

A dusty road that snakes through areca nut plantations and forests leads one to Jegala, a hamlet wedged between the Sharavathy hydel reservoir and the hills of the Western Ghats in Karnataka's Shivamogga district.

Late on Christmas eve, Shwetha J.S., 17, a student and resident of the neighbouring town of Sagar, came up this road to spend the holidays with her family. In the morning she was at their plantation, taking photographs with her father, Devaraj, 42, who was a farmer, and the farm help, who shimmied up the slender areca tree trunks to harvest nuts. There was also something more – the faint smell of rotting carcass, but this did not dampen her joy.

Shwetha had her examinations coming up in the next few months. She was aware that she could be the first in the family to enrol in an undergraduate course. Her ambition was to get a doctorate degree in agriculture to help her father fight the diseases that often ravaged their plantation.

After she left for Sagar on December 27, her family scoured the plantation and the nearby woods for the putrid odour that had by then become unbearable. Their search led to a highly decomposed carcass of a monkey in a ditch nearby. State forest department and health officials then burnt it and doused the area with a strong insecticide. By this time, however, nymphs, or young ticks, that had feasted on the monkey before its death had already spread.

On December 28, Shweta was admitted to a hospital in Sagar as she was running a high fever. She was diagnosed with Kyasanur Forest Disease (KFD), a viral haemorrhagic disease endemic to the region. Better known as 'Monkey Fever', KFD is primarily transmitted through ticks – in short, a tick-borne zoonotic disease. Doctors treat only the symptoms, for KFD has no known cure.

Shwetha's mother Lata, 37, a tailor and beautician, was trying hard to control her panic. Devraj had been diagnosed with KFD too, and was also suffering from bacterial leptospirosis (rat fever). He was taken to Manipal hospital, 150 km away, while Lata devoted her time tending to Shwetha, who seemed to be recovering.

On January 2, Lata arrived in the hospital in the evening, planning to spend the night with her daughter. But, says Lata, choking on her words as she struggles to talk through uncontrollable sobs, "Shwetha looked at me, and said 'Amma, you're here'. Then she collapsed."

Shwetha went into a coma. On January 4, she was pronounced dead.

A day after Shwetha's visit to the plantation, the Aralagodu Gram Panchayat, which encompasses multiple hamlets including Jegala, registered its first case of Monkey Fever death. Shwetha was the sixth victim in Aralagodu. The toll has since risen to eight.

An old menace

In the current outbreak in the State, at least 65 people have tested positive for KFD, but the number of suspected cases –awaiting confirmation through blood tests – has touched 204. At least 38 monkeys have died in the plantations. Aralagodu is the epicentre of the outbreak, but infected areas are also being reported in villages across four districts of Karnataka (Shivamogga, Udupi, Dakshina Kannada, and Uttara Kannada) - and in Kerala (Wayanad) and Mahārashtra (four cases).

KFD virus is no stranger to Shivamogga, first reported in Kyasanur village in this district, about 30 km from Jegala, back in 1957. The virus belongs to the Flaviviridae family, whose other members are responsible for causing Yellow Fever, Zika and Dengue. Multiple species of ticks of the genus *Haemaphysalis* are the principal vectors. Infections peak between November and March, which coincides with the larvae-nymph cycles of ticks.

But little else can be said with certainty. Since 1957, it has flared up in sporadic outbreaks Post-2013, it has even expanded its range, with fatal consequences in Maharashtra, Kerala and Goa. According to State data, in the past 15 years, KFD has infected 2,067 people and killed 42. (The International Society for Infectious Disease estimates 3,836 infections and 98 deaths between 1999-2017 through the country.) The horrific spike in the number of deaths in one village/district in Karnataka, in the last one month, has taken the civic administration completely by surprise.

As uncertain as KFD's spread may be, what is increasingly clear is that the outbreak in Aralagodu was aggravated by systemic failures and lax monitoring of a disease that has lurked in Shivamogga's fragmented forests for over six decades.

Back after 12 years

Visitors to Aralagodu village are greeted by posters that warn them about Monkey Fever. A habitation of barely 3,000 people, located a few kilometres from the Jog falls, it has been hit hard by the disease. Ambulances ferry those with persistent fevers every day to hospitals 150 km away. Government vans zip around, reaching out to villagers in remote hamlets to identify and test fevers that could potentially be KFD.

Such is the fear that between January 5 and 15, none of the 49 school-going children showed up at the government



An epidemiological view: "Despite the threat of Kyasanur Forest Disease looming over the district for decades, official responses have been purely reactive." Picture shows an expert team drawing samples from a rat in the Tirthahalli forest area of Shivamogga district. • VAIDYA

Kyasanur's ticking time bomb

Reckless human forays into eco-sensitive forest areas and lax public health monitoring have led to a deadly outbreak of Kyasanur Forest Disease, or Monkey Fever, in Karnataka's Shivamogga district, disrupting normal life and the local plantation economy. **Mohit M. Rao** reports from Aralagodu, the epicentre of the outbreak



primary school here. Says Devendra Naik, the school headmaster and who travels to work from a nearby town, "We tried to convince the parents that the school was safe. But how can we convince them when we ourselves are scared to come to the village?" When classes resumed from January 16, nine children showed up.

All the activity in the village is centred around the two-room primary health centres (PHC) which are perched on a hill. The telephone rings every few minutes and a steady stream of villagers make their way to meet Nitin Patel, the resident doctor, with complaints of fever and body pain.

The 24-year-old doctor was posted here six months ago as part of the year-long rural stint which is mandated at the end of an MBBS course.

Initially, things were a bit dull for him, with most villagers relying on an array of medicinal herbs to treat ailments. But early in November, Padmavathi, 35, from Nellimakki hamlet, came down with a fever that refused to subside. A few days later, her husband Komraju, 38, too developed similar symptoms. They live on the fringes of the forest on the outskirts of the village. Says Padmavathi, a scrawny areca nut farmer, "None of the medicines given at the PHC worked. It was a fever unlike anything I had experienced."

A bewildered Patel sent her to a hospital in Sagar for further tests. On November 24, it was confirmed to be a case of KFD, a disease which had not been detected in Aralagodu for 12 years.

Says Patel, "It's been a scramble since," recollecting that his medical college textbooks had just a single paragraph about KFD. A small group of officials now help him oversee the stream of patients. Says Patel, "The outbreak is difficult to contain as forest patches and a large number of monkeys create a conducive atmosphere for ticks to breed."

Though a vaccination programme began on November 30, it was too late for Aralagodu. The first dose hardly provides protection, while the efficiency of the second dose (administered after a month) is only of 63% efficacy. Of the seven dead, two persons had received

their first dose, while one had been administered the second dose. The demographic group most vulnerable to KFD are people more than 40 years old. But three out of the seven dead are between 17 and 31 years, suggesting an incredibly high viral load.

A State Health Department official sums up the situation bluntly: "After the fire has broken out, we're now searching for water to douse it." Interviews with villagers, experts and government officials reveal that the inflammable cinders of this 'fire' were sighted nearly a year ago.

Protocols that failed

In April 2018, one person tested positive for KFD, in Bidarur village. As in established protocol, everyone within a 5 km radius needed to be vaccinated. However, officials drove down 5 km from the infected spot, which, in the undulating landscape, led to the identification of just 500 people. Bidarur was fortified against the outbreak, but Aralagodu, on the other side of the hillock, was left unprotected against a ticking time bomb.

Despite the threat of KFD looming over the district for decades, official responses have been purely reactive. The KFD field station was set up in Sagar to monitor monkey deaths and to randomly test ticks. Started by the Rockefeller Foundation and researchers of the Indian Council of Medical Research (ICMR), immediately on discovery of the disease, it transitioned from a research station to a surveillance station in the years since. But three posts in this field station have been lying vacant for nearly a year. The post of 'District Epidemiologist', who tracks diseases in populations, is being filled only now. Instead, junior officers – unvaccinated and untrained – have been pressed to the front lines.

While vaccines provide only a certain level of protection, they are an important preventive measure. The KFD vaccine, which causes acute pain and is not very efficient, has not been improved upon since the 1990s. Its only manufacturer is the Institute of Animal Health and Veterinary Biologicals in Bengaluru, which otherwise specialises in livestock vaccines. Until September, only 35,000 vials had been procured by the district administration. Junior officials assumed that Bidarur's infection had been dealt with. Now, containing the outbreak is the responsibility of Kiran S.K., a Taluk Health Officer in neighbouring Tirthahalli, who was recently put in charge of the KFD field station in Sagar. His mobile phone rings incessantly as local leaders who are clearly panicky, demand that their villages be vaccinated on priority. "We don't have enough vaccines to do this," says the soft-spoken officer.

Last year, when Tirthahalli was the focus of a minor outbreak, about 23,000 vials that are needed for a booster dose (it bumps up immunity to 82%) were procured. But the KFD spectre at Bidarur was lost in paperwork.

Now, the demand is for 70,000 vials. But officials have only 16,000 vials at hand, with monkey deaths and new infection areas being reported daily. Says Kiran, "We just can't vaccinate a 5 km radius any more. We are instead focussing on a core area of 2 km radius to prevent further outbreaks."

It was only in January that nearly one lakh vials were procured from the Bengaluru institute. Now they are being tested for potency at the Virus Diagnostic Laboratory in Shivamogga. The hope and prayer is that the worst is over, as these vaccines will be available only in February.

The genesis

Barely 30 km as the crow flies from Aralagodu, a clump of houses separated by a road marks where Kyasanur is, which is well aware of its association with KFD. As it happens, the village is not much older than the disease itself. Huchappa, 77, was a boy of 10 when his father carved out a small piece of land from the Kyasanur forests to set up a house and a paddy field. Says Huchappa, "Our previous village had become crowded and my father's generation had no land to till. We had to find a new home." Eventually, the hamlet grew in size as the forests receded, giving way to paddy fields and plantations, and the deer scampered away. The monkeys, however, stayed. But by 1957, they were dying in the hordes.

American and Indian scientists thronged the village, believing that these could be the first cases of yellow fever in India. When vaccinated researchers started contracting heamorrhagic fevers, it soon became clear that the affliction was something else. KFD was discovered, and by 1958, 681 persons were confirmed to have been infected. Studies estimate that between 1957-2017, 9,594 persons were infected in 16 districts along the Western Ghats in five States.

Huchappa was infected in the early outbreaks and spent more than a month in the hospital. He says, "I had high fever, I was bleeding, I lost weight. I thought I was going to die." For reasons unknown, the disease vanished from the hamlet three decades ago and found pastures elsewhere. He adds, And yet, people think this is the village that started this scourge."

Until 2013, the disease was largely confined to Shivamogga and its neighbourhood. Since then, it has broken out in Wayanad (Kerala), North Goa, and Sindhudurg in Maharashtra. While the 'how' and the 'why' remain unclear, can the future be predicted?

Tapping the virus reservoir

The first rays of the day penetrate the dense canopy of forests that surround Kudige village, a hamlet close to Tirthahalli town. The 'rodent team' sets out on the chilly morning along a forest path where metal boxes laced with sweets serve as bait-and-cage. The village has 60 such traps spread across

plantations, harvested paddy fields, and around homes.

Says Abhijit Kumar, a research assistant with the Bengaluru-based Ashoka Trust for Research in Ecology and the Environment (ATREE), "Monkeys are a good reservoir for the virus. But rodents could be the maintenance hosts, ensuring that the virus remains in the ecosystem through the year."

Five white-bellied rats and shrews are trapped. An anaesthetic knocks out the rodents providing the team a two-minute window to tabulate physical attributes, draw blood, and collect ticks.

Kudige village, categorised by the team as 'severe' (which denotes more than 10 cases of KFD in five years) for its recent trysts with KFD, is among the 42 sites to be sampled in the region under the Indo-UK MonkeyFeverRisk project. This collaborative initiative of 10 private and government research institutes and the State Health Department seeks to optimise forest benefits while minimising the impact of KFD. Microbiologists, entomologists, epidemiologists, animal health specialists, and social scientists are working together for a better understanding of KFD.

Says S.L. Hoti, Director, ICMR-National Institute of Traditional Medicine, Belagavi, and Principal Investigator of the project, "Different angles are being looked at: from the effect of rodents and ticks on livestock to human behaviour in forests. It is a complex disease and needs a multi-disciplinary effort."

The 'tick team' had first carried out a 'drag-and-flag' operation in Kudige. This involves research associates dragging white sheets of cloth over leaf litter and shrubs. Every 10 metres, they peer into the dirt-covered sheets to check for ticks, which are then collected. They also collect data on temperature, humidity, habitat type, and the presence of invasive plant species known to host ticks in large numbers.

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S.L. HOTI, Director, ICMR-National Institute of Traditional Medicine, Belagavi

K.S. Manjappa, 55 looks on at the process with some curiosity. A decade ago he cleared out a half-acre of forests for his acre plantations, while the forests themselves remains part of his daily routine. Like most villagers, his plantation is technically considered forest land. He says, "We've applied to regularise the land. We've been given assurances from politicians, but nothing has happened so far."

Praying for the rain

At the heart of the Monkey Fever story is a cautionary tale of repeated human incursions into eco-sensitive, ecologically-rich areas. Says Bethan Purse, Principal Investigator and scientist at the Centre for Ecology & Hydrology, Wallingford, U.K., "KFD emerged when the forests

were cut down for roads, mines and plantations. This brought people into closer contact with the virus that was cycling naturally between wild animals and ticks in the forest."

Nearly every study on the disease so far has highlighted the role of forest degradation in the spread of KFD. Kiran, who has helmed multiple research papers on KFD, says that villagers living near highly-fragmented forests are more susceptible to the disease. He says, "Tick densities remain high in these forests, and with the presence of monkeys, peacocks, rodents and other reservoirs, there is always a chance of the disease spilling over to the village. This risk factor is not given its due in the health response to KFD."

Shivamogga district has a dismal record when it comes to forest degradation. About 156 sq km of forests were lost here between 2003 and 2017, according to the Forest Survey of India. The district accounts for 70% of Karnataka's denotified forest land and a third of the regularisation applications seeking the reclassification of forest land as agricultural land. Mass approval of such applications is a politically lucrative move that has made the careers of many a politician.

The scope of the MonkeyFeverRisk project is ambitious: over 15,000 ticks are to be sampled and tested, data from hundreds of rodents collected, hundreds of pages of social surveys, and creation of land-use maps, micro-climate data to be worked on, and so on, with each element contributing a piece in the complex jigsaw puzzle.

A preliminary risk map – a map of the region where the risk of a KFD outbreak is shaded differently depending on the various risk factors – has been prepared and is being verified. As data pour in, Purse hopes that they can determine which communities are at risk when, where and why.

For now, each day presents a new challenge for those in charge of containing the 2018 outbreak. At Aralagodu, villagers are advised to liberally apply insect repellent oil on their bodies before venturing out. There is a ₹500 reward for anyone offering information on monkey deaths.

But anger is rising and protests for compensation erupt each day. The State government has formed an expert committee to investigate lapses and officials have been suspended. Village leaders have submitted petitions demanding the culling of monkeys.

Agriculture, their mainstay, has come to a halt and vast swathes of plantations remain unharvested. Says Mahabala Giri, 58, "People are scared to enter plantations, and we do not want to take the risk either." He estimates that he stands to lose about ₹3 lakh on account of the unharvested areca nut on his 5 acre farm. He does not know why KFD has taken Aralagodu hostage this year. But he knows when it will end. "We will pray for early rains. If it pours, the ticks go away."