Preface

With its high taxonomic, morphological, and ecological diversity and excellent fossil record, the placental mammal order Carnivora has proven to be a model group for addressing questions of large evolutionary significance. Recent work has resulted in a well-resolved phylogeny of extant taxa, as well as for many extinct clades, allowing for rigorous analysis of a wide range of evolutionary questions. Although the order is named after its meat-eating members, the dietary breadth of living carnivorans (members of the order Carnivora) extends from frugivorous to insectivorous taxa, durophagous taxa, as well as the hypercarnivorous taxa that are usually associated with the group. Carnivoran locomotor diversity is also remarkable among mammals, with fully aquatic, semi-aquatic, arboreal, terrestrial, and fossorial taxa. Recent studies have shown that this diversity extends to their early fossil representatives. Multiple ecological and morphological convergences of carnivorans and distantly related clades, including the extinct creodonts and extant and extinct carnivorous marsupials, also strengthen the utility of carnivorans for comparative ecomorphological and biomechanical studies. This volume focuses not only on the current advances in our understanding of mammalian carnivoran evolution, but especially on how carnivorans are being used as a model clade for testing new methodologies and addressing fundamental issues in palaeontology, which can ultimately be applied to clades with poorer fossil records.

The subtitle of this volume – 'New Views on Phylogeny, Form, and Function' – while being pleasantly alliterative, highlights some of the most exciting fields of study in evolutionary biology and palaeontology to which carnivorans have lent themselves. In recent years, mammalian carnivorans have been the focus of extensive phylogenetic analyses, both molecular and morphological, and incorporating both extant and fossil taxa, which have resolved many long-standing issues in carnivoran relationships. Flynn *et al.* (Chapter 2) provide an overview of the state of overall carnivoran phylogeny, erect a new clade, and demonstrate some of the patterns that can be studied using a phylogenetic framework. Contributions by Veron (Chapter 3) and Morlo and Peigné (Chapter 4) look closely at some of the more interesting evolutionary problems within Carnivora. Veron tackles the viverrids, a diverse Old World group that has undergone extensive revision in recent years. Morlo and Peigné look closely at the evolution

of the red panda and its relatives in the Ailuridae. Although represented by only one taxon today, the fossil history of this family reveals more diversity in taxonomy and form.

All three of the phylogenetic studies use the latest in techniques, including combining molecular and morphological data, and especially data from fossil specimens, in their analyses. Goswami and Polly (Chapter 5) use carnivorans to investigate a potential issue in phylogenetic methodologies – the correlated evolution of characters. Using simulations and empirical data, they test whether character correlations influence discrete character states over evolutionary time scales, and assess methods to identify these correlations in existing analyses. Benoit (Chapter 6) addresses another issue in phylogeny and taxonomy – how to identify species. Using lions as an example, Benoit uses sophisticated analyses of allometric trajectories to assess the strength of characters used to justify the American lion as a separate species.

With this solid taxonomic and phylogenetic framework and their excellent fossil record, carnivorans easily lend themselves to interesting studies of macroevolutionary patterns and more fundamental issues of influences on diversity. Holliday (Chapter 7) uses a phylogenetic framework to assess biases in morphological evolution, testing whether hypercarnivory tends to limit further morphologic change and testing hypotheses of a macroevolutionary ratchet that leads hypercarnivores into an evolutionary 'dead end'. Both Werdelin and Wesley-Hunt (Chapter 8) and Wesley-Hunt *et al.* (Chapter 9) address the biogeographic distribution of carnivoran ecomorphologies. The broader study of Werdelin and Wesley-Hunt looks at morphological disparity across the entire order and compares disparity among families and among continents. Their companion piece, Wesley-Hunt *et al.*, focuses on just two of the more widely distributed families, civets and mongooses, to investigate how they divide up community ecospace in different regions.

Ecologies within communities can be traced across time as well as space, and both Morlo *et al.* (Chapter 10) and Friscia and Van Valkenburgh (Chapter 11) use this approach to look at the earliest carnivorans. In the Paleogene, carnivorans shared the meat-eating niche with the extinct creodonts, and how this temporal overlap affected their respective ecologies, as well as the history of their diversity, has long been a topic of research and debate. The broader, global study of Morlo *et al.* addresses how ecospace and guild structure vary temporally and spatially across the history of carnivorous mammals, as taxonomic membership varies. Friscia and Van Valkenburgh test the more specific question of whether creodonts were actively replaced by carnivorans, as the former decrease in diversity during the Eocene of North America.

While most studies of carnivorans focus exclusively on the terrestrial clades, the pinnipeds represent one of the most extraordinary transitions in mammal evolution. The study of Jones and Goswami (Chapter 12) bridges form and function, by using pinnipeds as a case study for investigating reproductive and ecological influences on cranial morphology, as well as identifying types of convergence across the three extant clades of pinnipeds.

Polly (Chapter 13) returns to the terrestrial realm, using sophisticated analyses of biomes and limb morphology to assess the relationship between locomotory styles and the environment in North American carnivorans and exploring its potential as a tool to reconstruct past environments. Lewis and Lague (Chapter 14) follow on the postcranial theme, comparing limb morphology in machairodontid sabretooth felids to modern felids to assess whether they employed similar locomotory and hunting styles, or were as distinct in the postcranium as they were in cranial and dental morphology.

Lastly, Wroe (Chapter 15) provides an overview of the latest in 3D imaging and finite-element techniques and presents several comparisons of skull mechanics in placental and mammalian carnivores. Finite element analysis has proven to be a unique and fascinating tool for reconstructing the mechanical capabilities of extinct morphologies, and Wroe's chapter details how these methods reveal surprising differences between superficially similar carnivores.

Few vertebrate groups can claim such a diversity of topics that can be rigorously tested with fossil and extant taxa as carnivorans can. Advances in development, genetics, phylogenetics, morphometrics, finite element analysis, and 3D imaging have all been extensively applied to carnivorans, keeping this clade at the forefront of research in evolutionary biology and palaeontology. We hope that this volume will serve not only as an overview of recent advances in carnivoran evolution, but also as a methodological guide for studying large-scale patterns in the fossil record and for addressing fundamental questions in evolutionary biology with morphological and palaeontological data.