

A Tiny Fish Loud as a Gunshot

Pitamber Kaushik



Image Credit: Senckenberg Press Release

IN the murky rapids of streams running down the southern and eastern slopes of the Bago Yoma Range in Central Myanmar lives a minuscule marvel of the aquatic world — *Danionella cerebrum*, a species so tiny that it could rest comfortably on the tip of a finger. A study published in the *PNAS* describes that despite its diminutive size, the unassuming fish possesses an extraordinary ability to produce sounds louder than a gunshot.

Discovered in 2021 within the turbid low-altitude streams of the Bago Yoma mountain range and found in an irrigation canal near Hmawbi, a township just northwest of Yangon, this species swiftly captured the attention of researchers due to its unique attributes. Measuring a mere 10–13.5 mm in length, roughly the size of a peanut, and having a brain volume scarcely larger than a pinhead, *Danionella cerebrum* boasts the smallest known adult vertebrate brain. Despite its miniature dimensions, the fish harbours a rich behavioural repertoire and maintains optical transparency into adulthood, rendering it an invaluable subject for neuroscience exploration.

The species is closely related to *Danionella translucida*, which shares its endemic habitat. Their similarity resulted in the former being previously erroneously identified as the latter. The two species belong to the same family as zebrafish (*Danio rerio*), a widely popular aquarium fish native to South Asia and a model organism for scientific study. Being nearly completely transparent throughout its life, *Danionella*

cerebrum is housed in various research institutes and university departments of neurological studies.

Scientists passing by the fish tanks housing these fish at the Einstein Center for Neuroscience at the Charité University in Berlin repeatedly noticed conspicuous clicking noises emanating from the tanks. They were initially confused about the origin of the mysterious but prominent sound.

Males of the species possess the remarkable ability to emit sounds exceeding 140 decibels at a distance of one body length, i.e. about 12 mm. The distance gives an idea of how loud the fish in its vicinity perceive the sound. Such a sonic blast is comparable in intensity to a gunshot or a firecracker explosion. Since much of the sound emitted in a fish tank is reflected into the water, it would be heard as a continuous buzzing noise by someone standing next to it. Even 3 feet from the source, the sound intensity was 108 decibels, comparable to car horns and symphony orchestra. Such a feat defied conventional understanding, prompting scientists to delve deeper into their physiology.

The Einstein Center for Neuroscience researchers embarked on a multidisciplinary investigation employing advanced techniques ranging from high-speed video recordings to micro-computed tomography scans. They unveiled a unique and intricate sound production apparatus within *Danionella cerebrum*'s diminutive, ethereal frame.

Danionella cerebrum harbours a bespoke propulsion mechanism, allowing it to produce sounds far shriller and



Image Credit: Wikimedia Commons

louder for its size than any other fish. At the heart of this mechanism lies a trifecta of anatomical marvels: a drumming cartilage, a specialised rib, and a specialised fatigue-resistant muscle. Together, these components orchestrate a symphony of movement.

To produce the sound, the fish contracts the muscle, thus pulling on the rib, which in turn loads the cartilage embedded in the muscle with stress. The tensed-up muscle is then released within a tiny fraction of a second, propelling the drumming cartilage forward to strike the swim bladder akin to a percussionist's drumstick. The fish can generate bursts of rapid, thunderous pulses through a string of concerted muscle contractions.

Each discrete pulse lasts for a four hundredth of a second and the pulses are typically strung together in repetitive sequences of variable duration with a few milliseconds of gap between each pulse. This gap varies around two distinct modes — one double the other. If other fish are tapping a table to produce sounds, *Danionella cerebrum* is equipped with a kettledrum. The rib's exceptional hardness in males elucidates why females cannot partake in this sonic spectacle.

Such a sophisticated and potent actuation mechanism reminds one of the punching apparatus of the mantis shrimp, a surprisingly formidable marine crustacean which can deliver lightning-fast blows that can shatter crab shells, deter potential predators, and overwhelm rivals. It also uses a specialised spring-release mechanism that gets loaded, latched

in place, and then suddenly released, propelling its calcified club-like claw at its target with an acceleration greater than a 0.22 calibre bullet. *Danionella cerebrum* has one of the highest ratios of loudness to body size, far greater than that of elephants, whales, songbirds, and bats, and is exceeded only by certain insects such as fruit flies.

While the precise purpose of *Danionella cerebrum*'s cacophony remains shrouded in mystery, scientists are primarily speculating on two potential functions for the sounds — a navigational aid in murky waters and a means of social communication in the form of an assertive display of dominance among competing males. The latter is hinted at by the researcher's observations that the sounds were only made when multiple males were present together; only some of them would make the sound, and each individual's loudness would be different. Since the sound is extraordinarily high-pitched with dominant frequencies lying in the range of a few kilohertz, it would serve as a suitable communication or navigation tool in the low-visibility turbid, shallow waters since high-pitched sounds tend to travel further in such environments. The revelation of *Danionella cerebrum*'s extraordinary adaptation expands our understanding of animal motion.

Mr Pitamber Kaushik is an independent journalist, columnist, writer, and educator. Email: pitamberkaushikjournal1@gmail.com