University of Birmingham

Dr Scott Hayward PhD FRES

Lecturer - Molecular Ecophysiology

School of Biosciences (/schools/biosciences/index.aspx)

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About

Dr Hayward's research group seeks to understand how organisms cope with variable and stressful environments. Temperate, polar and tropical terrestrial invertebrates (insects, mites and nematodes) are the primary focus of this endeavour. His lab uses state-of-the-art tools, and a systems biology approach, to investigate how these organisms detect, repair and stabilize the cellular and molecular damage induced by environmental stress, as well as their broader physiology and ecology. This research has fundamental applications in controlling agricultural pests and vectors of disease, as well as optimising ecosystem services such as pollination. Terrestrial invertebrates are also excellent biological thermometers in modelling the potential impact of climate change.

Qualifications

- BSc (Zoology) University of Edinburgh
- PhD University of Birmingham

Biography

- 2008 - present: Lecturer, University of Birmingham (UK)
- 2004 - 2008: Postdoctoral Researcher, University of Liverpool (UK)
- 2002 - 2004: Royal Society & Fulbright Postdoctoral Fellow, Ohio State University (USA)

Teaching

Dr Hayward's roles have included being Head of the Biology Degree Programme as well as First Year Teaching Lead. He is a member of the School of Biosciences Teaching Quality Enhancement Committee and is passionate about research-led teaching using a student-centred enquiry-based learning approach. He teaches on a number of undergraduate modules including BIO145 "Introduction to Evolution and Animal biology"; BIO259 "Alpine Ecology", the 2nd year field trip to Norway. He is also module organiser for BIO389 "Adaptation to Changing Environments". He interacts closely with the Centre for Learning and Academic Development (CLAD), and is involved in teaching doctoral researchers and staff different approaches to learning and enhancing their academic practise.

Postgraduate supervision

For a list of possible PhD projects offered by Dr Hayward:

www.findaphd.com/search/customlink.asp?inst=birm-Biol&supersurname=Hayward (http://www.findaphd.com/search/customlink.asp?inst=birm-Biol&supersurname=Hayward)

Research

Research Theme within School of Biosciences: **Biosystems and Environmental Change (BEC) (/research/activity/biosystems-environmental-change/index.aspx)**

Environmental Stress Adaptation - a systems biology approach

Since its inception, life on earth has had to adapt to unfavourable environmental conditions - this represents a driving force of evolution. Our lab seeks to characterise how organisms detect, repair and stabilize the cellular and molecular damage induced by environmental stress; the magnitude and limitations of these responses, and their impact upon fitness.

Work in the group addresses rapid, seasonal and long term (evolutionary) adaptations to environmental change using temperate, polar and tropical terrestrial invertebrate species. The group has three main areas of research.

1. **Environmentally adaptive dormancies - insect diapause:**

Insect diapause is an environmentally adaptive dormancy, similar to hibernation, and represents the main strategy evolved by temperate insects to: a) coordinate their growth, development and reproduction (phenology) with annual cycles of changing environmental conditions; and b) survive seasonally recurring chronic forms of environmental stress.

Using the overwintering diapause of species such as the blue bottle fly Calliphora vicina, the bumble bee Bombus terrestris, and the red mason bee Osmia rufa, our group seeks to identify key mechanisms underpinning diapause and its enhanced stress tolerance phenotype. We also investigate the potential impact of climate change on diapause, and how this might disrupt the synchrony between insect species and their environment.

2. **Molecular mechanisms underpinning stress adaptation:**

Using the model organism Caenorhabditis elegans, we employ a range of post-genomic, reverse genetic and metabolomic approaches to identify the molecular mechanisms that underpin the phenotypic transition from the stress-sensitive to stress-tolerant state. A particular focus of this work has been to characterise the role of homeoviscous adaptation (changes in membrane phospholipid composition) in stress adaptation.

3. **Life in extreme environments**

Through an ongoing collaboration with the British Antarctic Survey (BAS), our group investigates how terrestrial invertebrates cope with the extreme conditions encountered in polar environments. We also investigate the impact of rapid climate change at high latitudes. In addition, our group examines insects in tropical environments, where many species are close to their upper thermal tolerance thresholds and could become extinct as a result of climate warming.

Other activities

Dr Hayward is keen on all kinds of outdoor pursuits including hiking and kayaking.

Publications

Hayward S. A. L. (in press) Application of functional 'Omics' in environmental stress physiology: insights, limitations, and future challenges**.** Current Opinion in Insect Science DOI: 10.1016/j.cois.2014.08.005

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and **Hayward, S. A. L** (in press) Can the Antarctic terrestrial midge, *Eretmoptera murphyi*, tolerate life in water? Ecological Entomology DOI: 10.1111/een.12147.

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and **Hayward, S. A. L** (in press) Responses of invertebrates to temperature and water stress: A polar perspective. Journal of Thermal Biology DOI: 10.1016/j.jtherbio.2014.05.004.

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and **Hayward, S. A. L** (2014) Are the Antarctic dipteran, *Eretmoptera murphyi*, and Arctic collembolan, *Megaphorura arctica*, vulnerable to rising temperatures? Bulletin of Entomological Research 104:494-503.

Coleman, P. C., Bale, J. S. and **Hayward S. A. L**. (2014) Cross generation plasticity in cold hardiness is associated with diapause, but not the non-diapause developmental pathway, in the blow fly, Calliphora vicina. Journal of Experimental Biology 217:1454-1461

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and **Hayward, S. A. L** (2014) Contrasting strategies of resistance vs. tolerance to desiccation in two polar dipterans. Polar Research 33: Art. No.22963

Hayward, S. A. L., Bruno Manso, Cossins, A. R. (2014) Molecular basis of chill resistance adaptations in poikilothermic animals. Journal of Experimental Biology 217: 6-15.

Owen, E. L., Bale, J. S. and **Hayward, S. A. L.** (2013) Can winter-active bumblebees survive the cold? Assessing the cold tolerance of *Bombus terrestris audax* and the effects of pollen feeding. PLoS ONE 8: e80061.

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and **Hayward, S. A. L** (2013) The effect of acclimation temperature on thermal activity thresholds in polar terrestrial invertebrates. *Journal of Insect Physiology* 59:1057-1064

Everatt M. J., Worland M. R., Bale J. S., Convey, P. and Hayward, S. A. L (2013) Heat tolerance and physiological plasticity in the Antarctic collembolan, *Cryptopygus antarcticus*, and mite, *Alaskozetes antarcticus. Journal of Thermal Biology* 38: 264-271

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Everatt M. J., Worland M. R., Bale J. S., Convey, P. and Hayward, S. A. L (2012) Pre-adapted to the maritime Antarctic? - Rapid cold hardening of the midge, Eretmoptera murphyi, *Journal of Insect Physiology* 58:1104-1111

Bale, J. S. & Hayward, S. A. L. (2010) Insect overwintering in a changing climate. Journal of Experimental Biology 213: 980-994.

Elnitsky, M. A., Hayward, S. A. L., Rinehart, J. P., Denlinger, D. L. & Lee, R. E. Jr. (2008) Cryoprotective dehydration and the resistance to inoculative freezing in the Antarctic midge, Belgica antarctica. Journal of Experimental Biology 211: 524-530.

Lee R. E. Jr., Elnitsky, M. A., Rinehart, J. P., Hayward, S. A. L., Sandro, L. H. & Denlinger, D. L. (2006) Rapid cold-hardening increases freezing tolerance of the Antarctic midge Belgica antarctica. Journal of Experimental Biology 209: 399-406.

Hayward, S. A. L., Murray, P. A., Gracey, A. Y. & Cossins, A. R. (2007) Beyond the lipid hypothesis: mechanisms underlying phenotypic plasticity in inducible cold tolerance. In: Csermely P and Vigh L ed(s). Molecular Aspects of the Stress response. Austin, TX, Landes Bioscience.

Murray, P. A.*, Hayward, S. A. L.*, Govan, G. G., Gracey, A. Y. & Cossins, A. R. (2007) Acquired cold tolerance in Caenorhabditis elegans: and explicit test of the phospholipid saturation hypothesis. Proceedings of the National Academy of Sciences USA 104: 5489-5494. (* Joint first author).

Rinehart, J. P., Li, A. Q., Yocum, G. D., Robich, R. M. Hayward, S. A. L. & Denlinger, D. L. (2007) Upregulation of heat shock proteins is essential for cold survival during insect diapause. Proceedings of the National Academy of Sciences USA 104: 11130-11137.

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Rinehart, J. P., Hayward, S. A. L., Elnitsky, M. A., Sandro, L. H., Lee, R. E. & Denlinger, D. L. (2006) Continuous Up-regulation of heat shock proteins in larvae, but not adults, of a polar insect. Proceedings of the National Academy of Sciences USA 103: 14223-14227.

Hayward S. A. L., Pavlides, S. C., Tammariello, S. P., Rinehart, J. P. & Denlinger, D. L. (2005) Temporal expression patterns of diapause-associated genes in flesh fly pupae from the onset of diapause through post-diapause quiescence. Journal of Insect Physiology 51: 631-640.

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Hayward, S. A. L., Worland, M.R., Convey, P. & Bale, J. S. (2004) Habitat moisture availability and the local distribution of the Antarctic Collembola *Cryptopygus antarcticus* and *Friesia grisea*. Soil Biology and Biochemistry36: 927-934.

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antarcticus from the maritime Antarctic. Physiological Entomology 28: 114-121.

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Hayward, S. A. L., Worland, M.R., Bale, J. S. & Convey, P. (2000) Temperature and the hygropreference of the Arctic Collembolan *Onychiurus arcticus* and mite *Lauroppia translamellata*. Physiological Entomology 25: 266-272.

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