

# Saving the banded leaf monkeys

Genetic sequencing enables researchers to find ways to prevent extinction of species



Audrey Tan

Shy and elusive, the banded leaf monkey stays hidden in Singapore's forests, well away from people and human homes, unlike its cousin, the long-tailed macaque.

That reclusiveness and the small population size are why researchers have not been able to learn much about the critically endangered species here, except that they dwell in forest canopies and rarely descend to the ground.

Now, state-of-the-art genetic sequencing has allowed researchers from the National University of Singapore (NUS) to find out more about the monkeys, including their diet and biology, from their stool – which has enabled the team to come up with strategies to protect the species from extinction here.

Research showed in 2011 that there were probably only about 40 banded leaf monkeys here. In contrast, long-tailed macaques numbered more than 1,000.

The banded leaf monkey is largely black but sports white bands along the underside of its body and limbs, while the long-tailed macaque – the species that has made headlines here for disturbing people – is covered in brown fur.

The banded leaf monkey is found in other places such as Indonesia, but “there is reason to believe the species is in decline, considering the extensive habitat loss that has taken place”, according to the Red List of Threatened Species published by the International Union for Conservation of Nature (IUCN).

The IUCN listed the banded leaf monkey as “near threatened”, but added that it “almost qualified as threatened... (and) it will be necessary to reassess this species”.

The animals were once widely found here, but their numbers plunged to an abysmal 10 in the 1980s because of habitat loss and, for a long time, they were thought to be on the verge of extinction.

Between 2008 and 2011, NUS re-



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There might be only about 40 banded leaf monkeys (above) left in Singapore, but critical research by biological science students Amrita Srivathsan (bottom left) and Andie Ang could help craft new ways to rejuvenate the species here, for instance by re-connecting the fragmented population through “wildlife corridors”.

searcher Andie Ang set out to discover more about them, as part of her master's degree.

For three years, she staked out the Central Catchment Nature Reserve, where the monkeys can be found, to observe them.

She wore the same all-black outfit every time, so the monkeys could recognise her more easily and get used to her presence.

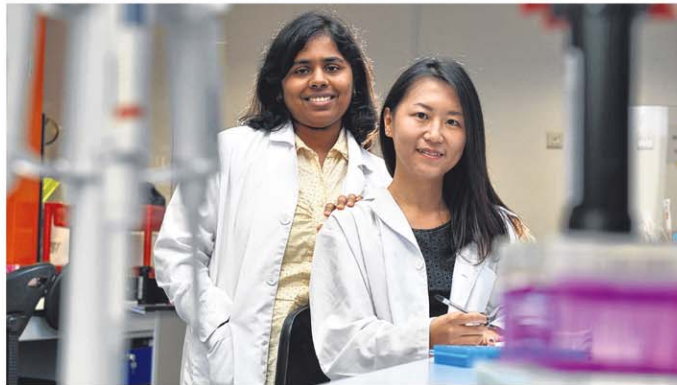
“I cut my hair once and, the moment the monkeys saw me, they ran away – it took another week or two for them to recognise me again,” said Ms Ang, who is now 29 and a doctoral student at the University of Colorado Boulder.

Finally, after about a year, she was allowed to venture within 30m of a troop of the monkeys and observe their natural habits up close.

She collected six stool samples and, later, a blood sample from a pebble where the carcass of one of the monkeys had lain after it was hit by a car. The body had been removed by the time she got there.

She found that the population had slowly grown over the decades to reach a more promising 40 in number. But the faecal and blood samples showed that the monkeys were very similar genetically – a possible sign of inbreeding, which could put them at risk of being wiped out by a single disease.

“A decline in the genetic variability of a species with as small a population as the banded leaf monkey means it is likely that the individu-



als are more prone to diseases,” said NUS biologist Rudolf Meier, who supervised Ms Ang's work.

Professor Meier, who heads the Evolutionary Biology laboratory where the genetic work was carried out, added: “The native population in Singapore could be well adapted to cope with viruses or intestinal parasites, but this might not be the case for diseases carried by monkeys from other populations.”

In 2010, Ms Amrita Srivathsan, 26, a doctoral student in the NUS-Imperial College London joint PhD programme, built on Ms Ang's work by doing a more thorough genetic analysis of the faecal samples.

She found that the monkeys fed on plants such as the rubber tree and figs. More information was al-

so obtained about their intestinal parasites.

She said the new data would allow conservationists to design “wildlife corridors” using trees and plants that make up the monkeys' diet. Such corridors could expand their habitat, while enabling separate troops to travel along them and eventually meet to mate and improve their genetic diversity.

“A wildlife corridor could re-connect the fragmented population, now separated by artificial urban structures,” Ms Ang said.

However, Prof Meier noted, preventing inbreeding might do little to increase genetic diversity, given the low diversity levels of the banded leaf monkey population here.

“For example, even if there were

1,000 animals in five separate populations, getting them to cross-breed would not help much to increase genetic variability if all of them were the result of inbreeding.”

Another possibility is introducing banded leaf monkeys from other countries to boost genetic diversity. However, factors such as genetic compatibility and susceptibility to diseases must first be considered, Prof Meier said.

Dr Geoffrey Davison, deputy director of the National Biodiversity Centre at the National Parks Board (NParks), said it had received preliminary findings from the banded leaf monkey research.

“NParks will take the findings into consideration in managing the endangered monkeys' numbers and genetic variability,” he said.

Prof Meier, also deputy head of the NUS Lee Kong Chian Natural History Museum, said the university and museum hope to do similar genetic work on leopard cats, assassin bugs and other endangered species, to help conserve them.

“Before, we had to observe feeding to find out what a species fed on. Now, we can use indirect forensic techniques.”

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## Two species native to Singapore

### Banded leaf monkey

■ Shy and reclusive, the banded leaf monkey dwells mainly in forest canopies and rarely descends to the ground.

■ Native to Singapore, Indonesia, Malaysia, Myanmar and Thailand, it can grow up to 84cm in length, including its tail.

■ Due to habitat loss, the monkey is considered a “near threatened” species on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

■ Although banded leaf monkeys were once widespread here, there are now only about 40 of them in Singapore, according to 2011 research findings.

■ These monkeys can now be found only in the swampy forests of the Central Catchment Nature Reserve. The last one in Bukit Timah Hill, an elderly female, was mauled to death by dogs in 1987 when it ventured to the ground.

### Long-tail macaque (below)

■ Including its tail, the long-tail macaque can grow up to 56cm in length.

■ The monkey is native to countries such as Singapore, Bangladesh, Brunei, Cambodia, India, Indonesia, Laos and Malaysia.

■ It is listed as a species of “least concern” on the IUCN Red List, as it is widely distributed and has a large population.

■ In Singapore, there are now more than 1,000 long-tail macaques. In 2013, the authorities culled about 570 of them – nearly a third of the estimated 1,800-strong local population.

■ The original habitat of these monkeys is mangroves, but they can now also be encountered in parks and urban areas such as Bukit Batok Nature Park and Sentosa.

■ The monkeys are often known to be a cause of human-animal conflict when they venture into residential areas in search of food.

**Audrey Tan**  
Sources: IUCN, Ecology Asia, Wild Singapore, National Parks Board

