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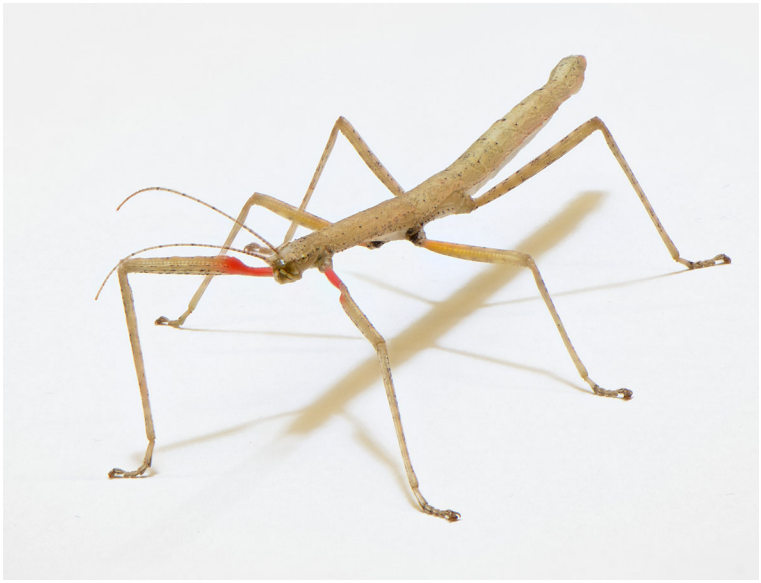
INSIDE JEB

Stubborn insects stick to regular walk when scaling slopes



A stick insect (*Carausius morosus*). Photo credit: Department of Biological Cybernetics, Bielefeld University.

Anyone who has ever visited the historic city of Cambridge, UK, will know that something is missing: hills. Residents rarely experience the challenge of negotiating an incline. Chris Dallmann from Bielefeld University, Germany, explains that when we walk up or down a gradient, gravity works against us. 'It pulls the body backwards when walking uphill, but when walking downhill, gravity pulls the body forward. Somehow the nervous system needs to account for these different mechanical demands', he explains. So how do animals that ascend and descend slopes counteract the effects of gravity? Bizarrely, insects could hold the key. According to Dallmann and Josef Schmitz, their simpler, and more accessible, nervous system makes it easier for scientists to identify the key circuits that control their movements, even though they have six limbs. And Dallmann's personal favourite is the stick insect: they are relatively large and move quite slowly. Yet, it wasn't clear whether the pedestrian insects completely change the way they move when tackling a gradient or adapt each stride in response to their individual circumstances.

'Our understanding of how insects (and other animals) control walking is largely based on findings from walking on level ground', says Dallmann, who filmed the animals as they crawled up or down a walkway tilted at 45 deg with plates embedded in the surface to measure the forces exerted as they clambered up and down. As stick insects are active at night, Dallmann had to do this in the dark using infrared light. However, the insects weren't always cooperative. 'When a stick insect was not in the mood, recording the data required a lot of patience', he recalls, adding with a chuckle, 'their species-specific name is *morosus*, which is Latin for stubborn'. Dallmann also designed a tiny stick insect-sized back pack to carry the wires embedded in the insects' muscles – to record how the muscles were moving the limbs – in order to avoid hampering their manoeuvres.

After months of perseverance, Dallmann, Schmitz and Volker Dürr compared the electrical signals that controlled the leg movements as the insects ascended and descended the slope with those of animals walking on the flat and found clear differences. The muscles that push the body forward were more activated when the insects were climbing the slope while the muscles that slow the body down were more activated as the insects descended. 'Stick insects strongly adjust the activity of their leg muscles when walking uphill or downhill, in terms of both timing and magnitude', says Dallmann. And when the team analysed the forces exerted by the insects' limbs as they scaled the ramp, they could see that the rear legs were pushing backward when the insects were clambering uphill to counteract gravity, but forward when moving downhill. Yet, their movements were essentially indistinguishable when Dallmann compared movies of the insects walking on all three surfaces, which is surprising, given the reversal of the forces exerted on the ground when they switched from walking uphill to downhill.

'One interpretation of these observations is that stick insects do not use distinct motor programmes on inclines, but rather adjust leg muscle activity from one step to the next to maintain their favourite, regular walking pattern', he says. So, stick insects do not use a specialised pattern of movements designed exclusively for climbing and Dallmann is keen to find out how they use their senses to help them control all six legs when striding up slopes.

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