

Editorial

The Journal of Experimental Biology Outstanding Paper Prize, 2007

The editors of *The Journal of Experimental Biology* are pleased to announce the winners of this year's JEB Outstanding Paper Prize. Conceived in memory of the journal's fifth Editor-in-Chief, Bob Boutilier, the award is made by the editors to the most exceptional paper published in the journal in 2007. This year it is presented jointly to Drs Juliet Osborne and Andy Reynolds for their contributions to 'Honeybees perform optimal scale-free searching flights when attempting to locate a food source' (Reynolds et al., 2007). Ken Lukowiak, an editor at the journal, says 'I really got turned on by this paper because it shows that even simple animals can perform extremely complex tasks'. Reynolds, a theoretical physicist, admits that when he heard the news he initially thought that he had misread the email. 'I had to reread it three times', he remembers, 'to be sure that I'd read it right'. Osborne adds that she was 'surprised and delighted'. Speaking on behalf of the rest of the team, she says 'we are all very pleased'.

Osborne and Reynolds are both based at Rothamsted Research, one of the largest agricultural research institutes in the UK. Osborne joined Rothamsted after finishing her PhD in Cambridge 12 years ago. Since then her interests have focused on insect behaviour, specifically in a farming context. Reynolds, on the other hand, is a relatively recent recruit, having moved from the Silsoe Institute in 2004. With a background in aerosol dispersion modelling, Reynolds was invited to 'find an area that was relevant to Rothamsted' and soon settled on bees as his new interest, which is where serendipity stepped in. Osborne already had an interesting challenge for Reynolds to get his teeth into: untangling a pattern from some intriguing bee foraging data that she had collected in 2003 with Norman Carreck, Don Reynolds and Alan Smith.

At that time Osborne was interested in how bees navigate using landmarks. Osborne and Carreck released the insects from a hive in a flat, featureless airfield in Cambridgeshire. The team tracked the bees as they foraged at a sucrose feeder and monitored their responses to the only significant feature in the landscape, a large white van, to see if they used it as a reference for navigation. Tracking individual bees with a revolutionary

new radar system, developed by Smith and the Natural Resources Institute radar unit, Osborne tested whether the bees used the van as a reference by moving it to see if it sent the bees off in the wrong direction. But it didn't. The bees paid little or no attention to the van, successfully returning every time to the sucrose feeder site, regardless of the van's location, even returning to the sucrose site after it had been removed.

The bees were not using features in the landscape to navigate, but Osborne noticed the insects behaving strangely whenever the sucrose feeder had been removed. The bees began searching around the area, making looping flights out from the point where the sucrose had been situated, with each successive loop seeming to go in a slightly different direction to the previous

one. Osborne was excited by this discovery. It was the first time that anyone had tracked a bee searching for food and Osborne quickly realised that 'I didn't have the maths to see if the bees were optimally searching'.

Enter Andy Reynolds. Since his arrival at Rothamsted, Reynolds had been developing his ideas about bee search behaviour and when Osborne saw how his work was progressing 'we volunteered this set [of data] as a good example. He positively pounced on it', she recalls.

Presented with reams of data, Reynolds began the arduous task of writing the sophisticated software required to unearth underlying flight patterns. After months of painstaking analysis, Reynolds eventually noticed some distinctive features appearing in the data. The bees were using Lévy-flights. Reynolds explains that Lévy-flights minimise the distance travelled during a search. In other words, they are the most efficient search strategy possible. Reynolds' mathematical know-how had unlocked the bee's secret. They were not using conventional navigational techniques, memory or scent to locate new nectar, they were simply using the most efficient search strategy.

Had Reynolds been surprised by the discovery? 'I was expecting it', he says, 'but maybe I was being a naïve physicist thinking that if this [Lévy-flight] was the best way to search and if animals had evolved to have the best searching flights, then the flights must be Lévy like'. The



biologists, on the other hand, were genuinely amazed by the discovery; they had been concerned that the bees were relying on other behaviours while foraging, rather than adopting an optimised search strategy.

Reynolds admits that his transition into biology has been 'very enjoyable'. He adds that he has found discussions about his work with Don Reynolds particularly rewarding; 'Don Reynolds is very much my guiding light', says Reynolds. In the long term, Osborne is optimistic that this work could help

scientists to predict insect movements and pollination patterns in response to food distributions. 'Understanding searching behaviour is another important piece in the jigsaw', she says.

Reynolds, A. M., Smith, A. D., Reynolds, D. R., Carreck, N. L. and Osborne, J. L. (2007). Honeybees perform optimal scale-free searching flights when attempting to locate a food source. *J. Exp. Biol.* **210**, 3763-3770.

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