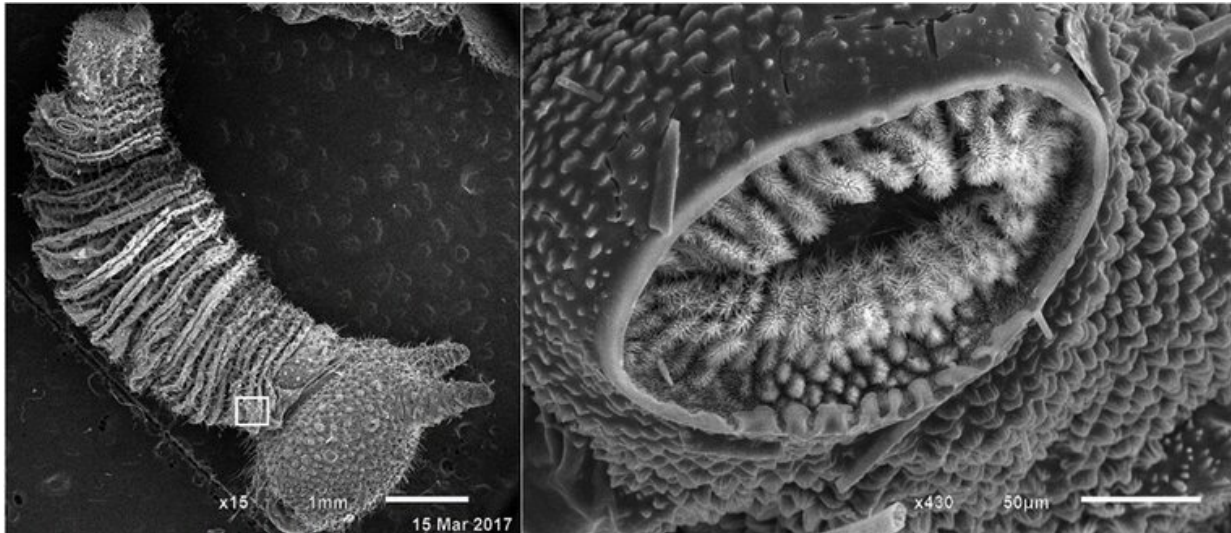


Haze smoke affects butterfly caterpillars

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Scanning electron microscopy (SEM) photos reveal the spiracle openings of a caterpillar. These are structures by which air enters into the insect's body. (Left) SEM image of a caterpillar. (Right) Magnified view of the boxed area in the left image. Credit: E. Dion

NUS biologists have discovered that haze affects the survival and development of butterflies, which could have an adverse impact on our environment.

The Southeast Asia (SEA) transboundary haze is a large-scale air pollution issue caused by the burning of regional peat forests to clear the land for agricultural purposes. Apart from causing [economic losses](#) for

countries in this region, the haze is also hazardous to [human health](#). The smoke causing the haze contains harmful gases (e.g. carbon monoxide, carbon dioxide and sulphur dioxide), and tiny particles. Although there are studies on the impact of haze on human well-being, the effect on other species and our ecosystems is less clear. Insects are very sensitive to changes in air quality because the air reaches cells inside their body in a very direct way. Insects breathe via spiracles which are valve-like openings on the side of their bodies. These openings connect to internal tracheal tubes that branch repeatedly into finer tracheoles and eventually reach every cell inside the insect's body, where diffusion of gases occurs. This is not the case in our own bodies, where the air first diffuses into the blood system in our lungs before reaching cells.

A research team, led by Prof Antónia Monteiro from the Department of Biological Sciences, NUS discovered that smoke-induced toxicity to the environment and [toxic chemicals](#) found in haze resulted in a higher larval mortality and slower development in the [caterpillars](#) of the Squinting Bush Brown Butterfly (*Bicyclus anynana*). While this species lives naturally in Africa, relatives of this butterfly, from the genus *Mycalesis*, are commonly found in Singapore and in many forests of SEA. The experiments were conducted in a controlled laboratory setting using artificially generated smoke from burning incense coils.

The caterpillars were found to be affected in at least two ways. First, a large proportion of individual caterpillars did not survive before they could reach their adult stage due to the toxic chemicals in the smoke. Second, the smoke reduced the available food sources to the surviving caterpillars, either by damaging the plant which they feed on, or by preventing the caterpillars from locating it. Those individuals that developed in the smoke treatment took longer to reach the adult stage and turned into smaller adults than the caterpillars which developed in a cleaner air environment (simulating the air quality in SEA without haze), and thus were likely to suffer from reduced potential for reproduction.

Dr. Emilie Dion, a postdoctoral fellow on the team said, "This study is only the first step in understanding the impact of smoke on a population of insects. In the natural environment, the haze may affect multiple members of a complex food web, which includes their predators and this may lead to a less predictable outcome."

"Our findings provide an insight into the adverse effects of haze smoke on butterflies, which are sensitive to environmental disturbances. As they are easy to identify and monitor, butterflies could be useful as bioindicators of the health of an ecosystem for better [haze](#) management in the SEA region and other important biodiversity hotspots on our planet," added Prof Monteiro.

More information: Yue Qian Tan et al. Haze smoke impacts survival and development of butterflies, *Scientific Reports* (2018). [DOI: 10.1038/s41598-018-34043-0](#)

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