
Preface

The first beasts that we identify as turtles emerged abruptly in the Triassic about 220 million years ago. Since then, countless diverse lineages of turtles—terrestrial, marine, freshwater, and in-between—have come and gone, yet many lineages persist for tens of millions to more than 100 million years. All bring with them the suite of traits that are uniquely turtle: a bony shell, usually a retractable neck, lack of trunk musculature, and limb girdles located inside the rib cage (instead of lying outside of it). The reptiles we identify as turtles, or testudines, or chelonians, have captivated many naturalists and other scientists because of these and other unique traits and their consequences.

Some 180 years ago while in Jena, Germany, Ludwig Heinrich Bojanus developed an interest in the anatomy of the European turtle *Emys obicularis*. By dissecting specimens and illustrating their anatomy over the next decade, Bojanus authored one of the most detailed studies on any single vertebrate species, *Anatome Testudinis Europaeae* (1819–1821). This unparalleled book on turtle anatomy represents the intersection of his interests as a naturalist, comparative anatomist, veterinary surgeon, and teacher of anatomical art. It was because of this historical backdrop that the biology, particularly the anatomy, of turtles was visited again fittingly at the Sixth International Congress of Vertebrate Morphology, which was held in Jena in 2001. The symposium and its many contributed papers served as the foundation upon which this volume is based. However, this book goes beyond a morphologically based symposium in recognizing that the structures of turtles are particularly interesting and best understood within the context of their formation, their diversity of functions, their novelty, and their evolution. Whereas several areas of interest (e.g., turtle genetics, sensory systems and behavior, and life history evolution) are not included—as these fields continue to progress rapidly without a clear stable point—we have brought together a wide range of discussions on other novel features of turtles.

For the first time anywhere, we have a robust discussion about the origins, development, and diversity of the shell in chapters by Gilbert et al. (Chapter 1) and Pritchard (Chapter 3). Snover and Rhodin (Chapter 2) synthesize the important work on bone growth and aging, while Llorente et al. (Chapter 4) bring forward an understanding of limb bone strength in this unique group. Turtle locomotion is unique in many ways because of the presence of the shell. Renous et al. (Chapter 5) provide a novel synthesis of the field while Blob et al. (Chapter 6) present an experimental and functional perspective on the motor patterns used by turtles during locomotion. The retractable neck is expertly described by Herrel et al. (Chapter 7) and given functional context beyond the simple view of “protecting the head.” Bels et al. (Chapter 8) provide a functional, anatomical, and behavioral overview of feeding in herbivorous versus carnivorous types and aquatic versus terrestrial turtles that has never previously been summarized. Wyneken (Chapter 9) discusses cardiopulmonary anatomy and function from functional perspectives. Reproductive strategies receive a thorough overview by Miller and Dinkelacker (Chapter 10). Hulin et al. (Chapter 11) challenge the reader to think rigorously in their analysis of the consequences of environmental sex determination and turtle sex ratios, and Milton (Chapter 12) reminds us that at least some turtles (particularly the aquatic species that hibernate underwater) have a number of very unique structural and functional adaptations for tolerating low oxygen levels. Rieppel (Chapter 13) examines why the origin of turtles and their relationships to other amniotes is such a great challenge. Despite more than a century of intensive study, our understanding of the phylogenetic origins of turtles remains indefinite. This chapter particularly challenges us to look both inside and outside the shell as we build an understanding of the evolution of turtles. This challenge extends across all fields represented in this volume and those yet to come.

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