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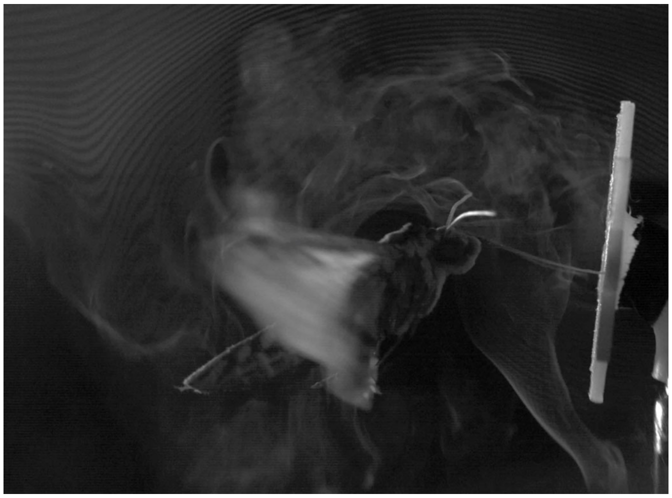
INSIDE JEB

How hawkmoths surf flower wakes on windy days



Hawkmoth feeding from a still flower in the wind. Photo credit: Megan Matthews.

The world is a complicated place, so it often helps to keep things simple if you want to get to the heart of a matter. When scientists first began analysing insect flight in the 1950s to learn how they remain aloft, they made sure that the aeronauts were essentially flying in still air with none of the turbulence that the animals encounter naturally. Air is rarely still, yet insects, such as hawkmoths, manage to go about their business sipping nectar from bobbing flowers while being buffeted by the bloom's wake. Deciding to add some reality back into the lives of lab-bound hawkmoths, Megan Matthews and Simon Sponberg from the Georgia Institute of Technology, USA, built a robot flower and tempted hawkmoths to hover downwind of the bloom in a gentle breeze to find out how well the insects match the flower's motion while surfing in its wake.

After perfuming the roboflower with fake datura scent and filling it with synthetic nectar, Matthews programmed the flower to bob from side to side to see how well the downwind insects faired in a breeze of 0.7 m s^{-1}. 'We also changed the lighting to mimic dusk, which is when the moths prefer to feed', says Matthews, in the hope of enticing the insects to pull up for a drink. Even then, some of the moths failed to locate the nectar, while others panicked when Matthews filled the airstream with smoke to reveal the airflow around the flower and insects' bodies.

Impressively, of the moths that managed to feed downwind, all successfully tracked roboflower as it bobbed from side to side at speeds of up to 6.1 bobs per second (6.1 Hz) – over 3.5 times the natural bobbing rate of flowers (1.7 Hz). In fact, almost three-quarters of the downwind moths still managed to track roboflower as it wobbled at an insanely fast 11.3 Hz. And when Matthews compared the downwind moth's bobbing motion with that of moths tracking the bloom in still air, tracking was clearly more difficult in a breeze. All of the moths (with or without the wind) lagged slightly behind the bobbing flower; however, the moths struggled more to keep up with the flower when they were engulfed by swirls of wind spinning off it. As the disrupted insects overshot the flower's position, they began falling further out of synch with the flower until the flower eventually lapped the insect and they fell back in synch. In contrast, the moths that were pursuing the flower in still air were able to keep much better track as they raced to stay in step with their mobile meals, although the details of each close pursuit were more complex.

Wondering why the downwind moths' pursuit paths were simpler than those of the moths in still air, Matthews and Sponberg suggest that swirls in the flower's wake could tug at the moths to help smooth out their tracking motion while they try to keep pace with the bobbing flower. And when the duo checked for the mini spinning tornado that sits atop flying insect wings – known as the leading edge vortex – that keeps them aloft, the duo were impressed to see that it remained intact, even when the moths encountered the swirling wake. 'The structure of the leading edge vortex was thought to burst on hawkmoth-sized wings', says Matthews.

So, although flower wakes pose a challenge for hovering hawkmoths, they do not destroy the insect's ability to generate lift, and Matthews suspects that downstream wakes may even benefit other blooms by throwing some insects off course on windy days to pollinate flowers that they may not otherwise have encountered.

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