Blood-sucking leeches can help scientists map biodiversity

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Leech that has regurgitated part of its blood meal. Credit: Naomi Pierce and Chris Baker

Scientists looking to measure the biodiversity of wild animals have added a surprising tool to their arsenal—blood-sucking leeches.

In a new study led by a team of Harvard researchers, DNA samples extracted from the blood meals of leeches were used to map which animals live in the Ailaoshan Nature Reserve in Yunnan, China. The findings from the study show that these samples can be used to find out which wild animals are present across large, protected areas such as national parks and helps establish leeches as a surveillance instrument for animal conservation.

"This study shows how leech-derived DNA can be used to estimate biodiversity on a scale that makes it useful as a real-world conservation tool," said Chris Baker, a postdoctoral fellow in Naomi Pierce's lab at Harvard and one of the study's lead authors. "We're offering a way to measure the biodiversity of wild animals and, in particular, a way to measure biodiversity directly."

The research uses DNA extracted from more than 30,000 leeches to survey over 80 species of vertebrates, including amphibians, mammals, birds, and squamates. The leeches were collected over a three-month period by forest rangers throughout the 260 square mile nature reserve, which stretches for nearly 80 miles along a mountain ridge in Southern China.

The work, published in *Nature Communications*, addresses a major practical challenge in measuring animal biodiversity by providing a way to do so in detail over large spaces. Protected areas are often set aside with the goal of conserving wild animal communities, but it is costly and time-consuming to monitor those communities directly.

"You can set out automated cameras, you can set out acoustic recorders, or you could do it manually with people out into the field to survey

things, but it's difficult to do that on a really large scale," Baker said. "These surveys tend to be either limited in the spatial scale that they can cover, limited in the frequency with which they can be done or limited in the resolution that they can provide. We wanted to be able to use environmental DNA as a way to be able to address this problem…. instead of having to rely on proxies, like forest cover or the budget of forest rangers."

Leeches turned out to be perfect for the job.

One reason is that they are abundant, at least in tropical environments. They also feed on a broad range of animals, from large bears to small mice. Their sit-and-wait feeding strategy means wherever they are collected, it's highly likely the animal they fed on was in that area, making them easy to map. It also means they digest their meals slowly from one meal to the next. Scientists from China's Kunming Institute of Zoology that the Harvard researchers collaborated with, for instance, could still get animal blood from the leeches four months after the last feed.

The researchers looked for DNA sequences present only in vertebrates to identify the animals the leeches fed on. Past studies have shown this was possible, but this is believed to be the first time that a DNA analysis has been done at such a large scale.

The Harvard and Kunming Institute researchers coordinated with about 160 volunteer park rangers to collect the leeches. The team in China extracted DNA from the samples, arranged the sequencing, and investigated which animals the DNA belonged. The team at Harvard analyzed the locations of the animals using a technique known as multi-species occupancy modeling, which accounts for ecological patterns.

The team was able to identify 86 vertebrate species. Some of those

species are listed as near-threatened or threatened by the International Union for Conservation of Nature. These included the Asiatic black bear, the tufted deer, the stump-tailed macaque, several types of frogs, and an antelope-like creature called a serow.

The study also showed encroaching pressures on the reserve from human activity such as farming, livestock management, and poaching. DNA from cows, sheep and goats, for example, was recovered from leeches collected within the reserve, especially close to the edges. It suggests that animals from surrounding farmland are being grazed within the reserve where they could start competing for resources or otherwise degrading the habitat.

The researchers are optimistic that the results from their study can be used as a baseline to help track changes in Ailaoshan's wild animal populations going forward, and that the method could grow as strategy for the improved monitoring of wild animals in tropical and subtropical areas where leeches are abundant.

They also see broader applicability in terms of tracking zoonotic reservoirs for diseases, since leech blood meals can also be screened for the viruses they contain. This is especially relevant considering the COVID-19 pandemic was believed to be harbored by animals, such as bats, before being transferred to humans.

"You can use the leeches to look for what kinds of viruses they're carrying," said Pierce, Hessel Professor of Biology in OEB and Curator of Lepidoptera in the Museum of Comparative Zoology. "It's a pretty effective way to sample a great diversity of wild animals, and if we think that [zoonotic disease reservoirs] are really something to worry about and monitor, this is a good way to do it."

More information: Yinqiu Ji et al, Measuring protected-area

effectiveness using vertebrate distributions from leech iDNA, *Nature Communications* (2022). DOI: 10.1038/s41467-022-28778-8