

INSIDE JEB

Brachyhypopomus bennetti are simplifying their bolts of electricityA preserved *Brachyhypopomus bennetti*. Photo credit: David Saenz.

Zapping opponents with bolts of electricity is a staple of the superhero magazines, but the reality for most electric fish is far more benign. ‘Fish generate electric signals to communicate with each other and to explore and navigate their environment’, says David Saenz from Texas A&M University, USA. ‘Most only generate a few millivolts of electricity, so you can’t feel it’, he adds. Explaining that some electric fish modulate their electric signals through the day with hormones – producing higher voltage discharges at night, while crackling more softly when inactive during the day – Saenz describes how many electric fish produce complicated discharge patterns by closely synchronising two or several electrical discharges. Knowing that adrenocorticotrophic hormone regulates the strength of the mild electric discharges produced by one family of bluntnose knifefish, *Brachyhypopomus*, Saenz, Kirk Winemiller (Texas A&M University) and Michael Markham, at the University of Oklahoma, USA, decided to find out how the hormone affects the electric crackles of two members of the family – *B. gauderio* and *B. brevirostris* – that produce complex discharges, and

B. bennetti, which produces a simpler, single-peaked discharge pattern.

Unfortunately, only *B. gauderio* can currently be bred in captivity, so Saenz joined José Alves-Gomes from the Instituto Nacional de Pesquisas da Amazônia, Brazil, to collect eight wild *B. bennetti* and one *B. brevirostris* from the Amazon River. Joining Markham in Oklahoma, Saenz began the painstaking task of measuring how adrenocorticotrophic hormone affected the discharge patterns produced by the three fish. ‘We removed a piece of the tail, which fully regenerates in 2–3 weeks ... and manoeuvred four glass electrodes into and around a single electric cell’, Saenz says, adding that the process was particularly nerve-racking, given his shaky hands. As Saenz applied the hormone, the voltage of *B. brevirostris*’ multip peaked discharge became 20–35% stronger. However, the voltage of the single-peaked *B. bennetti* discharge pattern barely increased (~5%). Unlike their knifefish cousins, *B. bennetti* are unable to vary the strength of their crackling electric calls through the day.

Knowing that the more sophisticated discharge patterns of *B. gauderio* and

B. brevirostris are produced by sodium ion channels located on opposite faces of the electric cells – triggering electric currents flowing in opposite directions within 0.5 ms of each other to produce the distinctive voltage traces – Saenz and Markham reasoned that *B. bennetti* must have lost the sodium channels from the front side of the electric cells, resulting in their single-peaked discharge pattern. However, when Tingting Gu (University of Oklahoma) and Yue Ban (University of California, San Diego, USA) helped Saenz reveal where sodium ion channels occur in the electricity generating cells, they were surprised to find that *B. bennetti* still retained the front side sodium ion channels. And, when Saenz measured the electric currents produced by both faces of the cells, he was surprised to see that the *B. bennetti* cells were still generating oppositely directed currents, but the discharges were simultaneous, partially cancelling out the larger current generated by the rear side of the cells, to produce what appeared to be a single-peaked discharge voltage.

Brachyhypopomus bennetti seem to be in the process of losing the complex and variable electrical signals generated by other members of the *Brachyhypopomus* family, and Saenz admits that it isn’t clear why *B. bennetti* have reverted to their simpler discharge signature, which could inadvertently reveal them to hungry catfish. He suggests that *B. bennetti* may be trying to pass themselves off as terrifying electric eels, which also produce a single-peaked discharge or simply attempting to stand out from the knifefish crowd to catch the attention of mates.

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