INSIDE JEB

Sipping takes no effort for hovering hawkmoths

A hawkmoth (*Macroglossum stellatarum*) hovering at a flower to feed. Photo credit: Andrew Dejardin.

Since the dawn of time, humans have been mesmerised by flying creatures, but amongst the airborne there is a true elite: animals that hover. Holding in one place to survey territory or positioning before a luscious flower to sip nectar, these creatures, including bats, birds and insects, expend colossal amounts of energy staying put while in the air. Alexandre Palaoro from Clemson University, USA, explains that there is also pressure on these animals to fine-tune how they feed to ensure that consuming food uses as little energy as possible, and hawkmoths, with their fabulously long proboscises, are particularly famed for sipping from blooms. But how much energy do these insects exert as they drink from flowers? Do they suck hard or are their slender proboscises constructed in such a way that they naturally draw fluid up the vessel, allowing the insects to benefit from an almost free drink? Palaoro, Konstantin Kornev (Clemson University) and colleagues decided to find out how fluid travels along the elegant proboscises of 13 hawkmoth species to learn more about the effort required when they drink.

'Contrary to popular belief, the moth proboscis is not simply a drinking straw', says Kornev, explaining that the slender organ is composed of two lengthy C-shaped tubes with a channel between the two, which carries fluid to the insect's mouth. To find out more about how the insects drink, Peter Adler (Clemson University), Palaoro and Kornev went moth catching at dusk in South Carolina Botanical Garden on Clemson University campus, collecting 63 individuals ranging from Virginia creeper sphinxes (*Darapsa myron*), with stubby ∼12 mm long proboscises, to pink-spotted hawkmoths (*Agrius cingulata*), with spectacular ∼113 mm proboscises.

The team then filmed the insects as they gently unfurled each hawkmoth's proboscis in water, measuring the angle of the water's surface clinging to the extended structure at points along its length to find out how wettable the proboscises are. Impressively, the water naturally clung to the sides of the proboscis, climbing up the structure at different points along almost its entire length, indicating that the hawkmoths' proboscises were extremely wettable. This suggests that the insects do not have to invest much effort to sip a nectar meal as nectar naturally surges up the tube. And the team explains that it is this capillary action which has allowed some hawkmoth species to evolve the extraordinarily long proboscises, as the fluid flows unhindered along even the longest proboscis.

The team also discovered that the hawkmoths' wettable proboscises naturally carry fluid into the central feeding channel through the seams (front and back, between the two C-shaped tubes that comprise the proboscis) that run along the entire length of the proboscis. Palaoro explains that this ability for fluid to flow through the proboscis-long seam allows hawkmoths to take advantage of even the briefest stop at a bloom, by sucking fluid adhering to the proboscis's external surface into the feeding channel if the moth has to make a speedy exit after briefly dipping its proboscis into a well-filled nectary. In addition, the moths could benefit from picking up the final droplets smeared around the inside of a drained nectar chamber by collecting them along the length of the extending proboscis and then transporting them through the seam into the feeding channel.

'Hawkmoths have a unique set of characteristics that enhance their ability to gather nectar passively', says Palaoro, and this allows the hovering insects to consume nectar as rapidly as possible with virtually no exertion required to suck the fluid through their lengthy proboscises.

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Kathryn Knight
kathryn.knight@biologists.com