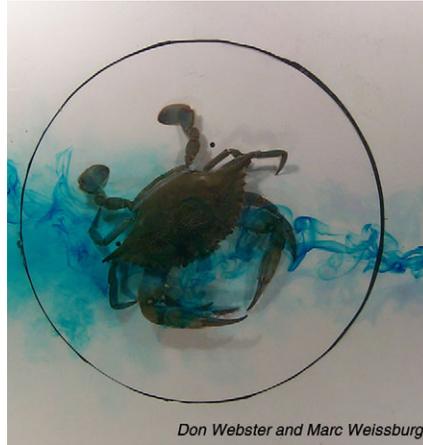


Inside JEB highlights the key developments in *The Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

CRABS SENSE ODOUR PLUME STRENGTH ACROSS WIDTH



Don Webster and Marc Weissburg

Following a delicious odour to its source is more than just a pleasure for most creatures: it's how they find their next meal or mate. Equipped with odour detectors on legs and antennae, insects and crustaceans are happy to follow their senses. But which aspects of an odour plume do they use for guidance? Marc Weissburg and his colleagues from the Georgia Institute of Technology, USA, explain that tiny insects tend to use wind direction as a cue when following odours because they are too small to sense variations in strength across the width of an odour plume. However, larger animals with odour receptors on their wide-set limbs may be able to distinguish between the middle and dilute edges of a wide plume to home in on the source. Curious to find out how blue crabs follow odour plumes, Weissburg and his colleagues devised a way of tracking crabs' responses to complex scent distributions (p. 1513).

Placing crabs in a flow tank, the team produced three appetising prawn-flavoured plumes for the crabs to pursue: one that flowed continuously, another that was more diffuse and swept from side to side and a third that was released intermittently. Visualising the plume's strength with a fluorescent dye, the team then filmed the crabs as they scuttled towards the tempting odour.

Analysing each plume's distribution and the crab's responses, the team could see that the crabs were able to sense the odour strength across each plume's width with their widely spaced legs. Although the crustaceans paid attention to the direction of flow and usually headed towards it, they also tracked where the odour was strongest, and preferred to head across the flow when the plume meandered to one side.

Monitoring the crab's reactions to the continually undulating plume's motion, the

team found that the crab's leg odour receptors were very sensitive to differences in the plume's strength so that they could follow shifts in the plume's direction of less than 1 cm – only 5% of the crab's leg span. However, the crabs did seem to have more problems following the moving and intermittent plumes. They wandered off course more often while following the variable plumes.

So, blue crabs are able to track odour plumes by sensing the strength of the smell across the plume's width and follow the plume where it is strongest.

However, Weissburg and his colleagues point out that the crabs may pay a relatively high price when following more diffuse plumes. They explain that crabs that orient their bodies across the flow significantly increase their drag. Usually the crabs aligned their bodies with the flow to reduce drag as they followed a strong plume. However, in the diffuse plumes they occasionally faced directly into the flow so that they could use their antennules to detect the weaker odours, and this raised the drag on their bodies. The team suspects that crabs may be happy to incur the additional energetic cost of drag in diffuse plumes to capitalise on the information they collect that gets them to their goal.

10.1242/jeb.058297

Page, J. L., Dickman, B. D., Webster, D. R. and Weissburg, M. J. (2011). Staying the course: chemical signal spatial properties and concentration mediate cross-stream motion in turbulent plumes. *J. Exp. Biol.* **214**, 1513-1522.

DEMANDING CHICKS GET AHEAD

Nestlings appear to put a lot of effort into begging. Stretching their scrawny necks and gaping wide, chicks seem to invest a significant amount of energy to attract the next beak full from their parents. So, how much does begging cost nestlings? David Martín-Gálvez and his Spanish colleagues, from the Estación Experimental de Zonas Áridas in Almería and the University of Granada, explain that enthusiastic begging could be costly so the team decided to estimate the cost of exaggerated begging relative to the benefits of being well fed by their parents. Giving newly hatched magpie chicks an appetite stimulant (cyproheptadine) in the hope that it would make the youngsters feel hungry and beg harder, the team monitored the chicks to see what affect it had on their behaviour (p. 1463).

'Cyproheptadine is broadly used in humans, including children, as a safe and effective appetite stimulant,' explains Martín-Gálvez.



Having identified new magpie nests in the surrounding countryside, the team gave magpie youngsters a tiny dose of cyproheptadine every 2 days during their development in the nest, and filmed the 10–12 day old birds as their parent's returned from foraging. They saw that the chicks that had been treated with cyproheptadine begged more often, but with the same intensity as chicks that had received a drink of water instead of the stimulant. So, the cyproheptadine-treated chicks seemed to be hungrier than the chicks that had only had a drink, but how did the parents react to the chicks' demanding behaviour?

Placing collars around the chicks' necks for 2 h so that the nestlings couldn't swallow food, the team were able to measure how much each chick had been fed while monitoring their mass. They found that the chicks that begged more often received 209% more food than the normal chicks, and the youngsters also lost more mass during the brief period when they couldn't swallow. So the chicks that begged more often had attracted more of their parents' attention; however, they had also used more energy.

But what was the long-term effect of the chicks' increased begging behaviour? Monitoring the chicks until they were about to fledge, the team measured the chicks' growth and the strength of their immune systems to find out whether additional begging had given them a better start in life. It had. Not only were the high-frequency beggars heavier and larger but also they had a stronger immune response than chicks that begged at the normal rate. Despite the additional energetic cost of begging, the hungry chicks had benefitted from the increased parental attention that they attracted.

So why don't begging chicks bend the rules and cheat to attract more than their fair share from mum and dad? Martín-Gálvez and his colleagues explain that there could be several reasons. Greedy chicks that beg dishonestly could go on to produce even greedier young, escalating to the point where the parents and their chicks could not survive the chicks' excessive demands, removing the tendency to cheat from the gene pool. Alternatively, the chicks and their parents could pay some other way – as yet unidentified – for rearing deceitful offspring and the team is keen to find out which indirect costs keep cheating chicks in check.

10.1242/jeb.058271

Martín-Gálvez, D., Pérez-Contreras, T., Soler, M. and Soler, J. J. (2011). Benefits associated with escalated begging behaviour of black-billed magpie nestlings overcompensate the associated energetic costs. *J. Exp. Biol.* **214**, 1463-1472.

HOW HYPOXIA AFFECTS DROSOPHILA DEVELOPMENT



Oxygen levels can have a dramatic effect on body size. It is thought that the colossal insects that roamed the planet during the Carboniferous period were only able to grow large because of elevated oxygen levels. And low oxygen can have the opposite effect: some species that grow at high altitude are smaller than organisms living at sea level. Jon Harrison and his colleagues from Arizona State University, USA, are fascinated by the mechanisms that regulate body size in response to oxygen levels. 'We were interested to see if there was a period during development during which this size reduction takes place,' says Erica Heinrich, an undergraduate student working in Harrison's lab. So she joined Manoush

Farzin and Jaco Klok to find out when developing *Drosophila melanogaster* are sensitive to oxygen levels (p. 1419).

Designing a complicated array of experiments where *Drosophila* at various stages of development were exposed to periods of hypoxia (10% oxygen), the team then collected the fully-grown adults and measured their wing cell size, body mass and body cell size to find out how a limited oxygen supply had affected their growth.

Surprisingly, all of the adult insects that had experienced hypoxia during any developmental stage were on average 7% smaller than the insects that were exposed to normal oxygen levels. Even the insects that were exposed to brief – 24 h – hypoxic windows were small. And by carefully controlling when the flies experienced hypoxia, the team found that the insects were most sensitive to limited oxygen availability during the final stage of larval development and early in pupal development.

Curious to find out why the flies that were reared in hypoxic conditions were smaller than flies reared in 21% oxygen, the team looked at the insect's cell sizes and cell number. All of the flies that had experienced hypoxia had smaller wings than flies reared in normoxia and insects that had only experienced hypoxia as pupae had smaller wing cells.

Having found that the insects were more sensitive to hypoxia during the late larval and pupal stages, and that developmental stage also affected the size of the insect's wing cells after hypoxia exposure, the team says, 'There may be at least two independent mechanisms by which hypoxia reduces adult body size.' Explaining that hypoxia inducible factor and nitric oxide are known to modulate cell function in response to hypoxia, they are keen to find out if either play a role in the hypoxic fruit flies' size.

10.1242/jeb.058289

Heinrich, E. C., Farzin, M., Klok, C. J. and Harrison, J. F. (2011). The effect of developmental stage on the sensitivity of cell and body size to hypoxia in *Drosophila melanogaster*. *J. Exp. Biol.* **214**, 1419-1427.

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