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Inside JEB

WHY RING-TAILED LEMURS NEVER TROT



It's a long time since we gave up our primate lifestyle in favour of a bipedal existence, but even so, anthropologists are still intrigued by how our primate cousins move. Matthew O'Neill from Stony Brook University School of Medicine, USA, explains that quadrupedal primates do not use the same spectrum of gaits that other quadrupeds employ; they never trot. He adds that ring-tailed lemurs are also exceptional because, unlike the majority of primates that move primarily through trees, they move between foraging sites at ground level. Intrigued by the lemur's relatively terrestrial lifestyle, O'Neill and his PhD advisor Daniel Schmitt from Duke University, USA, decided to investigate their movements to find out which gaits lemurs use while crossing the ground (p. 1728).

'The most reliable approach for determining the specific gaits of ring-tailed lemurs is to measure how their centre of mass moves', explains O'Neill. So, the duo filmed five animals from the Duke Lemur Center moving at speeds ranging from a pedestrian 0.43 m s^{-1} up to a 2.91 m s^{-1} dash, while capturing the ground reaction forces acting on the animals as they crossed a force plate buried in the runway's floor. Calculating the trajectory of each lemur's centre of mass, based on the force plate measurements, and analysing the lemurs' footfall patterns, the team found that the lemurs walked at slow speeds, switched to a canter at high speeds and broke into a gallop at their top speed. Despite their terrestrial lifestyle, the lemurs never trotted.

Curious to find out why lemurs do not trot, O'Neill built a computer model where he could simulate a lemur trotting. Modelling the forces acting on the simulated lemur's legs as it trotted like a dog and cantered, he calculated the movement of the cyber-primate's centre of mass and found that the trot would give the lemurs a much bumpier ride than a canter. 'Our data show that the smoother ride is due to the fact that in a canter, the centre of mass bounces up and down once in a stride, rather than twice as in a trot', explains O'Neill. He also realised

that the centre of mass of the simulated cantering lemur bounced higher than the centre of mass of the trotting simulation. However, he suspects that in practice the additional bounce is not a problem for the cantering animals. 'The differences between the vertical displacements of a trot and canter are only a few centimetres and may simply matter less for a lemur than some other factors, like bumpiness', says O'Neill. In addition, O'Neill found that cantering allowed the lemur to keep one foot in contact with the ground at all time, as well as allowing the animals to move faster without increasing the peak forces exerted on them.

Essentially, the duo suspect that primates failed to evolve a trotting gait because cantering is more stable and better suited to an arboreal existence. 'We think that cantering may have some advantages over trotting when moving in trees. So, the absence of a trotting gait in primates is likely tied to their early evolution as tree-living mammals', says O'Neill.

10.1242/jeb.073395

O'Neill, M. C. and Schmitt, D. (2012). The gaits of primates: center of mass mechanics in walking, cantering and galloping ring-tailed lemurs, *Lemur catta*. *J. Exp. Biol.* **215**, 1728-1739.

Kathryn Knight

WAGGLE DANCE AFFECTS HIVE MASS

The waggle dance is a rather enigmatic behaviour. Gyrating and walking in a figure-of-eight pattern, bees communicate the location of luscious flowers to their fellow foragers. Ryuichi Okada and colleagues from Japan explain that although waggle dances are renowned for recruiting foragers, no one had directly measured whether this translated into foraging success and affected the amount of food obtained for the colony. So, the team decided to test the impact of the bees' intriguing behaviour on their foraging success (p. 1633)

Explaining that waggle dancing bees release air-borne chemicals that encourage other residents of the hive to follow their guidance, the scientists realised that they had to prevent returning foragers from communicating in any way with their hive mates, and they did this by touching the insects with a brush. The team then alternated days when the insects were allowed to waggle with days when they were prevented from dancing and weighed each hive at the end of each day to find out whether communication had affected the amount of food that the foragers retrieved. The team also repeated the experiments over a period of years – always in the early autumn – and at three different locations in



Ryuichi Okada

Japan to be sure that no other factors influenced the bees' foraging success.

Comparing the hives' masses, the team found that they all lost mass consistently over the course of the experiment. 'This was an expected seasonal change for the species', the team says, explaining that the hive loses mass over the winter as the bees forage less. However, when the team scrutinised their results closer, they realised that the hives where the bees were not allowed to waggle dance lost more mass than the hives where the bees danced. They also realised that the bees were able to adapt to their altered circumstances, as the hives that were allowed to waggle dance on the first day of the experiment lost less mass than hives that were only permitted to waggle dance on the second day. 'Because the colonies of both groups were allowed to communicate – waggle dance – [one group on the first day and the other group on the second day] we expected close values of weight change. However, very different values came out', says Okada.

So, Okada and his colleagues have shown that waggle dancing does impact on the amount of food collected by the hive and that foragers can adapt to altered circumstances. The team also discovered that the number of waggle dances affected the hive's mass gain and they say, 'the dance is effective to maintain the colony.'

10.1242/jeb.073387

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Kathryn Knight

SMALLEYE PYGMY SHARKS GLOW FOR CAMOUFLAGE



Jérôme Mallefet

Some sharks deserve a blood curdling reputation, but not the diminutive smalleye pygmy shark (*Squaliolus aliae*). Reaching a maximum length of only 22 cm, the tiny animals are more likely to be on someone else's menu. Silhouetted against weak light penetrating from the surface, the tiny sharks should be most at risk from predators approaching from below. However, Julien Claes from Université catholique de Louvain, Belgium, explains that the minute sharks have evolved a handy trick. Their undersides are covered in tiny light-emitting photophores that probably fill in their telltale silhouettes. Adding that the distantly related velvet belly lantern sharks have adopted this luminous tactic for camouflage and communication, Claes and colleague Jérôme Mallefet were curious to discover whether these fish had acquired bioluminescence from the same origin, or developed the ability independently. Having already discovered that the lantern sharks regulate light production with hormones, the duo decided to find out whether the smalleye pygmy sharks use the same mechanism (p. 1691).

Teaming up with Hsuan-Ching Ho from the National Dong Hwa University, Taiwan, the scientists went trawling for smalleye pygmy sharks off the Taiwanese coast. Back in the lab, the team collected samples of the fish's skin, injected substances – ranging from neurotransmitters to hormones, which are known to regulate a wide range of biological processes – and waited to see whether the skin began glowing. Recording the time when the skin started producing light, and the maximum intensity and duration of light production, the team discovered that the hormone melatonin – which stimulates light production in the lantern sharks – made the smalleye pygmy shark's skin glow, while the neurotransmitters – which regulate light

production in deep-sea bony fish – had no effect at all.

However, when the team applied prolactin to the glowing skin, they were in for a surprise: the glow faded. Instead of stimulating 30-min-long bursts of glowing light – as it does for lantern sharks – prolactin dimmed the sharks' glow, which, according to Claes, is intriguing from two perspectives.

He explains that in addition to using continual bioluminescence for camouflage, lantern sharks communicate using bursts of glowing of light from patches of skin on the pectoral and pelvic fins. They regulate this specific form of bioluminescence with the hormone prolactin. Having discovered that smalleye pygmy sharks use prolactin to inhibit light emission and that the photophores were restricted to the shark's lower surface, Claes and Mallefet concluded that instead of using bioluminescence for communication, the smalleye pygmy sharks use it purely for camouflage.

The team also explains that the lantern and pygmy sharks inherited their bioluminescence from an ancient predecessor, which used hormones to regulate skin pigmentation for camouflage. According to Claes, this ancient predecessor probably used melatonin to lighten the skin while using prolactin to darken the skin. The team says that smalleye pygmy and lantern sharks regulate their bioluminescence by adjusting the degree of pigmentation in cells covering the photophores. However, the pygmy shark has retained the pigment-mobilising effect of the ancestor's prolactin, which dims their glow by darkening the skin covering the photophores, whereas the lantern sharks have adapted prolactin to lighten the skin and emit light for communication. This suggests that the smalleye pygmy shark is more closely related to their ancient ancestor than the lantern shark.

10.1242/jeb.073379

Claes, J. M., Ho, H.-C. and Mallefet, J. (2012). Control of luminescence from pygmy shark (*Squaliolus aliae*) photophores. *J. Exp. Biol.* **215**, 1691-1699.

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TROPICAL BIRDS DOWNSIZED ORGANS



Life in the tropics tends to have a more relaxed pace than at more extreme latitudes. According to Joe Williams and his colleagues from Ohio State University, USA, the basal and peak metabolic rates of tropical birds are significantly lower than those of their more temperate cousins. Knowing that some internal organs account for a disproportionate amount of an animal's net metabolic energy consumption, Williams, Popko Wiersma and Brittany Nowak decided to find out whether tropical species have scaled down the size of any of their major internal organs to account for their reduced metabolic demands (p. 1662).

Scouring the literature for details of the organ masses of 408 species and collecting

an additional 32 tropical species in Panama and 17 temperate species in Ohio, the team compared the masses of the birds' organs, ranging from the liver, kidneys, heart and lungs to the flight and leg muscles. Analysing the masses of these tissues, the team found that the heart, lungs, flight muscles, liver, kidneys, ovaries, testes and feathers of tropical species were significantly lighter than the same tissues from temperate birds. However, the masses of the leg muscles, gizzards, intestines, skin and brain did not seem to be affected by the birds' latitude.

Suggesting that the tropical birds, which do not require as much insulation, conserve energy by reducing their plumage

and cutting down on the size of some organs, the team suspects that warmer tropical conditions have driven the evolution of smaller organs in tropical species. Williams also adds that the cells of tropical birds may also run at a slower pace than those of birds from higher latitudes, and he and his team are currently testing this idea.

10.1242/jeb.073403

Wiersma, P., Nowak, B. and Williams, J. B. (2012). Small organ size contributes to the slow pace of life in tropical birds. *J. Exp. Biol.* **215**, 1662-1669.

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