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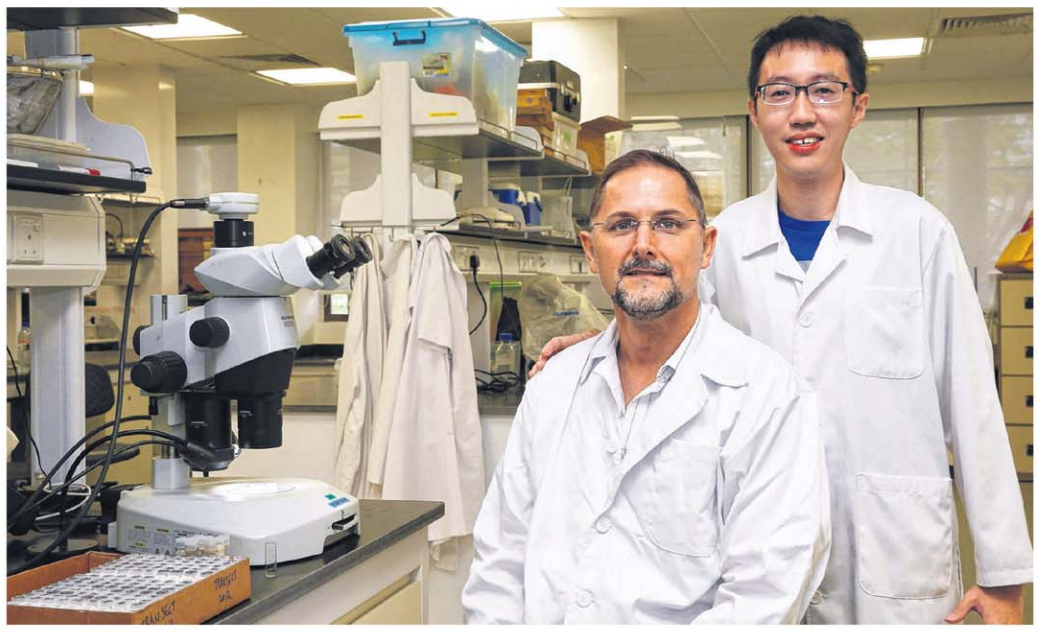
[I AM A SCIENTIST]

Don't let those creepy-crawlies bug you

NUS entomologist Theodore Evans is fascinated by insects, termites in particular

Samantha Boh



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Associate Professor Theodore Evans, from the NUS department of biological sciences, and PhD student Aloysius Teo, 27. Mr Teo is studying decomposition in forests to understand how matter is broken down and recycled.

■ You study termites, spiders and other invasive species, which many people are afraid of, and see as pests. How did your interest in them develop?

There are a few reasons. I like all plants and animals as they are all interesting. Insects and spiders – they are called arthropods – are incredibly diverse and incredibly abundant, so they are very successful.

It's about trying to understand why they are so successful, why there are 350,000 species of beetles but fewer than 10,000 species of mammals, why they do so well.

Another reason I am particularly interested in is social behaviour. So I am mostly interested in the social ones: the ants, the bees and the termites. The thing about social insects is that most of them are sterile. So how did they evolve to become sterile and not become extinct?

■ So why are they not extinct?

The answer is inclusive fitness. Direct fitness is when an organism has offspring directly. Inclusive fitness is when an auntie or an uncle does not have the offspring but helps the parents, so the offspring has a better chance of survival.

In some situations, if everybody tries to reproduce, nobody will succeed because, for example, there are not enough resources or the resources you want are too difficult to obtain.

The group shares the resources and then some of them can reproduce and you get some indirect reproduction because you share your genes.

■ Are there things about termites that might come as a surprise to people?

Termites are blind except for the king and queen, which use their eyes only when they fly. They perceive the world through touch, taste and smell. They use vibrations a lot, so they sound an alarm by banging their heads on the ground.

They can also tell how big a piece of wood is by chewing on it. They chew on one edge and that will create vibrations and there will be a harmonic frequency depending on how big the wood is. So a big piece of wood will have a different harmonic from a smaller one.

You might want to know they make four kinds of "poo".

The first kind is not poo at all; it is digested food, basically like baby formula, and they feed it to the babies and king and queen.

The second kind of poo is partly digested food and they mostly feed that to each other. So if somebody's hungry and says "give me a snack", they will give him that.

The third kind of poo is cement. When they build – you have seen termite mounds and mud trails which come up inside buildings – the soil particles are held together with a cement glue, which is another kind of poo.

And the fourth kind of poo is real poo. And they actually have a latrine, they go and poop in a latrine in the colony.

■ You recently published a study on the evolutionary history of termites. What were some of your findings?

The paper uses the mitochondrial genome. The mitochondrion is the part of the cell which takes the food and produces the energy that keeps the cell alive. It has its own DNA.

Up until now, people have mostly tried to look at smaller parts of the mitochondrial genome and used only 600 to 2,000 base pairs (chemicals which make up DNA) of information. We are using the whole mitochondrial genome – 16,500 base pairs – so we are basically using a lot more of information on its genetic make-up.

The other great thing is that we estimated the time since divergence (of species). You can calculate when two groups part, when their last common ancestors lived. We found out that termites are a 170 million years old, that's when they split from cockroaches. This is about 40 million years older than previously thought, based on just termite and cockroach fossils. At that time, all the continents of the world were still squashed together as one big mass called Pangaea. But the majority of termite species appear to have originated in what is now Africa between 30 million and 50 million years ago and spread from there to the rest of the world.

■ How are termites different from cockroaches?

The termites do not grow all of the adult features of a cockroach, they stay more "child-like". It is the same thing for humans and chimpanzees. If you look at a baby chimpanzee and a baby human, we look pretty similar up to a certain age and the humans sort of stop maturing. We stop growing in that way and we retain more child-like features, and the chimpanzees keep maturing especially with obvious things like big jaws and big teeth and so on.

Termites also always live in family groups comprising the mother (queen), father (king), and between 200 and two million offspring. The only time they don't is when the daughters and sons leave home to find mates. That is the only time in their lives that they are solitary, which lasts a couple of hours.

Cockroaches are solitary. For most cockroaches, the female mates, lays her eggs, which would be in an egg case (a protective suitcase), and dumps it. Eventually they hatch and they have to look after themselves.

■ What is the significance of your latest findings?

Part of it is that we know that not all termites are found in every part of the world, which raises the question of how they got around the world, how they travel. That is what our next stage is. This study has 66 species, which is the largest study of its kind, and we are trying to do one with 500. Before this, the biggest similar study was done with only 12 species in 2012. So now we would love to study how they got to Africa from other places and how some groups probably evolved in other places and spread.

■ Do you think insects are intelligent?

We talk about what appears to be collective intelligence. So any one termite has a very small brain and it makes decisions on very simple rules. If X, then Y; if A, then B. If I am hungry, I walk to the food source. If you have a million of them and they work together, those simple minds can complete complex tasks which make them seem intelligent, such as building a termite nest, which is one of the most complex forms of architecture in nature.

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HE SWITCHES STUDENTS ON – WITH TALES OF 'CRAZY' LIVES

Making discoveries and sharing new knowledge with the public are some of the perks of his job, says Associate Professor Theodore Evans, 47, who is with the biological sciences department of the National University of Singapore.

"I think one of the things that scientists like the most is trying to understand something and explain it," says the insect expert, an Australian with a PhD in zoology from the University of Melbourne.

As a boy, he would seek out animals and plants at the forest near his home.

He got the chance to examine them seriously as a student at James Cook University in Queensland, and later at the University of Miami in the United States and the University of Western Australia.

He chose to focus on insects partly because they offer opportunities to conduct larger experiments. The sample size of experiments on insects such as termites can run into the thousands, which makes the results statistically more significant, he notes.

He also finds it less ethically challenging to experiment on insects than on mammals.

"It is one thing to run an experiment on termites, which have half a million neurons (nerve cells)," he says. "A lower monkey has a much higher intelligence (about seven billion neurons) and the ability to show emotion. It would be harder to subject one to complex experiments."

Since he moved here in 2011, he has tried to inspire NUS students, so they can share his passion for the subject.

"It is a real pleasure when students understand – when they get switched on," he says.

He tries to flip this switch by recounting stories about bugs and their "crazy" lives and habits, which he believes even the most bizarre science-fiction films cannot match.

Taking the popular movie Alien as an example, he points out that the life cycle of the alien creature is basically that of the parasitic wasp. This wasp lays its eggs in the caterpillars of other species, and the host insect is later eaten alive by the wasp larvae.

"When you can show students examples of how life is so amazing, that experience often is inspiring," he says.

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