Inside JEB highlights the key developments in *The Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

HOW CHEETAHS OUTPACE GREYHOUNDS

In a 0–60 mph stand off, most cars would be hard pressed to give a cheetah a run for its money, and at their highest recorded speed of 29 m s^{-1} (65 mph) cheetahs easily outstrip the fastest greyhounds. But, according to Alan Wilson from the Royal Veterinary College, UK, there is no clear reason for the cheetah's exceptional performance. 'Cheetahs and greyhounds are known to use a rotary gallop and physically they are remarkably similar, yet there is this bewitching difference in maximum speed of almost a factor of two', he says. Teaming up with Penny Hudson and Sandra Corr, Wilson decided to compare how cheetahs and greyhounds sprint to see if there were any mechanical differences between the two animals' movements (p. 2425).

Knowing that captive big cats are happy to chase a lure, the trio were confident that they could get the cheetahs at ZSL Whipsnade Zoo, UK, to sprint across force plates buried in a track in the animals' enclosure. The problem would be getting the valuable equipment to work in the open. 'Force plates are cosseted, loved pieces of equipment that people don't generally take outside of the lab and bury in the ground in the English summer', Wilson chuckles. However, after successfully installing eight force plates in the cheetahs' enclosure, along with four high speed cameras filming at 1000 frames s^{-1}, Hudson tempted the cheetahs to gallop along the track with a piece of chicken attached to a truck starter motor while she measured the forces exerted on the animals' limbs, their body motion and footfall patterns. She also repeated the measurements on galloping greyhounds back in the lab, filming the animals at a slower 350 frames s^{-1}.

But, when Hudson compared the animals' top speeds, she was surprised to see that trained greyhounds can gallop faster than captive cheetahs, clocking up a top speed of 19 m s^{-1} compared with the cheetahs' 17.8 m s^{-1}. Nevertheless, Hudson was able to identify clear differences in the animals' stride patterns that could explain how wild cheetahs would outpace the dogs.

When running at the same speed, the big cats' stride was slightly longer than the greyhounds', although the cheetahs compensated for this with a slightly lower stride frequency. Also, the cheetahs increased their stride frequency as they shifted up through the gears – running at 2.4 strides s^{-1} at a leisurely 9 m s^{-1}, rising to 3.2 strides s^{-1} at their top speed of 17 m s^{-1} – whereas the greyhounds maintained a constant stride rate around 3.5 strides s^{-1} across their entire speed range. Wilson suspects that wild cats may be able to reach stride frequencies of 4 strides s^{-1}, which, in combination with longer stride lengths, may allow them to outstrip their captive cousins and hit top speeds of 29 m s^{-1}.

Also, when Hudson analysed the length of time that each animal's foot remained in contact with the ground – the stance time – she noticed that it was longer for the cheetahs, and the team suspects that this may be another factor that contributes to the wild cheetah's record performance. Explaining that increasing the stance time reduces the peak loads on the animal's legs, Wilson says, '[with] a longer stance time the cheetah will get to the limiting load at higher speed than the greyhound'.

Speculating about the relatively poor performance of the Whipsnade cheetahs, Wilson suggests that they may lack motivation. 'They have lived in a zoo for several generations and have never had to run to catch food. They have probably never learned to run particularly', he says, adding, 'The next stage is to try to make measurements in wild cheetahs in the hope of seeing higher speeds.'

10.1242/jeb.075788

Hudson, P. E., Corr, S. A. and Wilson, A. M. (2012). High speed galloping in the cheetah (*Acinonyx jubatus*) and the racing greyhound (*Canis familiaris*): spatio-temporal and kinetic characteristics. *J. Exp. Biol.* **215**, 2425-2434.

Kathryn Knight

SHARK CARBON AND NITROGEN ENRICHMENT MEASURED

'You are what you eat', is an old adage, and according to Sora Kim from the University of California, Santa Cruz (UCSC), USA, you can learn a lot about an animal's diet by analysing the accumulation of heavy isotopes in its tissues. Kim explains that heavy carbon and nitrogen isotopes (^{13}C and ^{15}N), which occur naturally at very low levels in the diet, tend to accumulate in the diner's body at fractionally higher levels than they occur naturally: the heavy isotopes become enriched relative to the lighter – and more common – ^{12}C and ^{14}N

isotopes. By knowing the rates at which these isotopes are incorporated into an animal's tissues and the relative abundance of nitrogen and carbon isotopes in the predator and its prey, it is possible to learn about an animal's ecology. 'Stable isotope ratios can tell you that it is more likely to be eating squid than fish and they can also give you a sense of whether they are feeding near or off shore, or in an estuary or pelagic environment', Kim says. However, before you can begin to learn about an animal's diet from its accumulated heavy isotope ratios, you have to know how fast the animal accrues the isotopes and the impact of different diets on the isotope ratios; and in order to establish those, you need to do a long-term feeding study (p. 2495).

Backed up by a loyal army of enthusiastic undergraduate researchers and the UCSC vet, David Casper, Kim and her thesis advisor, Paul Koch, collected nine leopard sharks from the Marine Science Institute, California, and relocated the animals to the Long Marine Lab at UCSC. Then the team fed the sharks on a diet of chopped squid three times a week and collected plasma and red blood cell samples and muscle biopsies every 3 weeks. Kim then analysed the carbon and nitrogen isotopic ratios for all three tissues.

'Other isotope incorporation rate studies have only lasted for 3–6 months', says Kim, who had expected that the ratios of the heavy and light isotopes would reach steady-state levels in a year at most. However, 12 months in, Kim was still seeing alterations in the isotope ratios. The shark's incorporation rates were incredibly slow, but after 18 months all three of the sharks' tissues reached stable isotope ratios for both elements. Then she switched the leopard shark's diet to tilapia – which had different $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios – repeating the same laborious feeding routine while continuing to take tissue samples until the sharks' isotopic ratios readjusted to the new diet.

Calculating the final enrichment values and incorporation rates for red blood cells, plasma and muscle with Carlos Martínez del Rio, Kim realised that they were very different for each tissue and significantly higher than the values that had previously been estimated. 'The carbon enrichment value that a lot of people use based on the literature was more like 1‰ or 1.5‰. However, for the tilapia diet the enrichment value for carbon in plasma is 3.7‰, for red blood cells is 2.8‰ and for muscle is 3.5‰', she says. Also, the different tissues reached equilibrium at very different rates. 'Those give different ideas of time and diets because the plasma has a much quicker incorporation rate than red blood cells and muscle, so the plasma would give an idea of what the shark was eating more recently but the muscle would give an impression of what the shark was eating over a longer period of time', explains Kim.

10.1242/jeb.075796

Kim, S. L., Martínez del Rio, C., Casper, D. and Koch, P. L. (2012). Isotopic incorporation rates for shark tissues from a long-term captive feeding study. *J. Exp. Biol.* **215**, 2495-2500.

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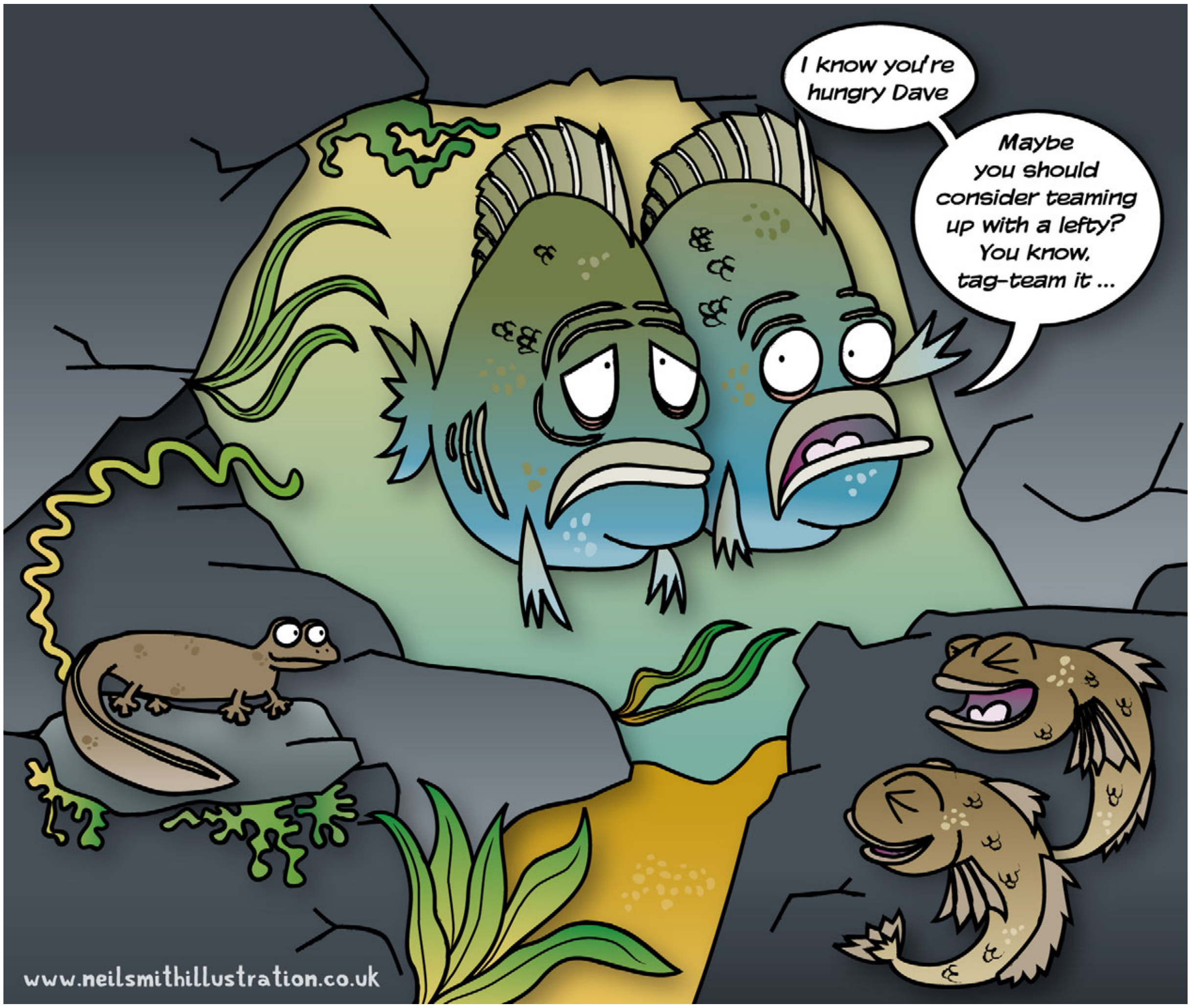
LEFT-BIASED BASS PICK OFF RIGHT-BIASED GOBIES



Most humans have a strong preference for the hand that they write with. But humans are not the only animals that favour one side of their body. Masaki Yasugi and Michio Hori from Kyoto University, Japan, explain that the behaviour of many fish is biased to one side or the other. 'This antisymmetry is defined as a dimorphism in which one side of the body is structurally and/or functionally more developed than the other', the duo explains, leading some fish to turn preferentially in one direction while other fish prefer the opposite. But what impact could a fish's preference for a dominant side have on the interaction between fish predators and their prey? For example, would predators that preferentially turned in one direction have more success in capturing prey that turned toward or away from them? And if so, could the predator and prey's preferences for particular turning directions result in a natural cross-predation pattern, with right-dominant predators selectively picking off left-handed prey and *vice versa* (p. 2390)?

Yasugi and Hori filmed encounters between largemouth bass and their freshwater goby victims as the predators approached from the rear. Recording the distance, direction, speed and success of the bass strike, the duo also noted the point during the attack when the goby began to take evasive action and the direction in which it turned. Finally, knowing that left-biased individuals tend to be more strongly developed on the left side (and *vice versa*), the duo measured the size of the bass lower jaws, looking for the telltale asymmetry that would confirm their directional preference.

Correlating the bass approach direction with the direction preference, Yasugi and Hori realised that when approaching from the rear the left-biased bass always circled in a clockwise direction while the right-biased bass circled anti-clockwise. Meanwhile, the left-biased gobies reacted earlier to the approach of left-biased bass and right-biased gobies escaped more quickly from right-biased bass. This suggests that right-biased gobies are more at risk from left-biased bass approaching from behind while left-biased gobies are more vulnerable to attacks from right-biased bass approaching from the rear. 'We believe that the lateral biases in approach direction and in evasive response corresponding to morphological antisymmetry are the principal mechanism causing the predominance of cross-predation', say Yasugi and Hori.

10.1242/jeb.075770

Yasugi, M. and Hori, M. (2012). Lateralized behavior in the attacks of largemouth bass on *Rhinogobius* gobies corresponding to their morphological antisymmetry. *J. Exp. Biol.* **215**, 2390-2398.

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