

NEWS

Announcing the 2021 Journal of Experimental Biology Outstanding Paper Prize shortlist and winner

Kathryn Knight*

Rarely has science been so high on the news agenda. Thanks to the Covid-19 pandemic, terms such as antigen, mRNA and vaccination are now routinely bandied about, and the recent COP26 conference means that climate change is seldom far from the headlines. Many of the scientific discoveries highlighted in 2021 were the fruit of years and even decades of toil and enterprise inspired by keen minds and driven forward by the scientific passion of graduate students and postdocs. ‘The past couple of years have been tough going with the impacts of the pandemic, so recognising and celebrating great scientific discoveries, especially undertaken by early career researchers, has taken on even greater significance’, says Craig Franklin, Editor-in-Chief of Journal of Experimental Biology. Since JEB launched the Outstanding Paper Prize in 2005, in memory of Bob Boutilier, to celebrate early-career researchers and their contributions to science, we have featured discoveries ranging from elastic energy storage during guinea fowl jumping to carbohydrate regulation in ant colony growth. And now, as the calendar clicks around to another year, the journal Editors are pleased to announce the 12 papers shortlisted for the 2021 Outstanding Paper Prize award.

‘This year’s shortlist of outstanding papers reflects the breadth and exceptional quality we have come to expect and are delighted to publish in JEB’, says Franklin, who nominated Sugjit Padda, Jordan Glass and Zachary Stahlschmidt’s research article, from the University of the Pacific, USA, investigating how life history influences the effect of heat waves and drought on field crickets (jeb236398). ‘This was an elegant study... that was truly integrative’, says Franklin, adding that he really enjoys papers, such as this one, that consider the impact of multiple stressors and how species may mitigate their costs. In another paper examining the impact of heatwaves, this time focusing on southern pied babblers in South Africa, Lesedi Moagi and Andrew McKechnie, from the South African National Biodiversity Institute, with colleagues from other institutions in South Africa, analysed how high temperatures affected the birds’ stress hormone levels (jeb242535). Katie Gilmour, who oversaw peer review of the article, says, ‘I was impressed by the patience and persistence of the authors, who collected faecal samples (nearly 900) in the wild from individually identified study birds by following the individuals and collecting their droppings within 1 min of defecation’.

In Julian Dow’s nominated paper, Ya-qi Chen from Xiamen University, China, Yun-Wei Dong from Ocean University of China and colleagues from other Chinese institutions analysed how the periwinkle *Echinolittorina malaccana* is able to withstand temperatures up to 55°C by switching to anaerobic metabolism



Emily Hardison, winner of the 2021 Journal of Experimental Biology Outstanding Paper Prize.

and producing molecules that mop up toxic forms of oxygen (jeb238659). ‘This paper used cutting edge metabolomics to elicit some genuinely novel insights into temperature adaptation in a remarkable, heat-tolerant mollusc’, says Dow. Meanwhile, Emily Hardison, Erika Eliason and colleagues from the University of California, Santa Barbara, USA, investigated how changing diet could affect how fish cope with rising temperatures (jeb242846). ‘This is an important but understudied issue that has critical implications for predicting how organisms will respond to climate change’, says Editor Trish Schulte, recalling how the team discovered that the ability to switch diet could allow species to survive temperature rises that would place less versatile diners at risk.

Continuing the physiological theme, Stuart Egginton’s shortlisted nomination, ‘New insights into the allosteric effects of CO₂ and bicarbonate on crocodilian hemoglobin’ (jeb242615), by Naim Bautista and Angelo Fago (Aarhus University, Denmark) and an international team of collaborators, shows that the build-up of CO₂ and bicarbonate ions in red blood cells facilitates oxygen delivery to tissues during diving, while oxygen desaturation allows for CO₂ transport. ‘This imaginative study provides the first integrative link between the unusual allosteric regulation of haemoglobin and CO₂ transport during diving, offering a stimulus for further work on both mechanisms and potential insight into other physiological challenges’, says Egginton.

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Monica Daley, Sheila Patek and Pat Wright each nominated papers investigating the mechanical and structural properties of three uniquely different structures: mussel shells, eggshells and robin moth cocoons. Reflecting on Rachel Crane and Mark Denny's analysis revealing that fractured mussel shells recover their strength and heal dramatically within a matter of days (jeb242681), Daley says 'The authors present a clear and thorough investigation of the timeline for shell repair, showing evidence of surprisingly rapid repair and do a great job discussing the broader implications for ecological risks and benefits for survival'. In contrast, the eggs of brown-headed cowbirds have to withstand the malicious pecks of other cowbirds intent upon parasitising the nest in which they were deposited by their parents (jeb243016). 'The authors [Analia López from the Universidad de Buenos Aires, Argentina and colleagues from Argentina and the USA] integrated substantial cross-species field work with rigorous experimental methods to compare eggshell mechanical properties, morphology, and even ultrastructural features', says Patek, adding 'This is a truly impressive and fascinating paper'. Moving on to the relative benefits of the cocoon designs used by overwintering robin moth pupae, Wright recalls the inventive analysis of Adam Parlin and Patrick Guerra (University of Cincinnati, USA), revealing that baggy cocoons are capable of storing water during dry winters, while more compact cocoons offer better protection from damp conditions during wet winters (jeb239780). This strategy ensures that some pupae develop successfully, regardless of the conditions they endure. 'I really like how the authors set out clear hypotheses and used inventive methodology to understand a fundamental and intriguing structure–function relationship', she says.

Switching focus to neuroethology, another core field in the journal, Almut Kelber's nominated paper investigates how echolocating harbour porpoises distinguish objects that should be too close together to be distinguished, while Ken Lukowiak's nomination looks at how fruit fly memories are impacted by their gut flora. 'I like studies that ask a seemingly simple question that is highly sophisticated at the same time', says Kelber, referring to the study by Chloe Malinka and colleagues from the University of Aarhus, where they presented harbour porpoises with spheres that were as little as 13.5 cm apart, to find out whether the porpoises were capable of distinguishing them by echolocation (jeb242779). 'Not only does the paper answer the question – it is possible to distinguish much closer objects than expected from their neural sound analysis system – but it also reveals the strategies that the animals use', says Kelber. Equally impressively, Valeria Silva and colleagues from the Universidad de Valparaíso, Chile, painstakingly bred fruit flies lacking a gut microbiome and the team was able to show that sleep, memory and ability to learn in the insects lacking gut flora were significantly impaired (jeb233619). '[This] is a lesson that all of us should take to heart', warns Lukowiak.

The final pair of shortlisted papers consider different aspects of flight: from the hunting strategy of novice gyrfalcons to the developmental pathways that have led to the glasswing butterfly's eponymously transparent wings. Monica Daley, says the paper by Caroline Brighton and colleagues from the University of Oxford, UK, and Wingbeat Ltd [jeb238493], edited by retired Deputy Editor-in-Chief Andy Biewener, 'presents a very nice application and integration of flight navigation theory to predict attack flight behaviours'. She adds, 'The authors very effectively combined challenging experiments with hypothesis-driven model-based predictions and find interesting differences in navigation behaviours between gyrfalcons and peregrine falcons'. Meanwhile, in the paper nominated by Sanjay Sane, Aaron

2021 Journal of Experimental Biology Outstanding Paper Prize shortlist

Bautista, N. M., Malte, H., Natarajan, C., Wang, T., Storz, J. F. and Fago, A. (2021). New insights into the allosteric effects of CO₂ and bicarbonate on crocodilian hemoglobin. *J. Exp. Biol.* **224**, jeb242615. doi:10.1242/jeb.242615.

Brighton, C. H., Chapman, K. E., Fox, N. C. and Taylor, G. K. (2021). Attack behaviour in naive gyrfalcons is modelled by the same guidance law as in peregrine falcons, but at a lower guidance gain. *J. Exp. Biol.* **224**, jeb238493. doi:10.1242/jeb.238493.

Chen, Y.-q., Wang, J., Liao, M.-i., Li, X.-x. and Dong, Y.-w. (2021). Temperature adaptations of the thermophilic snail *Echinolittorina malaccana*: insights from metabolomic analysis. *J. Exp. Biol.* **224**, jeb238659. doi:10.1242/jeb.238659.

Crane, R. L., Diaz Reyes, J. L. and Denny, M. W. (2021). Bivalves rapidly repair shells damaged by fatigue to bolster strength. *J. Exp. Biol.* **224**, jeb242681. doi:10.1242/jeb.242681.

Hardison, E. A., Kraskura, K., Van Wert, J., Nguyen, T. and Eliason, E. J. (2021). Diet mediates thermal performance traits: implications for marine ectotherms. *J. Exp. Biol.* **224**, jeb242846. doi:10.1242/jeb.242846.

López, A. V., Bolmaro, R. E., Ávalos, M., Gerschenson, L. N., Reboreda, J. C., Fiorini, Vanina D., Tartalini, V., Rizzo, P. and Hauber, M. E. (2021). How to build a puncture- and breakage-resistant eggshell? Mechanical and structural analyses of avian brood parasites and their hosts. *J. Exp. Biol.* **224**, jeb243016. doi:10.1242/jeb.243016.

Malinka, C. E., Rojano-Doñate, L. and Madsen, P. T. (2021). Directional biosonar beams allow echolocating harbour porpoises to actively discriminate and intercept closely spaced targets. *J. Exp. Biol.* **224**, jeb242779. doi:10.1242/jeb.242779.

Moagi, L. L., Bourne, A. R., Cunningham, S. J., Jansen, R., Ngcamphalala, C. A., Ganswindt, A., Ridley, A. R. and McKechnie, A. E. (2021). Hot days are associated with short-term adrenocortical responses in a southern African arid-zone passerine bird. *J. Exp. Biol.* **224**, jeb242535. doi:10.1242/jeb.242535.

Padda, S. S., Glass, J. R. and Stahlschmidt, Z. R. (2021). When it's hot and dry: life-history strategy influences the effects of heat waves and water limitation. *J. Exp. Biol.* **224**, jeb236398. doi:10.1242/jeb.236398.

Parlin, A. F. and Guerra, P. A. (2021). Dimorphic cocoons of the robin moth, *Hyalophora cecropia*, reflect the existence of two distinct architectural syndromes. *J. Exp. Biol.* **224**, jeb239780. doi:10.1242/jeb.239780.

Pomerantz, A. F., Siddique, R. H., Cash, E. I., Kishi, Y., Pinna, C., Hammar, K., Gomez, D., Elias, M. and Patel, N. H. (2021). Developmental, cellular and biochemical basis of transparency in clearwing butterflies. *J. Exp. Biol.* **224**, jeb237917. doi:10.1242/jeb.237917.

Silva, V., Palacios-Muñoz, A., Okray, Z., Adair, K. L., Waddell, S., Douglas, A. E. and Ewer, J. (2021). The impact of the gut microbiome on memory and sleep in *Drosophila*. *J. Exp. Biol.* **224**, jeb233619. doi:10.1242/jeb.233619.

Pomerantz from the University of California, Berkeley, USA, and colleagues discovered that the scales on transparent regions of the butterfly wings were thin and bristly, in contrast to the flat round scales on opaque sections (jeb237917). They also revealed that the scales on transparent sections have a unique coating, which could inspire the next generation of anti-reflective materials. 'The paper was fascinating!', exclaims Sane, adding that the team used a series of approaches, including confocal microscopy, electron microscopy and developmental techniques.

Considering the 2021 shortlisted papers, Franklin says, 'It was an extremely difficult task to come up with an overall winner as all the

shortlisted articles were deserving winners in their own right, each demonstrating wonderful creativity and exceptional science'. However, after reviewing the 12 nominated papers, the Editors are delighted to announce that Emily Hardison's paper, 'Diet mediates thermal performance traits: implications for marine ectotherms', has been awarded the 2021 JEB Outstanding Paper Prize. 'It was the first email I saw that day and I had to re-read it multiple times to believe it. I was surprised, honoured and extremely thankful', says Hardison. Senior author Erika Eliason was equally pleased, 'I was just so excited and delighted for Emily and all the students in the lab who participated on this project. It's such an honour', she says, adding that working with Emily was truly a joy: 'She's bright, driven, hard-working and a dedicated mentor to undergraduate students'. Hardison was one of the first students to join Eliason as she established her UCSB lab. 'Emily had to set up the tanks, plumb everything, build respirometers, order all the equipment. Absolutely every aspect was novel – how to catch opaleye, hold them in the

lab, what to feed them', Eliason says, and this is the first paper to come from her wet lab. In addition, the Covid-19 pandemic struck just as Hardison was finalising her heart rate study; 'the entire university shut down, so Emily had to abruptly stop everything', Eliason recalls. Despite this setback, Hardison is excited by the implications of her discovery that diet impacts the thermal acclimation responses of fish. 'The interaction between diet and temperature has many applications, including ecology, aquaculture and conservation', she says. In addition, she is keen to credit her colleagues and co-authors for their help and support. 'Erika provided an enormous amount of mentorship throughout the entire project. I have learned so much from her', says Hardison, also mentioning the contributions of her co-authors, Krista Kraskura, Jacey Van Wert and Tina Nguyen. And Craig Franklin concludes by congratulating Hardison: 'This was such a great article', he says, adding, 'I wish Emily all the best with her PhD studies and future research'.