Pearls of wisdom

In order to hear, bony fish grow peculiarly shaped 'pearls', called otoliths, in their inner ears.

Scientists are paying a good deal of attention to these otoliths since it was discovered that they grow in response to the fish's life rhythms.

In particular, the otoliths of a number of fish grow in distinct daily layers, allowing the age of the fish since hatching to be determined with precision. As with tree rings, it's simply a matter of counting them.

In addition, otolith growth appears to vary with the temperature of the water the fish inhabits, its feeding patterns, and important events in its life history.

At least since the time of Aristotle, keen observers have noted the bony growths in the ears of fish. They correspond to the small bodies in our own inner ears, which we use to establish balance. Fish have cleverly adapted them to detect sound under water.

Although the hearing mechanism is still obscure, we do know that the dense otolith is involved in detecting sound passing through the fish. It rests on a carpet of sensory hairs, and these may well pick up relative motion of the otolith directly.

There are three otoliths on each side of the fish's head; the largest, called the sagitta, has attracted the most study. Its length may range up to several millimetres, or even centimetres in large fish, but in a larva it may be only a hundredth of a millimetre across.

Even so, under the microscope, daily layers only several micrometres thick can be discerned. Dr Ron Thresher of the CSIRO Division of Fisheries Research counts the layers to establish the length of fish larval stages, and he took the startling photomicrograph reproduced here.

He believes that further study of sagittae will decode more of the information written into them, providing us with a greater understanding of fish biology and ecology.

One of the big challenges is to explain irregularities: sometimes more than one ring is laid down in a day, or rings may be skipped, or sometimes even an existing outside ring is reabsorbed. However, the more that scientists study otolith rings, the clearer it becomes that 'irregularities' are really extra pieces of information, if only we knew the code to retrieve their meaning.

For example, whereas fish with marked daily variations in activity (feeding in the day, resting at night) show clear rings, those that are constantly active show indistinct bands. Discontinuities have been traced to spawning, migrations, starvation, stresses such as transfer to an aquarium, tides, and storms.

The question is whether all such hiccups can be traced to the ecology, habits, and life history of the otolith's owner.

A recent breakthrough has been the discovery that the structure of each single growth ring is significant. The thickness of the ring depends most strongly on temperature, and a number of small temperature fluctuations throughout the day can show up as a corresponding number of increments within it.

Similarly, the availability of food can affect the thickness of the ring, and fish that feed at dusk and dawn, and others that respond to the ebb and flow of the tide, seem to show two distinct increments per day.

Before he came to Australia, Dr Thresher and his American colleague Dr Edward Brothers used the otolith rings of 115 species to asssess the amount of time the fish spent as larvae. They found that the geographic range of a species correlated with the time spent in the free-drifting larval stage only for those few species with larval stages longer than 45 days.

Dr Thresher is now studying the spawning and growth of fish in Tasmanian waters; particularly the blue grenadier, which has considerable potential as a commercial fish stock. Study of the otoliths of larvae caught in fine trawl nets is helping him to follow their course of growth.

In order to extract more detailed information from the otoliths, he is planning to rear blue grenadier in captivity so that he can connect particular changes in its ring pattern with known environmental influences.

Andrew Bell

The microscope shows the daily rings in the otolith from the ear of a 25-day-old larva of a Tasmanian fish called blue grenadier. The diameter of the 'pearl' is one-fiftieth of a millimetre.