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Promoting developmental diversity in a changing world

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Scanning through early issues of the Journal of Embryology and Experimental Biology (the previous name for this journal) reveals the diverse range of organisms that were investigated by developmental biologists in the 1950s and 1960s. However, the rise of molecular genetics in subsequent decades led to a narrowing in species choice to a small repertoire of well-characterised model organisms for which there were genetic tools for functional experimentation. In recent years, however, technological advances, including genome and transcriptome sequencing, flexible genome-editing approaches and high-resolution four-dimensional imaging, provide an opportunity to once again study developmental questions in organisms across all kingdoms of life. Given the current global challenges of climate change and biodiversity loss, it is particularly important that we turn our attention to understanding development in an unstable world.

This important topic was the basis of Development's Journal Meeting, 'Unconventional and Emerging Experimental Organisms in Cell and Developmental Biology' in 2023, which you can learn more about in the Meeting Review published here (Lemke et al., 2024). Fuelled by the success of the meeting, we chose to focus this Special Issue, led by Academic Editor Cassandra Extavour, together with Liam Dolan (https://journals.biologists.com/dev/article-lookup/DOI/10.1242/dev.204440) and Karen Sears (https://journals.biologists.com/dev/article-lookup/DOI/10.1242/dev.204393) as Guest Editors, on a related topic: Uncovering Developmental Diversity. We are particularly delighted that multiple attendees from our meeting have contributed both research and review-type articles to this issue.

The 28 research papers in this Special Issue highlight 32 different organisms from across the multicellular tree of life, featuring cnidarians (Garschall et al., 2024), insects (Matsuda et al., 2024; Bai et al., 2024; Beaven et al., 2024; Pallarès-Albanell et al., 2024) and annelids (Bideau et al., 2024), as well as echinoderms (Barone et al., 2024; McDonald et al., 2024; Jackson et al., 2024; Clarke et al., 2024) and chordates (Gigante et al., 2024; Johnson et al., 2024), including vertebrates (Rees et al., 2024; Pérez-Gómez et al., 2024), many of which are various fishes (Leclercq et al., 2024; Li et al., 2024; Woronowicz et al., 2024; Peloggia et al., 2024; Jin et al., 2024). These articles demonstrate the importance of finding the best model to address a developmental question, such as making use of the curved epithelium in the sea star embryo to investigate cell organisation and packing (Barone et al., 2024) or using the regenerative capacity of annelids to learn more about cell plasticity (Bideau et al., 2024). In addition to annelids, a Perspective in this issue highlights five more 'extraordinary' model systems for regeneration across scales from single cells to whole organisms (Accorsi et al., 2024).

Not limited to animals, the Special Issue also embraces a wide array of studies uncovering fundamental developmental processes, such as axis formation and organogenesis in photosynthetic organisms, including brown algae (Vigneau et al., 2024; Boscq et al., 2024), liverworts (Attrill and Dolan, 2024; Attrill et al., 2024; Sakai et al., 2024), and vascular plants such as ferns (Woudenberg et al., 2024) and angiosperms (Mody et al., 2024; Spiegelhalder et al., 2024). Photosynthetic organisms feature heavily in the issue's review-type content, too, with articles describing how brown algae can inform us about the transition to multicellularity (Batista et al., 2024), how the environment and climate change influence development through the lens of stomata (Chua and Lau, 2024) and what we can learn about the evolution of plant development through the fossil record (Hetherington, 2024).

The evo-devo field, in particular, has benefitted from the appreciation of biodiversity and increased taxonomic sampling. Reflecting this, two Reviews discuss fundamental evolutionary concepts, including how phenotypes can be maintained by different underlying genetic architecture through developmental systems drift (McColgan and DiFrisco, 2024), as well as a cautionary tale of how reports on the low-hanging fruit of simple genetic explanations of evolution should not change our perception that evolution is inherently complex (Cooper, 2024).

A broad selection of available organisms also allows the study of rare evolutionary innovations, such as the ability of *Nematostella* to degrow in response to food availability (Garschall et al., 2024) or of teleost fish to adapt ionocyte differentiation to regulate osmotic levels within aquatic environments (Peloggia et al., 2024). Adaptive plasticity is also the focus of a Review article describing how organisms assess environmental cues across scales and respond via phenotypic changes (Hill et al., 2024). Furthermore, capturing developmental biodiversity furthers our understanding of complex life cycles (McDonald et al., 2024; Peloggia et al., 2024) – a topic motivating a Hypothesis for unravelling cellular rejuvenation (Berger, 2024). Indeed, studying organisms with metamorphic life cycles allows us to learn about the intrinsic developmental process, such as how the rhinoceros beetle remodels its horn (Matsuda et al., 2024) or neuronal cell survival in *Ciona* (Gigante et al., 2024).

Importantly, research using emerging model systems relies on new tools that facilitate functional experiments. Our Techniques and Resources section features methods for the delivery of proteins and nucleic acids into oocytes in a variety of species (Clarke et al., 2024), as well as approaches for generating stable genetic lines (Jackson et al., 2024) and tools for quantifying

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diversity (Mody et al., 2024). However, not all species are amenable to being cultured in the lab, and a Perspective describes the importance of fieldwork for developmental biology in unconventional model systems (Brown et al., 2024). In addition, a Spotlight article describes how modern innovations in stem cell technology might be employed for species conservation (Hutchinson et al., 2024), highlighting how understanding biodiversity is the first step to its preservation, an increasingly prevalent topic in the context of climate change.

Overall, we hope that this issue demonstrates both how technological advances have made it possible to understand development and regeneration in previously intractable organisms, as well as the importance of this pursuit. We continue to ensure Development is an appropriate home for your studies in developmental biology, stem cells and regeneration using any organism. We welcome your submissions.

Special Issue

This article is part of the Special Issue 'Uncovering developmental diversity', edited by Cassandra Extavour, Liam Dolan and Karen Sears. See related articles at https://journals.biologists.com/dev/issue/151/20.

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