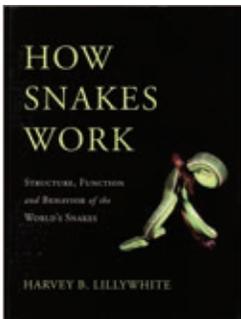


BOOK REVIEWS

Herpetological Review, 2014, 45(2), 365–368.
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How Snakes Work: Structure, Function, and Behavior of the World's Snakes

Harvey B. Lillywhite. 2014. Oxford University Press, New York (<http://global.oup.com>). Hardcover. xiii + 241 pp. US \$49.95. ISBN 978-0-19538037-8.



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Randomly flipping open Harvey Lillywhite's new book is likely to land you on one or more fascinating photos or figures. If you are like me, that will begin an exploration of a topic that will have you flipping back and forth through this book to see

what Harvey has to say about skin color, or egg form and size, or predator-prey interactions, or any one of innumerable questions that snake enthusiasts think about. As a physiologist with a broad spectrum of interests focused on snakes, Harvey has done serious scientific work on an amazing variety of questions. To communicate his interests and findings to the general public, he has devoted a lot of energy to finding excellent photos or drawings that encapsulate concepts or processes and their structural foundations.

Harvey Lillywhite has managed to convert his scientific prose from many publications into readable and entertaining explanations. The book is profusely illustrated in color, mostly with previously unpublished photos and illustrations by the author, his students, and a host of colleagues. Since this is a review for herpetologists, I'll comment on what I regard as the scientific value of the various parts of the book — and on some of its scientific weaknesses. Because Lillywhite's expertise in many aspects of the physiology of snakes is probably unparalleled, my criticisms focus primarily on those parts of the book with which I have experience.

The book has a foreword by Rick Shine, a brief preface explaining Lillywhite's goals in writing the book, acknowledgments, nine chapters, each with its own selected bibliography, a glossary, and a useful index of taxa and terms. Given the number of popular books on snakes, one might ask whether this book provides anything new. The pithy title turns out to be accurate. The only books I'm aware of that come close to this are Parker's (1965) little book (revised by Grandison, 1977) and Bellairs' two volumes on Reptiles (1970). Ernst and Zug's (1996) volume *Snakes in Question* covers some of the same topics and questions but not in the coherent manner of Lillywhite's book.

The book begins with a brief survey of snake diversity and Lillywhite's current view on snake relationships drawn primarily from recent molecular studies. As with all the following chapters, it begins with a quote, this one from Malcolm Smith's (1943) book on Indian snakes noting the importance of natural history in interpreting structure, function, and phylogeny. To emphasize the potential rigors of meeting this demand, among the many photos of henophidian snakes is a large photo of Jesus Rivas and a friend carrying what looks like a 6-m anaconda. It accompanies neat photos of *Anomochilus monticola*, *Anilius scytale*, a vertebra of *Titanoboa*, and others. Abundant photos of other representative species show the diversity of habitats that snakes have successfully occupied and the diversity of head and body shapes and colors that snakes have evolved. It ends with a cladogram drawn largely from recent molecular analyses that provides the framework for discussions in the rest of the volume. Although many readers may not be interested in the evolutionary relationships of major snake clades, the inclusion of the cladogram could have provided an opportunity to comment on the fact that recent morphological (Gauthier et al. 2012—not cited) and molecular analyses (Pyron et al. 2013—cited) of snake phylogeny are raising important questions about how both sets of characters evolve.

The second chapter covers the physiological aspects of nutrient acquisition—feeding, digestion, and water balance. It starts by noting the major constraints acting on snakes, reminding the reader that snakes are basically animated tubes with a head at one end and a tail at the other. The explanations of how different snakes eat include some descriptions of kinetic skulls in henophidian and colubroid snakes and briefly mentions some of the structural foundations of jaw kinesis. Specialized feeding mechanisms, like mandibular raking in leptotyphlopids, and mandibular transport in snail eaters, are also explained, with credit given to Nate Kley and Beth Brainerd for figuring out the remarkable characteristics of the former. The chapter covers almost all aspects of feeding in snakes, including specializations for restraining prey, venoms and venom delivery systems, digestion and digestive adaptations including beautiful micrographs of stomach and intestinal histology from Jacobson (2007), and sequential x-ray images of a barium-injected chick being digested by a rat snake. It ends with the roles of skin, kidneys, and salt glands in maintaining water balance and with the basic mechanisms of drinking.

Locomotion, the subject of the third chapter, begins by noting the relationship among vertebral number, speed of locomotion, and body form. Skeletal and muscular features are described with the aid of photos of vertebrae and ribs and neat dissections of body segments that make clear the extraordinary length of tendons and some of the complexity of muscle arrangements. However, the photos will also make clear to those who actually know some anatomy why photos are poor substitutes

for good drawings. Sea snakes and swimming are treated first along with some of the experimental approaches to testing relationships between the form and function of swimming snakes. This leads into a brief treatment of terrestrial locomotion and the limited studies of how snakes generate the forces necessary for locomotion, apparently done at human generational intervals (about every 30–40 years). The rest of the chapter focuses on the different kinds of locomotory movements that snakes use and how these relate to the environment, and ends with a brief introduction to snakebots, the use of engineering methods to create robots that move like snakes and also make clear some of the basic functional and structural demands operating on snake-like locomotion.

The next chapter deals with temperature and is introduced with a quote from Michael Angilletta's 2009 book and a photo of a *Crotalus durissus* with arrows and labels showing the various routes and types of heat flow to and from the snake. After explaining in very general terms how heat influences metabolism and molecular structure and function, and how snake bodies limit the kinds of behaviors snakes can use for thermoregulation, we learn about the types of physiological studies that have been done to understand thermal relationships of snakes. Lillywhite discusses both field and laboratory studies and rightly notes the limitations of our current data. He also considers the difficulties entailed in measuring some of the factors influencing regional differences in temperature within snake bodies and responses to temperature extremes. Evidence for thermogenesis during egg incubation in pythons and in colubrids exposed to extreme cooling (below 2–4°C) is given along with a review of the many studies on heat and cold tolerance and the effects of temperature on activity.

How snakes exchange things between themselves and their environments is really the fundamental theme of the book but Lillywhite has sensibly not focused on all the quantitative physiological aspects of the issue. After discussing heat exchange, and intimating frequently that the skin plays a role, he gets down to explaining exactly how the skin does this in snakes in Chapter Five. As in the other chapters, the basic structure of the skin is introduced first with excellent micrographs by Jacobson (2007). The chapter goes on to explore the basis of color and patterns and how the potential functions of the skin in mimicry and defense have been experimentally tested. A short section on color acquisition from the environment deals primarily with soil adherence in some species like Cottonmouths (*Agkistrodon piscivorus*). A longer section on the genetics of coloration doesn't actually deal with any genetics but describes various polymorphisms, with three color morphs of *Lampropeltis californiae* shown but only one color morph of *Python brongersmai* shown and none of *P. regius*, the species that appears to be the current craze among snake color morph fanciers for its extraordinary range of colors and patterns.

Given Lillywhite's many publications on vascular function in snakes, I was looking forward to his synthesis of how circulatory and respiratory systems of snakes work. Getting into the chapter involved delving through the basics of circulatory system design and terminology written in a style that seems suitable for elementary school students. The anatomy of the snake heart and how its form allows shunting between pulmonary and systemic outflows is covered with some interesting details and then the chapter progresses to vessel patterns and hemodynamics. Lillywhite discusses at length how the design of the snake body should generate major potential problems in hemodynamics

due to gravity in terrestrial environments, using sea snakes to show how blood pools in the lower part of the body if the snake is held vertically by its head. Holding terrestrial species in this manner rarely results in changes as observable as those in sea snakes, and Lillywhite comments on some aspects of vascular design that permit maintenance of blood flow to the head regardless of body position in climbing snakes. The last half of the chapter introduces lungs with some photos of fresh lungs, including tracheal lungs, and an excellent micrograph of a resting, uninflated lung, again from Jacobson (2007). The basics of gas transport are developed and the functions of both vascular and non-vascular regions of the respiratory tract (saccular lung, tracheal air sacs) discussed. Numbers appear intermittently to make points—blood pressure values and lung faveolar spacing in various species, but how these fit into a form/function argument are not elaborated. Lillywhite fittingly ends the chapter exhorting readers to contemplate all the unanswered questions about how different snakes may have resolved cardiovascular and respiratory demands.

Perceiving the snake's world, the next chapter, leads into an area about which I have long accepted that I know very little. Inasmuch as my perception of most things differs from my wife's, understanding what a snake perceives has always been to me the equivalent of a leap into an abyss. Others do not accept my view, and they have forged ahead on trying to understand sense organs in snakes. Lillywhite summarizes the years of research on snake sense organs with illustrations of the superficial aspects of the organs only. However, he covers what we know of the physiology of those organs and the correlations with behavioral changes. The many experimental tests on infrared sensing, vomerolfaction, hearing, and tactile receptors combine to show that snakes do sense an extraordinary range of environmental stimuli but how these all lead to 'perception' remains, to me, a puzzle. Lillywhite ends the chapter with "...perhaps our perception of the world around us is not really that different from that of a snake. Think about this." I have, and I have reached a different conclusion.

Anyone who has kept Puff Adders or rattlesnakes knows that some snakes are noisy. Lillywhite must have puzzled over this like many of us. Sound production in snakes amazingly gets a whole chapter devoted to the careful scientific studies by relatively few people, most notably Bruce Young and his teams of students. I can understand Lillywhite's dilemma in conveying the scientific problems involved in rattles, hisses, growlings, and poppings without the physics of acoustics. He manages to cover both the range of sounds made by snakes and the various structures that produce the sounds, but unlike all the other chapters, this one doesn't benefit much from its figures. Reference to some of the excellent photos two chapters previously help to explain the respiratory associated sound-producing structures. However, the photo of an *Echis* doesn't show the scales responsible for sound production clearly and a later photo of the skin of a sea snake is presented without any reference to sound. I was unable to figure out where the circumferential ridges are on the photo of the Gaboon Viper external naris.

The last chapter of the book deals with courtship and reproduction. The "essentials" of reproduction follow a short section on the mythology of snakes and their relationship to various human cultures. After commenting briefly on generations of individuals (here referred to as G_1 and G_2 -instead of the more familiar F_1 and F_2 generations) and the transmission of genetic information as DNA, there is a similarly brief explanation of how

to tell male from female snakes by probing. The description suggests that the probe actually enters a pocket housing the hemipenis, rather than entering the inverted hemipenis itself. Tail is somewhat confusingly misspelled as 'tale' several times in this section. The claim is made that the erected hemipenis is inserted into the cloaca or vagina. I have always assumed, having admittedly watched relatively few mating events, that the hemipenis everted into the cloaca while the vents of the mating pair were pressed together, and I've always wondered how the male regulates which side is everted. Gonads are introduced, and a real puzzle, how sperm get from the ductus deferens (not mentioned) to the sulcus spermaticus of the hemipenis, is not mentioned, possibly because no one has figured it out. Oviparity and viviparity are compared from physiological and environmental perspectives. Egg laying and the attendance and incubation of eggs are reviewed as is the limited available evidence on parental care of neonates. Growth patterns, sexual maturation, and survivorship are all considered although the difficulties of measuring energy flow in natural populations, and the efforts to do it, are not included.

The book is not without its problems and errors. Some of these should have been averted by competent editing prior to publication. Others are clearly the author's responsibility. In a figure showing three frames of a striking *Corallus hortulanus* recorded by Phil Nicodemo, propulsive and reaction forces, and their explanations in the legend, seem reversed and the legend ends with "the head moves forward to bite forcefully and immobilize the prey." After recording over 2000 strikes from about 50 species of boas and pythons, Fran Irish and I can attest that mammals bitten by snakes, even long-toothed *Corallus* or *Morelia*, are rarely if ever immobilized by the bite. Immobilization is the result of death by constriction. One egregious error involves a finding attributed to me. In the feeding chapter, I am cited as saying that "up to 47% of rattlesnake strikes result in neither fang penetrating the prey." What I actually wrote (2002) was "Among the strikes recorded by me, 19/88 (22%) were flawed in some respect and 9/19 (47%) resulted in no fang penetration at all." In other words, almost half the flawed strikes but only 10% of all strikes result in no fang penetration. In a later paper (2009—not cited) based on about 10 times as many strikes, I provided a better estimate of how frequently vipers reposition one or both fangs during a predatory strike, estimates supported by data previously published by Young et al. (2001) for a single species of rattlesnake.

As an anatomist, I was disappointed to see a surprising number of errors in presenting aspects of snake anatomy. In Fig. 2.2, carotid is misspelled (cartotid). Drawings of a lizard and a snake skull (Fig. 2.4) will astound anyone with a basic knowledge of skeletal anatomy in vertebrates. The ostensible reason for the drawing was to show lizard and snake modifications of the diapsid condition, but sutures are randomly included and show bone arrangements unknown in any lizard or snake (Evans 2008; Cundall and Irish 2008). Figure 2.7 supposedly shows a sequence of jaw movements in a king snake (*Lampropeltis californiae*) swallowing a mouse, but the jaws cannot be seen, and the caption ends by noting that "the mouse is positioned within a loose coil of the snake, thereby 'anchoring' the prey so that it does not shift away from the snake during advances of the jaws." ...a statement that seems to ignore the fundamental ratchet properties of the pterygoid walk. Figure 2.21, a drawing of tooth implantation in snakes, shows aspects of a lizard pleurodont condition but with no alveolar socket, a much higher labial pleura than

is found in most alethinophidian snakes, and ligaments rather than bone of attachment connecting the base of the tooth to the tooth bearing element (Zaher and Rieppel 1999). As noted by Savitzky (1981), only a few hinged-toothed snakes retain ligamentous tooth attachment. Figure 2.27, another drawing, this one copied from Kardong (2006, also 2009), converted what was originally the quadratomaxillary ligament into what appears to be a new bone in front of the quadrate and lying over the venom gland compressor. The intestine is described as having villi (p. 65) despite the fact that Parsons and Cameron (1977) and Luppia (1977) both reviewed snake intestinal anatomy and showed that the small intestines of most snakes lack villi. Even more surprisingly, nutrient absorption from the gut is claimed to take place primarily in the large intestine (p. 65).

Other minor errors abound. The snake heart is claimed to have a "valved interaortic foramen" (p. 143), a structure I cannot find described anywhere, although crocodylians do have a foramen between the left and right systemic arteries, the foramen of Panizza. Perhaps interaortic foramen refers to the space between the ventricular septum and the entries to the systemic and pulmonary arteries? The chapter cites Wallach's (1999) chapter on snake lungs but includes no citations or mention of other chapters in the same volume that review the structure and function of the heart in snakes. The chapter on reproduction contains a figure (9.10) copied from Blackburn and Stewart (2011; not Stewart and Brasch 2003, as stated in the caption) showing placental types in snakes—but done without color so that the vascular nature of the extraembryonic yolk sac and allantois are not clear or labeled. Worse, none of the extraembryonic membranes are shown as having any connection to the embryo—an unfortunate feature of the original drawing and one that makes it unclear as to how anything could be transported between these membranes and the embryo.

The focus of the book is on how things work, not how they are built. Lillywhite has done an excellent job of showing where we are in understanding how things work. However, forging ahead on most of the "how they work" questions is likely to require a much better understanding of how they are built. Lillywhite tacitly acknowledges this by explaining relevant structures in every chapter. In almost all cases, the anatomy could have been developed more carefully and with better illustrations.

The book's cover says "written for both professionals and a more general audience," but trying to satisfy both groups is a serious challenge. Much of the writing is clearly intended for a "general" audience. Not being a publisher, I do not know how a general audience is defined, but I assume it is people not trained in science beyond the high school level. Some parts of the book actually seem to be targeting an audience with no science education at all, but the treatment of snake examples suggests it is intended for the amateur herper. I'm not sure, however, that the amateur herpers of today are like those at the time when Harvey Lillywhite and I were both amateur herpers ourselves. Having spent years going to the local Hamburg, Pennsylvania, "herp expo," I have watched a change in the nature of both the types of people attending and the nature of items for sale. What are no longer for sale are books, a change that has occurred just in the last few years. Unlike the bibliophilic amateur herpers of old, the current crowd is apparently not a book-buying population.

In summary, I like the book despite its shortcomings. What Lillywhite has given us is a summary of his life's work and interests. I think he has succeeded in showing both what he and colleagues have discovered and why snakes deserve a lot more

research—including research on the foundations of function, namely, anatomy. He ends the book with a plea to readers to encourage others to appreciate snakes ... and the rest of the natural world. One can only hope that the book will be an unbridled commercial success—both to support his plea, and possibly to justify a second edition with a little more polish.

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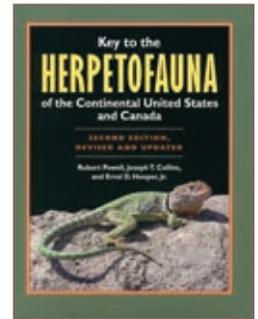
Herpetological Review, 2014, 45(2), 368–370.
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Key to the Herpetofauna of the Continental United States and Canada, Second Edition, Revised and Updated

Robert Powell, Joseph T. Collins, and Errol D. Hooper, Jr. 2012.
University Press of Kansas (www.kansaspress.ku.edu). viii + 152 pp.
Softcover. US \$19.95. ISBN 978-0-7006-1833-0.

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When presented with a lizard or frog that eludes immediate identification, the first reference for many, interested amateur and professional herpetologist alike, is a field guide. For North American taxa, that usually means referring to the Peterson Field Guides, either Conant and Collins (1998) or Stebbins (2003). However, as field guides are specifically geared toward identification of living individuals and tend to emphasize color pattern, specific identification of preserved specimens often proves impossible, and even live animals can be troublesome to identify when “off-color” due to physiological changes, an approaching skin shed, or other factors. In these cases, identification keys prove their worth. Since 1998 the standard general key to the herpetofauna of North America has been Robert Powell, Joseph Collins, and Errol Hooper’s First Edition *Key to the Herpetofauna of the Continental United States and Canada*. Now, a revised and updated second edition, released in 2012, admirably fills the role of comprehensive North American key. Much of the text in the Second Edition is identical to the First Edition; nonetheless this update is sorely needed. As stated in the Second Edition’s introduction, coverage of native taxa has increased from 545 to 634 species, while coverage of alien taxa has risen from 39 to 58. In addition to an increase in the number of covered species, there are two other significant changes present in the new edition. Range maps have been contributed by Travis Taggart and are included for select sets of species, and taxon-specific commentary has been significantly expanded, most of which highlights areas of taxonomic disagreement or uncertainty and provides references to the relevant literature in each case.

For readers unfamiliar with the current or earlier edition, the product is exactly as advertised on the cover: the vast majority of pages in the book are devoted to a dichotomous key to the reptiles and amphibians of North America north of Mexico. The key itself is preceded by a short introductory section and followed by a glossary and the literature cited. The four-page introductory section (actually an “Introduction to the Second Edition” and “A Word to Users of This Key,” plus acknowledgments and a list of

abbreviations), while short, accomplishes several things. It defines the intended core audience: college-level herpetology students. It defines the taxonomy followed in the key (Collins and Taggart 2009), which may seem trivial, but is not. It defines the intended scope of the key, which is written to allow one to identify an adult individual of every species of amphibian and reptile with established populations in North America north of Mexico. Finally, it includes the admonition that not all specimens can be successfully identified with a key alone, a truism many of us have experienced firsthand.

The heart of the book is of course the 134 pages of dichotomous keys. For any such key, authors must make structural decisions that can ultimately affect utility to particular audiences. What taxa should be included? Should arrangement favor diagnostic simplicity and grouping of phenetic clusters, or should taxonomy rule the day? What types of characters should be used? Powell et al. have made reasonable decisions in all these areas. Upon receiving my copy of the book, I went through several cycles of "I wonder if the authors included *this* species?" Invariably, the answer was yes, whether it was the continental United States' only amphibian listed by the IUCN as extinct (*Plethodon ainsworthi*) or the latest exotic species established in Florida. Even some exotic species that have been reported but have not established populations are mentioned, such as Anacondas (*Eunectes*), though such species are not included in the key. It should be noted that coverage extends only to the species level, and each species receives a single terminal entry, which is generally not problematic but can result in unwieldy couplets when one species is polytypic, a prime example being the couplet differentiating *Ensatina eschscholtzii* from *E. klauberi*. Though each species is associated with a single terminal entry, inner reticulation is used where appropriate, so that, for instance, multiple roads lead to *Lampropeltis*. This allows for a reasonable compromise between producing an idealized diagnostic key versus producing an idealized synoptic key: members of the same genus or family are always grouped together, but by not forcing a single entry to lead to a particular family or genus; concise, easy-to-follow diagnoses are maintained for internal couplets.

Powell et al. have not restricted themselves in the classes of data used to characterize sets of taxa. The major exception is internal anatomy, which is avoided, though characters requiring observation of the inside of the mouth (tooth rows and counts, presence of choanae, tongue shape and attachment site) are used regularly for amphibians, and acrodont tooth attachment is used as the distinguishing trait for Agamidae. Most entries in the key stress external anatomy, however, with geography and color pattern also being important. Occasionally, other classes of distinguishing characteristics are also included where appropriate (e.g., acoustic and karyotypic information for *Hyla chrysosceles* and *H. versicolor*). When color pattern is used, the authors are also careful to note pattern elements that tend to fade in preservative (such as the yellow thigh markings of *Hyla avivoca*). Terminal entries for species also include referrals to each species' accounts and illustrations in Conant and Collins (1998) and/or Stebbins (2003), along with accounts from the *Catalogue of American Amphibians and Reptiles*, if available.

Important morphological characteristics and geographic ranges are illustrated through the use of 279 line drawings and 25 maps. While a few of the maps depict the range of only a single species, most serve to illustrate range differences among members of a species complex. Maps (sometimes two) are included for all the well-known troublesome species complexes:

slimy salamanders (*Plethodon* spp.), southwestern leopard frogs (*Lithobates* spp.), Gulf Coast drainage map turtles (*Graptemys* spp.), fence lizards (*Sceloporus* spp.), and kingsnakes (*Lampropeltis* spp.), among others. These prove their worth, especially when, as in the slimy salamanders, identification to species level is impossible based on external morphology alone. Even more so than the maps, the line drawings are exceptional. They are, in fact, my favorite aspect of the entire book. Significant morphological features are illustrated with a level of detail and precision that is difficult to depict in a photograph or field guide illustration. Coupled with captions describing the relevant features, the result is that written descriptions that have the potential to confuse instead enlighten, so that a user of the key need not wonder just how big an enlarged preanal scale is supposed to be, or what a gular crest looks like. Especially notable are the head and body drawings that appear at the start of sections for each major herpetofaunal group, which identify features such as types of head scales in lizards and snakes (oculars, gulars, labials, etc.) or dorsolateral folds in frogs. The identity of these structures is second nature to most professional herpetologists, but can be a source of confusion to non-specialists.

Following the key itself are 14 pages of glossary and literature cited, which together complete the book. The glossary, which spans four of these pages, is exhaustive and as far as I can tell includes entries for all but the most basic of anatomical terms used in the key. For example, while "hand" does not get an entry, "claw" does. Directional terms (distal, dorsal, etc.) are given entries in addition to the many entries describing various anatomical structures. There are also a few non-anatomical terms defined in the glossary (e.g., *sensu lato*). The literature cited is complete, and is actually a good starting point if one were interested in synthesizing the literature on recent taxonomic changes and uncertainty affecting the North American herpetofauna. In this respect, it serves as a reminder of the work done by the late Joseph Collins through the Center for North American Herpetology to disseminate our ever-changing conception of North American herpetofaunal diversity.

There are some features not included in the book, two of which in my opinion would significantly increase its utility. First, the Table of Contents only lists taxa down to the family level, and the book has no index or other comprehensive list of included genera and species. One might think that this list exists outside the book in the form of Collins and Taggart (2009), but that would be inaccurate. Powell et al. did not limit their coverage to species recognized up to 2009, so that there are species in the book than are not listed by Collins and Taggart (2009), and there is no easy way to determine which additional species have been added. For example, among turtles only by paging through entries can one determine that *Graptemys sabinensis* gets its own entry while *Kinosternon steindachneri* does not. In addition, the lack of a numbered taxonomic index makes it more difficult to work backwards in the key from a set of potential species as a means of identifying diagnostic features.

The second major omission is the lack of identification keys for larval amphibians. This significantly cuts into the comprehensiveness of the key, and is especially problematic for salamanders. The decision not to include salamander larvae results in the erection of an artificial morphological distinction between these and the adults of related paedomorphic species. This has a strong potential to lead to misidentifications of aquatic, gilled salamanders. The authors do briefly state their non-inclusion of larval keys in their introductory word to users, but do not

suggest alternatives for larval salamanders or tadpoles. Although becoming dated in nomenclature and species content, such resources do exist, the best of which for North America as a whole are probably Altig et al. (1998) for tadpoles and Altig and Ireland (1984) for larval salamanders.

Despite these non-inclusions, the *Key to the Herpetofauna of the Continental United States and Canada* is ultimately an eminently useful volume that I am glad to have available. The core purpose of any key is to identify organisms to their respective species, and for adult amphibians and reptiles of North America, no resource is better suited to the task than this book. While the authors have specifically pitched their product as an identification aid for university herpetology students, other audiences will find it equally useful. The careful prose, clear illustrations, and large glossary combine to make following the key easily comprehensible to interested amateurs with no formal background or training in herpetology, while the comprehensive coverage makes it by far the most convenient identification resource for herpetological professionals, especially those of us who are at a loss when confronted with a generic plethodontid.

Further, while the book is designed with preserved specimens in mind (even if the authors didn't say so directly in the introduction, the volume's dimensions—nearly identical to the copy of *Herpetological Review* in your hands—would be a giveaway), it is by no means deficient in allowing identification of live animals. This is especially the case when it is used in concert with the relevant Peterson Field Guide, where, thanks to the included cross-referencing, one can easily key out a specimen in hand and then turn to the relevant field guide entry for secondary confirmation. The *Key* is sturdily constructed and should stand up quite nicely to outdoor use, if such use is desired, while for indoor use the pages seem to be able to stand up to the occasional solvent drip. Overall, the *Key to the Herpetofauna of the Continental United States and Canada* is one of those rare volumes that all North American herpetologists and herpetophiles should own, and at a list price of around US \$20 (or less online), there is little excuse for not picking up a copy.

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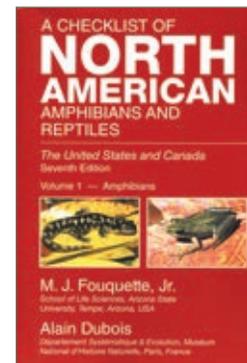
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A Checklist of North American Amphibians and Reptiles: The United States and Canada: Volume 1—Amphibians, Seventh Edition

M. J. Fouquette Jr. and Alain Dubois. 2014. Fouquette and Dubois, Tempe, Arizona and Paris, France. Softcover. 612 pp. US \$34.99. ISBN 978-1-4931-7035-7.

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In the America of the 21st century, a baffling 50% of the voting public claim to believe in special creation rather than evolution through natural selection. Therefore, it is curious that more people of the cloth, in their quest to reveal the inner workings of a supreme being, aren't roaming the bowels of our great museums examining specimens and working through nomenclatural history trying to figure out how to name these representatives of the five kingdoms and how they might relate to each other. Absent such divine intervention, it falls to mere mortals—the scientists—to work out the relationships of the tens of millions of species that constitute life on earth.

Fouquette and Dubois' book is the most recent attempt to document the species of amphibians in North America and their relationships to each other. I'll admit that the world of taxonomy and systematics is mostly foreign to me. As a rubber boot field biologist I simply want to insure that people know the species I'm working with, and where I'm working with them, so that should a new diagnostic technique reveal a different taxonomy, my successors can translate. In the one instance where I needed to know the current taxonomic and systematic relationships of North American amphibians (Lannoo 2005), I simply relied on the current authority (Crother 2000). My indifference (based on being very much aware of my shortcomings in understanding the rules of the International Code of Zoological Nomenclature and Hennigian systematics) does not mean that I underestimate the profound importance of taxonomy and systematics on the day-to-day professional lives of all the rest of us. I understand that everything we do rests on this foundation provided by our nomenclature. How can you run a business if you do not know your inventory? More specifically, how can we prevent the loss of a species if we disagree on how to define a species, and how can we prioritize taxa for conservation if we cannot agree on what to call them? My indifference simply means I've got no dog in this fight (although I wonder why Fouquette and Dubois chose to ignore our updated digital distribution maps, given Fouquette was a contributor to the effort). My plea to those who occupy the world of systematics is to provide stable names I can use, not choices that give the impression that I am taking sides in a war I would rather not be fought.

So, the first question is, where are the battle lines? Among the most important practical differences between Fouquette and Dubois and the Standard Names list compiled by Crother

(2012) are the retention (or resurrection, depending on your perspective) of the genus names *Bufo* for *Anaxyrus* and *Rana* for *Lithobates*. *Pseudotriton montanus* is placed in the genus *Gyrinophilus*. Fouquette and Dubois recognize *Batrachoseps aridus*, *Desmognathus aureatus*, *D. melanius*, *Eurycea wallacei*, and *Necturus louisianensis* as valid species. They recognize subspecies within *Bufo boreas*, *Rana clamitans*, and *Pseudacris streckeri*, but not within *Aneides flavipunctatus*, *Bufo debilis*, *Hyla avivoca*, *Rana sphenoccephala*, and *Notophthalmus meridionalis*. They recognize as subspecies *Gyrinophilus porphyriticus palleucus* and *Siren intermedia texana*. Fouquette and Dubois also recognize the introduced species *Dendrobates auratus*, *Eleutherodactylus coqui*, *E. martinicensis*, *E. planirostris*, *Litoria caerulea*, *Leptodactylus fragilis*, and *Xenopus laevis*.

The second question then, is why do these battle lines exist? One answer resides in overall nomenclatural philosophy. Without attacking the Crother series directly, Fouquette provides a rationale for hostilities (p. 11):

“... we firmly hold to the [International Code of Zoological Nomenclature] as the only authority for nomenclature of animals. Every so often some of us become dissatisfied with the *Code*, and introduce an alternative, which may have some advantages, but overall is unsatisfactory as a substitute. The current alternative system of nomenclature that enjoys a significant degree of popularity (which I assume is represented by Crother) is called the *Phylocode*. It purports to be based on the evolutionary history of animals, so that its rules are designed to name taxa that conform to evidence of their phylogenies, providing names for the major clades, in a looser system not requiring hierarchical ranking. We consider the Linnean system of a hierarchy of taxa to be one of the finest concepts that has been contributed to taxonomy. The system has been codified into a complex of rules for the proper naming of taxa, at least for species, genera, and family-series ranks.”

Fouquette then goes on to dedicate his contribution to the memory of Stejneger, Barbour, and Schmidt (p. 13), “being the giants upon whose broad shoulders we may stand.” Similarly, in their introduction, Crother’s (2012) group addresses this same philosophy with a long quote from Stejneger and Barbour (1943) which can be summarized by the embedded sentence “But when the phylogenists begin to play with the nomenclature and want to express their (often very tenuous, sometimes fantastic) ideas in names, then goodbye to stability of nomenclature which we have been sweating for all these years ...”

Another front in this war lies in the application of standard common names. Stejneger and Barbour (1943) used common names sparingly, while their successor, Schmidt (1953) used common names but without their emphasis. Three years later, Conant et al. (1956), in the second ASIH publication devoted to nomenclature presented common names as “standardized,” in order to be “suitable for use by zoo and museum personnel, other writers of labels, guide books, and popular handbooks, camp counselors, biology teachers, professional zoologists whose chief interest is not herpetology, and anyone else who could make profitable use of such a standard list of names” (Crother 2012). Subsequently, Collins (1997) “strongly urged people to use such standardized common names.” Fouquette and Dubois tie their intellectual lineage back to the time before the application of standardized common names with the sentence (p. 9),

“The most recent edition of a herpetological checklist for North America (Schmidt 1953) appeared about 60 years ago.” (This also explains the curious “seventh edition” designation of the title; Schmidt’s 1953 treatise is the sixth edition.) In doing so, Fouquette and Dubois effectively ignore the work of Conant et al. (1956), Collins and his collaborators (first through fourth SSAR editions) and Crother and his collaborators (fifth through seventh SSAR editions; the fifth and sixth editions were also sanctioned by the Herpetologists’ League and ASIH; in addition to these sponsors the seventh edition was sanctioned by the Canadian Association of Herpetologists, the Canadian Amphibian and Reptile Network, and Partners in Amphibian and Reptile Conservation [PARC]). Crother (2012) backs away from the term “common names,” since such names differ by language.

A final front in this war rests in the use of paper vs. electronic formats for nomenclatural distribution. Fouquette and Dubois argue that a published paper checklist is critical as a nomenclatural document, which should be re-visited and republished on about half-decade intervals. That “when changes are made in an online checklist in 2001, then updated or modified in 2003, the original change may disappear and there is no record of the event.” In contrast, Crother and his colleagues publish paper editions (for example, the sixth edition) with frequent online updates (v. 6.1, 6.2, etc.) leading up to a subsequent edition, published in paper (the seventh edition was published in 2012).

And so there lies the rub. As Dylan (1964) sang, “The line it is drawn. The curse it is cast.” Where do we go from here, or perhaps the better question is, can we go anywhere from here? These are not trivial questions, because, as I point out above, names matter; and in some cases, where legislative wording leading to legal protection enters into the conversation, what you call something can mean life or death.

In taking a step back from the issues, it is obvious that Fouquette and Dubois face a daunting task in convincing herpetologists to take their side. All of the major in-print North American herpetological societies and a major conservation group (PARC) support Crother’s list. And, while it would cost me \$35 to purchase Fouquette and Dubois (with a re-purchase necessary every half-decade or so), I can download Crother as a PDF for free. Further, with Fouquette and Dubois being a self-published volume with its only institutional backing originating from Europe, it is unclear who will carry this battle forward, especially after the authors are unable. I sympathize with their struggle because I am a traditionalist (I prefer wool to polar fleece), but I’m also practical, (when I need to travel light I go synthetic). And I sure prefer “*Rana*” to “*Lithobates*” and “*Bufo*” to “*Anaxyrus*,” but I’ve gotten over it now and have learned to live with it.

In puzzling through this book, from its oblique introductory material carefully avoiding mentioning the society-sponsored checklists from 1956 to the present, to the “seventh edition” moniker, to the self-publication, I think I finally get it. Schmidt (1953)—the stated intellectual predecessor of Fouquette and Dubois—was published the very same year that Watson and Crick presented their discovery of DNA as the stuff of inheritance. And Fouquette and Dubois set their philosophical foundation squarely on the perspective of Stejneger and Barbour (1943; quoted above) lamenting the use of phylogenetic hypotheses in nomenclatural decisions, thus setting up the battle between the “Code” and the “Phylocode.” But the phylogenetic hypotheses of Stejneger and Barbour’s day must have been clunky, or at least incomplete, by the standards of today, and certainly evolutionary hypotheses have been much improved by the application

of molecular tools developed since 1953. Indeed, these various forms of molecular techniques have been largely responsible for the huge increase in North American amphibian species now recognized by both Fouquette/Dubois and Crother/collaborators. It does seem ironic that Fouquette and Dubois recognize the use of molecular data in deciding species designations, but reject the branch-based pattern such molecular data derive.

I imagine way back in 1735, when he first published his new-fangled "Systema Naturae," Linnaeus had his detractors (especially among the botanists), and now the Phylocode is going through the same birthing pains. I'm reminded of another line, this one from the band Semisonic's (1988) song "Closing Time," borrowed from the Roman philosopher Seneca the Younger: "Every new beginning comes from some other beginning's end." Or, maybe not. Perhaps Fouquette and Dubois' argument has a shot; people of the cloth know an Old Testament story about David and Goliath.

Acknowledgments.—I thank Alan Resetar, Andrew Hoffman, Jamie Klemish, Susan Lannoo, Rochelle Stiles, and Jonathan Swan for comments on earlier drafts of this manuscript.

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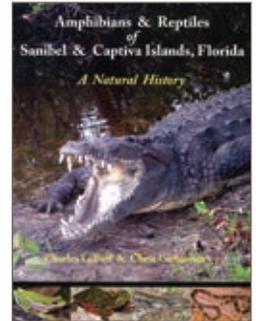
Herpetological Review, 2014, 45(2), 372–373.
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Amphibians & Reptiles of Sanibel & Captiva Islands, Florida: A Natural History

Charles LeBuff and Chris Lechowicz. 2013. Amber Publishing, Fort Myers, Florida (www.sanybel.com) and Ralph Curtis Publishing, Sanibel, Florida (www.ralphcurtisbooks.com). xxiii + 279 pp. Softcover. US \$29.95. ISBN 978-0-9625013-4-0.

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Sanibel and Captiva islands lie in the Gulf of Mexico off Florida's southwest coast near Fort Myers. They are separated from Pine Island and the adjacent mainland by the brackish waters of Pine Island Sound and San Carlos Bay. Charles LeBuff and Chris Lechowicz have nearly seven decades of combined experience living and working on the islands, and their observations form the basis for this herpetofaunal natural history of the islands.

The book is very attractively produced, with a heavy-weight, glossy exterior covered with color photographs of six of the species of reptiles and amphibians found on Sanibel and Captiva islands. The binding is solid, and the book should hold together well.

Part I addresses Location, Geologic Formation, Climate, Land Use History, Hydrology and Water Management, Mosquito Control, Island Ecosystems, Species Recruitment, Environmental and Other Threats to the Island Herpetofauna, Early Herpetological Evidence, and Collection Techniques. This section is especially interesting and informative relative to the history of the islands, knowledge of which is critical to an understanding of their past and present herpetofauna.

Part II presents an Annotated List of the Amphibians and Reptiles of Sanibel and Captiva Islands, Florida. Sections within the species accounts include Other common names, Similar species, General range of the species, Island distribution, Preferred habitat type, Size, Color, Other characteristics, Diet, Reproduction, Call (for frogs), Life history, Population status, Threats, and Comments. Each species account is beautifully illustrated with color photographs by Bill Love, Daniel Parker, and others. Because some species have been seen only rarely on the islands, it is understandable that not all pictures are of Sanibel-Captiva specimens. Nonetheless, given the decades of work with *Caretta caretta* on the islands, I was surprised to see a photograph from South Carolina used to illustrate the hatchling of that species.

As the title suggests, this work is provincial and will be primarily of interest to residents and visitors to Sanibel and Captiva. This is especially so because no general map of the islands is provided. The somewhat anecdotal species accounts refer frequently to local roads and other features that will be known only to longtime residents. Periwinkle Way, Rabbit Road, and Las Conchas Road are intriguing names, but where are they? Perhaps of greatest interest to the non-islander will be 1) the history of the intentional introduction of *Lithobates grylio* or the invasion by *Pantherophis guttatus*, species native to the adjacent mainland

but apparently not to Sanibel-Captiva; 2) the chronicling of the extirpation or near extirpation of *Crotalus adamanteus*, *Drymarchon couperi*, and *Thamnophis sirtalis*; and 3) the surprising absence of *Agkistrodon piscivorus* and *Sistrurus miliarius* from the islands. The absence of *A. piscivorus* from the islands is especially enigmatic, as the species is known to occur on some much smaller offshore islands normally devoid of fresh water (e.g., Wharton 1969; Lazell 1989).

The authors acknowledge two fellow islanders for copyediting the manuscript and proofreading the final draft, and other than several cases of subject-verb disagreement, the text is relatively clean. However, the book would have benefited from the attentions of a good technical editor. It is easy for writers to read what they meant to write rather than what they actually wrote, and the book includes a number of factual errors, many of which the authors themselves would doubtless recognize. Errors are relatively few in those sections dealing with Sanibel-Captiva, but they magnify when the discussion wanders from the islands.

Particular problems arise when the discussion of general ranges becomes confused, leading to gross overstatement of ranges. For example, we read that “The southern ring-necked snake is found throughout the eastern U.S. and southeastern Canada from the Florida Keys to Nova Scotia, and as far west as...Minnesota in the north and Arizona in the south.” Similarly, we read that “The southern black racer is found throughout the southeastern U.S. [with]...isolated populations in west Texas and a subspecies that ranges into Mexico from South Texas.” In both cases the range of the stated subspecies has been expanded to include the much broader range of the species.

The composite account for *Trachemys scripta* indicates that *T. s. scripta* “ranges from northern Florida to southeastern Virginia.” Oddly, the following sentence reads, “It is not native to Florida but is now found throughout the state as a result of escaped or released pets.” The latter sentence would have been true of *T. s. elegans*, but *T. s. scripta* is native to the entire Panhandle region of Florida. Also within the *T. scripta* account, we read that females of the species range from 19 to 30 cm in carapace length, with maxima of 28 cm for *T. s. scripta* and 28.9 cm for *T. s. elegans*.

The native range of *Python bivittatus* is said to span the Indian subcontinent, a region instead occupied predominantly by *P. molurus*. The following sentence then correctly outlines the range of *P. bivittatus* as extending from eastern India through Southeast Asia to southern China and into Indonesia.

The venter of *Coluber constrictor priapus* is said to be white, whereas it is actually black, as can be seen in the accompanying photograph. *Caiman “crocodilis”* is thrice misspelled. *Hyla squirella* is said to be “found throughout...Florida, excluding some barrier islands and the Keys,” whereas it is actually found throughout the Florida Keys (Lazell 1989; Krysko et al. 2011). *Kinosternon baurii* is said to be “...found mostly in the coastal plain of Georgia, the Carolinas, and Virginia”, which is presumably not what was intended, as the species occurs commonly throughout peninsular Florida. *Pseudemys peninsularis* is called both peninsula cooter and peninsular cooter. “Picking individual [box] turtles up as pets” is erroneously said to now be prohibited, whereas individuals in Florida may pick up one box turtle per day, with a possession limit of two (Florida Administrative Code 68A-25.002[6]).

Crocodiles often bask with the mouth agape. The book presents the oft repeated but poorly documented explanation that this is a method of thermoregulation. Downs et al. (2008) briefly discussed some of the shortcomings of such an explanation. Is

gaping behavior to facilitate heating or cooling? The crocodilian mouth is neither moist nor highly vascularized. Gaping behavior can occur in the early morning and at night. I recall early one cold morning in South Africa walking past a birdbath glazed with ice and then seeing Nile crocodiles basking with mouths agape. Loveridge and Blake (1987, p. 260) provided a photograph of a large *Crocodylus niloticus* immobilized with gallamine; the fully relaxed animal sits with mouth agape, just as seen in basking individuals. The intuitive explanation of thermoregulation seems inadequate.

The glossary that follows the species accounts includes some terms for which definition seems unnecessary (e.g., diminutive, diurnal, erosion, habitat, insular, National Wildlife Refuge System, pathogen). The neologism “deteologic agent” appears in both text and glossary where “etiologic agent” is intended. Watershed is given a definition more apt for drainage divide. And botanists will be surprised to learn that taxonomy is “The science of naming animals”.

The book ends with lists of Suggested Reading and Literature Cited. Conant and Collins (1998) is included in the suggested reading, but it is not included in the Literature Cited, despite the fact that the sizes reported in most species accounts were obviously taken directly from that classic work.

In summary, this book is very attractively produced, and it is destined to long grace many a coffee table on Sanibel and Captiva. Visitors to the islands and residents will find the sections on geology, hydrology, and land use history informative. Otherwise, though, the book will not be of particular interest to most readers.

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Guía de Reptiles de España. Identificación, Historia Natural y Distribución

Alfredo Salvador and Juan Manuel Pleguezuelos. 2013. Canseco Editores S.L., Talavera de la Reina, Spain (www.cansecoeditores.com). 462 pp., 454 plates, 281 line drawings, 70 maps. Hardcover. 35 € (approx. US \$48.00). ISBN 84-936191-6-9.



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Spain has continental Europe's highest reptile diversity; 71 naturally-occurring species inhabit its borders or visit its shorelines. In comparing the former version of this guide (*Reptiles Españoles*; Salvador and Pleguezuelos, 2002; see Busack 2003) to the current volume, one immediately notices several taxonomic changes. Increased understanding of phylogenetic relationships among Iberian taxa (due primarily to extensive DNA research) has resulted in reassignment of four snake species to different genera: *Coluber hippocrepis* to *Hemorrhoids*

Boie, 1826, *Coluber viridiflavus* to *Hierophis* Fitzinger in Bonaparte, 1834, *Elaphe longissima* to *Zamenis* Wagler, 1830a, and *Elaphe scalaris* to *Rhinechis* Michahelles in Wagler, 1830b. In addition, three subgenera formerly considered closely related within *Lacerta*, and now understood to represent evolutionary lineages distinct from *Lacerta sensu stricto*, warrant re-assignment as well. For *Lacerta lepida* its former subgenus, *Timon* Tschudi, 1836, is appropriate, and the species is now correctly known as *Timon lepidus*. Similarly, *Lacerta* is replaced by *Scelarcis* Fitzinger, 1843, for *S. perspicillata*, and by *Zootoca* Wagler, 1830a, for *Z. vivipara*. *Lacerta monticola* and *L. bonnali* are also no longer considered representative of *Lacerta* and are assigned to the recently defined *Iberolacerta* Arribas, 1997 (see also Arribas 1999). Former subspecies elevated to species include *Iberolacerta cyreni* (Arribas, 1996) (formerly within *L. monticola*); *Iberolacerta martinezricai* (Arribas, 1996) (formerly within *L. cyreni*, see Arribas and Carranza 2004); *Iberolacerta aranica* (Arribas, 1993) (formerly within *L. bonnali*); *Podarcis carbonelli* Pérez Mellado, 1981 (formerly within *P. bocagei*, see Sá-Sousa and Harris 2002); *Podarcis vaucheri* Boulenger, 1905 (formerly within *P. hispanica*); *Psammodromus edwardsianus* (Dugès, 1829) (formerly within *P. hispanicus*); and *Chalcides coeruleopunctatus* Salvador, 1975 (formerly within *C. viridanus*). *Blanus mariae* Albert and Fernández, 2009; *Iberolacerta galani* Arribas, Carranza, and Odierna, 2006; *Iberolacerta aurelioi* (Arribas, 1994); and *Psammodromus occidentalis* Fitze, Gonzalez-Jimena, San-Jose, San Mauro and Zardoya, 2012, are recently described additions to the fauna. *Macroprotodon brevis* is now the correct appellation for mainland Iberia's population, and *M. cucullatus* is correctly applied to populations found in the Balearic Islands (Crochet and Dubois 2004). The Canary Island Giant Lizard on Gomera Island (*Gallotia gomerama* in Salvador and Pleguezuelos

2002) is currently assigned to *G. bravoana* Hutterer, 1985 in this *Guía* (see Bischoff 1998, for details).

Teira dugesii from the Archipelago de Madeira, and Portuguese distributions for all species found both in Spain and Portugal are no longer included. Persons interested in distributions for Portugal may consult Loureiro et al. (2008) for coverage. *Sauroidactylus mauritanicus* is no longer found on Isla de Alborán and has also been omitted from the current version.

This volume is essentially a 2013 update of the now out-of-print *Reptiles Españoles* and, as with that edition, it is more an informational treatise than the typical field guide. The authors, each a well-positioned professional (Salvador at the Museo Nacional de Ciencias Naturales, Madrid, and Pleguezuelos [currently president of the Asociación Herpetológica Española (AHE) – Spain's answer to SSAR] at the Universidad de Granada, have up-dated natural history information, included both replacement, and additional, photographs, and completely revised distributional information using the AHE's computerized data base of nearly 200,000 records. Each species account is introduced by a generally superb color portrait that often includes an insert illustrating the head. Species identification is facilitated by Salvador's excellent line drawings, both in diagnostic keys and within species accounts. The bibliography guiding the user to additional information found at the conclusion of each species account in the former edition is, however, no longer provided in this edition and readers are encouraged to visit www.vertebradosibericos.org for continually updated information. Errors noted in the former edition have been corrected, but two photographs are labeled incorrectly: the juvenile turtle pictured on p. 44 is *Emys orbicularis*, not *Mauremys leprosa*, and the female *Podarcis carbonelli* pictured on page 245 is actually a male.

The degree of reptile species diversity present in Spain places an elevated responsibility upon the country for facilitating conservation. While both editions address general threats to survival and protective legislative measures among comprehensive introductory materials, species accounts in this version also contain a "State of Conservation" section. Survival status within Spain, as well as status throughout a species' entire range, are each provided and specific threats are elaborated in this section. The stated degree of concern for *Gallotia galloti* (p. 350) is incorrect, it is actually considered to be of "minor concern." Survival of *Iberolacerta aurelioi*, an endangered species restricted to the Pyrenees Mountains, is threatened by ever-increasing vehicular traffic and alteration or destruction of habitat due to the construction and maintenance of infrastructure required to support skiing, trekking, and hydroelectric power generation. Only ten years on the faunal list and already this unique species is being threatened by man's activities in rugged mountainous areas of northern Spain, southern France, and northeastern Andorra.

Introduced species are becoming a disturbing feature of life among the earth's expanding and increasingly mobile human population, and the former edition reported introductions of *Anolis carolinensis*, *Pelodiscus sinensis*, *Pseudemys picta*, and *Trachemys scripta*. As serious threats to aquatic systems, all turtle species, in my opinion, should be considered invasive species when introduced to non-native habitats, and be closely monitored and/or controlled where necessary. The 2013 edition reports significant expansion between 2002 and 2013 in localities reporting *Trachemys scripta* (see maps, p. 46, in each edition). This turtle, once ubiquitous in the United States wherever pets are sold, is now more widely-distributed in the autonomous regions Catalonia (especially around Barcelona) and Andalucía

(especially around Sevilla, and coastal portions of Málaga, Granada, Cádiz, and Huelva Provinces) than reported in 2002. In this edition the New World endemic is newly reported from autonomous regions Castilla-La Mancha and Galicia (Pontevedra Province), and appears widely-distributed throughout Madrid Province. A newly added section, “Introduced Snakes in the Canary Islands,” informs us that the parthenogenetic *Ramphotyphlops braminus*, discovered on Gran Canary Island in 2004, and *Lampropeltis getula*, discovered there in 1998, can today be considered established introductions. The kingsnake eradication campaign that began on Gran Canary Island in 2007 did locate and remove 92 specimens from the wild in 2008, and an additional 131 specimens in 2009—an indication there is an established population on Gran Canary Island.

Producing a guide to the fauna of any area is extremely complex, and these authors have done an admirable job capturing and incorporating recent data in light of the massive increase in herpetological research being done in Spain today. While new maps suggest a slightly reduced number of records for some species, these maps are more accurate than those previously presented because AHE’s database includes only checked and verified distribution data. When I noted some quadrants on sea turtle maps non-randomly colored a darker blue than others, I queried the authors. The darker blue quadrants are those from which fishing boats, etc., had reported at-sea sightings and the small red circles along the shoreline represent records from beaches and harbors. This explanation was inadvertently omitted from the Introduction.

Psammodromus hispanicus is listed in the tables of contents, alphabetical indexes and species keys for each volume as a single entity. In 2002 this species was considered to be represented by two subspecies, but recent investigations by Fitze et al. (2011, 2012) have determined *Psammodromus hispanicus*, *Psammodromus edwardsianus*, and *Psammodromus occidentalis* to be separate lineages and this version incorporates this recent taxonomic rearrangement in a single section (pp. 289–294). The frontispiece, unlike the four color plates in the species account, however, is not labeled as to species but is suggestive of *Psammodromus occidentalis*. Line drawings in this section have been reprinted from the earlier edition and likely represent *Psammodromus hispanicus*, but are not so-labeled. Fitze et al. (2012: Fig. 1) provide a map of “prospective” distribution for the three species but this edition includes only one map for all three species without any suggestion as to which species may be found where. The variation section does present a broad delimitation of ranges as understood for these recently distinguished taxa, however. Explanation for these anomalies of presentation in an otherwise up-to-date, well-presented guide are likely the result of two competing issues: independent genetic lineages (species) identified using DNA techniques are often difficult to distinguish morphologically (see color photographs in the present edition) and placement in the species key may not have been appropriate at the time this volume went to press (all species could have been listed together in the key couplet leading to *Psammodromus hispanicus*, however). The map for the two species of *Blanus* (p. 91) also lacks indications regarding prospective distributions. In any event, users of this guide are informed with regard to these newly discovered taxa and made aware of problems involved with casual identification and determination of precise distribution limits.

In the realm of popular guidebooks, this *Guía* is, as was the earlier edition, lavishly illustrated and very well-presented. If

you are already interested in European reptiles you will find it a necessary addition to your bookshelf. If you have not yet visited Spain, or enjoyed this country and experienced the excitement of your first encounter with its reptile fauna, now is the time—and this is the one guide you will find most helpful.

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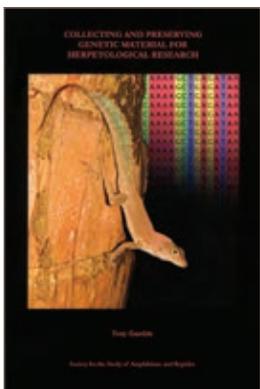
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Herpetological Review, 2014, 45(2), 376–377.

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Collecting and Preserving Genetic Material for Herpetological Research

Tony Gamble. 2014. SSAR Herpetological Circular No. 41 (www.ssarbooks.com). 50 pp. Softcover. US \$11.00. ISBN 9780916984885.



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Since publication of the Hillis et al. (1996) classic review *Molecular Systematics*, technological advances in the rate and amount at which various classes of molecular data can be collected, coupled with cost reductions and increased computational power for analyses of large data sets, have fostered a steady expansion of the kinds of biological questions to which molecular data sets are being applied. The dizzying pace at which these advances have occurred challenges investigators to keep abreast, and this review by Gamble provides a thorough but easily accessible review of methods for

collecting and preserving genetic material for a broad range of research themes in herpetology.

The publication includes a brief Introduction in which Gamble emphasizes that studies of amphibians and reptiles have been at the leading edge of many of these advances, and given the time and cost of field work, the collection and preservation of samples for molecular studies is the single most important component of these research programs. The text is for people with a basic background in biology, and complements the work of Simmons (2002) on how to collect, euthanize, and preserve voucher specimens for museum collections, and Beaupre et al. (2004) for guidelines to practical and ethical issues in herpetological field and lab research.

The first two of the paper's four chapters are short. Chapter 1, "Why collect genetic material?," summarizes the many uses of molecular data in biological research, what tissues are collected and how they are preserved, whether these will be acquired via loans or field collected, and whether field work is general (as in poorly-sampled regions), or targets specific taxa. Gamble identifies three emerging trends that are likely to increase exponentially: genomics (see Haussler et al. 2009, for details), studies of amphibian pathogens, and species identification via DNA barcoding. Each of these topics is further elaborated in separate paragraphs, and the final point made is that properly archived tissues can also be used to detect environmental contaminants or in stable isotope studies of foodwebs. Embedded Box 1 describes methods for extracting/sequencing DNA and detection of the *Batrachochytrium dendrobatidis* (*Bd*) fungus, as well as targeted enrichment and next-generation technologies for sequencing fragmented DNA from formalin-fixed/ethanol-preserved museum specimens, but emphasizes that most of us will continue to need access to field-collected tissue samples archived for molecular genetic studies. Chapter 2, "The Science of Preserving Genetic Material," describes processes by which DNA and RNA may be degraded if improperly preserved and stored under field conditions, and ways to protect field-collected samples.

Chapter 3 is the longest and devotes 18 pages to "Methods for Collecting and Preserving Genetic Material," and includes eight figures and three boxes. The introductory paragraphs and Box 2 summarize "Things to avoid when storing genetic material." The topical coverage is extensive and begins with a "Permits and Ethics" section that emphasizes laws governing collection and transportation of wildlife, and those related to animal safety and welfare. This is followed by a short "Euthanasia" section summarizing means of humanely killing amphibians and reptiles that are usually acceptable to institutional Ethics Committees for this type of research.

The next three sections, "Documenting Samples," "Sample Containers/Packaging," and "Sampling Tissues from Specimens," offer clear descriptions and illustrations of accepted means of properly documenting collection of specimens. These include taking detailed field notes, geo-referencing localities, and field tagging specimens and tubes in which tissues are stored. Several methods are described for numbering tubes and also for maintaining field-collected samples so as to minimize degradation of nucleic acids. The last section covers types and amounts of tissue to be sampled, storage to minimize degradation, collection of "back-up" samples on filter paper blots, and treatment of scissors, forceps, etc. between excision of tissues to minimize cross-contamination. A separate paragraph is devoted to treatment of samples from which RNA will be extracted.

The “Nonlethal Sampling” section is one of the most extensive, and is justified by the many studies in which individuals must be non-lethally sampled (species of conservation concern, re-sampling of individuals through time, permitting issues in protected areas, etc.). Methods are described for collecting five classes of samples: buccal/cloacal swabs, blood, biopsies/tail/toe clips, shed skins, and “other,” which includes DNA from mosquito blood meals (think “Jurassic Park”), frog DNA from carrion flies, dried snake venom, bone fragments taken from notching turtle shells, and reptile eggshells.

A short paragraph describes “Sampling Pathogen DNA,” which may include: blood to detect lizard malarial parasites, skin swabs for amphibian *Bd* (which is illustrated in Fig. 7 and presented in detail in Box 3), liver or kidney (preferred) and toe or nail clips (less sensitive) to detect Ranavirus.

The final section in this chapter describes “Cell Culture,” which is likely to be the least familiar protocol to most herpetologists; this requires collection of some tissue type under sterile conditions, which is then stored in a cell culture medium for establishing fibroblast cell cultures in a lab incubator. In my own experience, field-collected animals can be euthanized in a lab and tissue excision performed under sterile conditions in a laminar-flow hood. Sterile cells are then minced in a growth medium to establish fibroblast cultures for harvest; cultures may be subdivided to establish new cultures to increase cell populations available for harvest. In my example cultures were treated with colchicine to harvest metaphase chromosomes for cytogenetic studies (Sites et al. 1979), and we successfully extended the protocol to field conditions (sampling/storing mammalian ear clips under sterile conditions in a portable plexiglass field hood; Sites et al. 1981). Ideally, tissues are frozen slowly for LN² transport, although before the days of Mr. Frosty, this was not possible or necessary (Sites et al. 1981).

The final chapter, “Storage, Curation and Transportation of Genetic Material,” provides thorough coverage of storing tissues, emphasizing the value of fresh tissues above all other kinds of samples for most studies, but also that there is no single preservation method for every possible downstream use. A short “Cryopreservation” section emphasizes flash freezing of tissues in LN² as most effective for preserving the highest quality DNA and RNA, and how this can be done. This is followed by short section on “Desiccation,” and then an expanded treatment on “Fluid Preservation,” which is most relevant to researchers working in remote areas without access to any form of cold storage. Under these conditions high-salt solutions (RNAlater[®]) or 95–100% ethanol are the preferred media for keeping DNA/RNA intact, but because ethanol is considered a hazardous material (flammable), shipping ethanol-stored tissues requires proper documentation and package labeling. A final section described other fluid preservatives, followed by a short paragraph on “Long-term Tissue Storage.” A brief but important section covers “Shipping” of tissue samples, and the last describes “Museum collections”; both of these are rich in detail and will inform researchers from multiple disciplines. Gamble emphasizes archival of tissues in research collections that link to online databases (HerpNet, VertNet, etc.), and eventually standardizing links between published sequences, tissues, and voucher specimens. When voucher specimens are not available (non-lethal sampling), options include use of DNA barcodes to verify identifies. Lastly, because tissue collections are unique in that loans usually not returned after use, amplification of whole genomes (using GenomiPhi) would permit return of the loan as an amplified genomic sample.

I found this contribution to be clearly written, well-organized into a logical sequence, with figures and boxes appropriately placed in the text, and no missed citations. Figure 4 would convey more clarity if it had been a more close-in photo, but overall Gamble has contributed a publication that will be of great service to multiple groups of researchers both in and far beyond the taxonomic boundaries of herpetology.

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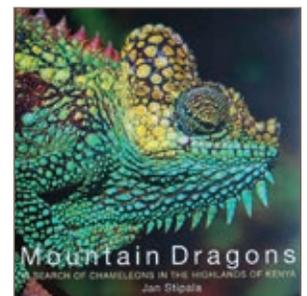
Herpetological Review, 2014, 45(2), 377–378.
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Mountain Dragons—In Search of Chameleons in the Highlands of Kenya

Jan Stipala. 2014. Privately published (available from the author, at 2 Murtons Terrace, Lanner, Cornwall, TR16 6HW, United Kingdom). 124 pp. Hardcover. £26.00 (approximately US \$42.00). ISBN 978-0-9928176-0-2.

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The late Alex Duff-MacKay, senior herpetologist at Kenya’s National Museum for 30 years, once wrote that chameleons “can melt the heart of bank managers” (MacKay 1994). Beautiful, brightly-colored charismatic lizards of Africa and its surroundings, chameleons have found their niche in the highlands of eastern and south-eastern Africa. Tanzania has 40 species and Kenya has 24, many endemic. No other mainland African country approaches those sorts of numbers. Those that entered the forests have developed strange, often unfathomable head ornamentation. Chameleons have inspired many enthusiasts, generated Facebook groups and stimulated the production of richly-illustrated books, for example Necas (2004), Tolley and Burger (2007), and Tilbury (2010). The book by Tilbury, a medical doctor and lifelong chameleon enthusiast who travelled the length and breadth of Africa in search of

chameleons, was regarded as the last word. But since its publication several new species have been described. Now biologist Jan Stipala has made his contribution, with this beautifully produced, large format book (30 × 30 cm, an unusual size).

This book is proof of what you can do with a bit of enthusiasm. Stipala spent a year exploring the magical mountain forests of the highlands of Kenya, in a battered Toyota Land Cruiser that he bought cheaply, accompanied by herpetologists from the National Museum of Kenya and game scouts. When the team managed to get the vehicle back from the repair shop and into the field they got stuck in the mud, frozen and soaked at high altitude, had encounters—some scary—with elephant and buffalo, were stalked by a leopard, and had a drunken game scout shoot a hole through the roof of the Land Cruiser. But, in the high country they also located, and described two new species of chameleon (Stipala et al. 2011, 2012), one of which required a wet four-day trek onto Mt Kinangop in the southern Aberdare Range. They also recorded a Tanzanian and a Sudanese species in Kenya for the first time, and documented numerous range extensions. These are all documented here.

The book opens with several full-page and double page photographic spreads of chameleons and their habitats. There follows a preface, introduction and rationale, some useful maps and background information on the landscape, climate, geological history of highland Kenya and fieldwork techniques (including a page on how to catch chameleons). There is a seventy-odd-page travelogue, describing the team's adventures visiting 12 mountain massifs of southern and western Kenya, two pages on chameleon farming, twelve pages of species profiles documenting eleven Kenyan chameleon species, nine pages detailing the research, a page on chameleon photography, an index and a short bibliography of 23 pertinent references. The species profiles have three or four representative pictures, a map with spot localities, an elevation profile and entries under the headings: size, description, distribution, ecology, behaviour, reproduction and taxonomic comments. The maps greatly expand our knowledge of the range of these species within Kenya, every species shows range extensions beyond that documented by Spawls et al. (2002). The research section has some useful phylogenetic trees and maps showing haplotype distributions. I noted with interest that these interlace elegantly with the known dates of uplift of the various sections of the Kenyan Rift Valley and the associated volcanic mountains (Spawls and Mathews 2013).

The text is lucid, entertaining, and informative; Stipala's easy style reads well. The color photos are one of this book's strengths. There are over 360, showing the land and the chameleons. The habitat pictures are superb, with panoramic views that would not be out of place in *National Geographic*. The chameleon pictures are equally good, illustrating some 12 species of Kenyan chameleon, some the first records for the country. Many are finely composed, showing the animal relaxed in the landscape, and all are taken by daylight; a refreshing technique in these days when the general consensus seems to be that chameleons are best photographed by flash, at night, after infuriating them into displaying defensive colors, and then boosting the colors digitally. There is an astonishing sequence of pictures, showing two vivid blue-green and yellow Jackson's chameleons (*Trioceros jacksonii*) from Machakos having a scrap in a coffee bush. It's all here, the attendant female, the confrontation, the horns locking, finally the defeated male changes color and slinks off. And sadly the female then rejects the victor, hissing at him to keep away. The course of true love hardly ever runs smooth!

Stipala concentrated his research on two species, *Trioceros jacksonii* and *T. hoehnelii*, and the morphology section is largely concerned with these two species, with data on body size variation, how it correlates with elevation and a Principal Component Analysis of head morphometrics in *T. hoehnelii*. The bulk of the photographs are of these two species. I thought I knew both but there are color varieties and forms here that I have never seen, from places where I would not have thought of looking. I know the dry coniferous forest of the northern slopes of Mt Kenya fairly well, but have never found a chameleon there. I gnashed my teeth to find out that there is a Jackson's Chameleon there with bright blue and orange skin around the eye!

At £26 or US \$42, this book represents remarkable value for money when you consider how much many specialized reptile books cost nowadays. I perceive a few shortcomings; there are 75 pictures of *Trioceros jacksonii* and 63 pictures of *T. hoehnelii*, an indulgence that can creep in when you are your own editor. By cutting some of these Stipala could have covered a few more of Kenya's chameleon species. I would liked to have seen details of the localities shown on the spot maps. There is the odd typo; Stipala has managed to lose one of his own co-authors from the citation of their description of *Trioceros kinangopensis* (Stipala et al. 2012). But overall, this is a bewitching, beautiful book, it brings alive the landscape, the chameleons, and the ordinary citizens of highland Kenya. All chameleon enthusiasts, East African herpetologists, and Kenyaphiles will want it—and many will want to visit. Jan Stipala has taken us into the heart of highland Kenya and its enchanting chameleons.

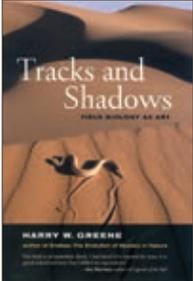
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Herpetological Review, 2014, 45(2), 379–380.
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Tracks and Shadows. Field Biology as Art

Harry W. Greene. 2013. University of California Press, Berkeley & Los Angeles, California (www.ucpress.edu). xiii + 280 pp. Hardcover. US \$29.95. ISBN 978-0-520-23275-4.



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For those who don't know, Harry Greene is the Stephen H. Weiss Presidential Fellow and Professor of Ecology and Evolutionary Biology at Cornell University, a recipient of the E.O. Wilson Award from the American Society of Naturalists, and a recently elected member of the American Academy of Arts and Sciences. Previously he spent 20 years on the faculty of the University of California at Berkeley, where he played a seminal role in interpreting the phylogenetic context of reptile behavioral ecology (Greene 1973, 1979, 1983, 1986, 1988, 1994a, 1999). The quality of Greene's writing is superb, as demonstrated by his previous book (1997) — *Snakes: The Evolution of Mystery in Nature* (hereafter referred to as *Snakes*) — which won a PEN Literary Award.

Unless you know Harry Greene or what he does, however, there is not much in the title of this book to signal its herpetological interest. The cover shot of Peringuey's Adder (*Bitis peringueyi*) side-winding across Namibian dunes may give some indication into the scope of the inner essays, but not the blurb on the dust wrapper: "Intellectually rich, intensely personal, and beautifully written, *Tracks and Shadows* is both an absorbing autobiography of a celebrated field biologist and a celebration of beauty in nature." This is an accurate and nice summary, but the book could still be about flowers or pretty bovines.

Tracks and Shadows is divided into three parts. The first, 'Descent with Modification,' is a nice play on the forces that influence the trajectory of an individual life. It elegantly interweaves the punctuated equilibria that result from the impact of tragedy and renewal. Whilst in essence this is part autobiography, the story also entwines the lives of other herpetologists, particularly Henry Fitch who mentored Greene in his early studies. Fitch's early, quiet, formative influence is in contrast to Greene's own wild, disrupted youth. Many will be surprised at some of the events relived in these pages. It certainly made me realize how simple and peaceful has been my own journey. Meaning in life is not an objective but a personal perspective, and this section of *Tracks and Shadows* reiterates the impacts of pain and renewal that characterize a life's journey.

In the middle section, 'Conversing with Serpents,' Greene retraces his own broad studies on different groups, particularly the various aspects of what it means to be a snake. It covers the period in which Greene's studies and papers really influenced conceptual thinking in herpetology and in the evolution of behavioral ecology. Henry Fitch had patiently documented the autecology of Kansas reptiles, many of which were summarized in his monograph on *A Kansas Snake Community* (Fitch 1999), and various reviews of reptile biology (1981, 1982). The youthful Greene was more synthetic in his approach, placing these and other observation in a more phylogenetic context. This section,

however, is more than historical narrative as it also introduces a more general discourse on what it means to be a field biologist.

On starting this review I glanced at *Snakes*. It is full of good prose and insight. This time I happened to open at the chapter on basal snakes, and noted a sentence on increasing insight into the lives of Boa Constrictors. The section reads: "Some tantalizing chance observations suggest that the best is yet to come, that there is much more to being a huge serpent than we realize." The quote captures both Greene's fresh style and questioning mind, but I bet even he was later gob-smacked when learning that boas (Booth et al. 2011a) and other species (Booth et al. 2011b, 2012) may undergo "virgin births" (facultative parthenogenesis), displaying previously unappreciated reproductive flexibility. Moreover, Indian Pythons are now known to display "homing" abilities (Pittman et al. 2014), admittedly a poignant and problematic term for discoveries made on an introduced Florida population. These are sophisticated behaviors, and highlight how easily our anthropocentric ego confuses "basal" with "primitive." Greene may be right when he notes that "A book that captures the majesty of giant snakes has yet to be written," but his own brief summary (Chapter 9) makes a good start.

In the final section Greene allows himself to ponder larger issues and present his views on the central role of organismal biology and the enlightenment that comes from contemplating nature. Science and the humanities are often juxtaposed as if they were alternate views of Life, as if a scientific outlook somehow deprived the world of beauty and poetry. The distinction between these two cultures (Snow 1959) is artificial, and belies the creativity that attends scientific insight. By fieldwork Greene doesn't mean prosaic mud and fresh air, but rather the opportunity to observe and discover. It is not simply observed natural history, although both Fitch and Greene have defended the value of the anecdote. Rather, it is seeing Life's inter-relatedness, opening oneself to the opportunity for the creative moment when the forest becomes more than the trees. Greene's prose and evocative text ("mud-smudged") says it much better.

It is difficult to find suitable language to describe new discoveries of the rich, subtle complexity of reptile life. In part, Science has been its own enemy, insisting on non-emotive descriptions. Yet, the natural fear associated with snakes because of a venomous minority requires vigorous rebuttal and positive appeals. Too often public perception views evolution as laddered, with "lower vertebrates" primitive, governed by instinct and possessing limited behavioral flexibility. Greene argues against anthropomorphizing animals, but has been challenged (Walker, 2014) for this same "sin" when he notes "that blacktail and timber rattlesnakes hunt mammals, lie around after big meals, search for mates and wrestle with rivals, court and mate, give birth, and attend their young." However, none of these actions (hunt, lie, search, wrestle, court, mate, attend) are anthropomorphic. They are simple verbs that describe the parameters of Life. That they should be considered only applicable to humans, and their use in describing snake behaviors as anthropomorphic, perfectly reflects the modern lack of "connectedness" to wildlife that is one of Greene's major concerns.

Concern for the loss of Natural History as a central axiom of biological science is a common theme in Greene's publications (1993, 1994b), and is increasingly noted in other works (Tewksbury et al. 2014; Wilson 2014). For some, I am sure, it thus seems paradoxical that Greene centers himself within the natural world via hunting, by insisting that he embrace the predator within. Personally I do not find this necessary but as I live in Africa,

perhaps I'm more aware of the coin's flip side. Greene is also an advocate of Pleistocene re-wilding to repair and reintegrate damaged ecosystems. In the North American context it urges the re-introduction of large mammals and their associated predators, or ecological proxies where these have become extinct. This is already happening, albeit in a limited, non-threatening, and easily reversible manner, using giant tortoises as surrogate herbivores (Burney et al. 2012, 2013; Griffiths et al. 2013). These selective grazers are being used to clear island ecosystems of alien vegetation after the extinction of indigenous avian grazers (e.g., the Dodo in the Mascarenes and the *moa nalo*, a flightless duck, in Hawai'i). However, re-introduced large mammalian herbivores and carnivores may come into more direct conflict with humans. In Africa I have stumbled into lion and buffalo whilst herping in the bush, and have also come too close to crocs and hippo when preoccupied with collecting frogs at night. These are real dangers, and although Greene notes that deaths from lion in Tanzania did not make the top 50 mortality categories in the country, this is no solace to the 40 families bereaved by lion kills each year.

This book is subtitled "Field biology as art," and Greene states that "I aim to persuade others to get out there and learn more about themselves." The biggest challenge for many may be finding their place in an indifferent universe, and regaining a lost connectedness to our biological heritage offers a rebuttal to a human arrogance that demands dominion over the whole Earth. In the preface to this beautiful book, Harry writes of the acceptance of personal loss: "Studying predators, I contemplated violence without evil, death without tragedy." Later he delights in finding a lost and favored quote — *The Earth is mostly a bone yard, but pretty in sunlight* (McMurty 1985). This review ends with my own favorite aphorism, anonymous and black, and taken from my son's surfing magazine a generation ago. I offer it in thanks for a book that is timely, thought-provoking and which, more simply, I thoroughly enjoyed.

"It's not that Life is short it's just that you're dead for such a long time."

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