PREFACE

This is the 86th volume of *Current Topics in Developmental Biology* (CTDB). Considering that this series began in 1968, one could ask why it has taken so long for a thematic CTDB volume to appear on Evo Devo? An answer might be that Evo Devo is at once an old and a newly emerging discipline. Under the alias of evolutionary morphology or embryology, it was a popular scientific study in the 1800s, predating the surfacing of neo-Darwinism in the next century. As a new breed of experimental embryologists, and ultimately molecular embryologists, rushed to determine the secrets of development, the evolutionary perspective was temporarily left by the wayside. In retrospect, this was probably the right course: one should know the rules of development in some detail before attempting to find out how they are fashioned during evolution.

Beginning in the 1970s, there was a rebirth of interest in Evo Devo, sparked in large measure by the publication of two books: "Ontogeny and Phylogeny" by Stephen Jay Gould (1970) and "Embryos, Genes, and Evolution" by Rudolf Raff and Thomas Kaufman (1983). The latter volume, in particular, described evolution within the backdrop of new genetic and molecular discoveries showing that the rules and basic molecular tool kits used in development are fundamentally similar in all animals and plants. This launched the first phase of Evo Devo, which was devoted to understanding this deep conservation of developmental mechanisms. Although important, conservation is not the key issue in understanding the role of ontogeny in evolution. Instead, we must strive to understand the more complex issue of diversity, that is when, how, and how frequently different ontogenies arise during evolution. This activity defines the second phase of Evo Devo and is what this CTDB volume is about.

A large part of Evo Devo's second phase is understanding when and how major phenotypes evolved, and the emergence of novel biological entities during crucial evolutionary transitions, such as the transition from invertebrates to vertebrates. Two articles in the current volume are centered on this theme. Nikita, Sauka-Spengler, and Bronner-Fraser (Caltech) trace the fascinating evolution of the neural crest to the most basal vertebrates and perhaps even to invertebrate chordates. Zhang, Eames, and Cohn (University of Florida) take a similar approach to understanding the evolution and relatedness of cartilage, and its role in establishing a skeletal renaissance during vertebrate evolution. Another important part of contemporary Evo Devo depends on the comparative approach. Here emerging model systems

consisting of two or more species are used to investigate complex problems, such as the diversity of body plans, the evolution of sexual reproduction, and the loss and gain of phenotypes in extreme environments. Raff and Smith (Indiana University) describe their pioneering studies on direct and indirect developing sea urchins in which the first molecular discoveries are presented for the rapid evolution of axial development. Likewise, Moczek (Indiana University) describes the evolution of horn diversity in horned beetles, a system that has immense potential for improving our understanding of microevolutionary mechanisms, and especially the role of developmental tradeoffs. When emerging models are coupled with pre-existing models—their "rich cousins" with respect to detailed developmental knowledge and molecular genetic tools—powerful new insights can be forthcoming. Thus, Kramer (Harvard University) describes a host of new land plant models linked in this way to *Arabidopsis*, Haag (University of Maryland) shows how divergence in evolution of sex determination can be studied by comparing *Caenorhabditis briggsae* to *C. elegans*, and Jeffery (University of Maryland) charts the importance of pleiotropy using the blind cavefish *Astyanax mexicanus* and zebrafish as companion species. Another important part of Evo Devo is obtaining a more complete understanding of the development of classic systems that are ripe for in depth evolutionary analysis. One of these systems, the polar lobe forming and spirally cleaving gastropod *Illyanassa*, is described here by Lambert (University of Rochester), who shows the importance of localized mRNAs and spatial signaling cues in determining this novel type of development.

The CTDB volume does not cover every contemporary issue in Evo Devo. Indeed, many important topics are not addressed. In this sampling, however, we merely hope to provide examples of how modern cutting-edge approaches are being used to investigate and generate new understanding of some central issues this field. By doing so, we endeavor to encourage, and perhaps even inaugurate, the next major phase in Evo Devo.

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