INSIDE JEB

Colossal triple-bladed claw latches swift louse flies to feathers

A louse fly clinging onto a swift (photo credit: Ilka Kureck) and the claw that it uses for attachment (photo credit: Sebastian Büsse).

Why flap yourself when you can hitch a ride on your meal ticket? In fact, parasitic swift louse flies (*Crataerina pallida*) are so content to piggyback on the swifts upon which they dine that they have almost done away with their wings. Yet, should the louse flies lose their footing, all is lost. Dennis Petersen from Kiel University, Germany, says, 'Swifts can fly really fast and the louse flies are incapable of flight, so detachment is normally a death sentence'. As most flies grip onto surfaces using a combination of a grappling hook and sticky attachment pads, Petersen and his colleagues Stanislav Gorb and Lars Heepe wondered how the blood-sucking swift parasites have adapted their feet to anchor themselves so firmly to their acrobatic hosts.

The parasites reside as pupae in abandoned swift nests over winter, ready to emerge as adults when the swifts return to lay their eggs, so Arndt Wellbrock and Klaudia Witte from the University of Siegen, Germany, retrieved pupae from nests under a road bridge near Siegen before the adult flies emerged in spring. However, Petersen explains that it is impossible to rear the adult insects in the lab without a supply of fresh swift blood, 'so we put them in a wine fridge at 10°C to cool them down and prolong their life', he says. Nils Kreuter and Sebastian Büsse, also from Kiel University, then scrutinised the insect's feet using a scanning electron microscope and were impressed to see that the flies were equipped with a colossal claw, which is huge in comparison with the size of the insect and is split into three scythe-like blades. 'The claw looks like a three-toothed comb', says Petersen; however, a conventional comb would just slide through the barbs of a feather, so how were the insects locking on?

Petersen allowed four louse flies to clamber onto swift feathers and fasten themselves on to reveal that the feather barbs become lodged in the tapering gaps between the claws' curving blades, effectively clamping the parasite in place. In addition, Petersen and Büsse could see that the sticky foot pads – the pulvilli, which other flies use to attach themselves to smooth surfaces – were coated in minute double-headed petal-shaped hairs that also snag on the feather. Next, Petersen and Kreuter tugged on the feet of flies that were clamped onto feathers and they were amazed that each individual leg could grip on with a force of 200 mN – 1000 times the weight of the fly; with six legs, nothing could tear the parasite free.

Having tested the louse flies' ability to latch onto feathers, the team also investigated how well they attach to smoother surfaces, as the parasites often encounter egg shell, the skin of naked nestlings and plant fragments in the nest. Encouraging the flies to scamper over smooth glass, silicone and epoxy resin, in addition to ridged versions of the silicone and epoxy resin, Kreuter and Petersen found that the insects could grip onto the smooth epoxy resin and glass with forces (~15 mN) that were 75 times greater than their weight, but only 25 times greater (~4 mN) on smooth silicone. However, when the insects were provided with 1.6 mm ridges to grip onto, their grasp on the epoxy resin and silicone was even tighter (~19.5 mN and ~19.4 mN, respectively).

'We were really surprised about the high interlocking forces observed on feathers', says Petersen, who admits that it was impossible to detach the louse flies without damage to them or the feathers and is eager to find out whether, and how, other parasites get their claws into their hosts.

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Petersen, D. S., Kreuter, N., Heepe, L., Büsse, S., Wellbrock, A. H. J., Witte, K. and Gorb, S. N. (2018). Holding tight to feathers – structural specializations and attachment properties of the avian ectoparasite *Crataerina pallida* (Diptera, Hippoboscidae). *J. Exp. Biol.* **221**, doi:10.1242/jeb.179242.

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