# Preface

This book grew out of a suggestion from Paul Harvey, to whom we are greatly indebted. Like the biomechanical systems that it discusses, this book has evolved over an extended, if not quite geological, period of time. It has, in fact, outlived several generations of assistant editors at Oxford University Press, and we thank Ian Sherman for his forbearance as Senior Commissioning Editor throughout. We thank Lucy Nash for helping us see the project to completion, and our research groups for their patience as our time was absorbed to this end. We would also like particularly to thank our own families—Rachel, Isabelle and Isaac—Sue and Lauren—for their patience and support throughout the process.

In our defence, if we have taken our time in writing this book, it is because the material that it contains is almost entirely new. It was, after all, only a decade ago that Lauder (2003) was able to write: '*The discipline of biomechanics has had a long but relatively superficial flirtation with evolutionary biology. ... biomechanics and the allied areas of functional morphology and comparative physiology have focused largely on the question of how organisms work... only to a lesser extent have issues relating to historical patterns and transformations been current within biomechanical research programmes*'. Lauder went on to propose a series of challenges for integrating evolutionary thinking into biomechanics—any one of which could form the basis of a research career in its own right. We would go a step further, however, and argue that the greatest challenge lies not in integrating evolutionary biology into biomechanics, but in integrating biomechanics into evolutionary biology.

In our view, evolutionary biomechanics should not be a niche specialism aimed only at studying the evolution of biomechanical systems. Rather, evolutionary biomechanics should be a discipline of much broader interest, aimed at understanding evolution *through* the study of biomechanical systems. Biomechanics is uniquely well placed to contribute to analyses of evolution because of the precision with which it is possible to predict physical constraints and physical performance from first principles. This precision can bring into sharp focus key questions about evolution which would otherwise remain vague or ill posed. We see a great opportunity here, waiting to be grasped. For example, much as evo-devo has helped to make sense of developmental constraints and possibilities in evolution, so evolutionary biomechanics can help to make sense of physical constraints and possibilities, and their interactions with the biological process of natural selection.

Theoretical evolutionary biology is founded upon the mathematics of population genetics; theoretical biomechanics expresses the mathematics of Newtonian mechanics; and comparative biology is grounded upon the mathematics of statistical modelling. It is difficult to escape the conclusion that a book which aims to build the foundations of evolutionary biomechanics must—by necessity—be mathematical through and through. We have not been shy of this, but have always tried to follow as our guiding principle that '*the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience*' (Einstein, 1934). We have taken the approach of verbally explaining all of the mathematics presented in the main text, with the goal of making it fully comprehensible to any reader with a solid grasp of high school mathematics. In consequence, the text is not easy-going in some places, but we have confined all of the more involved mathematics to text boxes, to avoid interrupting the flow.

Fundamentally, this is a book about evolutionary biology and the contribution that evolutionary biomechanics can make to that discipline. We make no attempt or pretence to be exhaustive in our coverage, and there are certainly many important areas of biomechanical investigation that do not receive attention here, including materials, structures, swimming and feeding. Biomechanics is already blessed with some superb textbooks and collected volumes, and for recent surveys we refer the reader to: Dudley (2000), Alexander (2003), Bels et al. (2003), Biewener (2003), Vogel (2003), Videler (2005), Pennycuick (2008), Taylor et al. (2010) and Ennos (2012). Hence, instead of attempting to review the biomechanical literature in a broad sense, we have chosen to explore a few examples in depth. These examples serve as vehicles for discussing fundamental concepts, analytical techniques and ideas about evolution. In summary, this is book that is about population genetics, optimization theory, dimensional analysis, statistical models and the comparative method as much as it is a book about biomechanics and the physics of life.

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we analyse in Chapters 5–8. Finally, we thank our colleagues in other disciplines with whom we have had the opportunity to interact through the unique environment of an Oxford college. Although they may not be aware of the fact, lunchtime conversations with Andrew Dancer, Iwao Hirose, Steffen Lauritzen, and Jim Oliver have all contributed in different ways to different parts of this book. Any mistakes are wholly of our own making.

*Graham K. Taylor and Adrian L. R. Thomas*
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