

Book Review

How Snakes Work: Structure, Function and Behavior of the World's Snakes

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“They are magnificent. They are splendid creations ingeniously constructed after eons of gradual change.” Kauffeld, *Snakes and Snake Hunting*, 1957

There are many books about snakes for every level of understanding, but rarely, if ever, has there been a book about snakes that matches Harvey Lillywhite's offering. As I went through the volume, I kept thinking how I wish I had such a book when I was in high school/college, or even as a kid. I wrote a term paper in high school on how snakes move and this book has an entire chapter devoted to it! I honestly got goosebumps and bursts of adrenaline as I read it, because it brought me back to my younger days of discovery about the biology of snakes. How fascinating they were/are! Lillywhite's volume details all the reasons why snake are magnificent organisms.

The volume is in a comfortable 8 1/2 by 11-inch format with 241 pages, glossary, index, and references at the end of each chapter. Rick Shine wrote the Foreword and Lillywhite explains in a short Preface his personal reasons and goals for the book. Lillywhite hoped that he “might bring a unique perspective to the subject matter, and to cover a range of topics...that will interest a wide group of readers.” I think he is completely successful in reaching those goals. Perhaps the reason he is so successful—and why this is such a terrific book—is because the author is an insider, a professional research scientist who has studied how snakes work for his entire career. We are all lucky that Lillywhite is sharing his expertise and passion with us in such a volume.

There are nine chapters: 1) Evolutionary History and Classification, 2) Feeding, Digestion, and Water Balance, 3) Locomotion: How Snakes Move, 4) Temperature

and Ectothermy, 5) Structure and Function of Skin, 6) Internal Transport: Circulation and Respiration, 7) Perceiving the Snake's World: Structure and Function of Sense Organs, 8) Sound Production, and 9) Courtship and Reproduction. There is obviously a lot of information here and it is as up to date as it could be. Each of the chapters is wonderfully adorned with terrific photos and illustrations that help the reader grasp and/or visualize the text descriptions.

Even in a book on how snakes work, a chapter on evolution and classification is practically obligatory because it puts the rest of the book's information into context. Maybe the most important nugget of knowledge given in this chapter is “The latter [snakes] are essentially highly derived lizards.” It is critical to point out that snakes are not related to lizards, but *are* lizards. That realization makes all the novel evolutionary changes relative to lizards that are described in this book even more remarkable. With that fact written in the book, it is somewhat unfortunate that an accompanying figure shows snakes and lizards as separate branches on a phylogeny of the tetrapods. The natural history comments in the “tip toe through the taxa” section of the chapter are a welcome addition.

An example of how having a volume written by a professional research scientist enhances the content is near the beginning of Chapter 2. Lillywhite wrote, “The following discussion is essentially speculative, but it provides a conceptual basis from which to launch considerations of feeding and digestion in snakes.” Because of his long history of work in the field, his speculations are valuable and make you feel like you just asked an expert a question and he is giving you

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his unique insight. I consider it a bonus. Beyond the speculation, this chapter is a trove of information on the diversity of feeding adaptations among snakes, such as the physiology required to handle digestion of various food types, and the myriad aspects of how snakes physiologically deal with water.

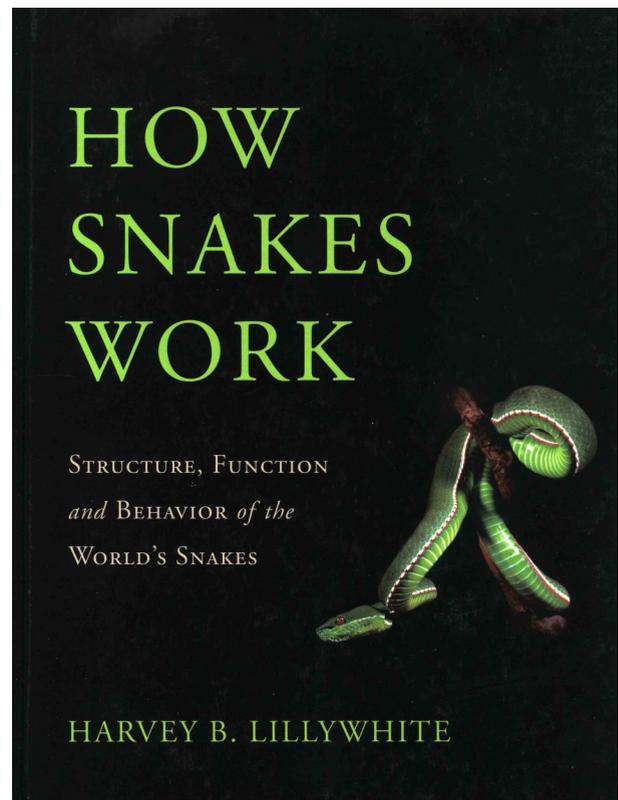
So, you think you know how snakes move? In my high school term paper that I previously mentioned, I described three modes: lateral, concertina, and rectilinear motion. I was woefully incomplete. The illustrations in Harvey's book, from anatomy to movement, are excellent and useful. The final section of this chapter, titled *Snakes as Robots*, is a treat.

Of course, we recognize snakes as ectotherms, but as Lillywhite reveals in Chapter 4 on "Temperature and Ectothermy," being an ectotherm is an extremely complicated deal for snakes. The chapter goes through these many complications and even provides examples of **endothermy** in snakes, which makes the label "ectotherm" require an even more broad interpretation. Lillywhite does a great job pointing out how much is not known about thermoregulation, especially with regard to trade-offs or cost-benefits when thermoregulation is coupled with any of the myriad of other physiological processes of the organism.

There is something magical about seeing snake skin that is either as glossy as glass, like mud snakes (*Farancia abacura*), or spectacularly iridescent, like rainbow boas (*Epicrates cenchria*). Well the chapter on skin covers it all and tells you everything you need (or wanted) to know about snake skin, from cultural references to histology and micrographs to mimicry and color/pattern variation. As usual for this book, the photos and illustrations are terrific!

The concluding paragraph of the chapter on Internal Transport opens with: "Few persons probably give much thought to how the blood circulates within a snake and how the lung functions to assist in the delivery of oxygen." I have to agree with Lillywhite here, but I also have to add that after reading the chapter one can't help but learn things, even if you think you already know everything there is to know about circulation and gas exchange in snakes.

One of the most amazing aspects of snake biology is the way they perceive the environment around them. Snakes are famous for their chemosensory abilities, and some groups of snakes are well-known for their thermal and infrared radiation detection abilities. The chapter on how snakes perceive the world covers those topics in excellent fashion. Even though hearing is less of an obvious pathway for snakes in sensing the environment, the coverage on that is well done here too. When I teach herpetology, I love to talk about snake eyes because of all the novel structures (and of the typical structures that are absent), because it seems fairly well-established that in the evolution of snakes the eyes were radically reduced if not essentially lost.



Title: *How Snakes Work: Structure, Function and Behavior of the World's Snakes*

Author: Harvey B. Lillywhite

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Thus, I was disappointed to see that all those interesting things were not pointed out in the discussion of snake eyes in the book. The illustration of the eye was simplistic and sort of generic. For example, there are no muscles associated with the ciliary body in snake eyes, and the conus, sphincter, and dilatator all have mesodermal origins in snakes, but are ectodermal (!) in lizards. Those are big differences.

Snake vision received the same generic treatment. For example, regarding pupil shape, while it's true that a slit pupil can close more completely than a round pupil, which the author attributes to crepuscular and nocturnal activity, that's not the primary function. There are lots of diurnal snakes with slit pupils. The real function is that all animals with a slit pupil also have a multifocal lens. The slit allows a reduction in light while still allowing all of that light to pass through all peripheral layers of the lens (which have different refractive indices or color filters), rather than just through the lens center. No doubt, almost every aspect of snake vision is poorly known, but what is known is spectacular and its coverage in greater detail would have fit perfectly well with the rest of this excellent book.

Book Review: How Snakes Work

When people think of snakes, how many first think of sound production? Perhaps folks who mainly encounter rattlesnakes during their lives may associate snakes with sounds, but typically snakes are associated with their stealth, with their silence. And that is what makes the chapter on sound so enjoyable. **I want to hear a gopher snake bellow!** I want to hear a cloacal pop or a king cobra growl! Like vision, there is much that is not known about snake sound production and communication, and the author does a nice job bringing up those questions.

The beginning and end of lineages is intimately tied to successful reproduction, and the book closes with a chapter on the subject. It is another very well-done

chapter, with cultural and biological information as well as bits of expert-based speculation included. I greatly suspect that for many non-experts this chapter will hold a number of surprises about snakes, which really, in a nutshell, is what is great about this book. I very much like the encouraging, upbeat style of writing that gets the reader excited about the topics.

I think this is a terrific book for readers with a variety of knowledge levels. I really believe elementary school aged kids can get excited by this book and grow with the book, appreciating it more and more as they learn and progress through school. I also think the book fits well at the university level and would be a welcome addition to any biologist's library, including herpetologists!



Brian I. Crother is the Schlieder Foundation Professor of Biological Sciences and interim Department Head of Computer Sciences at Southeastern Louisiana University in Hammond, Louisiana, USA. Brian earned his B.S. from California State University at Dominguez Hills, his Ph.D. from the University of Miami, Florida, USA, and he conducted post-doctoral research at the University of Texas, Austin. He has well over 100 publications on a broad range of topics, including edited books on *Caribbean Amphibians and Reptiles*, *Ecology and Evolution in the Tropics: A Herpetological Perspective* and *Assumptions that Inhibit Progress in Comparative Biology*. Brian was the chair and coauthor of the 5th through 8th editions of the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. He is active in several professional organizations and is an ex-president of both the *Society for the Study of Amphibians and Reptiles* and the *American Society of Ichthyologists and Herpetologists*. Brian's research interests are broad, but have in common that they cover amphibians, reptiles, and/or evolution (empirical, theoretical, and philosophical).