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ECR SPOTLIGHT

ECR Spotlight – Nicholas Burnett

ECR Spotlight is a series of interviews with early-career authors from a selection of papers published in Journal of Experimental Biology and aims to promote not only the diversity of early-career researchers (ECRs) working in experimental biology during our centenary year but also the huge variety of animals and physiological systems that are essential for the 'comparative' approach. Nicholas Burnett is an author on 'Close encounters of three kinds: impacts of leg, wing and body collisions on flight performance in carpenter bees', published in JEB. Nicholas is a postdoc in the lab of Stacey Combes and Brian Gaylord at University of California, Davis, USA, investigating how biomechanical traits respond to the environment and influence organismal function and ecology.

Nicholas Burnett

Describe your scientific journey and your current research focus

I was originally fascinated by the behavior and physiology of intertidal mollusks, which led me to find an undergraduate research experience in the field of biophysical ecology. My interests transitioned from biophysics to biomechanics in graduate school, where I examined the biomechanical ecology of intertidal kelp (doi:10.1242/jeb.190595). In my postdoctoral research, I maintained my focus on biomechanical ecology but transitioned from marine and intertidal systems to terrestrial systems – I first focused on the collision-avoidance strategies of flying bees near wind-blown clutter (doi:10.1242/jeb.222471) and later focused on the biomechanical consequences of in-flight collisions of bees (doi:10.1242/jeb.245334).

How would you explain the main finding of your paper to a member of the public?

We often think of flying insects as gracefully moving through the world around us – dipping around branches, zipping around leaves. In reality, insect flights are full of accidents and collisions. In our paper, we described three of the most common ways that the large bee, the valley carpenter bee, crashes while flying around obstacles that mimicked plants. These collisions included hitting their wings, their body or their legs on the obstacles, and each collision type had unique consequences for the bee's flight behavior, which we measured as flight speed and body orientation. Wing collisions were most common but had minimal effects on flight behavior, whereas body and leg collisions were less frequent but caused big reductions in flight speed and destabilizing body rotations. We concluded that insect flights around obstacles are far from perfect – there can be many collisions – but some species have flight behaviors that are robust to the most common collisions and may even capitalize on collisions to traverse tricky obstacles.

What are the potential implications of this finding for your field of research, and is there anything that you learned during this study that you wish you had known sooner?

Considering the role of collisions in insect flight can help us better understand how complex habitats, such as cluttered vegetation, constrain insect movement. Furthermore, knowing how insects respond to, and perhaps intentionally use, collisions to move through clutter can inform future generations of bio-inspired aerial vehicles that need to traverse tricky flight paths, such as those going through narrow corridors or around intricate series of obstacles.

Which part of this research project was the most rewarding/challenging?

This project gave me an opportunity to use machine learning techniques (DeepLabCut) to digitize high-speed videos of bee flight. I enjoyed developing this skill and think that it will come into play with future investigations.

Are there any modern-day JEB papers that you think will be the classic papers of 2123?

I anticipate that 'Avoiding obstacles while intercepting a moving target: a miniature fly's solution' by Fabian et al. (2022; doi:10.1242/jeb.243568) will be a classic paper in 2123 because of its innovative consideration of insect flight, predator–prey interactions, and complex terrains, all within a mathematical framework. This paper will pave the way for future work in the field of insect flight biomechanics that considers our traditional model systems or approaches under more realistic settings.

What do you think experimental biology will look like 50 years from now?

One possibility for experimental biology 50 years from now is that advanced computational and statistical techniques will become commonplace in most research groups. This shift will complement

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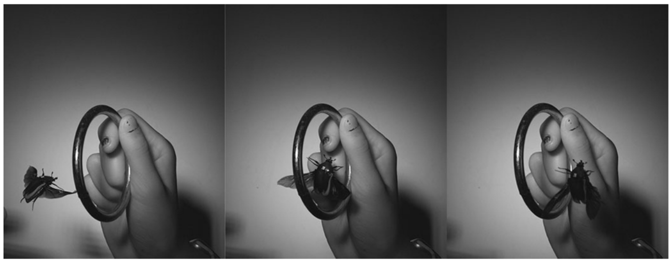

A figeater beetle *Cotinis mutabilis* flies through a handheld hoop. This photograph was taken during a pilot experiment to determine how beetles traverse challenging obstacles and narrow spaces in flight.

the increased power and affordability of instrumentation due to technological innovations and competition within the marketplace. Together, these developments, which are already increasingly common, will allow every biologist to use 'big data' approaches for their research, smothering each fundamental question with an abundance of data and analysis and leading to insightful, breathtaking conclusions. As these methods become increasingly expected, the downsides of these approaches will amplify. Research groups will compete for funding, promising to build larger and longer datasets with more complex experimental designs and increasingly tedious analyses. Methodologies will be so convoluted that university students will be unable to participate in meaningful research experiences, and experimental results will be so intricate that they cannot easily be explained to the public. Eventually, some biologists will grow weary of these challenges and choose to scale back their approaches, giving rise to an era of 'artisanal' biology in which researchers test how one or two traits respond to a small number of experimental treatments. The elegant simplicity of these new experiments will immediately resonate with students, policymakers, funders and other biologists. Funding for computational infrastructure will gradually decrease, just in time for biologists to chase the next big innovation. That is just one possibility.

Reference

Burnett, N. P. and Combes, S. A. (2023). Close encounters of three kinds: impacts of leg, wing and body collisions on flight performance in carpenter bees. *J. Exp. Biol.* **226**, jeb245334. doi:10.1242/jeb.245334