

INSIDE JEB

Nile tilapia sagitta ear bones play dual role in balance and hearing



A sagitta ear bone from a Nile tilapia (*Oreochromis niloticus*). Photo credit: Emmanuelle Huet.

Scientists love fish ear bones. Growing continually throughout a fish's life, the bones, known as otoliths – which reside within the fish's hearing and balance organs – gain a layer of growth gradually each year, tracking the fish's age, which scientists are partial to knowing. The largest of the three bones, the sagittae, were thought to be involved exclusively in the fish's sense of hearing, vibrating to transmit sound to sensory nerves in the chamber where the bone resides. But Eric Parmentier, from Université de Liège, Belgium, wasn't so sure. He suspected that the continuously growing bones may also contribute to the fish's balance, but no one had checked. Teaming up with Arthur Van Damme, Emmanuelle Huet and Bruno Frédérick, Parmentier investigated whether growing up in a cluttered environment, where fish have to manoeuvre and require good balance, would affect the sagitta bones of young Nile tilapia (*Oreochromis niloticus*).

Collecting recently hatched tilapia from a Swedish hatchery, the researchers

transferred the young fish to a tank festooned with chains draped down through the water, which the fish had to negotiate and swim around as they grew. However, to find out whether the obstacles that the fish had to manoeuvre around altered the fish's sagittae, the team set up a second chain-free tank for some of the first tank's siblings; in the absence of obstructions, the fish did not require meticulous balance as they swam freely. After leaving the two groups of fish to grow for 5 months, the team tested their hearing and then CT scanned the minute ear bones to see whether there were any differences.

When the team compared the hearing between the siblings from the two tanks, they found it was essentially identical. The cluttered environment had not affected the young tilapia's hearing. However, when the team compared the size of the fish's sagittae, things were different; the sagitta bones of the tilapia from the cluttered tank were longer and thicker, their volume greater and their

surface larger. Given that the only difference between the conditions in which the fish were raised was the complexity of the environment they were swimming in, 'we suggest that the observed differences in otolith size are linked to their involvement in manoeuvring abilities', says Van Damme.

But how might an environment with more obstacles lead young fish to develop larger sagittae? The team suspects that the larger bones may exert more leverage on the sensory cells that control fish balance, increasing the sensitivity of their balance as fish tip and negotiate past obstacles, while fish that live a relatively clutter-free life in clear water do not require a finely tuned sense of balance, as they rarely perform tight turns and manoeuvres. In fact, fish that grow up in uncluttered waters may even develop smaller otoliths, to avoid being overly sensitive to changes in direction.

So, it seems that the sagitta ear bones play a dual role in the life of fish, contributing to their sense of hearing and their balance. And the team suspects that fish lifestyle could also play a role in the evolution of the shape of these dual-function ear bones – from the elusiveness of the prey upon which they dine, to differences between loners and fish that shoal – all of which affect fish manoeuvrability and potentially the size and shape of their sagittae.

Van Damme, A., Huet, E., Frédérick, B. and Parmentier, E. (2025). The influence of habitat complexity on otolith morphology and sensory capacities in Nile tilapia: a controlled experimental approach. *J. Exp. Biol.* **228**, jeb249693. doi:10.1242/jeb.249693

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