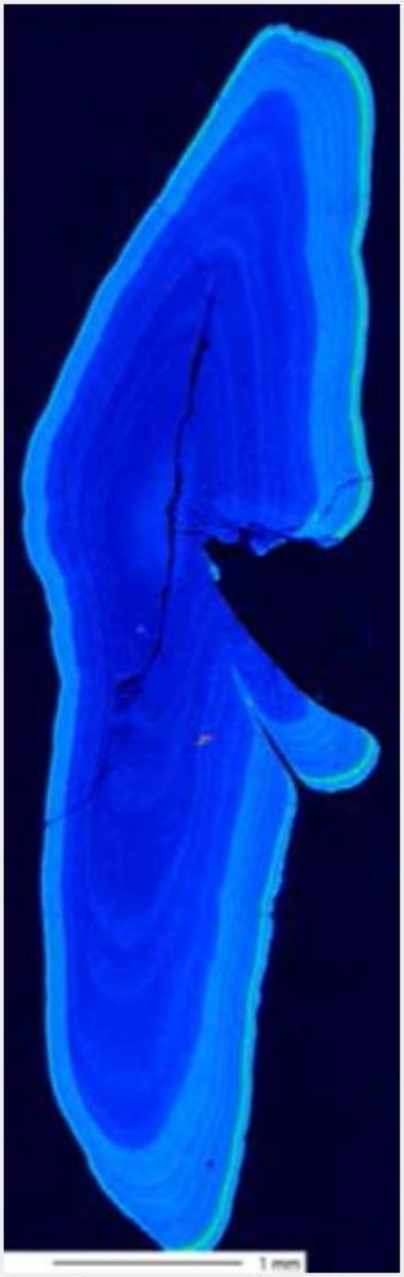
The stories otoliths tell

First published 13th June 2018

Were a fish capable of self-awareness, it might have a sense of how important its otoliths are in its daily life. Part gyroscope, part accelerometer, otoliths are small calcified objects that help fish keep their balance and orientation. But important as otoliths are to fish (or statoliths to squid), for fisheries biologists they are a natural data-logger that holds a wealth of data about the fish's life-cycle. As Brendon Lee of FIG's Fisheries Department puts it, "they are the backbone of fisheries biological research." Brendon is one of three PhD candidates from the Falklands who attended this year's International Otolith Symposium in Keelung, Taiwan. Brendon, Jessica Jones, Tom Busbridge, and Senior Fisheries Scientist Sacha Arkhipkin all gave talks on their research, which revolves around otoliths.



Strontium content of otoliths (lighter blue – green colours indicate a higher concentration and, consequently, deeper water)

Otoliths carry information on a molecular level, too. As the calcified matrix solidifies, it can trap particular chemical elements within it. The change in concentration of those elements over the fish's lifetime can then be measured and compared to known variables that affect take-up of those elements, such as water temperature or depth, to give a picture of the fish's life-cycle.

The shape of the otolith can tell a story too. Brendon, whose work is jointly funded by FIG and Consolidated Fisheries, has been comparing the shape of otoliths from toothfish caught in the Patagonian shelf – both off the Falklands and Chile – and toothfish caught in South Georgia. He has found that not only is the shape of toothfish otoliths from South Georgia different to those of the Patagonian Shelf, there are also differences in the shape of otoliths from the north of Falklands to those nearer to Chile and the Burwood Bank.

"It indicates high site-fidelity," says Brendon, "the fish, when they reach adulthood, it doesn't seem like they are moving around." The work gives some clues as to the movement of juvenile toothfish. "Regionally, it means we're not getting any influx of juveniles from South Georgia; that seems to be completely separate," says Brendon, but he is careful not to draw conclusions about the movement of juveniles in and around the Falklands and the wider Patagonian shelf, "it implies that the juveniles that we're getting in the South of our zone are probably from our own region, but that's not necessarily the case."

In his follow up work, Brendon has begun to look at how concentrations of strontium change across age bands in otoliths. Results so far show otoliths moving into deeper water as they age but, intriguingly, they also show a narrow spike in strontium. It is not yet clear what the peak indicates, and could be down to an environmental event, a routine life-cycle event, or simply an anomaly. "At this stage it leads to more questions than answers", he admits.

Trace element analysis has been a key part of Jessica Jones's work on squid. Jessica, whose PhD is funded by FIG in collaboration with SAERI and the University of Aberdeen, won a prize for top student oral presentation at Keelung. She has been looking at the extent to which the two spawning cohorts of *Doryteuthis gahi* (previously loligo) may be connected by so-called superbull squid – super-sized males that have been known to measure up to 44cm, well in excess of the average 14-17cm of adult squid. The two spawning cohorts – one in spring, another in autumn – are genetically the same, but how they are connected is not wholly understood. The super-bull squid, which are more streamlined and better adapted to longer migrations, are already thought to connect the two cohorts geographically. Jessica's work has focused on whether they may also provide a bridge in time between the two cohorts by mere virtue of being older.

"super-bull" squid

To accurately age the squid, Jessica has measured the trace element composition of their statoliths and compared it to recorded measurements in changes in water temperature and known migration patterns.

There is some indication that the super-bulls do live slightly longer, but only in the Autumn

spawning cohort, "potentially, because there's only a two-month gap in from the Autumn to the Spring spawning cohorts, the extra bit of age that they have on top may actually connect the populations, as well as then being streamlined and connecting geographically different spawning sites," says Jessica.

The results so far appear to support the current management approach, says Jessica, "if you understand to what extent the population is connected, you can decide whether you're going to manage the spawning cohorts separately, or whether you're going to do a stock assessment differently for each cohort or whether you can do it for the whole cohort together."

How otolith science applies to fisheries management is all too clear in Tom Busbridge's work. Funded by Fortuna Ltd, Tom's PhD aims to understand the reasons behind the collapse of the Southern Blue Whiting fishery some 10 years ago. Much like Jessica, Tom has focused on daily growth rings to validate the previous ageing of southern blue whiting otoliths. So far, his results suggest that the first year ring has previously been misidentified, and he is trying to determine whether that is true for the subsequent years. If the ages are indeed wrong, "that may have been a factor that's contributed to our models not being correct," says Tom.

The importance of correctly ageing fish from otoliths underpins stock assessment modelling, says Brendon, quite simply "it is the main age data that goes into the stock assessment model." The case of the Orange Roughy in New Zealand is a cautionary tale. "They thought that they matured at about 10 years and that they lived to 30 years, which underpinned their whole harvesting strategy. But then they found that they were only reaching maturity at about 30-40 years and living until 120-30, and because the ageing was wrong the entire fishery had collapsed."

Daily growth rings on Southern Blue Whiting otoliths

PhD candidate Jess Jones
PhD candidate Tom Busbridge
PhD candidate Brendon Lee
This article was written and published by the Penguin News on the 8th June 2018.