Brain switch controls glow-worm light

The pair drove to Springbrook National Park at dusk to collect the glowing larvae from the steep earthen banks beside a waterfall, and then provided each animal with its own personal mud-lined mini-cave to keep them comfortable back in Brisbane. Then they increased the CO₂ supply to the insects and watched; ‘The light brightened, casting a blue-green glow’, describes Merritt. However, when the duo tested the effects of various anaesthetics, including ethyl acetate and diethyl ether, on the larvae – to see whether these would also raise a glimmer – they found none, ruling out the possibility that CO₂ also works by anaesthetising the brake, allowing the insects to put on their light show.

In a bid to narrow down exactly whether the brain or the glowing light organ responds directly to CO₂ to flip on the light switch, Merritt and Charlton supplied both organs individually with the gas and waited for the insects to begin to glimmer. ‘The larvae are only 1–2 cm long and the light organ is only 1 mm or so in diameter, so dissecting the larvae and removing the light organ without damaging the cells was a challenge’, admits Merritt. However, when the duo bathed the brains of larva in CO₂, they were not able to trigger light production, which Merritt says casts doubt on the models suggesting that signals from the brain repres bioluminescence.

In contrast, bathing the light organ in CO₂ did trigger a glow, showing that the gas triggers light production directly in the light organ. Also, when the team tested the effects of rainfall on the insects’ ability to produce light, giving them a shake ranging from 180 to 200 Hz, the insects slowly turned up the glow to dazzling levels, leading Merritt to conclude that the increase in light is signalled from the brain.

Taking all of the observations into account, Merritt suspects that instead of switching off suppression of the larvae’s glow to allow the brilliant insects to shine at night, the insects’ nervous system actively activates the light show by delicately regulating the balance of CO₂ and oxygen – which fuels the production of light – in the cells that produce the enigmatic glow. Although accessing the insects to learn more about their ethereal light show became more challenging when the parks closed during the initial stages of the 2020 coronavirus pandemic, they have now reopened, allowing scientists and tourists alike to return and delight in the bewitching experience.

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What look like mesmerising sparkles on the roof of dank Australian rainforest caves spell almost certain doom for the insects and other creepy-crawlies lured in by the fatal illumination. David Merritt, from The University of Queensland, Australia, explains that each pinprick of light is produced by an Arachnocampa flava larva, which glimmers continually from dusk to dawn. Adding that the spectacle also lures in human tourists, Merritt explains that the light show is produced by a modified portion of the Malpighian tubule – the insect kidney – and it was thought that the brake that inactivates the light by day is itself dramatically deactivated at night by the anaesthetic effects of CO₂. In addition, Merritt knew that the glow-worms turn up the brightness when they sense the vibrations produced by torrential rain, yet he wasn’t so sure exactly how these two unrelated phenomena trigger the larvae to turn up their brightness, so he and student Hamish Charlton began investigating.