

**Emanuele Serrelli and Nathalie Gontier.** *Macroevolution: Explanation, Interpretations and Evidence*. Springer 2015. 403 pp. \$89.99 USD (Hardcover ISBN 9783319150444); \$89.99 USD (Paperback ISBN 9783319353708).

This book is divided into two parts, the first of which shows how macroevolutionary theories apply key insights from ecology and biogeography, developmental biology, biophysics, and molecular phylogenetics. In the second part, the phenomenon of macroevolution is examined with the help of life-history case studies. The evolution of eukaryotic sex, the formation of anatomical form and body-plans, extinction and speciation events of marine invertebrates, and hominin evolution and species conservation ethics are all covered. Composed of nine distinct chapters, this book brings together leading experts, who explain pivotal concepts.

In chapter 1, Emanuele Serrelli notes that adaptive landscape is an important diagrammatic concept that was conceived in population genetics. During the Modern Synthesis, the landscape imagery was used to represent large-scale evolution. Historic adaptive landscapes by Dobzhansky, Simpson, and others are a record of how macroevolution was thought of in those decades. Today, macroevolution is studied as a multifarious exploration of possibilities interconnected in complex ways: genotype spaces, molecular spaces, morphospaces, geographical spaces, ecological spaces, and genealogical spaces. In chapter 2, Stanley N. Salthe explores macroevolution from a general perspective focused upon energy and thermodynamics. The paper deals with the philosophy of development (involving final cause), the dissipative structure concept, the maximum entropy production, and maximum power principles. In Salthe's view, the course of human evolution can be understood as entrained by a universal development toward thermodynamic equilibration. Chapter 3 approaches complexity in evolutionary theory through networks and hierarchies. Ilya Tëmkin and Niles Eldredge therein attempt to revise the ontology of levels of biological organization and clarify the relationship between the economic and genealogical hierarchies; explore the implications of network theory for evolutionary dynamics in a hierarchical context; and elucidate evolutionary causality by disentangling abiotic drivers from proximal evolutionary processes and their integration across hierarchies.

Chapter 4, written by Nathalie Gontier, seeks to unite micro- and macroevolution into an extended synthesis. She explains that the Modern Synthesis explicates the evolution of life at a meso-level by identifying phenotype–environmental interactions as the locus of evolution and by identifying natural selection as the means by which evolution occurs. According to such a view, both micro- and macroevolutionary schools of thought are post-synthetic attempts to evolutionize phenomena above and below organisms that have traditionally been conceived as non-living. Chapter 5 written by Lutz Becks and Yasaman Alaviuses microevolution to explain the macroevolutionary observations for the evolution of sex. They note that since macroevolution is the accumulation of a number of microevolutionary changes leading over time to large-scale changes, understanding macroevolution requires understanding microevolutionary processes. In this chapter, they discuss the notion that sexual reproduction has evolved only once from asexual reproduction during the early stages of the eukaryote evolution. However, almost all animals and plants reproduce sexually rather than asexually, suggesting that sex is advantageous. In the sixth chapter Alycia L. Stigall, seeks to expand the role of biogeography and niche breadth in macroevolution, particularly with respect to speciation. She contends that developing a more complete understanding of speciation processes requires a broader synthesis of multiple explanatory factors including the role of external factors such as climate and tectonics, impact of ecosystem-level processes, relative niche breadth, and relative stability of

species' niches during environmental change (biotic and abiotic). Accordingly, this chapter explores the relationship between biogeography, ecological niches, and speciation.

In chapter 7, Alessandro Minelli discusses morphological misfits—a miscellaneous class of numerically marginal, often lately discovered taxa, deviating in one or more dramatic aspects from the structural organization of their closest relatives—and the architecture of development. Anatomically, there are modular misfits and systemic misfits. The former, but not the latter, are suggestive of developmental modularity. Ontogenetically, there are one-phase only misfits and whole-life-cycle misfits. One-phase only misfits, but not whole-life-cycle misfits, suggest an evolutionary independence of developmental stages, in Minelli's opinion. Bernard Wood and Mark Grabowski discuss macroevolution in the Hominin clade in chapter 8. They review the criteria for recognizing species and genera within the fossil record in general, and within the hominin clade in particular. They also review the grade concept, suggest how taxa within the hominin clade can be divided into grades, and define the grade categories. Although they note the difficulties of studying macroevolution in the hominin clade, they suggest that at least one trait, brain size, may provide insight into the tempo and mode of evolution. Chapter 9, written by Elena Casetta and Jorge Marques da Silva, deals with biodiversity conservation efforts aimed at facing 'the Big Sixth'—the new mass extinction we could be entering, the first one resulting from the human species as a primary cause. They characterize conservation biology as a form of biodiversity surgery and illustrate the main difficulties that this very special kind of surgery has to meet. They then focus on three challenges that *facing* extinction requires one to address: how to prioritize species; which conservation targets to focus on; and how to ethically justify species conservation.

In summary, this nicely edited volume shows that understanding evolution requires a solid grasp of above-population level phenomena. While species are real biological individuals, abiotic factors impact the future course of evolution. When the explanation of macroevolution is the goal, we need both evidence and theory beyond observation that enable us to explain and interpret how life evolves at the macro-level. The text is highly recommended for upper-division undergraduate and introductory graduate level courses as a supplementary text.

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