



Evolving Form and Function: Fossils and Development
Proceedings of a symposium honoring Adolf Seilacher for his
contributions to palaeontology, in celebration of his 80th birthday

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This book is a compilation of papers derived from a meeting held April 1-2, 2005 at Yale University to honor Adolf Seilacher's contributions to our understanding of the evolution of form and function. The quality and diversity of the chapters in this book certainly create a volume worthy of Seilacher's legacy in this field.

Derek Briggs, the editor, starts things off with a chapter summarizing Seilacher's contributions to the study of form and function in fossil organisms. Of particular interest is his emphasis on the importance of phylogeny and architecture in the construction of a broad range of organisms, from vendobionts to crinoids. The chapter also contains an Appendix of the complete publications of Seilacher, an invaluable resource.

The second chapter, by Karl Niklas, centers on the morphogenesis and biomechanics of modern plants, concluding that plants increase their root mass and strength while decreasing their height, leaf area, and the strength and stiffness of the stem in response to mechanical disturbance. This response helps the individual plant survive, but hinders its reproductive capabilities. Some reproduction is apparently better than none at all.

Jim Gehling, Mary Droser, Søren Jensen, and Bruce Runnegar author the next chapter, which focuses on the form and function of Ediacaran organisms. They review Ediacaran fossil preserva-

tion, as well as providing new evidence, primarily from trace fossils, for the life modes of some well-known Ediacaran organisms. Based on associated serial resting traces, for example, Dickinsonia and Yorgia are interpreted as using their lower surfaces to decompose the underlying microbial mat surface and absorb the released nutrients.



Placing his thoughts in an economic framework, Doug Erwin takes on the origin of animal body plans in the next chapter. Among other things, he reviews the environmental changes thought to have been taking place during the radiation and the current ideas about the early developmental biology of bilaterians. Erwin concludes that the most likely explanation for the Cambrian radiation lies somewhere in the ecological interactions of early animals.

Phil Donoghue and Xiping Dong next focus on the Ediacaran-Cambrian fossil record of animal embryos. They begin by reviewing the embryos preserved in the Ediacaran Doushantuo Formation and the Lower Cambrian Kuanchuanpu Formation, both of south China, as well as the global fossil

record of the Lower Cambrian–Lower Ordovician embryo *Markuelia*. The authors conclude that, based on the fossil record, there is reason to question the primitive nature of indirect development and that the temporal range of fossil embryos is unlikely to expand much with future exploration.

The mineralized skeletons of early animals is the focus of Stefan Bengtson's chapter. After reviewing the skeletonization of early animals, including discussions of small shelly fossils, general mineralization processes, and coeloscleritophorans, Bengtson argues that the coelosclerite skeleton may have been a plesiomorphic character of early bilaterians.

Ediacaran trace fossils are the subject of the chapter Mary Droser, Jim Gehling, and Sören Jensen. They briefly review the Ediacaran trace fossil record and then discuss criteria for identifying trace fossils and the taphonomic implications of mat-bound Ediacaran substrates. Using these criteria and keeping in mind the nature of typical Ediacaran substrates, the authors then evaluate four examples of described Ediacaran trace fossils and determine that three of them are unlikely to be traces. They therefore conclude that the diversity of Ediacaran trace fossils has traditionally been exaggerated.

Nigel Hughes examines the early developmental biology of trilobites in the next chapter, focusing on the number of adult thoracic segments. He finds that there is quite a bit of plasticity in this character in basal trilobites, but that it stabilizes in later taxa. One possible explanation for this trend is that increased trunk regionalization, and the accompanied stabilization of thoracic segment number, provided more advantages than plasticity in this character.

Arthropods are also the subject of the next chapter by Matthew Giorgianni and Nipam Patel. Serving as a general review, their attention is particularly placed on the latest results regarding the evolution and development of arthropod appendages. Building from the molecular and genetic studies of *Drosophila*, the authors discuss appendage development in a diverse array of arthropod groups. They conclude that arthropod appendage diversity is underlain by a conserved Proximal-Distal axis patterning mechanism, and that future studies of new model arthropods should increase our understanding of how this limb diversity evolved.

In the next chapter, Andrew Smith discusses the evolution of growth and form in echinoids, paying special attention to the role of changes in plate addition and plate accretion as growth strategies in

Paleozoic and post-Paleozoic forms. Paleozoic echinoids have different numbers of columns of plates in their test but similar body shapes, whereas post-Paleozoic echinoids have the same numbers of columns of plates in their test but have a diverse range of body shapes. Smith attributes this change to two innovations: a shift from growth through plate addition to growth through plate accretion and a shift to plate production earlier in ontogeny, locking in the adult plate positions at an early stage.

Geerat Vermeij authors the next chapter, the focus of which is the evolution and function of shell envelopment in molluscs. Vermeij provides a synthesis of published information and new observations that reveal shell envelopment by the foot in marine and freshwater molluscs occurs repeatedly in 47 clades, but is rare or absent in other clades. Clades exhibiting shell envelopment share certain physiological and ecological traits and tend to develop this innovation during warm, productive periods.

Venturing into the vertebrate realm for the first time in this volume, Jennifer Clack authors the next chapter about the fish-tetrapod transition. Through a systematic review of the latest results, Clack shows how increased knowledge of the fish-tetrapod transition fossil record reveals changes to the head for increased ability to breathe air, among other things, and changes to the pectoral skeleton, also potentially related to the increased ability to breathe air. The fossil record has also constrained the evolution of tetrapods to the Middle to Late Devonian and likely has more information in store for future researchers.

Richard Prum continues the vertebrate theme, but instead considers the functional evolution of feathers. The central point of this chapter is that modern studies of feather development combined with recent fossil discoveries indicate that complex feathers first evolved in the theropods for other purposes and were later co-opted for flight; a textbook example of exaptation.

Appropriately, Adolf Seilacher himself provides the capstone chapter of this volume. His chapter centers on the constructional morphology of secondary soft-bottom dwellers, and includes his standard classic illustrations and innovative ideas. Considering a broad range of organisms (including Paleozoic brachiopods, bivalves, gastropods, serpulids, corals, sponges, crinoids, bryozoans, and cirripedes), Seilacher defines and examines the guilds within secondary soft-bottom dwellers, each of which provides a different strategy for stabilizing

the organism on soft substrates. These guilds have different ecomorphs for each taxonomic group because of their differing phylogenetic constraints, and some are even excluded from certain guilds because of these constraints. Seilacher concludes that future constructional morphology studies should involve the reconstruction of “adaptational road maps” combined with cladistic analyses.

As you can probably tell by now, this volume serves up an exceptionally broad range of topics,

each of which is cogently reviewed, analyzed, and discussed in their respective chapters. In this manner, the volume is a fitting tribute to Seilacher’s work in this field, which is also known for its astounding breadth and depth. I would recommend this book to any professional paleontologist or graduate student, as it would be a worthy addition to any of their libraries.

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