Innovations in Aquaculture

Domestication of the Greenshell Mussel

The New Zealand Greenshell™ mussel industry began by collecting juveniles ("spat") from the wild. Today most of the spat supply comes from one unreliable and inconsistent source. From time to time, drift seaweed washes up on the beach along 90-Mile Beach in Northland, loaded with tiny mussel spat. This seaweed is then collected and trucked to mussel farms throughout the whole of New Zealand.

In 1993, Cawthron Institute was approached by a young marine biologist with a proposal for a PhD project with Auckland University. Sam Buchanan claimed believed he could solve a problem that had stumped New Zealand scientists for 20 years or more: how to grow mussels in a hatchery.

The problem researchers faced at that time was that although the mussels could be made to spawn, all of the offspring died relatively quickly. The females had to be in very good condition prior to spawning for the larvae to survive. Efforts had been focused on various methods to bring the shellfish up to the required condition, without success.

Sam took a different approach. If there was a reliable, non-invasive way to identify when a female had reached the required condition, then we could simply select those that were ready. Maintaining them in that condition should be much easier.

Cawthron didn’t have a hatchery, or anything remotely like the facilities required. How could this young man succeed where some of New Zealand’s very experienced aquaculture scientists had failed miserably? Sam was very persuasive. He convinced research leader Dr Henry Kaspar, who realised this may provide a much-needed boost for Cawthron's aquaculture research.

That proved to be the case. Henry managed to secure a research contract with The Foundation for Research Science and Technology, which gave Cawthron sufficient confidence to invest in a new aquaculture research centre. That's a rather grand description for a collection of recycled huts and tunnel houses, lacking frills such as offices or toilets. The scientists had to do a lot

themselves. Before he could start his research, Sam spent much of the first winter working inside a 100m drain pipe, hammering in bolts for the seawater intake pipes.

The location, tucked inside Nelson's Boulder Bank, was ideal. The seawater quality was superb, consistent throughout the seasons and relatively unaffected by rainfall or floods.

After several years of hard work, Sam began to achieve consistent results. A milestone was celebrated in 1999 at the Sanford workshops in Havelock when the Cawthron team delivered the promised "bucket of spat" (actually a 200 L drum) for ongrowing on longlines.

At that point Henry made a big decision. The temptation was to continue refining hatchery techniques. The real gains, however, would come from selective breeding programs made possible by this domestication of this feral shellfish. The decision was made to initiate such a program as rapidly as possible.

The key to success for any breeding program is the choice of breeding objectives: the desired characteristics which form the basis for selection. The research scientists could explain what was possible, but the mussel industry itself had to prioritise its needs. It proved to be a long and difficult task. Accustomed to dealing with a variable, heterogeneous feral product, it took some time for industry leaders to understand and explore the potential of this new opportunity. The scale of a mussel hatchery, to be economic, was beyond the resources of an individual company so cooperation between competing companies was essential.

Early in 2011, a new company was announced. SPATnz, Shellfish Production and Technology New Zealand Limited, is a joint venture between Sanford, Sealord Group and Wakatu Incorporation. With matching funding from Government, SPATnz plans to spend more than $50 million over the next seven years. The aim is to advance existing research into selective breeding and develop hatchery technology to breed and hatch genetically improved spat on a commercial scale. Wakatu chief executive Keith Palmer said "I liken it to farmers selectively breeding ewes which will produce three lambs. We are still collecting our lambs from the bush." The media release laid out the initial breeding objectives: "The shellfish market is asking

for larger mussels, which are uniform in size, and which have a high proportion of attractive apricot-coloured female mussels."

So 18 years after Sam Buchanan approached Cawthron with his PhD proposal, his hut and tunnel house have been transformed into a large, modern and well equipped "Cawthron Aquaculture Centre". The location of SPATnz's new hatchery will be decided in 2012, but is likely to be alongside the Cawthron facility. A spokesperson described this as "the biggest development in the industry since we started farming mussels on longlines nearly 40 years ago".

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From Menace to Competitive Advantage

During the summer of 1992/93 New Zealand reported its first major algae bloom. The first people to be affected were in the Auckland region but over the next few weeks it seemed as if the wave of toxic algae was sweeping down the country. One by one, shellfish harvesting areas were closed off. This was quite a shock because up to that point New Zealanders considered themselves to be free of these dangerous pests. The event stayed in the news headlines for weeks on end.

In response, the level of surveillance was dramatically increased. Shellfish samples were analysed using the only test available at that time, a mouse bioassay. This was slow and not particularly accurate. A year or so later the annual cost of the sampling and testing program had risen to over $3 million (and the country occasionally ran out of mice).

Cawthron scientists had been puzzled because outside the Auckland region they could find no trace of toxic microorganisms in any seawater samples. In Auckland waters, no one had managed to identify the organism responsible. Some years later the culprit was found, an organism called *Karenia mikimotoi*. We know now that nearly all the closures in other areas were false alarms.

The shellfish industry was faced with a problem. Food safety is of vital importance to them and their customers. Products such as oysters have long been regarded with caution: sexy, but dangerous. Most of New Zealand's shellfish production is exported, subject to food safety standards often much more stringent than those applied by the importing countries to their own domestic products.

A few well-informed, farsighted people in the shellfish industry were acutely aware of the potential impact on the brand of New Zealand export shellfish. A new approach to the testing was required. Cawthron scientists were pushing for the information available in sea water samples to be properly utilised. Analysis of phytoplankton for toxic species was much quicker, cheaper and more reliable than mouse tests.

Analytical chemists in Japan and Canada had begun to use mass spectrometers to identify the toxic compounds themselves.

With their help, an investment of well over $1 million and a commitment from industry to support this new approach, Cawthron purchased its first LC-MS instrument and started to develop analytical procedures for routine testing. Paul McNabb was hired to work on the project and a specialist in mass spectrometer techniques, Dr Pat Holland, joined him. It was a formidable task. Not only must routine test protocols be rapid and cost-effective, but they require extensive validation before they can be accepted by authorities as an alternative to established test methods. In this case, it wasn't just the New Zealand authorities but regulators throughout Europe and North America. Cawthron had to persuade the US FDA to change its approach. They did it.

Phytoplankton monitoring is now an essential part of the surveillance program. Cawthron's laboratory was actually the first in the world to be accredited under ISO 17025 for phytoplankton analysis. Of course, the harder you look the more you find. We now know that New Zealand has a great variety of toxic algae, many of them endemic. But that's not a problem. The key is to have sufficient warning of an impending bloom so that harvesting can be stopped in time. It can resume once the bloom has subsided.

It took a few years longer than the early optimistic estimates, but now New Zealand is acknowledged to have the best surveillance system in the world for monitoring marine biotoxins. Cawthron won an award from a government animal welfare committee for the elimination of the use of mice for routine shellfish testing. Paul McNabb and Pat Holland sit on expert panels in North America and Europe providing technical advice on the management of marine biotoxins.

One of the reasons for this success was New Zealand's small size. It's relatively easy to get people to meet face-to-face and, with good leadership, it was possible to have everyone – central government regulators, industry players, local health authorities, researchers and testing laboratories – all working together. The main driver however was the determination of the Greenshell™ mussel industry to safeguard its brand: a unique product found only in New Zealand, grown in pristine waters by the world's most advanced producers, with the world's best biotoxin management program. Sexy, but safe.