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.

Inside JEB

BEAM BENDING EXPLAINS HOW SEEDS SPRING

Even by invading plants' standards, the filaree, or common stork's bill, has been remarkably successful. Introduced into North America in the eighteenth century, it is now endemic in south-western states such as California, and the plant's intriguing seed dispersal mechanism seems to lie at the root of their success. Having launched as far as possible from the mother plant, the seed drills itself into the ground by repeatedly curling and unwinding a strap-like structure, known as an awn, to give it the best chance to germinate. But how do they self-drill? Having watched the seeds bore themselves into the ground in California, research associate Scott Hotton took them back to Jacques Dumais' Harvard laboratory to take a closer look and when Dumais set his introduction to botany class the challenge of making a time-lapse movie, Dennis Evangelista jumped at the opportunity to film the seed's drilling action.

Setting up a camera in his kitchen, Evangelista wet the dry seeds and filmed them as they uncurled and then rewound when they dried (p. 521). Evangelista explains that when humidity is low the awn dries, curls and drills the seed into the soil. When the humidity rises the awn uncurls, but backward facing hairs on the awn force the seed to move in one direction so that it continues drilling into the ground even when it uncurls. Plotting the tip's trajectory as it wound round, Evangelista realised that the awn behaved like a beam bending into a stretched logarithmic spiral. He could use engineering physics to calculate the amount of energy stored in the awn as it ripened and dried within the fruit and use it to explain how the seeds launch themselves. 'By knowing how much energy is in the dry awn when it is held straight in the seed head I can estimate the range that it goes,' says Evangelista; but first he needed to find out just how far the seeds could fly.

Setting up a high speed camera in Mimi Koehl's Berkeley laboratory and filming seed heads – formed from clusters of five awns – Evangelista captured the instant when an awn finally tore loose and the seed's speed as it catapulted free, launching it up to 0.5 m from the plant. But how well would Evangelista's energy storage model hold up when he used it to calculate how far the seed could be launched?

Calculating the amount of energy that was released as the dry awn curled and broke free of the seed head, Evangelista then subtracted the amount of energy required to tear the awn away and the energy lost to wind resistance as the seed tumbled through the air, before calculating the distance that the seed could be flung. His calculations matched the distance that the filmed seed had flown. So filaree seeds disperse by using energy stored in the dry awns, which act as springs to fling the seeds by up to 0.5 m.

Having discovered how filaree seeds are so successful at propagating, Evangelista and Dumais are now keen to find out how other members of the geranium family disperse their seeds. Evangelista explains that all geraniums are thought to use variations of the awn catapult mechanism for seed dispersal and propagation and he is keen to find out how changes in the awn's material properties affect seed dispersal in other members of the geranium family.

10.1242/jeb.055673

Evangelista, D., Hotton, S. and Dumais, J. (2011). The mechanics of explosive dispersal and self-burial in the seeds of the filaree, *Erodium cicutarium* (Geraniaceae). *J. Exp. Biol.* **214**, 521-529.

HOW FAMINE AFFECTS GREY MOUSE LEMURS

Most animals are well prepared to capitalise on times of plenty and live off their fat when food is scarce, but how are they going to cope if regular food supplies are affected dramatically by climate change? Cindy Canale and her colleagues from the Muséum National d'Histoire Naturelle, France, explain that the frequency of extreme environmental events, such as droughts and cyclones, is expected to increase, dramatically and unpredictably affecting food supplies. Curious to find out how one animal, the grey mouse lemur, may cope with sudden unexpected food loss, Canale, Martine Perret, Marc Théry and Pierre-Yves Henry measured the body temperatures and activity levels of the tiny primates when their food supply was suddenly cut short (p. 551).

Canale and her colleagues explain that grey mouse lemurs inhabit the island of Madagascar, where they regularly experience hardship courtesy of El Niño–La Niña climate oscillations. Selecting females

from the museum's captive colony of lemurs, the team simulated times of plenty – by feeding half of the animals on a healthy diet of fruit, carbohydrates and protein (the diet that covered 100% of the animal's energy requirements) – and lean seasons – by restricting the diet of the remaining animals to 60% of the well-fed animals' diet. Next the team simulated the devastation wreaked by a drought or cyclone. They cut the diets of all of the animals to 20% of the 100% diet for 12 days to find out which strategies the well-fed and undernourished animals might use to survive.

Knowing that grey mouse lemurs routinely conserve energy using torpor – dropping their body temperature and metabolism while resting – the team wondered whether the tiny primates may be able to adjust this energy saving pattern in response to a catastrophic decrease in food supply. The lemurs did. Even before times got really hard, the lemurs on the 60% diet entered torpor 4.4 h earlier than the well-fed individuals; they also dropped their temperature lower. When the 'severe drought' hit and the lemurs had to get by on a 20% ration, the lean season lemurs began dropping their body temperature 5.9 h earlier than the well-fed animals. The team also looked at the length of each torpor bout after the reduction of their food supply and found that both the well-fed and lean season lemurs dropped their body temperatures for a longer period. The lean season lemurs also cooled more than the well-fed animals, getting down to 24.3°C compared with 29.4°C for the well-fed lemurs.

Next the team analysed the lemur's activity levels and found that instead of reducing their activity when the food supply was cut, the tiny primates were more active immediately after bouts of torpor. And the lemurs on the lean season diet became twice as active as the better-fed animals when their rations were cut. However, when the team looked at the total activity levels of the well-fed and undernourished lemurs, they found that the two groups behaved the same.

So grey mouse lemurs are able to rapidly adjust their behaviour and metabolism in response to a catastrophic decrease in their food supply. Also, the undernourished animals seemed better prepared for hardship than better-fed members of their species. 'We suggest that physiological flexibility of energy saving mechanisms would be a key adaptation to respond to increased climate instability,' say Canale and her colleagues.

10.1242/jeb.055699

Canale, C. I., Perret, M., Théry, M. and Henry, P.-Y. (2011). Physiological flexibility and acclimation to food shortage in a heterothermic primate. *J. Exp. Biol.* **214**, 551-560.

PIGEONS USE RIGHT NOSTRIL TO SNIFF WAY HOME

The ability of pigeons to find their way home has fascinated people for millennia. Initially harnessing the birds to deliver correspondence, more recently people have raced pigeons competitively. But how do these remarkable aviators locate home after release in unfamiliar territory? Anna Gagliardo and her colleagues from the University of Trento, University of Pisa and Max Planck Institute for Ornithology explain that pigeons navigate using an olfactory map (p. 593). While sitting in their lofts, the birds are able to learn the directions from which odours originate and construct a map that is sufficiently accurate to guide them until they can switch to navigating by local landmarks. However, it seems that not all pigeon nostrils are equal: 'The right and the left olfactory systems are

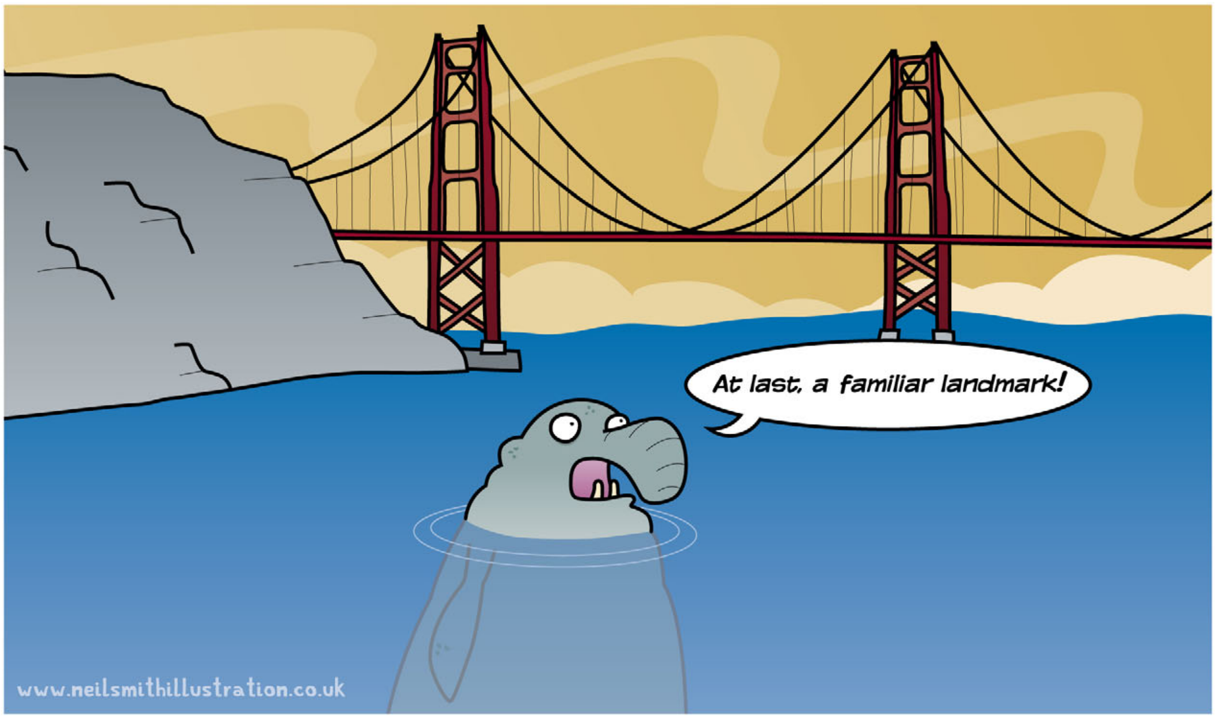
not equally efficient in processing olfactory cues,' says Gagliardo and adds, 'Studies on pigeons released with one nostril occluded highlight an asymmetry in favour of the right nostril.' Curious to find out how true this phenomenon is, Gagliardo plugged either the left or the right nostril of homing pigeons raised just outside Pisa and released the birds from Cigoli, 41.6 km away. Then the team tracked the birds' return routes with GPS to find out whether having a blocked nose affected their homing ability.

Analysing the flight paths of the birds, Gagliardo and her colleagues could see that pigeons that could not breathe through the right nostril took a more tortuous route, stopped more often and spent more time exploring stopover sites than birds that could breathe through the right nostril. The team suspects that the birds with blocked right nostrils spent more time exploring to gather additional navigational information and suggests that the left nostril is less sensitive to odours than the right. The team says, 'The behaviour of the right nose plugged pigeons suggests a specific role of the right nostril in processing olfactory information useful for the operation phase of the navigational map.'

10.1242/jeb.055681

Gagliardo, A., Filannino, C., Ioalè, P., Pecchia, T., Wikelski, M. and Vallortigara, G. (2011). Olfactory lateralization in homing pigeons: a GPS study on birds released with unilateral olfactory inputs. *J. Exp. Biol.* **214**, 593-598.

ELEPHANT SEALS NAVIGATE BY TWO STRATEGIES



Elephant seals have a nomadic lifestyle. Travelling between colonies and foraging out in the Pacific Ocean, northern elephant seals eventually return to their home colony. But how do they relocate home after a journey? Curious to find how northern elephant seals navigate to find their way home, an international team of researchers based in Japan, California and Scotland led by Moe Matsumura attached accelerometers, depth gauges, GPS trackers and VHF transmitters to three juvenile elephant seals. Releasing the animals in the Pacific Ocean 60 km from their colony, the team tracked the elephant seals' return journeys to try to identify which strategies the animals use (p. 629).

Retrieving the trackers when the youngsters returned to shore, the team analysed the seals' GPS diving profiles and saw that they had headed toward land before reaching the coast and following it back to the colony. When submerged the seals swam in almost perfectly straight lines, despite indulging in potentially disorienting drift dives, when they spiral upside down as they descend. However, the seals do not appear to become confused and the team suspects that the animals rely on either acoustic or geomagnetic cues to help them maintain their bearing.

Back at the surface, instead of swimming in straight lines the seals switched direction by anything up to 360 deg. Matsumura and her colleagues suspect that the seals use visual landmarks to guide their choice of bearing above the surface. So elephant seals appear to use several strategies when navigating to help them relocate the colony when they have strayed from home.

10.1242/jeb.055665

Matsumura, M., Watanabe, Y. Y., Robinson, P. W., Miller, P. J. O., Costa, D. P. and Miyazaki, N. (2011). Underwater and surface behavior of homing juvenile northern elephant seals. *J. Exp. Biol.* **214**, 629-636.

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