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New clues to where the Ebola epidemic started

A Guinean child who played with bats residing in a hollow tree later became the first known victim in the West African outbreak.

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The hollow cola tree growing in a remote area of southeastern Guinea was once home to thousands of bats routinely hunted and killed by the neighborhood children. It was also a popular spot to play. A year ago, one child in particular lived within fifty metres of the tree: a two-year-old boy who died in December 2013 and later was identified as the first person in west Africa known to have developed Ebola.

The tree was one of the few that loomed over his home village of Meliandou, a hamlet of 31 houses. The question that now haunts researchers: were the tree's occupants behind how that small boy contracted the virus in the first place?

Yet they will never know the answer. By March, Guinean health officials were told that they had an Ebola outbreak on their hands and alerted the public to halt any consumption of bushmeat. Either by coincidence or as a result of that public warning, that tree was burnt down. Thousands of dead bats rained down on the community, but all researchers were left with in the weeks that followed were fragments of bat DNA. By the time a German research group arrived to conduct tests in April 2014, the tree was gone. No bats were left, and thus no answers.

Ref. 1

The hollow tree in Meliandou, Guinea, where the two-year-old boy Emile Ouamouno used to play. In December 2013 he became 'patient zero' in what is now the largest Ebola epidemic in history.

Daniel Berehulak/NYT/Redux/Eyevine

Samples from the Ebola epidemic in West Africa are held by public-health agencies in the region and abroad.

Their scientific sketch of the village is reported in a new study published today in the journal *EMBO Molecular Medicine*[1]. The fire may have helped keep the virus from spreading but it was also a blow to the research team, which had hoped to test the bats for genetic markers of the Ebola virus. If they had found signs of the virus it would indicate the bats had acquired Ebola, even if they were not necessarily responsible for transferring it to humans. But the fire foiled their plans since no such Ebola genetic information could be garnered from the remains of charred bat. And, making matters worse, there were no other representatives of the same bat species in the area, says Fabian Leendertz, lead author of the research team from the Robert Koch Institute in Berlin.

The fire was “really unfortunate since we can never pinpoint if [that bat species] was really the reservoir or not,” says Leendertz. His team was able to identify the species of the bat by conducting genetic analysis on fragments of bat DNA — mostly stemming from bat faeces — located in soil in and around the tree, but they could not get any information on the virus from those traces of genetic material. The team also culled other bat species from the area, but found those other bats were all Ebola-free.

Leendertz was left with only circumstantial evidence to indicate that the insect-eating bat species, called *Mops condylurus*, may be a candidate to explain how humans contracted Ebola in the first place. “It’s probably the best we can get but we are very unhappy with the data,” he says. And so the search to identify the carrier — or perhaps carriers — of Ebola continues.

Exactly which creature may transfer the Ebola virus to humans has bedeviled scientists since the virus was first identified in 1976. Myriad setbacks, usually related to slow response and notification, have kept scientists from pinning down an answer. Bats have remained a top Ebola carrier suspect because other experimental data have shown that bat species – including the one located in the massive hollow tree in this village — can survive infection with Ebola in the laboratory.

But that alone is not definitive since a creature could survive such infection without being the carrier for the disease. In order to better prove that the correct bat reservoir had been identified, the virus would need to be isolated from a bat and grown in a laboratory setting. Still, there are clues that suggest that *M. condylurus* could be a strong candidate. This same species of bat was considered a possible suspect for an earlier Ebola virus outbreak. And most scientists believe a close cousin of Ebola, called Marburg virus disease, is transmitted by bats — an observation that bolsters bats’ credentials as the potential animal reservoir for the Ebola virus.

Yet even if bats are the true culprit, researchers still don't know how the animals transmit the virus to humans. Does the transmission of virus occur when blood spatters into the eyes or cuts during butchering of the bat? Or, perhaps it's by eating food that the bat had sullied with its own spit, urine or faeces? Then again, it could be through some other exposure to the bats' bodily fluids.

Unraveling these mysteries could save lives. With such information, "I think it will be possible to prevent [Ebola cases] from happening," says Gary Kobinger, head of the special pathogens program at the Public Health Agency of Canada. Yet getting such answers is enormously complex. "You are looking for this one rare event and trying to understand this one rare event in context and put together the circumstances that lead to this," he says. "It's hard to predict because you have to synchronize it with an outbreak."

One problem in the quest to identify the virus: timing. After a human outbreak is contained researchers usually only then expend resources to go into the field and spend time catching bats, rodents or arthropods they believe may be behind the outbreak. Part of the delay is logistical: it takes time to set up a research team, find contacts to work with in the field and be notified about the outbreak in the first place.

Researchers also want to take precautions to keep themselves and the community they are working in safe. And there's also the matter of ethics and devoting limited resources to protecting human lives. But, with that understandable delay, you could risk missing some information. The risk is "you could miss breeding seasons, humidity or other factors. If you wait you might not find the same thing you could have if you looked right when you had the first introduction of disease," says Ebola expert Daniel Bausch of Tulane University.

There are other intangibles that have to be weighed when conducting research in such an emotionally charged atmosphere during an outbreak. For example, coming in to do research during the epidemic could lead to misunderstandings and endanger researcher safety. Those types of cultural misunderstandings were on Leendertz's mind when he was collecting other bat species from Meliandou and elsewhere in Guinea last April. "We don't want to risk any new rumors coming out," he told *Scientific American* in an interview. "Normally we only take blood and small samples and release the bats again but in this case we needed to kill them because people may say 'look at those white people releasing bad bats.' We can't give them any reason to speculate in that sense."

Trapping bats is no easy feat. Often researchers set up massive nets that resemble volleyball nets with pockets made of netting. The bats fly into the net and then drop into a pocket where they are later collected by human researchers wearing protective equipment, dissected and studied. Researchers may spend weeks trapping hundreds of bats but only catch a small number of various species. Making matters worse, maybe only a fraction of a percent of those bats are infected. And even if they are infected that still would not prove they are the animal reservoir for the virus.

"It's laborious work and it doesn't lead to easy answers," says Bausch, who did such work trapping bats to better understand the Marburg virus in the Democratic Republic of the Congo.

For his part, Kobinger says that he doubts that Ebola researchers will wait until the massive epidemic is over to get at some of these answers. Instead, he says, the better time to do further animal testing for Ebola will be as the outbreak is in its final stages, which he says will likely be in the coming six to twelve months. But there's no guarantee, no matter when they go, that researchers will get the answers they're looking for; even though the Leendertz research team only took a few months to get to the field, it still proved too late.

The new work from Leendertz falls short of fingering the bat species that may be behind Ebola, but it does shed light on other circumstances around the outbreak. His team also found it's unlikely that primates — another top candidate for the animal reservoir title — were behind this outbreak. In that small village in Guinea there was no large game to be hunted and any bushmeat consumed there, he found, was packaged and sent there from elsewhere. His team's tracking of great apes living in the area also found there had been no recent drop in their numbers.

Those observations suggest there was no outbreak among the local primates of a lethal disease like Ebola, Leendertz says. Beyond primates and bats, however, there still could have been another creature fueling the outbreak that his team and others may not have even thought of, he says. So for now, the mystery remains.

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References

1. Saéz, A. M. *et al*. *EMBO Mol. Med.* http://dx.doi.org/10.15252/emmm.201404792 (2014).