PREFACE

Many years ago, when M.T. came to Maine to work with L.W. on shallow subtidal crustaceans, we established some amphipod populations in aquaria at the University of Maine's Darling Marine Center flowing seawater facility. What ensued was not just a series of remarkable behavioral observations but also a series of long discussions of "how do they do that?" in response to the burrowing and whip making that we observed. The two of us have maintained a lifelong interest in understanding how crustacean morphology "determines" what the animals can do and where they can live.

Crustaceans encompass a bewildering array of body forms that they use to occupy almost every habitat type on Earth. In fact, the only habitat not occupied by crustaceans is the open air; that is, they cannot fly. Understanding what modifications of the crustacean body plan have allowed this diversification is the subject of this book.

In its basic form, the crustacean body consists of a bilaterally symmetrical, segmented, more or less tubular body, with each segment bearing a pair of appendages. The number of body segments and the design or even presence of appendages vary considerably, with the most extreme cases being found in those groups that have invaded the bodies of other animals.

In this book we have asked the chapter authors to explore this diversification of form and to explain how various parts of the crustacean body work. While many authors have examined the functional morphology and anatomy of crustaceans in individual publications or book contributions, this has never been done in an integral way in one volume.

We were particularly interested in understanding the design limitations of the crustacean body, for example, how living in a dense fluid medium might restrict the movement capabilities of the animal, and how that would vary depending on the animal's size. But movement isn't all that crustaceans do in their daily lives—they have to eat, respire, reproduce, and grow, all of which needs to be controlled so that the animal functions as a successfully coordinated whole.

To set the stage, Schram (chapter 1) reviews the range of crustacean body plans, and Haug et al. (chapter 2) review what is known about appendage development in the earliest arthropods as they become what we would recognize now as crustaceans. Then follow four chapters that examine the exterior of the crustacean body. Williams (chapter 3) investigates the genetic control of appendage development as the animal develops. Olesen (chapter 4) surveys the functional constraints of the archetypical crustacean structure, the carapace. Dillaman et al. (chapter 5) take a detailed look at the crustacean cuticle, and Garm and Watling (chapter 6) review the structure and function of setae and other cuticular outgrowths.

Our examination of the integrated functional aspects of the crustacean body starts with Boxshall and Jaume's overview of crustacean antennae (chapter 7). Watling (chapter 8) integrates food consumption and digestion, showing that mouthpart appendage structure, foregut morphology, and digestive enzyme secretion are all related to diet. Belanger (chapter 9), Faulkes (chapter 10), Yen (chapter 11), and Boudrias (chapter 12) examine modes of locomotion in crustaceans and the functional constraints imposed on locomotory appendages by the physics of the medium in which they live.

We end the book with a series of chapters dealing with system-level integrative functional anatomy. Bauer (chapter 13) reviews the structure and function of appendages used for grooming and reproduction. Wirkner and Richter (chapter 14) examine the integration of respiratory structures with internal details of the circulatory system. An overview of the internal anatomy of the reproductive system is provided by López Greco (chapter 15). And lastly, the coordination of the whole body is dealt with in Sullivan and Herberholz's review of crustacean nervous systems (chapter 16).

We have asked the authors of these chapters to deal with their part of the crustacean body in isolation. Of course, we recognize that crustaceans are living creatures, and in order to live they have managed to integrate the functional aspects of their bodies that we have studied so well on their own. What we have not done is try to develop a fully integrated model of the crustacean body that accounts for all the physical aspects of the various habitats in which crustaceans live. We suspect this is possible but may be beyond the reach of any one of us.