



A long-tailed macaque pictured on Pulau Ubin on Aug 13. Recording the calls of these social primates – which are the natural hosts of a parasite that causes malaria – will allow researchers to detect the animals' presence in an area without having to physically see them.  
ST PHOTOS: LIM YAOHUI

(From left) Dr Chelsea Baker, Mr Shri Lak Nanjan Chandran and Dr Abdullah Hasib from the NUS Saw Swee Hock School of Public Health team involved in the AudioMoth project. The team plans to roll out the listening devices at 25 locations nationwide, pending final approval from the National Parks Board. The devices, costing about \$120 each, will be deployed across a mix of park connectors, and forest cores and edges.



# Eavesdropping on monkeys to keep S'pore safe from emerging diseases

## Acoustic data will help identify areas where people may catch diseases like malaria

Angelica Ang

Over two dozen audio recording devices will soon be deployed across Singapore's green spaces to record calls of the long-tailed macaque, the most common monkey species here.

It is not wildlife biologists who are eavesdropping on the monkeys, though, but a research team from the NUS Saw Swee Hock School of Public Health.

They are on a mission to identify "hot spots" where an emerging disease caused by a parasite in these monkeys could potentially spread to humans.

Recording the calls of these social primates – which are the natural hosts of a parasite that causes malaria – will allow researchers to detect the animals' presence in an area without having to physically see them.

The collected data can then be compared against information on places with high human and mosquito activity.

Pilot studies are currently being conducted on Pulau Ubin and in Mandai's Night Safari, and the project will expand nationwide in September.

Malaria can be passed from monkeys to humans when a mosquito feeds on a parasite-infected macaque, and subsequently bites a person.

While such zoonotic transmissions of malaria are commonly documented in places like Malaysia, only a few cases have ever been recorded in Singapore.

According to the Ministry of Health's HealthHub page, malaria brings about symptoms such as high fever, headaches, muscle aches and fatigue.

Singapore was declared malaria-free in 1982, which means the country had no locally transmitted cases for at least three consecutive years before that.

Despite this, the Republic needs to constantly be vigilant against the spread of diseases, due to its status as a transport hub.

The team plans to roll out the devices – dubbed AudioMoths – at 25 locations nationwide, pending final approval from the National Parks Board. The devices, costing about \$120 each, will be deployed across a mix of park connectors, and forest cores and edges.

Of particular importance to the team are locations such as the Rail Corridor and northern park connector loop – the latter connects Admiralty, Woodlands, Mandai and the Central Catchment area.

Mr Shri Lak Nanjan Chandran, one of the researchers in the NUS team, said: "They are of interest because on top of being frequented by people, there's a lot of green vegetation – so this will help us determine if the macaques are also using these spaces."

In humans, malaria is typically thought to have been caused by four different parasites from the genus *Plasmodium*. These four parasites are known to naturally live, grow and multiply in human hosts.

But in recent years, a fifth parasite has come to global attention. In 2004, a team of researchers sounded the alarm that the parasite *Plasmodium knowlesi* (*P. knowlesi*), which mainly replicates in long-tailed macaques, was also detected in humans.

Even Singapore's National Centre for Infectious Diseases considers the disease caused by *P. knowlesi* an "emerging infection" in

South-east Asia.

In 2007, Singapore recorded its first human case of locally acquired *P. knowlesi* infection, in a 20-year-old soldier in the Singapore Army, who had trained in forested areas where monkeys are commonly seen.

Subsequently, four more cases of human *P. knowlesi* infection were detected here in 2007, followed by another in 2008 – all among military personnel who had spent time in the forest.

In the Republic, no further cases were detected in humans after 2008.

A study published in 2021, however, found that the malaria-causing parasite was still prevalent within some macaque populations in Singapore.

*P. knowlesi* was detected in 80.5 per cent of 379 long-tailed macaques sampled between March 2009 and March 2017 from the Western Catchment area, a fully militarised zone.

Though monkeys living in other green spaces tested negative for malaria, Mr Lak said this may change as monkey troops are displaced by development.

Research projects like this can thus help to inform surveillance and mitigation strategies, he added.

For example, if hot spots where humans and animal vectors (animal carriers) intersect are known, government agencies like the National Environment Agency (NEA) could deploy more traps in these places for vector monitoring.

Such traps include the Night Catcher, which was designed and optimised for use in forested areas, Mr Lak said.

The NUS team's research is part of a larger bucket of projects funded by the Climate Impact Science Research programme, which is led by NEA.

Acoustic monitoring is not without its limitations, however.

## Monitoring zoonotic disease risk using sound

A group of NUS researchers is pioneering the use of a specialised recording device – the AudioMoth – to identify areas in Singapore where humans may come in contact with wildlife that are potential vectors of zoonotic diseases.

### What is the AudioMoth?

- The AudioMoth (right) is a compact, specialised recording device used to record the sounds of animals such as monkeys, bats and birds.
- Each device is smaller than the human palm, and powered by three AA batteries.
- In Singapore, the device is placed in a green plastic casing, which shields it from humidity and rain, and secured to the trunk of a tree (below), at the researchers' eye level.
- The whole set-up is housed within a metal cage, which prevents animals from tampering with the device.



### How does it work?

- The AudioMoth device is left in the wilderness to record sounds.
- The researchers return to replace the batteries and collect data (via SD card) from the device every two to three weeks.
- The researchers run the audio through an artificial intelligence



model to detect calls of the long-tailed macaque.

- When studied alongside other data sets, this allows researchers to identify the areas where there are overlaps between humans, mosquitoes and non-human primates, several of which are hosts of vector-borne diseases

like malaria.

- Pilot studies are currently being conducted on Pulau Ubin and in Mandai's Night Safari, and the project will expand nationwide in September.

Source: NUS SAW SWEE HOCK SCHOOL OF PUBLIC HEALTH

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According to Mr Lak, the recorded audio can be used to detect whether monkeys are present, but not how many there are.

These devices also ineffectively capture sound in green spaces where noise levels are high, such as parks close to the Changi and Seletar airports – where monkey calls may be masked by the roar of a passing plane.

Instead, acoustic monitoring data could be used alongside information collected via other methods, such as camera traps or researchers' direct observations in the field, Mr Lak said.

Research projects such as this, which span domains like health and environmental studies, should be the way forward for the Republic, said Dr Chelsea Baker, a research fellow with the NUS team.

"Climate intersects with disease, and you can't separate human health from animal and environmental health – these things are very intertwined and interconnected."

Associate Professor Adrian Loo, deputy director of NUS' Centre for Nature-Based Climate Solutions and who is not involved in the research, said the team's work helps

to fortify disease surveillance not just in Singapore, but also across South-east Asia.

He said: "The bioacoustics sensors can collect data 24/7. This can support field observations by researchers, which is usually limited by how much time one can spend in the field."

"They are also applicable not just in Singapore, but regionally, where vectors can have a larger range – bioacoustics may hence be helpful in extending coverage (over bigger areas)."

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