Dengue: Fever Pitch

Mozzies go for upgrades too

The enemy adapts to changing conditions — and fast. Lee Hui Chieh and Judith Tan find out more.

The dengue-carrying Aedes mosquito bites only during the day, breeds in clean water and can fly a distance of just 50m to 100m.

True?
Not necessarily so, says Singapore’s National Environment Agency (NEA). Research by the agency’s Environmental Health Institute has shown that the Aedes mosquito can bite at night under artificial light, can breed in water contaminated by repellent and can fly as far as 740m.

When push comes to shove, the enemy will adapt. And scientists have found mosquitoes to be quick at adapting to a changing environment.

There are two known dengue-spreading Aedes mosquitoes here: the Aedes aegypti and the Aedes albopictus.

Both have black and white stripes on their legs but the aegypti has two lyre-shaped silver markings on its body, while the albopictus has one central line running down its body.

The aegypti is seen as a bigger menace than the albopictus as it tends to be found more often indoors than outdoors and as it tends to take multiple bites, often from different people, instead of just one bite like the albopictus.

The Aedes mosquito is usually thought of as being active during daylight hours, with the peak biting periods being dawn and dusk.

But studies have shown that it bites under artificial lighting too, so people at home and in offices at night may not be as safe from dengue as they think.

Another study has demonstrated how the Aedes mosquito can adapt to poor breeding conditions.

It usually lays eggs in clean stagnant water, avoiding dirty water. However, the study found that mosquitoes bred in water contaminated with repellent grew up to not exhibit any preference — dirty water no longer bothered them.

This means that if the mosquito has no choice, it could lay eggs in dirty water, breeding a new generation that will not have any problems doing so.

In another study published last year, the institute’s medical entomologist and researcher, Dr Christina Liew, found that the Aedes mosquito can fly as far as 740m and as high as a 21-storey building, or 60m high.

She released female mosquitoes that had been fed blood with a special marker and tracked where they laid their eggs. The mosquitoes’ mouths had been sealed shut with super glue to ensure they died after laying their eggs.

In a rural area, where there was just open land, the marked eggs were found as far as 740m away from the place where the mosquitoes had been released. In an urban area with buildings, they were found 568m away.

In an unused apartment block with no working lift, they were found quite evenly distributed over the building’s 21 floors.

It had long been believed that the Aedes mosquito operated over much shorter distances and at lower heights.

“We have removed a lot of their breeding sites so they are now forced to fly further to find suitable sites,” explained Dr Liew.

“It’s possible for them to adapt to conditions that were previously thought to be unfavourable, and that’s why although vector control is so good, mosquitoes continue to breed.”

The current breed of mosquitoes is a result of selection and adaptation, said Associate Professor Rudolf Meier from the biological sciences department at the National University of Singapore.

“Every time we generate a new environment, some genetic strains of the mosquito will have a breeding advantage over others that are not as good at using the resources in the environment. The mosquitoes with the better means of exploiting the resources will replace those that are less capable,” he said.

“Is this through learning? No. Mosquitoes have little chance to learn. They never meet their parents and live for only a few weeks. But there is plenty of evidence that sophisticated behaviour can have a genetic basis.”

He added that when a population of mosquitoes is treated with insecticides, a small fraction of them will be naturally resistant to the chemical.

“Given that most of the ‘normal’ mosquitoes would have been killed by the insecticide, the few resistant survivors would have all the breeding sites in the environment at their disposal. They very rapidly rebuild the population, which now consists of mosquitoes that have genes conferring resistance to the insecticides and treating this population with the same insecticide again will be largely ineffective,” he explained.

He suggests that the only way around the problem is to resort to fogging and spraying only during a dengue outbreak. This will quickly reduce the size of the mosquito population to prevent infection.

“Fogging during an outbreak in the affected area is a good idea as long as it still kills any of the adult mosquitoes. The chance of getting infected is largely proportional to the number of people in a specific area.”
upgrades too

mosquitoes in the area, that is, even a relatively small reduction in numbers can make a difference.

"Fogging in areas without an outbreak is more problematic because the fogging starts a selection process for resistance. Once the population has a high proportion of resistant mosquitoes, it will be difficult to reduce the number of adults quickly when an outbreak occurs," he said.

Regular fogging, he said, will kill not only the mosquitoes but also their natural enemies, making the mosquito problem more serious. "This leaves a stronger and more lethal mosquito population that would be increasingly difficult to deal with."

The NEA is looking into how to enhance measures to deal with new information about the mosquito's behaviour.

So, what does all this mean for the individual?

"Don't be complacent about where the mosquito can be found; it could be in your home," Dr Liew said.

The war continues.

E-mail: huichieh@sph.com.sg
juditht@sph.com.sg

Dr Liew will be speaking at the dengue forum on Sunday organised by Tan Tock Seng Hospital and Mind Your Body.