fat and starvation-resistant. Exciting times lie ahead for explorations of the metabolic and adaptive changes that occurred as different cavefish populations evolved, and such studies might uncover the underlying evolutionary forces responsible for this striking metabolic adaptation. ■

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1. Riddle, M. R. *et al. Nature* **555,** 647–651 (2018).
2. Aspiras, A. C., Rohner, N., Martineau, B., Borowsky, R. L. & Tabin, C. J. *Proc. Natl Acad. Sci. USA* **112,** 9668–9673 (2015).
3. Hüppop, K. *Environ. Biol. Fishes* **17,** 229–308 (1986).
4. Moran, D., Softley, R. & Warrant, E. J. *PLoS ONE* **9,** e107877 (2014).
5. Atray, A. *et al. J. Diabetol.* **4** (2), 2 (2013).
6. Carrera, P. *et al. Hum. Mol. Genet.* **2,** 1437–1441 (1993).
7. Savage, D. B. & Semple, R. K. *Curr. Opin. Lipidol.* **21,** 329–336 (2010).
8. Toyoshima, Y. *et al. Endocrinology* **149,** 5996–6005 (2008).
9. Yang, B.-Y. *et al. Am. J. Physiol. Endocrinol. Metab.* http://dx.doi.org/10.1152/ajpendo.00227.2017 (2017).
10. Mitchell, R. W., Russell, W. H. & Elliott, W. R. *Spec. Publ. Mus. Texas Tech. Univ.* 12 (1977).
11. Simon, V. *et al. EvoDevo* **8,** 23 (2017).

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CARDIOLOGY

# The tornadoes of sudden cardiac arrest

**A clever combination of techniques has enabled, for the first time, simultaneous visualization of the 3D waves of electrical and mechanical activity that are responsible for many cases of sudden cardiac death.** **SEE LETTER P.667**

**JOSÉ JALIFE**

Sudden cardiac arrest is a common cause of death in people with coronary artery disease[1], and also kills many young people who have heritable heart diseases. In both cases, sudden death often occurs because of a heart-rhythm defect called ventricular fibrillation[2,3], in which the heart rate increases dramatically and cardiac-muscle contractions in the heart's ventricular chambers become uncoordinated, rendering the heart unable to pump blood. Blood pressure decreases, leading to unconsciousness, and death follows unless a defibrillating electrical shock is applied. The mechanism underlying this anomaly has been debated for more than a century. On page 667, Christoph *et al.*[4] show that the use of panoramic fluorescence imaging with a voltage-sensitive dye, combined with ultrasound imaging, could considerably advance our understanding of ventricular fibrillation. The study has potential implications for a broad range of researchers, from physicists to cardiologists.

Normal heart rhythm is maintained by cyclic changes in the electrical currents that drive and coordinate heart-muscle contraction. But during ventricular fibrillation, electrical impulses stop tracking their normal paths across the heart, and instead adopt a complex, vortex-like pattern similar to eddies in water or a tornado in the atmosphere. Fluorescence imaging of the voltage on the heart's surfaces has revealed[5] that these electrical vortices involve highly periodic, spiralling waves of activity organized around a central point called a rotor. The rotor, which is the organizing centre of fibrillation[6], spins rapidly and can meander across the heart's surface, generating turbulent, wave-like behaviour.

Until now, fluorescence imaging has allowed the visualization of rotors only on the surfaces of the heart's chambers, and so activity inside the ventricles has been inferred through computer simulations[7]. The 3D equivalent of 2D spiral waves (called scroll waves) and the filament-shaped rotors at their centres (vortex filaments) could only be reconstructed using simultaneous 2D video images of spiral waves on the outer and inner surfaces of the heart[8]. This is problematic, because it has not been possible to prove that the electromechanical changes that occur in the heart proper during ventricular fibrillation match predictions made by simulations. For example, cardiac defibrillation by an electrical shock is the only known treatment for ventricular fibrillation, but our understanding of how it works is currently based on numerical predictions.

Christoph *et al.* have overcome this hurdle, thanks to a clever combination of techniques. The authors kept isolated pig and rabbit hearts alive by perfusion with a warm solution through the coronary arteries. They induced ventricular fibrillation in the hearts, and used high-resolution 4D ultrasound imaging to document changing mechanical strain over time.

The group then combined these data with more-conventional 2D fluorescence imaging,

## 50 Years Ago

Throughout this week an unusual meeting has been taking place near Paris … experts from all over France — and some from other parts of the world — have been discussing what the world will be like in the year 2020. To keep the discussion within sensible limits, it has been set in a geographical context so that each day has been spent discussing the way in which different technological developments will affect the way land is used. It is clear that this meeting … is intended to be the first of a series which could, no doubt, last long enough for the results of this meeting to be compared with the reality of 2020.
**From *Nature* 30 March 1968**

## 100 Years Ago

Another Indian "miracle" has been explained by scientific investigation. The *Pioneer Mail* of January 11 reports a lecture by Sir J. C. Bose on "The Praying Palm Tree" of Faridpur. While the temple bells call the people to evening prayer, this tree has recently been seen to bow down in prostration, and to erect its head on the following morning. Large numbers of pilgrims have been attracted to the place, and offerings to the tree are said to have been the means of effecting marvellous cures. Sir J. C. Bose first procured photographs which proved the phenomenon to be real. The next step was to devise a special apparatus to record continuously the movement of the tree by day and night. The records showed that it fell with the rise of temperature and rose with the fall. The records obtained in the case of other trees brought out the fact that all the trees are moving, each movement being due to changes in their environment.
**From *Nature* 28 March 1918**