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Clues to evolution on the wings of butterflies

Scientists in S'pore are studying if spots on insects will shed light on speed of evolution



Feng Zengkun
Environment Correspondent

A butterfly flaps its wings, and a hurricane happens half a world away, or so chaos theory goes. Now the small, delicate insects may hold the key to something even bigger – advancing the theory of evolution.

Scientists in Singapore have been studying several butterfly species that have colourful, concentric circles on the edges of their wings, known as eyespots.

Associate Professor Antonia Monteiro, from the National University of Singapore's (NUS) Department of Biological Sciences, said her team's research showed that the butterflies evolved the eyespots about 90 million years ago, possibly as a defence to draw predators away from the more vulnerable parts of the insect's body.

Curiously, almost all of the eyespots appear to have sprung into existence at about the same time.

Prof Monteiro said she believes the butterflies essentially re-deployed a large genetic network that was already present somewhere else in the body to create the eyespots rapidly.

"Most people believe that evolution proceeds gradually but I'm testing the idea that evolution also proceeds in big jumps, by co-opting large networks that were already there and deploying them to new functions," she said.

If the butterflies indeed developed their eyespots in this manner, traits in other species could have also evolved in such leaps.

"We have to look at the possibility that big chunks get moved about in the genome, to create something new and complex right off the bat," Prof Monteiro said. Her latest scientific paper on the origin, development and evolution of the eyespots was published in January.

Dr Mark Rebeiz, an assistant professor of evolutionary development at the University of Pittsburgh in the United States, said Prof Monteiro's work could help scientists better understand how very complex anatomical structures evolve.

"Research has illuminated how complex networks... appear to not be built from scratch," he said. "What is particularly fascinating about the eyespot network is that it is not obvious what network was co-opted."

To test her theory, Prof Monteiro said she intends to isolate some of the key DNA switches of genes found in the eyespots, and re-introduce them into the butterflies' genome, together with fluorescent tags. If the eyespot genetic network

was ported wholesale from some other part of the butterfly's body to the wings, then a fluorescent signal will light up in those parts.

To confirm their results, the researchers will also look for the same DNA switch in other butterflies, for example the Monarch butterfly, which does not have eyespots, to see if such genes produce the same fluorescent signal.

If her theory of such "evolutionary jumps" is proven, it would be a new high in a career that has already uncovered many fascinating facts about how and why some butterflies developed eyespots.

Together with Dr Kathleen Prudic, who is now a scientist at Oregon State University, Prof Monteiro discovered that butterflies like the Squinting Bush Brown change the size of their eyespots in the dry and wet seasons to cope with predators such as the praying mantis.

Other scientists have found that when the butterflies grow at high temperatures, they develop very large eyespots. When they grow at low temperatures, however, the eyespots are much smaller.

High temperatures signal to the butterflies that it is the rainy season. "During this season, the butterflies are very actively mating and laying eggs. They will be very visible to predators, so they have very large eyespots at the margins of their wings to deflect attacks to their wing margins instead of their bodies," she said. "This helps them to escape and survive even after they are attacked."

During the dry season, which is signalled by low temperatures, the butterflies are less active. They develop smaller eyespots that do not attract attention and allow them to hide from predators by blending into the surroundings.

Prof Monteiro, 46, said she started studying butterflies as an undergraduate at the University of Lisbon in Portugal because she liked working with insects and studying genetics, and did not want to work in the "completely saturated field" of fruit-fly research at the time.

"With insects, you can rear a lot of them at the same time, so you have a lot of power in experiments," she said.

She obtained a doctorate from the University of Edinburgh in Britain, with a dissertation titled *The Evolutionary Genetics And Development Basis Of Eyespot Morphology In Butterfly Wings*.

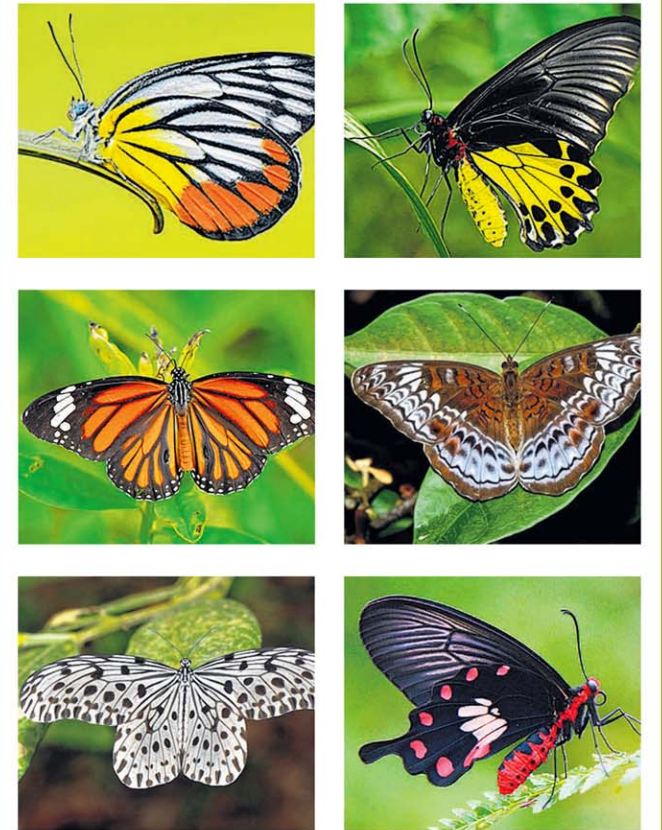
This was followed by almost five years of research at Harvard University in the United States and Leiden University in the Netherlands, and another 4½ years of research and teaching at the University of Buffalo in the US, before she joined Yale.

After the Yale-NUS College was set up in Singapore in 2011, she and her husband, who was director of bioinformatics at Yale's Peabody Museum of Natural History, moved here in 2013 to take up positions at the college. Along with her NUS appointment, Prof Monteiro is a Yale-NUS associate professor in biology.

Through the years, she has remained fascinated by the butterflies' diverse and intricate wing patterns, which allow them to attract mates and adapt to different environments, among other things. Her NUS team, for example, is studying how butterflies use eyespots for courtship.

"I'm doing some of the most important experiments of my career here," she said. "If I can find out where the co-opted genetic network came from, I think I will be able to retire happily."

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PHOTOS: TEA YI KAI
The six nominees for Singapore's national butterfly are (clockwise from top left) Painted Jezebel, Common Birdwing, Knight, Common Rose, Common Tree Nymph and Common Tiger.

2,000 votes cast to pick national butterfly

About 2,000 votes have been cast in the contest to determine Singapore's national butterfly.

The Nature Society (Singapore) had launched a campaign last month for Singaporeans and permanent residents to vote for the butterfly that they think best represents the Singapore spirit.

The six nominees are the Painted Jezebel, Common Birdwing, Common Tiger, Knight, Common Rose and Common Tree Nymph.

The butterflies had been short-listed by a panel of 14 experts from the society and the criteria included the species' beauty, size, conservation status and uniqueness to Singapore.

The Common Birdwing, for instance, despite its name, is a threatened species and the largest butterfly in Singapore. It also feeds on a native plant that is very rare in the Republic.

The Common Tiger's native

habitat is the mangrove and coastal areas. But its survival has been threatened by coastal erosion and the destruction of mangrove swamps here.

The Common Rose has a group of five rectangular to oval shaped white spots arranged in an arc around a crescent-shaped white spot, reminiscent of the five stars and crescent moon on Singapore's national flag.

Mr Anuj Jain, 30, chairman of the society's Butterfly and Insect Group, said it did not want to reveal each butterfly's vote tally so far as that may influence upcoming votes.

The society will pitch the winning butterfly to the authorities, and hopes that it will be granted the official status of national butterfly.

People can vote for their chosen butterfly species at www.nationalbutterfly.org.sg.

Voting ends on April 30.

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PHOTO: WILLIAM PIEL, COURTESY OF OREGON STATE UNIVERSITY

Beautiful science

During the wet season, this butterfly has large, bright eyespots that help it avoid the most important predator at that time – the praying mantis. The eyespots can change colour and intensity by season, as the types of predators change.