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Bats are suspected to be a wild reservoir of the Ebola virus.

EPIDEMIOLOGY

Ebola hunters go after viral hideout

As West Africa epidemic fades, researchers aim to prevent recurrences by finding the virus's natural host.

BY EWEN CALLAWAY

With the official end of Ebola transmission across West Africa anticipated on 14 January, an epidemic that killed more than 11,000 people in 2 years may be starting to fade into history. But that does not mean that Ebola has disappeared. The virus remains hidden in animal reservoirs, and is almost certain to spill over into humans again.

"We've got to focus on what could potentially happen next," says David Pigott, a spatial epidemiologist at the University of Oxford, UK — and that means uncovering the species that harbour Ebola in the wild to try to prevent deadly outbreaks in the future.

It is no easy task. Since the disease first emerged in Zaire (now the Democratic Republic of the Congo) 40 years ago, efforts to trace the origins of the outbreaks, including the most recent one, have come up frustratingly empty. Wild gorillas and chimpanzees in central Africa have experienced occasional Ebola outbreaks. But like humans, these species are too ravaged by the virus to serve as its natural host. Experts say that a reservoir species is likely to harbour the virus only at low levels, and without becoming sick.

The leading candidates are several species of fruit bat from across central and West Africa — where all known Ebola outbreaks have originated — that are often hunted for meat. A 2005 study[1] uncovered Ebola genetic material in some fruit bats from Gabon and the Democratic Republic of the Congo, and detected Ebola antibodies in the blood of others. Marburg virus, which is closely related to Ebola, is thought to be transmitted by fruit bats.

"I firmly believe fruit bats are the reservoir for Ebola," says Peter Daszak, a disease ecologist and president of EcoHealth Alliance, a conservation organization in New York City that plans to survey numerous bat species, including fruit bats, in Liberia for signs of Ebola infection.

Other researchers believe that focus is too narrow. "The evidence for fruit bats is the strongest, but it's still weak," says Fabian Leendertz, a wildlife epidemiologist at the Robert Koch Institute in Berlin.

Leendertz suspects another type of bat. He led a team that searched for the source of the latest West African outbreak in early 2014, a few months after a toddler in southern Guinea became the first human victim. The team captured dozens of bats near the toddler's village, but none — fruit-eating or otherwise — showed any conclusive signs of Ebola infection[2]. Still, circumstantial evidence has led the researchers to suspect that the culprit may have been small insect-eating bats living in a tree near the toddler's home. Although the tree had burned down before researchers arrived, it had been filled with such bats, and villagers told the team that children often played in its hollowed-out trunk. The team is now looking more closely at insectivorous bats, but Leendertz cautions against focusing on any one animal.

UNUSUAL SUSPECTS

Some researchers advise casting the net even wider. "I don't buy the bat story for Ebola virus, not at all," says virologist Jens Kuhn of the US National Institute of Allergy and Infectious Diseases at Fort Detrick, Maryland. He thinks that bats are much too abundant and too closely associated with humans to explain an infection that has emerged just two dozen times over the past four decades. "It's going to be a strange host," he says. Even arthropods or fungi could be possibilities, he adds.

Others intend to look at more-familiar

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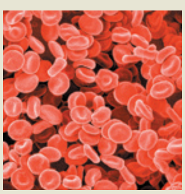

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species. The US Agency for International Development plans a two-year survey of animals ranging from rodents to livestock to domestic dogs and cats. These animals may not be natural reservoirs of Ebola, but they could contribute to spillovers into humans, says Dennis Carroll, director of the agency's Pandemic Influenza and Other Emerging Threats Unit.

But with so many question marks hovering over the identity of Ebola's reservoirs, some scientists say that it is time to eschew virus hunting in specific creatures and instead pursue more-holistic approaches that examine ecological and anthropological factors common to spillovers.

Tony Goldberg, an epidemiologist at the University of Wisconsin–Madison, is one such advocate. He no longer subscribes to the view that "we have to blanket the continent of Africa with field-deployable DNA sequencers and sample everything that crawls, flies or swims and eventually we'll come across it. I used to think that way," he says, "but I'm cooling off to that approach."

His team is studying how bush-meat hunters interact with wild ecosystems to identify factors that might be linked to the spillover of zoonotic infections such as Ebola.

In a similar effort, a team led by Pigott and his colleague epidemiologist Simon Hay is looking at past outbreaks for common ecological factors, such as vegetation, elevation and the presence of suspected reservoir species such as fruit bats and carriers such as apes. By modelling these data, the team has created a map of areas at risk of Ebola spillovers[3].

And Barbara Han, a disease ecologist at the Cary Institute of Ecosystem Studies in Millbrook, New York, is using machine-learning techniques to predict which bat species are likely to harbour Ebola and related viruses because they share ecological factors common to suspected reservoir species.

Research on Ebola therapies and vaccines saw an infusion of public and private funding during the epidemic, and scientists hunting the virus in the wild hope to capture the same sense of urgency and financial support. But they know that the job won't be easy. "It has lit a fire under people's butts, mine included," says Goldberg. "The problem is, we're not sure what to do with the fire." ■

1. Leroy, E. M. *et al. Nature* **438,** 575–576 (2005).
2. Saéz, A. M. *et al. EMBO Mol. Med.* **7,** 17–23 (2014).
3. Piggott, D. M. *et al. eLife* **3,** e04395 (2014).

EXOPLANETS

Rebooted Kepler spacecraft hauls in the planets

Worlds found by K2 mission push beyond original discoveries.

BY ALEXANDRA WITZE, KISSIMMEE, FLORIDA

In the second phase of its life as a planet hunter, NASA's Kepler spacecraft is raking in exoplanet discoveries that are surprisingly different from those found during its first iteration.

Between 2009 and 2013, Kepler became the most successful planet-hunting machine ever, discovering at least 1,030 planets and more than 4,600 possible others in a single patch of sky. When a mechanical failure stripped the spacecraft of its ability to point precisely among the stars, engineers reinvented it in 2014 as the K2 mission, which looks at different parts of the cosmos for shorter periods of time.

In its first year of observing, K2 has netted more than 100 confirmed exoplanets, says astronomer Ian Crossfield at the University of Arizona in Tucson. They include a surprising number of systems in which more than one planet orbits the same star (E. Sinukoff *et al.* Preprint at http://arxiv.org/abs/1511.09213; 2015). The K2 planets are also orbiting hotter stars than are many of the Kepler discoveries.

"This is really showing the power and potential of K2," says Crossfield. "These are things we never found with four years of Kepler data." He and other scientists reported the findings last week at a meeting of the American Astronomical Society in Kissimmee, Florida.

The original Kepler mission was designed to answer a specific question: what fraction of Sun-like stars have Earth-sized planets around them? Unbound by those constraints — even if not as good at pointing itself — K2 has been able to explore wider questions of planetary origin and evolution. "Now we get to look at a much bigger variety," says Steve Howell, the mission's project scientist at NASA's Ames Research Center in Moffett Field, California.

And because K2 looks at stars that are generally brighter and closer to Earth than Kepler did, the exoplanets that the mission finds are likely to be the best-studied for the foreseeable future. This is because they are near enough to allow astronomers to explore them with other telescopes on Earth and in space.

UNEXPECTED BOUNTY

In the past year, K2 has uncovered not just planets — such as three super-Earths orbiting a single star — but also surprises such as the disintegrating remains of a planet swirling around a white dwarf star. It has even probed exploding stars — because K2 stares constantly at a patch of the sky, it is able to catch a supernova as it brightens instead of later in its explosion, as other telescopes typically do.

Among the K2 planets confirmed so far, 58 are singletons, 28 come from systems with at least 2 planets and 14 are triples, Crossfield says. In addition, K2 has unearthed more than 200 candidate planets, says Andrew Vanderburg, an astronomer at the Harvard Smithsonian Center for Astrophysics in Cambridge, Massachusetts.

K2 observes a larger fraction of the cool stars known as M dwarfs — the most common type of star in the Galaxy — than Kepler did. But surprisingly, fewer of the K2 planets are orbiting M-dwarf stars. A higher percentage of them, at least so far, circle stars that are hotter and more like the Sun, says Courtney Dressing, an astronomer at the California Institute of Technology (Caltech) in Pasadena.

K2 will begin a new type of planet-hunting on 7 April. Normally the spacecraft searches for a temporary dimming of a star caused when a planet crosses in front of it. For just under three months, however, it will look for the temporary brightening of cosmic objects, such as a galaxy, caused when a planet bends light as it crosses the line of sight between the object and the observer. The team expects to catch between 85 and 120 of these 'microlensing' planets during the campaign.

The survey will involve other telescopes and be the first automated search to be done simultaneously from the ground and in space, says Calen Henderson, an astronomer at NASA's Jet Propulsion Laboratory in Pasadena, California.

That means much more work ahead for mission scientists. "Kepler was one field and it ruined your summer," says Caltech astronomer David Ciardi. "K2 is ruining our whole year." ■