Regina rigida (Glossy Crayfish Snake). Marengo Co.: 5.47 km (air km) W of Dixon's Mill in a sand-bottomed creek (Probably Horse Cr.). 7 July 1975. J. Autery. AUM 29610.

Storeria dekayi (DeKay's Brownsnake). Bullock Co.: Found AOR on US Hwy 82 N of Union Springs (32.175567°N, 85.709517°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 175. Conecuh Co.: Collected DOR on State Rt. 106 1.45 km E of County Rd. 29 intersection (31.707533°N, 86.933592°W; WGS 84). 17 February 2008. S. Hoss. AUM 37650.. Hale Co.: Payne Lake Recreational Area, Talladega National Forest. In spring W of lake. (32.878206°N, 87.443716°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 159. Lowndes Co.: Collected AOR Lowndes County Rd. 40 (32.327649°N, 86.743344°W; WGS 84). 03 September 2007. S. Graham. AHAP-D 74. The Conecuh and Lowndes county records fill a substantial distribution gap from the nearest documented populations to the N (Bibb County) and NE (Montgomery County) to those to the SW (Washington County; Mount 1975).

Thamnophis sauritus (Eastern Ribbonsnake). Crenshaw Co.: Collected DOR on Crenshaw County Rd. 1, 200m NW Crenshaw County Rd. 7 (31.700153°N, 86.375061°W; WGS 84). 10 December 2008. S.Graham, R. Birkhead, and K. Gray. AHAP-D 169. Lowndes Co.: Collected DOR on Lowndes County Rd. 40 (32.331976°N, 86.594544 °W; WGS 84). 21 September 2007. S. Graham, S. Hoss, D. Steen, V. Johnson. AUM 37490. St. Clair Co.: Found under rock next to small creek along US Hwy 231 ~ 10 km S of Ashville (33.754353°N, 86.275546°W; WGS 84). 2 March 2008. S. Graham and S. Hoss. AHAP-D 103.

Thamnophis sirtailis (Common Gartersnake). Lowndes Co.: Collected DOR on Brownshill Rd. 100 m W of Lowndes County Rd. 40 (32.318552 °N, 86.577542 °W; WGS 84). 3 September 2007. S. Graham AUM 37477.

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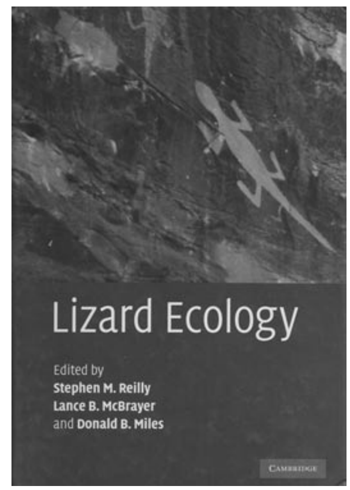
BOOK REVIEWS

Herpetological Review, 2009, 40(3), 371–374.

Lizard Ecology: The Evolutionary Consequences of Foraging Mode, edited by Stephen M. Reilly, Lance B. McBrayer, and Donald B. Miles. 2007. Cambridge University Press, Cambridge, New York. xiv + 531 pp. Hardcover. US $142.00. ISBN 978-0-521-83358-5.

BRETT A. GOODMAN
School of Marine & Tropical Biology
James Cook University, Townsville, 4811,Queensland, Australia
e-mail: Brett.Goodman@jcu.edu.au



Lizards have become a model group for research spanning a wide range of biological disciplines, including: morphology, physiology, ecology, behavior, and evolution. Over the past 40 years, many of the advances in lizard ecology have been periodically summarized in books beginning with the title *Lizard Ecology*. These include: *Lizard Ecology: A Symposium* (Milstead 1967), *Lizard Ecology: Studies of a Model Organism* (Huey et al. 1983), and *Lizard Ecology: Historical and Experimental Perspectives* (Pianka and Vitt 1994). The most recent addition, *Lizard Ecology: The Evolutionary Consequences of Foraging Mode* adds to this lineage and provides further evidence of the importance of lizards in understanding the evolutionary complexity and trade-offs inherent to the way animals forage for their food. At its core, *Lizard Ecology* focuses on the sit-and-wait (SW)/ambush mode of foraging versus the active, widely-foraging (WF) dichotomy (analogous to the r-K dichotomy of life history theory), where species are lumped into one or other foraging mode (FM). In the latest release, researchers have tested an immense range of hypotheses from the fields of ecology, evolutionary biology, and animal behavior using species with an equally diverse range of natural histories. The goal of the book is to review research on FM and assess its influence on the biology of squamates that has accumulated over the past 40 years. The book is divided into two parts: I. Organismal patterns of variation in FM, and II. Environmental influences of FM. The first 11 chapters make up Part I and include relationships between FM and various aspects of squamate biology, such as physiology, morphology, anatomy, performance, behavior, diet and life history. Part II centers around the influence of nocturnality (geckos) on FM, plasticity in FM in response to environmental variation, and habitat use and its relationship to food acquisition.

To begin, Ray Huey and Eric Pianka provide interesting insight into the emergence of the term FM (Pianka 1966). Following on, in one of the most important chapters (Chapter 1), particularly in terms of data collection and quality, Gad Perry identifies the all too often neglected issues of methodology and terminology of foraging behavior. This is followed by theoretical predictions of foraging theory. Measuring foraging behavior, and the qualitative versus quantitative measures of speed, moves per minute and percentage time spent moving has often been problematic and there has rarely been consensus on how such foraging behaviors should be measured. Perry examines various taxonomic groups to determine the number of observations necessary to reliably estimate foraging behavior. In general, we find that, with the exception of gekkonid lizards, relatively few samples (≥15) are needed to estimate a species' movement rates.

Early predictions on foraging mode suggested "SW" foragers should have high sprint speed and low endurance, highlighting an evolutionary trade-off. In the longest chapter of the book (Chapter 2; 45 pages), Miles et al. use published data on sprint speed, endurance and FM to examine these hypotheses, and provide a macroevolutionary perspective on whether morphology and locomotor performance correlates with FM, using size-corrected data for the majority of lizard groups. Finally, they examine data within *Anolis* to provide a microevolutionary perspective using field data on foraging behavior and locomotor performance in the field. Nonetheless, their ancestral reconstruction reveals that shifts in FM from SW-WF occurred early in the evolution of squamate reptiles, probably at the node of scleroglossans, as other studies have suggested (e.g., Vitt and Pianka 2003). An interesting result to emerge is that SW species have greater sprint speeds than WF species. In closing, the authors warn against categorizing SW-WF as end points of a continuum, but instead encourage the collection of additional data to develop a clearer picture of the differences in foraging behavior.

In Chapter 3, phyislogical correlates of lizards foraging mode, Kevin Bonine highlights known and potential correlations between physiology and performance traits that relate primarily to FM. Using Arnold's (1983) paradigm (morphology → performance → behavior → fitness) he presents results within a phylogenetic context to explore the link between morphology and performance. In addition, Bonine provides a thorough introduction to FM and physiology, and whole-animal performance measures, including energy balance, sprint speed, endurance, temperature, water loss, aerobic capacity, anaerobic scope, and the sub-organismal physiological traits of respiration and muscle physiology.

Chapter 4 (Brown and Nagy), addresses the fundamental ecological question: do WF species have greater energetic costs than SW species? The authors use published data on field metabolic rates (FMR), and doubly labeled water (DLW) for 46 lizard species, develop allometric equations for members of each FM, which they use to assess the position of new species, and to predict, develop and test bioenergetic hypotheses. They begin by reviewing older studies that examined distantly related SW-FW species, and move onto more recent studies which focus on more closely related species. Next, they examine DLW studies in an attempt to detect general patterns among SW and FW species, before examining the phylogenetic effects of energy use among lacertilians. While their results for the FMR data support the SW-FW dichotomy they suggest that as more foraging behavior data become available, it may be possible to use a continuous predictor (e.g., MPM) to investigate patterns in FM and energy use.

In Chapter 5, the modern-day fathers of lizard ecology, Laurie Vitt and Eric Pianka begin with the admission that… "the foraging mode paradigm is more complex than originally envisioned" (page 141). Fittingly, their chapter sets out to highlight major evolutionary and non-evolutionary factors that affect the prey types consumed by lizards, using diet data for 184 lizard species from Africa, Australia, North America and the New World Tropics. They begin by presenting factors likely to influence the prey consumed by lizards in addition to foraging mode, including; body size, biomechanics of feeding structures, thermoregulatory behavior, times of activity, sensory capabilities, physiological constraints, and resource availability. The results of their phylogenetic analyses revealed that variation among lizard diet is reduced by 80%, suggesting many of the differences are nested deep within the evolutionary history of lizards. The emergence of chemical prey discrimination, jaw prehension, and the use of a WF mode of locomotion to find prey, no doubt led to an increase in prey types that were unavailable previous to iguanians. The sheer number of extant scleroglossans (snakes and lizards; 6000) to iguanians (1230) provides ample evidence for the success of these evolutionary innovations.

In Chapter 6, Shine and Wall examine the reasons for the dramatic degree of intraspecific niche divergence, in body size and sex, observed in snakes compared to lizards. To begin, the authors highlight a series of mechanisms that may drive observed patterns of: size-dependent shifts in prey consumption, and intersexual niche divergence, including other factors that may cause variation in foraging traits within a species. In the final part of their chapter, the authors highlight the difference between lizards and snakes (e.g., snakes consume a wider range of prey sizes), and follow this with a series of hypothesis that test these ideas. The authors suggest that the functional basis for the intraspecific shift in dietary niche frequently observed in snakes relates mainly to differences in the anatomy, physiology, ecology and behavior observed between snakes and lizards.

Anthony Herrel (Chapter 7) aims to identify those traits (ecological, morphological and performance) in lizards that are typically associated with the two foraging modes, and compares these with the traits typically associated with an herbivorous life-style. One of the highlights of this chapter is the finding that ancestry appears not to have constrained the dietary mode of lizards. Regardless of FM the shift to herbivory has led to the evolution of flat, blade-like teeth, high bite force, large size and a longer colon. Moreover, given that these traits are present within omnivorous species, it suggests that the evolutionary shift to herbivory has occurred via an omnivorous diet. Given this, Herrel poses the question of why are their so few scleroglossan herbivores? Clearly, this is one question requiring additional data!

In Chapter 8, William Cooper describes the morphology and physiology of lizard chemosensory systems, the evidence for prey chemical discrimination, and how lizard FMs have influenced these relationships. Evidence is presented, in the form of correlated evolution between the lingual-vomeronasal system, food chemical discrimination, and FM. Such that differences in FM have influenced the evolution of diet, and this has then affected the responsiveness of species to the different chemicals of specific food types. In closing, Cooper discusses the role of the lingual-vomeronasal system and foraging mode, for prey chemical discrimination, in driving the evolutionary diversification of lizards.

In Chapter 9, McBrayer and Corbin examine patterns of head shape variation in response to FM, in order to establish the existence of trade-offs between head shape, biting force and FM using 22 species of lizard representing 12 families. Here we find that head length and width has evolved in concert with FM, but that there remains much to learn. In particular, whether head shape is changing in response to foraging mode alone, or whether other forces play a part. Following on, Reilly and McBrayer (Chapter 10) examine the convergence and divergence in prey capture and processing behavior and the evolution of lingual and sensory traits in lizards. In general, three distinct patterns of FM emerge: two distinct SW predators, one mixed forager, and thee distinct WFs. They suggest that despite the similar prey processing behaviors of the Iguania and Gekkota, it is achieved via fundamentally different forms of tongue use when capturing prey. The mixed FM and retention of primitive Autarchoglossan features and tongue prehension place the Scincoidea midway. Indeed, the evolution of a tongue with chemosensory abilities appears to have been a pre-determinate of a widely-foraging strategy and is probably a key component of the WF vs. SW FM dichotomy.

Beaupre and Montgomery (Chapter 11) change gear by focusing on the FM of snakes, with reference to interspecific and broad-scale patterns among snakes. They point out that the foraging modes of snakes differ from that of lizards by being strongly determined by phylogeny: species within the same family tend to forage in a similar way, with relatively few exceptions. The authors consider an impressive range of factors likely to influence snake foraging mode. There is evidence, however, that snake foraging modes conform to the "syndrome hypothesis" by being sufficiently variable. Results from a bioenergtic model suggest that within snakes the dichotomous classes of FM may represent adaptive peaks, with intermediate FMs favored only under certain conditions. In closing, it becomes clear that a suitable definition of FM for snakes is lacking.

In Chapter 12, Aaron Bauer examines a group that appears to be an exception to the SW–WF dichotomy, the Gekkota. The Gekkota contain some 1100+ species representing 106 genera from essentially three families. A large summary table (7 pages) provides details of the genera, number of species and FM. The Gekkota display a mixed foraging strategy, and provides some evidence that WF evolved with the Scleroglossa, and was probably facilitated by the development of chemosensory abilities. Thus, despite starting beginning with similar chemosensory ability as autarchoglossans, the Gekkotans moved along an alternative evolutionary pathway for foraging, having retained visual predation and SW foraging. However, apart from this generality little more can be concluded. Thus, while geckos do not fall neatly into the dichotomous foraging paradigm, Bauer concedes that more data (movement patterns, additional lineages, etc.) are necessary to provide greater confirmation on this placement.

In Chapter 13, Martin Whiting examines plasticity in FM using the lizard *Platysaurus broadleyi* – a member of a clade of SW foragers which shows considerable variation in FM. For instance, juveniles move more in order to hunt insects, while adults move less often making short movements, but switch to active "herbivory" in order to increase the likelihood of encountering figs when available. This provides a clear fitness benefit in situations where a high quality resource becomes available, but which requires a different FM then that which is typically employed. Indeed, whether lizards experience a trade-off between the amount of time spent foraging and courtship/reproducetive behavior, or simply increase energy intake, is unknown-and a question in need of study. In closing, Whiting posses two questions highlighted by the *Platysaurus* system: 1. how widespread is FM plasticity and what is the effect of a spatially and temporally variable high energy resource on FM? and 2. what effect on FM does having traits common to both ambush and active foragers? Clearly, there awaits considerable research potential for such a system!

In Chapter 14, Vanhooydonck et al. provide insight into the relationship between locomotor performance, bite performance and head morphology of lacertid lizards. They investigate how endurance and sprint performance may affect an organisms feeding ecology, and whether there is a trade-off between species that rely on sprint performance to acquire prey versus species that are reliant on increased stamina for prey capture. The results suggest endurance and the proportion of soft bodied prey consumed is co-evolved in lacertid lizards. However, speed was not correlated with evasive prey, but with the proportion of intermediate prey in the diet. In males, body flattening and climbing trade-off due to a reduction in head height, which is likely to be beneficial for maintaining the centre of mass close to the substrate (Aerts et al. 2003), and reduce the possibility of the animal lifting off the substrate. Conversely, there was no trade-off between body flattening and climbing in females, possibly because of differential selection on head shape in males versus females.

In Chapter 15, Roger Anderson examines FM from the perspective of the principal ecological features required by any organism to survive: finding food, avoiding becoming food, avoiding abiotic extremes (e.g., temperature), and reproducing. Anderson examines how food acquisition mode (FAM), as opposed to FM *per se*, varies among lizards, and among habitats. Unfortunately, the message from this chapter is that we still know too little to conclude much regarding the role of FAM on the evolution of lizard FM. Nonetheless, Anderson proposes promising possibilities for future research, such as the use of laboratory microcosms and semi-natural mesocosms for conducting experimental tests of FAM, prey types, competitors and predators.

In the shortest chapter (Chapter 16), Vitousek et al. examine the Galapagos marine iguana, whose short, intense bouts spent foraging on macrophytic marine algae are unique among reptiles, and more reminiscent of a SW foraging style. Using the marine iguana as a model system to test how natural and sexual selection drive morphological and behavioral adaptation, including the physiological and environmental constrains that act as intense selective pressures on this species. We find that in response to the strong selective pressures their energetically costly grazing bouts, marine iguanas have evolved a blunt head, salt glands, and dark coloration allow for maximal energy intake.

In Chapter 17, McBrayer et al. summarize by highlighting the volume of studies to emerge since Huey and Pianka (1981). They point out that while many traits relate to foraging mode, there remain many areas in need of additional research attention. The authors suggest that because FM span both physiological and morphological parameters there is a need for more integrative approaches and thinking; only in this way can both general patterns and variation in lizard foraging biology be understood.

In closing, *Lizard Ecology* brings together a diverse range of information, offering a great starting point for anyone contemplating lizard studies likely to incorporate aspects of food acquisition and foraging behavior. Presumably, this is because it achieves its main goal by determining the influence of FM on the biology of squamate reptiles. Overall, the book contains few errors, a complement to the three editors. While some may lament the lack of color images, the text is well complemented by numerous tables (37), and figures (90). On the downside, however, the book is highly priced (US $142), and may be out of reach for students or people with just a general interest in lizard ecology. Price not withstanding, this work is a worthy acquisition for anyone interested in lizard ecology and behavior. As stated by Kevin Bonine in Chapter 3, the success of books of the *Lizard Ecology* series (Milstead 1967; Huey et al. 1983; Pianka and Vitt 1994), and the recent *Lizards: Windows to the Evolution of Diversity* (Pianka and Vitt 2003) highlight the appeal of lizard biology to scientists and a wider audience alike.

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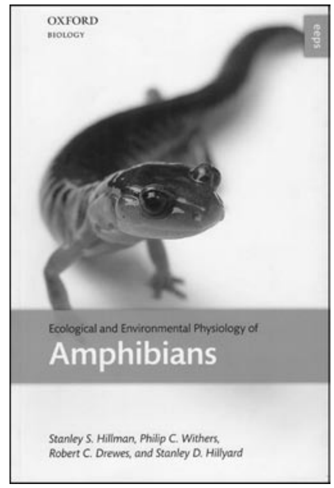
Herpetological Review, 2009, 40(3), 374–376.

Ecological and Environmental Physiology of Amphibians, by Stanley S. Hilman, Philip C. Withers, Robert C. Drewes, and Stanley D. Hilyard. 2009. Oxford University Press (www.oup.com). xii + 469 pp. Softcover. US $65.00. ISBN 978–0–19–857032–5.

DAVID C. BLACKBURN
Natural History Museum and Biodiversity Research Center
University of Kansas, Lawrence, Kansas, 66045, USA
e-mail: david.c.blackburn@gmail.com



The new book *Ecological and Environmental Physiology of Amphibians* provides an up-to-date and relatively concise summary of comparative research on amphibian physiology. This is the first volume in the Ecological and Environmental Physiology Series published by Oxford University Press; similar volumes are in the works for reptiles, fishes, birds, insects, and crustaceans (http://www.eeps-oxford.com). One may wonder whether this review is necessary following the relatively recent synthesis edited by Feder and Burrgren (1992). However, this new book fills a different niche and is more appropriate for those looking for a concise review, especially students. This multi-authored book provides a relatively well-integrated and cohesive view of the topic that should prove accessible to researchers, graduate students, and those teaching courses in physiology or amphibian biology. While Hillman and co-authors touch on many aspects of amphibian physiology, the book places a particular emphasis on water balance, an obviously important topic for amphibians and a dominant area of expertise of the authors. This book will serve as a useful and up-to-date addition to the much larger volume by Feder and Burggren (1992).

Most importantly, this book will serve as an entry point for students and researchers interested in integrating a physiological component into their comparative and phylogenetic studies. While not as all encompassing as Feder and Burggren (1992), Hillman et al. succeed in producing a work is perhaps a more engaging introduction to amphibian physiology. This book provides references to and short summaries of relevant literature published since 1992, especially for some topics such as metabolic depression. It also provides interesting gems for young physiologists and comparative biologists interested in unusual features of amphibians, such as the sections dealing with cutaneous water exchange (including "waterproof" frogs in *Chiromantis* or *Phyllomedusa*), the physiology of the "pelvic" or "seat" patch, cocoon formation, dehydration tolerance, and hypoxia.

The book is organized into six chapters: an introduction with a discussion of diversity, phylogeny, and basic physiological challenges faced by amphibians; two chapters summarizing both basic and specialized aspects of amphibian physiology; a chapter on the