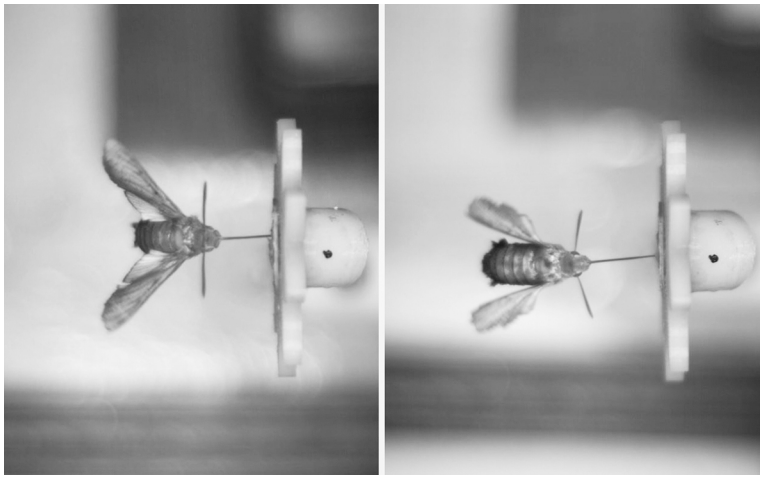
INSIDE JEB

Wing damage no obstacle for hummingbird hawkmoths



A moth with intact wings (left) and another with damaged wings (right), hovering to feed from an artificial flower. Photo credit: Anna Stöckl.

It's a sad fact, but life takes its toll. From saggy skin to creaky joints, older animals build up wear and tear, and insects are no different. Over days and weeks, wings become more tattered from collisions and ageing. Yet the dogged aeronauts seem to keep going regardless, compensating for the reduction in the lift force that they can generate by beating their frayed wings faster. Yet it wasn't clear how much of an impact this deterioration might have on insect manoeuvrability. Knowing that nectar sipping hummingbird hawkmoths (*Macroglossum stellatarum*) must weave in sync with bobbing flowers while feasting on the sweet fluid, Anna Stöckl from University of Würzburg, Germany, with Eric Warrant and Klara Kihlström from Lund University, Sweden, decided to find out how well elderly insects with tatty wings keep up with bobbing flowers while dining.

'I went to France to collect a few adult animals and then we let them mate and raise their offspring in Sweden', says Stöckl. Once the new adults emerged, Kihlström provided them with stands of artificial flowers to sip from when hovering, allowing some to grow old and develop tattered wings naturally, while she trimmed the wings of younger moths to simulate the effects of ageing before putting them all to the test. Fitting a motor to an artificial flower, Kihlström set the robo-bloom bobbing at speeds ranging from a gentle 11-mm-wide, 5 s long sway to frenetically bobbing back and forth 20 times per second over a narrower (0.07 mm) arc. Then she filmed the insects' wing beats and manoeuvres as they tried to keep up. 'We were surprised how keenly even the wing-damaged individuals approached the flowers', says Stöckl.

She and her colleagues then joined forces with Simon Sponberg and Brett Aiello from the Georgia Institute of Technology, USA, to analyse how the damage affected the moths' movements and they were impressed to find that the moths managed to keep up even with the speediest blooms. 'Flower tracking and manoeuvrability was not compromised by natural or artificial wing damage', says Stöckl. However, when the researchers analysed how the impaired moths compensated for the loss of lift caused by the reduction in wing surface area, they were surprised that in addition to flapping their wings faster, the moths also swept their wings over wider arcs: they increased their wing beat amplitude. 'A similar increase in wing beat amplitude has not been observed in any of the insect species so far studied', says Stöckl.

So why do hummingbird hawkmoths resort to this belt and braces approach to keep up with bobbing blooms when other elderly insect hoverers only beat their wings faster? The team suspects that aged hummingbird hawkmoths would have to flap their wings at rates of up to 93 flaps s^{-1} to compensate for their reduced wing area – a flap rate that their flight muscles are probably unable to achieve – forcing them to compensate for their lack of lift by also sweeping their wings through ever wider arcs.

'Our findings suggest that intact wings are not crucial for the precise control of lateral flight manoeuvres, which hawkmoths perform when tracking flowers within their natural movement range', says Stöckl, adding that these moths rarely land, feeding exclusively on the wing and even laying their eggs on bobbing stickyweed when in mid-air. And the robust insects are more likely to accumulate wing damage over their lengthy lives than other species since some even hibernate over winter, making it even more essential that they maintain manoeuvrability when they emerge the following spring.

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