Preface

The study of modern organisms is invaluable for understanding ancient life, ecosystems, and environments. In most instances, the only way for paleontologists to address questions related to the life activities of extinct taxa is to investigate their closest living ancestors. Modern-analog studies allow paleontologists and sedimentary geologists to assess a range of questions regarding ancient life, from the behavioral and environmental significance of ichnofossils to the conditions responsible for different modes of fossil preservation, to the biomechanics of animal locomotion. While the application of modern observation and experimentation to assessing the past has been fundamental in the geosciences since the nineteenth century, recently developed techniques have arisen in multiple disciplines that allow new questions about the history of life to be addressed.

Experimental Approaches to Understanding Fossil Organisms is based on a topical session that we organized and held on October 11, 2011 at the Geological Society of America's Annual Meeting in Minneapolis, Minnesota. This session included 24 presentations covering a wide range of topics all focused on studying modern organisms to better understand and interpret ancient life. This was the third time we organized a session with this theme for the Geological Society of America. The first was at the 2007 Joint South-Central and North-Central Section Meeting in Lawrence, Kansas and the second was at the 2008 Annual Meeting in Houston, Texas. Given the diversity of the research presented and the size of the audiences attending these sessions, we felt that this was a topic of great interest and held relevance to the modern paleontological and sedimentary geology communities.

This volume is intended to provide professionals and students in the fields of paleontology and sedimentary geology in academia and industry with specific case studies demonstrating the variety of questions that can be asked, techniques and methodologies that can be employed, and interpretations that can be made using modern analogs to study ancient life. We hope that the work described in this volume will be useful in launching new research questions and methods which will ultimately lead to a better understanding of the history of life on our planet.

Experimental Approaches to Understanding Fossil Organisms is divided into three parts. Part I includes papers that analyze the functional morphology of ancient organisms by conducting experiments with fossil material or by studying the morphology, physiology, and behavior of similar modern organisms. These studies include the investigation of the function of a unique type of anchor-shaped crinoid holdfasts by directly testing models of well-preserved fossils (Chap. 1), an assessment of the functional role of elongate shells in bivalves (Chap. 2), a test of the morphological features of fossil bivalves thought to suggest chemosymbiosis (Chap. 3), a comparison of the interpreted life habits of eurypterids to those known in modern horseshoe crabs and scorpions (Chap. 4), and an investigation of the feeding behaviors of Eocene whales through comparisons with skull morphologies of extant whales (Chap. 5). Part II incorporates studies of taphonomy and environmental controls on organism distribution. These studies include an investigation of microbialites through time (Chap. 6), the preservation of tropical, shallow marine mollusk assemblages (Chap. 7), the distribution of burrowing organisms on beaches (Chap. 8), the concentration of iron minerals around burrows (Chap. 9), and the preservation of phytoliths in modern, disturbed ecosystems (Chap. 10). Part III broadly covers organism-substrate interactions or neoichnology. While these studies also examine aspects of functional morphology, taphonomy, and environment, the focus is on the production of biogenic structures in the sediment or other media. These studies include the characterization of burrows produced by modern scorpions (Chap. 11), salamanders (Chap. 13), skinks (Chap. 14), and lemmings (Chap. 16) in a variety of media and environmental conditions, surface trails produced by swimming fish (Chap. 12), an array of novel surface traces produced by modern African and Asian elephants (Chap. 15), and a new means of detecting animal burrows and buried tracks and trails in various types of sediment using ground-penetrating radar (Chap. 17).

We are very grateful to our group of expert reviewers who provided insightful, helpful, and timely reviews of the papers included in this volume. Our panel of expert reviewers consisted of 26 researchers from around the world including Emese Bordy (University of Cape town), Danita Brandt (Michigan State University), Joseph Carter (University of North Carolina), Al Curran (Smith College), Shahin Dashtgard (Simon Fraser University), Jason Dunlop (Museum für Naturkunde), Murray Gingras (University of Alberta), Leslie Harbargen (SUNY Oneonta), Gary Haynes (University of Nevada),Daniel Hembree (Ohio University), Jonathan Hendricks (San Jose State), Adiël Klompmaker (Florida Museum of Natural History and University of Florida), Dirk Knaust (Statoil ASA), Matthew Kosnik (Macquarie University), Ricardo Melchor (INCITAP (UNLPam-CONICET)), Radek Mikulas (Academy of Sciences of the Czech Republic), Elizabeth Nesbitt (University of Washington), Renatta Netto (PPGeo Unisinos), Karla Parsons-Hubbard (Oberlin College), Brian Platt (University of Mississippi), Roy Plotnick (University of Illinois at Chicago), Sara Pruss (Smith College), Tami Ransom (Salisbury University), Jon Smith (Kansas Geological Survey), Nigel Trewin (University of Aberdeen), and Andrea Wetzel (University of Basel). We would also like to thank Tamara Welschot, Judith Terpos, and Sherestha Saini at Springer for all their help with putting this volume together.

The wealth and breadth of active modern-analog research featured in this volume demonstrates that the solutions to many unanswered questions may be achieved by honoring the founding geological principle of uniformitarianism. Far from being stifled or replaced by technological advances in modeling simulations, digital resources, and statistical analyses, we anticipate that modern-analog studies will remain relevant to the geosciences and will, indeed, thrive as researchers find new creative applications for empirical, experimental approaches. As geoscientists continue to look to the world around us for perspectives on the history of life, new opportunities for interdisciplinary collaborations and the integration of new technologies promise to expand the range of paleontological problems that can be addressed through modern-analog experiments.

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