

BOOK REVIEW

Endless brains most beautiful: a review of *Arthropod Brains: Evolution, Functional Elegance, and Historical Significance*

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Arthropod Brains: Evolution, Functional Elegance, and Historical Significance, Nicholas James Strausfeld, 2012. The Belknap Press of Harvard University Press, Cambridge, MA. 830 pp. ISBN 978-0-674-04633-7 (alk. paper)

They have a brain? This is not an uncommon response I get when I talk about insect behavior and development, not just from children. I then explain that—yes of course they have a brain, all arthropods do, and those brains are remarkably beautiful, and allow arthropods to do some remarkable things—and if my audience lets me we are off to the lands of metamorphosis, learning, sensory integration, the honey bee dance, etc. In his *magnum opus*, Nicholas Strausfeld takes his readers on a much greater journey, in fact along multiple journeys, through morphological space, evolutionary time, and the history of science, all centered around the biology and study of arthropod brains and what they tell us about the nature of innovation in the natural world.

Arthropod Brains: Evolution, Functional Elegance, and Historical Significance is a massive accomplishment, and a massive book. With 830 pages, 224 of which are notes and references, and with countless full-page color plates it weighs in at a hefty 2.9 kg. But that's ok, because it is really several books in one. For example, it is, over its first three chapters, a book about the history of microscopy as applied to the study of arthropods. Here one learns that modest technology does not preclude deep insights into the relationships between form, function, and evolution if combined with creative thinking and thorough analysis. Those chapters also present a history of the beginnings of the science of arthropod brains and a history of the lives of its major early contributors. Chapters 4–7 then present a beautifully illustrated textbook on arthropod neuroanatomy, focusing on, respectively, vision, olfaction, the mushroom body and “the brain within the brain,” the central body. Throughout these chapters Strausfeld relates historic to recent insights, and what is perhaps most valuable, synthesizes what is known well beyond the most widely used model species to as much of arthropod diversity as he can get a hold of. Chapter 8

then focuses on arachnids and myriapods, whereas chapter 9 explores the origin and diversification of the arthropod CNS, presenting some more and some less-familiar views on the origin of the arthropod brain and head as well as their relationships to their respective annelid counterparts. This chapter is especially important as the origin and diversification of the arthropod head easily ranks among the most passionately argued fields in comparative morphology, and one that evolutionary developmental genetics has much to contribute to. Strausfeld in many ways provides a comparative neuroanatomical canvas onto which these contributions can be sorted and integrated by future studies. The remaining chapters then return at least in part to a historic narrative. Chapter 10 speculates on the relationships between the brains of arthropods and those of chordates, whereas chapters 11 and 12 explore what we may learn from relating the brains of insects and those of crustaceans. Strausfeld especially highlights crustaceans in these as well as earlier chapters because they have so much more to offer to those interested in arthropod brain evolution than has been utilized thus far, and because his studies and synthesis cause him to argue for a malacostracan origin of the hexapods, a view not completely in line, but also not completely off from the most recent large-scale phylogenetic studies (Regier et al. 2010).

Last but not least *Arthropod Brains* is also an autobiography of one of its major contemporary contributors. We learn about Strausfeld's youth and upbringing as the son of German immigrants in postwar England where he worked as a steelworker in the summers, and his love for Reibekuchen, a distinctly German specialty, and one that may have followed him from one country to the next. These autobiographical notes are not organized but instead sprinkled throughout, making for unexpected discoveries as one turns the pages.

What this book is *not* though, is one about development, and neither is it really a book about the evo-devo of brains. Instead it is mostly about adult brains and heads and bodies across evolutionary time. Apart from a modest (though

critical) amount of developmental genetic observations in chapter 9 there is no deep coverage of how brains develop, form and differentiate during ontogeny, and Strausfeld stays away from incorporating the rapidly growing amount of data from comparative gene expression studies, an area he admits lies beyond his field of expertise. But that is ok, because it is not what Strausfeld set out to do with this book. Instead, he has provided us with the to date most comprehensive synthesis on the comparative morphology and neuroanatomy of arthropod brains, a framework onto which the next generation of arthropod enthusiasts can now add developmental and development-genetic insights, and which collectively will

enable a powerful examination of the relationships between genotype, developmental mechanisms, and phenotypic complexity through developmental and evolutionary time. This book deserves to be not just on the book shelves, but to be read, by anyone interested in arthropod evolution and evo-devo.

REFERENCE

Regier, J. C., et al. 2010. Arthropod relationships revealed by phylogenomic analysis of nuclear protein-coding sequences. *Nature* 463: 1079–1082.