Preface

One of the greatest achievements of biology in the 20th century, carried forward with vigour into the 21st, has been to translate the theory of natural selection into a practical reductionist science. This development, complemented by the 'molecular revolution' ensuing from the cracking of the genetic code, has immense potential for our understanding of the evolutionary relationships between organisms and the basis of variation within and between populations. For many ecologists these advances have provided opportunities to expand and refine investigations of the population genetics of individual species. However, this has to a large extent left unattended the urgent requirement for ecologists to bring order and predictive science to the study of ecosystems, many of which are suffering degradation and extinction in an over-exploited and rapidly changing world. In established sciences, including physics and chemistry, the revelations that eventually led to general theories were surprisingly discrete and testable. We believe that ecology, despite its reputation as an 'ambitious but ramshackle science' (Calder, 2003), is no exception to this pattern, and that it is now opportune to attempt integration of the disparate fields of animal, plant and microbial ecology within a single theoretical framework that keeps natural selection at the fore.

To address this need, this short book endeavours to understand how evolutionary adaptations govern the manner in which organisms assemble into communities and process matter and energy within ecosystems. We first chart the tentative steps by which some ecologists over the course of more than a century have attempted to establish a path from evolutionary theory to an understanding of variation in the structure, functioning and vulnerabilities of ecosystems. In marked contrast to the technical difficulties of microbial ecology and the limited insights into general principles gained by animal ecology, the accessibility of plants and their dominance of terrestrial ecosystems have revealed generalities in the constraints to evolution. These, in light of recent research, are now

apparent for all organisms, from the largest whale to the smallest virus. We have distilled the essence of these constraints to evolution and ecology into a novel **universal adaptive strategy theory**, in which only a restricted set of viable approaches to survival, or adaptive strategies, are possible and in turn set limits to the performance of ecosystem functions. We explain, in terms of a **twin-filter model**, how it is possible to distinguish between mechanisms of natural selection that control the functioning of ecosystems and those that merely determine which among many candidate species actually perform these functions in particular ecosystems at individual locations. Finally, we present a detailed version of the twin-filter model that provides a conceptual framework integrating evolutionary processes such as natural selection, extinction and different modes of speciation with the assembly of communities and the functioning of ecosystems.

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