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NEWS

The 2017 Journal of Experimental Biology Outstanding Paper Prize shortlist and winner

Kathryn Knight*

While each new research article published in Journal of Experimental Biology presents a novel discovery or observation that furthers our understanding of the animals on the planet, each publication can also represent a personal triumph for its authors. For the junior researchers who dedicated so much of their own time and creativity while tackling challenges and overcoming setbacks, each piece of research can mark a significant milestone along their career progression. With the journal's long tradition of supporting graduate students and postdoctoral researchers through travelling fellowships and travel grants – and more recently in our Conversations with early-career researchers – the Editors founded the JEB Outstanding Paper Prize in 2005 to recognise the contributions of outstanding young scientists to the research published in the journal. Hans Hoppeler, Editor-in-Chief, says, 'We feel we have a mandate to support young scientists, to give a voice to their research, and we hope that the JEB Outstanding Paper Prize is a small help for promising young talent'. This year, the journal Editors have nominated nine exceptional studies to the shortlist of papers for consideration for the 2017 JEB Outstanding Paper Prize. In recognition of this diverse group of young scientists, we celebrate their contributions here.

Life on the edge: O_2 binding in Atlantic cod red blood cells near their southern distribution limit is not sensitive to temperature or haemoglobin genotype

Sam Barlow worked with Michael Berenbrink on 'Life on the edge: O_2 binding in Atlantic cod red blood cells near their southern distribution limit is not sensitive to temperature or haemoglobin genotype'.

As ocean temperatures continue to rise, there are increasing concerns about how fish populations will adapt. While many species could be vulnerable to rising temperatures, cod that carry a form of haemoglobin known as type I were thought to be at less risk from the damaging effects of high temperatures than cod that produce the type II form of the protein; the type I haemoglobin was believed to carry more oxygen in warm conditions than the type II form. However, Michael Berenbrink from the University of Liverpool, UK, explains that no one had thoroughly checked the oxygen binding characteristics of the two proteins to confirm the relationship. Knowing that his graduate student, Sam Barlow, would have to test fish from both blood group types that had experienced identical conditions, Berenbrink suggested that she should go fishing in the Irish Sea, where fish carrying both blood groups are found, in the depths of winter in the hope of collecting enough fish to lay the matter to rest. 'It was a logistical nightmare', says Berenbrink, recalling how Barlow collaborated with the skippers of two local fishing boats that kept her supplied with fresh fish while she analysed the oxygen binding characteristics of the fish's blood. 'The most exciting thing was when we began to realise that previous assumptions about the role of the different haemoglobin genotypes in temperature adaptation may have been wrong', says Berenbrink, recalling how Barlow eventually confirmed that there was no difference in the oxygen binding characteristics of the two forms of haemoglobin at different temperatures. He adds that Barlow's analysis will allow us to make more accurate predictions of North East Atlantic cod stocks in the future.

Achilles tendon is mechanosensitive in older adults: adaptations following 14 weeks versus 1.5 years of cyclic strain exercise

Gaspar Epro worked with Kiros Karamanidis, Jonas Doerne, Julian A. Luetkens and colleagues on 'Achilles tendon is mechanosensitive in older adults: adaptations following 14 weeks versus 1.5 years of cyclic strain exercise'.

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The ageing process is inevitable, but the outcome isn't always catastrophic; how we age can be alleviated by the care we take of our bodies. 'I wanted to assess whether older Achilles tendons show similar adaptive responses to mechanical loading as younger ones', says Kiros Karamanidis from London South Bank University, UK, who explains that little is known about how the tendons of older people respond to exercise. Wondering whether older tendons could become stiffer and thicker like those of younger athletes and whether they may need more time to adapt, Karamanidis and his student Gaspar Epro at the German Sport University Cologne embarked on an ambitious 18 month programme of exercise with 21 volunteers ranging from 58 to 73 years old. Working with radiologists Jonas Doerner and Julian A. Luetkens at the University of Bonn, Germany, to measure the volunteers' Achilles tendons, Epro discovered that the tendons were significantly stiffer and thicker after 14 weeks of calf press exercises. However, the volunteers showed no further improvement after the initial period, despite continuing their exercise regime for a further 15 months. 'This was a huge logistical effort', says Karamanidis, thanking his colleagues who supported the work at the Universities of Bonn and Cologne. 'All of the young scientists, and Gaspar in particular, kept highly motivated and focused throughout the 1.5 year intervention', he concludes.

Box 1: 2017 Journal of Experimental Biology Outstanding Paper Prize shortlist

Barlow, S. L., Metcalfe, J., Righton, D. A. and Berenbrink, M. (2017). Life on the edge: O_2 binding in Atlantic cod red blood cells near their southern distribution limit is not sensitive to temperature or haemoglobin genotype. *J. Exp. Biol.* **220**, 414-424.

Epro, G., Mierau, A., Doerner, J., Luetkens, J. A., Scheef, L., Kukuk, G. M., Boecker, H., Maganaris, C. N., Brüggemann, G.-P. and Karamanidis, K. (2017). The Achilles tendon is mechanosensitive in older adults: adaptations following 14 weeks versus 1.5 years of cyclic strain exercise. *J. Exp. Biol.* **220**, 1008-1018.

Douglas, T. K., Cooper, C. E. and Withers, P. C. (2017). Avian torpor or alternative thermoregulatory strategies for overwintering? *J. Exp. Biol.* **220**, 1341-1349.

Swierzbinski, M. E., Lazarchik, A. R. and Herberholz, J. (2017). Prior social experience affects the behavioral and neural responses to acute alcohol in juvenile crayfish. *J. Exp. Biol.* **220**, 1516-1523.

Wolff, J. O., Řezáč, M., Krejčí, T. and Gorb, S. N. (2017). Hunting with sticky tape: functional shift in silk glands of araneophagous ground spiders (Gnaphosidae). *J. Exp. Biol.* **220**, 2250-2259.

Bhattacharyya, N., Darren, B., Schott, R. K., Tropepe, V. and Chang, B. S. W. (2017). Cone-like rhodopsin expressed in the all-cone retina of the colubrid pine snake as a potential adaptation to diurnality. *J. Exp. Biol.* **220**, 2418-2425.

Vu, H. M. and Duman, J. G. (2017). Upper lethal temperatures in three cold-tolerant insects are higher in winter than in summer. *J. Exp. Biol.* **220**, 2726-2732.

Woll, S. C. and Podrabsky, J. E. (2017). Insulin-like growth factor signaling regulates developmental trajectory associated with diapause in embryos of the annual killifish *Austrofundulus limnaeus*. *J. Exp. Biol.* **220**, 2777-2786.

Snelling, E. P., Duncker, R., Jones, K. K., Fagan-Jeffries, E. P. and Seymour, R. S. (2017). Flight metabolic rate of *Locusta migratoria* in relation to oxygen partial pressure in atmospheres of varying diffusivity and density. *J. Exp. Biol.* **220**, 4432-4439.

Avian torpor or alternative thermoregulatory strategies for overwintering?

Tegan Douglas worked with Christine Cooper and Phil Withers on 'Avian torpor or alternative thermoregulatory strategies for overwintering?' Photo credit: P. Douglas.

Maintaining a warm body can seem like a costly luxury when the temperatures begin to fall, so many mammals use torpor and hibernate to conserve energy during chilly conditions when food is scarce. However, Christine Cooper from Curtin University, Australia, explains that it was unclear whether birds also resort to cost-saving torpor to combat cold. 'We wanted to see if this really was simply a case of a lack of research, or if birds used other mechanisms to withstand cold overnight temperatures while roosting', says Cooper. Working with Phil Withers from the University of Western Australia and graduate student Tegan Douglas, Cooper recalls how Douglas spent two field seasons measuring the overnight body temperatures of white-browed babblers and the temperatures of their nests to build a comprehensive overview of how the animals cope. 'Tegan is one of Australia's top young ornithologists. She has an outstanding knowledge of birds and excellent practical skills in a whole array of field techniques', says Cooper. She also adds that Douglas's determination was essential to the success of the study: with no background in physiology, Douglas not only had to learn how to measure the metabolic rates of the resting birds but also had to perform the measurements overnight. Douglas eventually showed that instead of using torpor to conserve energy, the birds huddle together in their nests to maintain body temperature, which, Cooper says, is important for 'understanding how birds "work"'.

Prior social experience affects the behavioral and neural responses to acute alcohol in juvenile crayfish

Andrew Lazarchik and Matthew Swierzbinski worked with Jens Herberholz on 'Prior social experience affects the behavioral and neural responses to acute alcohol in juvenile crayfish'.

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Adding a drop of alcohol to your coffee at the end of a meal can be a pleasant end to a culinary experience, but when Jens Herberholz from the University of Maryland, USA, adds alcohol to his tank of crayfish, he isn't looking to improve their flavour. 'I have been working with crayfish for many years, mostly on neurobehavioural mechanisms underlying aggression and decision making', explains Herberholz. So, when he decided to investigate the neurological effects of alcohol, crayfish seemed the obvious choice: 'We wanted to know if crayfish would be a suitable model', he says. Working with Matthew Swierzbinski and Andrew Lazarchik to find out whether prior social experience might alter how crayfish respond when they are drunk, the team discovered that isolated crayfish are less sensitive to the effects of alcohol than gregarious animals. Having discovered that sociability predicts vulnerability to alcohol, Swierzbinski was able to identify that this change in sensitivity extends down to the individual neuron. 'Matt did all the single cell electrophysiology, which is very challenging and … takes a lot of talent and perseverance', says Herberholz, adding that both of the young scientists coped remarkably well with the setbacks and frustrations that they encountered over the course of the study: 'Which is what good scientists do', he smiles.

Hunting with sticky tape: functional shift in silk glands of araneophagous ground spiders (Gnaphosidae)

Jonas Wolff worked with Milan Řezáč, Tomáš Krejči and Stanislav Gorb on 'Hunting with sticky tape: functional shift in silk glands of araneophagous ground spiders (Gnaphosidae)'.

Just as there are many different ways to catch a fish, there are also numerous variations on the sticky silk theme that spiders use to trap their victims. Although many spiders resort to building elaborate webs, the Gnaphosidae family of ground spiders, which prey on spiders and other large prey, essentially lasso their victims with a form of sticky silk that is usually used to anchor the radial threads of orb webs. Intrigued by the unconventional use of the robust silk, graduate student Jonas Wolff and Stanislav Gorb from the University of Kiel, Germany, investigated the thread and the glands that produce it. 'Jonas made the most significant contribution', says Gorb, recalling how Wolff collected the animals during a field trip to the Southern Alps. Back in the lab, Wolff filmed the lightning-fast assaults as the ground spiders attacked their victims, in addition to collecting minute samples of the novel silk and its associated glue to measure their mechanical properties. Collaborating with microscopists Milan Řezáč and Tomáš Krejči from the Czech University of Life Sciences, Wolff and Gorb discovered that the spigots that produce the exceptionally tough and stretchy material are much larger than those of conventional spiders, allowing the spiders to smother the filament in a glue that can withstand stresses that are 750 times greater than those endured by artificial glues. Paying tribute to his colleagues, Gorb says, 'The team spirit was great', adding, 'Sometimes too many data can be confusing, but not for this team'.

Cone-like rhodopsin expressed in the all-cone retina of the colubrid pine snake as a potential adaptation to diurnality

Clockwise from top left: Nihar Bhattacharyya, Benedict Darren, Ryan Schott and Vincent Tropepe worked with Belinda Chang on 'Cone-like rhodopsin expressed in the all-cone retina of the colubrid pine snake as a potential adaptation to diurnality'.

Close relatives usually share many similar characteristics, but no one seems to have told colubrid snakes. Belinda Chang from the University of Toronto, Canada, explains that closely related members of the snake family can have dramatically different retinas, with some packed with cones that are fine tuned to bright daylight, while the retinas of other close relatives are made up of rods that are optimised to dim and nocturnal conditions, raising the question of how this transformation between different types of retina could have occurred so swiftly. Chang says, 'We were intrigued by the idea, proposed over 70 years ago, that some of the photoreceptors in the snake retina might have been transformed in evolution from one type to another, in this case rods to cones'. Explaining that the study began as a second-year undergraduate project, Chang says, 'Benedict Darren cloned and sequenced the opsin genes … which gave us our first hints of how interesting the vision of these snakes might be'. But it was only when Nihar Bhattacharyya, with the help of Ryan Schott and Vincent Tropepe, confirmed the presence of rod rhodopsins in the all-cone retinas of northern pine snakes that Chang knew that they had the first convincing evidence that rod cells can be converted into cones. 'Nihar was the key person in pulling all the diverse aspects of this paper together into a complete story,' says Chang, adding, 'It is

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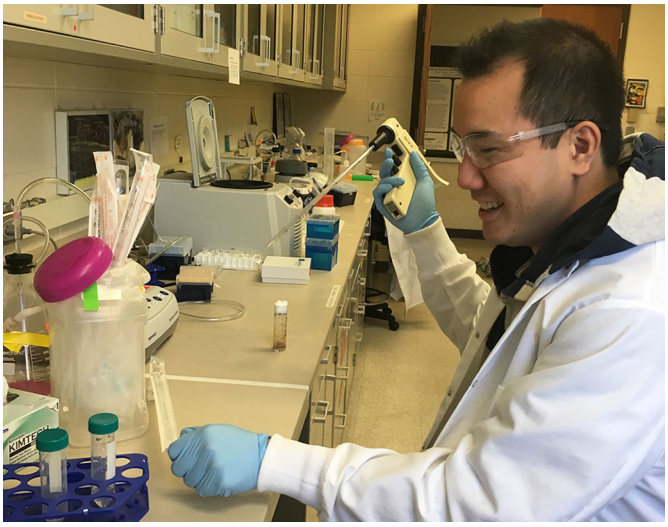
rare in evolutionary biology to be able to reconstruct a plausible scenario for an adaptive event that may have happened millions of years ago'.

Upper lethal temperatures in three cold-tolerant insects are higher in winter than in summer



Henry Vu worked with John Duman on 'Upper lethal temperatures in three cold-tolerant insects are higher in winter than in summer'.

John Duman at the University of Notre Dame, USA, has a 40 year history of investigating how fire-coloured beetles (*Dendroidies canadensis*) survive cold. However, as the frequency of warmer winters increased, he began to wonder how much of a risk the warmer conditions may pose to insect populations that are adapted to the chilly season. Knowing that high temperatures are lethal for insects, Duman expected that the summer-adapted insects would be better able to tolerate higher temperatures than overwintering beetle larvae that had just been dug out of an icy log. 'Initially, the bulk of Henry Vu's thesis was to address the role of antifreeze glycolipids in cold tolerance in these insects', says Duman, who recalls how Vu went out into the field in all seasons, even the bitter cold of the 2014 Arctic vortex, to retrieve beetle larvae from logs. But he was astonished when it turned out that the overwintering larvae were significantly more heat tolerant than the summer insects, surviving temperatures over a 60°C range – from 40°C to below −20°C – in contrast to the summer larvae, which could only tolerate temperatures over a 40°C range and never survived above 36.7°C. However, after making the initial discovery, Vu had to prove that the unorthodox results weren't a fluke, retesting the larvae over consecutive years, in addition to testing other species. 'This was nearly totally Henry's work, with only occasional suggestions from me', says Duman, who was impressed by Vu's resilience tackling such a challenging field-based project.

Insulin-like growth factor signaling regulates developmental trajectory associated with diapause in embryos of the annual killifish *Austrofundulus limnaeus*

Most fish don't have to worry about their homes drying out, but not *Austrofundulus limnaeus* annual killifish. Their ponds routinely

Cody Woll worked with Jason Podrabsky on 'Insulin-like growth factor signaling regulates developmental trajectory associated with diapause in embryos of the annual killifish *Austrofundulus limnaeus*'.

vanish during the dry season, leaving them high and dry, yet the fish return as soon as the rains resume. Jason Podrabsky from Portland State University, USA, explains that the secret of the fish's success lies in their embryos, which go into a form of suspended animation known as diapause when their homes evaporate. As insulin-like growth factor (IGF) is known to be a key component in the mechanism that drives diapause in *Caenorhabditis elegans*, Podrabsky and his student Cody Woll began investigating the role of the hormone in the annual killifish's survival mechanism. Describing how Cody developed the assays that allowed them to track the presence of IGF I and II as the embryos entered different forms of diapause, Podrabsky says, 'Developing the ELISA assays in our species was no small task; he was a champion at troubleshooting and never gave up'. Podrabsky admits that he was excited by the discovery that IGF is a key player in vertebrate and invertebrate diapause and adds that the embryos that enter diapause may develop faster than embryos that avoid the process, 'suggesting some compensation for the time spent dormant'.

Flight metabolic rate of *Locusta migratoria* in relation to oxygen partial pressure in atmospheres of varying diffusivity and density

Edward (Ned) Snelling and Rebecca Duncker worked with Roger Seymour and members of his lab on 'Flight metabolic rate of *Locusta migratoria* in relation to oxygen partial pressure in atmospheres of varying diffusivity and density'. No image of Duncker was available.

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Roger Seymour at the University of Adelaide describes the approach that is taken in his lab as 'inductive': he says, 'Nature frequently gives us the answers to questions that we cannot imagine, so we interrogate our animals and see what they say'. Driven by his curiosity, Seymour and his postdoc Edward (Ned) Snelling wondered how locust flight muscles would respond when they tinkered with the amount of oxygen that the insects inhaled. Would the insects be able to take advantage of an enhanced oxygen supply and shift up a gear to produce more power from their flight muscles, or would they be stuck in first and unable to change up no matter how much oxygen was available? Providing undergraduate Rebecca Duncker with the lab's exotic gas mixer and tanks of nitrogen, sulphur hexafluoride, helium and oxygen, to produce novel atmospheres, Seymour and Snelling measured how hard the locusts flew in the gas mixtures that she created. After analysing the insects' oxygen consumption, the team realised that the insects' flight power maxed out at 21% oxygen: the locusts could not produce additional power, even when there was surplus oxygen. While honing her gas mixer skills, Duncker realised that she could also alter the rate at which oxygen moved through the different atmospheres as she varied the density and oxygen diffusivity of the atmospheres independently in order to separate the effects of each on oxygen uptake. 'I did not think it was possible', admits Seymour; however, Duncker's resourcefulness confirmed that the flight muscles' pumping action was mainly responsible for delivering oxygen to the tissues. He recalls, 'Rebecca's design is so elegantly beautiful that it was described as "lovely" by one referee'.

And the winner is…

While this year's shortlist showcases nine fascinating papers and provides an intriguing insight into the diversity that is the journal's hallmark, the Editors are happy to announce that the 2017 JEB Outstanding Paper Prize is awarded to Jonas Wolff for his work on 'Hunting with sticky tape: functional shift in silk glands of araneophagous ground spiders (Gnaphosidae)'. Reflecting on the paper, nominating Editor Michael Dickinson explains that the paper provides a rare, but clear-cut, example of a biological trade-off, which allows the spiders to ensnare their prey while losing the ability to spin webs. 'Based on an elegant morphological and biomechanical analysis, Wolff and his colleagues have provided a very compelling case for such trade-offs in the silk use of ground spiders', says Dickinson.

Principal Investigator, Stanislav Gorb, recalls the challenges encountered by Wolff during the project, explaining that obtaining the piriform stress–strain curves took skill and patience: 'This silk is one of the thinnest among spiders', he says. In addition, Wolff scanned the spigots that extrude the silk to reveal the mechanism that prevents the structures from becoming blocked. 'Jonas learned all of the techniques by himself and performed the study with a great passion, from planning and experimentation to writing'. He also adds that there was an excellent rapport between Wolff and his Czech collaborators, Řezáč and Krejči, who contributed their expertise on ground spiders to the study. Reflecting on Wolff, who is currently a research fellow at Macquarie University, Australia, Gorb attributes his success to his character, saying, 'He is creative, persistent and has a good eye for new phenomena; but the main thing is that he really enjoys experimental biology'.