

# Heaven is where there are Mahua trees – and their bat friends

by Bhanu Sridharan on 19 June 2018



- *The Mahua tree (Madhuca longifolia) dots the dry tropical forests of southern India. Indigenous communities use the bark of the tree as medicine, the fruit as food and of course the flowers as an intoxicant.*
- *Starting from a misconception that bats eat up Mahua flowers, researchers have discovered that bats actually pollinate Mahua, and disperse its seeds.*
- *Smaller bats like the tiny short-nosed fruit bat and the mid-sized Leschenault's rousette dispersed seeds over shorter distances, less than 100 m. The large flying foxes dispersed seeds over as much as seven kilometres.*

It was while studying the breeding and courtship behaviour of short nosed fruit bats that biologist Parthasarathy Thiruchenthil Nathan began to examine roosting sites around every house from the ancient temple

town of Tirunelveli to the town of Kutralam at the edge of the southern Western Ghats.

Even though the aim was to look up at the bats hanging from palm trees, Nathan, curious to see what they were eating, started to look down at the remains of their meals. "Most of the sites had left over fruits, flowers and seeds of the Mahua tree," he said. He began reading about the plant. No tree has come to symbolise the dry tropical forests of Peninsular India like *Madhuca longifolia*, called *Mahua* in Hindi and *Illupai* in Tamil. Indigenous communities use the bark of the tree as medicine, the fruit as food and of course the flowers as an intoxicant.

"Heaven is where there are Mahua trees and hell is where there is no mahua tree to make wine," Nathan recalled reading one version of a popular Gond saying. "That's when I became interested," he said. From the scant literature that was available in 2004, Nathan learnt that fruit bats were believed to eat up Mahua flowers, ruining the tree's chances of bearing fruit.



*Mahua* is a treasured plant species across Peninsular India. Photo by Dinesh Valke / Wikimedia Commons.

## The bats help, too

To find out if this was really true, he spent three years observing Mahua trees in the Madurai Kamaraj University in Tamil Nadu. In a 2009 paper (<http://www.bioone.org/doi/abs/10.3161/150811009X485657>), Nathan and his colleagues reported that two species of fruit bats – the gigantic

Indian flying fox *Pteropus giganteus* and the diminutive short-nosed Indian fruit bat *Cynopterus sphinx* – did indeed eat Mahua flowers. But far from destroying the flowers, the bats actually pollinated them.

“The bats only removed the fleshy corolla of the flower,” spreading pollen to the female parts as they moved from one flower to the other, Nathan explained. And the plant could use the help. Although Mahua can pollinate itself, the study showed that the flowers pollinated by bats yielded many more fruits.

This wasn't all. Four years after the pollination study was published, Nathan moved to Periyar University, Salem, and began to work with a PhD student, Valliyappan Mahandran.

Mahandran was interested in studying how fruit bats interacted with plants of a specific type. “I was particularly looking for [the] plants that are exhibiting 'bat fruit' and 'bat flower' syndromes,” he said. Nathan directed him towards fruiting Mahua trees.

### **The Mahua flower is designed for bats**

Ecologists have long believed that plants have a variety of strategies to attract pollinators and seed dispersers. Colourful flowers attract butterflies and bees to feed on their nectar while fruits that are red, yellow and black attract more birds.

Since fruit bats are nocturnal, colourful fruits or flowers make little sense. For trees to attract bats, they had to produce large white or pale yellow flowers that bloomed nocturnally and had a lot of nectar, explained Mahandran.

Similarly, he added that attractive fruits would be green when ripe, large and hang free of the canopy so that large animals like flying foxes could access them. Since, fruit bats searched mostly by scent, bat flowers and fruits had to have strong odours. The Mahua tree seems designed to attract bats.



*Ecologists believe that the flowers and fruits of the Mahua tree have evolved to mainly attract bats as pollinators and seed dispersal. Dull colour, blooming in the night, hanging in the open and a rich strong odour are some of the traits that help catch the attention of bats. Photo by Dinesh Valke / Wikimedia Commons.*

In a study

(<https://www.sciencedirect.com/science/article/pii/S2351989418300027>)

published in the journal *Global Ecology and Conservation* in May this year, Mahandran, Nathan and their colleagues reported that the Indian flying fox, the short nosed fruit bat and the Leschenault's rousette *Rousettus leschenaultii* fed on Mahua fruits.

Mahandran observed two Mahua trees in Karaikudi, a small village from the drier Northern part of Tamil Nadu for two years and noted important differences in the bats.

The tiny short-nosed fruit bat and the mid-sized Leschenault's rousette never fed directly from the tree. They plucked the fruits and carried them to an adjacent feeding roost, typically neem and mango trees in the area. The two smaller bats dispersed seeds around 30-70m away from the parent tree. It doesn't sound like much but moving and growing even a few meters away from the parent tree gave young plants a chance to establish, explained Mahandran.

### **Flying foxes go batty for Mahua**

Unlike the smaller bats, seed dispersal was much more complicated with the Indian flying fox. Small bats carried fruits away to other known safe roosts, so that they could eat without fear of predators like owls.

On the other hand, flying foxes, the largest bat species in India, often fed on fruits directly from the Mahua trees and dropped seeds right under. The only thing these giant bats feared were their own kind. Studies have shown that when a large crowd of flying foxes descended on a single fruiting tree, especially what Nathan calls a big bang tree – one that produced a lot of fruits for a short period of time – the bats competed aggressively for the fruits. “You can see the craze, whenever a Mahua tree is fruiting.”

When the encounters got too violent, at least some individuals would carry fruits away from the tree towards their feeding roosts.

In the present study, only 13% of all flying fox visits to the Mahua tree resulted in fruits being carried away from the parent tree. But whenever they did fly away with fruits, they dispersed seeds as far as seven kilometres away from the parent tree.



*The Indian flying fox feeds on fruits directly from the Mahua tree, except in the case of tough competition from fellow bats. When they do carry fruits away, they can disperse seeds several kilometres away from the parent tree. Photo by V. Mahandran.*

Could this sort of conditional seed dispersal be considered useful compared to the smaller bat species?

Kim McKonkey, based at the Malaysia campus of the University of Nottingham (<https://www.nottingham.edu.my/index.aspx>), disagrees.

McKonkey who was not part of these studies, was the first researcher to

observe the flying fox dispersal conundrum. Writing from her field site in Thailand, she points out that flying foxes' role should be seen as complementary to that of the smaller bats in the study.

"While *Pteropus* did disperse the majority of seeds beneath the parent tree, they were also the bats that had the potential to move seeds the longest distances," she said. "Both roles may be required to ensure regeneration of the species (regular local dispersal, rarer long distance dispersal)."

Did this mean, that commercial species like the Mahua, which were grown in plantations, be lost without bats? Mahandran believes so but Nathan and McKonkey are more cautious.

Mahua fruits were eaten and dispersed by other animals like monkeys but pollination, Nathan pointed out may entirely rest on bats. With a few exceptions, McConkey believed that it was unlikely that a plant species would be reliant on bats in Asia, "but this could be a result of our ignorance of their diets."



*The short nosed Indian fruit bat carries a Mahua fruit to a nearby temporary roosting site to feed and disperses the seed in the process. Photo by V. Mahandran.*

Part of the problem seems to be the lack of studies. "One of the strengths of Mahandran et al's paper, is the quality of the dispersal observations and measurement of dispersal distances," she said. "For the majority of bat species, we are not even certain what species [fruits] they consume."

What does the future hold for fruit bats and trees from heaven? We may have to wait a long time to find out. Having finished his doctoral work, Mahandran has moved on to a post-doctoral position studying how bats locate fruits.

Nathan on the other hand is unsure of the future of this research. "I am not getting students willing to do field work in the forest," he said ruefully. "Everybody wants to be in a lab."

**CITATION:**

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