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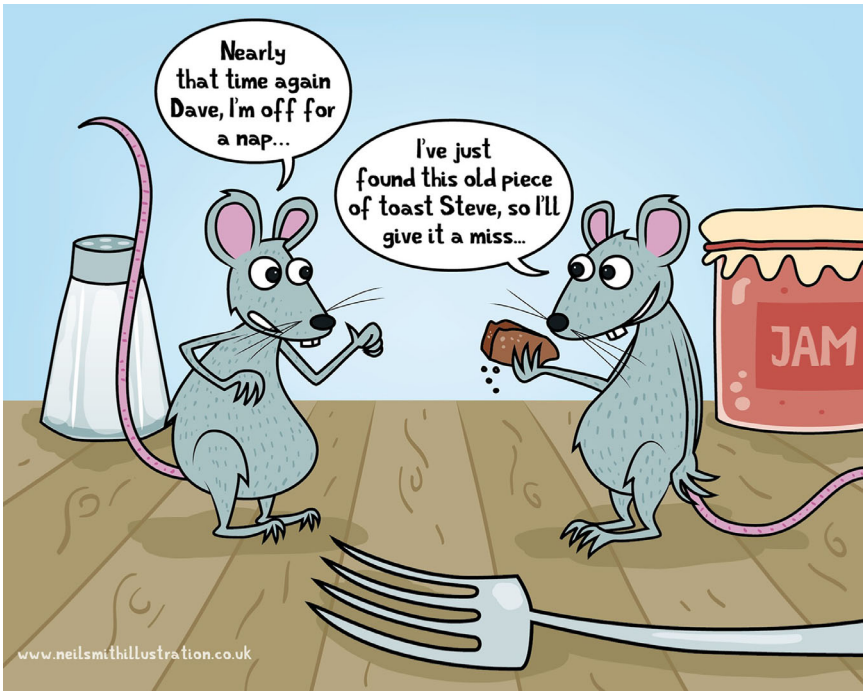
INSIDE JEB

Body clock schedules torpor for energy-conserving mice



As any homeowner looking at their heating bill will tell you, staying warm is costly and, when your fuel source is unreliable, sometimes you just have to turn the thermostat down. The same holds true for small animals. Some allow their body temperature to drop when food is scarce – reducing their energy consumption by as much as 90% in a process known as torpor – and many follow a strict schedule, reducing their body temperature from late at night until early morning. Although no one knew the mechanism that allows animals to control the timing of these energy-saving dips, scientists had suggested that animals either use their internal body clocks or time torpor to follow a meal. To test which mechanism holds the key, Vincent van der Vinne and David Weaver from the University of Massachusetts Medical School, USA, with Steven Swoap from Williams College, USA, tested when hungry house mice drop their temperature to conserve energy when meal times are shifted.

As the body clock of house mice is remarkably precise, even when it's dark 24/7, the team monitored the body temperature and activity patterns of the animals in a completely dark room and fed them only one meagre meal a day on the dot of 6 pm. Within a few days, the mice locked into a regular programme, with their body temperature falling 4 h after consuming the meal as they became torpid. But then Mark Bingaman and Swoap tinkered with the timing of the animals' meals – by feeding them every 20 h, shifting the feeding time 4 h earlier each day – this sent the regular torpor pattern haywire relative to dinner time. The mice took longer and longer after their meal to drop into torpor and even missed energy-saving temperature drops when they coincided with a displaced feeding time. And when the team delayed meal times, feeding the mice once every 28 h, the torpor bouts fell out of synch with their dinners again. However, when the team shifted the feeding times of mice that had no body clock to once every 20 h, these rodents reliably dropped their body temperatures 4 h after the meal. 'This showed that in the absence of a clock, the timing of torpor can be controlled by the timing of meals', says van der Vinne.

In short, torpor is triggered by the internal body clock of the mice, but mice that have just fed – which do not need to conserve energy – skip temperature dips that should have coincided with a meal, while dinner can determine when mice enter torpor when the creatures have lost track of time. 'Overall, our data show that while daily torpor is an opportunistic strategy employed in response to energetic challenges, its occurrence is conditional upon appropriate food timing and its timing is tightly regulated by the endogenous circadian clock', says van der Vinne.

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van der Vinne, V., Bingaman, M. J., Weaver, D. R. and Swoap, S. J. (2018). Clocks and meals keep mice from being cool. *J. Exp. Biol.* **221**, doi:10.1242/jeb.179812.

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