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EDITORIAL

Looking to the future: Building New Paradigms in Comparative Physiology and Biomechanics

Craig E. Franklin[1,*], Sheila N. Patek[2] and Patricia A. Wright[2]

Journal of Experimental Biology Special Issues are generally centred on a specific theme or topic that is discipline focused (https://journals.biologists.com/jeb/pages/special-issues). For our 2022 Special Issue, we have chosen an expansive and open topic: Building New Paradigms in Comparative Physiology and Biomechanics. We sought submissions that were future-gazing and explored novel and fundamental phenomena in comparative physiology and biomechanics. We were especially interested in receiving submissions that undertook comparative analyses and those that incorporated meta-analytical approaches in exploring physiological data to generate new questions or illuminate paradigm shifts in comparative physiology and biomechanics. We were delighted by the positive response from our community and the quality of the submissions we received. As a result, this is the largest Special Issue we have published, with 26 Reviews, Commentaries and Research Articles spanning a broad array of topics – from biomechanics and muscle physiology to ecophysiology, endocrinology, neurobiology and cardiovascular physiology, to name but a few. Below, we highlight only some of the many excellent contributions in the issue. It is heartening to see the involvement of so many early-career researchers/PhD students included as authors, as we recognise and acknowledge that the disruptions to research and productivity owing to the pandemic have been particularly pronounced for this group.

Handling and analysing large datasets collected and compiled from multiple published studies is complex and requires a structured and rigorous approach. The Commentary by Lisa Schwanz and colleagues provides a valuable guide for building and curating databases for comparative analyses (Schwanz et al., 2022). The authors provide practical approaches to maximising the efficiency and accessibility of comparative databases, which in turn helps to promote and ensure data transparency and integrity. Daniel Noble and co-workers (Noble et al., 2022) also provide a very useful guide to dealing with ‘nuisance heterogeneity’ in comparative physiology meta-analysis, offering a way forward to compare data across studies even when, for example, temperatures or dosages are different.

Comprehensive comparative analyses of physiological, morphological and transcriptomic data feature prominently in this Special Issue. For example, Till Harter and colleagues took a data mining and modelling approach to more thoroughly understand the complex relationship between respiratory efficiency and osmotic homeostasis in fish (Harter et al., 2022). Surveying the literature on hundreds of species, they discovered something very interesting: systematic differences in gill and blood characteristics between freshwater and seawater teleosts that might be linked to differences in environmental salinity. They further explored gill and blood parameters through a mathematical model, testing predictions and validating the model outcomes with literature values. Using transcriptomic data, Dennis Kolosov and Michael O’Donnell turned their attention to epithelial cells that have the amazing capacity to switch between ion secretion and absorption. Although they identify multiple mechanisms that play a role in the switch, a survey of transcriptomic data from many vertebrates and invertebrates revealed that a mechanosensitive ion channel appears to be a key player across clades, providing exciting new directions for future work (Kolosov and O’Donnell, 2022).

Biomechanics is strongly represented too. For instance, Vamsy Godthi and colleagues took the canonical calls of crickets and catapulted this historical and remarkable biomechanical system into an insightful, quantitative, comparative biomechanics realm (Godthi et al., 2022). While most previous studies have relied on morphological measurements to understand the evolutionary diversity of cricket calls, Godthi and colleagues developed a rigorous and successfully predictive finite element modelling (FEM) approach to represent the nuanced effects of materials, dimensions and energetics of the stridulatory apparatus. They honed the model using a single species and then tested the model’s predictions across species – finding excellent congruence with the acoustic output of other species. This integration of finite element modelling with cross-species predictions and large-scale tests of physical basis of evolutionary constraints is a notable paradigm for today’s researchers interested in all aspects of the evolution of mechanical systems – extending well beyond the canonical acoustic of crickets.

Candido Diaz and colleagues examine dynamic connections and arising paradigms at the intersection of material properties, the environment and evolution, specifically through the lens of aggregate glue in spiders (Diaz et al., 2022). This silk serves as rapidly adhering glue for capturing moths, which are notoriously difficult to trap with their easily shed scales. The paper draws lessons from the surprising genomic basis for variation in the glue materials and the crucial role of the environment in correctly determining the function of the glue. The authors encourage a broader framework than the historic morphology–performance–fitness axis by recommending inclusion of genomic and material properties datasets and not just morphology (which typically includes shape and linear dimensions, but not material properties in their relevant environmental context). This type of highly integrative research – connecting genomic coding of materials to predatory behavioural strategies in dynamic ecological settings – illustrates the data-driven nature of new paradigms in evolution, comparative biomechanics and behaviour.

We are delighted with the breadth of this Special Issue and hope that the articles will excite you about current progress being made in comparative physiology and biomechanics and where research

[1]Editor-in-Chief, Journal of Experimental Biology. [2]Deputy Editor-in-Chief, Journal of Experimental Biology.

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

C.E.F., 0000-0003-1315-3797; S.N.P., 0000-0001-9738-882X; P.A.W., 0000-0002-4749-5106

could be heading in the future. We invite you to dive deeper into the articles, to discover more of these unique contributions, and hope you enjoy reading this issue as much as we have enjoyed putting it together.

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