us how microbes respond to different environmental conditions and how we expect them to change given future climate projections.

"The primary production and carbon use by marine microbes determines how much food is provided to the rest of the food chain, so our forecasts will be incredibly relevant to scientists but also to industries such as

fisheries and tourism."

Going with the flow

The project was funded by the Australian Research Council (ARC), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the National Collaborative Research Infrastructure Strategy (NCRIS) via Bioplatforms Australia (Bioplatforms) and the Integrated Marine Observing System (IMOS).

Monthly samples were taken from seven marine National Reference Stations operated by IMOS, including Darwin Harbour, the Yongala wreck inside the Great Barrier Reef Lagoon, North Stradbroke Island off Brisbane, Port Hacking off Sydney, Maria Island off Tasmania, Kangaroo Island off Adelaide and Rottnest Island off Perth.

The project will continue in collaboration with IMOS and Bioplatforms Australia for another three years.

Senior author, Dr. Lev Bodrossy of CSIRO Oceans and Atmosphere, said the project will continue to provide new knowledge that will contribute to the field of marine science in Australia and beyond.

"The value of an observing network increases exponentially with time, so it is now crucial we maintain our sampling and expand our observations into the future." The DNA sequence data is available to the public and can be accessed via the Bioplatforms Australia website.

More information: Mark V. Brown et al. Systematic, continental scale temporal monitoring of marine pelagic microbiota by the Australian Marine Microbial Biodiversity Initiative, *Scientific Data* (2018). DOI: 10.1038/sdata.2018.130

Provided by Macquarie University