Date: Wed, Jan 20, 2010 at 8:22 PM

Subject: Scholes Cabin 5 (P): The iron fish

Dear Stirling,

You have heard me moan about the 'iron fish' which has come close to disaster on many occasions. We are towing it alongside again, and once again had to rescue it from stray ice-floes when we unexpectedly entered a patch of pack-ice. What is it for?

There is evidence that the phytoplankton productivity of the Southern Ocean is limited by iron. 'Limited' is a physiological term, which basically means that iron is the factor in shortest supply, and if you added a bit, productivity would respond by a proportionate amount. Iron is an essential element for all plants, but is only needed in tiny amounts - a few parts per billion. The seawater around us in the Southern Ocean generally has enough nitrogen and phosphorus, the nutrients that usually cause limitation in ecosystems. But it has lower productivity than you would expect from such apparently nutrient-rich water - this is the paradox of High Nutrient Low Productivity (HNLP) waters, which dominate in the Southern Oceans.

The places in the Southern Ocean that have high productivity provide some clues. The whales, seabirds and fishermen found these places long ago, but now we can map them accurately using satellite images of ocean colour. They are mostly 'down-stream' of islands - for instance, east of South Georgia, where we are heading now. What do the islands provide? After a process of elimination, it turned out that iron and silica are two of the key micronutrients that are plentiful in rocks and soils, but scarce in the surface waters of the ocean. Yes, I know there are rocks under the ocean floor too, but that is many kilometres down from where the sunlight is, and in between is the barrier formed by the thermocline.

Some experiments growing phytoplankton in the lab soon confirmed that iron and silica were often the missing element. It took a while to find out about the silica, because laboratory experiments are usually carried out in glass flasks, which supply enough silica to confuse the results! A similar problem occurs with measuring iron, when you sample the water from an iron ship with iron pipes. So we needed to have a way to collect seawater without touching the ship - which is harder than you would think. Perhaps you could invent something?

Our solution is what we call the 'iron fish'. It is, in fact, a solid steel torpedo, about 1 m long, painted white. It dangles on a rope from a boom which we swing out about 5 m from the starboard of the ship, and when we winch it down into the water, swims happily about 2 m below the surface. Fitted into the nose of the 'fish' is a funnel made of a special non-contaminating plastic called Teflon, and that connects to a plastic pipe

which runs back to the ship. We pump seawater through this system before it has a chance to be contaminated by either the ship or the fish itself.

Some people think that the Southern Ocean should be fertilised with iron to help it suck up carbon dioxide. Other people think that idea stinks, because it would give an excuse not to tackle the problem at its source: reducing the emissions. Actually, it is not at all clear that iron fertilisation of a big part of the ocean would lead to carbon uptake lasting more than a few days. For the extra uptake to be semi-permanent, the carbon would need to sink out of the upper ocean to the ocean floor. Only big organisms and zooplankton pooh gets that right. More experiments are needed before the fertilisation option can be either ruled in or ruled out. Some people feel that even doing the experiment sends the wrong signal. But blocking research usually turns out to be a bad move. It is better to know, one way or another.

Sorry to hear you and Mom have been sick.

Love,

Dad.

PS I am really proud of you doing rowing and pipe band. I hope you manage to keep the tennis up somehow!