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Book Reviews

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BOOK REVIEWS

Copeia 103, No. 3, 2015, 715–720

Reproductive Biology and Phylogeny of Lizards and Tuatara. J. L. Rheubert, D. S. Siegel, and S. E. Trauth (Eds.). 2014. CRC Press. ISBN 9781466579866. 760 p. \$143.96 (hardcover).—According to the authors, this book was intended to summarize the current knowledge of phylogeny and reproduction of the Lepidosauria. I believe the authors have achieved their goal. Many of the chapters in this book are derived from presentations that took place at the Symposium on Reproductive Biology of Lizards at the Joint Meeting of Ichthyologists and Herpetologists held in Chattanooga, Tennessee in 2014. Although the majority of the authors are from the United States, the book includes authors from nine countries representing four continents and New Zealand.

In the first chapter, Laurie Vitt states (p. 1), “It is difficult to imagine anything more interesting to biologists... than understanding the origins of reproductive patterns among lizards.” I agree. Vitt continues with the early history of topics such as seasonality of reproduction and fat storage, parthenogenesis, evolution of viviparity, placentation, and several other topics. For each of these topics, Vitt explains the origin of the field and the major researchers responsible for the insights and hypotheses in each field. His chapter ends with a call for natural history studies.

In chapter two, John Wiens and Shea Lambert discuss the phylogeny of lizard families. They present a compelling argument for combining molecular and morphological data sets in phylogenetic studies. The authors admit that there are still many unresolved issues and more data are needed to fully understand the phylogeny of the lizards.

In chapter three, José Martín and Pilar López define pheromone, discuss chemosensory abilities, and describe the role of pheromones in lizard reproduction. They present a list of studies on lizards and Tuatara, describe the source of chemicals, and the chemical nature of putative pheromones. Martín and López conclude with the evolutionary origin of chemical signaling in lizards and a call for additional work on pheromone communication in lizards.

Robert Cox and Atiel Kahrl discuss sexual selection and sexual dimorphism in lizards in chapter four. They include a list of studies and evaluate the data to determine what factors led to sexual dimorphism. They discuss intra- and intersexual selection. Cox and Kahrl discuss the ultimate cause and proximate mechanisms for sexual dimorphism and conclude with a discussion of the consequence of sexual selection on speciation and species recognition.

In chapter five, James Van Dyke discusses cues for reproduction in squamates. He explains how the brain controls reproduction via the hypothalamic–pituitary–gonadal (HPG) axis. Van Dyke continues with a description of the temporal relationship of gametogenesis and mating season in both male and female squamates. He then discusses how photoperiod, temperature, and moisture may affect the activity of the HPG axis. Also discussed is the role of nutrition and mating on the initiation of reproductive cycles in female squamates.

In chapter seven, William Neaves presents a detailed description of the discovery of parthenogenesis in lizards. Neaves provides a timeline and narrative of this discovery, with numerous quotes from the students and professors involved. His narrative provides insight into the conservative nature of early investigators and their interactions with one another to get the science correct.

Two chapters (8 and 10) describe the reproductive cycles of lizards. Chapter eight by Martha Ramírez-Pinilla, Gloria de Pérez, and Camilo Alvarado-Ramírez describes oogenesis and the ovarian cycle of lizards. They include light and electron micrographs (six in color) of ovary and germ cell anatomy as well as a comprehensive discussion of the physiology of development. They present descriptions of the corpus luteum and its life span, vitellogenesis, follicular atresia, and several other topics. In chapter 10, Fausto Méndez de la Cruz, Norma Manríquez Morán, Edith Arenas Ríos, and Nora Iburgüengoytia discuss male reproductive cycles in lizards. The authors begin with a description of the variation of patterns found in lizards, emphasizing not only the cycles as they relate to season, but also to the female cycle. The authors then discuss long-term sperm storage, which occurs primarily in females. They plot the occurrence of various cycles on a phylogeny to determine ancestral and derived reproductive patterns within *Sceloporus*. Later in the chapter, the authors give a warning about the future survival of lizards. They point out that because of the dependence of spermatogenesis on environmental temperatures, global warming may place lizards in jeopardy. The chapter ends with a plea to investigators to sacrifice only as many individuals as necessary for their field studies.

Three chapters (6, 9, and 11) describe the anatomy of the reproductive tract of lizards. These chapters are well illustrated with both light and electron micrographs, and many of the plates consist of serial sections showing the changes in structures at different levels along the tract. In chapter six, Dustin Siegel, Aurélien Miralles, Justin Rheubert, and David Sever present a straightforward and detailed description of the female reproductive tract. Siegel and his colleagues describe the cloaca and oviducts and include a section on sperm storage. This chapter includes new descriptions of tracts from several lizard species. The chapter has 10 plates, seven in color. In chapter nine, Justin Rheubert, David Sever, Dustin Siegel, and Stanley Trauth describe the male reproductive anatomy of lizards. They provide detailed descriptions of the rete testis, ductuli efferentes, epididymis, ductus deferens, posterior ducts and papillae, the sexual segment of the kidney (SSK), and the cloaca. In this chapter the authors map traits of the rete tubules and SSK onto morphological and molecular phylogenies to show the evolution of these reproductive traits. This chapter has 26 plates, eight in color. In chapter 11, Kevin Gribbins and Justin Rheubert discuss the structure of the testis, spermatogenesis, and the mature spermatozoa in lizards. They include descriptions of Sertoli cells, interstitial tissue, Leydig cells, the germ cell cycle, and spermiogenesis. They conclude with a section on sperm evolution. The chapter has 46 figures, nine in color.

In Chapter 12, Tobias Uller and Geoffrey While discuss reproductive investment in lizards. They start with a discussion of diversity in reproductive investment among species and consider this in terms of life-history theory. The authors continue with a discussion on how climate affects reproductive investment, how to determine the cause of the differences in reproductive investment, and how to determine the source of genetic variation. They conclude that the emerging field of genomics will provide opportunities to determine the genetic basis of phenotypic variation in reproductive investment.

Chapter 13, by James Stewart and Daniel Blackburn, is an in-depth examination (116 pages) of viviparity and placentation in lizards. The authors estimate that squamates evolved viviparity 115 times, with most of the unique origins occurring in lizards. They present an extensive list of benefits and costs of viviparity and include descriptions of the types of placentae found in lizards. Finally the authors present six testable hypotheses to explain the evolution of lizard placentotrophy. The chapter has 27 plates, 10 in color.

In Chapter 14, Erik Wapstra and Matts Olsson discuss polyandry and multiple paternity in lizards. As in most chapters in this book, the authors present a thorough history of the studies conducted on lizards. They discuss the need for more studies to determine if polyandry benefits the female in direct fitness gains, indirect genetic fitness, or to reduce male harassment. They conclude that more studies are needed to document the occurrence and variation between individuals, populations, and species.

Chapter 15, by Geoffrey While, Ben Halliwell, and Tobias Uller, is devoted to parental care in lizards. They discuss the provisioning of gametes, nest building/oviposition sites, care of eggs, viviparity, and care of neonates. While and colleagues point out that the paucity of data prevents an evolutionary analysis of the transitions of parental care (excluding viviparity); however, it is clear that parental care evolved multiple times within lizards.

The Tuatara (*Sphenodon punctatus*) is the focus of the final two chapters. In Chapter 16, Alison Cree describes reproduction in Tuatara and compares their anatomy and seasonal reproductive cycles to lizards. The anatomy and reproductive cycle of Tuatara are similar to lizards in many respects, but differ dramatically from most lizards in the length of vitellogenesis. In Tuatara, vitellogenesis may take several years. Cree notes that several species of lizards in the Southern Hemisphere have extended vitellogenic cycles. She suggests that prolonged vitellogenesis might be an adaptation of Southern Hemisphere semi-nocturnal lepidosaurs to temperate or cool-temperate climates. In the final chapter (17), Barrie Jamieson (editor of the *Reproductive Biology and Phylogeny* series) describes the ultrastructure of spermatogenesis and spermatozoa in Tuatara. In this chapter he describes how previous work by Jamieson and coworkers, using sperm morphology as a phylogenetic character, concluded that Tuatara (Sphenodontia), a primitive amniote, is more closely related to turtles than to squamates. In the present chapter, Jamieson reiterates the primitive nature of Tuatara sperm, and then presents a possible scenario of how specific changes to Tuatara sperm morphology could explain the autapomorphic traits of squamate sperm.

In the preface to the book, the authors state that the last major symposium on reptiles that included lizards was in 1981 and they thought it was time for an updated review. The book's editors included a photo of the participants of that symposium. Every chapter in the current book includes references to one, and in most cases many, of the 1981 symposium participants. Two of the contributors to the

1981 symposium, Stan Trauth and Laurie Vitt, are also authors of the current book.

In summary, every chapter in this book was well researched and well written and the index made finding topics and species easy. The authors, reviewers, book editors, series editor, and editors at CRC Press did a stellar job on this book. I believe this book will serve as the starting place for beginning researchers and serve as a reference for accomplished researchers interested in lizard phylogeny and reproductive biology.

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Tuatara. Biology and Conservation of a Venerable Survivor.

A. Cree. 2014. Canterbury University Press. ISBN 9781927145449. 583 p. \$89.99 (hardcover).—If ever there was a species of reptile deserving of a whole book, it is the Tuatara. The Tuatara is a remarkable species with a fascinating story. It is important historically because of its evolutionary history and phylogenetic position, as well as the scientific history of its discovery as the sole extant rhynchocephalian. It is culturally important, has been the subject of an enormous amount of scientific study, and represents one of the most remarkable conservation success stories in herpetology.

Alison Cree has done a remarkable job assembling all of the strands of the story of the Tuatara into a thoroughly researched, data-informed treatise. She outlines facts and myths about Tuatara, and debunks some entrenched attitudes about them, not least of which is the idea that the Tuatara is a maladapted "living fossil" that was lucky to hang on tenuously in New Zealand. Instead, she thoroughly and methodically makes the case for the Tuatara being well adapted to its environment, or at least the environment with which it evolved prior to human occupation of New Zealand. Another very strong and important message that comes through in the book is the dangers of extrapolating aspects of the biology of one population to another, especially between southern and northern populations, or rat-free versus rat-occupied islands in the case of Tuatara.

Alison Cree is an Associate Professor at the University of Otago in New Zealand, and has been in the enviable position of working on Tuatara for most of her career. Her expertise lies predominantly in reproductive biology, but she and her students and colleagues have studied aspects of the ecology, behavior, physiology, and conservation of Tuatara since her first visit to Stephens Island in 1985. Hence, she is uniquely placed to write this book, which stands out among its contemporary volumes in the herpetological literature. The book is well written, free of typographical errors, and comprehensively illustrated.

The comprehensive nature of the book is illustrated by its 583 pages and a quick look at the extensive Acknowledgements section. The text is very accessible, although some of it reads like a textbook (which was one of the aims) and therefore inevitably contains very basic information that a professional biologist will know, but it is all easy to read. The book has 11 chapters, divided into three sections. The first section outlines the evolutionary history of Tuatara, how the geology of New Zealand has influenced the evolution of Tuatara, the impact of the arrival of the Polynesians to New Zealand, Tuatara in Māori culture, and the first 200 years of

discovery and scientific study of Tuatara after European settlement. The second section outlines the current status of Tuatara on different islands, and detailed summaries of important aspects of its biology: ecology, reproduction, physiology, behavior, and more. The last section is about the remarkable story of how a species, once in rapid decline, was brought back from near the brink of extinction to be secure and expanding in numbers and distribution. Each of these sections could have been a separate book by itself, but putting them together represents a tome that is greater than the sum of its individual parts.

Alison Cree sets out to achieve three aims, (1) to provide a comprehensive resource for students and professional herpetologists, (2) to overturn the concept of *Sphenodon* as a “living fossil,” and (3) to explore the story of New Zealand—its geological origins, settlement by people, development of a community of scientists, and growing awareness of the fragility of its biota. There is no doubt that she has achieved all three aims. After reading this book, herpetologists who have thought about working with Tuatara will understand why they are so highly protected, and why New Zealanders are so protective of “their” Tuatara.

Here I comment on some of the chapters. My comments are not exhaustive, but designed to give a sense of the flavor of the book. Chapter 1 is about the evolution of Tuatara, and collates information that has never before been brought together so comprehensively, including some very recent discoveries. The chapter has a box that discusses the use of the term Rhynchocephalia versus Sphenodontia or Sphenodontida, names that have been proposed to differentiate *Sphenodon* and its close relatives from rhynchosaurs. The book settles on the use of the name Rhynchocephalia as the order to which *Sphenodon* belongs, based on historical precedent and a redefinition of the Rhynchocephalia (Gauthier et al., 1988), and will probably set the benchmark for the future, pending further scientific evidence to the contrary.

Chapter 4 on Tuatara in Māori culture does an excellent job at integrating Māori words and defining them. The chapter could otherwise have been almost impenetrable to a non-New Zealander. Interestingly, we learn that Māori tradition does not necessarily distinguish tuatara and lizards, making the job of interpreting some older accounts difficult. A minor criticism of this chapter is that there are probably too many descriptions of carvings, although the carvings themselves are very interesting and their photos have been used to good effect.

Chapter 5 is a comprehensive historical account of discovery of the biology of *Sphenodon* up to about 1980. First described as an agamid lizard (Gray, 1831), its recognition as something deserving of its own reptilian order by Albert Günther in 1867 led to a massive increase in interest in the species and massive (over-) collecting for European scientific institutions. Although the huge interest in eggs and embryos of Tuatara in the late 1800s is well described, I was surprised that there was no mention that the interest in embryos stemmed directly from Haeckel's hypothesis that ontogeny recapitulates phylogeny (see Gould, 1977).

Chapter 6 leads off the second section of the book: Biology of Tuatara Today. It gives island-by-island accounts of the presence, conservation status, and efforts to restore Tuatara on all islands on which it occurs. It is unlikely that many people will want to read the entire chapter, but the information it contains will be of great interest and prove very useful to anyone with an interest in any particular island or island group. Interestingly to me, there is no

mention of the presence of the military on Stephens Island during World War II given the high potential of the unintended introduction of rats, which remarkably did not happen. This chapter contains my favorite line in the book, “Stephens Island is unquestionably a global gem for its exceptional abundance of tuatara” (p. 252), which is a significant understatement as anyone who has been fortunate enough to go there will attest.

Chapters 8–10 give excellent summaries about what is known for various aspects of the biology of Tuatara and provide suggestions for future research projects. I imagine that these suggestions will provide fertile ideas for a generation of New Zealand research students.

There are relatively few problems with this book, although some photos could have been enhanced (e.g., Figures 1.6 and 1.7 could have been lightened). The color coding on the figure in Box 1.4 is not explained and the Woomera Pine referred to in Box 2.3 should be the Wollemi Pine. There is a bladder in the diagram of the female reproductive tract (Fig. 8.10), but this structure is not illustrated for the male (Fig. 8.2). Such issues are rare; on the whole, the presentation is excellent.

The final section, Future Survival, contains just two chapters that describe what must be one of the most comprehensive, remarkable, and successful conservation programs ever undertaken for a species of reptile. Not only has the decline and imminent demise of populations on many islands been reversed, islands from which Tuatara had been extirpated have been restored and Tuatara have been reintroduced; attempts are now underway to establish even mainland populations. All of this has been achieved in the context of cultural sensitivities and indigenous engagement.

In summary, Alison Cree's *Tuatara* is a complete collation of the history, life, and conservation of an iconic reptile that is supported by a comprehensive literature base, a terrific cover photo, and numerous, high-quality illustrations and photos.

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Beach-Spawning Fishes: Reproduction in an Endangered Ecosystem. Karen L. M. Martin. 2014. CRC Press. ISBN 978-1482207972. 223 p. \$79.96 (hardcover).—You may have already heard of the grunion run in California: a fish spawning event occurring during the summer months when the California grunion (*Leuresthes tenuis*) come to shore in droves. The full and new moons, in conjunction with a recent high tide, drive the grunion ashore to lay and fertilize their eggs on the sandy beaches. This all-natural reproductive showcase can be witnessed by hundreds of

interested human observers and is a perfect opportunity for education and outreach. Aside from the charismatic grunion on the California coast, can you name any other species of fish that engage in beach-spawning behavior? Before reading this eye-opening book by Dr. K. L. M. Martin, I personally could not list a single additional species; however, Martin explores this surprisingly prevalent and intriguing behavior found in many teleost families.

Dr. K. L. M. Martin is an excellent resource for information regarding beach spawners. She has over 20 years of research experience on intertidal fishes including two co-authored books related to the subject (Sumida and Martin, 1996; Horn et al., 1999), with *Beach-Spawning Fishes* being her first book as sole author. In addition to researching and writing on intertidal spawners, Martin is the Executive Director of the citizen science program Grunion Greeters and Executive Producer of the half-hour documentary, "Surf, Sand, and Silversides: The California Grunion." With Martin's extensive experience with the California Grunion, one might expect this book to skew in favor of this particular species; however, Martin demonstrates that although the California Grunion's behavior is unusual, it certainly isn't the only species finding an evolutionary benefit in being, at least temporarily, a fish out of water.

Beach-Spawning Fishes covers the wide range of questions one might immediately ask: Is this behavior convergent or limited to a certain family? Which taxa behave like this? What are the habitat requirements? These questions and more are readily answered in the first two chapters of the book. Spawning in the intertidal zone is not limited to the night-time activities of the California Grunion, but to multiple families of teleost fishes. From a general background on overall behavior and evolution of this unique life-history trend, the book then moves from overall patterns of diversification to specific cases of beach-spawning behavior.

Chapters 3 and 4 cover the adult players: the locals, or fish already living near the shore vs. the vacationers, fish coming to shore exclusively to spawn. Whether a local or a vacationer, these fish show different spawning strategies to ensure eggs are fertilized and in suitable habitat before the tides run out. Just as beach-spawning behavior is diverse across multiple fish families, the reproductive behaviors are highly varied as well as the preferred habitats. In this book, we see beach spawners make use of multiple reproductive strategies with an added twist of doing this all in low or receding waters. Like some freshwater sunfish (*Lepomis*), there are examples of sneaker males in many intertidal species, as well as internal fertilizers with diagnostic intromittent organs similar to those in Poeciliidae (live-bearers, including guppies and mosquitofish). Parental involvement can range from non-existent to bi-parental nest guarding behavior. Although much is known about the reproductive behaviors of many beach-spawners, Martin also makes it clear that much work is still needed to understand the diverse reproductive strategies implemented by these fascinating fishes.

Sex on the beach, for fish at least, requires novel physiological adaptations. Not all fish come completely out of the water like the Capelin (*Mallotus villosus*), but even fish in shallow water must be able to tolerate hypoxia when the spawning grounds are packed. In order to mate in the intertidal zone, adults must be able to handle the unusual environment. Chapter 5 focuses on the multitude of respiration strategies implemented in fish physiology and reviews methods developed to understand metabolism and respiration. From gills to gas bladders, the physiology of beach-spawning fishes is explored.

Being out of the water is a physiological struggle, but that isn't the only challenge faced by beach-spawning fishes and their offspring. Chapter 6 addresses the pressure that predation from the ocean as well as the beach puts on adults and juveniles alike. Congregations of fish in shallow waters attract hungry whales, seals, fish, and birds, which are all ready for an easy meal. The chances of snagging a tasty meal increase for predators like birds, raccoons, coyotes, and humans as fish make their way onto beaches to spawn. Predation pressures are not limited to the adults, but also extend to the eggs and embryos, which must survive while immobile and often out of water where they are susceptible to the hunger of myriad predators.

The focus switches from active spawners of previous chapters to the embryos and fry in Chapters 7 and 8, which must survive in inhospitable habitats. The placement of eggs in the intertidal zone is important to embryonic survival, and multiple species and their particular strategies are discussed. Of course, the goal of spawning is to ultimately create the next generation of beach spawners, but the transition from exposed egg to larval fish is complex. In order to most effectively hatch at the prime time, most embryos rely on environmental cues to signal an optimal time for hatching. These cues can be mechanical (agitation in seawater) or chemical (hypoxia) and signal to different species when to initiate hatching. In the absence of these cues, embryos must be able to delay hatching until the time is right, and examples of embryonic delay are thoroughly discussed.

The final chapters take the amazing behaviors of these fish and the environments on which they spawn and grow, and consider the threats to these beach spawners as well as conservation efforts to protect them. The worldwide distribution of beach conservationists follows the worldwide distribution of beach-spawning fish. From the Grunion Greeters in California to the Whitebaiters in New Zealand, many locals take pride in protecting and conserving the beach-spawning fishes and their habitats. Researchers, local fishers, and others work in coordination towards conservation of the fish and their habitat.

Running the gamut from evolution, physiology, life history, and conservation, *Beach-Spawning Fishes* is an excellent resource for your bookshelf. Just as the many chapters of this book cover diverse questions with regard to beach spawners, the ways in which this resource can be used are diverse as well. *Beach-Spawning Fishes* has many possible uses for education at the undergraduate, graduate, or professional level. This book is an excellent resource for a professor wanting to bring a textbook-based, in-depth focus on unique spawning strategies in fishes, and it could certainly stand alone as a textbook for a special topics course on marine fish behavior. *Beach-Spawning Fishes* would be a useful supplement to a reproduction chapter in an ichthyology class or a jumping off point for discussions on diversity and convergent evolution. Anatomy and physiology courses could benefit from the real-life examples of physiological processes discussed. Other portions of this book could be summarized for ecology courses as examples of food webs, ecosystem functionality, or embryonic development. As an extra bonus, this book comes in hardcover, and is also available as an ebook, further lending it to class-based use.

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Handbook of Larval Amphibians of the United States and Canada. R. Altig and R. W. McDiarmid. 2015. Cornell University Press. ISBN 9780801439438. 368 p. \$75.00 (hardcover).—This handbook of larval amphibians of the USA and Canada is a welcome addition to the global diversity and biology of larval amphibians, which remain poorly known compared to adult forms. The authors have dedicated their professional lives to understanding and documenting various aspects of larval amphibian diversity (Altig, 1970; Altig and Ireland, 1984; Altig and Johnston, 1989; Altig et al., 1998; Altig and McDiarmid, 1999, 2007). This volume provides a summary and key for eggs and larvae of 98 species of salamanders and 102 species of frogs. Anyone reading this book will be impressed by the authors' grasp and knowledge of amphibian larval diversity.

The book consists of five chapters. A short introductory section provides a list of previous keys to amphibians of North America, noting the lack of information on eggs, and describing the overall scope of the book. The next two chapters are introductions to the amphibian fauna of North America. Within the Amphibian Life Cycle chapter, the sections covering keys to eggs, embryos, and genera (pp. 11–57) are detailed and summarize extensive information accumulated mostly over the last century. These sections are organized by geographic region. This is the most effective, and most likely the only, way to key eggs and early embryo stages. The sections build and expand on the authors' previous work (Altig and McDiarmid, 2007). These keys are significant contributions to herpetology and conservation biology; they will assist with field identifications as well as help researchers pursuing studies on diverse areas of developmental, comparative, and evolutionary biology.

The last two chapters are the bulk of the handbook and focus on Caudata and Anura, respectively. Each of the chapters starts with an introduction to the group that describes general morphology, standard measurements, characters, and terminology used in the keys. The glossary at the end of the book focuses on terms specifically used to describe the morphology and biology of amphibian larvae, but also provides definitions for some of the taxonomic groupings used in the book. Although most of the terminology can be found in their previous work (Altig and McDiarmid, 1999, 2007), the introductions facilitate reading this book. The overall introductions coupled with the glossary and the indexes of common and scientific names will facilitate the use of the keys, particularly to individuals outside or new to herpetology. The keys are to the species level and include native and introduced species. There are two sets of color plates, each plate includes photos of larvae of 12 species (Plates 1–6 for salamander larvae, Plates 7–12 for anuran larvae). These plates provide a quick and good representation of color and overall body, tail, and fin shape and proportions. The legends for the plates provide basic information: species name, total length, locality data, and for larval anurans, Gosner's (1960) developmental stage. In addition, throughout

the book there are numerous line and gray-scale illustrations. These vary in quality and specialists will notice the somewhat uneven amount of information retrievable from them. The line illustrations are usually more informative (e.g., compare the oral disc of *Hyla cinerea*, Figure 79E with that of *H. squirella*, Figure 82D, or the larva of *H. andersoni*, Figure 76B, and *H. arenicolor*, Figure 77C). The large majority of the gray-scale images provide a fair amount of detail; some are very good (e.g., *Ambystoma bishopi*, Figure 9A; *H. gratiosa*, Figure 81D), but a few provide little information (e.g., *Eurycea rathbuni*, Figure 34A; *Anaxyrus canorus*, Figure 64B).

The keys are followed by taxonomic accounts that begin with a general characterization of larvae by family, including number of genera and species found in the USA and Canada. This is followed by the identification of larvae by species, or by "morphotypes" in cases where larvae are similar (e.g., *Anaxyrus americanus* and *A. houstonensis*, p. 73); still, the authors made an effort to include other potential differences (e.g., color) among species. The account of *Lithobates heckscheri* (p. 230) describes the larval body color as overall dark brown or gray to black depending on age. But the specimen in Plate 11D has an overall greenish-brown body color; perhaps the specimen was chosen to illustrate the distinctly red eye that characterizes advanced stages and larger tadpoles as described in the species account. Early on in the book (p. 3), the authors are careful to emphasize that larval coloration varies ontogenetically and with environmental conditions, making identification from single images problematic.

Each of the species accounts also includes information on natural history and species range. As expected for a larval biology volume, most of the natural history focuses on different aspects of reproductive biology (e.g., months and site of oviposition, clutch size, eggs, egg-mass characteristics, etc.). The duration of metamorphosis and time to reach sexual maturity is also provided, where known. The citations in the accounts are organized into four categories: general, development/morphology, reproductive biology, and ecobehavior. Although not comprehensive, with variable coverage of the information available for the species, they include key references for each taxon.

This book will appeal to a wide audience of specialists and non-specialists; anyone interested or curious to know more about the diversity of larval amphibians will find the book useful and accessible. Although it is not intended as a field guide, definitely it will be a very useful companion for field studies. Herpetologists with a solid understanding of taxonomy and species identification will benefit from the keys to eggs and larvae provided in this volume. It can also serve as a reference for distributions of amphibian of North America (north of Mexico). Given the current decline of amphibian populations, identification of eggs and larvae will assist ecologists and conservation biologists in their assessment of the status of amphibian assemblages as an alternative to recording the mostly nocturnal adult forms. Undoubtedly, this volume would be an extremely valuable guide and tool for generations of undergraduate and graduate students interested in pursuing studies in herpetology, ecology, and behavior as well as developmental and conservation biology.

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Sharks: The Animal Answer Guide. Gene Helfman and George Burgess. 2014. Johns Hopkins University Press. ISBN 9781421413099. 249 p. \$26.95 (soft cover).—This book follows the same format and comfortable reading style as the other *Animal Answer Guide* books produced by Johns Hopkins Press (e.g., frogs: Dorcas and Gibbons, 2011; fishes: Helfman and Collette, 2011) but focuses on one of the most charismatic group of fishes of interest to the general public. As shark books go, and there are hundreds of them out there now, this book provides a nice balance of facts, details, and examples for many of the typical shark questions expected from any interested layperson. The authors have no doubt pulled from their vast years of experience and knowledge on a variety of topics ranging from systematics, biology, behavior, ecology, conservation, and shark-human interactions, giving the text considerable breadth. The book is organized around 12 chapters with 10 to 15 questions per chapter topic, and includes some handy glossaries and tables, line drawings, and a mix of halftone and color photographs. Unfortunately, a lot of the halftone photographs and illustrations are not very clear in the paperback version of the book. While there are no research citations in the text to direct readers to original science sources, there is a bibliography at the end that lists about 50 books and review papers, but they are all pretty outdated. This book is clearly written for a more knowledgeable lay audience, as it contains a fair bit of technical terminology, but the authors do a good job of defining terms where appropriate. Overall, this book provides a nice casual read that will certainly be enjoyed by elasmobranch enthusiasts, and offers a plethora of science-based information readily digestible for the general public.

The first chapter introduces chondrichthyan fishes, describing the higher taxonomic groups (sharks, skate, rays, and chimaera) and their unique characters. This chapter addresses questions about diversity, evolution, size ranges, and dedicates a generous amount of text on fossil shark teeth—a popular topic among shark enthusiasts. This first chapter is clearly written in way that prepares the reader for the all chapters that follow. Chapter 2 focuses on questions related to form and function of sharks, addressing questions about metabolism, endothermy, dentition, sensory systems, swimming, and respiration. Obviously, there is a tremendous amount of information that could be poured into this chapter, but the authors keep the answers brief and informative. Chapter 3 covers questions about shark coloration, distinctive markings, and physiological color change, which provides a logical transition to chapter 4 where there are answers to typical questions about shark behavior, including topics such as social behavior, communication, territoriality, intelligence, and learning. The chapter on shark ecology (chapter 5) covers a wide, eclectic range of questions including movements, predation, immune function, parasites, and ecosystem roles. This is again, another challenging topic to cover within a single chapter, but there are lots of examples across a wide range of taxa. Unfortunately, there is not much information provided as to how scientists attempt to answer these questions within these chapters; however, there is a chapter at the end of the book where this is casually and broadly addressed. Chapter 6 focuses on questions related to reproduction, development, age, and growth, including lots of examples across a variety of species. In chapter 7, questions about what sharks eat, how they find food, how different species capture their prey, and how often they might eat are addressed using some great examples. Because there are lots of opportunities for these topics to bleed into other chapters, there are good links to questions in other chapters. Chapters 8–12 transition to topics and questions related to human-shark interactions, including shark and humans, shark problems, human problems, sharks in stories, media, and literature, and sharkology. These chapters certainly address many of the mainstream, public interest topics and questions that arise among non-biologists. There are many interesting anecdotes and stories in these chapters. This book will certainly appeal to an educated lay audience.

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