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EDITORIAL

Elucidating mechanism is important in forecasting the impact of a changing world on species survival

Craig E. Franklin[1,*] and Hans H. Hoppeler[2]

NASA recently declared that 2020 was one of the hottest years on record (matching 2016) and that the past decade was the warmest since global temperatures have been recorded. It is highly likely that in the coming decade, Earth's mean temperature will continue to increase, oceans will become more acidic, hypoxic dead zones will enlarge and the extent of Arctic sea ice will decrease. There will be more extreme weather events, and sea-levels will continue to rise, resulting in the inundation of low lying areas and the salinisation of freshwater systems. While there is a high degree of certainty that these predicted changes will occur, what is unclear is the magnitude of change to Earth's climate and environments that will result from further increases in atmospheric carbon dioxide concentrations that are being driven by human activity. Even more uncertain is the impact these future global environmental changes will have on ecosystems and biodiversity. Given that we have already witnessed changes in the phenology of organisms, range shifts, species abundances and even extinctions as result of current climate warming, the future looks bleak.

This special issue of JEB is a follow-up to the 2010 special issue of JEB entitled 'Survival in a Changing World' (https://jeb.biologists.org/content/213/6). We have asked the contributors to reflect upon how the field of experimental biology and our understanding of the impacts of environmental change have changed over the past decade. What has become evident over the past 10 years, and is reflected in this collection of papers, is that experimental biologists and physiologists are now playing a significant role in assessing and predicting the susceptibility or resilience of species to future, human-induced environmental change (Pagano and Williams, 2021). Understanding how changing environmental drivers – including temperature, rainfall, salinity, oxygen levels, pH and UV radiation – affect physiological processes, fecundity and survival (Buckley et al., 2021) and whether organisms have the capacity to physiologically compensate is becoming more critical given the potential effects on ecosystem functions and services. We know that both mechanism and establishing cause and effect are important, but they are complex (Lefevre et al., 2021). Developing models to predict the future requires not only a mechanistic understanding of the effects of environmental drivers and their interactions on physiological homeostasis but also a greater understanding of the genotypic (adaptation) and phenotypic (acclimatisation, developmental) plasticity of species (Carter and Janzen, 2021; Diamond and Martin, 2021; Putnam, 2021; Rodgers et al., 2021). Complexities in the responses of organisms also arise from interactive effects between different environmental drivers (Sokolova, 2021) and with biotic factors, such as body size, reproductive state, life-history stage and with behavioural modifications (Fuller et al., 2021; Le Lann et al., 2021; McKechnie et al., 2021).

If we are to address the challenges ahead, the broad message that comes from the collection of papers in this special issue is the need for consensus building, data sharing and better integration across disciplines that aim to understand and address climate change (Hof, 2021; Pörtner, 2021). By doing so, we will be able to provide more accurate projections of the impacts of anthropogenic-driven environmental change on biodiversity and ecosystems and human society, and then hopefully use this knowledge to deliver mitigation measures and actions to conserve our natural world and ensure our future.

[1]Editor-in-Chief, Journal of Experimental Biology. [2]Department of Anatomy, University of Bern, 3000 Bern, Switzerland.

*Author for correspondence (c.franklin@uq.edu.au)

C.E.F., 0000-0003-1315-3797

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