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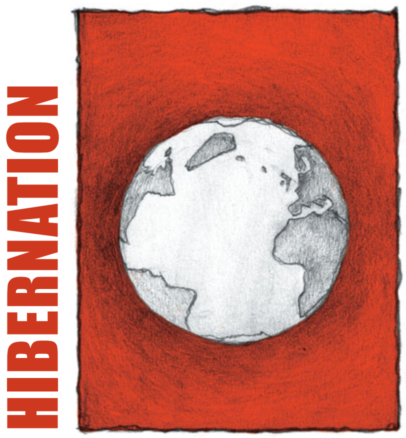
OUTSIDE JEB

Some hibernating bats like it hot



Hibernation, for most of us, conjures up images of woodchucks, marmots and bears curled up in their cold caves for the winter. Derived from the Latin *hibernare*, meaning 'to pass the winter', the term hibernation has now shifted to include any time when an animal is in a torpid state (where metabolic rate and body temperature are lowered to a fraction of what they are in an active animal) for more than a few days. However, hibernation has also been observed in a number of species from warm climates, including the egg-laying echidnas, marsupials and lemurs, which hibernate anywhere from cold burrows to relatively warm tree-hollows and show a variety of body temperature patterns. Eran Levin and his colleagues from Tel-Aviv University, Israel, have now added two species of cave-dwelling mouse-tailed bats to the roll-call of warm hibernators in their recent *Proceedings of the Royal Society B* paper. They show that these bats specifically choose to roost and hibernate in the warmest most humid parts of the caves that they inhabit near the Sea of Galilee.

Heated by geothermal activity, sections of the caves selected by the bats remain above 20°C, and close to 100% relative humidity, for most of the winter, providing a stable thermal environment. Previously, the researchers had observed that the mouse-tailed bats fatten considerably before the winter and, unlike other small species in the same cave system, the bats were not observed foraging again until the spring. They therefore believed it likely that these bats hibernated through the winter. To confirm their hypothesis, the scientists fitted the bats with tiny temperature-sensitive data loggers that recorded skin temperature for a few weeks at a time. They also measured the resting metabolism of individual bats over a range of ambient temperatures to find out whether the animals ever entered torpor.

The team saw that the bats' body temperatures remained close to the cave temperature throughout the study period and their laboratory metabolic rate measurements confirmed that the bats were entering torpor at these low body temperatures. Interestingly, the researchers found that the metabolic rates were lowest, and therefore the energy savings were optimised, at around 20°C, which is the average temperature of the bats' chosen winter habitat. They hypothesized that this may be the result of a diet high in saturated fats and relatively low in polyunsaturated fatty acids (which are believed to allow hibernators to lower their body temperatures below 20°C).

The researchers also reported a couple of other fairly novel characteristics of hibernation in these bats. The first is that even when torpid the bats responded to external stimuli, calling and showing signs of movement when someone entered their section of the cave. This stands in contrast to most temperate climate hibernators who, with much colder torpid body temperatures, are usually unresponsive to both noise and touch. In addition, the bats remained torpid throughout the study period and did not show the occasional periods of rewarming that are characteristic of almost all hibernators studied to date. It is unclear whether this is the result of the relatively high torpid body temperatures or the high humidity – and associated low water losses – allowing them to forgo rewarming for a drink. What is clear is that hibernation at a relatively high temperature is optimal for these species, allowing them to remain in sheltered caves throughout the cold winter while staying relatively alert to potential predators; a useful trait when living close to the cave entrance.

10.1242/jeb.112508

Levin, E., Plotnik, B., Amichai, E., Braulke, L. J., Landau, S., Yom-Tov, Y. and Kronfeld-Schor, N. (2015). Subtropical mouse-tailed bats use geothermally heated caves for winter hibernation. *Proc. R. Soc. B* **282**, 20142781.

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Sunbathing helps senior flies keep active

Living well into their senior years is a dream for many people. As animals age, their mitochondria progressively become less functional; they produce less energy in the form of adenosine triphosphate (ATP) and more inflammatory compounds such as reactive oxygen species (ROS). Keeping active and continuing your favourite activities for the majority of your golden years is tricky, but a new study using the model species fruit fly *Drosophila melanogaster* suggests that exposure to near-infrared light – that's red light on the very end of the visible spectrum – might help out.

Cytochrome *c* oxidase is a key enzyme in the electron transport chain in the mitochondria, responsible for pumping protons across the mitochondrial

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membrane to provide a proton gradient to help other enzymes produce ATP. Researchers in the past have also found that absorbing near-infrared light improves cytochrome *c* oxidase's proton pumping efficiency, which helps the mitochondria produce more ATP. As ageing animals produce less ATP, Rana Begum from University College London, UK, and colleagues from Universidade Federal Fluminense, Brazil, and Moorfields Eye Hospital, UK, decided to investigate whether exposure to near-infrared light improved activity later in life in *D. melanogaster*.

The researchers housed newly metamorphosed adult flies in small containers that had a rack of built-in 'heat lamps' – LED lights that produced a small dose of radiation at the near-infrared wavelength of 670 nm – that the flies were exposed to for 20 min each day. Then, as the flies aged over a period of 3 months, the researchers assessed the insects' climbing ability, survival and the amount of available energy in ATP.

While the extent of the very longest lifespans did not differ between the groups, flies that had a daily sunning session lived longer on average. They also produced much more ATP and less of a protein marker of inflammation, which suggested they were producing fewer inflammatory compounds like ROS. Finally, the senior citizen flies that had been bathing in the lamps' warmth were able to climb much better than their control counterparts – a key marker of activity level. So, even a short dose of daily near-infrared light allowed geriatric flies to have much more active lives and extended their health span.

As promising as these results are, the researchers note this type of whole-body exposure would not work with mammals because near-infrared radiation would not pass through their larger bodies as it does with flies. Instead, their study suggests that ageing is at least partially due to ATP limitation and that this might be why fast-ageing tissues that can absorb in the 670 nm range – like the retina – are treatable with near-infrared light. While we're a long way off providing humans with the benefits that the flies received from their glowing infrared lamps, understanding the mechanisms behind the effects of ageing could lead to treatments that might give a better quality of life to seniors of all species.

10.1242/jeb.112482

Begum, R., Calaza, K., Ho Kam, J., Salt, T. E., Hogg, C. and Jeffrey, G. (2015). Near-infrared light increases ATP, extends lifespan and improves mobility in aged *Drosophila melanogaster*. *Biol. Lett.* **11**: 20150073.

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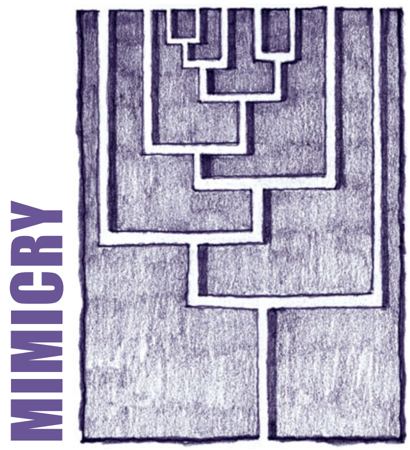
Dusky dottyback actors avoid typecasting



Many animals make a living as actors. Some harmless animals will mimic toxic animals, in order to make potential predators think twice before attacking. On the other end of the spectrum, some predators will mimic harmless animals or objects, and use this ruse to sneak up on their prey. However, there are costs to acting if animals become typecast in a role. If predators discover that a delicious prey animal is merely pretending to be dangerous, they will learn to differentiate the truly noxious from the imitators. Similarly, if the predators always take on a single disguise, then prey animals will learn to associate the costume with danger.

Fabio Cortesi, from the University of Basel, Switzerland, and the University of Queensland, Australia, and an international group of collaborators from Australia, Canada, UK and Sweden, decided to investigate how a coral reef fish, the dusky dottyback (*Pseudochromis fuscus*), maximizes the benefits of being a mimic, while avoiding some of the pitfalls. Cortesi and his colleagues conducted their experiments at Lizard Island, in Australia's Great Barrier Reef, where the dusky dottyback comes in two colours: bright yellow and brown. First, the researchers confirmed that there are no genetic differences underlying the colour variation in dottybacks. When the team examined the histology of dottyback skin, they also learned that the dottybacks were able to change colour by changing the ratios of yellow to black pigment cells within the skin. Thus, the researchers had good evidence that the dottybacks change colour to imitate something in their environment. But what are dottybacks imitating, and why?

The yellow dottybacks at Lizard Island are usually found on live yellow coral with yellow damselfish (*Pomacentrus* spp.), while the brown dottybacks are usually found on brown coral rubble, with brown damselfish. To investigate whether the dottybacks match their colour to the background coral or to their damselfish neighbours, Cortesi and his colleagues set up artificial coral patches around Lizard Island, composed of either yellow coral or brown coral rubble, and stocked these patches with either yellow or brown damselfish. The researchers then added either yellow or brown dottybacks to the patches, creating all potential coral, damselfish and dottyback colour combinations. When the scientists returned to the patches 2 weeks later, they found that the dottybacks always matched their local damselfish neighbours and not the background coral colour.

Cortesi and his colleagues hypothesized that the dottybacks might be imitating the adult damselfish in order to prey upon the juvenile damselfish. To test this theory, the researchers brought dottybacks and damselfish into the laboratory where they could conduct more detailed behavioural observations. They found that when the dottybacks matched the colour of the local adult damselfish, the juvenile damselfish were much less wary of them and the dottybacks were able to prey easily on the unsuspecting fish. The authors noted that the juveniles should eventually figure out this disguise in the wild. However, the dottybacks are able to outsmart their prey by not being typecast in either a consistently brown or yellow role.

Although the dottybacks match their prey rather than their habitat, there is

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another benefit of being adaptable actors. In a final experiment, the researchers showed that the predatory coral trout (*Plectropomus leopardus*) strike less often at dottybacks that are matched to the coral. Thus, these little animal actors make the most of their disguise by flexibly imitating their prey and benefit from some anti-predator camouflage themselves.

10.1242/jeb.112490

Cortesi, F., Feeney, W. E., Ferrari, M. C. O., Waldie, P. A., Phillips, G. A. C., McClure, E. C., Sköld, H. N., Salzburger, W., Marshall, N. J. and Cheney, K. L. (2015). Phenotypical plasticity confers multiple fitness benefits to a mimic. *Curr. Biol.* doi:10.1016/j.cub.2015.02.013.

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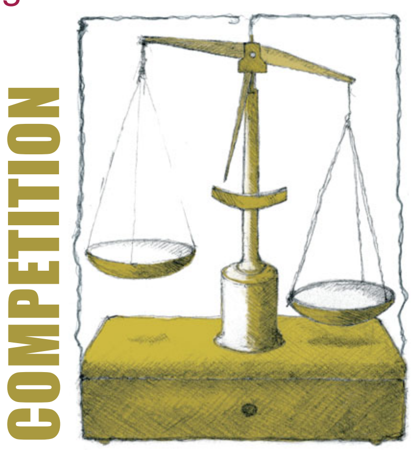
The dubious motives of generous men



Humans have an enormous capacity for generosity. We give money to the homeless in need of shelter and to distant strangers in times of catastrophe. We even give indirectly by donating money to friends and colleagues fundraising for their own charities. But why do we give? And how much are we willing to part with? These were the questions taken up by Nichola Raihani and Sarah Smith in a clever study in a recent issue of *Current Biology*. The answer is amusingly predictable; in short, it's all about sex.

Each spring, an army of athletes raises money for their favourite charity by completing the London Marathon. After picking a charity, runners solicit everyone they know to pledge money that is paid out following race completion. It's a spectacularly successful scheme, raising some £50 million annually. It also provided Raihani and Smith with a unique opportunity to study patterns of human generosity because donations are online and completely public.

Each donation page has a photo of the runner and then a consecutive list of the money given by each donor. On their own, donors would (probably) contribute different amounts, perhaps varying according to their financial circumstances or their relationship to the runner. However, this set-up is highly context dependent: donors know the recipients and, crucially, they can also see what the previous person gave. And it turns out this context matters a great deal.

When following an 'average' donor, individuals in turn contribute the average amount. However, when the previous donor gave an especially large donation, this triggered a response known as 'competitive helping', a form of one-upmanship that results in the second donor out-giving the first. Crucially, however, competitive helping was sex specific. While donations from females were unaffected by the sex of earlier donors, men gave more if the previous large donor was a male. More interesting is that the extent of competitive helping among men was entirely dependent on the attractiveness of the runner herself. In practical terms, this amounted to about £30 more per donation. In short, the researchers found that men compete with each other for the perceived recognition of attractive female fundraisers, and the manner in which this is done is by flaunting cash.

Humans, of course, are not alone in using social cues to adjust their behaviour. Males vying for access to females use all manner of exaggerated displays to convince potential mates of their suitability, and the extent of their signalling increases with an audience. The present study clarifies that, for humans, males work harder to beat each other when their perceived 'mate' is a more attractive catch. At the same time, the men are using fairly honest signals of their own quality. Not only do the men in these fundraising games provide direct evidence of their wealth, a quality that is difficult to fake, but they also hint at their generous, good-hearted tendencies. And who doesn't want this in a mate?

But what is generosity anyway? Is it entirely selfless, and is it any less so if it is tainted with cryptically selfish and largely unconscious motivations? The work of Raihani and Smith cannot answer this. However, one can envisage the exciting follow-ups to this study that seek to identify the consequences for these competitive helpers. In the end, do they get the girl? Do the fundraisers run straight from the marathon into the arms of their donors? Probably not – but we'll have to wait until the sponsorships from the next London Marathon are in to find out!

10.1242/jeb.112474

Raihani, N. J. and Smith, S. (2015). Competitive helping in online giving. *Curr. Biol.* **25**, 1-4.

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