To deal mathematically with genetic drift in a finite population, they adopted the model developed in the 1930s by R. A. Fisher and Sewall Wright and the mathematical framework developed in the early 1970s by Motoo Kimura and Tomoko Ohta.

The model yielded a quantitative picture of TF evolution. For example, under famine conditions and when the food supply fluctuates much faster than the mutation rate, neither control mode has an evolutionary edge over the other. But as the fluctuations in the scarce food supply lengthen, mutations have more time to accumulate and the wear-and-tear principle increasingly prevails: Evolution selects (+ +) control rather than the (− −) control of use it-or-lose-it.

The effect of finite population size emerged from the model as expected, but with a twist. Small populations are more vulnerable to adverse effects of genetic drift than large populations are. Under famine conditions and when the fluctuations are modest, (− −) control emerges as the winner and use-it-or-lose-it prevails. But at a critical population size, (− −) control loses its advantage over (+ +) control and wear-and-tear prevails.

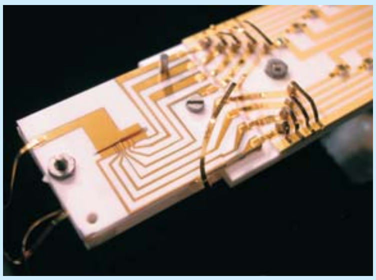
Gerland and Hwa ran their model for billions of generations and found rare cases where use-it-or-lose-it is literally true: In small populations, genetic drift could destroy TF function within one nutrient fluctuation period. When that happens, TF-mediated gene regulation becomes extinct until random mutations eventually restore it.

Figure 2 shows the phase diagram Gerland and Hwa derived for the case

## physics update

These items, with supplementary material, first appeared at http://www.physicstoday.org.

**Entangled mechanical oscillators.** Entanglement is one of the hallmarks of quantum mechanics and is a key tool in the burgeoning field of quantum information processing. Generating entangled states has become routine in the quantum realms of photons and of electron and atomic spins. Now John Jost and colleagues at NIST in Boulder, Colorado, the Weizmann Institute of Science, and Lockheed Martin Corp have demonstrated entanglement in separated mechanical oscillators. Each oscillator consists of a pair of ions—one $^{9}Be^{+}$ and one $^{24}Mg^{+}$—that behave like two unequal masses connected by a spring 4 $\mu$m long. The pairs are separated by 240 $\mu$m, so their individual vibrational motions are decoupled. To entangle those vibrational modes, the researchers cool the four ions in one zone of a multizone ion trap (shown here) while coaxing them with electrode voltages to line up in a specific order: a Be ion at each end. They next entangle the spins of the two Be ions and then separate the pairs into different trap zones. Lasers tuned to the Mg ions recool the separated pairs while maintaining the Be entanglement. The team finally uses laser pulses to coherently transfer the entanglement from the Be spin states onto the pairs' motional states. The end product is the entangled superposition of vibrational oscillations in the pairs' ground and first excited states. Along the way, the team also demonstrated the entanglement between one ion's spin state and the motion of the other ion pair. Mechanical entanglement and the tools developed to achieve it will be important ingredients for scaling up quantum information processing with trapped ions. (J. D. Jost et al., *Nature* **459**, 683, 2009.)



—RJF

**Bees trade energy efficiency for stability** when flying in turbulent winds. Traveling smoothly through a turbulent medium is no mean feat, as anyone who regularly flies in an airplane can attest. Scientists have investigated how fish navigate through turbulent currents, but until recently they had not addressed the analogous issue of animal flight through turbulent air. Now biologist Stacey Combes has filmed male orchid bees (genus *Euglossa*) flying in turbulent airstreams and, with colleague Robert Dudley, has described the effects of the turbulent air on the bee's flight stability and maximum speed. Combes induced the bees to fly in a turbulent airstream by luring them with an attractive scent. As the airspeed increased, the bees found it increasingly difficult to avoid rolling. When the airspeed was high enough and maintaining stable flight difficult enough, the bees extended their hind legs, as depicted in the photograph. That move increased the moment of inertia about the roll axis by roughly 50% and improved stability, but it also increased body drag and energy expenditure by about 30%. In a second experiment, Combes altered the turbulence of the stream by inserting different geometric grids. Bees flying in the lower-turbulence environment were able to reach higher speeds before instabilities caused them to be ejected from the air stream. (S. A. Combes, R. Dudley, *Proc. Natl. Acad. Sci. USA* **106**, 9105, 2009.)

—SKB

**Smog reduced for Beijing Olympics.** In an effort to reduce the pervasive smog in Beijing (see photo), Chinese authorities imposed measures to restrict traffic and close factories around the city during the 2008 Olympics. Were those efforts successful in reducing total atmospheric aerosol? Climate scientists Jan Cermak and Reto Knutti at ETH Zürich in Switzerland attempted to find out. They began by comparing absolute values of aerosol

optical thickness—transmittance measurements from the Moderate-Resolution Imaging Spectroradiometer aboard NASA's *Terra* satellite—for the years 2002–08. They found that within a