CLOACAL COOLING

When Dale DeNardo saw a Gila monster wandering around the Sonoran Desert with its cloaca protruding from its body, the Arizona State University physiologist speculated that the animal might be shedding heat as well as waste from its cloaca. DeNardo went on to show that evaporative heat loss from a Gila monster’s cloaca can cool the animal by 3°C. Ty Hoffman, working with DeNardo and Glenn Walsberg, immediately wondered if birds can also use their cloacae to cool off when the temperature soars (p. 741).

‘For the last 50 years or so, physiologists have assumed that any evaporation that doesn’t happen through a bird’s mouth must happen through the skin,’ Hoffman explains. He points out that the cloaca is a large, moist surface that’s perfect for evaporative heat loss, yet nobody had measured how much heat birds lose through their cloacae. Hoffman decided to examine cloacal evaporation in Inca doves, which are known to have high rates of skin evaporation.

To determine how much water doves lose through their mouth, skin and cloacae, Hoffman placed each dove in a glass chamber separated into two compartments by a latex sheet with a hole for the bird’s head to poke through, so that the top compartment captured water lost through the bird’s mouth and the bottom captured water lost through the skin and cloaca. To measure water loss through the birds’ skin only, Hoffman sealed the birds’ cloacae with glue and measured the water content of air samples from the bottom compartment using a hygrometer. To measure water loss through the skin plus the cloaca, he removed the cloacal seals and repeated the water content measurement. ‘Unsealed’ birds had higher rates of water loss than ‘sealed’ birds, suggesting that cloacal evaporation was playing a large role in evaporative heat loss.

But can doves regulate how much heat they lose through their cloacae? To find out, Hoffman prevented evaporative heat loss from the birds’ mouths by pumping humid air into the chamber’s head compartment, and then cranked the temperature up. At 30°C, 35°C and 40°C, doves hardly relied on their cloacae. But at 42°C, cloacal evaporation accounted for a quarter of evaporative heat loss. ‘This mirrors what we saw in the Gila monsters,’ Hoffman says. Because cloacal evaporation only kicks in at extreme temperatures, it may be an emergency thermoregulatory tactic.

To show that this is not simply a ‘by-product’ of having a cloaca, Hoffman repeated the measurements for Eurasian quail, which have a large cloacal opening and may therefore be expected to use cloacal evaporation. Unfortunately, Hoffman could only test quail up to 32°C, because the birds became heat stressed above this temperature. Yet, despite the fact that the birds were showing obvious signs of heat stress, the evaporative heat loss from quail cloaca was negligible. This supports Hoffman’s conclusion that doves actively regulate the contribution of their cloacae to heat loss.

Hoffman speculates that this ability could increase doves’ fitness in hot places, as it may allow the animals to be active when predators aren’t around, or increase the time they spend foraging at the hottest time of day. He would now like to establish whether other birds can also use their cloacae to cool off. ‘It would be nice to show that I haven’t simply stumbled across the only species to do this!’ he laughs.


Yfke Hager

THE UPS AND DOWNS OF BEE NAVIGATION

Honeybees might have small brains, but their navigation skills are second to none. Marie Dacke and Mandyam Srinivasan’s bees at the Australian National University, Canberra, could find a 4 cm wide feeder 500 m from their hive on many repeat visits, and like many honey bee researchers, Dacke wondered: ‘how can an animal with such a small brain solve such incredibly complex tasks?’ Dacke and Srinivasan specifically wanted to know how bees measure the distance that they travel using their internal ‘step measurer’, or odometer, when they fly three-dimensional trajectories (p. 845).
Bees calculate the distance they have flown using ‘optic flow’ which is how quickly, and in which direction, the image of the environment moves across their eyes. When they return to the hive they transmit this information to the other bees through the waggle dance. The duration of dance’s waggle phase tells the other bees the heading relative to the sun. The duration of dance’s waggle phase tells the other bees the distance calculation seem to be insensitive to the direction of optic flow.’ ‘Ultimately’, she says, ‘we want to understand the neural basis of how the odometer works’.


EVOLVING FLIES’ CIRCADIAN Clocks

It’s not just human beings that divide into early rising ‘larks’ and late rising ‘owls’. Flies too are governed by biological, or circadian, clocks that dictate when they emerge from the pupa and when they are active. But how did these clocks evolve? To investigate, Vijay Kumar Sharma and his colleagues at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India, imposed a selection pressure on flies (Drosophila melanogaster) as they emerged from the pupa. By selecting flies that emerged in the morning or evening, they wanted to see if they could change the timing of the flies’ clocks over many generations (p. 906).

Keeping flies in a regime of 12 h dark then 12 h light every 24 h, the team chose larks that emerged from their pupae in the morning between 5 am and 9 am, or owls that emerged in the evening between 5 pm and 9 pm. The team kept these early and late clocks, and the team found the same faster circadian rhythm than animals with early clocks have a slightly activity. Previous studies had shown that animals with early clocks have a slightly activity. Previous studies had shown that animals with early clocks have a slightly faster circadian rhythm than animals with late clocks, and the team found the same with their flies. The flies’ emergence patterns as when the lights were on and off, although the early flies had a slightly faster daily rhythm of 23.6 h compared to the late flies’ rhythm of 24.3 h. This shows that ‘clocks evolve through selection pressure on the timing of rhythmic behaviour,’ Sharma says.

Frog muscles survive the ‘big sleep’

When the sun really starts to sizzle, most animals tough it out in the shade. But the Australian green-striped burrowing frog, *Cyclorana alboguttata*, avoids the sun and lethal dehydration altogether by retreating into the ground and undertaking a ‘summer hibernation’, or aestivation, for up to nine months. Long hibernations often cause havoc with mammals’ muscles, which atrophy through misuse, however previous research on the green-striped burrowing frog showed that their leg muscles weren’t affected by a three month aestivation. But, since the frogs are in the ground for up to nine months, Beth Symonds and her colleagues from the University of Queensland and Coventry University wanted to know if the frogs’ muscles were still unaffected after a full aestivation. They chose to scrutinise the structure and the contractions of two frog ‘thigh’ muscles: the sartorius, which is a mostly fast twitch muscle at the front of the leg; and the iliofibularis, a slow twitch muscle found at the back of the leg (p. 825).

The team found that while the cross-sectional area of the iliofibularis and sartorius muscle fibre density decreased after aestivation, no other properties of the muscles such as muscle mass or the proportion of slow and fast fibres changed. Examining the muscles’ contractions, they found that muscle contraction speed slowed down in the slower-twitch iliofibularis only, but despite these small changes the muscles still produced the same amount of power, showing that that they resisted atrophy during their subterranean break. The next challenge will be to work out how the frogs manage this feat.

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