

Book Review

Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles

Jonathan Losos. University of California Press, Berkeley, 2009. xx + 507 pp. Price \$75.00 (hardcover). ISBN 978-0-520-25591-3.

Few vertebrate groups have become more celebrated model organisms than the anoles. This group of almost 400 lizard species have played a major role in scientific disciplines spanning from functional morphology to molecular ecology. In *Lizards in an Evolutionary Tree*, renowned evolutionary biologist Jonathon Losos provides the most thorough treatment of anoles to date. From the outset, it is clear this book is more than a summary of a group, but a labour of love. The book is arranged around four general sections. First presented is the ecology, natural history and evolution of anole diversity (chapter 2–4), phylogenetic perspectives of anole diversity and distribution (chapter 5–7), anole biology, ecology and behaviour (chapter 8–13), speciation and adaptive radiation (chapter 14–16), and a conclusion placing anoles within a broader context (chapter 17). Footnotes provided throughout supply additional information, facts and anecdotes to keep the reader on track regarding specific details, scientific advances, etc. To begin, chapter one introduces the field of evolutionary biology, and how evidence for contemporary evolutionary patterns can be gained from both the fossil record and modern phylogenetic approaches, and why anoles are such a useful natural system. Here is where Losos firmly incites the reader's interest and highlights other potential avenues of anole research – a perspective provided for each chapter. Chapter two defines anole morphology, distribution, species concepts and reproductive isolation. This includes a discussion on the role (territoriality, mate choice) and diversity of the dewlap (an extendible membrane under the lizard's throat). Chapter three focuses on evolutionary patterns of the six Greater Antillean anole ecomorphs – unrelated species that show convergence in habitat use, morphology and behaviour. Assisting the reader here are descriptions of the six main ecomorphs as well as colour plates and size-relative figures. Chapter four compares and contrasts the Greater Antillean anoles with the other anole faunas (Lesser Antilles and mainland). Here, we find that like the Greater Antillean anoles, mainland anoles are also regionally and locally diverse.

Chapter five explores the strengths and limitations of phylogenetic approaches to study anole ecology and evolution, and concludes with a historical perspective on the development of anole phylogenetic relationships. Chapter six examines the evolutionary

origins and migration of the *Anolis* lineage, which initially diversified on the mainland around 65 MYA, before colonizing the West Indian islands. An interesting contrast here is that the phylogenetic data suggest anoles of the *Norops* clade re-colonized the mainland from the West Indies. In a similar vein, beginning with the anoles of the Greater Antilles, we find out how anole diversity evolved within and among the different regions (chapter seven), by examining evidence in favour of repeated, independent evolution of a similar set of ecomorphs on each island. This chapter also examines body-size divergence, which typically occurs when two anole species co-occur on the same island, but is intermediate in size when either species is the sole occupant of an island. Here, there is a thorough discussion of the evidence for character displacement and taxon cycles in generating and maintaining species.

Chapter eight presents an overview of anole biology (reproduction, diet, etc.), and a brief mainland-island comparison. Surprisingly, it appears much remains unknown about the basic ecology of the majority of species. Territoriality, mate choice, sexual dimorphism and sexual selection are the core of chapter nine. Habitat use and the ways anoles partition their environment along the gradients of perch use, temperature, moisture, and light is the focus of chapter 10. Beginning with an overview of adaptive radiation is chapter 11, for which evidence from a number of lines indicates that the interactions of sympatric anoles are key in their evolutionary divergence. A review of the studies of differences in niche breadth of species in sympatry vs. allopatry, provides evidence for ecological release. Next, we learn what is known about microevolutionary processes in anoles, including the strength and targets of natural selection in the wild and in experiments, associations between morphological and environmental variation, heritability, and phenotypic plasticity (chapter 12). Chapter 13 provides a macroevolutionary perspective on the repeated evolution of ecomorphs and convergence of similar phenotypes living in similar habitats, as seen from the perspective of an arboreal lizard.

Chapter 14 covers the mechanisms of speciation in anoles. While the role and influence of resource partitioning and habitat adaptation may be overriding, it is clear that there is more to speciation in this group. Chapters 15 and 16 examine the adaptive radiation of anoles, how it may have proceeded, and what factors may be associated with variation in diversification rates. As with most adaptive radiations, we know much less about how and why only certain groups successfully radiate (Schluter 2000; Gavrillets & Losos 2009). It seems the evolution of a key innovation – the

toepad – enabled anoles to adopt a more arboreal life-style, and provided much of the impetus for this adaptive radiation. An examination of the anole faunas provides a solid introduction to adaptive landscapes and the concept of historical contingency. Finally, chapter 17 summarizes how and why anoles are unique, potential areas of research on anoles and potential threats to specific anole species.

This book sums up a considerable body of past, present and possible research on this well-studied lizard group, and provides a superb historical summary by one of its foremost researchers. This book is accessible to both expert and lay persons alike, with an easy to read style, which is aided by the many large colour plates and photographs. At times, I would have liked some reference to how anoles compared with other vertebrate groups, particularly those which have undergone large adaptive radiations (e.g. skinks; Rabosky *et al.* 2007; Skinner *et al.* 2008); such a criticism is minor. There is little doubt this book will make a valuable addition to the library of a broad audience of readers, and could suffice as the prescribed text in an undergraduate evolutionary biology course. Established and budding researchers alike will find the future directions sections particularly fruitful. Indeed, in the preface Losos acknowledges, ‘I will consider this

book a success if it helps produce a new generation of anole researchers’. In this extremely well-researched and written book, it would appear this is likely to be the case.

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