LICENSED FOR KRILL

When So Kawaguchi is not skiing the piste in Japan, you might find him conducting scientific experiments on an icebreaker in the middle of the Southern Ocean, tending krill in the Australian Antarctic Division's krill aquarium, or crunching fisheries data on his computer.

The multi-talented krill biologist, and qualified ski instructor, began work with the Antarctic Division five years ago, after leaving his fisheries research job with the Japanese Government in Tokyo. His reason? 'This is the best place in the world to study krill, and the krill aquarium is the world's best facility to do krill research,' he says.

Krill research at the Australian Antarctic Division began when Japanese scientist, Tom Ikeda, joined the organisation in 1982. During his five-year tenure, Dr Ikeda undertook pioneering work to show that krill live for 7-11 years, rather than 3-4 years, which was the conventional wisdom at the time. This finding had major ramifications for the management of the krill fishery. He also demonstrated that krill shrink in the absence of food.

So and his team have subsequently significantly advanced scientific knowledge about krill biology and behaviour, and contributed to the practical and sustainable management of the Southern Ocean krill fishery through the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

School behaviour

A recent success was to get wild Antarctic krill (*Euphausia superba*) to school in captivity – something that has never been achieved before. It means that the Antarctic Division team can now study the animals' natural behaviour and response to various stimuli, and collect more accurate information on their growth and metabolism.

'Krill are very social animals, but in captivity they tend to behave individually, rather than as a group, and you can't get much information from them,' So says.

'Observations and measurements made on schooling krill are really important because the information is used in modelling for fisheries research and defining sustainable krill catch limits for CCAMLR,

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So monitors phytoplankton cultures (microscopic marine algae) which make up the bulk of a krill's diet.

Recent changes in krill fishing methods will change the dynamics of how fishing fleets interact with the resource, and the impact on krill predators.

So recently collected Antarctic krill from the sea ice environment, during the Sea Ice Physics and Ecosystem Experiment*, to help improve scientific understanding of the krill life history.*

and normal behaviour means they should be physiologically normal, rather than stressed.'

So and his colleagues are now taking advantage of this success to conduct behavioural experiments.

'Recently, we put different sized objects in different colours in or near the tank,' So explains. 'The krill weren't worried by small, black objects at a distance from the tank, but when we put a large, fake penguin in their tank they went crazy. They escaped to the other side of the tank and started schooling and swimming rapidly – as they might do when confronted by a real penguin or some other predator.'

Synchronised swimming

The team also observed that when krill are feeding they swim around randomly, but when schooling, they swim faster, with their bodies close to horizontal and all pointing in the same direction. This information is important when measuring the abundance of krill at sea using acoustic 'echo-sounders'. These instruments send pulses of sound into the water and record the echo strength as the sound waves bounce off objects. However, as the echo-sounder is sensitive to krills' body orientation, the echo strength may be different depending on what the krill are doing. If they are swimming horizontally, for example, the echo strength will be far stronger than when krill are more vertical.

'A better understanding of natural krill behaviour will help us interpret and extrapolate echosounding results from field surveys,' So says. 'This work will ultimately enable more accurate measurements of krill density in the field, which is important for developing sustainable catch limits.'

Modelling growth

So's work has also resulted in a new growth model for krill. In the past, krill growth rates were determined by measuring the size of krill in the wild at different times during the growing season (November to April). However, this method relied on a lot of assumptions, including that the same population of krill was sampled each time.

The new model measures the growth of individual animals – in the wild and the aquarium – each time they moult (shed their shell). This allows for changes in krill size as a result of temperature, food availability, sex (males grow faster than females), and reproductive state, and gives a more accurate picture of the population growth rate. It means a lot of work for the aquarium team, however.

'Krill moult in the aquarium every three to four weeks, and we collect moults every day,' So says. 'We also capture krill when we're at sea and take measurements for the duration of the voyage.'

Practical fisheries management

Another aspect of So's work involves analysing information on the size of krill catches and fishing fleet behaviour (where ships fish and for how long), which is voluntarily provided to CCAMLR by most member countries. His results are then presented to CCAMLR, both for its scientific value and for practical management.

'You can't put scientific knowledge in place without understanding the commercial nature of the fishery,' he says.

'It is also important to understand fleet behaviour in relation to the krill predators' foraging ground. CCAMLR allows rational use of the resource, but we need to make sure that as the fishery develops – and it's really starting to take off now – it does not have any irreversible effect on the ecosystem.'

Some krill boats have recently begun using new equipment that allows larger volumes of krill to be caught and processed efficiently. This will change the dynamics of how fishing fleets interact with the resource, and the impact on krill predators – something So and his colleagues will monitor with interest.

In the mean time So is busy analysing data collected during an early-season sea ice voyage in August 2007. During the Sea Ice Physics and Ecosystem Experiment, an International Polar Year project (www.acecrc.sipex.aq), So and his team used a variety of equipment to study the distribution and condition of krill under the sea ice. Initial results indicate that krill associated with sea ice are in better condition than those in open water, underscoring the importance of sea ice to this valuable crustacean.

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