

Butterflies may not always be forever

NUS experiment on how temperature affects insect's eyespots poses an intriguing question

Carolyn Khew

When the seasons change, so do the eyespots on the wings of the *Bicyclus anynana* butterfly.

When temperatures are higher during the wet season in the insect's African habitat, the concentric circles on its wings become larger and brighter so that predators will be lured to attack its wing margins instead of its body.

However, the reverse takes place during the dry season as the eyespots become smaller and duller to blend in with brown leaves.

While this tendency is known, Associate Professor Antonia Monteiro of the National University of Singapore's (NUS) Department of Biological Sciences has found that not all the eyespots on this butterfly species respond in the same way to temperature changes.

"We didn't know that before the experiment," she said.

It turns out that the eyespots on the front wing do not change much during both seasons unlike those found on the hind wing, because they lack a hormone receptor, said Prof Monteiro.

Without the receptor, the eyespots on the front wing are insensitive to the different levels of the hormone produced in response to changes in seasonal temperatures.

The receptor is expressed only in eyespot cells on the hind wing which in turn causes the brightness or size of the eyespots to change during the wet and dry seasons.

Widely abundant in East Africa, the butterfly is believed to have de-

veloped those features over thousands of years of exposure to fluctuating temperatures. (See story at right)

The average temperature during the dry season from September to March is 17 deg C, rising to an average 27 deg C during the wet season.

To study the mechanism behind these eyespot changes, Prof Monteiro and her team conducted an experiment on over 600 caterpillars.

After subjecting the caterpillars to temperatures of 17 and 27 deg C, she noticed that the "wandering" stage of the caterpillar's development was when it was most sensitive to these temperature changes.

"That's when the caterpillars have stopped feeding and they are looking for a place to pupate, to become a pupa," said Prof Monteiro.

"If you rear these caterpillars throughout at low temperatures, except for two days during this wandering stage when you rear them at high temperatures, their eyespots will be brighter and bigger when they become adults..."

During the wandering stage of development, the caterpillars also start to form clusters of cells which would become the centre of future eyespots. The team noticed that only those caterpillars whose cells expressed the hormone receptor were able to alter the size and brightness of their eyespots. The hormone receptor was tagged with fluorescent antibodies that showed up under a microscope.

Apart from butterflies, other animals adapt physically to changes in temperature. For instance, the arctic hare, which lives in the North American tundra, sheds its brown



Prof Antonia Monteiro and her team at NUS conducted an experiment on more than 600 caterpillars of the *Bicyclus anynana* butterfly. They discovered a hormone receptor that is responsible for how these insects change their eyespots. Their study sheds light on the consequences of environmental change on these organisms. ST PHOTO: YEO KAI WEN

fur coat and becomes white to blend in with the snow during winter.

While the butterflies have changed with these "incredible adaptations" in their eyespots over their evolutionary history, with climate change, it is unclear if they would be able to adapt accordingly.

"If the climate stops being as pre-

dictable as it has been in the past thousands or millions of years, these butterflies may actually start producing seasonal forms mismatched to their environment... If they experience high temperatures in the dry season, they may start developing eyespots when that may be maladaptive for them," she said.

"What we showed with this study is that there is such a precise mechanism that controls this plasticity... It could take maybe a few hundred years to alter genetically, and I don't know if we have a few hundred years."

kcarolyn@sph.com.sg



PHOTO: WILLIAM PIEL AND ANTONIA MONTEIRO

About the *Bicyclus anynana*

- Found in sand forests in Africa, this small brown winged insect comes from the most diverse family of butterflies, Nymphalidae.
- Its ventral eyespots are used to deflect attacks from predators towards its wing margins.
- It uses the dorsal eyespots to choose a mate.
- The male butterfly becomes the choosy sex during the dry season. The female courts the male's attention because he provides a spermatophore – a package of sperm and nutrients needed for the eggs to be fertilised, and for females to survive the dry season.

Source: Associate Professor Antonia Monteiro, NUS