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The rolling stones live: Hard X-ray phase contrast and neutron imaging allow for the in-situ visualization of otolith motion and associated structures in the fish ear

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In the fish ear, the basics of the relative motion between the calcareous otolith and the underlying sensory epithelium (SE) are still elusive. The few experimental studies and mathematical modeling indicated that otolith motion is mass-, shape- and frequency-dependent. Yet, it is widely unknown how 3D-otolith shape affects otolith motion and if this translates into differential patterns of ear stimulation. At the ESRF, we successfully designed a set-up to visualize otolith motion *in-situ* using hard X-ray phase contrast imaging and tested the effects of otolith shape and mass and different swimbladder types. The studied species thus differed in otolith and swimbladder morphology. *Steatocranus tinanti* has fusiform otoliths and a vestigial swimbladder, *Etroplus maculatus* displays rhomboid otoliths and possesses a swimbladder contacting the ears. In goldfish (*Carassius auratus*), the otoliths are needle-shaped and a chain of ossicles and ligaments transmits vibrations from the swimbladder to the ears. In a water-filled tank, pure tones of 0.1 or 0.2 kHz were presented to a single otolith embedded in agarose, to a fish head, and to a whole fish. Additionally, we investigated the native structure of the otolithic membrane that mediates the motion between otolith and SE using neutron tomography and neutron grating interferometry imaging. We will present outcomes of our combined study using synchrotron and neutron imaging which aims to elucidate otolith function in the fish ear.

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