However, it is clear that we generally underappreciate the intelligence of many animal species besides primates and birds, including corvids may not be so different from many other nonprimate species.

Overall, this volume is well suited for the general public as it provides a comprehensive description of research in avian cognition in a very accessible way. On the other hand, brevity and accessibility of information seem to have prevented in-depth discussion of important issues, which makes the book of less value to specialists in animal cognition.

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STRUCTURE AND EVOLUTION OF INVERTEBRATE NERVOUS SYSTEMS.

Edited by Andreas Schmidt-Rhaesa, Steffen Harzsch, and Günter Purschke. Oxford and New York: Oxford University Press. $250.00. xi + 748 p.; ill.; index. ISBN: 978-0-19-968220-1. 2016.

Invertebrate biologists late in their career (the graybeards among us) will remember "growing up" with Ted Bullock and Adrian Horridge's time-honored 1965 compendium, *Structure and Function in the Nervous Systems of Invertebrates* (San Francisco (CA): W. H. Freeman and Company). It was the standard reference we all turned to for answers in a field with an otherwise highly scattered literature. That book, and a German-language text by Hanström (1928. *Vergleichende Anatomie des Nervensystems der wirbellosen Tiere unter Berücksichtigung seiner Funktion.* Berlin (Germany): Julius Springer), were the starting place for what eventually grew into a broad field of neurological research on squids, *Drosophila*, and numerous other model invertebrates (neither book shows up in a search on Amazon.com today). Bullock and Horridge included ultrastructural observations, but their book was pre-TEM (transmission electron microscopy), and well before modern immunohistochemistry and confocal laser scanning microscopy techniques. As the years passed, no other treatises like those appeared, and students were still forced to scour the literature to assemble their own synthesis of neural systems across the animal kingdom. Techniques have expanded dramatically since the 1960s, and new information has proliferated. Thus it is timely and exciting that Schmidt-Rhaesa et al. have stepped up to the plate to produce an important new compendium on comparative invertebrate neuroanatomy.

In addition to new observational techniques, we now have a phylogenetic framework that is far more refined than just 20 years ago, allowing researchers to approximate the evolution of neuronal systems and structures among the Metazoa. Furthermore, gene expression studies allow us to identify specific cell types and track their evolutionary history within nervous systems across major clades. In fact, homologues of genes known to be essential for neurons to develop and function have now been found in animal phyla that do not even possess neurons (sponges and placozoans). This new work has revealed some unanticipated patterns, such as the possibility that, in both arthropods and vertebrates, formation of the nervous system is by way of neural stem cells—a method of neural patterning that may have evolved independently in the two groups (see Chapter 40, by Stollewerk). Also touched on in this volume is the recent discovery that neurogenesis is not confined to early developmental stages as long thought. In fact, Sandeman et al. (Chapter 41) argue that neurogenesis may be a standard feature of the adult decapod brain, rather than a process confined to early developmental stages, and that the immune system might be an important source of neural precursors underlying adult neurogenesis in animal brains.

The three editors, each highly respected in their own right, wisely chose to invite authorities to author chapters on their specialty groups. These "taxon chapters" are the meat of the volume. Interestingly, 57 (73%) of the contributors are from Europe (44% from Germany) and Russia, reflecting the long and distinguished tradition of detailed comparative anatomy in those scientific cultures—a discipline that, sadly, has greatly diminished among North American zoologists.

This book contains 55 chapters, by 78 authors. The detailed, taxon-by-taxon chapters are enhanced by a dozen shorter ones, on perspectives and research spotlights, including one by Horridge himself (obliquely titled, How to Write an Invertebrate Anatomy Book, but actually being the short story of how he met Bullock and decided to coauthor their book). Other perspective chapters touch on the evolution of neural cell types, a view of how the first "brain" might have evolved, testing the "primary larva" hypothesis by way of the neuronal perspective, seven perspective chapters treat the perennially debated phylum Arthropoda, and a closing perspective chapter discusses the origin of vertebrate neural organization. Although the taxon-based comparative neuroanatomy chapters offer deep fodder for the discipline, these shorter "opinion pieces" are excellent (and fun) reading that will be enlightening for biologists of all stripes.

One of the well-written and useful perspective chapters is by Richter et al. treating the concept of the "primary larvae." Many writers have mentioned this elusive idea, often ambiguously, over the past 50 years. Richter et al. take us to the roots of the concept—as proposed by Gösta Jägersten in *Evolution of the Metazoan Life Cycle: A Comprehensive Theory*

(1972. New York: Academic Press)—noting that Jägersten used it as a genealogical concept, rather than referring to any particular suite of specific morphological characters. By Jägersten's view, trochophores, dipleurulas, tornarias, cyphonautes, actinotrochs, pilidiums, and even the veliger larva (probably derived from a trochophore) all constitute "primary larvae," although likely not the crustacean nauplius larva. That is, they can all be phylogenetically traced back to an ancient larva already present in the common ancestor of all Bilateria. The early larval stage in echinoderm development, the bilateral dipleurula, and the tornaria of enteropneusts are so similar that they are often subsumed under the moniker "dipleurula-type larvae." This similarity was one of the main reasons that Grobben (1908. *Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien* 58:491-511) united Echinodermata and Hemichordata as the Ambulacraria, a phylogenetic hypothesis that is now supported by modern molecular studies. On the basis of comparative neuroanatomy of primary larvae, Richter et al. propose ancestral larval morphologies for the major clades within Bilateria. Regarding the important (but rarely mentioned) apical organ of metazoan larvae, Richter et al. note that it is not only present in the two principal bilaterian clades (protostomes and deuterostomes), but also in cnidarian planula larvae, suggesting this sensory structure, and perhaps the primary larva itself, predates the last common ancestor of the Bilateria.

It was heartening to see a chapter on sponges (Porifera)—one of the two animal phyla lacking a structural nervous system altogether. Sponges may not have nerves, but they possess genes that suggest they have the potential to carry out synaptic-like signaling (probably in ways we do not yet understand). And they certainly sense and respond to their environment. And it is also encouraging to see the latest phylum to be recognized and named, Xenacoelomorpha (Acoelomorpha and *Xenoturbella*—neither protostomes nor deuterostomes by most reckoning) treated independently from the Platyhelminthes, allowing for clear comparisons among the groups.

This text also gives a great deal of attention to brains—those prominent anterior condensations of neurons that receive input from sense organs and send motor output to somatic effectors in the body via nerve cords. As Wolff and Strausfeld note, "No consideration of the [insect] brain can escape its ancestry" (p. 597). In this book, brains are dissected in detail, both anatomically and phylogenetically. The question of whether brains, and the CNS (central nervous system) in general, had one or multiple evolutionary origins is touched upon by several authors. The overall consensus seems to be that they evolved only once, although the controversial idea that Ctenophora are the oldest living phylum (which might argue for the CNS not being monophyletic) is briefly broached a few times, but see Jékely et al. (2015. *EvoDevo* 6:1) and Pisani et al. (2015. *Proceedings of the National Academy of Sciences of the United States of America* 112:15402–15407) for contrary views. Also, the evolutionary derivation of the unique brain of the putative clade known as Cycloneuralia (phyla Nematoda, Nematomorpha, Priapulida, Kinorhyncha, Loricifera) remains a bit of a mystery.

This new compendium does not treat animal nervous systems in the detail that Hanström or Bullock and Horridge attempted, but that would be impossible in a single volume today. Sensory structures, for example, are touched on only superficially. Chapter lengths vary greatly, from just four pages (Gnathostomulida) to 58 (basal Annelida), but I do not find this problematic in any way. And the editors note that they have given more space to groups having not enjoyed any recent published summaries. The index is weak, a common problem with today's science publishers it seems.

Overall, this is an important, up-to-date, and highly useful summary of comparative neuroanatomy among the invertebrates, by 78 of the world's top neuroanatomists. How I wish this book had been available while writing my own invertebrate textbooks (e.g., Brusca et al. 2016. *Invertebrates*. Third Edition. Sunderland (MA): Sinauer Associates). The volume by Schmidt-Rhaesa et al. belongs in every invertebrate zoologist's library. It will stand the test of time.

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Language in Mind: An Introduction to Psycholinguistics.

By Julie Sedivy. Sunderland (Massachusetts): Sinauer Associates. $119.95. xv + 558 p.; ill.; author and subject indexes. ISBN: 978-0-87893-598-7. [A companion website is available.] 2014.

This is an introductory textbook on psycholinguistics for students with no prior background in linguistics or psycholinguistics. One of the primary goals of a psycholinguistics textbook is to help students understand fascinating cognitive processes that make it possible for us to use language in daily life seemingly without much effort. This commonly involves introducing students to scientific ways of thinking about human language and familiarizing them with a range of theories and methodologies in psycholinguistics. This can, however, be challenging because students often have a variety