OUTBREAKS

Going to Bat

NATURAL RESERVOIR FOR EMERGING VIRUSES MAY BE BATS **BY CHARLES Q. CHOI**

Bats are creatures of the night that are commonly held in fear. At first glance, those fears might seem to have some medical justification. Long known as vectors for rabies, bats may be the origin of some of the most deadly emerging viruses, including SARS, Ebola, Nipah, Hendra and Marburg. Instead of demonizing bats, however, research shows the real culprit behind these outbreaks could be human error.

GOOD WAY TO GET SICK? Live fruit bats hang in a Sumatran food stall. Having the bats in such close proximity to people and live animals for sale in the market could be the reason new viruses have emerged to infect humans.

The Nipah and Hendra viruses were the first emerging diseases linked to bats. Hendra claimed two of its three victims in its first and so far only known appearance in Australia. Meanwhile Nipah has in repeated Southeast Asian outbreaks killed nearly 200 people, and blood tests of wildlife have suggested that the viruses came from the largest bats, flying foxes.

The connection to SARS, or severe acute respiratory syndrome, was less direct. During the outbreak that began in China in 2002, investigators found that civets and two unrelated species harbored the SARS coronavirus, prompting mass culling of the mongooselike civets by the Chinese government. Subsequent research, however, found no widespread SARS infection among wild or farmed civets, indicating that the disease arose in another species and might remain in wait there.

From research with Nipah and Hendra, virologist Linfa Wang of the Australian Animal Health Laboratory knew bats could get chronic infections from the viruses while not getting sick, making them ideal carriers for disease. Bats, civets and a menagerie of other animals were often found caged near one another in live-animal markets in Asia. So Wang hypothesized that bats might harbor SARS as well.

Wang and his colleagues analyzed blood, throat and fecal swabs from 408 wild bats from China. Genetic analysis revealed five bats, which represented three of nine species of horseshoe bats tested, possessed viruses closely related to SARS. They reported last September that the genetic variation within those coronaviruses was far greater than that seen in human or civet SARS. Therefore, bats, probably having lived longer with the diseases, may be the origin of the coronaviruses seen in other species.

Then, in December, researchers connected fruit bats to Ebola, whose origin in the wild had remained unknown since its first recorded appearance 30 years ago. During the Ebola outbreaks in humans, gorillas and chimpanzees between 2001 and 2003 in Gabon and the Republic of the Congo, a team led by virologist Eric M. Leroy of the International Center of Medical Research in Franceville, Gabon, tested some 1,000 animals. Of 679 bats studied, 16 had antibodies against Ebola, and 13 others possessed Ebola gene sequences in their liver and spleen. The sequences demonstrated genetic diversity, "indicating that Ebola probably has spent a long time within bats, suggesting that bats might be the origin," Leroy says. Virologist W. Ian Lipkin of Columbia University notes that scientists suspect that the Marburg virus, a relative of Ebola, also originated in bats.

Leroy vigorously argues that bats should not be culled. Wang agrees, observing that bats play critical ecological roles, such as eating insects and other pests. Besides,

FEAR OF THE NEW

Ebola, SARS and other viruses recently linked to bats "are scary diseases," states senior research scientist Jon Epstein of the Consortium for Conservation Medicine. But he remarks that "far more people die of malaria, cholera and influenza. We need to maintain a sense of perspective with regards to the global burden of infectious diseases." Most emerging diseases transmitted from animals to humans actually come from domesticated animals and carnivores, whereas bats currently account for only 5 percent of such infections, explains the consortium's executive director Peter Daszak. "With bats making up around a fifth of all mammal species, this means they are in fact underrepresented as carriers of emerging diseases," he says.

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Wang points out, culling is simply not practical when it comes to bats, which can just fly away. Satellite collars on fruit bats carrying Nipah showed they could fly between Thailand, Sumatra and Malaysia, and the horseshoe bats linked with SARS range across Asia, Europe and Australia.

Preventing future emergences may instead focus on human behavior. Just as SARS is potentially linked to animal markets, so was Nipah linked to pigpens encroaching on bat habitats. And people living in Ebola-endemic areas eat the bats harboring the virus. Knowledge that bats can carry dangerous viruses could work to prevent epidemics, notes Peter Daszak, executive director of the New York City–based Consortium for Conservation Medicine, which studies the connection between emerging diseases and human interactions with the environment. Keeping bats from the wildlife trade might have dramatically cut the risk of SARS emerging, perhaps saving $50 billion worldwide in loss to travel, trade and health care costs "and hundreds of lives," Daszak says.

Charles Q. Choi is a frequent contributor.

PHYSICS

Ion Power

ATOMIC IONS PROVE THEIR QUANTUM VERSATILITY

BY GRAHAM P. COLLINS

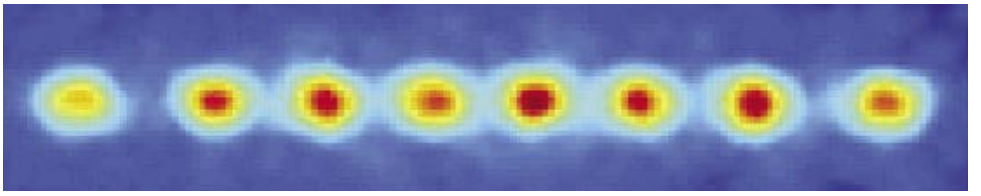
In their quest to build a computer that would take advantage of the weirdness of quantum mechanics, physicists are pursuing a number of disparate technologies, including superconducting devices, photon-based systems, quantum dots, spintronics and nuclear magnetic resonance of molecules. In recent months, however, teams working with trapped atomic ions have demonstrated several landmark feats that the other approaches will be hard-pressed to match.

A quantum computer operates on quantum bits, or qubits, instead of ordinary bits. A qubit can be not just 0 or 1 but also a superposition of the two, in which proportions of zero-ness and one-ness are combined in a single state.

An important class of multiqubit superpositions are entangled states. In these configurations, the state of each qubit is linked in a subtle way to the state of its companions, a linkage that Albert Einstein disparaged as "spooky action at a distance." For example, in a so-called Schrödinger cat state, all the qubits will give the same result—0 or 1—on being measured, even though the choice between 0 and 1 is totally random. (The name comes from the famous thought experiment in which 0 and 1 correspond to the cat being dead or alive and the individual "qubits" are all the particles in the cat's body.)

Cat states are a fundamental building block of techniques for correcting errors in qubits. Such errors inevitably plague all the standard approaches to quantum computation, because states of qubits are exceedingly fragile.

Researchers at the National Institute of Standards and Technology in Boulder, Colo., led by David J. Wineland and Dietrich Leibfried, have now created cat states involving four, five and six beryllium ions.



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ENTANGLED: Eight calcium ions held together in a trap are in a special quantum condition known as a W entangled state, in which their properties are subtly correlated. Such states are of use for error-correction schemes in quantum computers. Entangled states become harder to create and maintain as the number of particles increases.

NEED TO KNOW: SCALING UP

Experiments with atomic ions involve custom-built, bulky electromagnetic traps to confine the ions in a vacuum. Though fine for experiments with a small number of ions, they are utterly impractical for the large-scale system that a quantum computer would need to be of any significant use. Now University of Michigan at Ann Arbor researchers Christopher Monroe, Daniel Stick and their co-workers have demonstrated a 100-micron-size ion trap on a semiconductor chip. They used their chip to trap a single cadmium ion and move it to different locations in the trap by applying electrical signals to electrodes. The trap was built using standard lithography techniques, so, Monroe says, it could be scaled up to include hundreds of thousands of electrodes using existing technology.

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