INSIDE JEB

Head lice dispose of blood meal fluid through breathing tubules

Male human head louse, *Pediculus humanus capitis*. Photo credit: Gilles San Martin, CC BY-SA 2.0 https://creativecommons.org/licenses/by-sa/2.0, via Wikimedia Commons.

The moment when you realize that your itchy child has an infestation of headlice can be an instant of pure horror suffused with relief. Horror at the thought of the hideous creatures dining on your child's blood, and relief that they can usually be cleared. It's a rite of passage. Most insects that feast on fluids pee large volumes as they process their liquid lunches. But not lice. In fact, they don't urinate at all, for fear of alerting their host to their presence. Yet they lose fluid and dehydrate rapidly if separated from their succulent host, desiccating within 24 h when unable to feed regularly. So how do these pernicious pests dispose of the large volumes of fluid they ingest each day? Headlouse expert Ian Burgess (Insect Research & Development Ltd, UK) decided to find out.

Fortunately, Burgess had access to a ready supply of fresh head lice: the school children of Cambridgeshire, UK. 'Some of our regulars just give us a call when the kids next get lice', says Burgess, who has been working with local schools and parents for 25 years, helping them to vanquish tenacious infestations. Fortunately, the larger and more robust human clothing louse (*Pediculus humanus humanus*) survives more easily in the lab, so Burgess was able to keep a colony content by simply offering them a rabbit to feed on once a day.

Monitoring the insects' masses before and after dining, Burgess recorded that the smaller head lice (*P. h. capitis* ~0.68 mg) consumed ~0.11 mg of blood, losing 75% of the mass they gained within 3 h. In contrast, the larger clothing lice (~1.87 mg) downed more than 50% of their body mass in blood (~0.98 mg), losing the mass more slowly. 'Most head lice returned to their pre-feeding mass by approximately 4 h after feeding, compared with 17–24 h for clothing lice', says Burgess, explaining that head lice dine little and often.

However, when Burgess checked how fast the insects lost mass after feeding in air at different humidities, there was no difference in the rate of mass loss, even at 100% humidity. 'If humidity affected the rate of water loss, then the lice exposed to a saturated atmosphere would have some difficulty eliminating water… through cuticular evaporation', says Burgess. In other words, the lice must be actively pumping water out of their bodies instead of simply allowing it to evaporate like sweat. But which orifices were the insects losing water from?

As insects breathe through a network of tubules (tracheae) that open at structures – spiracles – at the surface of the body, Burgess recorded the mass change of clothing lice as they excreted water after dining and found that the creatures lost 15% of their blood meal mass over the next 40 min. Then, after feeding the lice, he smeared Vaseline (petroleum jelly) over their spiracles and the thoracic spiracles turned out to be particularly critical: blocking them reduced the insects' water loss by ~50%. In addition, when Burgess blocked the spiracles by immersing the insects in water – which should allow them to lose water but without breathing air – the lice also failed to lose mass; they could no longer inhale oxygen to power water excretion through their spiracles.

Most intriguingly, when Burgess coated the insects' abdomens in Vaseline, that supercharged their ability to lose water. The partially smothered insects disposed of more than 25% of their blood meal through the remaining spiracles. Burgess suspects that blocking the abdominal spiracles stimulates a feedback mechanism that triggers each louse to work harder to excrete water, 'with the result that it "overdoes" it', he says.

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