JOHN RUNCIE

Shedding light on seaweed

The OctoPAM can measure the photosynthetic rate of macroalgae on the seabed 24 hours a day, using eight pulse amplitude modulated measuring lights. The instrument will help determine whether the absence of macroalgae near the old Casey waste disposal tip is due to contamination or natural environmental conditions.

Supporting scientists in Antarctica requires enormous effort. The activities of many staff at Kingston, the logistics of shipping people across the Southern Ocean and the facilities at our stations, are all necessary to enable scientists to gather information that addresses the important questions of Antarctic science. Thus, anything that increases the ability of scientists to gather data ultimately increases the efficiency of the entire programme. This is particularly true of research that relies on diving under the Antarctic sea ice, as it requires a minimum of five people on site to get a single scientist underwater. The multichannel-PAM (pulse amplitude modulated) fluorometer, a new and innovative piece of scientific equipment developed at the AAD, has been outstandingly successful in increasing our ability to capture data.

The PAM technique is well established in plant science and there are a number of commercial PAM instruments available. However, the new multichannel-PAM is designed to do much more than any off-the-shelf instrument. The PAM technique enables us to measure photosynthetic rates of macroalgae (seaweeds) in their natural environment underwater. It stimulates chlorophyll with a pulse amplitude modulated measuring light and measures how much light is re-emitted as fluorescence. We planned to use the technique to understand why macroalgae do not grow near the old Casey waste disposal tip that drains into Brown Bay and specifically, whether their absence is caused by contamination leaching from the tip, or by other natural environmental conditions.

To maximise the value of every minute underwater, Dr John Runcie conceived of a PAM that could measure eight independent samples simultaneously and could be left on the seabed to run continually for 24 hours, without a diver in attendance. The ability to measure eight samples is important because we need to know how much natural variation there is from one plant to another. The ability to operate around the clock is also important for understanding processes, such as photosynthesis, that vary as light levels change during the course of the day. If this could be achieved we could increase the amount of data from a single dive by nearly 200 times.

The concept became a reality with the help of the talented people in the workshops and design offices of the AAD, and the electronics company Second Harmonic. The prototype, christened 'the OctoPAM', was first deployed in the 2001–02 season at Casey and, after some deft tinkering in the field, was a great success. The ability to measure up to eight samples simultaneously enabled us to confirm that the photosynthetic efficiency of algae under the sea ice declined significantly at midday, even though the maximum irradiance reached only 0.5% of the irradiance on land. This unexpected finding supports the idea that Antarctic algae are well adapted to the low light levels found in sea ice-dominated environments, and take advantage of all the light available as insurance against the possibility that the sea ice might not break up in summer.

The OctoPAM is helping us understand the environmental effects of contaminants from the Thala Valley tip and it may allow us to make predictions about the effects of modified sea ice conditions (created by global climate change) on Antarctic seabed communities.

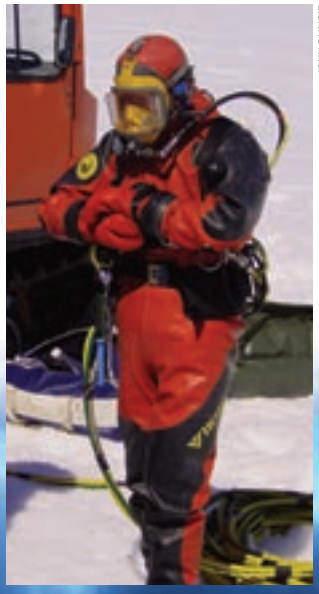
We are now developing the next generation of multi-channel fluorometers, working on a modular basis where sensor heads and logging units are interchangeable. We have increased the amount of replicates from eight to 12 (naturally it is called the DodecaPAM) and are developing a PAM that, on command, can acclimatise a plant to dark conditions before operating. This will enable more sophisticated measurements of the ability of macroalgae to recover from high light stress. It will be used to test the theory that contaminants from the Thala Valley tip reduce the tolerance of seaweeds to high intensity light.

There are few harsher environments on earth for deploying sophisticated electronic equipment than the Antarctic sea. The unique combination of skills and experience of the AAD workshop staff and the engineering consultants they work with, make it possible for scientists to dream up complex experiments to address the important questions of Antarctic science; and for these to be realised.

—MARTIN RIDDLE and JOHN RUNCIE
Impact of Human Activities in Antarctica Programme, AAD

At least five people are required to support divers under the Antarctic sea ice. Here programme leader Martin Riddle prepares to deploy an OctoPAM to maximise the amount of data that can be gathered during the short research season.

Antarctic macroalgae are well adapted to the low light levels under the sea ice.



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