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Weakly electric fishes' secret social lives revealed

A weakly electric fish *Apteronotus leptorhynchus*. Photo credit: Rüdiger Krahe.

There's a lot of chit-chat going on in the rivers of Panama, but most creatures can't even tune in. That's because the conversations are literally electric. 'Weakly electric fish continuously generate an electric field', says Jörg Henninger from Eberhard Karls University of Tübingen, Germany, explaining that each individual produces a unique electrical signature which they use for identification, communication and when navigating after dark. But PI Jan Benda and Henninger realised that the fish's charged communications could also provide them with an unprecedented glimpse inside the furtive animals' social lives. 'Most outdoor studies require loggers or tags to be mounted on the animals', says Henninger, explaining that the tracking devices allow scientists to follow social interactions between individuals. However, the electric signatures produced by each fish are effectively individual tags, if only the scientists could build a system to disassemble the electric babble.

Initially, Benda, Henninger and Rüdiger Krahe from Humbolt Universität zu Berlin, Germany, built a grid of 54 electrodes distributed across an area of 3.6 m^2 that could be dropped into a river to record the fish's electric fields. Then they teamed up with Fabian Sinz, also from Eberhard Karls University of Tübingen, Germany, to develop complex computer algorithms to interpret the intricate electric fields. Benda, Henninger and Krahe then travelled to Quebrada La Hoya creek in Panama to try out the grid for real. 'In the early stages, many things broke, partly because of high humidity. Once, we even lost a grid because of an unexpected and sudden rise of water level', recalls Henninger. However, after successfully recording 130 h of electric cacophony, Henninger eventually focused on one 25 h period of uninterrupted dialogue.

Analysing the electric field frequencies, the team identified three species occupying the same stretch of river: *Eigenmannia humboldtii*, producing electric fields between 200 and 580 Hz, *Sternopygus dariensis* with electric field frequencies lower than 220 Hz and *Apteronotus rostratus* generating electric fields with frequencies ranging from 580 Hz to over 1000 Hz. 'We were very surprised and lucky to find that the species and individuals were separated so clearly', says Henninger. Charting the fish's manoeuvres over the course of 24 h, the team noticed that the fish mainly migrated upstream at speeds of up to 0.2 m s^{-1} in the hours after dark, returning downstream towards the end of the night at speeds of almost 0.3 m s^{-1}, with some potentially covering distances of up to 3 km each night. In addition, the fish preferred swimming close to the river bank packed with tree roots, where the dragonfly larvae and midges upon which they dine shelter. Most *E. humboldtii* also seemed to prefer travelling solo (61 out of 65) rather than in shoals and when the team analysed the strength of individual *A. rostratus* electric signals, some were actively courting and trying to attract mates. 'This suggests that a substantial number of fish disperse from their group during the night either to forage on their own or to find mating partners', says Benda.

Pointing out how few of these observations could have been possible using conventional tagging approaches, Krahe adds, 'The multispecies community we describe here hints at the complexity of signals weakly electric fish are actually facing'. However, for the time being, the residents of Quebrada La Hoya creek are probably content continuing their crackling conversations until more electronic eavesdroppers come to visit.

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