

BOOK REVIEW

When evo–devo transcends the etiological myth

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How the Snake Lost Its Legs. Curious Tales From the Frontier of Evo–Devo. Lewis I. Held Jr. 2014. Cambridge University Press, Cambridge. 285 pp. ISBN 978–1-107–62139-8 (paperback).

How the Snake Lost its Legs is Lewis Held's second essay approaching the theme of developmental evolution with a focus on natural oddities. His previous opus—*Quirks of Human Anatomy: An Evo-Devo Look at the Human Body*—unraveled the peculiarities and flaws of our own bodies in light of evo–devo research (Held 2009). In *How the Snake Lost its Legs*, Held directly delves into animal diversity to shed light on the remarkable or bizarre features of our metazoan cousins. The main text (156 pages) can be covered in a few hours or left on the coffee table for occasional small bites. The diagrams and color plates used to illustrate the book are eye-candy and potential teaching material. The lifespan of the book is extended by an up-to-date and certainly impressive bibliography of 2526 references. Held's scientific curiosity is sizeable in the breadth of studies included here, infusing the dimensions of a landscape view to his essay. Overall, this format makes the book accessible to any reader interested in evolutionary biology while also satisfying the more expert “evo–devotees” willing to explore the depicted topics in depth.

More than just-so stories

As children, we have all wondered about “the How and the Why” of animal features, and if you are reading this it is in fact quite possible that a similar inquisitiveness still burns within you. The tone of *How the Snake Lost its Legs* finds its roots in the famous *Just So Stories* of Joseph Rudyard Kipling by tickling this curiosity with the formulaic *How the leopard/elephant/camel got its spots/trunk/hump*. Held's ability to captivate the reader's imagination compares to the mischievousness of Kipling's pourquoi stories, but overrides their implicit predicament that singular features of the living world must be the products of equally singular explanations. Indeed, the reader gets to learn about how the cheetah got its spots (if

not the leopard), but is also encouraged to extrapolate from general principles by the constant reminder that animals use a conserved set of developmental genes to construct their bodies. The text also refers to fundamental concepts that are explained in a concise manner in a glossary, and each chapter is punctuated by a few bullet points presented as take-home messages. The essay, thus, works well as a page-turner by reigniting a certain form of child-like fascination within us, and also transcends it by sharpening our thoughts with incisive concepts.

The great evo–devo parade

Chapter 1 is a brief introduction to the metazoan genetic toolkit, with a discussion of Urbilateria, the prototypical last common ancestor of bilaterian animals. Chapters 2 and 3 cover the developmental genetics of some of the remarkable anatomical idiosyncrasies of fruit flies and butterflies. These parts may be a little bit disheartening for some readers, as they include extensive descriptions of genetic regulatory networks, but they also convey basic concepts about the molecular mechanics of morphological evolution (e.g., co-option, selector genes, morphogens). The gene-heavy content of Chapters 1–3 softens in the rest of the book and in Chapter 4, snakes are put on a pedestal with the evolution of derived traits such as their limbless and elongated skeleton and other specialized organs (eyes, tongue, and fangs). Chapter 5, entitled “The Cheetah,” is an original take on the formation of vertebrate pigmentation patterns that benefits from some recent data (e.g., on the formation of fish stripes and feline spotted coat patterns). The spirit of the book is well captured in a longer Chapter 6, “An Evo–Devo Bestiary.” This section functions as a cabinet of Evo–Devo curiosities: it includes 50 alphabetically arranged cameos (from “How the Ant lost its wings” to “How the Zebu got its Dewlap,”), and is according to the author an incomplete compilation of personal favorites in the field. Their treatment is necessarily superficial, but it is a gold mine of discussion starters and inductive reasoning schemes.

Quirks, evolutionary tricks, and other analogies

If you have ever asked your parents about the giraffe's neck, they probably said something about the functionality of this feature, and perhaps brought an externalist explanation based on ultimate causation (e.g., by invoking an environmental variable such as tree height to explain the neck length). The emphasis on the *how* question in the present book naturally implies an internalist treatment of the phenomena at stake, thus giving us the other side of the story. Held's insistence on quirky traits may be more infused in *How the Snake Lost its Leg* than in his earlier book (Held 2009), but crucial nonetheless, because we tend to define as quirky things that would be unsatisfyingly explained by adaptation *alone*. Throughout the pages, the reader is confronted by the existence of structures and mechanisms that are difficult for the human mind to comprehend, because they violate our conceptions of optimality and functionality. The vestigial limbs of some lizards (page 78), the complete twirl of the fruit fly penis (page 40), or the shaping of the swallowtail butterfly wing by tissue removal (page 62) are all striking examples of how evolutionary developmental biology makes sense of the living world by delving into the past. The cases compiled in the book illustrate how evolution works opportunistically with what is accessible at a given moment. In that sense, the empirical orientation taken by Held revives the pre-Evo-Devo era analogy comparing evolution to a tinkerer (Jacob 1977). Of note, the author does not hesitate to use other analogies with manufactured objects to carry its message (e.g., genetic "circuits"; the "flashlight" of the firefly; the "mittens" of the yeti crab), but his combination of casual writing style and emphasis on generative processes avoid the pitfalls of teleological thinking.

Etiological myths revisited

Evo-devo science is inherently colorful and well placed to fulfill the dual goal of etiological myths: explaining origins and causes while also stirring imagination and awe. Overall, the latest opus by Lewis Held Jr. fits that niche nicely, and shines by its ability to span essential concepts and empirical work with enough rhetoric punch. It is accessible to most readers with a light background in biology, and also a good side tool for the teacher of evolutionary developmental biology, although not an ideal primary reading for the classroom (unlike the previous "Quirks of Human Anatomy," which I recommend for this endeavor). Its originality also makes it a worthy addition to the bookshelf of contributors to the evo-devo field, but they should be warned that some sections contain high levels of extrapolation and speculation. For this erudite audience, Held's book should best work as a generator of hypotheses and bibliographic resource, and it often acknowledges its unsolved mysteries, perhaps with the ambition to stimulate future work. Kipling published the "Just So Stories" in 1902, 20 years after Charles Darwin passed away, and corresponded with Alfred Russell Wallace between 1897 and 1907 (Wallace Letters Online, URL: <http://wallaceletters.info>). The three British men would be thrilled by the ongoing progresses made in evo-devo, and we can hope this book will stimulate the next generations of researchers to decipher more evolutionary tricks and quirky traits.

REFERENCES

- Held, L. I., Jr. 2009. *Quirks of Human Anatomy: An Evo-devo Look at the Human Body*. Cambridge University Press, New York, NY.
 Jacob, F. 1977. Evolution and tinkering. *Science* 196: 1161–1166.