

INSIDE JEB

Spittlebugs snorkel in cuckoo spit



A newly moulted adult spittlebug (*Philaenus spumarius*) within its bubble chamber
Photo credit: Kephra Beckett.

In the lexicon of garden pests, spittlebugs (*Philaenus spumarius*) are probably one of the least offensive. Sipping sap destined for a plant's leaves, the tiny spittlebug nymphs do not linger long; yet, the foam that covers them – known euphemistically as cuckoo spit – drives gardeners wild. However, when Philip Matthews moved from Australia to Vancouver, Canada, the frothy blobs dotted across the city during spring transfixed him. 'I'd never been anywhere where they were so abundant', he laughs. He also realised that the froth-encrusted insects are essentially manufacturing their own aquatic environment. 'Some of my previous research had been looking at aquatic insects carrying bubbles of air to breathe while underwater', recalls Matthews. Which got him wondering: how could the bugs breathe while lathered in bubbles? Were they inhaling air trapped in the foam or poking their abdomens out of the frothy blanket to breathe?

To answer these questions, undergraduate Kephra Beckett located cuckoo spit on shrubs in the University of British Columbia (UBC) campus and carefully poked a tiny fibre-optic oxygen sensor into the edge of a blob, recording the

amount of oxygen as she painstakingly moved the sensor through the foam. 'We never saw sub-atmospheric levels of oxygen in the centre of the spittle mass as you'd expect if the bug was breathing oxygen from the surrounding bubbles', says Matthews. In addition, when Beckett measured the insects' oxygen consumption in the lab, she could clearly see their abdomens protruding from the bubbles, unless they were startled. Then, they dived beneath the foam and their oxygen consumption ceased until they re-emerged minutes later.

So the nymphs weren't using their foam bubbles as an aqualung, they were snorkelling. However, Matthews knew that during their final life stage, before metamorphosing into adults, spittlebugs produce a larger bubble chamber by popping the surrounding bubbles. Might they be consuming the oxygen in the enlarged chamber during their final moult? Collecting youngsters on the verge of the transition, complete with foliage residences, and returning to the lab, Beckett cautiously inserted the oxygen sensor into the bubble chamber and found that the oxygen concentration was about 10% lower than that of the

external atmosphere, suggesting that they were breathing the oxygen within. Her colleague Anne Robertson also sandwiched young spittlebugs between a microscope slide and a coverslip, to find out if they could resort to breathing the air trapped in the foam, and saw the youngsters puncturing the bubbles with their abdomens. In addition, when she coated the microscope slide with an oxygen-sensitive dye, she could see the dye glow intensely as the oxygen declined. The tiny nymphs are able to use their bubbles as an aqualung when necessary.

In addition, Beckett and Matthews were curious to find out just how hard it is for the nymphs to dine on dilute xylem sap. According to Matthews, the sap is under negative pressure – air gets drawn into the sap channels when they are punctured – making it hard for spittlebugs to suck against. The question was, how hard? Back in the lab, Beckett recorded the carbon dioxide produced by the patiently waiting nymphs, before providing them with juicy sheep sorrel plants and rerecording their carbon dioxide production as they gorged on sap and spewed out foam. However, the insects' carbon dioxide production only increased by a modest 20%. 'That was a big surprise', says Matthews. 'It's not much greater than their cost of walking', he adds.

So, spittlebugs appear not to be struggling to take a sip, but Matthews suspects that there may be more to the story and is looking forward to next spring when splodges of cuckoo spit begin bubbling up all over Vancouver again.

10.1242/jeb.199109

Beckett, K. I. S., Robertson, A. B. and Matthews, P. G. D. (2019). Studies on gas exchange in the meadow spittlebug, *Philaenus spumarius*: the metabolic cost of feeding on, and living in, xylem sap. *J. Exp. Biol.* **222**, jeb191973

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